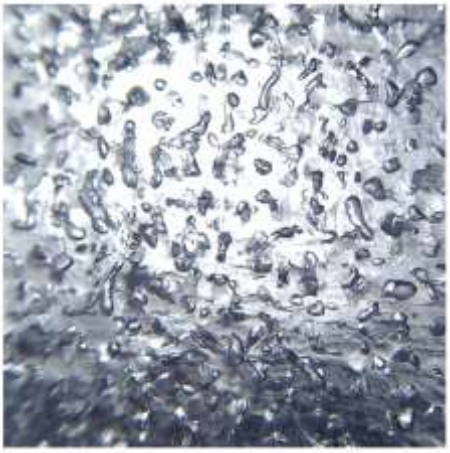

IPICS 2016
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Abstract

Dr Tyler Robert Jones

Submission ID	1
Name:	Dr Tyler Robert Jones
Institution:	Institute of Arctic and Alpine Research, University of Colorado at Boulder
Country:	United States
Presentation Title:	A connection between Laurentide ice sheet topography, the El Niño-Southern Oscillation, and West Antarctic climate
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ABSTRACT

Ultra-high resolution water isotope measurements (δD and $\delta^{18}O$) from the WAIS Divide Ice Core (WDC) have been analyzed using a continuous flow system to ~60 ka bp. Frequency analysis of the water isotope signal shows 1-year spectral power persists until about ~15 ka bp, while signals at 4 years and greater are preserved throughout the entire record. At this level of resolution, a diffusion correction must be applied because high-frequency water isotope signals are attenuated mainly in the firn (but also in deep ice). We quantify diffusion over a 500-year sliding window to obtain an estimate of original power spectra at the time of deposition, and then determine the amplitude of high-frequency signals to ~30 ka bp (the extent of the annually dated chronology). We observe that the amplitude of the annual signal varies with maximum insolation at 60°S, while the 2-15 year signal is elevated in the glacial, decreases at ~16 ka bp until ~10-11 ka bp, and maintains a constant minimum throughout the rest of the Holocene. While the annual (1-year) signal primarily represents seasonal temperature variations, the interannual variations reflect regional atmospheric circulation variability associated with the El Niño-Southern Oscillation (ENSO) and intrinsic atmospheric dynamics. It should be noted that the strength of the 2-15 year signal is not strongly dependent on the diffusion calculations - indeed, the amount of diffusion to be corrected for only amplifies differences in the magnitude of interannual variability between Glacial and Holocene. Results from general circulation model experiments with $HadCM^3$ (courtesy of William Roberts and Paul Valdes, Bristol) suggest changes in the strength of the 2-15 year

signal we observe at WAIS Divide reflect either changes in the strength of the ENSO teleconnection to West Antarctica, changes in the strength of ENSO, or both. The timing of the 16 ka bp decline in signal amplitude is likely related to a change in the climate of the Western Tropical Pacific, which is also seen to change at this time in a central Indonesian lake sediment core. Model results show that this change in the tropical Pacific climate is related to the size of the Laurentide Ice Sheet (LIS), suggesting that the tropics provide a link between the size of the LIS and climate in West Antarctica.

Abstract

Dr Frédéric Parrenin

Submission ID	2
Name:	Dr Frédéric Parrenin
Institution:	LGGE (CNRS/UJF)
Country:	FRANCE
Presentation Title:	Is there 1 million-year old ice near Dome C, Antarctica?
Full Author List:	F. Parrenin1,2, D. D. Blankenship3, M. G. P. Cavitte3, J. Chappellaz1,2, H. Fischer4, O. Gagliardini1,2, F. Gillet-Chaulet1,2, V. Masson-Delmotte5, O. Passalacqua1,2, C. Ritz1,2, M. J. Siegert6, D. A. Young3
Author Affiliations:	[1]{CNRS, LGGE, F-38000 Grenoble, France} [2]{Univ. Grenoble Alpes, LGGE, F-38000 Grenoble, France} [3]{University of Texas John A. and Katherine G. Jackson School of Geosciences, Institute for Geophysics (UTIG), Austin, USA} [4]{Climate and Environmental Physics, Physics Institute, University of Bern, Bern} [5]{Laboratoire des Sciences du Climat et de l'Environnement, UMR8212 (CEA-CNRS-UVSQ/IPSL), Gif-Sur-Yvette, France} [6]{Grantham Institute, and Department of Earth Science and Engineering, Imperial College, London, UK}

ABSTRACT

Ice sheets provide exceptional archives of past changes in polar climate, regional environment and global atmospheric composition. The oldest deep ice drilled in Antarctica has been retrieved at EPICA Dome C (Antarctica), reaching 800,000 years. Retrieving an older paleoclimatic record from Antarctica is one of the biggest challenges of the ice core community (Jouzel and Masson-Delmotte, 2010). Here, we use a combination of internal layers identified with airborne radar and ice-flow modeling to estimate the age of basal ice along two transects across the Dome C summit. Based on the age of the bottom ic eat EDC, we find a geothermal heat flux of 66.8 mW/m^2. Assuming the same geothermal heat flux all along both transects, we identify a region located only ~40 km from the dome on a bedrock relief where the estimated basal melting is small or inexistant. As a result, basal age is estimated to be >1,500,000 years. However, this oldest ice hot spot disappears if the geothermal heat flux is only 5 mW/m^2 higher than at EDC. Our work also demonstrates the utility of combining radar layering with ice flow modelling to accurately represent the true nature of ice flow in the center of large ice sheets.

Abstract

Frédéric Parrenin

Submission ID	3
Name:	Frédéric Parrenin
Institution:	LGGE (CNRS/UJF)
Country:	FRANCE
Presentation Title:	IceChrono1: a probabilistic model to compute a common and optimal chronology for several ice cores
Full Author List:	F. Parrenin 1,2 , L. Bazin 3 , E. Capron 4 , A. Landais 3 , B. Lemieux-Dudon 5 , and V. Masson-Delmotte 3
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ABSTRACT

Polar ice cores provide exceptional archives of past environmental conditions. The dating of ice cores and the estimation of the age-scale uncertainty are essential to interpret the climate and environmental records that they contain. It is, however, a complex problem which involves different methods. Here, we present IceChrono1, a new probabilistic model integrating various sources of chronological information to produce a common and optimized chronology for several ice cores, as well as its uncertainty. IceChrono1 is based on the inversion of three quantities: the surface accumulation rate, the lock-in depth (LID) of air bubbles and the thinning function. The chronological information integrated into the model are models of the sedimentation process (accumulation of snow, densification of snow into ice and air trapping, ice flow), ice- and air-dated horizons, ice and air depth intervals with known durations, 1depth observations (depth shift between synchronous events recorded in the ice and in the air) and finally air and ice stratigraphic links in between ice cores. The optimization is formulated as a least squares problem, implying that all densities of probabilities are assumed to be Gaussian. It is numerically solved using the Levenberg–Marquardt algorithm and a numerical evaluation of the model's Jacobian. IceChrono follows an approach similar to that of the Datice model which was recently used to produce the AICC2012 (Antarctic ice core chronology) for four Antarctic ice cores and one Greenland ice core. IceChrono1 provides improvements and simplifications with respect to Datice from the mathematical, numerical and programming point of views. The capabilities of IceChrono1 are demonstrated on a case study similar to the AICC2012 dating experiment. We find results similar to those of Datice, within a few centuries, which is a confirmation of

both IceChrono1 and Datice codes. We also test new functionalities with respect to the original version of Datice: observations as ice intervals with known durations, correlated observations, observations as air intervals with known durations and observations as mixed ice–air stratigraphic links. IceChrono1 is freely available under the General Public License v3 open source license.

Abstract

Prof. Pavel Talalay

Submission ID	4
Name:	Prof. Pavel Talalay
Institution:	Polar Research Center, Jilin University
Country:	China
Presentation Title:	Temperature distribution of the normal drilling fluid circulation in deep ice boreholes and its influence on drilling technology
Full Author List:	P. Talalay1, O. Alemany2,3
Author Affiliations:	1Polar Research Center, Jilin University, Changchun, China 2CNRS, LGGE, Grenoble, France 3Université Grenoble Alpes, LGGE, Grenoble, France

ABSTRACT

Temperature of the normal drilling fluid circulation in deep ice boreholes greatly varies with depth. A temperature change of the drilling fluid flow in the downward flow occurs as a result of heat exchange with the flow rising in annular, the temperature of which is effected by heat exchange with the surrounding ice. The temperature change of the drilling fluid is also associated with the cooling of the drill head and the generation of heat due to the hydraulic friction of the drilling fluid. Predictions of temperature distribution of the normal drilling fluid circulation was made for 3000 m deep borehole drilled in the region of Dome C (temperature at 10 m depth is 54.5 °C) with initial temperature of –30 °C. At first, temperature of the drilling fluid decreases due to heat exchange with upward cold flow to the minimal temperature of –48.5 °C at the depth of 500 m, but then temperature begins to increase. Deeper than 2600 m, the drilling fluid temperature is above zero. When the drilling fluid reaches drill bit, the temperature attains 7.1 °C. The positive temperature in the upward flow can adversely effect on the borehole wall by melting them. In the upper part of the borehole temperature of the drilling fluid decreases due to cooling by surrounding ice. If the upward flow brings melted water, it would eventually be frozen and can cause a problem. This phenomenon should be taken into consideration in the drilling operations with normal drilling fluid circulation.

Abstract

Chiara Uglietti

Submission ID	6
Name:	Chiara Uglietti
Institution:	Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institute, Villigen, 5232, Switzerland
Country:	Switzerland
Presentation Title:	The debate on the basal age of Kilimanjaro's plateau glaciers
Full Author List:	C. Uglietti1,2,3, A. Zapf1,2,3†, T. Jenk1,2,3, S. Szidat1,2,3, G. Salazar[2], D.R. Hardy4, M. Schwikowski1,2,3
Author Affiliations:	1 Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institute, Villigen, 5232, Switzerland 2 Department of Chemistry and Biochemistry, University of Bern, Switzerland 3 Oeschger Center for Climate Research, University of Bern, Switzerland 4 Department of Geosciences, University of Massachusetts, Amherst, MA 01003, USA † Deceased

ABSTRACT

Radiocarbon dating is a powerful tool when the annual layers counting in the lowermost segments of high altitude ice cores is constrained by ice flow-induced thinning limits, but the organic material amount in the ice can be a limiting factor. We present a radiocarbon dating approach using carbonaceous aerosols enclosed in the ice to help resolve the controversy about the age of the Kilimanjaro's plateau glaciers. Paleoclimate reconstructions based on six ice cores drilled in 2000 assigned a basal age of 11,700 years. A recent study claims recurring cycles of waxing and waning controlled primarily by atmospheric moisture and an absence of the ice bodies was suggested for 1200 AD. Solving the dispute of the interval for the extinction of the Kilimanjaro ice might have implications for the understanding of the climate variability in the tropics.

A stratigraphic sequence of 45 horizontal short cores was collected in 2011 from the exposed vertical ice cliffs at the margins of the Northern Ice Field (NIF). The insoluble carbonaceous particles were filtrated and combusted by means of a thermo-optical OC/EC analyser and ^{14}C was analysed using the compact radiocarbon AMS system 'MICADAS'. The results of ^{14}C calibrated ages span between modern ages at the surface to 1200 AD at the bottom, thus supporting the hypothesis that the ice on Kilimanjaro's plateau has come and gone recurrently throughout the Holocene. It is possible that the cores collected further from the margin of the NIF contained older, relict ice, implying hiatuses, and a non-continuous record.

Abstract

Prof. Dr. Margit Schwikowski

Submission ID	9
Name:	Prof. Dr. Margit Schwikowski
Institution:	Paul Scherrer Institut
Country:	Switzerland
Presentation Title:	Filling the gap of millennial temperature reconstructions for Siberia
Full Author List:	M. Schwikowski1,2,3, P.-A. Herren1,2,3 A. Eichler1,3 T. Papina4
Author Affiliations:	1Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institut, Villigen, Switzerland 2Department of Chemistry and Biochemistry, University of Bern, Bern, Switzerland 3Oeschger Centre for Climate Research, University of Bern, Bern, Switzerland 4Institute for Water and Environmental Problems, Barnaul, Russia

ABSTRACT

Current climate change has strong regional patterns. To investigate the spatial-temporal differences, regionally resolved paleoclimate records are required. Here we reconstructed temperatures in Siberia for the past 3,200 years based on concentration records of the biogenic species ammonium and formate measured in an ice core from Tsambagarav ice cap in the Mongolian Altai. Previous studies showed a positive link between emission rates of various biogenic species and temperature for different regions of the globe, including ice core studies from the Andes, Himalaya and Altai (Kellerhals et al., 2010; Eichler et al., 2009; Kang et al., 2002). Air masses reaching the Tsambagarav ice cap mainly originate from the northwest. During transport over the Siberian taiga belt they collect biogenic emissions. The novel ice-core based temperature record together with two tree-ring chronologies from locations north and south of the ice core site, suggest elevated temperature at the start of the Current Era (CE) 2,000 years ago. This time period is known for its positive temperature anomaly in Europe (Roman Warm Period, RWP). We argue that Siberia also experienced a pronounced RWP. The agreement with other Asian records indicates a wide-spread continental occurrence. The rapid transition to colder climate is consistent with the Migration period. On a long-term perspective (100 years) current temperatures in Siberia are at least as warm as any time during the past 3,200 years.

Eichler, A., Tinner, W., Brütsch, S., Olivier, S., Papina, T., Schwikowski, M., 2011, An ice-core based history of Siberian forest fires since AD 1250, Quaternary Science Reviews 30 (9–10), 1027–1034.
Kang, S., Mayewski, P. A., Qin, D., Yan, Y., Zhang, D., Hou, S., Ren, J., 2002, Twentieth century increase of atmospheric ammonia recorded in Mount Everest ice core, Journal of Geophysical Research 107 (D21), 4595.
Kellerhals, T., Brütsch, S., Sigl, M., Knüsel, S., Gäggeler, H., Schwikowski, M., 2010, Ammonium concentration in ice cores: A new proxy for regional temperature reconstruction? Journal of Geophysical Research 115 (D16), D16123.

Abstract

Reserch Professor Kendrick Taylor

Submission ID	11
Name:	Reserch Professor Kendrick Taylor
Institution:	Desert Research Institute
Country:	USA
Presentation Title:	The SPICE and WAIS Divide ice core projects
Full Author List:	Murat Aydin1 Kendrick Taylor 2
Author Affiliations:	1 University of California, Irvine; Irvine, California, U.S.A 2 Desert Research Institute, Nevada System of Higher Education; Reno, Nevada, U.S.A

ABSTRACT

The U.S.A is conducting several Antarctic ice coring projects. The South Pole ice core (SPICE) is an intermediate depth project that primarily aims to recover atmospheric records of ultra-trace level gases and a record of the South Pole climate for the last 40 ka. The cold temperatures and the low-impurity ice make South Pole an ideal spot for trace gas analysis. The SPICE drilling reached 736 m during the first field season and is expected to reach 1500 m when completed in 2016/2017. The non-brittle ice from the first season (top 580 m) has been transported back and the top 556 m have already been dated using visual and volcanic stratigraphy. The WAIS Divide project was designed to collect a high time resolution record of greenhouse gases and climate proxies spanning the last 68 kya. A location on the ice divide in West Antarctica was selected because of thick annual layers and simple ice flow. The last of the borehole logging is planned for the 2016/2017 season. The timescale for the top 28 kya is biased on annual layer counting and has greatly improved the accuracy of Antarctic ice core dating. The low gas age-ice age difference has enabled a more detailed comparison of gas and climate records than previously possible, as well as a better comparison of the timing of climate changes between the polar regions. The highly resolved greenhouse gas records have provided a more detailed view of features previously observed in other cores.

Abstract

Michael Sigl

Submission ID	12
Name:	Michael Sigl
Institution:	Paul Scherrer Institut
Country:	Switzerland
Presentation Title:	Alpine ice-core based black carbon record suggests that the end of the “Little Ice Age” in Europe was unlikely forced by industrialization
Full Author List:	M. Sigl1,2, D. Osmont1,2, J. Gabrieli3, C. Barbante3, S. Nussbaumer4, M. Schwikowski1,2,
Author Affiliations:	1 Paul Scherrer Institut, Villigen, Switzerland 2 Oeschger Centre for Climate Change Research, University of Bern, Switzerland 3 University Ca’Foscari, Venice, Italy 4 Department of Geography, University of Zurich, Switzerland

ABSTRACT

Light absorbing aerosols in the atmosphere and cryosphere play an important role in the climate system. Their presence in ambient air and snow changes radiative properties of these media, thus contributing to increased atmospheric warming and snowmelt. High spatio-temporal variability of aerosol concentrations and a shortage of long-term observations contribute to large uncertainties in properly assigning the climate effects of aerosols through time.

Glaciers in the European Alps began to retreat abruptly from their mid-19th century maximum, marking what appeared to be the end of the Little Ice Age. Radiative forcing by increasing deposition of industrial black carbon to snow has been suggested as the main driver of the abrupt glacier retreats in the Alps. Basis for this hypothesis were model simulations using elemental carbon concentrations at low temporal resolution from two ice cores in the Alps.

Here we present sub-annually resolved, well-replicated concentration records of refractory black carbon (rBC; using a SP2 soot photometer), mineral dust (Fe, Ca), biomass burning (NH_4, K) and distinctive industrial pollution tracers (Bi, Pb, SO_4) from Colle Gnifetti ice core in the Alps covering the past 250 years. The well-dated records allow to precisely compare the timing of observed acceleration of glacier melt in the mid-19th century with that of the increase of soot deposition on the glacier caused by the industrialization of Western Europe. Our study suggests that at the time when European rBC emission rates started to significantly increase the majority of Alpine glaciers had already experienced more than 70%

of their total 19th century length reduction. Industrial BC emissions can therefore not been considered as the primary forcing of the rapid deglaciation at the end of the Little Ice Age in the Alps.

Abstract

Michael Sigl

Submission ID	13
Name:	Michael Sigl
Institution:	Paul Scherrer Institut
Country:	Switzerland
Presentation Title:	Volcanic eruptions, climatic impact and human susceptibility – Case studies through space and time
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ABSTRACT

Radiative forcing resulting from stratospheric aerosols produced by major volcanic eruptions is a dominant driver of climate variability in the Earth's past. Accurate knowledge of the climate anomalies resulting from volcanic eruptions provides important information for understanding the global and regional responses of the Earth system to external forcing agents, including anthropogenic greenhouse gases. It also offers the opportunity to improve our understanding of the relationship between climate and society, using abrupt volcanically-triggered climatic shocks as test-cases of societal impact and response.

A new PAGES Working Group "Volcanic Impacts on Climate and Society (VICS)" to foster interdisciplinary activities towards better understanding of the impacts of volcanic forcing on climate and societies with annual workshops will be supported by PAGES. The first phase (2016-2018) will focus mainly on the Common Era, while the second phase (2019-2021) will extend the focus also to longer timescales. This open community effort invites active contributions from multiple research disciplines including the ice-core community.

Ice cores will play an important role: Volcanic signals in ice cores are an invaluable tool in estimating the timing and magnitude of the forcing, producing chronologies – most notably for dating and matching between different ice cores — but also for synchronizing ice core

and tree-ring chronologies. Cryptotephra analysis provides information on the volcanic source and sulfur-isotopes capture information on the pathway of the sulfate prior to deposition on the ice sheets. Ice cores further contain valuable information on the response of different climate parameters (e.g., temperature, ENSO, sea-ice) to volcanic forcing. On the basis of selected case studies we will demonstrate the climatic response and feedbacks as well as societal impact to large radiative perturbations caused by explosive volcanic eruptions. We use various proxy records and model simulations and demonstrate the potential and limitations of these datasets to advance our understanding of the volcanic influence on climate and societies.

Abstract

Christo Buizert

Submission ID	14
Name:	Christo Buizert
Institution:	College of Earth, Ocean, and Atmospheric Sciences, Oregon State University
Country:	USA
Presentation Title:	Northern and Southern Hemisphere controls on the Dansgaard-Oeschger cycle
Full Author List:	C. Buizert1, E.J. Brook1, D. Baggenstos2, K.M. Cuffey3, T.J. Fudge4, B.R. Markle4, J.R. McConnell5, R.H. Rhodes1, A. Schmittner1, J.P. Severinghaus2, T. Sowers6, E.J. Steig4, K.C. Taylor5 and WAIS Divide Project Members
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ABSTRACT

Glacial periods exhibit abrupt Dansgaard-Oeschger (DO) climatic oscillations that are thought to be linked to instabilities in the Atlantic meridional overturning circulation (AMOC). Great uncertainty remains regarding the dynamics of the DO cycle, as well as controls on the timing and duration of the events.

First, we briefly review recent observations from the high-accumulation WAIS Divide core, showing that, on average, abrupt Greenland DO warming leads the corresponding Antarctic cooling onset by 218 ± 92 years; Greenland cooling leads Antarctic warming by 208 ± 96 years. This result is consistent with a northern hemisphere (NH) origin of DO events, and suggests a propagation of the climatic signal to the Southern Hemisphere (SH) high-latitudes by oceanic rather than atmospheric processes.

Second, we show that the duration of the NH interstadial phase is strongly correlated with Antarctic climate (r=0.92), and presumably with Southern Ocean (SO) temperatures and the

position of the SH westerlies. We propose that SH (high-latitude) climate is an important control on AMOC stability and DO interstadial duration, and discuss four mechanisms through which SH climate can exert such control – the rate of AABW formation, meridional density gradients in the surface ocean, Agulhas Leakage and SO upwelling . We support our hypothesis using climate model experiments in which warming the SO and/or strengthening the SH westerlies results in a more vigorous AMOC that is less susceptible to perturbations – allowing the interstadial AMOC mode to persist longer.

Together, these observations suggest a rich interplay of hemispheric controls on the DO-cycle.

Abstract

Dr Elizabeth R Thomas

Submission ID	15
Name:	Dr Elizabeth R Thomas
Institution:	British Antarctic Survey
Country:	UK
Presentation Title:	A new proxy for reconstructing past wind strength in the Amundsen Sea
Full Author List:	E.R. Thomas, C.S. Allen, R.A. Warren, H.J. Blagbrough, E.C. Ludlow
Author Affiliations:	British Antarctic Survey, Cambridge, UK

ABSTRACT

Winds in the Southern Ocean drive exchanges of heat and carbon dioxide between the ocean and atmosphere, and also explain the dominant patterns of both basal and surface melting and the collapse of Antarctic ice shelves in the Amundsen and Bellingshausen Seas. However, long records of past wind strength and atmospheric circulation are needed to assess the significance of these recent changes. Here we present a novel proxy for past wind strength in the Amundsen-Bellingshausen Sea, based on diatoms entrained in ice cores. The diatom abundance, species assemblages and total particulate content vary from year to year and are believed to be related to the local/regional wind strength and circulation patterns that influence the onshore northerly winds. We present data from two ice cores drilled in the southern Antarctic Peninsula and Ellsworth Land to investigate past wind strength and circulation over the past 300 years.

Abstract

Dr Elizabeth R Thomas

Submission ID	16
Name:	Dr Elizabeth R Thomas
Institution:	British Antarctic Survey
Country:	UK
Presentation Title:	Twentieth century increase in snowfall in coastal West Antarctica
Full Author List:	E.R. Thomas, J.S. Hosking, R.R. Tuckwell, R.A. Warren, E.C. Ludlow
Author Affiliations:	British Antarctic Survey, Cambridge, UK

ABSTRACT

The Amundsen Sea sector of the West Antarctic ice sheet has been losing mass in recent decades, however long records of snowfall are needed to place the recent changes in context. Here we present 300-year records of snowfall from two ice cores drilled in Ellsworth Land, West Antarctica. The records show a dramatic increase in snowfall during the 20th century, linked to a deepening of the Amundsen Sea Low (ASL), tropical sea surface temperatures and large-scale atmospheric circulation. The observed increase in snowfall and inter-annual variability during the late 20th century is unprecedented in the context of the past 300 years and evidence that the predicted deepening of the ASL, in response to greenhouse gas forcing, is already happening.

Abstract

Dr. Daniela Festi

Submission ID	17
Name:	Dr. Daniela Festi
Institution:	University of Innsbruck
Country:	Austria
Presentation Title:	Enhanced ice core dating from the combined use of pollen analyses and mass balance modeling on the Alto dell'Ortles Glacier (Italy)
Full Author List:	D.Festi 1 L. Carturan 2 W. Kofler 1 E. Bucher 3 P. Gabrielli 4 K. Oeggl 1
Author Affiliations:	1 University of Innsbruck, Innsbruck, Austria 2 University of Padova, Padova, Italy 3 Autonome Provinz Bozen Südtirol, Bolzano, Italy 4 The Ohio State University, Columbus, USA

ABSTRACT

This contribution presents a multi-disciplinary approach developed to obtain a high resolution timescale for a 10 m firn core retrieved from the Alto dell'Ortles Glacier (Italy). Based on single species flowering periods, our results indicate that the Ortles pollen spectra show seasonal/annual variability, which enables to discriminate snow accumulated during flowering seasons and winter snow. Results indicate that the core encompasses five accumulation years. A high resolution timescale was then established by means of statistical analyses, comparing Ortles pollen assemblages with daily pollen monitoring data from Solda (base of Mt. Ortles). Ortles snow samples are characterized by their depth and pollen spectra, while Solda's samples are characterized by their pollen spectra and specific date. Thus, by finding for an Ortles sample the most similar Solda's sample according to their pollen content, we established a direct depth-to-day link. In this way every snow samples was dated. Finally, the obtained firn core timescale was compared with results from a mass balance model run at the drilling site. The comparison of the two independent dating methods enabled a better understanding of depositional and post depositional processes affecting pollen, δD, snow and firn at the study site. In addition, their combined use proved to be useful for achieving enhanced confidence in the core dating.

Abstract

Dr. Peter Neff

Submission ID	18
Name:	Dr. Peter Neff
Institution:	University of Rochester
Country:	United States
Presentation Title:	A review of the brittle ice zone in polar ice cores.
Full Author List:	P. D. Neff1,2,3
Author Affiliations:	1 University of Rochester, Rochester, USA 2 Victoria University of Wellington, Wellington, NZ 3 GNS Science, Lower Hutt, NZ

ABSTRACT

Maintaining ice core quality through the brittle ice zone (BIZ) remains challenging for polar ice core studies. At depth, increasing ice overburden pressurizes trapped air bubbles, causing fracture of cores upon exposure to atmospheric pressure. Fractured ice cores degrade analyses, reducing resolution and causing contamination. BIZ encounters at eighteen sites across the Greenland, West and East Antarctic ice sheets are documented. The BIZ begins at a mean depth of 545 ± 162 m (1 standard deviation), extending to depths where ductile clathrate-ice is reached: an average of 1132 ± 178 m depth. Ice ages in this zone vary with snow accumulation rate and ice thickness, beginning as young as 2 ka before present (BP) at Dye 3, Greenland, affecting ice >160 ka BP in age at Taylor Dome, Antarctica and compromising up to 90% of retrieved samples at intermediate-depth sites. Effects of pressure and temperature on the BIZ are explored using modeled firn-column overburden pressure and borehole temperatures, revealing complex associations between firn densification and BIZ depth, and qualitatively supporting expected thinning of the BIZ at low ice temperatures due to shallower clathrate stability.

Abstract

Dr. Paolo Gabrielli

Submission ID	19
Name:	Dr. Paolo Gabrielli
Institution:	The Ohio State University
Country:	USA
Presentation Title:	Co-evolution of atmospheric warming and environmental changes from a new high altitude European ice core
Full Author List:	Ortles Ice Core Project community members, (in alphabetical order) C. Barbante1,2, M. Bertó2, L. Carturan3, M. Davis4, G. Dalla Fontana3, G. Dreossi1, R. Dinale5, G. Dragà6, J. Gabrieli1, P. Gabrielli4, D. Festi7, T. Jenk8, N. Kehrwald1, D. Kenny4, V. Mair9, V. Mikhalenko10, P. N. Lin4, K. Oeggl7, U. Schotterer11, M. Schwikowski8, R. Seppi12, A. Spolaor1, B. Stenni1, C. Uglietti8, L.G. Thompson4, D. Tonidandel9, T. Zanoner3
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ABSTRACT

While robust evidence indicates that anthropogenic greenhouse gases are contributing to the increase in Earth's surface temperature, insights into short-term regional changes are ambiguous. In particular, synergies between local aerosol dispersion and global climate change are not sufficiently understood, especially at high elevation where rapid areal shrinking of alpine glaciers and the consequent decrease in albedo may provide an additional positive feedback. We retrieved four ice cores from the ice field atop Mt. Ortles (3905 m), the highest mountain in South Tyrol (Italian Alps). Our goal is to identify co-evolutionary interactions between mid- tropospheric warming and environmental changes in the ecosystems and human society from the coldest time interval of the Holocene (Little Ice Age) to the current warm period. This drilling site is well suited for this purpose as it is located in a rapidly warming area of the world that is also a global hotspot of atmospheric pollution originating from the extensively industrialized and cultivated areas of Central and

Southern Europe. Here we present records of stable isotopes, major ions, trace elements, pollen types, black carbon and levoglucosan to show possible interactions between: 1) climate at high elevation (air temperature); 2) human impacts (industrialization, changes in land use/fire activities); and 3) ecosystems (composition of the vegetation, aridity conditions, types of exposed soils). We discuss how strong regional environmental variations may interact with superimposed climatic changes of global significance.

Abstract

Dr. Hans Christian Steen-Larsen

Submission ID	20
Name:	Dr. Hans Christian Steen-Larsen
Institution:	Centre for Ice and Climate, University of Copenhagen
Country:	Denmark
Presentation Title:	Using in-situ observations of atmospheric water vapor isotopes to benchmark isotope-enabled General Circulation Models and improve ice core paleo-climate reconstruction
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ABSTRACT

We have since 2010 carried out in-situ continuous water vapor isotope observations on top of the Greenland Ice Sheet (3 seasons at NEEM), in Svalbard (1 year), in Iceland (4 years), in Bermuda (4 years). The expansive dataset containing high accuracy and precision measurements of $\delta^{18}O$, δD, and the d-excess allow us to validate and benchmark the treatment of the atmospheric hydrological cycle's processes in General Circulation Models using simulations nudged to reanalysis products.

Recent findings from both Antarctica and Greenland have documented strong interaction between the snow surface isotopes and the near surface atmospheric water vapor isotopes on diurnal to synoptic time scales. In fact, it has been shown that the snow surface isotopes take up the synoptic driven atmospheric water vapor isotopic signal in-between precipitation events, erasing the precipitation isotope signal in the surface snow.

This highlights the importance of using General or Regional Climate Models, which accurately are able to simulate the atmospheric water vapor isotopic composition, to understand and interpret the ice core isotope signal.

With this in mind we have used three isotope-enabled General Circulation Models (isoGSM, ECHAM5-wiso, and LMDZiso) nudged to reanalysis products. We have compared the simulations of daily mean isotope values directly with our in-situ observations. This has allowed us to characterize the variability of the isotopic composition in the models and

compared it to our observations. We have specifically focused on the d-excess in order to characterize why both the mean and the variability is significantly lower than our observations.

We argue that using water vapor isotopes to benchmark General Circulation Models offers an excellent tool for improving the treatment and parameterization of the atmospheric hydrological cycle. Recent studies have documented a very large inter-model dispersion in the treatment of the Arctic water cycle under a future global warming and greenhouse gas emission scenario. Our results call for action to create an international pan-Arctic monitoring water vapor isotope network in order to improve future projections of Arctic climate.

Abstract

Christian Panton

Submission ID	22
Name:	Christian Panton
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	In-situ site-selection for the RECAP drilling project
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ABSTRACT

The Renland ice cap is situated on a plateau east of the Greenland ice sheet, with the highest elevation of 2340 m. The ice cap is thickest near the summit with almost 600 m ice. A previous 325 m ice core drilled in 1988 on Renland revealed that the deepest ice can be dated to the last interglacial, providing an attractive and local basis for validating and comparing deep Greenland ice cores.

Radar surveys have revealed a complex bed topography in the area. As a result of the steep slopes of the mountainous bed, recent airborne radar surveys have not been able to resolve the deep internal layering, which is needed to locate an a better drill site.

In May 2015 we set out to perform site-selection for the RECAP ice core project. Using a tailor-made accumulation radar and rapid iteration between surveying and processing, we were able to locate the optimal drill site in four days. The drilling started just 11 days after this. Echograms reveal a highly convoluted internal stratigraphy, dominated by bed topography and ice flow. The ice core was drilled between the two summits, where a north-south trough holds the oldest ice. A few kilometers east of the summit, we sounded an area where the bed is flat and smooth with minimal disturbance to the internal layers.

Abstract

Florian Adolphi

Submission ID	23
Name:	Florian Adolphi, PhD
Institution:	Lund University
Country:	Sweden
Presentation Title:	Assessing the precision and accuracy of the Greenland Ice Core timescale, GICC05, over the last deglaciation
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ABSTRACT

The layer counted Greenland Ice Core timescale is one of the most widely used reference timescales in paleoclimatology. However, recently a number of studies have highlighted uncertainties in its accuracy during the late Holocene. Cosmogenic radionuclides ($^{10}Be/^{14}C$) provide a climate independent tool to precisely and continuously synchronize GICC05 to dendrochronologically dated tree-ring timescales. Applying this method Muscheler et al. (2014) found a rapid jump in the timescale difference between tree-rings and ice cores during the Younger Dryas. The reason for this jump remained, however, elusive, as it might originate from either underestimated uncertainties in the GICC05 layer count, or dating mismatches in the oldest section of the tree-rings. We will discuss this feature in the light of new tree-ring ^{14}C measurements and in comparison to ^{14}C data on U/Th dated speleothems, providing insights into the accuracy and precision of GICC05 over the last deglaciation.

Abstract

Dr Emilie Capron

Submission ID	29
Name:	Dr Emilie Capron
Institution:	British Antarctic Survey
Country:	United Kingdom
Presentation Title:	A new Last Interglacial temperature data synthesis as an improved benchmark for climate modelling
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ABSTRACT

The Last Interglacial (LIG, 129-116 thousand of years BP, ka) offers an opportunity to assess the effect of warmer-than-present-day climate on the Earth System. However, mainly because aligning different palaeoclimatic archives and from different parts of the world is not trivial, a spatio-temporal picture of LIG temperature changes is difficult to obtain.

Here, we provide the first compilation of high-latitude temperature changes across the LIG associated with a coherent temporal framework for 47 ice core and marine sediment records. We compile data-based surface temperature time slices at 115, 120, 125 and 130 ka which provide improved benchmarks to perform climate model-data comparisons.

In particular, the 130 ka data-based time slice highlights non-synchronous maximum temperature changes between hemispheres. We perform a comparison of this 130 ka data-based time slice with surface temperatures simulated by two General Circulation Models (GCMs) as part of the PMIP3 2012 General Meeting. We highlight that the GCMs predict warmer-than-present-day conditions earlier than documented in the North Atlantic, while

neither model is able to produce the reconstructed early Southern Hemisphere warming. It strongly suggests that important processes were missing in the set-up of those model experiments.
By including realistic freshwater forcing in new simulation to account for the early melting of the Northern Hemisphere ice sheets, we are now able to simulate the asynchronous pattern observed between the hemispheres at 130 ka. Our new 130 ka simulations also suggest that Antarctic surface temperatures are better reproduced when accounting also for the disintegration of the West Antarctic Ice sheet.

Abstract

Dr Emilie Capron

Submission ID	30
Name:	Dr Emilie Capron
Institution:	British Antarctic Survey
Country:	United Kingdom
Presentation Title:	Sequence of events from the onset to the demise of the Last Interglacial: evaluating strengths and limitations of chronologies used in climatic archives
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ABSTRACT

The Last Interglacial (LIG, 129-116 ka) represents a precious case study to investigate the response of vulnerable components of the Earth system to polar warming. However, the scarcity of precise absolute age constraints in most archives during this time interval leads to the use of different reference chronologies and various strategies to align paleoclimatic records. Therefore, the investigation of the climatic sequence of events across the LIG remains limited.

Here, we review strengths and limitations of commonly used methods to date or define chronologies in paleoclimatic archives (corals, speleothems, ice, marine and lake sediments, and peat sequences) for the time span encompassing the penultimate deglaciation, the LIG and its demise. In particular, we provide quantitative estimates of associated absolute and relative age uncertainties.

Subsequently, we formulate recommendations on how to define at best absolute and relative chronologies. Future climate alignments should provide (1) clear statements of climate hypotheses involved, (2) a detailed understanding of environmental parameters controlling selected tracers and (3) a careful evaluation of the synchronicity of aligned paleoclimatic records. We insist on the need to (1) systematically report quantitative estimates of age uncertainties (2) assess the coherence of chronologies when comparing different records and (3) integrate these uncertainties in paleoclimatic interpretations and comparison with climate simulations.

We finally present a sequence of major climatic events with associated age uncertainties from the LIG onset to its demise. This sequence should serve as a benchmark to disentangle mechanisms of Earth system response to orbital forcing and evaluate transient climate simulations.

Abstract

Mai Winstrup

Submission ID	31
Name:	Mai Winstrup
Institution:	Centre for Ice and Climate, University of Copenhagen
Country:	Denmark
Presentation Title:	An annual-layer counted chronology for the EPICA Dronning Maud Land (EDML) ice core, Antarctica, over the Holocene and the deglaciation
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ABSTRACT

Accurate and consistent timescales for paleoclimate records are fundamental to advancing our understanding of the processes behind rapid climate change. For some ice cores, high-resolution chronologies can be established by counting annual layers, but the feasibility of this approach depends on a range of factors, including snow accumulation rates. In Antarctica, only a few ice core locations have sufficiently high accumulation rates for annual signals to be preserved deep in the core.

We present an independent layer-counted chronology for the EPICA ice core from Dronning Maud Land (EDML), Antarctica, over the Holocene and deglaciation. The chronology is based on high-resolution impurity and electrical conductivity records. Annual layers were counted by two investigators manually and by the StratiCounter algorithm; concordance between the multiple independent outcomes allowed an estimation of the timescale accuracy.

We compared the new EDML timescale to existing Antarctic ice-core timescales (e.g. AICC2012) and to the Greenland Ice Core Chronology 2005 (GICC05). Synchronization to Greenland was performed using bipolar volcanic markers, and validated by observed

synchroneity of cosmic ray fluxes as reflected in the ice core 10Be records. Over the Holocene, we find good agreement with GICC05. Prior to the Holocene, annual layer identification was more challenging with some disagreements between the independent layer counts. During this period, synchronization to GICC05 was also less certain.
With this layer-counted timescale for EDML, and its synchronization to the Greenland ice cores, it will be possible to start investigating in detail the leads and lags of climatic events between the Northern and Southern hemispheres.

Abstract

Monica Arienzo

Submission ID	32
Name:	Monica Arienzo
Institution:	Desert Research Institution
Country:	United States of America
Presentation Title:	Black carbon from two Antarctic ice cores parallels Southern Hemisphere climate during the Holocene
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ABSTRACT

Biomass-burning and fossil-fuel combustion emit black carbon (BC) aerosols which impact climate directly by changing Earth's radiation budget and indirectly by changing cloud formation and reducing albedo when deposited on bright surfaces such as snow and ice. BC aerosols have been shown to be the second most important anthropogenic climate-forcing agent today, after carbon dioxide. Current records of BC extend over the last 2,000 years. However, on longer timescales, knowledge of natural variations in BC emissions and climate drivers of regional-scale biomass burning is limited.

Here we present the first high-resolution 14,000-year record of BC aerosol deposition in Antarctica. The two ice cores are the West Antarctic Ice Sheet Divide (WD) core from 14,000 years before 1950 (yr BP) to 2,475 yr BP and the East Antarctic B40 core from 2,485 yr BP to present. BC and a wide range of trace elements were analyzed via a continuous melter system allowing for sub-annual resolution in both cores.

BC fluxes in the WD and B40 composite more than doubled from <25 μg m^{-2} yr^{-1} at the end of the last glacial termination (14 kyr BP) to >50 μg m^{-2} yr^{-1} in the mid-Holocene ($\sim$7.5 kyr BP), and then declined to <20 μg m^{-2} yr^{-1} in the late Holocene. The lowest BC fluxes were observed during the Little Ice Age. We compare Antarctic BC fluxes to low-latitude paleoclimate proxies including lake sediment, cave, ice core and temperature proxies to investigate potential linkages between low latitude climate, hydrology, biomass burning, and BC emissions.

Abstract

Ernst-Jan Kuiper

Submission ID	33
Name:	Ernst-Jan Kuiper
Institution:	Utrecht University
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Presentation Title:	Identifying deformation mechanisms in the EDML ice core using EBSD measurements
Full Author List:	E. N. Kuiper1,2 I. Weikusat2 M. R. Drury1 G. M. Pennock1 M. D. A. de Winter1
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ABSTRACT

One of the methods used to study the deformation mechanisms in natural materials is electron backscattered diffraction (EBSD). We obtained ca. 200 EBSD maps of nine different depths from a Greenlandic ice core (NEEM) and an Antarctic ice core (EDML). The step size varied between 8 and 25 μm depending on the size of the deformation features. The size of the maps varied from 2000 to 20000 grid points. Indexing rates were up to 95%, partially by saving and reanalyzing the EBSP patterns.

With EBSD we characterize subgrain boundaries and determine the lattice rotation configurations of each individual subgrain. Combining these observations with arrangement/geometry of subgrain boundaries the dislocation types can be determined, which form these boundaries. Three main types of subgrain boundaries have been recognized in the EDML ice core.

Here, we present more results obtained from EBSD measurements performed on the EDML ice core samples from the last glacial period, focusing on the relevance of dislocation activity of the possible slip systems. We also compare the EBSD maps of the EDML ice core to the EBSD maps of the NEEM ice core.

Preliminary results show that all three subgrain types, recognized in the NEEM ice core, occur in the EDML samples. In addition to the classical boundaries made up of basal dislocations, subgrain boundaries made of non-basal dislocations are also common.

Abstract

Benoit S. Lecavalier

Submission ID	35
Name:	Benoit S. Lecavalier
Institution:	Memorial University of Newfoundland
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Presentation Title:	The high Arctic Agassiz ice core Holocene climate record
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ABSTRACT

Polar amplification of climate warming is borne out by both proxy and instrumented observations from the Arctic. A variety of feedback mechanisms are responsible for this amplification and a complete understanding of these relies on the existence of robust data sets that capture the temporal and spatial variability of Arctic climate change. Here we present a revised and extended high Arctic temperature reconstruction that spans the past ~12,000 years (up to 2009 CE), obtained from the Agassiz ice cap. Our new reconstruction indicates an earlier and more pronounced Holocene Thermal Maximum with early Holocene temperatures 4-5°C warmer compared to a previous reconstruction, thus indicating a stronger polar amplification. A glaciological model sensitivity analysis demonstrates that this more pronounced, high-latitude warming led to a larger response of the Greenland ice sheet, enhancing its contribution to global mean sea levels since the last glacial maximum by ~20% (or ~1 m sea-level equivalent) compared to recent reconstructions. Our Agassiz temperature reconstruction indicates that present-day air temperatures are at their warmest in the past 6,800–7,800 yr and that century-scale rates of temperature change in this region are currently at their highest since entering the current interglacial period around 11,700 years ago.

Abstract

Passalacqua Olivier

Submission ID	36
Name:	Passalacqua Olivier
Institution:	Laboratoire de glaciologie et géophysique de l'environnement
Country:	France
Presentation Title:	Dating old ice near Dome C using thermomechanical ice flow models
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ABSTRACT

One of the main present-day challenges in ice core sciences consists in finding a continuous ice archive as old as 1.5 million years. This would allow studying the Mid-Pleistocene Transition (MPT), a transition which occurred ~900,000 yr ago, from low amplitude 40,000 yr cycles to high amplitude 100,000 yr cycles. The previous oldest ice core was drilled at Dome C, on the East Antarctic plateau (800,000 years), and some observations seem to indicate that even older ice could be retrieved in the vicinity of the dome.

Forty kilometers from the dome lies a bedrock relief that makes the ice thinner (~2700 m), so that the bottom ice could be prevented from encountering basal melting. Because of a small dome configuration leading to low horizontal velocities, the ice at this possible drilling site mainly comes from ~15 km upstream only. As a consequence, the ice may not have undergone too much bedrock perturbation, and we will assume that the accumulation and geothermal flux values can be considered as uniform along the flow band.

The presented models consist in steady-state ice flow simulations along the ridge to Vostok, that accounts for thermal advection and diffusion. We compare 3D simulations with 2D simulations accounting for the width of the flow tube (2.5D model), in order to see the capability of the latter to correctly locate the isochrone layers. The bottom age strongly depends on the geothermal flux value, and the isochrones pattern on the accumulation. The computed ice flow shows that ice older than 1 million years is anyway likely to be retrieved at this site. Further work will imply transient simulation to account for the temporal variations of the surface topograhy.

Abstract

Prof. Pavel Talalay

Submission ID	37
Name:	Prof. Pavel Talalay
Institution:	Polar Research Center, Jilin University
Country:	China
Presentation Title:	The recent progress on drilling project in the region of Gamburtsev Subglacial Mountains, East Antarctica
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ABSTRACT

The Gamburtsev Subglacial Mountains (GSM), located in the central part of East Antarctica, has become the subject of great scientific interest because the mechanism driving uplift of the young-shaped range in the middle of the old Antarctic Plate is unknown. Another challenging scientific task is connected with investigation of complicated folded structures at the lower portion of the Antarctic ice sheet which were recently recorded by radar survey in this area. The next step of the GSM exploration focuses on the direct observation of ice sheet bed by drilling. It is proposed to use cable-suspended drilling technology. All drilling equipment (two diesel generators, winch, control desk, etc.) will be installed inside a movable sledge-mounted warm-keeping and wind-protecting drilling shelter. Drilling shelter is transported to the chosen site with crawler-tractor, and all equipment is ready to start drilling in 2-3 days upon arrival to the site. To drill through ice and bedrock a new, modified version of the cable-suspended Ice and Bedrock Electromechanical Drill 'IBED' is designed and tested. The expected average daily production of ice drilling would be not less than 25 m/day. According to approved schedule, the first field tests are planned to carry out just outside Zhongshan Station near Antarctic coast in season 2016-2017. Next season 2017-2018 the movable drilling shelter is planned to be transported to the chosen drilling site in the region of GSM, and drilling to the bedrock would be finished during two seasons.

Abstract

Dr Julius James Rix

Submission ID	38
Name:	Dr Julius James Rix
Institution:	The British Antarctic Survey
Country:	United Kingdom
Presentation Title:	A New Rapid Access Isotope Drill
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ABSTRACT

The British Antarctic Survey (BAS) Rapid Access Isotope Drill (RAID) is an innovative new class of ice drill, which can dry drill a 75mm diameter borehole to a depth of 600m in a week whilst collecting ice. The drilling rate is based on results from a prototype tested in Antarctica and assuming two 8 hour shifts with 2 operators on each shift. Rather than an ice core, ice chippings are collected for water isotope analysis. This is at a lower depth resolution than is possible with cores. The dry borehole is then available for instrumentation and we have incorporated into the RAID system a Distributed Temperature Sensing (DTS) system with a fibre optic cable to measure temperatures every 1m. The RAID/DTS was designed to help identify potential sites for the “oldest ice”.

To minimise total system weight the drill is an electro-mechanical wireline drill. The 650m winch is a development of the BAS 150m winch and, as core-breaking is not required, is able to raise and lower the drill at speeds in excess of 60m/min. 5m long barrels with internal spirals collect the chippings. Auger style cutters are used for quick penetration. All components fit into a Twin Otter and total boxed system weight including two complete drill units, 650m winch, generator, tools, spares and DTS instrument weighs $<$700kg. Although intended to help in the search for “oldest ice”, the RAID has a number of other potential applications which are being pursued.

Abstract

Prof. Hubertus Fischer

Submission ID	39
Name:	Prof. Hubertus Fischer
Institution:	Climate and Environmental Physics, Physics Institute & Oeschger Centre for Climate Research, University of Bern
Country:	Switzerland
Presentation Title:	Millennial changes in North American wildfire and soil activity over the last glacial cycle
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ABSTRACT

Climate changes in the North Atlantic region during the last glacial cycle were dominated by the slow waxing and waning of the North American ice sheet as well as by intermittent, millennial-scale Dansgaard-Oeschger climate oscillations. However prior to the last deglaciation, the responses of North American vegetation and biomass burning to these climate variations are uncertain. Ammonium in Greenland ice cores, a product from North American soil emissions and biomass burning events, can help to fill this gap. Here we use a continuous record of annual ammonium concentrations between 110,000 to 10,000 years ago from the Greenland NGRIP and GRIP ice cores to reconstruct North American wildfire activity and soil ammonium emissions. We find that, on orbital timescales, soil emissions increased under warmer climate conditions when vegetation expanded northward into previously ice-covered areas. For millennial-scale interstadial warm periods during Marine Isotope Stage 3, the fire recurrence rate increased in parallel to the rapid warmings, whereas soil emissions rose more slowly, the latter in line with slow ice shrinkage and delayed ecosystem changes. We conclude that sudden warming events had little impact on soil ammonium emissions and ammonium transport to Greenland, but did result in a substantial increase in the frequency of North American wildfires.

Abstract

Pascal Bohleber

Submission ID	40
Name:	Pascal Bohleber
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Country:	USA
Presentation Title:	Atmospheric temperature and dust variability recorded in two low accumulation Alpine ice cores over the last millennium
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ABSTRACT

The small scale Colle Gnifetti glacier saddle (CG, 4450 m asl, Monte Rosa region) is the only ice core drilling site in the European Alps with a net accumulation low enough to offer multi-millennia climate records. However, a robust interpretation of such long-term records is strongly challenged by depositional noise associated with a highly irregular annual layer stratigraphy. Consequently, atmospheric signals can only be identified reliably as shared signal variability in an inter-core comparison of time series.

As the latest addition to a unique multi-core array at CG, a new ice core was drilled in 2013 and specifically designated for a broad combination of state-of-the-art analyses. Novel ultra-high resolution impurity analysis utilizing laser ablation (LA-ICP-MS) reveals highly thinned, sub-cm annual layers that could be counted quasi-continuously over the last millennium. Combined with efforts to find absolute age constraints by micro-radiocarbon analysis resulted in the most reliable age scale for a CG ice core thus far, recently supplemented by a pilot investigations into tephra particles.

Considering a neighboring ice core drilled on the same flow line, the comparison of stable water isotopes and insoluble particle time series revealed multi-decadal variability shared among the two cores- for the first time extending all the way over the last millennium. Based on these findings we discuss the climate significance of the common ice core variability, in view of i) constraints arising from calibration of the isotope thermometer, dating uncertainties and systematic glaciological up-stream effects and ii) comparison to other proxy reconstructions, including historical records.

Abstract

Pascal Bohleber

Submission ID	41
Name:	Pascal Bohleber
Institution:	Climate Change Institute, University of Maine
Country:	USA
Presentation Title:	Geophysical reconaissance for deep ice core drilling at Fedchenko glacier, Pamir, Central Asia
Full Author List:	P. Bohleber1,2, C. Mayer3, A. Lambrecht3 and V. Aizen4
Author Affiliations:	Climate Change Institute University of Maine, Orono, USA Institute of Environmental Physics Heidelberg University, Heidelberg, Germany Commission for Glaciology Bavarian Academy of Sciences, Munich, Germany Departement of Geography University of Idaho, Moscow, USA

ABSTRACT

Fedchenko glacier (Pamir, Tadjikistan), the largest alpine glacier outside the polar regions, offers unique high-resolution ice-core records of the entire Holocene and possibly beyond. Precise knowledge of recent glacio-meterological conditions at Fedchenko is key to select an adequate drilling site and hence crucial to the success of the envisaged international deep ice core drilling. To this end, a dedicated reconnaissance field campaign was conducted at a large accumulation basin (5400 m asl) in summer 2015.

High-frequency ground-penetrating radar (GPR) was used to investigate englacial reflection horizons achieving high spatial coverage of the accumulation basin. To provide complementary information on basic snow stratigraphy, several shallow firn cores were analyzed for stable isotopes and meltwater conductivity.

Here we present first results from combining the firn core and GPR datasets in order to derive a spatial map of net snow accumulation. With additional surface GPS measurements and existing data on bedrock topography, the results allow to perform simple flow modeling to estimate upstream catchment area and age distribution of a potential drilling location. This provides a comprehensive picture of the targeted drilling area and thus constitutes the prerequisite for assessing the paleoclimatic potential of future deep ice core records from Fedchenko glacier.

Abstract

Helene Hoffmann

Submission ID	42
Name:	Helene Hoffmann
Institution:	Institute for Environmental Physics, Heidelberg University
Country:	Germany
Presentation Title:	Micro Radiocarbon dating – Applications and challenges in Alpine glaciology
Full Author List:	H. Hoffmann1, P. Bohleber1,2, D. Wagenbach1,3
Author Affiliations:	1: Institute for Environmental Physics, Heidelberg, Germany

ABSTRACT

The interpretation of proxy records from ice cores obtained at cold small scale Alpine glaciers is hampered first and foremost because of challenges in obtaining a reliable age scale, especially for highly thinned basal ice. Where conventional stratigraphic dating methods fail, radiocarbon measurements of organic impurities are up to now the only option to retrieve absolute age markers and ages of the basal ice. Organic material in ice can be separated into DOC (Dissolved Organic Carbon) and POC (Particulate Organic Carbon). Here we focus on radiocarbon dating of the POC fraction, because the DOC fraction is known to be biased by in situ production at high Alpine sites. Concentrations of POC in high Alpine ice can be very low, ranging from about 10μgC per kg ice to 50 μgC per kg ice. After developing a unique sample preparation system with a process blank reproducibly below 1μgC, this approach becomes applicable for high Alpine ice samples. Here we present first results from POC radiocarbon dating of Alpine ice cores along with selected basal ice samples from smaller ice caps and cave ice in order to obtain a broader picture regarding age ranges of Alpine ice bodies. For reliable age interpretation, special focus lies on the investigation of possible reservoir effects such as inputs of old Saharan dust and their potential bias of radiocarbon dates. As part of this investigation, we present new results from a methodological study on air filters, to constrain the optimal settings for radiocarbon dating of ice samples with respect to reliable ages.

Abstract

Diana Vladimirova

Submission ID	43
Name:	Diana Vladimirova
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	Continuous measurements of CH4 content in the RECAP ice core, Greenland (preliminary results)
Full Author List:	D.Vladimirova1, P.T. Vallelonga1, B.M. Vinther1, T. Blunier1
Author Affiliations:	1.Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark

ABSTRACT

Methane is amongst the most important greenhouse gases both under natural conditions and during the Anthropocene. With a residence time in atmosphere of only ~10 years methane is a good indicator of climate variations and anthropogenic emission changes.

The Renland ice cap contains in contrast to the Greenland ice sheet no brittle ice zone. The recently drilled Renland core (RECAP) thus has the potential to provide a high resolution methane record for the entire Holocene measured with the on-line CFA method. The RECAP ice core is 584 m long covering mostly the Holocene period. It was drilled in summer 2015 and will be measured in fall/winter 2015 in Copenhagen.

Here we present preliminary results of methane concentration measurements of the RECAP ice core using the laser spectroscopy technology and continuous flow extracting system. Of particular interest is the methane signal during the numerous melt layers in the core. In the NEEM Eemian ice, melt layers are likely the reason for high methane excursions. We will see if such an effect is also seen in RECAP and hope to be able to put them into a perspective of the climate changes Renland has seen after the termination of the ice age.

Abstract

Prof Yongqin Liu

Submission ID	45
Name:	Prof. Yongqin Liu
Institution:	Institute of Tibetan Plateau Research, Chinese Academy of Sciences
Country:	China
Presentation Title:	Bacterial responses to environmental change in the Tibetan Plateau over the past half century
Full Author List:	Y. Liu1,.J. C. Priscu2,T. Yao1
Author Affiliations:	1 Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, China 2 Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, Montana , USA

ABSTRACT

Climate change and anthropogenic factors can alter biodiversity and lead to the homogenization of biological communities. Despite these potential changes, no long-term records of these impacts on microbial communities exist. The Tibetan Plateau is a highly sensitive region that is currently undergoing significant change resulting from both climate change and increased human activity. Ice cores from glaciers in this region serve as unique natural archives of bacterial abundance and community composition, and contain concomitant records of climate and environmental change. We report high-resolution profiles of bacterial density and community structure over the past half-century in ice cores from three glaciers on the Tibetan Plateau, a region experiencing unprecedented changes in climate and human activity. Statistical analysis showed that the bacterial community composition in the three ice cores converged strongly starting in the 1990s. Changes in bacterial community composition were related to changing precipitation, increasing air temperature and anthropogenic activities in the vicinity of the Plateau. Collectively, our ice core data on bacterial in concert with proxies of climate and black carbon indicate that the convergence of bacterial communities deposited on glaciers across a wide geographical area and situated in diverse habitats types was likely induced by climatic and anthropogenic drivers.

Abstract

Hong Jialin

Submission ID	46
Name:	Hong Jialin
Institution:	Polar Research Center, Jilin University, Changchun
Country:	China
Presentation Title:	Optimization of Ice Cuttings Transportation by Electromechanical Auger Drills
Full Author List:	J. Hong, P. Talalay
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ABSTRACT

In recent decades, electromechanical auger drilling has become a very popular method of ice core sampling, and the drilling sites are spread all over the world, covering the whole glacial distribution from polar to high-mountain regions. However, auger options were usually determined by experience, and the main parameters (helix angle of the fights and rotational speed) are varied in a wide range from drill to drill. The external parameters which have a large influence on the efficiency of the cuttings transportation are friction coefficients between ice inner/outer barrels and the size of ice cuttings. Totally 424 linear friction experiments with common and promising slider materials for auger drills were carried out at the wide range of temperatures observed in glaciers from -60 to 0 °C. The coefficient of friction increases with decreasing of temperature but this dependence is not monotonous. To determine the patterns of ice cuttings, sixteen ice cuttings were sampled in the course of drilling in natural lake ice. The size distribution of the cuttings has an asymmetrical shape. Approximately half of the ice cuttings by weight are classified as small sized (□0.6 mm). In all of the sieving samples, the ice cuttings have prolate form with a ratio between the major and minor axis 1.55 in average. In order to choose the optimal auger parameters, the discrete element method is used to analyze the performance of cuttings transportation for different rotation speeds in the range 50–200 rpm and auger angles in the range 25–45°.

Abstract

Theo Manuel Jenk

Submission ID	49
Name:	Theo Manuel Jenk
Institution:	Paul Scherrer Institute
Country:	Switzerland
Presentation Title:	Reconstruction of El Niño-Southern Oscillation (ENSO) from an Andean ice core (Cerro Mercedario, Argentina)
Full Author List:	T.M. Jenk1,2, A. Graesslin-Ciric1, L. Tobler1, H.W. Gäggeler1, U. Morgenstern3, G. Casassa4, M. Lüthi5, J. Schmitt2,6, A. Eichler1,2, M. Schwikowski1,2,7
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ABSTRACT

How ENSO will react to global warming is of high importance to society. To investigate changes in the natural inter-decadal to centennial variability of ENSO, instrumental records are too short. South America is a key region for the understanding of climate dynamics in the Southern Hemisphere. With precipitation amounts in Central Chile being significantly correlated to the Southern Oscillation Index, high altitude Andean glaciers located between 28 and 35°S potentially record an ENSO signal allowing for reconstructions reaching further back in time.

We present results from an ice core drilled in 2005 on Cerro Mercedario, Central Argentinean Andes (La Ollada glacier, 31°58'S, 70°07'W, 6100 m asl.). Measured borehole temperatures, ranging from -16.7°C at 104 m to -18.5°C at 10 m depth, are the lowest englacial temperatures observed in Andean glaciers to date. This is reflected in a well preserved ice archive and the complete absence of melt features. Dating was performed by a combination of independent tools such as annual layer counting based on chemical dust tracers, nuclear dating with ^{210}Pb, tritium and ^{14}C of POC, measurements of atmospheric trace gases and glacier flow modelling. Dating was consistent for the different techniques, resulting in a well-defined chronology for the past 350 years. A mean annual accumulation rate of 0.27 m weq. allowed for seasonal to sub-seasonal resolution. This revealed an unusual and notable lack of seasonality in the records of water stable isotope ratios (δ^{18}O, δD). We will discuss the relation between sources and transport of the ice incorporated proxies and tropical eastern Pacific sea surface temperatures. The finding that water stable isotopes and chemical impurities are strongly modulated by the ENSO, allows presenting a new reconstruction for this climatic phenomenon back to ~1700 AD.

Abstract

Associate Prof. Nancy Bertler

Submission ID	50
Name:	Associate Prof. Nancy Bertler
Institution:	Antarctic Research Centre, Victoria University of Wellington and GNS Science
Country:	New Zealand
Presentation Title:	The Roosevelt Island Climate Evolution (RICE) Project
Full Author List:	Nancy A.N. Bertler1,2, Howard Conway3, Dorthe Dahl-Jensen4, Giovanni Baccolo6, Thomas Beers12, Thomas Blunier4, Edward Brook5, David Clemens-Sewall10; Gabriela Ciobanu4, Ruzica Dadic1, Barbara Delmonte6, Zhang Dongqi7, Ross Edwards8, Aja Ellis8, Daniel B.
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ABSTRACT

Geological evidence and modelling experiments suggest that the removal of ice shelves from marine based ice sheets can lead to catastrophic collapse. Roosevelt and Ross Islands are thought to be key stabilization anchors for the Ross Ice Shelf and thus the West Antarctic Ice Sheet.

As part of the Roosevelt Island Climate Evolution (RICE) project, a 763m deep ice core was recovered during 2011-2013 from Roosevelt Island, at the northern edge of the Ross Ice Shelf. The ice at Roosevelt Island is grounded 210m below sea level and accumulates in situ, with the Ross Ice Shelf flowing around the rise. High resolution radar surveys show a well developed Raymond Bump at the divide of the ice dome. With the conclusion of the RICE core processing campaign in July 2014, a preliminary age model is developed using annual layer count, volcanic ash layers; and high resolution methane data tied to the WAIS Divide ice core record, and a glacial flow model.

Here we show preliminary data spanning over 60 ka. We discuss reconstructions of sea surface and air temperature, sea ice extent, atmospheric circulation patterns, and ice shelf retreat. An ensemble of sensitivity modelling experiments is used to determine thresholds for the removal of ice on Roosevelt Island and correlated grounding line and ice volume changes of the Ross Ice Shelf and the West Antarctic Ice Sheet.

Abstract

Ikumi Oyabu

Submission ID	51
Name:	Ikumi Oyabu
Institution:	National Institute of Polar Research, Tokyo, Japan
Country:	Japan
Presentation Title:	Chemical compositions of soluble and insoluble particles around the last termination preserved in the Dome C ice core, inland Antarctica
Full Author List:	I. Oyabu1,2, Y. Iizuka2, E. Wolff3, and M. Hansson4
Author Affiliations:	1: National Institute of Polar Research, Tokyo, Japan 2: Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan 3: British Antarctic Survey, Natural Environment Research Council, Cambridge, UK 4: Department of Physical Geography, Stockholm University, Stockholm, Sweden

ABSTRACT

The chemical composition of particles preserved in the polar ice sheets is important for the understanding of past atmospheric chemistry. Recently, several studies have been reported chemical compositions of soluble salt particles preserved in the ice cores from inland and peripheral regions in Antarctica and Greenland, and clarified their differences. On the other hand, there is no study that compared salt compositions between different sites in inland Antarctica. Here, we present chemical compositions of soluble salt particles around the last termination in the EPICA Dome C (EDC) ice core, and discuss differences between EDC and Dome Fuji (DF). Particles were obtained from the ice core by an ice sublimation method, and their chemical compositions were analyzed by SEM-EDS. The major soluble salt particles are CaSO4, Na2SO4 and NaCl, which is the same as in the DF core. Time series changes in these salts compositions are similar to the DF core as well. From 25 to 18 kyr BP, the CaSO4 and NaCl fractions are high and the Na2SO4 fraction is low. Between 18 and 17 kyr BP, the CaSO4 and NaCl fractions decrease and the Na2SO4 fraction increases. Between 16 and 6.8 kyr BP, the CaSO4 and NaCl fractions are low and Na2SO4 fraction is high. However, sulfatization rate of NaCl at EDC is higher than at DF. This may be because more SO42- was available for NaCl to form Na2SO4 due to lower concentration of Ca2+ in the EDC ice core compared to DF.

Abstract

Jochen Schmitt, Dr.

Submission ID	52
Name:	Dr. Jochen Schmitt
Institution:	Climate and Environmental Physics & Oeschger Centre for Climate Change Research University of Bern
Country:	Switzerland
Presentation Title:	Glacial-Interglacial and Holocene N2O Stable Isotope Changes Constrain Terrestrial N Cycling
Full Author List:	J. Schmitt1, R. Spahni1, M. Bock1, B. Seth1, B. D. Stocker1,2, Xu-Ri3, A. Schilt1,4, E. Brook4, B. Otto-Bliesner5, Z. Liu6,7, I. C. Prentice2,8, H. Fischer1, F. Joos1
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ABSTRACT

The land biosphere contributes most to the natural source of the long-lived greenhouse gas nitrous oxide (N_2O), with N_2O emissions being dependent on the turnover rate of both the terrestrial nitrogen (N) and carbon (C) cycle. The C:N stoichiometry of vegetation and soil organic matter links the cycles intimately. Sustained plant productivity increase must be supported by biological N fixation. Intensified N cycling in turn enhances N loss and thereby N_2O emissions. The temporal and spatial dynamics of terrestrial N and C cycles and related terrestrial N_2O emissions are poorly constrained over the glacial-interglacial transition and the Holocene. Here we reconstruct increased terrestrial N_2O emissions since the Last Glacial Maximum based on N_2O concentration and isotope measurements on several ice cores and show that this N_2O increase can be explained by N cycle modelling – provided N fixation is allowed to respond dynamically to increasing N demand and turnover. The Ice core reconstructions suggest a deglacial increase of 1.1 ± 0.4 Tg N/yr in terrestrial and 0.6 ± 0.4 Tg/yr in oceanic N2O emissions, but relatively constant terrestrial emissions over the Holocene. Transient simulations with a Dynamic Global Vegetation Model are shown to represent the climate and CO_2 induced changes in terrestrial N_2O emission, and suggest a deglacial increase in biological N fixation by 20%, independently of its absolute magnitude. Deciphering the response of biological N fixation during climatic changes is an important factor for our understanding of plant growth and the land carbon sink, alongside anthropogenic greenhouse gas emissions.

Abstract

Prof. Tandong Yao

Submission ID	53
Name:	Prof. Tandong Yao
Institution:	Institute of Tibetan Plateau Research, CAS
Country:	China
Presentation Title:	Climate Change in the Past 2000 Years and their impacts on society on the Tibetan Plateau
Full Author List:	Climate Change in the Past 2000 Years and their impacts on society on the Tibetan Plateau
Author Affiliations:	CAS Center for Excenllence in Earth Science in Tibetan Plateau and Institute of Tibetan Plateau Research, Beijing, 16 Lincui Road, 100101, China

ABSTRACT

Temperature variation on the Tibetan Plateau (TP), by using stable oxygen isotope as a proxy, in the past 2000 years is reconstructed, based on Puruogangri ice core (central TP), Dunde ice core (northeast TP), Guliya ice core (northwest TP) and Dasuopu ice core (south TP). The integration of the ice core records reveals the synchroneity of large-scale climate changes as the warming in the 7th century, 12-13th centuries and the present, and the cooling in the 3th century, 16th century, and 19th century. We searched for historical documentaries about the response of the Tibet society since A.D. 620. Historical documentaries extracted record of human activities and social development directly determined or indirectly influenced by climate. We categorized them into five aspects including basic resources, economic development, military strength, national coherence, and cultural and religious development, to quantify Tibetan societal development till A.D. 1900. The results show a close Tibetan society response to climate changes in the past 2000 years, particularly, before modern ages.

Abstract

Christoph Schaller

Submission ID	55
Name:	Christoph Schaller
Institution:	Alfred-Wegener-Institut
Country:	Germany
Presentation Title:	Local variability and automatic detection of density layers in firn cores
Full Author List:	C. F. Schaller1, J. Freitag1, B. M. Vinther[2], O. Eisen1
Author Affiliations:	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany

ABSTRACT

Nowadays, due to surrounding conditions such as cost and logistic requirements, it is best practice in ice core sciences to bring in only one deep ice core from a specific location. Nonetheless, additional shallow cores are drilled if possible. Now the question arises how representative such local acquisition of data is.

In May/June 2015, three cores were obtained by the international RECAP project at Renland ice cap, Greenland. Apart from the one deep ice core, two firn cores were drilled approximately 30 meters from each other in a distance of about 100 meters from the main site. Both of them cover a depth of around 72 meters.

These cores were measured in the AWI-Ice-CT, a worldwide unique X-ray computer tomograph in a cold lab, which allows creation of high-resolution density profiles in 2D and 3D. The outcome provides an excellent data base to compare the density layering all the way to the firn-ice-transition for different samples from the same area. To do so, we use self-developed algorithms to automatically detect layers of homogenous density as well as wind and melt crusts, determine statistic parameters of the obtained layering and thereby identify similarities and differences.

Inter alia, we were able to locate the same candidate layer for sealing in all three cores. Detection of such effects is crucial to understand pore close-off and improve estimations of gas ages in deep ice cores.

Abstract

Dr. Anja Eichler

Submission ID	56
Name:	Dr. Anja Eichler
Institution:	Paul Scherrer Institute
Country:	Switzerland
Presentation Title:	Ice-core evidence of earliest extensive air pollution from copper metallurgy in the Andes
Full Author List:	A. Eichler1,2, L. Tobler1,2, G. Gramlich1,2,3, T. Kellerhals2,4, M. Schwikowski1,2,3
Author Affiliations:	1 Paul Scherrer Institut, Villigen PSI, Switzerland 2 Oeschger Centre for Climate Change Research, University of Bern, Switzerland 3 Department for Chemistry and Biochemistry, University of Bern, Switzerland 4 Climate and Environmental Physics, University of Bern, Switzerland

ABSTRACT

The exploitation of the extended polymetallic deposits of the Andes in South America led to significant emissions of toxic heavy metals into the atmosphere already in precolonial times. Copper is one of the most essential resources of the Andean metallurgy. Although copper was important for the wealth of precolonial cultures as the Incas, the beginning of earliest large-scale air pollution from copper metallurgy is still debated. The oldest central Andean copper metal artefacts from hammering native copper date to ~1400 BC. However, peat bog records from southern South America suggest earliest anthropogenic copper pollution already around 1700-1300 BC, preceding that of any archaeological evidence.

Here we present a 6500-years copper emission history for the Andean Altiplano in South America, based on ice core records from Illimani glacier in Bolivia. We show that earliest copper pollution exceeding the background range occurred during the period ~700-50 BC. This first anthropogenic copper maximum is consistent with a hypothesized onset of intensified copper smelting during the Early Horizon from the central Andean Chiripa and Chavin cultures. Anthropogenic copper emissions from these Early Horizon civilizations and the Middle Horizon Tiwanaku culture (500-850 AD) exceeded those of the colonial period. This is explained by the fact that the colonist regarded copper as “plebeian” metal because of its relative low value compared to silver and gold. The abrupt rise of the copper production in South America during the 2nd half of the 20th century finally led to the highest anthropogenic copper emissions within the past 6500 years.

Abstract

Brice Van Liefferinge

Submission ID	57
Name:	Brice Van Liefferinge
Institution:	Université libre de Bruxelles (Brussels, Belgium)
Country:	Belgium
Presentation Title:	Probability of detecting 1.5 million year old ice in the divide area between Dome Fuji and Dome Concordia, Antarctica, based on high-resolution thermomechanical modelling
Full Author List:	B. Van Liefferinge1, F. Pattyn1
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ABSTRACT

Finding suitable potential sites for an undisturbed record of million-year old ice in Antarctica requires slow-moving ice (preferably an ice divide) and basal conditions that are not disturbed by large topographic variations. Furthermore, ice should be thick and cold basal conditions should prevail, since basal melting would destroy the bottom layers. Therefore, ice-flow conditions and thermodynamic characteristics are crucial in identifying potential locations of undisturbed ice. Van Liefferinge and Pattyn (2013) identified suitable areas based on a pan-Antarctic simplified thermodynamic ice sheet model. In order to refine these estimates and potential location sites, we limited our analysis to the divide area of the East Antarctic ice sheet, i.e. Dome Fuji, Argus, Concordia, and Ridge B. The refined calculations are with a full thermo-mechanically coupled higher-order ice sheet model (Pattyn, 2003; Pattyn et al., 2004). Initial conditions for the calculations are based on an inversion of basal slipperiness, based on observed surface topography (Pollard and Deconto, 2012; Pattyn, in prep.). Uncertainty in geothermal conditions is introduced with the methodology previously applied (Pattyn, 2010; Van Liefferinge and Pattyn, 2013). The higher-order model approach has major advantages over previous approaches, as the calculated flow field is dynamically coupled to the thermal balance, which was not the case previously.

Abstract

Dr. Andrea Spolaor

Submission ID	58
Name:	Dr. Andrea Spolaor
Institution:	Ca Foscari Univerity of Venice
Country:	Italy
Presentation Title:	Bromine in the NEEM ice core: a history of Arctic sea ice
Full Author List:	A. Spolaor1,2, P. Vallelonga3, C. Turetta2, N. Maffezzoli3, G. Cozzi2, J. Gabrieli2, C. Barbante1,2, D. Dahl-Jensen3
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ABSTRACT

The ice core from NEEM (North Greenland Eemian Ice Drilling Project, 77°45' N, 51°06' W, 2484 m a.s.l.) is a precious archive of the past climate conditions in Greenland and of the Arctic environment. Ice cores record past atmospheric conditions, dust loading and other climate signals such as past sea ice changes. Sea ice is an important parameter of the Earth climate system, particularly with respect to planetary albedo, sea surface salinity and atmosphere-ocean exchange of reactive gases. New analytical techniques have permitted the development of new climate proxies, such as the investigation of bromine (Br) enrichment as an indicator of sea ice dynamics. Bromine chemistry is extremely active at the polar sea ice margins with enhanced concentrations of BrO in the air column compared to the ocean surface or snow-covered land. So-called "Bromine explosions" occur principally in first-year sea ice close to the sea ice edge and are the major source of reactive bromine in the polar atmosphere. The net effect is the enrichment in Br- compared to the seawater Br/Na ratio in snow deposition, resulting in bromine excess (Brexc). We present a record of Brexc in the NEEM ice core. Our data are focused on the Holocene (including climate optimum), the glacial-interglacial transition (including Younger Dryas) and during the glacial, in particular from Dansgaard-Oeschger events 8 to 13. The results strongly suggest a connection between Brexc and sea ice. These results, combined with climate modelling, could improve our understanding of past and future sea ice changes.

Abstract

Giovanni Baccoloate

Submission ID	59
Name:	Giovanni Baccolo
Institution:	University of Siena
Country:	Italy
Presentation Title:	New insights from neutron activation analysis and synchrotron X-ray fluorescence and absorption spectroscopy on aeolian dust from the Talos Dome ice core (East Antarctica, Ross Sea Sector)
Full Author List:	G. Baccolo1,2,3, B. Delmonte2, G. Cibin4, M. Clemenza3,5, D. Hampai6, A. Marcelli6, E. Previtali3,5, V. Maggi2,3
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ABSTRACT

Aeolian dust from the TALDICE ice core has been characterized through novel geochemical methods based on neutron activation analysis (INAA) and synchrotron X-ray fluorescence and absorption spectroscopy. Application of these techniques to ice core samples allowed to obtain a complete elemental fingerprint of dust based on major, trace and ultra-trace elements. Particular attention will be given to iron and titanium geochemistry and mineralogy. In addition, a new analytical protocol allowed to extend the lower grain size detection limit down to 600 nm and to recalibrate the old data. Combination of these new results on the TALDICE ice core and comparison with dust source areas allowed to recognize dust composition and mineralogy changes in different climate periods over the past 150 kyrs. These shifts could be related to mechanisms involving atmospheric circulation, environmental changes occurring at the sources, post-depositional processes or a combination of them. A discussion on these points will be presented, with a particular attention to the climatic implications.

Abstract

Tobias Erhardt

Submission ID	60
Name:	Tobias Erhardt
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	Towards reliable continuous particle size records from polar ice cores
Full Author List:	T. Erhardt1, H. Fischer1
Author Affiliations:	Climate and Environmental Physics and Oeschger Center for Climate Change Research, University of Bern, Switzerland

ABSTRACT

Mineral dust aerosol plays a major role in the radiative balance of the atmosphere as well as in fertilizing the ocean and land biosphere.
Ice cores have been used to reconstruct atmospheric dust load over the past 800 ka using proxies as well as direct measurements of insoluble particles in the ice.
Direct measurements of the insoluble particle content in ice is commonly done using either Coulter Counter (CC) type devices or Laser Particle Sizers (LPS).
CC are the reference method for the measurement of particle size distributions in discrete ice core samples.
However the sample preparation and decontamination are very work intensive.
To overcome this drawback, LPS sensors have been integrated into continuous flow analysis (CFA) setups and have been used to obtain high resolution continuous particle concentration records.
Unfortunately the LPS suffers from issues for the particle size calibration due to the optical properties and shapes of the particles.
This is mitigated by cross calibration to CC measurements, however the validity and stability over time and between sensors is questionable.
Here we present an adaption of the reference discrete Coulter Counter method for continuous flow measurements.
It is optimized for the application to polar ice core studies with extended lower limit of detection with regard to particle size while also improving sizing resolution and accuracy in comparison to the LPS it surpasses.
The CFA Coulter Counter enables the study of changes in the atmospheric dust concentration and size distribution in high resolution and in conjunction with other aerosols.

Abstract

Audrey M. Yau

Submission ID	61
Name:	Audrey M. Yau
Institution:	Desert Research Institute
Country:	USA
Presentation Title:	The WAIS Divide (6-68 ka BP) and the B40 ice core (0-2.5 ka BP) aerosol records
Full Author List:	A.M. Yau1, J.R. McConnell1, M. Sigl1,2, O. Maselli1, S. Kipfstuhl3
Author Affiliations:	1Desert Research Institute, Reno, USA 2Paul Scherrer Institut, Villigen, Switzerland 3Alfred-Wegener-Institut, Bremerhaven, Germany

ABSTRACT

Aerosols from sea spray, windblown dust, biomass burning, volcanism, and industrial activities impact biogeochemical cycles and climate forcing. With their short lifetimes in the atmosphere, aerosol concentrations and deposition in the polar regions maybe dominated by regional, rather than global sources, transport processes, and pathways. In addition, intra- and inter-annual variability of aerosol deposition maybe large. As a result, high-time-resolution records with a broad range of analytes are required to understand aerosol concentrations, sources, and variability while providing adequate information for evaluating global circulation, snowpack radiation, and other models. Here, we present a comprehensive dataset of trace elements for the WAIS Divide ice core covering the period 6 – 68 ka BP and the B40 ice core spanning the last 2500 years. We use a multivariate data analyses method (positive matrix factorization) to determine the source characteristics and source apportionments contributing to the observed datasets.

Abstract

Audrey M. Yau

Submission ID	62
Name:	Audrey M. Yau
Institution:	Desert Research Institute
Country:	USA
Presentation Title:	A 225-Year Pollen, Aerosol, and Pollutant Record from McCall Glacier, Alaska: Implications for Ice Core Records from Small, Polythermal Valley Glaciers
Full Author List:	A.M. Yau1, J.R. McConnell1, M. Sigl1,2, C.A. Reese3, M. Nolan4
Author Affiliations:	1Desert Research Institute, Reno, USA 2Paul Scherrer Institut, Villigen, Switzerland 3University of Southern Mississippi, Hattiesburg, USA 4University of Alaska Fairbanks, Fairbanks, USA

ABSTRACT

McCall Glacier in the Brooks Range, Alaska is a climate sensitive valley glacier that has recorded both regional and local climate information for the past 225 years. We present a comprehensive, high-resolution geochemical data set from a 152 m deep ice core, which includes a new, nearly annually resolved age scale for McCall Glacier, a record of accumulation rate, a number of different elements and chemical species (of which, S, Pu, Black Carbon, NH_4, Pb, Tl, Na, Mg, Al, Ca, Ce, and U are discussed here), and a history of ice core pollen concentrations and species. Records of accumulation rate, $\delta^{18}O_{ice}$, and pollen indicate that McCall Glacier faithfully documents regional climate signatures, namely influences of the Pacific Decadal Oscillation and recent regional warming. Tracers for dust and sea salt point to an increasing component of local dust and sea salt deposition since the end of the Little Ice Age. This signature is likely a result of sea ice retreat in the Arctic Ocean, and ice/snow retreat around the Brooks Range, Alaska since the end of the Little Ice Age. Indicators of industrial emissions and biomass burning resemble records from Greenland, indicating similar emissions sources. Collectively, these data indicate that McCall Glacier faithfully records the changing climate of the Alaskan Arctic.

Abstract

Dr. Nicole Spaulding

Submission ID	63
Name:	Dr. Nicole Spaulding
Institution:	University of Maine Climate Change Institute
Country:	USA
Presentation Title:	GLACIAL-INTERGLACIAL VARIABILITY IN PAIRED SURFACE ICE AND ICE CORE RECORDS FROM THE ALLAN HILLS BLUE ICE AREA, ANTARCTICA
Full Author List:	N.E. Spaulding1, P.A. Mayewski1,2, J.A. Higgins3, M.L. Bender3, S.B. Sneed1, M. Handley1, D. Introne1, A.V. Kurbatov1,2
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ABSTRACT

We have previously demonstrated that surface ice along the primary glaciological flow-line through the main ice field of the Allan Hills Blue Ice Area (AH BIA), Antarctica ranges in age from 90-250 ka and that ice as little as 125 meters below the surface is as old as 990 ka. We have also shown that the climate history inherited from stable water isotopes (δD and δ18O) in both surface ice and at depth within the AH BIA is consistent with other East Antarctic ice core-based climate records, suggesting it has been unaltered by stratigraphic disturbance between the accumulation region and its point of exposure in the ablation zone. Here, we show the first measurements of major ions and trace elements from surface trenches and ice cores collected throughout the AH BIA. These signals also appear to be well preserved, including within ice from the Eemian interglacial and much earlier. Because ice within the AH BIA generally never exceeds ~ 800 m depth, the climate record of even its oldest ice should not be impacted by the pressure related changes in fabric observed in deep Antarctic ice cores. As such, carefully selected samples from the AH BIA could enhance the existing continuous paleoclimate record. The proxy quality we observed extends to the surface ice, providing further evidence that the AH BIA is an ideal location for the development of an international "climate park" where it would be possible to conduct detailed multi-parameter investigations requiring large sample volumes impossible to attain with traditional ice coring techniques.

Abstract

Dipl.-Phys. Michael Döring

Submission ID	64
Name:	Dipl.-Phys. Michael Döring
Institution:	Climate and Environmental Physics, University of Bern
Country:	Switzerland
Presentation Title:	Matlab based automatization of an inverse surface temperature modelling procedure for Greenland ice cores using an existing firn densification and heat diffusion model
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ABSTRACT

Surface temperature reconstruction relies on firn densification combined with gas and heat diffusion (Severinghaus et al., 1998). In this study we use the model developed by Schwander et al. (1997). A theoretical δ15N record is generated for different temperature and accumulation rate scenarios and compared with measurements by minimizing the mean squared error (MSE).

The goal of the presented study is a Matlab based automatization of this inverse modelling procedure. The crucial point is to find the temperature and accumulation rate input values minimizing the MSE. We follow two approaches: (i) a Monte Carlo type input generator which varies each point in the input time series and calculates the MSE. Then the solutions that fulfil a given limit or the best solutions for a given number of iterations are saved and used as new input for the next model run. This procedure is repeated until the MSE is below a given threshold (e.g. analytical error of measurement data); (ii) different Matlab based derivative free optimization algorithms (Nelder-Mead Simplex Method, (Lagarias et al., 1998)) are used to find those values for temperature sensitivity and offset for calculating the surface temperature from the oxygen isotope records of ice core water samples minimizing the MSE as done manually by Kindler et al. (2013).

We compare two different approaches and apply them to existing observed time series from NorthGRIP (Kindler et al., 2013; Kobashi et al., 2015) and GISP2 (Kobashi et al., 2015) to retrieve surface temperature estimates that are compared to earlier evaluations.

Abstract

Dr Adam Treverrow

Submission ID	65
Name:	Dr Adam Treverrow
Institution:	Antarctic Climate and Ecosystems Cooperative Research Centre
Country:	Australia
Presentation Title:	Using ice core and borehole data from the Dome Summit South (DSS) drilling site to assess the performance of ice flow relations.
Full Author List:	A. Treverrow1, R.C. Warner1, W.F. Budd1, J.L. Roberts1,2, T.H. Jacka1
Author Affiliations:	1 Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Australia 2 Australian Antarctic Division, Kingston, Australia

ABSTRACT

Numerous field and laboratory observations indicate how multiple factors influence the dynamics of polar ice masses. These include the large-scale flow pattern, stress- magnitude, temperature and ice microstructure. Data obtained from polar ice cores, and their corresponding boreholes, provides a valuable resource for evaluating the flow relations for ice used in ice sheet models. In this study we use ice microstructure, temperature and strain rate observations from the Dome Summit South (DSS) ice-coring site at Law Dome to compare four anisotropic flow relations for polycrystalline ice. Observations from laboratory ice deformation experiments are used to guide assessment of the flow relation predictions for the DSS site. The flow relations in which the rheology is parameterised by a scalar anisotropic function, so that the strain rate and deviatoric stress tensor components are collinear, provide the most realistic simple shear and vertical compression stress profiles for the DSS site. Those flow relations where i) the anisotropy is derived from the magnitude of applied stresses resolved onto the basal planes of individual grains and ii) the macroscopic deformation is obtained via homogenisation of individual grain responses, provide stress estimates inconsistent with observations from experiments conducted in combined simple shear and vertical compression stress configurations that are similar to conditions at the DSS site. This analysis highlights the difficulties associated with the development of flow relations which incorporate a physically-based description of microdeformation processes. In particular, this approach requires the adequate parameterisation of all relevant microdeformation, recrystallisation and recovery processes.

Abstract

Trevor J. Popp

Submission ID	66
Name:	Trevor J. Popp
Institution:	Center for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	Drilling to Bedrock at the Renland Ice Cap (RECAP), East Greenland
Full Author List:	T.J. Popp, S.B. Hansen, L.B. Larsen, S.G. Sheldon, and B.M. Vinther
Author Affiliations:	Centre for Ice and Climate, University of Copenhagen, Copenhagen, Denmark

ABSTRACT

During May and June 2015 we drilled a 584.11 m ice core to bedrock through the Renland ice cap in East Greenland as part of the REnland Ice CAP Project (RECAP), a coordinated science program between Denmark, Germany, and the US. The task was completed over a single eight-week field season which included site selection, camp construction, drill installation, routine drilling operations, collection of subglacial material at the bedrock interface, and finally the removal of all camp facilities. The drilling was performed using a newly constructed version of the Danish Hans Tausen drill with design features and operational procedures that proved advantageous for collecting consistently good ice core quality, fast surface intervals between runs, efficient chips recovery, and the effective recycling of the ESTISOL-140 drilling liquid using a melting system to separate used drill liquid from the chips. Here we report on these efforts and offer our experiences with the use of HT-type drills, including chips transport and recovery, and advocate for the use of partial kerf (step) cutters for improved drilling performance.

Abstract

Steffen Bo Hansen

Submission ID	67
Name:	Steffen Bo Hansen
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Denmark
Country:	Denmark
Presentation Title:	Adaptations to the Hans Tausen drill design and the challenges for the EGRIP drilling
Full Author List:	S.B. Hansen, T.J. Popp, S.G. Sheldon, D. Wistisen
Author Affiliations:	Centre for Ice and Climate, University of Copenhagen, Copenhagen, Denmark

ABSTRACT

Through the last twenty years the Hans Tausen drill design has proven to be an effective concept for various ice drilling applications in both Greenland and Antarctica. Adaptations have been made for many shallow, intermediate and deep drilling systems by various groups. The versatile design allows for use in both dry and wet drilling modes, and is light weight with a modular design that allows for ease of deployment, assembly and operation. In Denmark, the design has also been adapted to perform passive borehole deviation and for the collection of subglacial basal material. Here we review our most recent updates to Danish HT-drill and lessons learned from recent deployments to Aurora Basin, Antarctica and to Renland, East Greenland. Our next challenge will come at EGRIP, Greenland which will require drilling to bedrock with the HT-drill in a fast moving ice stream with additional requirements for the recovery of higher quality brittle ice. We review our experiences and the coming EGRIP challenges, including the collection of basal and bedrock materials and proposals to improve the drill's performance for deviation drilling in inclined boreholes.

Abstract

Ms. Runa Antony

Submission ID	68
Name:	Ms. Runa Antony
Institution:	National Centre for Antarctic and Ocean Research
Country:	India
Presentation Title:	Role of microbial communities in dissolved organic matter cycling in Antarctic snow
Full Author List:	Antony R. 1; Willoughby A.S. 2; Grannas A.M. 3; Catanzano V. 3; Sanyal A.1; Sleighter R.L. 2,4; Thamban M. 1 and Hatcher P.G. 2
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ABSTRACT

Snow overlays the majority of the Antarctic continent and is a major habitable ecosystem on Earth. Despite its potential contribution to global biogeochemical cycles, little information exists on DOM transformation through supraglacial microbial communities. Here, culture-dependant and -independent microbiological analysis, combined with ultrahigh resolution mass spectrometry was used to study DOM cycling through in situ microbial processes. Using high resolution mass spectrometry, we were able to identify the presence of lignins, tannins, carbohydrates, proteins, lipids, unsaturated hydrocarbons, and condensed aromatics. Assessment of the microbial communities associated with the snowpack revealed the presence of a diverse assemblage of bacteria (Proteobacteria, Actinobacteria, Firmicutes, Bacteroidetes, Deinococcus-Thermus, Planctomycetes, Verrucomicrobia), Archaea (Euryarchaeota), and Eukarya (Basidiomycota, Ascomycota, Cryptomycota and Rhizaria). Several of the microbial phylotypes produced lipase, protease, amylase, β-galactosidase, cellulase, and lignin modifying enzyme, indicating that snowpack microbial communities may be active in supraglacial carbon cycling. In situ experiments revealed that supraglacial DOM is highly bio-available and is rapidly transformed by resident microbial communities through parallel processes of degradation and synthesis. Refractory compounds, such as dissolved black carbon and carboxylic-rich alicyclic molecules, were also rapidly and extensively reworked. Microbially reworked DOM exhibited an increase in the number and magnitude of N-, S-, and P-containing formulas suggesting that microbial processes may be important in the cycling of not only C, but other elements such as N, S, and P. Microbial reworking also appears to produce photo-reactive compounds, with implications for DOM photochemistry. Our findings highlight the relevance of microbes for supraglacial DOM cycling and suggest that post-depositional microbial processing of snowpack DOM need to be considered while interpreting past ice core records.

Abstract

Dr Carly Tozer

Submission ID	69
Name:	Dr Carly Tozer
Institution:	Antarctic Climate & Ecosystems CRC
Country:	Australia
Presentation Title:	An ice core derived 1013-year annual rainfall reconstruction for an eastern Australian catchment
Full Author List:	Tozer, C. R. 13 Vance, T. R. 1 Roberts, J. 12 Kiem, A. S. 3 Curran, M. A. J. 12 Moy, A. D. 12
Author Affiliations:	1 Antarctic Climate & Ecosystems CRC, Hobart, Australia 2 Australian Antarctic Division, Kingston, Australia 3 University of Newcastle, Callaghan, Australia

ABSTRACT

Water infrastructure design and flood/drought management planning for catchments in Australia is currently based on instrumental period statistics (~100 years of data). Paleoclimate research, however, indicates that the instrumental climate record does not cover the full range of climate variability possible. To better understand the implications of this for catchment-scale water resources management, 1013 years of annual rainfall is reconstructed for the Williams River catchment in coastal eastern Australia based on a teleconnection between the region and summer sea salt deposition recorded at Law Dome. The reconstruction shows that significantly longer and more frequent wet and dry periods were experienced in the preinstrumental compared to the instrumental period which suggests that flood and drought risk in the catchment is underestimated. This raises questions about the robustness of existing water security and flood protection measures and has serious implications for water resources management, infrastructure design, and catchment planning. The method used in this proof of concept study is transferable and enables similar insights into the true risk of flood/drought to be gained for other locations that are teleconnected to East Antarctica. This will lead to improved understanding and ability to deal with the impacts of multidecadal to centennial hydroclimatic variability.

Abstract

Mathieu Casado, Ph-D

Submission ID	70
Name:	Mathieu Casado, Ph-D
Institution:	LSCE
Country:	France
Presentation Title:	Measurements of isotopic composition of vapour on the Antarctic Plateau
Full Author List:	Mathieu Casado (1), Amaelle Landais (1), Valérie Masson-Delmotte (1), Samir Kassi (2), Erik Kerstel (2), Christophe Genthon (3), Etienne Vignon (3), Hans-Christian Steen-Larsen (1), Laurent Arnaud (3), Olivier Catani (1), Ghislain Picard (3), Frederic Pri
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ABSTRACT

The oldest ice core records are obtained on the East Antarctic plateau. The composition in stable isotopes of water permits to reconstruct past climatic conditions over the ice sheet and at the evaporation source. Paleothermometer accuracy relies on good knowledge of processes affecting the isotopic composition of surface snow in Polar Regions. Both simple models and global atmospheric models with isotopes provide good prediction of precipitation isotopic composition in East Antarctica but post deposition processes can alter isotopic composition on site, in particular exchanges with local vapour. To quantitatively interpret the isotopic composition of water archived in ice cores, it is thus essential to study the continuum water vapour – precipitation – surface snow – buried snow.

While precipitation and snow sampling are routinely performed in Antarctica, climatic conditions in Concordia, very cold and very dry, impose difficult conditions to measure the water vapour isotopic composition. New developments in infrared spectroscopy enable now the measurement of isotopic composition in water vapour traces. We present the results of a campaign of measurement of isotopic composition in Concordia in 2014/2015. Two infrared spectrometers have been deployed or the first time on top of the East Antarctic Plateau allowing a continuous vapour measurement for a month. Comparison of the results from infrared spectroscopy with cryogenic trapping validates the relevance of the method to measure isotopic composition in dry conditions. Identification of different behaviour of isotopic composition in the water vapour associated to turbulent or stratified regime indicates a strong impact of meteorological processes in vapour/snow interaction.

Abstract

Sven Erik Avak

Submission ID	71
Name:	Sven Erik Avak
Institution:	Paul Scherrer Institute
Country:	Switzerland
Presentation Title:	Development of a Cryocell for High-Resolution Trace Element Analysis of Ice Cores
Full Author List:	S.E. Avak1,2,3, M. Birrer1, M. Wälle4, T. Bartels-Rausch1, M. Schwikowski1,2,3, A. Eichler1,2
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ABSTRACT

Past changes of atmospheric pollution can be reconstructed from ice core trace element records of cold mountain glaciers. Due to the current global temperature increase glaciers at low and mid altitudes are in danger to turn into polythermal ones, where postdepositional processes like percolation of melt water alter the information originally stored in those environmental archives. The preservation of impurities with respect to melt water depends on whether they are located at grain boundaries or embedded into the matrix. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is the method of choice for the direct in situ chemical analysis of trace elements at high spatial resolution in ice (Sneed et al., 2015). However, applications with glacial ice samples show that some obstacles still remain. The quantification of signals and the internal standardization are not yet matured (Reinhardt et al., 2001, Della Lunga et al., 2014). Here, we present the setup of a newly designed cryocell compatible to a commercially available laser ablation system. This cryocell is able to simultaneously hold ice samples and frozen standard solutions for quantifying concentration differences between grain boundaries and ice grain interiors. Furthermore the development and optimization of frozen standards for calibration will be discussed. Once this analytical technic is established, this will smooth the way to investigate the potential of ice cores from polythermal glaciers as archives of past atmospheric pollution.

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Abstract

Prof. Thomas Blunier

Submission ID	72
Name:	Prof. Thomas Blunier
Institution:	Centre for Ice and Climate, University of Copenhagen
Country:	Denmark
Presentation Title:	Continuous gas measurements from ice cores
Full Author List:	T. Blunier1, D. Vladimirova1, R. H. Rhodes2, J Chappellaz3, Xavier Faïn3
Author Affiliations:	(1) Centre for Ice and Climate, University of Copenhagen, Copenhagen, Denmark (2) British Antarctic Survey, Cambridge, United Kingdom (3) University of Grenoble / Laboratoire de Glaciologie et Géophysique de l'Environnement, St Martin d'Hères, France

ABSTRACT

During the 2009 NEEM field season we tested for the first time the possibility to measure trace gases from the CFA melt stream. What seemed like an easy task given the new analytical possibilities of laser spectrometers turned out to be quite demanding. The main challenges lie in extracting the gas from the continuous melt stream and calibration of the system. Except for NEEM 2010 the method was applied in the laboratory and no longer in the field. We now have experience from a fair number of campaigns and we will show the advantages and limits of the method using two types of extraction membranes.

Abstract

Joseph M. Souney, Research Project Manager

Submission ID	76
Name:	Joseph M. Souney, Research Project Manager
Institution:	University of New Hampshire
Country:	USA
Presentation Title:	The 1500 m South Pole Ice Core: Recovering a 40,000 year environmental record
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ABSTRACT

The stable isotope, aerosol, and atmospheric gas records in ice cores provide exceptional archives of past climate. Supported by the U.S. National Science Foundation Division of Polar Programs, a new 40,000-year long ice core is being recovered from South Pole using the new U.S. Intermediate Depth Drill. During the 2014-2015 field season, 736 m were drilled and completion of drilling to 1500 m is expected during the 2015-2016 field season. Thus far, 556 m have been processed, with a bottom age of just over 7000 years determined by annual layer counting of visual stratigraphy and volcanic matches to the WAIS Divide record. The combination of low temperature, relatively high accumulation rate, and low impurity concentrations will yield a detailed record of atmospheric trace gases. The South Pole ice core will also provide a record of the climate history of a unique area of the East Antarctic plateau that is partly influenced by weather systems that cross the West Antarctic ice sheet.

Abstract

Assistant Professor Thomas Dylan Mikesell

Submission ID	77
Name:	Assistant Professor Thomas Dylan Mikesell
Institution:	Boise State University
Country:	USA
Presentation Title:	Laser ultrasonic characterization of annual layers in ice cores
Full Author List:	T. D. Mikesell, 1 K. van Wijk, 2 L. T. Otheim, 1 HP Marshall, 1 A. Kurbatov, 3
Author Affiliations:	1 Boise State University, Boise, USA 2 University of Auckland, Auckland, New Zealand 3 University of Maine, Orono, USA

ABSTRACT

The paleoenvironmental study of ice cores requires an accurate determination of the seasonal layering within the cores in order to establish a depth-age relationship. Current tools to identify these layers range from the interpretation of visual properties, to chemical, to electrical and to electromagnetic methods. In reality scientists often analyze a combination of data from these methods because no single technique captures every layer in all circumstances. Here we present a novel and complimentary method; whereby, we propose to use the variation in elastic parameters within an ice core to estimate seasonal layer stratigraphy and bulk changes in ice-crystal orientation. Our data acquisition system utilizes laser sources and receivers so as to be non-contacting and non-destructive to the ice core. The system resides within a cold room and we use computer-controlled motion stages to acquire data at sub-millimeter spatial resolution. We present results from an Antarctic ice core that lacks visual evidence of a layered structure. Using our new method, we are able to infer seasonal layering and layer orientation that is highly correlated with, and supported by, existing chemical analysis data and in-situ field observations.

Abstract

Jihong Cole-Dai

Submission ID	78
Name:	Jihong Cole-Dai
Institution:	South Dakota State University
Country:	United States
Presentation Title:	Perchlorate: A Potential New Proxy of Atmospheric Chemical Processes and Environment
Full Author List:	Jihong Cole-Dai1, Kari M. Peterson1, Thomas S. Cox1, and Dave G. Ferris2
Author Affiliations:	1: South Dakota State University, Brookings SD, United States 2: Dartmouth College, Hanover NH, United States

ABSTRACT

With a newly developed analytical method, we have measured ultra-trace perchlorate concentrations in snow and ice core samples from both Greenland and Antarctica. Typical perchlorate concentrations in polar snow are at the level of low nanograms-per-kilogram or parts-per-trillion (ppt), several orders of magnitude lower than major chemical impurities. For example, the average perchlorate concentration in recent Summit, Greenland snow is approximately 2 ppt; in surface and near-surface snow at South Pole and central West Antarctica, measured concentrations range approximately from a few to 40 ppt. We also observe significant temporal variations, on both short (sub-annual and annual) and long (decadal and longer) time scales.

Perchlorate in polar snow comes from primary sources (dust) and/or secondary sources (i.e., formation in the atmosphere). The higher concentrations in Antarctic snow (low dust) than in Greenland (high dust), along with patterns of temporal variation, suggest that production in the atmosphere is likely the dominant source of perchlorate, at least under present environmental conditions. Our preliminary data indicate that temporal variations in perchlorate concentration on decadal or longer time scales probably reflect the rate of perchlorate formation, which is likely related to atmospheric chemistry including ozone production. This connection makes perchlorate records from ice cores a potentially valuable proxy for atmospheric chemical processes and environment (e.g., oxidative capacity). Challenges to interpreting potential perchlorate records include (1) identifying key atmospheric precursors, (2) characterizing the chemistry of perchlorate formation, and (3) understanding processes affecting perchlorate preservation in snow.

Abstract

Favier Vincent

Submission ID	79
Name:	Favier Vincent
Institution:	LGGE
Country:	France
Presentation Title:	On the potential control of SAM and IPO climate variability on Law Dome sea salt deposition
Full Author List:	V. Favier1, T. Vance2, V. Masson-Delmotte3, J. Roberts2, V. jomelli4, N. Jourdain1, S. Goursaud3
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ABSTRACT

The Southern Annular Mode (SAM) is known largely control climate variability in the high and mid- latitudes of Southern hemisphere. The SAM positive (negative) phase results into strengthening (weakening) of the mid-latitude westerly wind belt and a poleward (equatorward) shift of this belt. Since the 1950s, the SAM increasingly shifted to its most positive phase (SAM+) over the last millennium, associated with a strong moisture decrease in particular in the southern Indian Ocean. Resulting from this situation, the storm track was shifted to the coastal regions of Antarctica, where the strength of the zonal winds is expected to have significantly increased. Here analyze and confirm this assumption using reanalysis and climate models data, precipitation at Kerguelen, and of sea salt deposition during summer from the Law Dome (LD) ice core in East Antarctica. However, sea salt deposition at Law Dome has been recently demonstrated to display decadal-scale variability similar to changes in the interdecadal Pacific oscillation (IPO). Here we use the 2ka sea salt signal from Law Dome to analyze a potential connection between the SAM and the IPO variability in order to interpret the resulting changes in large scale circulation over the Indian Ocean and on the incoming sea salt fluxes at Law Dome.

Abstract

Prof. Kumiko Goto-Azuma

Submission ID	80
Name:	Prof. Kumiko Goto-Azuma
Institution:	National Institute of Polar Research
Country:	Japan
Presentation Title:	Comparison of measurement techniques of micro-particles in polar snow and ice
Full Author List:	K. Goto-Azuma1, 2, M. Hirabayashi1, H. Motoyama1, 2, Y. Ogawa1, K. Sugiura3
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ABSTRACT

Temporal and spatial variations of concentration, size distribution and flux of water-insoluble micro-particles in ice cores give valuable information on the past climate and environment. Definition of particle size, however, is not always straightforward. Comparison of size distribution and flux data from different measurement techniques requires caution. To compare traditionally used techniques, we analysed same snow and ice samples with a Coulter Multsizer 4 (Coulter Counter) and a Met One Model 211 (a laser scattering type particle detector). We analysed some of the samples additionally with an Abakus (which detects shading of laser light caused by each particle). Coulter Multisizer 4 and Met One Model 211 gave similar results for MIS 16 ice samples from the Dome Fuji ice core drilled in East Antarctica. But they show different size distributions for Greenland snow, seasonal snow cover in Alaska, and MIS17 ice samples from the Dome Fuji ice core. Abakus also showed size distribution different from the other two detectors for Greenland snow. We used a new particle detector based on image processing technique, which enabled us to have information on particle shape. The new detector showed that Abakus and Met One Model 211 gave size distribution different from Coulter Multisizer 4 when particle shape departed greatly from spherical shape. The new detector would be a useful tool to analyse micro-particles in ice cores.

Abstract

Dr. Tian Lide

Submission ID	81
Name:	Dr. Tian Lide
Institution:	Institute of Tibetan Plateau Research, Chinese Academy of Sciences
Country:	China
Presentation Title:	Stable Isotope record from Qiangtang No. 1 Glacier, middle of the Tibetan Plateau
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ABSTRACT

A bedrock ice core was drilled at the col of the Qiangtang No.1 Glacier (33.29° 7N, 88.69° E, 5900m) in 2014, with an depth of 109m. The ice at the drilling site flows to two directions, making the glacier thinning easy to simulate. The bottom ice temperature is -2.1℃ above freezing point. This ice core was cut into 4387 samples for stable isotope analysis aiming to establishing the air temperature change in the central Tibet. Ice core surface dating is established by through measuring the total beta activity and 137Cs, confirming that the 9.0m depth is the 1963 radioactivity layer. By comparing with two other shallow ice cores drilled in 2011 and 2013, it is found that the accumulation rate is about 187mm of ice accumulation. In the bottom of the ice core, there are clear alternations between transparent ice (summer layer) and bubble layer (winter layer), make the annual counting possible. The bottom annual layer is about 2cm in depth. In this way, the dated ice core include a record of paleoclimate change of about 1000yrs.

The $\delta^{18}O$ variation with depth of the Qiangtang No.1 ice core shows a gradual increasing trend in the past millennium. The δ-excess variation with depth shows a gradual increasing trend, parallels with that of $\delta^{18}O$ in the long-term trend. However, the high frequent δ-excess fluctuations show apparent opposite variation, reflecting the dry-humid variation in the past millennium.

Abstract

Sentia Goursaud

Submission ID	82
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Institution:	Laboratoire des Sciences du Climat et de l'Environnement (LSCE
Country:	FRANCE
Presentation Title:	What controls the triple isotopic composition of water in the precipitations of Bolivia?
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ABSTRACT

Combining the measurements of all stable isotopic ratios of water (δD, δ18O, δ17O) in ice core allows the reconstruction of several climatic parameters. In polar ice cores, this combination can lead to reconstruction of polar temperatures as well as humidity and temperature of the oceanic water sources. Unfortunately, such reconstructions were never done on tropical ice cores. In the tropical regions, the interpretation of water isotopic ratios, and especially second order parameters such as d-excess and 17O-excess, is still questionable. Here, we propose to progress in the understanding of water isotopic ratios of water, and especially the added value of 17O-excess, by comparing present day measurements and outputs of different types of models (from simple models to atmospheric general circulation models equipped with water isotopes). We especially try to disentangle the different influences of distillation of a water mass, reevaporation, refilling of the water mass from soil water through transpiration, equilibrium evaporation or evaporation including both equilibrium and kinetic fractionations.

Our basic objective is to understand the seasonal cycle of water isotopic parameters. For this, we have compiled water isotopic measurements in the Zongo Valley (16°6''S-68°3''W) in Bolivia for the years 2007/2008 and 2009/2010. We have especially performed the first measurements of δ17O in seasonal cycles in Bolivia. The measurements enable us to obtain a characteristic difference between wet and dry season in δ18O, d-excess and 17O-excess. Then, we have compared the data with outputs of two General Circulation Model, LMDZ-iso (AGCM equipped with isotopes) and iLOVECLIM (coupled model of intermediate complexity equipped with water isotopes). However, these two models do not permit to disentangle the influence on each process on the isotopic composition of the precipitations. We thus developed a simple isotopic model simulating the history of an air mass along the trajectory from the ocean to the Zongo Valley for each season. In this simple isotopic model, we have

included separately distillation, reevaporation, transpiration without fractionation and evaporation with different kinds of fractionations. The model is run on different water mass trajectories for the dry and the wet seasons. Modelled δ18O and δD values of precipitations along the trajectories from the coast to the Zongo valley are then confronted with water isotopic ratios available from the IAEA/GNIP network on stations over the trajectories. This modelling study enables us to propose the most plausible explanation for the seasonal difference (wet - humid seasons) in δ18O, d-excess and 17O-excess in the Zongo valley. These results are of direct use for the interpretation of water isotopic records in Andean ice cores.

Abstract

Dr. Alison Criscitiello

Submission ID	83
Name:	Dr. Alison Criscitiello
Institution:	University of Calgary
Country:	Canada
Presentation Title:	Influence of tropical-Arctic teleconnections on ice core marine aerosol records from Prince of Wales Icefield, Ellesmere Island, Nunavut, Canada
Full Author List:	S. Marshall1, M. Evans2, M. Sharp3
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ABSTRACT

Recent surface warming over Greenland and the northeastern Canadian Arctic has been strongly influenced by remote forcing from the tropics. Cooling tropical sea surface temperature (SST) since the 1970's have impacted the climate of the Canadian Arctic via an atmospheric Rossby wave. Here, we demonstrate that tropical SST anomalies also influence the transport of marine-derived aerosols to the northeastern Canadian Arctic. Using a coastal ice core collected from the Prince of Wales (POW) Icefield, Ellesmere Island, the relationship between sea ice–modulated chemical species and large-scale atmospheric variability in the tropics is investigated (1979–2001). SST anomalies in the eastern tropical Pacific generate an atmospheric Rossby wave response that influences atmospheric circulation over Greenland, Baffin Bay, and the eastern Canadian Arctic. Regression analyses reveal negative sea level pressure (SLP) anomalies over southern Greenland and southern Baffin Bay during times of MSA deposition, resulting in wind patterns in Baffin Bay favorable for opening of the North Water Polynya (NOW), and subsequent oceanic dimethyl sulfide (DMS) production. Air mass transport density analyses reveal significant residence times over NOW for air masses reaching the ice core site, consistent with a marine biogenic source within the polynya. Regression analyses during times of Cl- deposition reveal positive SLP anomalies over southern Baffin Bay, indicating a broader oceanic region of sea-salt sources to the core site. These results suggest glaciochemical records from our new 2015 POW ice core will capture both local polynya and regional Baffin Bay sea ice variability.

Abstract

Daniel Baggenstos

Submission ID	84
Name:	Daniel Baggenstos
Institution:	Climate and Environmental Physics, University of Bern
Country:	Switzerland
Presentation Title:	Insights into Taylor Dome from Taylor Glacier
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ABSTRACT

The Taylor Dome ice core record has been the subject of much debate. It suggests an abrupt, Greenland-style deglacial warming, unlike the rest of Antarctica, which experienced a more gradual transition over several thousand years. The validity of the Taylor Dome record has been questioned but there are to date no other temperature records from that region. We use measurements of calcium and H_2O isotopes in a true horizontal ice core from Taylor Glacier to show unambiguously that the Taylor Dome area temperature history is synchronous with the warming observed in other Antarctic ice cores, and not with North Atlantic records. We also find that the accumulation rate during the Last Glacial Maximum was extremely low, the overestimation of which led to the error in the original time scale. There is evidence from noble gas isotopic composition that a substantial convective zone formed during the same period. We present a new Taylor Dome time scale to replace the now obsolete original Taylor Dome chronology.

Abstract

Dr. Nan Zhang

Submission ID	85
Name:	Nan Zhang Dr.
Institution:	Polar Research Center of Jilin University
Country:	China
Presentation Title:	Ice and Bedrock Electromechanical Drill (IBED): Control, Electronics and Electrical Design
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ABSTRACT

Ice and Bedrock Electromechanical Drill 'IBED' is a new special equipment applied to core drill in ice sheet and subglacial bedrock in polar regions which was developed in Polar Research Center at Jilin University, China. Control, Electronics and Electrical systems are major parts of the IBED drill system. The control subsystem mainly includes drill control and winch control panels. It can be operated to control the drill motor in drill tools in borehole and the winch on surface, further, drilling key points of whole drilling process including lowering and lifting speed, penetration rate, rpm of motor would be controlled. The components of electronics subsystem are distributed in drill tools and surface devices. The electronics subsystem is comprised of distinct sensors, data sending unit, data receiving and relay unit. It is in charge of monitoring the drilling status during drilling process, and converting signals of various parameters, meanwhile, communicating with host computer which shows parameters by monitor. Electrical subsystem includes surface d.c. power supply and power control unit in drill tools. It supplies power for drill motor, pump motor, and electronics components in pressure chamber. The power will processed by converter and lower voltage electric circuit constituted from driver and power modules which are main parts of power control unit. CAN bus has been used for communication between surface and borehole. In addition, friendly and multifunctional interfaces and software were designed. In the interfaces, data are displayed in form of graph and digital, and audible and visual alarm were designed.

Abstract

Anna Dal Farra

Submission ID	86
Name:	Anna Dal Farra
Institution:	Paul Scherrer Institute
Country:	Switzerland
Presentation Title:	Effect of particulate matter on the albedo of alpine glaciers
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ABSTRACT

Glaciers worldwide are melting and one of the determining factors in this phenomenon is the lowering of snow albedo by light absorbing particles. These particles absorb solar radiation converting it into heat, thus accelerating melt. are particles of soot, organic matter and mineral dust. Plaine Morte glacier (Switzerland) was selected as study site and samples were collected. To quantify the amount of soot (Elemental Carbon), organic matter and mineral dust a thermal method was employed. The sample is combusted and the CO_2 emitted at the different temperatures is detected. The measurements reveal the preponderance of mineral dust (96%) in the samples. To determine the relative albedo lowering property of each component a hyperspectral imaging spectrometer was employed. An average reflectance spectrum was defined from the numerous spectra collected for each type of particle (soot, mineral and organic), and their integral was calculated. The ratio between the averaged spectra suggest that soot and organic matter reflected the least while minerals the most. Considering the link between absorption and reflection we defined each component's albedo lowering property. Thus we obtained both the average quantity of each component on the glacier and their relative albedo lowering property. Combining the two results we obtain a measure of which component contributes more to the lowering of surface albedo. In the case of Plaine Morte glacier it was found that the primary cause of albedo reduction is the large presence of mineral dust (98% mineral, 4% organic and 2% soot).

Abstract

Dr. Rachael H. Rhodes

Submission ID	87
Name:	Dr. Rachael H. Rhodes
Institution:	University of Cambridge
Country:	United Kingdom
Presentation Title:	Methane dynamics in the Last Glacial and deglaciation at millennial to centennial timescales: Implications for tropical hydroclimate
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ABSTRACT

Online methane (CH_4) records obtained from NEEM and WAIS-Divide mirror Greenland ice core $\delta^{18}O$ variability across Dansgaard-Oeschger (D-O) events. Growing evidence ascribes these millennial scale CH_4 oscillations to tropical wetland emissions responding to tropical hydroclimate shifts forced by the Northern high-latitudes. In line with this idea, CH_4 and Greenland $\delta^{18}O$ become decoupled during Heinrich stadials and across the deglaciation, when the tropics are not the predominant source of CH_4.

The WAIS-Divide online CH_4record (67.2-9.8 ka BP) also captures a previously unrecognised mode of atmospheric CH_4 variability at centennial timescales. This variability is reproducible within both replicate samples and Greenland ice of the same age. In comparison with D-O events, the CH_4 oscillations have relatively low amplitudes (10 vs. 100 ppb) and are more gradual and symmetric in form. However, in common with D-O events, many features appear to have counterparts in Greenland ice core $\delta^{18}O$ and Hulu Cave speleothem $\delta^{18}O$. Despite the high frequency signal being dampened by firn-based processes, it clearly persists through the glacial, deglaciation and earliest Holocene—time periods of vastly different climate, ice sheet geometry and sea level. Furthermore, preliminary analysis suggests that the amplitude of centennial scale variability is greater during interstadials compared to stadials.

Based on these observations, we explore the hypothesis that a high latitude-tropics teleconnection, similar to that driving D-O event CH_4 variability, is responsible for centennial scale CH_4 variability and consider the implications for the modern-day CH_4 budget.

Abstract

Dr. Mauro Rubino

Submission ID	88
Name:	Dr. Mauro Rubino
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Country:	Italy
Presentation Title:	Terrestrial uptake due to cooling responsible for low atmospheric CO_2 during the Little Ice Age
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ABSTRACT

Models of future carbon cycle-climate changes predict a large range in atmospheric CO_2, mainly because of uncertainties in the response of the land carbon cycle to the future temperature increase. The Little Ice Age (LIA, 1500-1750 AD) CO_2 decrease is the most significant pre-industrial atmospheric change over the last millennia and has been used to derive the climate sensitivity of the global carbon cycle (δ). While a recent study confirms that pre-industrial CO_2 variations were caused by changes in land carbon stores, there are open questions about the size of the atmospheric LIA CO_2 decrease reconstructed from ice cores, and about what caused the land to sequester CO_2. To quantify the size of the LIA CO_2 decrease, we have produced new CO_2 measurements from DML ice, that support the DSS LIA CO_2 decrease as a real atmospheric feature. To partition the contribution of ocean and

land, we have measured the $\delta^{13}C\text{-}CO_2$, showing that the cause of the CO_2 drop was uptake by the terrestrial biosphere. To identify whether the land uptake was caused by temperature, or by a decline in farming due to pandemics, we have simulated the effect of a temperature perturbation on atmospheric Carbonyl Sulfide (COS). In agreement with the previously published positive COS anomaly, our results indicate that Global Primary Productivity (GPP) decreased during the LIA, ruling out the early anthropogenic land use change hypothesis as the dominant cause of increased terrestrial carbon storage. This allows us to obtain a new, more coherent estimation of δ in the range -10/-60 Pg of C K-1.

Abstract

Dr Joel B. Pedro

Submission ID	90
Name:	Dr Joel B. Pedro
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Country:	Denmark
Presentation Title:	Antarctic Isotope Maximum Events forced by Southern Ocean deep convection
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ABSTRACT

Antarctic Isotope Maxima (AIM) are centennial-to-millennial-scale warming events, of 0.5–2.5 °C amplitude, observed in Antarctic ice core records from the last glacial period. Here we argue that heat storage and release from Southern Ocean (SO) intermediate depths can drive these Antarctic temperature variations. Simulations with the Kiel Climate Model feature unforced and quasi-periodic SO deep convection, in which massive ocean heat loss (ca. 10^{23} J) and internal southern-high latitude feedbacks ultimately cause temperature variations of 0.5–2.0 °C at Antarctic ice core sites.

The model results and comparison with ice and marine core data lead us to propose a mechanism for AIM events, comprising three steps. (1) Preconditioning, heat accumulates at depth in the stratified glacial SO, leading the water-column toward a buoyantly unstable state. (2) Convection onset, wind and sea ice changes (potentially influenced by remote atmospheric teleconnections) tip the preconditioned system into the convective state. (3) Ocean–atmosphere readjustment warms Antarctica via a two-timescales process: firstly, convective heat release amplified by sea-ice–albedo feedbacks immediately increases local sea surface temperature (SST); secondly (on multidecadal–century timescales) buoyancy loss from the convective zone forces a southward migration of SO fronts, an increase in the meridional temperature gradient and a poleward intensification of the Westerlies. The enhanced temperature gradient and Westerlies then support an increased atmospheric heat and moisture transport over Antarctica. Our mechanism offers an explanation for the lag between Greenland Stadial/Interstadial transitions and AIM onsets/terminations that was recently identified in the WAIS Divide ice core.

Abstract

Dr Célia Julie Sapart

Submission ID	91
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Institution:	Laboratoire de glaciologie (ULB)
Country:	Belgium
Presentation Title:	Reconstructing the recent methane atmospheric budget using firn air methane stable isotope analyses
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ABSTRACT

Methane is a strong greenhouse gas and large uncertainties exist concerning the future evolution of its atmospheric abundance. Analyzing methane mixing and stable isotope ratios in air trapped in polar ice sheets helps in reconstructing the evolution of its sources and sinks in the past. This is important to improve predictions of atmospheric CH4 mixing ratios in the future under the influence of a changing climate. We present an attempt to reconcile methane stable isotopes $\delta^{13}C(CH_4)$ and $\delta D(CH_4)$ records from 11 (for $\delta^{13}C(CH_4)$) and 5 (for $\delta D(CH_4)$) boreholes in firn from both Greenland and Antarctica to reconstruct a consistent methane atmospheric history over the last 50 years. In the firn, the atmospheric signal is altered mainly by diffusion and gravitation. These processes are taken into account by firn air

transport models. We show that for $\delta^{13}C(CH_4)$ the atmospheric signal is of the same order of magnitude as the firn fractionation which, together with other uncertainties such as inter-calibration problems, complicates the reconstruction of a consistent $\delta^{13}C(CH_4)$history from multi-site firn air data.
For $\delta D(CH_4)$, the atmospheric signal is about 10 times larger than firn fractionation, therefore the reconstruction is much less sensitive to firn processes. This large signal allows a very consistent reconstruction from firn air from both Antarctica and Arctic firn air data. The $\delta D(CH_4)$ firn air scenarios from both poles are used as input in an atmospheric inverse model to calculate the contribution of the different sources and sinks responsible for the atmospheric changes in methane observed for the past decades. Our preliminary results show that the $\delta D(CH_4)$ signature of the global methane source became more enriched from 1950 to the mid-1980's and started to decrease later on and we show that it is likely caused by changes in enriched sources such as: fossil or combustion sources.

Abstract

Florian Steinbach

Submission ID	92
Name:	Florian Steinbach
Institution:	Eberhard Karls University of Tübingen and AWI
Country:	Germany
Presentation Title:	Microdynamical simulations of polyphase deformation and recrystallisation processes in polar ice and firn
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ABSTRACT

The Antarctic and Greenland ice sheets store a significant amount of air within their upper, approximately thousand meters. Research shows how the presence of air inclusions can influence the microdynamical processes that affect the flow of ice (Azuma et al., 2012, Roessiger et al., 2014). The microdynamics of pure ice were successfully modelled by e.g. Montagnat et al. (2014) or Llorens et al. (2015), but studies taking into account second phases are scarce. Therefore, polyphase modelling was performed to focus on the implications of bubbles on recrystallisation and deformation.

The full-field theory crystal plasticity code (FFT) of Lebensohn (2001), was coupled to the 2D multi-process modelling platform Elle (Bons et al., 2008), following the approach by Griera et al. (2013). FFT calculates the viscoplastic response of polycrystalline materials deforming by dislocation glide, taking into account mechanical anisotropy. Our models further incorporate surface- and strain-energy driven grain boundary migration and intracrystalline recovery. Sequential operation of each process for small time steps enables multi-process modelling of deformation and concurrent recrystallisation.

Results show that air inclusions lead to increased strain localization and hence locally enhanced dynamic recrystallisation. This is in accordance with Faria et al. (2014), who theoretically predicted such localization, based on firn data from the EPICA Dronning Maud Land (EDML) deep ice core. Our results confirm that strain-induced grain boundary migration already occurs in the uppermostlevels of ice sheets, as observed by Kipfstuhl et al. (2009) and Weikusat et al. (2009) in the EDML core.

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Abstract

Dr. Ping Yao

Submission ID	93
Name:	Dr. Ping Yao
Institution:	Institute of Tibetan Plateau Research, Chinese Academy of Sciences
Country:	The People's Republic of China
Presentation Title:	Climate variability during the past 2000 years archived in the Tanggula ice core on the central Tibetan Plateau
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ABSTRACT

A 190.5m ice core was retrieved in 2004 from the Longxiazailongba Glacier in the Tanggula mountains of the central Tibetan Plateau. This upper 158m ice core yields paleoclimatic and environmental records extending through the past 2000 years on the base of multiparametric approaches including radioactivity horizons, annual layer counting of the seasonally varying signals, and the glacial flow model evaluation. Annual ice-core $\delta^{18}O$ records were positively correlated with surface air temperature data from nearby meteorological stations, suggesting that the $\delta^{18}O$ records are reliable temperature proxies in this region. The decadal average $\delta^{18}O$ results are set up to eliminate the dating uncertainties, and the entire curve shows an increasing trend during fluctuation. It fluctuated for the beginning to the end of 7th century, after an about 500-year long cold period, a warm period appeared and lasted about 100 years and then varied up and down over the average line, and then rose dramatically in the 20th century. No obvious Medieval Warm Period was captured by the ice core. However, the Little Ice Age within three cold events was documented clearly, even if it was not the coldest era in the past 2000 years. The 20th century was the warmest century compared to any other time in the past two millennia. As the Longxiazailongba ice core located in the boundary of the westerly and the Indian monsoon circulation, this ice-core climatic record complements previous ice-core histories from different parts of the Tibetan Plateau.

Abstract

Sébastien Pivot

Submission ID	94
Name:	Mr Sébastien Pivot
Institution:	Cerege-AMU
Country:	France
Presentation Title:	Analytical developments of the Chlorine-36 measurements in ice cores for the study of past solar activity and geomagnetic excursions.
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ABSTRACT

The study of cosmogenic nuclides, the beryllium 10 (10Be) and the chlorine 36 (36Cl) from ice cores or carbon 14 (14C) from tree rings, allows to reconstruct their production rates in the atmosphere. This production rate depends on the primary galactic cosmic ray particles that are deflected and modulated by magnetic fields of the Earth and of the Sun.
Once produced, the 36Cl, the 10Be and the 14C atoms have a different fate in the atmosphere. Thus, their comparison allows to get free from their own behavior in order to better constrain their production rates and finally this permits to observe solar activity variations through time and to detect geomagnetic lows such as excursions.
Only a few 36Cl ice core records are available. The scarcity of 36Cl data is mainly due to technical limitations that are now solved thanks to advances in Accelerator Mass Spectrometry. The Accelerator Mass Spectrometer, ASTER, installed at CEREGE allows to measure a large amount of 36Cl samples with a high precision.
We will present the first analytical developments on the extraction and the analysis of 36Cl from ice cores based on tests on standard and blank samples. Then, we will show preliminary 36Cl results from a Dome C ice core, covering the last 2,000 years and studied at a high resolution in order to detect the 11 year solar cycle that have already been observed in 10Be measurements.

Abstract

Peter Neff

Submission ID	95
Name:	Peter Neff
Institution:	University of Rochester
Country:	United States
Presentation Title:	Trajectory modeling of modern dust transport to Antarctic ice core sites
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Author Affiliations:	1. Victoria University of Wellington Antarctic Research Centre, Wellington, NZ 2. GNS Science, Lower Hutt, NZ 3. University of Rochester, Rochester, USA

ABSTRACT

Aerosol deposition over the Southern Ocean and Antarctica has the potential to alter marine productivity and thus ocean carbon uptake while also impacting radiative balance due to scattering and absorption from atmospheric particulates. Quantification of modern emission, transport and deposition of terrestrial dust and other airborne material from Southern Hemisphere sources is challenging due to low emission levels and poor detection from remote sensing platforms. We use forward trajectory modeling to explore atmospheric transport, independent of deposition processes, from 1979 to 2013. Trajectories are initiated from known arid dust source areas in South America (Patagonia), Australia, and southern Africa, with detailed consideration of New Zealand as a potential source. Results suggest that Patagonian and New Zealand dust and other aerosol emissions share strong atmospheric transport during all seasons, allowing even potentially small New Zealand emissions to contribute significantly to Southern Ocean and Antarctic aerosol loading. New Zealand and Patagonia rapidly contribute a high proportion of trajectories to West Antarctica, while in interior East Antarctica source contributions are limited and highly mixed. The sensitivity of existing deep ice core sites to modern atmospheric transport is discussed. Finally, interannual variability of poleward trajectory extension over the Pacific and Atlantic sectors of the Southern Ocean highlights the association of both tropical Pacific sea-surface temperature and high-latitude wind variability with transport of dust and other aerosols to the Southern Ocean and Antarctica.

Abstract

Alejandra Borund

Submission ID	97
Name:	Alejandra Borunda
Institution:	Lamont Doherty Earth Observatory, Columbia University
Country:	United States
Presentation Title:	Dust Provenance in West Antarctica
Full Author List:	Borunda, A. (1), Winckler, G. (1,2) , Goldstein, S., (1,2) Kaplan, M. (2), and Vallelonga, P. (3)
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ABSTRACT

Terrestrial mineral dust, transported from its source to a distal sink such as a polar ice core, can be used to trace past and present atmospheric transport patterns. The provenance of dust delivered to East Antarctica during cold glacial periods has previously been identified as Patagonia, but whether Patagonia also dominated dust delivery and deposition in West Antarctica was previously unknown. We identified the source of glacial-age dust in the WAIS Divide ice core and the Taylor Glacier horizontal ice core by analyzing of Sr, Nd, and Pb isotopes of dust extracted from ice samples, and find that southern South America dominates the delivery of dust to West Antarctica, as well as East. In Pb-Pb isotope space, the isotopic signatures vary across millennial-scale climate events, suggesting either changes in source area within Patagonia or a different mixing ratio between distal dust delivery and input from local Antarctic particulates. Dust, therefore, is sensitive to changes in hemispheric circulation, and records small-scale changes in both the South American source and in transport and depositional pathways.

Abstract

Associate Professor Tang Xueyuan

Submission ID	98
Name:	Associate Professor Tang Xueyuan
Institution:	Polar Research Institute of China
Country:	China
Presentation Title:	Ice thickness, Internal layers and subglacial bed topography in the vicinity of the Chinese Taishan station of Princess Elizabeth Land, East Antarctica, revealed by grounded radio-echo sounding
Full Author List:	Tang Xueyuan, Guo Jingxue, Sun Bo, Wang Tiantian, Cui xiangbin
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ABSTRACT

We present the results of two ground-based radio-echo sounding (RES) and GPS surveys carried out in the vicinity of the new Chinese Taishan Station, Princess Elizabeth Land, East Antarctica, during two austral summers of the 2004/2005 CHINARE-21 and 2012/2013 CHINARE-29. The radar surveys measured the ice thickness and the internal layers using 60MHz and 150MHz radar system. The GPS measurement showed the ice surface around the station is flat with altitudes of 2607-2636 m above sea level (a.s.l.).The radar profiles indicated an average ice thickness of ~1900 m, with a maximum reaching 1949 m and a minimal ice thickness of 1856 m, in a square area of ~ 2km×2km around the station. The ice thickness beneath the station site is 1870m.The subglacial landscape beneath the Taishan station is quiet sharp ranging from 662 to 770m a.s.l. , revealing a part of a mountainous topography. Ice volume of 7.6 km^3 in the grid is estimated. On a 60 MHz radar profile with a length of 17.6 km near the station, some internal layers disturbed can be identified and traced. The geometry of internal layers within englacial stratigraphy may imply a complex depositional process in the area.

Abstract

Dr. Jérôme Chappelaz

Submission ID	99
Name:	Dr. Jérôme Chappelaz
Institution:	CNRS Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE
Country:	FRANCE
Presentation Title:	The SUBGLACIOR probe for reconnaissance of potential oldest ice sites: concept, design and current status
Full Author List:	J. CHAPPELLAZ1, O. ALEMANY1, J. TRIEST1, M. CALZAS2, O. CATTANI3, J.F. CHEMIN1, Q. DESBOIS4, T. DESBOIS4, R. DUPHIL1, S. FALOURD3, R. GRILLI4, C. GUILLERME2, E. KERSTEL4, B. LAURENT1, E. LEFEBVRE1, N. MARROCCO4, O. PASCUAL1, L. PIARD1, P. POSSENTI1, D. R
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ABSTRACT

In response to the 'oldest ice' challenge initiated by the International Partnerships in Ice Core Sciences (IPICS), new rapid-access drilling technologies through glacier ice need to be developed. These will provide the information needed to qualify potential sites on the Antarctic ice sheet where the deepest section could include ice that is >1Ma old and still in good stratigraphic order. Identifying a suitable site will be a prerequisite for deploying a multi-year deep ice-core drilling operation to elucidate the cause and mechanisms of the mid-Pleistocene transition from 40 ka glacial–interglacial cycles to 100 ka cycles.

As part of the ICE&LASERS/SUBGLACIOR projects, we have designed an innovative probe, SUBGLACIOR, with the aim of perforating the ice sheet down to the bedrock in a single season and continuously measuring in situ the isotopic composition of the melted water and the methane concentration in trapped gases. We present the general concept of the probe, as well as the various technological solutions that we have favored so far to reach this goal, and lastly the current status of the probe construction and tests.

Abstract

Dr. Naoko Nagatsuka

Submission ID	100
Name:	Dr. Naoko Nagatsuka
Institution:	National Institute of Polar Research
Country:	Japan
Presentation Title:	Variations in Sr and Nd isotopic ratio of dust in Arctic snow
Full Author List:	N. Nagatsuka1, Y. Ogawa1, K. Goyo-Azuma1, K. Sugiura2, H. Enomoto1, T. Nakano3
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ABSTRACT

Eolian dust from vast deserts can be transported globally by wind and effect various environments on the Earth. The past variations in the eolian dust can be reconstructed by particle analysis of ice cores.

Stable isotopic ratios of Sr and Nd provide a means of identifying dust sources. The means can be used for the ice core dust because it requires low amount of samples for analysis. These isotopic ratios of the ice core dust depend on geological source and pathway of the dust. In this study, we analyzed Sr and Nd isotopic ratios of the dust collected from snow in several Arctic regions (Siberia, Mongolia, Alaska, and Greenland).

The Sr and Nd isotopic ratios of dust in Arctic snow showed geographical variations. This suggests that origins of the dust are substantially different among the regions. Compared with the isotopic ratios of loess, desert sand, and moraine reported over different regions, those of the dust from Mongolia and Greenland were close to those of nearby source regions. This result indicates that dust in snow from these two regions was mainly derived from surrounding regions. On the other hand, the isotopic ratios of dust in Alaskan snow were close to those of desert in Kazakhstan and Taklamakan Desert, suggesting that the dust was transported from such distant deserts to Alaska.

Abstract

Franciéle Schwanck Carlos

Submission ID	101
Name:	Franciéle Schwanck Carlos
Institution:	Centro Polar e Climático
Country:	Brazil
Presentation Title:	A 125-year record of climate and chemistry variability in a West Antarctica ice core
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ABSTRACT

Regions under marine influence are important as they reflect atmospheric conditions resulting from changes in ocean circulation and sea ice. The Mount Johns ice core (79°55'S; 94°23'W) was collected near the ice divide of the West Antarctica ice sheet during the 2008–2009 austral summer, reaching a depth of 92.26 m. The upper 45 m of the record covers approximately 125 years (1883-2008), showing a marked seasonal variability with an mean accumulation rate of 0.21 m w. eq. a^{-1}. Trace elements concentrations in 2137 samples were determined using inductively coupled plasma mass spectrometry. The concentrations of Al, Ba, Ca, Fe, K, Mg, Mn, Na, Sr, and Ti at the core site are controlled by seasonal climatic changes (summer/winter), transport distance, and natural sources of these aerosols. Natural contributions from dust, mainly derived from the arid areas of Patagonia and Australia, are important sources for aluminum, barium, iron, manganese and titanium. Marine aerosols from sea ice and transported by air masses are important sources of sodium and magnesium. Calcium, potassium and strontium showed considerable contributions of both continental dust and marine aerosols. Correlations between trace element concentrations and sea surface temperatures (SST) from ECMWF Re-Analysis Interim show that the Southern Ocean SSTs are correlated with concentrations found at Mount Johns. However, correlations with 2-meter air temperatures are much lower meaning that the concentrations at the site are marine driven more so than atmospheric.

Abstract

Sarah Aarons

Submission ID	104
Name:	Sarah Aarons
Institution:	University of Michigan
Country:	United States
Presentation Title:	Addressing the impact of ice shelf retreat on local climate: A case study of the effect of the Ross ice shelf retreat upon the surrounding coastal area
Full Author List:	S.M. Aarons1, S.M. Aciego1, P. Gabrielli2, B. Delmonte3, and M. Blakowski1
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ABSTRACT

Ice cores from Antarctica provide valuable records of past climates encompassing hundreds of thousands of years. Recent declines in ice shelf and sea ice extent in polar regions highlight the importance of evaluating variations in local weather patterns due to climate change. Chemical and mineralogical characterization of airborne mineral particles (dust) transported through the atmosphere and deposited on ice sheets and glaciers in Antarctica allows reconstruction of regional and global climatic systems throughout time. We present high time resolution radiogenic isotope (strontium, neodymium, hafnium) data for dust entrained in ice from 0-55 ka using ice from a 'horizontal ice core' taken from the Taylor Glacier, the outlet glacier for Taylor Dome (77°47'47" S, 158°43'26" E), accompanied with rare earth element (REE) composition, dust concentration, and size distribution of dust during the Last Glacial Maximum (LGM)-Holocene transition. We use these combined ice core data to determine dust provenance, with variations indicative of shifts in either dust production, sources, and/or transport pathways. The combined measurements have thus been used to infer an evolving local climate in the Ross Sea Region.

Abstract

David Thornton

Submission ID	106
Name:	David Thornton
Institution:	CSIRO
Country:	Australia
Presentation Title:	The ^{14}C O_2 bomb pulse in firn air at Aurora Basin, East Antarctica.
Full Author List:	D.P. Thornton 1, D.M. Etheridge 1, C.M. Trudinger 1, M. Rubino 2 , A.M. Smith 3 , M.A.J. Curran 4 , T.R. Vance 4 and J. Chappellaz 5
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ABSTRACT

The ^{14}C isotope of CO_2 produced in the atmosphere by nuclear weapons testing in the 1960's is incorporated in air in open pores of firn before close-off in bubbles in Antarctic ice. The rapid growth and subsequent decline provides a unique test for the smoothing of atmospheric CO_2 signals due to firn diffusion and bubble close off, and the level of smoothing quantifies the time resolution with which trace gas histories can be reconstructed from ice cores. The presence of a 'bomb pulse' in the record also permits accurate dating of CO_2 and other gases in air.

Aurora Basin North (ABN) will contribute new and valuable 2000-year atmospheric records from this data sparse region of inland East Antarctica. ABN has an annual snow accumulation up to 150 kgm^{-2} $year^{-1}$, a low mean annual temperature and high elevation. Firn air samples were collected from ABN during December 2013 in stainless-steel canisters and cylinders and 0.5L glass flasks, from varying depths covering the whole firn column at the ABN site.

Extraction of CO_2 from ABN samples has been performed at the CSIRO ICELAB and transferred to ANSTO to derive the ^{14}C activity of CO_2 in ABN firn air. As expected, results suggest the age spread at ABN is wider than sites with higher accumulation, such as Law Dome. Firn modelling is also planned and the ^{14}C results will be used as inputs for the modelling to help determine (with other gas measurements) the age and age spread of air in firn and ice at ABN.

Abstract

David Thornton

Submission ID	107
Name:	David Thornton
Institution:	CSIRO
Country:	Australia
Presentation Title:	Atmospheric reconstruction at Patriot Hills, West Antarctica.
Full Author List:	D.P. Thornton 1, D.M. Etheridge 1, M. Rubino 2, C.S.M. Turney 3 and C.J. Fogwill 3
Author Affiliations:	1 CSIRO Oceans & Atmosphere, Aspendale, Victoria, Australia. 2 Dipartimento di Matematica e Fisica, Seconda Università di Napoli, viale Lincoln 5, 81100 Caserta Italy. 3 Climate Change Research Centre, School of Biological, Earth and Environmental Sciences, UNSW.

ABSTRACT

Ice core programs involve the vertical drilling and collection of ice in order to develop the history of an ice sheet, the atmospheric composition and climate. The extraction and analysis of air within bubbles trapped within the ice matrix to assess past concentrations of trace gases contributes to this endeavour. Blue Ice Areas (BIAs) however provide an opportunity to access ice which has been dynamically tilted, stripped of snow and ablated at the surface. This upwelling of ancient ice to the surface in effect provides a horizontal ice core, therefore negating the requirements associated with traditionally expensive and logistically complex vertical drilling programs. It also allows access to large volumes of ice for analysis of trace gases and their isotopes that require large sample size.

As part of a wider ice sheet history study, we report on a reconstruction of trace gas concentrations from the Patriot Hills BIA in West Antarctica. This area presented issues with ice core quality (cracks, possible impurities) and made the extraction of air from within ice core bubbles a challenge.

By matching multiple trace gas concentrations with trace gas records from different Antarctic sites and improving the quality of the ice cores via deeper samples, results thus far suggest our trace gas measurements from Patriot Hills can be used to reconstruct atmospheric and climatic changes through the Holocene and into the last interglacial period.

Abstract

Akane Tsushima

Submission ID	108
Name:	Akane Tsushima
Institution:	National Institute of Polar Research
Country:	Japan
Presentation Title:	Understanding spatial distribution of δ17O and 17O-excess in surface snow at the Greenland and East Antarctica ice sheets.
Full Author List:	T. Akane1, G. Vasileios2, G.-A. Kumiko1,3, M. Hideaki1,3, S. Martin4, A. Teruo5, D. Remi1 and V. Bo2
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ABSTRACT

Stable water isotope ratios (δD and δ18O) in ice cores have long been used as proxies for past temperature. A second-order parameter d-excess, defined as d-excess = δD – 8δ18O, mostly depends on the sea surface temperature and relative humidity in the water vapor source region. Therefore, d-excess has been used to deduce a water vapor source and to understand climate change in the water vapor source region.

With the improvement of water isotope analyzers, the ability to measure δ17O in water with high precision provided another second- order parameter: 17O-excess = ln (δ17O+1) - 0.528 × ln (δ18O+1). Previous studies reported that 17O-excess in polar snow is mainly controlled by the relative humidity in the water vapor source region, therefore expected as a new proxy of past climate change. In this study, we analyzed δ17O and 17O-excess in surface snow collected along the 1000 km long traverse route from the coastal (Syowa station) to the inland Dome Fuji station and across the Greenland ice sheet.

Abstract

Dr Samuel Poynter

Submission ID	111
Name:	Dr Samuel Poynter
Institution:	Curtin University
Country:	Australia
Presentation Title:	Volcanic sulfate deposition across a high accumulation gradient regime at Law Dome
Full Author List:	S. Poynter1, M. Curran2,3, C. Plummer3, A. Moy2,3, T. van Ommen2,3, J. Roberts2,3, T. Vance3, J. McConnell4, D. Etheridge5.
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ABSTRACT

Ice cores provide an important means to estimate sulfate aerosol loadings for past volcanic events, and hence to estimate the climate forcing of these events. Snow deposition is influenced by the physical characteristics of the site, including local and regional atmospheric circulation patterns and the relative importance of deposition with precipitation ("wet" deposition) versus settling from the atmosphere independent of precipitation ("dry" deposition). Localised variation in volcanic sulfate deposition is not widely understood, in part due to the small number of ice core sites with spatial and precipitation controls.

Here we describe a study that uses the well-dated volcanic records from Law Dome and the observed strong spatial gradient in accumulation to investigate differences in sulfate deposition for nine volcanic events over the period of 270 years up to 2009 CE. The largest events over this period are the 1815 CE Tambora eruption and the 1809 CE southern hemisphere eruption. We investigate four cores along an east-west transect of approximately 40 km, essentially perpendicular to the accumulation gradient. These cores all sample essentially the same air mass.

The absolute concentration of volcanic sulfate is in agreement between the sites for the 8 smallest events, as expected for wet deposition without any local perturbations (e.g. washout, erosional losses). Concentrations for the Tambora event however display a negative relationship with respect to the accumulation rate, increasing at the lower accumulation sites. This may be the result of variation in transport and deposition processes for very large volcanic events which produce very high atmospheric sulfate loading, although the mechanism is unclear.

Understanding the mechanisms responsible for this observation will help improve uncertainty estimation for ice core-inferred sulfate deposition estimates for other sites.

Abstract

Alemany Olivier

Submission ID	112
Name:	ALEMANY OLIVIER
Institution:	LGGE / CNRS
Country:	FRANCE
Presentation Title:	The SUBGLACIOR drilling probe: hydraulic considerations
Full Author List:	Alemany. O1,2, Triest. J1,2, Talalay. P3 ,Boissonneau. P1.2, Chappellaz. J1,2, Chemin. JF1,2, Piard. L, Podoliak. A4, Possenti. P and Wingert. L1,2
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ABSTRACT

Using significant technological breakthroughs and unconventional approaches, the ANR SUBGLACIOR and ERC Ice&Lasers projects aim to advance ice core research by inventing, constructing and testing an in-situ probe to evaluate if a target site is suitable to recover ice as old as 1.5 million years. The probe will make its own way down into the ice and, relying on the progress of laser technology, will measure in real time and down to the bedrock the depth profiles of the ice δD water isotopes, as well as the trapped CH4 gas concentration. The probe, anticipated to have a diameter of around 110 mm, will electromechanically drill down into the ice sheet to a depth of possibly 3500m and will sample the melt water continuously using a downward pointing melt-probe. One key aspect of the project is to design and implement an efficient method to continuously remove the ice chips from the borehole. Here we conduct a detailed analysis of the flow rates and pressures required to overcome friction losses and effectively transport the ice chips to the surface in order to size the whole drilling system.

Abstract

Barbara Stenni

Submission ID	113
Name:	Barbara Stenni
Institution:	Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice
Country:	Italy
Presentation Title:	Reconstructing Antarctic climate over the last 2000 years
Full Author List:	B. Stenni1,2, on behalf of PAGES Antarctica2k members
Author Affiliations:	1. Department of Environmental Sciences, Informatics and Statistics - Ca' Foscari University of Venice, Venice, Italy 2. Institute for the Dynamics of Environmental Processes - CNR, Venice, Italy

ABSTRACT

Paleotemperature reconstructions from Antarctica mainly rely on water stable isotope records from ice cores. The key factor controlling this proxy has been mainly related to temperature variations; however this is not always straight forward and other processes acting on different spatial and temporal scales may influence the calibration between water stable isotopes and temperature. These processes can include precipitation-weighting of recorded air temperature, post-depositional movement and loss of snow, and ice flow and elevation effects. Early efforts to reconstruct the continental-scale temperature history of Antarctica over the past 2000 years indicated that at the continent-scale Antarctica is the only land region where the long-term cooling trend of the last 2000 years has not yet been reversed by recent significant warming. However, this Antarctic temperature reconstruction has large uncertainties and masks important regional-scale features of Antarctica's climate evolution over the last 2000 years. Here using a greatly expanded paleoclimate database and new reconstruction methodologies we present the initial results obtained from the Antarctica2k working group in the framework of the PAGES 2k initiative aiming to reconstruct the climate of the past 2000 years at both global and continental scales. This will include the compilation of ice core isotope records over 5 distinct climatic regions (Antarctic Peninsula, West Antarctica, the East Antarctic Plateau, and two coastal domains of East Antarctica), and the comparison of these synthesis products with paleoclimate evidence from other archives (borehole temperatures, inert gas isotopes, marine and lake sediment records).

Abstract

Massimo Frezzotti

Submission ID	114
Name:	Massimo Frezzotti
Institution:	ENEA
Country:	Italy
Presentation Title:	Decadal migration of Dome C and Talos Dome inferred by global navigation satellite system measurements
Full Author List:	L. Vittuari1, C. Ritz2, S. Urbini3, A. Zanutta1 and M. Frezzotti4
Author Affiliations:	1 DICAM, Bologna, Italy 2 LGGE, Grenoble, France 3 INGV, Roma, Italy 4 ENEA, Roma, Italy

ABSTRACT

To improve understanding of present dome-divide dynamics it is necessary to establish how the dome responds to current and past environmental conditions. The behaviour of ice dome position is a significant parameter for the accurate interpretation of ice core records. Due to the extremely difficult field conditions in the inner part of East Antarctica, the extremely low slope (less than 0.1 m per km) of the domes and their surface morphology at meter scale (e.g., sastrugi) it is a great challenge to determine the summit point of the dome and its migration over time. Due to the extremely slow velocity (from meter to decimetre per yr) and deceleration/acceleration (mm per yr) information about the dynamic of dome summit can be extracted only by repeated ice velocities measured on dedicated stakes by the Global Navigation Satellite System measurements (GNSS). Twenty years ago in the framework of EPICA Dome C (DC) and Talos Dome (TD) ice core projects, stake networks were established. Since 1996, using GNSS these surface strain networks have been measured 5 times at TD and 3 times at DC. These GNSS measurements have highlighted changes in ice velocity patterns at both domes, with a deceleration and acceleration in the opposite portions and the migration of dynamic dome summit. These change are apparently correlated with changes in accumulation distribution inferred by snow radar measurements. The observed behaviour in velocity and accumulation indicates that even the most remote areas of East Antarctica are changing also from the decadal to secular scale.

Abstract

John M. Fegyveresi

Submission ID	115
Name:	John M. Fegyveresi
Institution:	U.S. Cold Regions Research and Engineering Laboratory (CRREL)
Country:	USA
Presentation Title:	Visual Stratigraphy, EMC Volcanic Matching, and a New Depth-Age Scale for the South Pole Ice Core (SPC14) to ~7ka.
Full Author List:	J.M. Fegyveresi1,4 T.J. Fudge2 D.G. Ferris3 R.B. Alley4
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ABSTRACT

We have developed a chronology to 556m and ~7100 years BP (bf 1950) for ice ages of the SPC14 South Pole Ice Core. This ice-age timescale is based on two independent data sets: (1) visual identification of annual layers, and (2) matches of electrical conductivity (ECM) peaks to dated volcanic sulfate concentration peaks in the WAIS Divide ice core (WDC06A). The visual identification of annual layers was based on coarse-grained and/or depth-hoar layers and included an estimate of uncertainty. A total of 42 SPC14 ECM peaks were confidently tied to WDC06A sulfate peaks as determined by independent investigators. Comparing these data sets, a timescale was determined by adjusting the vis-strat interpretation within uncertainties to best match ages of ECM peaks. The maximum offset in ages between the vis-strat timescale and the ECM matches is 5 years and is within the uncertainty of the WAIS Divide timescale (WD2014). The oldest ECM match is at 524.9m depth (~6662 years BP) and the bottom age at 556m is 7103 ± 71 years BP. Ice-flow layer thinning is estimated assuming a uniform vertical strain rate. The average accumulation rate is 7.54 cm a-1 (w.e.), approximately equal to the modern value. The accumulation history shows variability at centennial to millennial timescales which may be climatological in origin or a result of ice flow over varying topography. The visual investigation and ECM data both noted uniform stratigraphy with no significant dips in layering. This chronology agrees well with other independent ice-age estimates for the South Pole site.

Abstract

Barbara Stenni

Submission ID	116
Name:	Barbara Stenni
Institution:	Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice
Country:	Italy
Presentation Title:	δ18O and deuterium excess records from the GV7 ice core (Oates Coast, East Antarctica)
Full Author List:	B. Stenni1,2, E. Selmo3, G. Dreossi1, M. Frezzotti4, B. Narcisi4, A. Spolaor1, S. Becagli5, B. Delmonte6, J. Gabrieli2, C. Scarchilli4
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ABSTRACT

Here we present an overview of the GV7 drilling project along with the δ18O and deuterium excess records obtained from a snow pit (4 m), two shallow firn cores (5.6 m and 12 m long respectively) and at the main drilling (low-resolution 60 cm-samples) which reached a depth of 245 m ice. This core was drilled at a near coastal site in East Antarctica, during the 2013-2014 Italian Antarctic Expedition. The project, funded by PNRA with KOPRI cooperation, represents a contribution to the IPICS theme "The 2k Array". The drilling site (GV7, 70°41'S, 158°52'E; elevation 1950 m, T= – 31.8°C), located on the ice divide extending from the Oates Coast to Talos Dome, is characterised by a relatively high snow accumulation rate (240 mm w.eq. during the last 150 years). Previously, a 55 m-length firn core was retrieved in the same area. The obtained data, combined in a multicore-approach, will be used to produce a stacked climate record of the past centuries with at least an annual resolution.
A preliminary age scale was built using a snow accumulation rate of 237 mm w.eq. for the upper part of the core and two stratigraphic markers represented by the bottom age (1855 CE) of the previous core and a tephra layer found at 183 m dated 1254 ± 2 CE. The low-resolution δ18O profile indicates a cooling trend over the last millennium, while the deuterium excess record shows an abrupt increase between 1400 and 1450 CE, which suggests an atmospheric circulation change.

Abstract

Jonas Beck

Submission ID	117
Name:	Jonas Beck.
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	Bipolar CH4, δ13CH4 and δD(CH4) measurements over the Holocene
Full Author List:	J. Beck1, M. Bock1, J. Schmitt1, B. Seth1, T. Blunier[2], H. Fischer1
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ABSTRACT

The past variations of the atmospheric methane (CH_4) concentration is observed to be generally in phase with the insolation cycle. However, in the mid-Holocene this regularity breaks down, and atmospheric CH_4 starts to rise again while the northern summer insolation continues to decline. To date, there is no clear explanation for the evolution of the atmospheric methane concentration during the Holocene.

Here we present records of methane and both its stable isotopes ($\delta^{13}C$ and δD) measured on polar ice cores from both Greenland (NGRIP) and Antarctica (EDML and TALDICE) over the period of the Holocene. These data allow us not only to draw conclusions about the hemispheric imbalance of the ancient sources and sinks of methane, but due to the different isotopic fractionation also about the importance of the individual processes involved in the past methane cycle.

A two-box model approach enables us to calculate the mean hemispheric CH_4 emissions and their isotopic signatures analytically.

The results indicate that more than half of the additional methane that led to the change in the CH_4 trend 6,000 years ago was emitted in the southern hemisphere mainly by isotopically heavy methane sources. This may contradict the much debated hypothesis, attributing this rise to the increase in rice agriculture in China at this time, thus causing the observed divergence between the atmospheric CH_4 concentration and insolation.

Abstract

Olivier Eicher.

Submission ID	118
Name:	Olivier Eicher
Institution:	University of Berne
Country:	Switzerland
Presentation Title:	High-resolution NGRIP total air content record sensitive to insolation and rapid DO-warmings
Full Author List:	O. Eicher1, M. Baumgartner1, A. Schilt1, J. Schmitt1, J. Schwander1, H. Fischer1, T.F. Stocker1
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ABSTRACT

We present a high-resolution dataset of total air content (TAC) along the North Greenland Ice Core Project (NGRIP) ice core. The TAC measurements are a byproduct of CH_4 and N_2O measurements and therefore provide TAC data in unprecedented resolution, however, the measurement technique was not designed especially for this purpose and was not optimized for TAC precision.

The TAC shows a clear insolation signature and wavelet analysis reveals strong precession and obliquity contributions, comparable to previous TAC records from Antarctic ice cores. This provides independent Greenland evidence of a local insolation influence on snow structure and thus TAC.

The unprecedented resolution makes it also possible to investigate the TAC response to Dansgaard-Oeschger (DO) events. On average TAC is decreasing by 3-4% during a DO-event and the decrease starts synchronously with the surface temperature warming as documented in $\delta_{15}N2$.

Previous studies suggested pore volume at close-off to depend on firn temperature, however that effect is much too small and would show a phase lag in TAC relative to the temperature changes. Moreover, our results suggest that the firn temperature/pore volume relation may hold only in steady-state. Instead our observed TAC variations during stadial/interstadial transitions represent a direct imprint of changes in the number density of the air enclosed in the bubbles by changes in the gas temperature and potentially synoptic pressure.

Abstract

John M. Fegyveresi

Submission ID	119
Name:	John M. Fegyveresi, Research Physical Scientist
Institution:	U.S. Cold Regions Research and Engineering Lab (CRREL)
Country:	U.S.A.
Presentation Title:	The development and formation mechanism behind the very-low-porosity crusts (i.e. “glazes”) observed on the surface at the WAIS Divide site, West Antarctica: an integrated surface and ice core study
Full Author List:	J.M. Fegyveresi1,2 R.B. Alley2 A. Muto3 M.K. Spencer4
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ABSTRACT

Observations at the WAIS Divide site show that near-surface snow is strongly altered by weather-related processes, such as strong winds and temperature fluctuations, producing features that are recognizable in the ice core. Prominent reflective “glazed” surface crusts develop frequently during summer. Summertime surface observations from 2008-2013, supplemented by Automated Weather Station (AWS) data with insolation sensors, revealed that crusts formed during relatively low-wind, low-humidity, clear-sky periods with intense daytime sunshine. After formation, such glazed surfaces typically developed cracks in a polygonal pattern with few-meter spacing, likely from nighttime thermal contraction. Cracking was commonest when several clear days occurred in succession, and was generally followed by surface hoar growth. Vapor escaping through the cracks during sunny days may have contributed to the high humidity that favored nighttime formation of surface hoar; temperature and radiation observations showed that solar radiation often warmed the near-surface snow above the air temperature, contributing to mass transfer favoring crust formation and then surface hoar formation.

Subsequent investigation of the WDC06A deep ice core revealed preserved surface crusts (often “bubble-free”) averaging ~4.3 ± 2 yr-1. They are consistently ~35-45% more common in layers deposited during summers than during winters. Although no one has been on-site to observe crust formation during winter, it may be favored by greater wintertime wind-packing from stronger peak winds, large meteorologically-forced temperature changes reaching as high as -15°C in midwinter, and perhaps longer intervals of surface stability.

Abstract

Marcel Haeberli

Submission ID	120
Name:	Marcel Haeberli
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	Global mean ocean temperatures in the late Pleistocene based on ice core noble gas thermometry
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Author Affiliations:	Climate and Environmental Physics, Physics Institute and Oeschger Center for Climate Research, University of Bern, Bern, Switzerland

ABSTRACT

Oceanic heat uptake carries the lion's share of glacial/interglacial changes in the planetary heat content, and is thus the most integrative and representative parameter for quantifying long-term changes in the Earth's energy budget. The krypton/xenon ratio in the atmosphere is a proxy for mean ocean temperature (MOT) because of the temperature dependence of their solubility coefficients. The MOT in past times can therefore be estimated using high-precision measurements of noble gas elemental ratios from gases trapped in glacial ice. To reconstruct the true atmospheric abundances the ice core measurements need to be corrected for systematic fractionations in the firn column. We present elemental ratios and isotopic composition from a suite of inert and noble gases (nitrogen, argon, krypton, xenon) that allow us to quantify and correct for the fractionation effects. The resulting temperature change between today's ocean and the LGM ocean is 2.45±0.5°C, while the difference between today and the late glacial stage ocean (approx. 30 ka) amounts to 1.9±0.5°C. During the Eemian, the MOT was 2 to 3°C higher than today. These findings are consistent with most previous estimates of deep ocean temperature based on benthic foraminifera. The derived MOT estimates represent only snapshots of the ocean heat content at a given time, which is a convoluted signal of sea surface temperature of the preceding millennia and ocean ventilation. Upcoming measurements of Termination 1 in high temporal resolution will allow a closer look at the transient response of ocean heat content under changing boundary conditions.

Abstract

Bess Koffman

Submission ID	122
Name:	Bess Koffman
Institution:	Dartmouth College
Country:	USA
Presentation Title:	Abrupt Late Holocene Shift in Atmospheric Circulation Recorded by Mineral Dust in the Siple Dome Ice Core, Antarctica
Full Author List:	B. G. Koffman, S. L. Goldstein, M. R. Kaplan, G. Winckler, A. Bory, P. Biscaye
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ABSTRACT

Dust provenance information from Antarctic ice cores has until now been limited to sites in East Antarctica. Here we present some of the first provenance data from West Antarctica. We use Sr-Nd isotopes to characterize dust extracted from late Holocene ice (~1000-1800 C.E.) from the Siple Dome ice core. The data form a tight array in Sr-Nd isotope space, with 87Sr/86Sr ranging between ~0.7087 and 0.7102, and εNd ranging between ~ -7 and -16. This combination is unique for Antarctica, with low Nd and low Sr isotope ratios compared to high-elevation East Antarctic sites, requiring a dust source from ancient (Archean to early Proterozoic) and unweathered continental crust, which mixes with young volcanic material. Both components are likely sourced from Antarctica. We also observe significant, systematic variability in Sr and Nd isotopic signatures through time, reflecting changes in the mixing ratio of these sources, and hypothesize that these changes are driven by shifts in circulation patterns. A large change occurs over about 10 years at ca. 1125 C.E. (ΔεNd = +3 and Δ87Sr/86Sr = -0.0014). This shift coincides with changes in climate proxies in Southern Hemisphere paleoclimate records reflecting variability in the Westerlies. We therefore interpret the shift in dust provenance at Siple Dome to be related to larger-scale circulation changes. In general, the observed shifts in the particle source signatures indicate that dust transport pathways to and around the West Antarctic Ice Sheet are highly responsive to perturbations in atmospheric circulation, and can record rapid shifts in provenance.

Abstract

Associate Prof. Emmanuel Witrant

Submission ID	123
Name:	Associate Prof. Emmanuel Witrant
Institution:	Université Joseph Fourier
Country:	France
Presentation Title:	A new automatic synchronization method applied to high-resolution methane records.
Full Author List:	E. Witrant1, P. Martinerie2, F. Parrenin2
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ABSTRACT

New continuous flow analysis records of methane concentration from different ice cores show many common features at short time scale. However examining their detailed consistency, for example with firn smoothing deconvolution models, requires precise chronological synchronisation.

We developed a fast and user-friendly chronology synchronisation method which requires the pre-definition of at most two match points. It allows to easily evaluate the similarity between two sequences of the same proxy and correct the chronology of one signal to be optimally consistent with the other. It is based on auto-correlation analysis performed on a moving time-window. A recursive implementation of the method provides a continuous estimate of the age shift between the signals. In order to properly implement the boundary conditions, one match point can be specified near each end of the signals. The maximum allowed age shift as well as its smoothness are specified by the user. It is optionnally possible to rescale one signal with respect to the other, e.g. as a first order correction of an inter-hemispheric difference. We discuss the efficiency and limitations of this method and show example results.

Abstract

Dr Andrew Milford Smith

Submission ID	124
Name:	Dr Andrew Milford Smith
Institution:	Australian Nuclear Science and Technology Organisation (ANSTO)
Country:	Australia
Presentation Title:	A quasi-monthly record of 10Be concentration at Law Dome, Antarctica, from 2000 to 2015.
Full Author List:	A.M. Smith1, M.A.J. Curran2,3, D.M. Etheridge4, B.K. Galton-Fenzi2,3, U. Heikkilä5, A.R. Klekociuk2,3, A.D. Moy2,3, J.B. Pedro6, K.J. Simon1 & T.D. van Ommen2,3.
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ABSTRACT

This paper presents an overview of work undertaken over a number of Australian Antarctic Science projects, beginning in season 2001/02 with a shallow snow pit. In season 2005/06 this was augmented with a 260 m thermally drilled ice core and a 4.5 m snow pit. A core taken in 2008/09 overlapped the 2005/06 core and pit samples. From 2009/10, short cores spanning a few year's deposition, along with snow pit samples spanning about half a year, have been taken each season. This has continued through to the current 2015/16 season. The cores permit an overlap with earlier years to match the chronology and to yield samples for ^{10}Be analysis at the Australian Nuclear Science and Technology Organisation (ANSTO) by the technique of accelerator mass spectrometry (AMS). Together, the data provide a unique, continuous, quasi-monthly record over 2000 to 2015 as we have moved from Solar Cycle 23 to 24. The snow pits yield larger samples for ^{7}Be analysis, earlier by gamma spectroscopy but lately by AMS. Along with comparison with neutron monitor data and GCM modelling, this unique, high-precision record has enabled us to learn much about the production, transport and deposition of ^{10}Be to Law Dome and to improve our use of ^{10}Be as a proxy for past solar variability.

Abstract

Tine Nilsen

Submission ID	125
Name:	Tine Nilsen
Institution:	University of Tromsoe, the Arctic University of Norway
Country:	Norway
Presentation Title:	Is there a break in scaling on centennial time scale in Holocene temperature records?
Full Author List:	T. Nilsen1, K. Rypdal1, Hege-Beate Fredriksen1, D. Divine1,2
Author Affiliations:	1) University of Tromsoe, the Arctic University of Norway, Tromsoe, Norway 2) Norwegian Polar Institute, Tromsoe, Norway

ABSTRACT

A variety of paleoclimatic records have been used to study scaling properties of past climate, including ice core paleotemperature records and multi-proxy reconstructions. Analysis of a scaling exponent in a climate related series and its changes across the range of time scales allow testing for the presence of long-range dependence in the background climate process. This may have further implications for the inference on statistical significance of trends and extremes in the data. Records extending further back in time than the Holocene are divided into glacial/interglacial segments before analysis. By elaborating on physical mechanisms for the actual climate fluctuations seen in the paleoclimatic temperature records as well as uncertainties in both data and methods, we demonstrate the possible pitfalls that may lead to the conclusion that the variability in temperature time series can be separated into different scaling regimes. Categorizing the Earth's surface temperature variability into such regimes has little or no practical meaning since the different components in the climate system are connected and interact on all time scales. Our most important result is that a break between two different scaling regimes at time scales around one century cannot be identified in Holocene climate. We do, however, observe departures from scaling, which can be attributed to variability such as a single internal quasi-periodic oscillation, an externally forced trend, or a combination of factors. If two scaling regimes are claimed to be present in one single time series, both regimes must be persistent. We show that the limited temporal resolution/length of the records significantly lowers the confidence for such persistence.

Abstract

Dr. Patrick Ginot

Submission ID	126
Name:	Dr. Patrick Ginot
Institution:	Institut de Recherche pour le Développement (IRD)
Country:	France
Presentation Title:	Black Carbon emission and deposition fluxes reconstructed from shallow Illimani firn core (Bolivia).
Full Author List:	P. Ginot 1,2, D. Aliaga3, I. Moreno3, S. Lim2,6, F. Vimeux4,5, P. Laj2 ,M. Andrade 3, F. Velarde3
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ABSTRACT

Ice cores from high altitude sites are the best archive for past atmospheric composition in inhabited regions. In this study, we use a firn core from Illimani glacier (6430m, Bolivia) to reconstruct 15 years of Andean atmospheric composition and their changes. This high resolution record for a wide range of chemical or physical proxies was produced with the new continuous flow analytical system developed at LGGE. It allows to identify each particular deposition event related to biomass burning or dust plumes, to characterize their sources and to reconstruct deposition fluxes for some particular light absorbing species (black carbon, dust) from 2009 to 1994. In comparison with atmospheric aerosol chemistry and physics monitored at Chacaltaya station, the seasonal pattern and events composition in the ice core shows strong similarities opening interesting perspectives for past atmospheric data extension. The deposition fluxes of black carbon were compared with MODIS AOD indexes over the Amazonian emission basin and Illimani region. Focusing on particularly strong biomass burning years (2007 and 2004), the detailed deposition and post-deposition processes of aerosol in the snow pack were investigated and correlated to meteorological and remote sensing information. Preliminary estimation of light absorbing particles impact on glacier melting were established and compared with previous results from the Himalaya.

Abstract

James Edward Lee

Submission ID	128
Name:	James Edward Lee
Institution:	Oregon State University, College of Earth, Ocean, Atmospheric Sciences
Country:	USA
Presentation Title:	Dating of the Roosevelt Island Ice Core and the interhemispheric relationship of warming during the last deglaciation
Full Author List:	J.E. Lee1, E.J. Brook1, N.A.N. Bertler[2], J.P. Severinghaus3, T. Blunier4, C. Buizert1, F. Parrenin5, T.J. Fudge6, H. Conway6, E.D. Waddington6, D. Dahl-Jensen4, P. Vallelonga4
Author Affiliations:	[Oregon State University],[Corvallis],[USA]

ABSTRACT

Ice cores drilled in Antarctica have proven to be remarkable archives of past climate, but most have been recovered from the remote Antarctic interior. In contrast, little is known about the climate history of coastal ice domes despite their relevance to ocean-ice interaction and sea level rise. The Roosevelt Island Climate Evolution project (RICE) recovered a 763 m ice core in 2013 from Roosevelt Island, West Antarctica. Located at the edge of the Ross Ice Shelf and grounded below sea level, Roosevelt Island is sensitive to oceanic forcing and may provide new information about potential drivers of abrupt interhemispheric climate connections. Its location is ideal for exploring the retreat of the West Antarctic Ice Sheet (WAIS) from its glacial maximum through the Ross Sea.

Here we present a continuous chronology for the RICE Ice Core covering the last 40,000 years by synchronizing new records of methane and the isotopic composition of atmospheric oxygen ($\delta^{18}O$ of O_2) to the established WAIS Divide WD2014 chronology (Buizert 2014, Sigl 2015). Evidence from a new record of $\delta^{15}N$ of N_2 from the RICE ice core documents an abrupt climatic or glacial adjustment starting near 15 ka. Timing of this abrupt event precedes Northern Hemisphere warming, near synchronous with early warming at several other coastal domes.

Abstract

Dr. Joel Barker

Submission ID	130
Name:	Dr. Joel Barker
Institution:	Ohio State University
Country:	USA
Presentation Title:	Changes in the concentration and size of black carbon particles in the Dasuopu Ice Core, central Himalaya.
Full Author List:	J.D. Barker1 P. Gabrielli2 S. Kaspari3 A. Wegner[2] R. Sierra2 E. Beaudon2 C. Uglietti2 L. Thompson1
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ABSTRACT

Black carbon (BC) is a product of incomplete biofuel, hydrocarbon, and biomass combustion. BC affects climate by absorbing solar radiation in the atmosphere and decreases the albedo of snow covered surfaces. Studies have highlighted the importance of BC concentration and its subsequent deposition onto glacier surfaces to regional water resource sustainability and global climate warming. BC emission regulation has been targeted to combat climate change because of its short atmospheric residence time and primarily anthropogenic source. However, the predominant BC sources and vectors of long range transport to remote regions remains poorly resolved.

We use the Dasuopu Glacier ice core (central Himalaya) to quantify the concentration of BC deposited onto the glacier over the past 200 years at annual/sub-annual resolution. We compare the BC record to a trace element record obtained from the same core to infer BC source. We examine BC particle mass over the record to determine if BC size-dependent absorption has changed over time. The Dasuopu core was collected at 7200 m thus isolating the BC record from influence by local sources and providing a regional perspective. The BC record indicates that deposition onto the glacier has increased with time towards the present. BC particle size also increase with time suggesting that a) the size of particles deposited onto the Dasuopu Glacier surface have increased, b) that particles undergo a physical size modification in the glacier. BC concentration is weakly ($r^2=0.4$), but significantly ($p<0.05$), correlated with barium and lead, suggesting diesel fuel burning as a BC source.

Abstract

Soon Do Hur, Ph.D

Submission ID	131
Name:	Soon Do Hur, Ph.D
Institution:	Korea Polar Research Institute
Country:	Republic of Korea
Presentation Title:	Ice core drilling on Styx glacier from Northern Victoria Land, Antarctica
Full Author List:	Y. Han1 S.J. Jun1 M. Miyahara2 H.-G. Lee3 J. Ahn3 J.W Chung1 S.B. Hong1 S.D. Hur1
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ABSTRACT

An ice core drilled by Korea Polar Research Institute as the first ice core drilling program since the establishment of the Antarctic Jang Bogo Station, the second Antarctic research station of Korea. The ice core drilled on the Styx glacier about 85km north of the Jang Bogo Station in the 2014-15 austral summer season. A 210.5m long ice core was taken in 300 runs, in 20days using electric mechanical type ice core drilling machine made by Geotech company, Japan. The tephra ash layers were observed at depths of 97.01, 99.18 and 165.37m, whose age were estimated to be 0.56, 0.57 and 1.04ka, respectively. The age at the bottoms of the ice core was estimated to be 1.36 ka based on the depth-density profile and on the temperature at 15m depth.

Abstract

Holly Winton

Submission ID	132
Name:	Holly Winton
Institution:	Curtin University
Country:	Australia
Presentation Title:	Dust and black carbon sources of soluble iron to Antarctic waters
Full Author List:	V.H.L. WINTON1,2,3, R. EDWARDS1, A.R. BOWIE2,3, P. ANDERSSON4, N. BERTLER5,6, M. CURRAN2,7, B. DELMONTE8, A. ELLIS1, M. KEYWOOD9
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ABSTRACT

The marine iron biogeochemical cycle and the distribution of bioavailable iron in surface waters plays a key role in marine primary productivity through iron limitation and nitrogen fixation. Iron inputs to iron limited surface waters of the Southern Ocean enhance macronutrient utilisation and primary productivity. While inputs of iron to nitrogen poor tropical and sub-tropical waters may modulate nitrogen fixation. Globally, the atmospheric deposition of mineral dust is thought to be the primary source of new bioavailable iron to the pelagic ocean. The distribution of atmospheric iron deposition is well known, but its solubility and bioavailablity is not. To date most studies have assumed that mineral dust aerosols represent the primary source of soluble iron in the atmosphere. However, fire emissions and oil combustion are other potential sources. To investigate spatial variability and mixed sources of soluble iron we investigated mineral dust, black carbon (a proxy for biomass burning), and iron deposition to East and West Antarctic sites from snow pit samples. The sites included Roosevelt Island Climate Evolution (RICE) in West Antarctica and Aurora Basin North (ABN) in East Antarctica. At Roosevelt Island, the variability in annual deposition of soluble iron paralleled black carbon and dust deposition. At ABN, there were episodic changes in soluble iron, with a complex relation between total iron inputs and black carbon. Iron solubility was not linearly related to total iron. To compare the Antarctic snow samples with those from lower latitude aerosols, aerosol samples from Cape Grim Baseline Air Pollution Station in Tasmania, Australia and Gunn Point in Northern Australia were analysed and determined for iron. In comparison to the Antarctic samples, the Australian aerosol iron

solubility was greater at lower latitudes and in aerosols associated with fire. As a whole, the results of the project revealed that iron solubility cannot be directly compared to total iron inputs, and that significant spatial and temporal variations likely exist. Thus, previous total iron fluxes estimates from Antarctic ice cores may not be translated into bioavailable iron estimates. New high-resolution soluble iron measurements from ice cores are needed to understand the impact of past iron deposition on Southern Ocean primary productivity.

Abstract

Associate Professor Paul Vallelonga

Submission ID	133
Name:	Associate Professor Paul Vallelonga
Institution:	University of Copenhagen
Country:	Denmark
Presentation Title:	Continuous Flow Analysis of the Renland (East Greenland) ice core
Full Author List:	P. Vallelonga1 (on behalf of the RECAP CFA Team)
Author Affiliations:	1. Centre for Ice and Climate, Copenhagen, Denmark

ABSTRACT

The Renland ice cap is located in the alpine zone of central East Greenland, independent of the Greenland ice sheet and sensitive to climate and sea ice changes in the North Atlantic Ocean and Greenland Sea. The drilling site was chosen from Radar Echo Sounding to recover well-stratified glacial and Eemian ice lying close to the bedrock. A 584 m deep ice core was drilled at Renland ice cap in May-June 2015, repeating and extending the climate record recovered from a 325 m ice core drilled in 1988. The deglacial transition was found at 533 m depth, below which the glacial section is approximately 20 m thick and Eemian section of approximately 20 m thickness.

After processing at Alfred Wegener Institute in Bremerhaven, a Continuous Flow Analysis (CFA) campaign was conducted at Centre for Ice and Climate in Copenhagen. The CFA campaign included analysis of stable water isotopes, methane concentrations, black carbon, conductivity, insoluble particles (dust) and a suite of dissolved ions. We present an overview of the CFA processing and analysis as well as initial findings from the Renland ice core.

Abstract

Elisabeth Isaksson

Submission ID	134
Name:	Elisabeth Isaksson
Institution:	Norwegian Polar Institute
Country:	Norway
Presentation Title:	Svalbard ice and snow as archives for climate and pollution
Full Author List:	E.Isaksson1, D. Divine1, T. Martma2, C. Vega3, M. Hermansson4, I. Wendl5,, A. Eichler5, M. Schwikowski5
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ABSTRACT

Over the last two decades ice cores from three major glacier-ice caps in Svalbard; Lomonosovfonna, Austfonna and Holtedahlfonna have been drilled. The longest of these cores covers the past 1200 years. Thus, these cores are providing information on both the spatial variability component in addition to the temporal record of both climate and pollution. For instance, we have used the $\delta^{18}O$ records to reconstruct the winter surface air temperatures utilizing techniques used in dendrochronology called 'scaling'. During the 1800s, which according to our results was the coldest century in Svalbard, the Little Ice Age –associated winter cooling was of the order of 4˚C compared to the 1900s. One of the most striking features of the reconstruction is a lasting pre-1300 period of warm winters where DJF temperatures were comparable to those that were observed in Svalbard in the 1930s and in the most recent decade. The rapid warming at the beginning of the 20th century is well documented in the instrumental data and was accompanied by a parallel decline of sea ice extent in the study area. Repeated sampling at the drilling location on Lomonosovfonna during field campaigns of 2000-2007 have demonstrated that such a degree of melt, as was observed in the Medieval times, has been exceeded only in the recent decade. Some major ions, black carbon and various other ice chemistry data show a clear east-west zonal gradient across the archipelago suggesting a different origin for air masses arriving in different sectors of Svalbard.

Abstract

Elisabeth Isaksson

Submission ID	135
Name:	Elisabeth Isaksson
Institution:	Norwegian Polar Institute
Country:	Norway
Presentation Title:	Antarctic Ice Rises as potential ice core drill sites - examples from Fimbul Ice Shelf, Dronning Maud Land
Full Author List:	C. Vega1,2, E. Isaksson1, D. Divine1, J. Kohler1, E. Schlosser3, T. Martma4, A. Eichler5, M.Schwikowski5
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ABSTRACT

In this study we present records of stable isotopes and major ions from 20-m firn cores retrieved from three ice rises on the ice shelf Fimbulisen, in Dronning Maud Land. The cores were drilled in January 2012 and 2014, and cover the past few decades. The cores are part of a project whose overall goal is to establish the mass balance and evolution history of the ice rises, including the spatial and temporal variability of surface accumulation. We also seek to evaluate if these cores are useful for climatic reconstruction, thus making the ice rises suitable sites for deeper cores. Our hope is that data from future ice cores from these ice rises can provide essential information on regional changes in key climate variables such as precipitation, temperature and sea ice cover, as well as changes in climate forcing and biogeochemical cycles. These three ice rises are geographically close but the data from the firn cores suggest that there are major differences in accumulation, ion composition and melt. Data will also be compared to previously drilled firn cores from Fimbulisen and together this will provide information about the spatial variability and in this part of coastal Dronning Maud Land.

Abstract

Biancamaria Narcisi

Submission ID	136
Name:	Biancamaria Narcisi
Institution:	ENEA
Country:	Italy
Presentation Title:	Enhancing the Eemian tephrostratigraphy for the Antarctic ice sheet: the Talos Dome record
Full Author List:	B. Narcisi1, J.R. Petit2, B. Stenni3
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ABSTRACT

We have characterised thirteen visible tephra layers embedded in the ice sections of the Talos Dome core (72°49'S, 159°11'E) related to the Last Interglacial period and the transition to the subsequent glacial period. The coring site is located at the South Pacific/Ross Sea periphery of the East Antarctic Plateau, in a sector still largely unexplored from the tephra point of view. The studied layers, related to primary deposition of fallout tephra and precisely framed within the climate (δ18O) record for the core, span in age from 111.6 ± 1.9 to 123.3 ± 2.2 ka. Coarse particle size suggests origin from regional sources. Indeed, the vast majority of the samples display an alkaline affinity and trachytic composition that are both typical geochemical features of rifting Antarctic volcanism. Using subtle differences in the geochemical signatures and the comparison with data from previous studies, a few layers are attributed to known coeval Mt. Melbourne eruptions. Another sample subset is consistent with derivation from The Pleiades and Mt. Rittmann volcanoes. One peculiar trachytic glass population appears to be related to activity of the more distant Marie Byrd Land volcanoes. The newly detected tephras augment the Antarctic tephra time-stratigraphic scheme and offer the prospects for dating and synchronisation of palaeoclimatic records from different realms. In addition to stratigraphic implications, our tephra inventory provides a chronicle of volcanic activity and represents a valuable data source for the reconstruction of past explosive volcanism in Northern Victoria Land.

Abstract

Luciano Marquetto

Submission ID	137
Name:	Luciano Marquetto
Institution:	Centro Polar e Climático
Country:	Brazil
Presentation Title:	Oxygen isotopic composition variations in surface snow along an antarctic traverse
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ABSTRACT

This work presents the distribution of oxygen isotope ratios in the surface snow in the West Antarctic Ice Sheet during the Chilean-Brazilian traverse held in the austral summer of 2004/2005. The traverse was carried out from Chilean Antarctic station Tenente Parodi, in Patriot Hills (80°18'S, 81°21'W) and the Geographic South Pole, along more than 1.205 km. We collected superficial snow samples of the upper 0.05 to 0.2 m deep, approximately at each 10 km (total of 104 samples). The average annual temperature was determined at six points spaced approximately 220 km apart, at a depth between 10 and 15 m. The oxygen isotope ratio (δ 18O) of each sample was determined by mass spectrometry with gas source (GSMS - Gas Source Mass Spectrometry) with a 0.05 ‰ precision. Results point out to the strong correlation between δ18O and the local temperature, latitude, altitude and distance from the coast, the first being positive and the others negative. Anomalous relatively high isotopic values are found between 87°30'S and 86°44'S, which are associated to post-depositional processes due to formation of glaze ice as identified in the field. The gradient δ 18O/Altitude is -0.08‰/100 m and the δ 18O/Temperature is 0.743‰/°C. Excepting for the cited anomalies, results are consistent with those found by other researchers in the Antarctic ice sheet.

Abstract

Filipe Gaudie Ley Lindau

Submission ID	138
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Presentation Title:	Major ions variability in snow and firn along an Antarctic transect
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ABSTRACT

In order to interpret variabilities in the chemical composition of the snow and firn along an Antarctic transect, we analyzed 5 firn cores collected between Patriot Hills (80°18'S, 81°21'W) and the South Pole, during the 2004-2005 Chilean-Brazilian traverse, as part of the ITASE (International Trans-Antarctic Scientific Expedition). At the Climate Change Institute (CCI, University of Maine, USA) we cleaned the samples and melted it (in a class 100 clean room), then we determined the Na+, K+, Mg2+, Ca2+, MS- ($CH3SO_2$2-), Cl-, NO3- and SO42- concentrations by ion chromatography, and the δD isotopic ratio by mass spectrometry. We dated the samples with annual precision and ±2 year accuracy by counting the Na+, nssSO42- and δD annual layers. The mean annual accumulation for the 5 cores show a negative correlation with increasing elevation and distance from the sea, also responding to local superficial features and katabatic winds occurrence. These cores reveal alterations in the sea salt aerosols Na+/Cl- ratios, but the aerosol produced during sea ice formation appear only on the nearest sites to coast. However, the sea ice may have an influence on some extreme MS- concentrations found in cores that are more interior. Sources of calcium are mainly crustal, as expressed by the high nssCa2+/Ca2+ ratio in all the cores. The NO3-, as the MS- record, indicates the occurrence of post-depositional processes connected to volcanic events and photochemical reactions, which intensity increases on glaze surfaces.

Abstract

Dr. Vladimir Lipenkov

Submission ID	139
Name:	Dr. Vladimir Lipenkov
Institution:	Arctic and Antarctic Research Institute
Country:	Russia
Presentation Title:	A comparison of air content records from the Vostok and EPICA DC ice cores
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ABSTRACT

Air content is a multi-proxy property of polar ice, which is thought to contain evidence about past changes in local insolation, climatic and meteorological conditions, and the elevation of glaciers at the site of ice formation. By revisiting two equally accurate air content records obtained at the Vostok and EPICA DC drilling sites, we attempt a careful assessment of the contributions of different natural components (orbital and non-orbital, global and local), as well as of experimental uncertainties to the total variance of the air-content data.

A major contribution (>85% of the total variance) is made by the non-thermal variations of the close-off porosity, which includes the local insolation signal (>55%) and the stratigraphic variations of the firn properties related to changes in weather conditions (20-35%). The insolation signal has been used to produce air-content based timescales for the EPICA DC and Vostok ice cores (Raynaud et al., 2007; Lipenkov et al., 2011). In order to better estimate the uncertainties of this dating technique, we compare the individual chronologies obtained for the two ice cores in the overlap age interval (150-400 ka) assuming that the insolation-related variations should be the same and synchronous at the two sites, which sit at similar latitudes. Such a comparison also allows us to study more closely the fraction of non-orbital variability, which is thought to be related to the local firn and ice formation conditions.

The models predict a close similarity in the changes in ice sheet elevation associated with glacial-interglacial transitions at the two drilling sites located ~700 km apart on the East Antarctic plateau. Using the model results and subtracting the non-thermal, orbital and non-orbital variations from the air content records, we investigate the residual signal and the sensitivity of the air content to the atmospheric pressure (elevation) changes. This consideration impels us to reappraise the old approach of interpreting the air content record in terms of elevation changes, which has been based on the present-day close-off porosity-temperature relationship. Finally, we discuss the conditions and limitations for using the air content of polar ice as a paleobarometer.

Abstract

Dr. Jason Roberts

Submission ID	140
Name:	Dr. Jason Roberts
Institution:	Australian Antarctic Division
Country:	Australia
Presentation Title:	Confidence Intervals for unevenly and differently sampled data
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ABSTRACT

Computing correlation between data-series is a ubiquitous method in the geosciences and elsewhere, which is especially useful when accompanied with confidence intervals that take into account the auto-correlation in the data-series themselves. However, not all data series are evenly sampled, either because of inherent non-uniform sampling or because the transformation from the sample-measurement domain to desired analytical domain is non-linear. A particular example of the latter is ice cores, where uniform spatial sampling results in non-uniform sampling when the depth is converted to time. Additionally, missing data results in unequal spacing.

Here we have developed a method to produce both the Pearson correlation coefficient and the associated confidence interval for unevenly and differently sampled data series in the presence of autocorrelation. This method is based on the Gaussian Kernel correlation method, but extended to provide confidence intervals using bias-corrected and accelerated (BCa) stationary bootstrapping. Software for our implementation is freely available.

We apply this method to the MSA sea ice proxy from separate Law Dome ice cores. Our results demonstrate the spatial coherence of Law Dome MSA data, supporting its use as a regional proxy

Abstract

Dr Cathy Trudinger

Submission ID	141
Name:	Dr Cathy Trudinger
Institution:	CSIRO Oceans and Atmosphere
Country:	Australia
Presentation Title:	Atmospheric abundance and global emissions of perfluorocarbons CF4, C2F6 and C3F8 since 1900 inferred from ice core, firn and atmospheric measurements
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ABSTRACT

Perfluorocarbons (PFCs) are very potent and long-lived greenhouse gases in the atmosphere, released predominantly during aluminium production and semiconductor manufacture. Here we present the first continuous records of the atmospheric abundance and global emissions of three PFCs (CF4, C2F6 and C3F8) from 1900 to the present. The records are derived using a multi-site inversion of high precision measurements of PFCs in air from two polar ice cores (DE08 and DE08-2) and four polar firn sites (DSSW20K, EDML, NEEM and South Pole), along with measurements of atmospheric air from recent decades. The inferred records give a good match to the firn and ice core measurements from sites with quite different smoothing characteristics, collected at different times in the past, with measurements made at two different laboratories and inverted using two different firn diffusion models. The advantage of measurements from sites with narrow age distributions to resolve features in the records is clear. We show that the background (preindustrial) level of CF4 was about 34.1 ppt attributed to a natural source from rocks, and zero (below detection) for C2F6 and C3F8, followed by large increases due to anthropogenic emissions. We find a significant peak in the CF4 and C2F6 emissions during World War II, presumably due to the high demand for aluminium for construction of aircraft.

Abstract

Meredith Kim Nation

Submission ID	142
Name:	Meredith Kim Nation
Institution:	Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre
Country:	Australia
Presentation Title:	Consideration for the use of ESTISOL™ 140 as an Antarctic ice core drilling fluid
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ABSTRACT

ESTISOL™ 140 was used successfully for the first time at a cold temperature (-44°C) Antarctic site as the drilling fluid for the 303m Aurora Basin North (ABN) ice core in January 2014, 550km inland from the coast. Previous studies showed that the density and viscosity properties of ESTISOL™ 140 was a potential new drill liquid at cold temperatures (Sheldon et al., 2014), combined the low environmental impact of the product and high safety status made it a desirable drilling fluid. Previous experience with Estisol™ 240 showed it may have an impact on clothing and other equipment, and perhaps it was difficult to remove from the core post drilling and prior to analysis. Therefore, we conducted laboratory testing on suitable products that would come into contact with ESTISOL™ 140 during the course of the field season and drilling campaign. Tests were made on core transport boxes, clothing, gloves, boots, aprons, ink for labelling, chip bags, and the ice core bags. The results of this testing, including outlining considerations for the use of ESTISOL™ 140 will be presented. A procedure was developed to remove any remaining liquid from the cores and a buffer structure was designed for the drilling procedure to allow for evaporation from the cores overnight. This limited the impact of the drilling fluid on the cores and resulted in little or no remaining drilling fluid detected on the ice cores in the laboratory back in Hobart.

Abstract

Cheryl Glor

Submission ID	144
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Institution:	Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia
Country:	Australia
Presentation Title:	Comparison of concentrations of trace dissolved ions (sea salts, MSA and volcanic sulphate) from ABN with the coastal Law Dome ice core.
Full Author List:	C. Glor1,2, M.A. Curran3,2, J.R. McConnell4, M. Sigl4, T. Vance2, A.D. Moy3,2, J. Roberts3,2, C. Tozer[2], M. Nation3,2, P. Vallelonga5, O. Magand6, and M.M. Arienzo4.
Author Affiliations:	1 Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia 2 Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Australia. 3 Australian Antarctic Division, Kingston, Australia 4 Desert Research Institute, Reno, USA 5 Center for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark 6 Laboratoire des Sciences du Climat et de l'Environnement/Institut Pierre Simon Laplace, Gif-sur-Yvette, France

ABSTRACT

Law Dome (66°46'S, 112°48'E) has proved to be a useful ice core site in providing detailed information on Antarctic coastal climate history covering the last two thousand years, and has proven links to Australian climate. However, there are still few detailed climatic records from the Southern Hemisphere and very few highly detailed records for the last 2000 years. IPICS has identified a project to produce an array of Antarctic ice cores covering this time period and will include Law Dome and the new Aurora Basin North (ABN) ice core to this array. ABN (71°10'S, 111° 22'E), located in the East Antarctic ice sheet, was selected as a site approximately half way between the coastal Law Dome and inland Dome C ice core sites. Here we present an initial investigation of trace ion concentrations in comparison with Law Dome to investigate spatial or temporal similarities between the two sites. Variations between the seasonality and transportation mechanisms will be studied. Volcanic activity and fluxes will be compared to those from Law Dome.

Abstract

Dr. Estrella Sanz Rodriguez

Submission ID	145
Name:	Dr. Estrella Sanz Rodriguez
Institution:	University of Tasmania
Country:	Australia
Presentation Title:	Significant reduction of sample volume required for the analysis of ice core samples using Capillary Ion Chromatography
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ABSTRACT

A new capillary ion chromatography (Cap-IC) based analytical method has been developed for quantitative analysis of organic and inorganic anions within limited volume Antarctic ice core samples. The developed analytical protocol applies Cap-IC (with suppressed conductivity detection) and direct on-column sample injection and focusing, thus eliminating the requirement for off-column sample preconcentration. This new approach provides a reliable and robust analytical method for the simultaneous determination of fluoride, methanesulfonate, chloride, sulfate and nitrate anions in ice core samples. The separation was carried out on an IonPac AS15 (0.4 $\times$ 250 mm) column. The method limits the total sample volume needed to 300 μL per analysis, enabling triplicate sample analysis with $<$1 mL of sample and potentially allowing the ultra high resolution analysis of ice cores. The method was also evaluated in terms of its analytical performance characteristics, such LOD, LOQ, linear range, repeatability and reproducibility. The LODs values obtained (0.07, 0.25, 3.31, 0.78 and 1.28 μgL-1 for fluoride, methanesulfonate, chloride, sulphate and nitrate, respectively) were within a similar range to those quoted by previous standard-bore IC-based methods. Cap-IC also provided further advantages, by scaling down column size injection volumes and required flow rates were reduced by a factor of 10 to 100, providing for excellent eluent economy ($\sim$5 L/year), 24/7 continuous system operation, reduction of waste solutions and, as a consequence, overall savings in system running costs. Additionally, for the first time, ion chromatograph coupled to high resolution mass spectrometry (Cap-IC-HRMS) has been used to confirm the presence and purity of the observed methanesulfonate, chloride, sulfate and nitrate peaks in a composite Antarctic ice-core samples.

Abstract

Dr Jason Roberts

Submission ID	146
Name:	Dr Jason Roberts
Institution:	Australian Antarctic Division
Country:	Australia
Presentation Title:	An updated Law Dome (DSS) age model
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ABSTRACT

We present a new age model for the Dome Summit South (DSS) ice core from Law Dome, East Antarctica. This new model augments the annually dated upper section of the existing ice-core chronology with a calculated age model that is constrained by 11 age ties. Here, we use a continuous piece-wise fit to a linear vertical velocity profile. Specifically, a piece-wise parabolic annual layer thickness model is used. This is equivalent to a piece-wise linear vertical strain rate or a piece-wise parabolic annual accumulation rate - or any combination of these. Consequently, any change in the vertical velocity, or equivalent annual accumulation rate profile is smooth. This piece-wise parabolic model only approximately passes through the age ties (in a least squares sense) and a small linear correction is applied between age ties to ensure the model honours the tie points. An ensemble of model estimates is produced to account for uncertainties which exist in both the depth and age of the tie points. This allows us to provide both median-value and uncertainty estimates of age, as a function of depth, for the DSS core.

Abstract

Dr. Estrella Sanz Rodriguez

Submission ID	147
Name:	Dr. Estrella Sanz Rodriguez
Institution:	University of Tasmania
Country:	Australia
Presentation Title:	The use of capillary-ion chromatography coupled to mass-spectrometry for the identification and quantification of inorganic species and organic acids in sea ice record from Law Dome, Antarctica
Full Author List:	E. Sanz Rodriguez1, S. Poynter2,3, M. Curran2,4, P.R. Haddad1, P.N. Nesterenko1, B. Paull1
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ABSTRACT

Antarctic winter sea ice extent is a valuable climate record, which is reflected by proxy of methanesulfonic acid (MSA) concentration in ice core records. The MSA in ice cores is produced solely by marine algae within the Southern Ocean region. MSA reaches a peak concentration in winter, when sea ice is at its maximum extent [1]. Herein we report results from a new joint project between the Australian Centre for Research on Separation Science (ACROSS) and the Australian Antarctic Division (AAD), initially focussed upon the development of new capillary ion chromatography (Cap-IC) methods for the quantification of organic and inorganic anions within limited volume Antarctic ice core samples [2].

The presence of a number of unidentified components in the samples lead to the extension of the above chromatographic capability via direct coupling of the suppressed Cap-IC system with mass-spectrometry (Cap-IC-MS). Cap-IC is particularly amenable to this application, as it requires low sample volumes, simplifies pre-concentration of trace analytes and enables the possibility of hyphenation with mass spectrometry. The Cap-IC-MS approach has been applied to the identification and quantification of unknown dissolved organic acid species present at trace concentrations within approximately 200 samples from a 30 m ice-core from Law Dome, Antarctica. The area has been extensively studied with well-documented ice-core chemical records and associated sea ice extent records which were used to validate the new data available from the current Cap-IC-MS based investigations.

[1] M.A.J. Curran, T.D. van Ommen, V.I. Morgan, K.L. Phillips, A.S. Palmer,Ice Core Evidence for Antarctic Sea Ice Decline Since the 1950s, Science 302 (2003)1203–1206, http://dx.doi.org/10.1126/science.1087888.
[2] E. Sanz Rodriguez, S. Poynter, M. Curran, P.R. Haddad,R. A. Shellie, P.N. Nesterenko, B. Paull,Capillary ion chromatography with on-column focusing for ultra-trace analysis of methanesulfonate and inorganic anions in limited volume Antarctic ice core samples, J. Chromatography A 1409 (2015) 182–188. http://dx.doi.org/10.1016/j.chroma.2015.07.034.

Abstract

Dr. Matt Woodhouse

Submission ID	148
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Institution:	CSIRO
Country:	Australia
Presentation Title:	Atmospheric composition change in the 20th century through ice cores and atmospheric chemistry modelling
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ABSTRACT

Measurements of atmospheric composition derived from air trapped in snow and ice reach much further back in time than in situ observations. These long-term records allow analysis of trends spanning both hemispheres for multiple atmospheric components relevant to climate. Firn and ice core records are therefore important datasets, and are invaluable for evaluating models of past atmospheric composition and climate.

The ACCESS-UKCA model is a state-of-the-art global composition-climate model with detailed representations of tropospheric and stratospheric chemistry and aerosol, and their impact on climate. We have developed an emissions dataset that drives the model which includes anthropogenic, biomass-burning, and biogenic sources of climatically-relevant atmospheric constituents.

In the work presented here, we evaluate the ACCESS-UKCA model by comparing to multi-decadal records of aerosol (e.g. black carbon, mineral dust) and gas-phase atmospheric constituents (e.g. carbon monoxide) from 1920 to the present day. With model biases characterized, we further explore trends in these constituents in both hemispheres, including the observed differences in carbon monoxide between the hemispheres. Variations in modelled seasonal and diurnal cycles over this time period are investigated. In the aerosol phase, black carbon and mineral dust can be considered as sporadic and poorly quantified vectors for nutrient supply to the remote oceans. Long-term records, combined with a model capable of simulating these quantities, provide an excellent tool for probing the effects of changing atmospheric composition on the climate system.

Abstract

Dr Jason Roberts

Submission ID	149
Name:	Dr Jason Roberts
Institution:	Australian Antarctic Division
Country:	Australia
Presentation Title:	A comparison of 2000 year accumulation records from Law Dome and Aurora Basin North
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ABSTRACT

Annually dated records of snow accumulation rates in Antarctica are essential for estimating ice sheet mass balance and subsequent sea level change. Accumulation rates at Law Dome, East Antarctica, have been linked with regional atmospheric circulation to the mid-latitudes as well as regional Antarctic snowfall. Here, we extend the existing 750 year Law Dome accumulation record to 2035 years, using a recently updated ice-core chronology that extends to 22 BCE. The calculated accumulation rates were based on a power-law vertical strain rate profile fitted to observed annual layer thickness, rather than the more traditional constant vertical strain rate assumption. Decadal-scale snow accumulation anomalies were found to be relatively common (74 events) throughout the record. Additionally, spectral analysis reveals periodicities in the accumulation record which may be related to El Niño–Southern Oscillation (ENSO). The calculated accumulation rates show good correlation with atmospheric reanalysis estimates, and significant spatial correlation over a wide expanse of East Antarctica. This shows that accumulation at the Law Dome site captures variability across a large region of East Antarctica, well beyond the immediate vicinity of the Law Dome summit. The lower resolution inland Aurora Basin North (ABN) ice core is used to expand this study to provide a regional accumulation rate history between known volcanic epochs.

Abstract

Andrew Moy, Dr

Submission ID	150
Name:	Andrew Moy, Dr
Institution:	Australian Antarctic Division
Country:	Australia
Presentation Title:	Climate history at Aurora Basin North, East Antarctica: A 2,000 year isotopic record
Full Author List:	Moy A.D.1,2, van Ommen, T.D.1,2, McConnell, J.3, Curran, M.A.1,2, Phipps, S.J.4, Masson-Delmotte, V.5, Orsi, A.5, Touzeau, A.6, Roberts, J.1,2, Dahl-Jensen, D6. Popp, T.6, Svensson, A.6, Maselli, O.3, Landais A.6, Vance, T.2, Liu, Y.7, Arienzo, M.3
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ABSTRACT

Contiguous measurements of water stable isotope ratios (δ18O and δD) have been performed along the entire length of the Aurora Basin North (ABN) ice core. The 303 m ice core extracted at ABN, 550 km inland of Australia's Casey station, provides a climate record at seasonal to decadal resolution for this region of East Antarctica spanning the past ~2000 years. The isotopic variability at ABN shows clear annual cycles in the upper ~50 m and longer-term variability on decadal to centennial timescales. The ABN record shows no long-term isotopic trend over the ~2,000 year record length, similar to the four isotopic ice core records used in East Antarctica, and in contrast with West Antarctic records in the PAGES Antarctic 2k temperature reconstruction (PAGES2k, 2013). Mean ABN isotopic values (δ18O -40.70 ‰, and δD -321.1 ‰) fall along the modern Antarctic spatial isotope/elevation and isotope/distance from the ocean relationships. The second order isotope parameter, deuterium excess (d) displays a relatively stable record (mean value of 4.4 ‰), with

occasional sharp transitions to values as high as 8-10 ‰ and as low as 0-1 ‰. The large deuterium excess variations may reflect changes in moisture origin and evaporation conditions (SST, relative humidity). The isotopic variability at ABN therefore potentially reflects a mix of changes in transport and local climate (acting on precipitation intermittency and distillation strength), as well as local elevation changes. A comparison of the preliminary dated ABN isotope record with the Law Dome isotopic record shows that they are correlated, despite the differences in site-specific influences. This correlation indicates a common climate signal at both sites and a spatial coherence in regional climate from the coastal Law Dome to the inland plateau of the Aurora Basin North site.

Abstract

Dr Mark Curran

Submission ID	151
Name:	Dr Mark Curran
Institution:	Australian Antarctic Division and Antarctic Climate and Ecosystems CRC
Country:	Australia
Presentation Title:	The Aurora Basin North (ABN) ice core drilling project – an overview and initial results from the 2000 year ice core record.
Full Author List:	Mark Curran1,2 on behalf of the Aurora Basin North (ABN) scientific team
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ABSTRACT

In Antarctica, a reasonable coverage of ice core records exist for the last couple of hundred years, however there is poor spatial coverage of high-resolution climate data from Antarctica, particularly over the last 2000 years, which is articulated in IPCC synthesis reports as limiting present understanding of climate processes. Two thousand years has been recognized as an important epoch as it contains both a significant natural period, prior to anthropogenic influence, and the full industrial era itself, including the onset. Additionally, high-resolution records of climate forcings over the past 2000 years are of importance to the climate modelling community, such as PMIP, and will improve our knowledge of the dynamics of the climate system over this epoch. The aim of the Aurora Basin North (ABN) ice core drilling project is to provide a 2000 year climate record from a data sparse area of East Antarctica to

add to the IPICS 2k array and the PAGES Antarctica2k projects. ABN is a 303m ice core from East Antarctica, 550km inland and about half way between the coastal Law Dome and inland Dome C sites. The ABN project is focussed on understanding the variability over the last 2000 years of a range of climate parameters and forcings, including, temperature, snowfall, volcanic forcing, solar forcing, greenhouse gas forcing, sea ice extent, atmospheric variability (ENSO, SAM, IPO), dust sources from Australia, and biomass burning events. Here we present an overview of the ABN project and highlight some of the initial important results.

ABN Scientific team: Mark Curran and, in alphabetical order, Nerilie Abram, Olivier Alemany, Monica Arienzo, Edouard Bard, Mélanie Baroni, Thomas Blunier, Jérôme Chappellaz, An Chunlei, Dorthe Dahl-Jensen, Valérie Masson-Delmotte, Ross Edwards, David Etheridge, Xavier Fain, David Fink, Johannes Freitag, Cheryl Glor, Sepp Kipfstuhl, Amaelle Landais, Manu Lemeur, Niccolo Maffezzoli , Olivier Magand, Patricia Martinerie, Olivia Maselli, Joe McConnell, Vin Morgan, Andrew Moy, Meredith Nation, Steven, Phipps, Trevor Popp, Sam Poynter, Sune Olander Rasmussen, Anais Orsi , Jason Roberts, Joël Savarino, Simon Sheldon, Michael Sigl, Andrew Smith, Jorgen Peder Steffensen, Anders Svensson, Alexandra Touzeau, Carly Tozer, Cathy Trudinger, Paul Vallelonga, Tessa Vance, Tas van Ommen, Feitang Wang, Holly Winton, Liu Yaping

Abstract

Dr Tessa Vance

Submission ID	152
Name:	Dr Tessa Vance
Institution:	Antarctic Climate & Ecosystems CRC
Country:	Australia
Presentation Title:	The Law Dome-east Australian rainfall proxy record: current understanding and future work
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ABSTRACT

Rainfall in Australia exhibits high multi-decadal variability, yet the short (~100 years) instrumental record and dearth of high resolution proxy records from many regions of the country hinders a full understanding of the features and climatic drivers of this high variability. Subsequently, statistics calculated from the instrumental record do not reflect the true risk of hydroclimatic extremes, and robust water resources management, planning and infrastructure design is virtually impossible. Previous studies have shown atmospheric teleconnections linking East Antarctica and eastern Australia can be exploited to produce accurate, annually-dated proxy records of Australian rainfall. Recently, an accurate, annually dated millennial-length IPO reconstruction from the Law Dome ice core, combined with the sea salt-derived rainfall proxy from the same core has enabled the first millennial-length megadrought (>5 year duration) reconstruction for eastern Australia (Vance et al., 2015). Eight megadroughts were identified including one 39 year drought (A.D. 1174–1212), which occurred during an unprecedented century of aridity (A.D. 1102–1212). Options for improving both the spatial coverage of the Law Dome proxies, their reconstruction skill along with comparisons with other proxy records are being explored. Furthermore, an extension to the sea salt-rainfall proxy is presented, which doubles the length of the existing annually-dated proxy for rainfall in eastern Australia.

Abstract

Dr Tessa Vance

Submission ID	153
Name:	Dr Tessa Vance
Institution:	Antarctic Climate & Ecosystems CRC
Country:	Australia
Presentation Title:	Optimal site selection for a high resolution ice core record in East Antarctica
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ABSTRACT

Selecting the best site for ice core drilling is essential, as retrieving a new ice core record is logistically challenging, time consuming and expensive. Assessments of new sites need to consider a variety of factors encompassing all of these concerns. With this in mind, we demonstrate a systematic approach to site selection for a new East Antarctic high resolution ice core record that incorporates seven glaciological, climatological and logistical constraints and criteria. The most stringent criteria were that 2000 year old ice must be achievable within 300 m of the surface, yet a minimum annual accumulation rate of 250 mm ice equivalent be preserved. In addition, we wanted to pinpoint a site with a strong teleconnection to mid-latitude climate in the southern Indian Ocean that reflected a different atmospheric regime to the existing Law Dome record (a high resolution ice core in East Antarctica). We used a number of approaches (including radar survey validation of satellite data) to produce all-of-Antarctica surface roughness, accumulation, age at specified depth, elevation and displacement change and representative temperature correlations to pinpoint promising locations. We also used the ERA 20th Century reanalysis to examine seasonal-scale

changes in decadal wind variability, to ensure we pinpointed a site that may add new information about multi-decadal variability in the southern Indian Ocean. Three promising sites in East Antarctica in the coastal zone from Enderby Land in the west to the Ingrid Christensen Coast in the east are described.

Abstract

Olaf Eisen

Submission ID	155
Name:	Olaf Eisen
Institution:	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Country:	Germany
Presentation Title:	Beyond EPICA: Oldest Ice
Full Author List:	Olaf Eisen1, Beyond EPICA members
Author Affiliations:	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

ABSTRACT

The retrieval and analysis of the “Oldest Ice Core“ with an envisaged age of 1.5 million years is one of the highest priority questions that science in Antarctica will be addressing in the next decade. Such a core will target the mid-Pleistocene transition from the 40 ka to the 100 ka glacial-cyclicity world and will provide important answers to current questions on climate sensitivity and future change. It became obvious over the last years that more than one ice core is likely necessary to reliably estimate paleoclimate conditions more than 1 million years ago. In accordance with the efforts under the auspices of IPICS, the European ice-core community has been developing a plan how to tackle the search for the most suitable site to recover ice of the envisaged age in a consortium project: "Beyond EPICA - Oldest Ice". We will present the project's current state and upcoming timeline, including an overview of the logistic organization, envisaged geophysical applications, fast drilling and borehole analysis tools to define the most promising sites in Antarctica as part of global international efforts.

Abstract

Dr. Jing Gao

Submission ID	156
Name:	Dr. Jing Gao
Institution:	Institute Of Tibetan Plateau Research, Chinese Academy of Sciences
Country:	China
Presentation Title:	Deuterium excess record in the Tibetan ice core reveals rapid and decade-scale changes of moisture origin
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ABSTRACT

Changes in atmospheric moisture origin plays a key role in climate change via impacting the key hydrological processes within the climate system. The hydrological process in the Tibetan Plateau as the “water tower” in Asia is unclear. Here we present an integrated tracer of hydrological processes, the isotopic composition of the ice core in the central Tibetan Plateau, to reveal the decade changes in the Tibetan moisture origins over the last 200 years. The oxygen isotopes was used to reflect the local temperature changes, and the deuterium excess (d), calculated by $d = \delta D - 8 * \delta 18O$, was predominantly controlled by the temperature of moisture origins. The d-excess changes in this ice core reflect the shifts of moisture origins. The similar shifts of d-excess are distinctly shown between the new record in the central Tibetan Plateau and the NEEM ice core during the past 200 years although some phase deviations exist.

Abstract

Dr. Catherine Ritz

Submission ID	157
Name:	Dr. Catherine Ritz
Institution:	Laboratoire de Glaciologie et Géophysique de l'Environnement UGA/CNRS
Country:	France
Presentation Title:	Oldest Ice reconnaissance in the vicinity of Concordia. Description of a collaborative data-modelling approach
Full Author List:	C. Ritz1,2, H. Corr3 and the Dome C reconnaissance group.
Author Affiliations:	CNRS,France Univers.Grenoble Alpes, Grenoble, France British Antarctic Survey, Cambridge, UK

ABSTRACT

Recovering a 1.5 million years record of climate and greenhouse gases from Antarctica is a major objective of the ice core community and from an assessment of all available data, there is agreement that such "Oldest Ice" could be found in the plateau area of the East Antarctic Ice Sheet. The region around the permanent station of Concordia (East Antarctica) appears to have all the right attributes to be amongst the few possible candidate sites.

In the framework of IPICS, it was decided to have a consortium to work on the reconnaissance for Oldest Ice in the region of Dome C. We present here the field measurements that are planned or already going on and how we plan to associate heterogenous observations and ice flow/thermal modelling to infer optimal location. The key issue for retrieving very old ice in central regions is to avoid zones with high basal-melting at the ice bed interface because this process removes basal layers, low accumulation and minimal flow. Modelling approach is a tool to make predictions about the thermal type of ice-bed interface as well as chronology of the deep layers, however it is limited by the badly known geothermal heat flux value and this approach has to be combined with field observations. The measurements we are considering are radar measurements (airborne, ground based, and pRES), relatively shallow drillings to measure temperature vertical profile, accumulation and strain net surveys.

Abstract

Mana Inoue

Submission ID	158
Name:	Mana Inoue
Institution:	Antarctic Climate & Ecosystems Cooperative Research Centre, Institute for Marine and Antarctic Studies, University of Tasmania.
Country:	Australia
Presentation Title:	A glaciochemical study of the Mill Island ice core
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ABSTRACT

Antarctic ice cores, especially those from East Antarctica, are limited in quantity and spatial coverage. Mill Island (65o30' S, 100 o40' E) is one of the most northerly ice coring sites in East Antarctica, and is located in a region with sparse ice core data. With high snow accumulation at the site (1.35 mIE/yr), the Mill Island ice core enables a sub-seasonal investigation of past climate. This study examines the seasonal and interannual variability of sea salt species trace ion chemistry and produces a sub-seasonal temperature proxy using the 120 m Mill Island ice core. We found that sea salt concentrations were the highest of all Antarctic ice core records (e.g., chloride mean 290 μEq/L and maximum 10,204 μEq/L), and post-depositional migration of sodium and chloride were observed for the first time in an ice core. MSA and magnesium post-depositional migration were also observed. The MSA record may show relationship with sea ice cover around Mill Island. Mill Island snow accumulation is most likely influenced by local orography with influence also from the Zonal Wave 3 pattern. It was found that the seasonal variation in precipitation leads to a cold bias when using the δ18O record as a temperature proxy. Summer and winter temperature proxies were produced from the δ18O record, covering the period 1913 to 2009 showing no significant trend during the period. Overall, the Mill Island ice core is quite a challenging record to interpret. However, it provides important evidence for significant regional changes.

Abstract

Niccolò Maffezzoli

Submission ID	159
Name:	Niccolò Maffezzoli
Institution:	Center for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	Bromine, Iodine and Sodium along the Talos Dome – GV7 traverse in Northern Victoria Land
Full Author List:	N. Maffezzoli 1, P. Vallelonga 1, A. Spolaor 2, C. Barbante 3, M. Frezzotti 4
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ABSTRACT

We present here Bromine (Br) and Iodine (I) measurements of shallow cores, in order to investigate their spatial variability in the coastal region of East Antarctica and their validity as sea ice proxies.

Bromine (Br) is drawing increasing attention because of its role in halogen chemistry, promoting ozone depletion in the lower troposphere at polar latitudes. Sea ice plays a crucial role in the production of Bromine aerosols, through frost flower crystal formation and sublimation of salty blowing snow on fresh sea ice surfaces. On the other hand, Iodine (I) is emitted by algae and other biologic communities living underneath sea ice. Hence, bromine and iodine offer the possibility of being applied as quantitative sea ice proxies.

Seven 2 m shallow cores were sampled in 2013 during the Talos Dome (72° 00'S, 159° 12'E) to GV7 (70° 41'S, 158° 51'E) traverse, in the Victoria Land region of East Antarctica. The snow samples were collected at 5 cm resolution and measured by Inductively Coupled Plasma Sector Field Mass Spectroscopy (ICP-SFMS).

The Bromine signal is preserved in the snowpack, showing clear annual cycles with spring peaks, as confirmed by satellite BrO observations. Iodine measurements, on the other hand, are inconsistent, suggesting post-depositional processes or the influence of melt events.

Abstract

Mr. Christopher Plummer

Submission ID	160
Name:	Mr. Christopher Plummer
Institution:	Institute for Marine & Antarctic Studies, University of Tasmania, Hobart
Country:	Australia
Presentation Title:	Holocene record of sea-salts at Law Dome, East Antarctica
Full Author List:	C.T. Plummer1,2, M.A. Curran2,3, J. Roberts2,3, T.D. van Ommen2,3, A.D. Moy2,3, T.R. Vance2 R. Traversi4 P.A. Mayewski5
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ABSTRACT

Wind activity across open water of the Southern Ocean is the dominant source for sea-salts at Law Dome. Links between the sub-annual sea-salt record and wind-driven climate patterns have been previously demonstrated with ENSO and IPO signals found in the summer record and the Southern Annular Mode (SAM) and strength of the Antarctic High in the winter record. Sea-salt concentrations are highest during the Antarctic winter therefore annual and multi-annual records are dominated by the winter signal. Here we present the Holocene Law Dome sea-salt record with 30-year temporal resolution and investigate features within the record for links with changing climate patterns on local and regional scales. Sea-salt records from EPICA Dome C and Talos Dome are used to investigate regional-scale patterns in sea-salt source and deposition. By comparing the sea-salt record with Law Dome methanesulphonic acid (MSA) and oxygen isotope records we explore the relationship between atmospheric circulation, temperature and sea-ice extent changes on the sea-salt record.

Abstract

Prof. Peter Ditlevsen

Submission ID	161
Name:	Prof. Peter Ditlevsen
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	What can we learn from the fast fluctuations in the isotope records?
Full Author List:	P. D. Ditlevsen Z. Shao
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ABSTRACT

Next to the glacial cycles, the Dansgaard-Oeschger(DO) events are the most dramatic natural climate changes observed in the paleoclimatic record. The cause of these is still unknown. By analyzing the short-term fluctuations prior to the rapid warming, almost at time scales of the weather, we can distinguish between different dynamical mechanisms for the jumps. From this, they seem to be stochastic in nature, and thus fundamentally unpredictable. Furthermore, the enormous timespan in the ice core records between the sub-annual scale to the glacial time scale enables us to “glue” the records together with the instrumental records in one end and the multi-million years ocean sediment records in the other end. We can thus investigate the scaling statistics over approximately 8 orders of magnitude in time.

The scaling exponents of the Holocene and the glacial climate are fundamentally different. The Holocene record is monofractal, in agreement with the instrumental records. On the contrary, the glacial record is multifractal, with a significantly higher scaling exponent indicating a longer persistence time and stronger non-linearity in the glacial climate. The glacial climate is dominated by the DO-events influencing the long-time correlation. However, by analyzing the last glacial maximum period, lacking DO-events, we find the same scaling for that climatic period as well. The unbroken scaling thus indicates that the DO-events are part of the natural variability and not externally triggered. At glacial time scales there is a scale break to trivial scaling, contrasting the DO-events from the similarly saw-tooth shaped glacial cycles.

Abstract

Valérie Masson-Delmotte

Submission ID	162
Name:	Valérie Masson-Delmotte
Institution:	IPSL/LSCE
Country:	France
Presentation Title:	Impact of volcanic forcing on northern hemisphere climate during the last millennium
Full Author List:	Valérie Masson-Delmotte1, Pablo Ortega2, Didier Swingedouw3, Myriam Khodri4, Markus Stoffel5
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ABSTRACT

This presentation will be focused on recent results exploring the short and long term impacts of volcanic forcing on North Atlantic and northern hemisphere climate, obtained combining ice core temperature records with other paleoclimate information, and with simulations performed with climate models. We show that, when volcanic forcing is prescribed realistically in coupled climate models for the largest eruptions of 1257 and 1815, the magnitude of simulated northern hemisphere extra-tropical land summer temperature cooling of 0.8 to 1.3°C is consistent with new tree ring based reconstructions. We also assess the ability of state of the art climate models to capture the spatial pattern of temperature change following the large 1257 eruptions, combining historical information, tree ring data, and Greenland ice core data. Further insights on the role of North Atlantic atmospheric dynamics in the last millennium are also presented. By screening 48 proxy records around the Atlantic Ocean, we establish an ensemble of yearly winter NAO reconstructions from multi-variate regressions, validated using climate simulations. This new reconstruction depicts positive NAO phases dominating during the 13th and 14th centuries but no persistent positive NAO during the medieval period, in contrast with an earlier millennial NAO reconstruction based on only two proxies. A robust feature from the new reconstruction is the recurrence of a positive NAO two years after strong volcanic eruptions. Finally, we explore the relationship between North Atlantic bidecadal variability and volcanic forcing. Greenland ice core records are sensitive to bidecadal variability of North Atlantic surface temperature. In these ice core data and in climate models, we show that coherent bidecadal cycles are excited following five Agung-like eruptions of the last millennium. Volcanic eruptions therefore act as pacemakers of this internal variability, which involves salinity advection from the Arctic. The dynamical response of the NAO and of the North Atlantic ocean circulation to large volcanic eruptions has therefore crucial implications for climate predictability at the seasonal to decadal timescale.

Abstract

Dr. Peter Köhler

Submission ID	163
Name:	Dr. Peter Köhler
Institution:	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Country:	Germany
Presentation Title:	On the role of volcanic CO_2 outgassing in the global carbon cycle on orbital time scales: two case studies from the last glacial cycle
Full Author List:	P. Köhler1, J. Havenclever2, G. Knorr1, T. Ronge1, L. Rüpke2, R.Tiedemann1
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ABSTRACT

Increasing evidences point to a more important role of volcanic CO_2 outgassing in the carbon cycle than previously thought. Here we present two examples, where data or models indicate that only volcanic CO_2 outgassing might explain some observed phenomena.

(1) The paleo data show that atmospheric CO_2 and Antarctic temperature changes are surprisingly synchronous on both millennial and orbital time scale, although there are some still unexplained exceptions. Here we show that the decoupling of temperature and CO_2 around the transition into full glacial conditions around the MIS 5/4 boundary (~75kyr BP) might have been caused by the volcanic CO_2 degassing, that itself was triggered by the sea level fall of 60-100m within ~10kyr. An additional volcanic CO_2 release from mid ocean ridges and hotspots calculated with a state-of-the-art 3D geodynamical model to ~500 to 900 $GtCO_2$ might explain the bulk of the ~18 ppm CO_2 anomaly, that is associated with this decoupling of CO_2 and temperature on orbital time scales.
(2) Radiocarbon (^{14}C) is widely used to detect the carbon that has been transferred from the atmosphere to the deep ocean during the LGM. New ^{14}C data from a depth transect indicate that this carbon might be found at mid water depths (~3 km) in the South Pacific. However, the maximum observed anomaly in deep ocean $\Delta^{14}C$ to the atmosphere of -1000permil can only be explained if a realistic increase in reservoir age and a hydrothermal influx of ^{14}C-free CO_2 from mid ocean ridges are considered together.

Abstract

Dr. Peter Köhler

Submission ID	165
Name:	Dr. Peter Köhler
Institution:	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Country:	Germany
Presentation Title:	On the state-dependency of the equilibrium climate sensitivity during the last 5 million years
Full Author List:	P. Köhler1, B. de Boer2,3,4, A. S. von der Heydt3, L.. B. Stap3, R. S. W. van de Wal3
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ABSTRACT

A still open question is how equilibrium warming in response to increasing radiative forcing — the specific equilibrium climate sensitivity S — is depending on background climate. We here present paleo-data based evidence on the state-dependency of S, by using CO2 proxy data together with 3-D ice-sheet model-based reconstruction of land ice albedo over the last 5 million years (Myr). We find that the land-ice albedo forcing depends non-linearly on the background climate, while any non-linearity of CO2 radiative forcing depends on the CO2 data set used. This non-linearity was in similar approaches not accounted for due to previously more simplistic approximations of land-ice albedo radiative forcing being a linear function of sea level change. Important for the non-linearity between land-ice albedo and sea level is a latitudinal dependency in ice sheet area changes. In our setup, in which the radiative forcing of CO2 and of the land-ice albedo (LI) is combined, we find a state-dependency in the calculated specific equilibrium climate sensitivity S[CO2,LI] for most of the Pleistocene (last 2.1 Myr). During Pleistocene intermediate glaciated climates and interglacial periods S[CO2 ,LI] is on average ∼ 45% larger than during Pleistocene full glacial conditions. In the Pliocene part of our analysis (2.6 – 5 Myr BP) the CO2 data uncertainties prevents a well-supported calculation for S[CO2,LI], but our analysis suggests that during times without a large land-ice area in the northern hemisphere (e.g. before 2.82 Myr BP) the specific equilibrium climate sensitivity S[CO2,LI] was smaller than during interglacials of the Pleistocene. We thus find support for a previously proposed state-change in the climate system with the wide appearance of northern hemispheric ice sheets. This study points for the first time to a so far overlooked non-linearity in the land-ice albedo radiative forcing, which is important for similar paleo data-based approaches to calculate climate sensitivity. However, the implications of this study for a suggested warming under CO2 doubling are not yet entirely clear since the necessary corrections for other slow feedbacks are in detail unknown and the still existing uncertainties in the ice sheet simulations and global temperature reconstructions are large.

Abstract

Eric Wolff

Submission ID	166
Name:	Eric Wolff
Institution:	University of Cambridge
Country:	UK
Presentation Title:	Does the recent loss of Arctic sea ice show up in potential ice core proxies?
Full Author List:	K.Pol1, E.W. Wolff2, N. Abram3, H. Fischer4, L. Fleet1, G. Gfeller4, J.R. McConnell5, O. Maselli5, R. Mulvaney1
Author Affiliations:	1 British Antarctic Survey, Cambridge – UK; 2 University of Cambridge, Cambridge – UK; 3 Australian National University, Canberra – Australia; 4 University of Bern, Bern – Switzerland; 5 Desert Research Institute, Reno – US .

ABSTRACT

While MSA and Na in ice cores have been tested as potential proxies of sea ice extent changes in Antarctica, little is known about a possible similar usage in the Arctic. Focusing on the 1979-2010 period for which satellite derived data are available, this study compares MSA and Na profiles - obtained from the chemical measurements of three different shallow cores distributed from North to South Greenland - with local meteorological conditions, changes in the origin of air masses coming on site and reconstructed Northern Hemisphere sea ice extent. We focus here on trends, after removing the annual cycle, and recognising that there is a lot of year to year variability attributable to meteorology. Results show a decreasing trend in measured concentrations in Na at the three sites, which cannot be explained by either changes in in situ meteorology or sources, but which corresponds to the decreasing trend in Arctic sea ice extent observed over the last 30 years. Such a correlation cannot be found when considering MSA concentrations. Further study is clearly needed to establish a mechanistic explanation for the apparent association between a trend in Na and a trend in sea ice extent, but we thus highlight the potential of sea salt (via Na) in Greenland ice cores as good indicators of past sea ice trends in the Arctic. In contrast, the fact that MSA does not show even the gross trend in sea ice suggests that it is tricky to use and interpret in the Arctic.

Abstract

Eric Wolff

Submission ID	167
Name:	Eric Wolff
Institution:	University of Cambridge
Country:	UK
Presentation Title:	Nitrate spikes cannot be used to assess the statistics of solar energetic particle events (SPEs)
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ABSTRACT

Large solar energetic particle (SEP) events have the potential to severely disrupt satellite, communications and electronic systems. There is therefore strong motivation to establish a proxy that could document the statistics of occurrence of SEP events of different magnitudes, and in particular the recurrence frequency of the largest events. For 30 years there has been a controversy as to whether spikes in the concentration of nitrate in polar ice cores can be used as such a proxy. Here we summarise several lines of evidence that show that they cannot. Firstly, we have shown that most of the nitrate spikes in Greenland, previously proposed as SEP signals, actually arise from biomass burning plumes. Secondly we show that sharp signals identified by other authors as SEP signals are not reproduced in parallel cores, and most likely arise as depositional events rather than as a result of changing atmospheric concentration of nitrate. Thirdly we summarise modelling work which shows that events 100-1000 times stronger than those that have occurred in recent decades should be needed to create signals of the size identified in ice cores. Finally we look for a nitrate signal associated with the recently identified 10Be signal at 775 AD – a signal which is believed to represent a very large SEP.

Abstract

Geoffrey Paul Lee

Submission ID	168
Name:	Geoffrey Paul Lee
Institution:	University of East Anglia
Country:	UK
Presentation Title:	A ‘strange event’: unexplained signals recorded in a Pleistocene Antarctic ice core
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ABSTRACT

Previous work at UEA (Mani, 2010) identified an interesting and unexplained phenomenon in an ice core record from Berkner Island, Antarctica, that followed two significant Antarctic Isotope Maxima (AIM) events (8 and 12). Between approximately 48 and 35 ka nitrogen gas isotope measurements (δ15N) from entrapped air bubbles covaried with the hydrogen water isotopic record (δD) from the ice, suggesting a locally temperature-controlled δ15N. However, the possibility that this signal reflects only temperature is undermined by a large positive excursion (the ‘Strange Event’ (Mani, 2010)) beginning at approximately 35 ka and not returning to ambient for almost 10 ka; a similar excursion is not seen in the coeval δD record. δ15N is controlled by temperature-dependent and gravitational fractionations, although the gravitational component can be quantified using the isotopic fractionation of argon isotopes (δ40Ar), which responds primarily to gravitational fractionation. However, Mani’s (2010) δ40Ar measurements were inconclusive and so he corrected for gravitational fractionation using a firn densification model, which may be less informative. One possible cause of the Strange Event is a large increase in the local ice accumulation rate which would have increased the diffusive column height, thus increasing gravitational fractionation. The observed δ15N-δD divergence certainly suggests some additional fractionation mechanism besides temperature. We intend, therefore, to present dual measurements of δ15N and δ40Ar from the same core and across the same events, supplemented by high-resolution ion chromatography of the ice to establish seasonality, constrain ice accumulation rates, and thus explore the origins of the Strange Event.

Abstract

Dr. Hwang Heejin

Submission ID	169
Name:	Dr. Hwang Heejin
Institution:	Korea Polar Research Institute
Country:	KOREA
Presentation Title:	Characterization of individual insoluble particles in ice core
Full Author List:	H. Hwang1, M.A. Malek2, H. Geng3, H.-J. Eom, C.-U. Ro2, J.-H. Kang1, S.D. Hur1, S. Hou4
Author Affiliations:	1 Korea Polar Research Institute, Incheon, Korea 2 Inha University, Incheon, Korea 3 Shanxi University, Taiyuan, China 4 Nanjing University, Nanjing, China

ABSTRACT

In this work, the practical applicability of the combined use of low-Z particle electron probe X-ray microanalysis (EPMA) and attenuated total reflectance (ATR) FT-IR imaging techniques for the characterization of individual aerosol particles is demonstrated. These two single particle analytical techniques provide complementary information on the physicochemical characteristics of the same individual particles, that is, the low-Z particle EPMA for the information on the morphology and elemental concentration; and ATR-FT-IR imaging on the functional group, molecular species, and crystal structure. Here, individual insoluble particles present in four samples, sample A-D, collected from different depths of the ice core of East Rongbuk glacier from Mt. Qomolangma (Everest), were characterized. Mineralogical characterization of sample A, C, and D show clear contrast in relative abundances and type of minerals with that of sample B. Some particles in sample D were identified as vitreous glass (amorphous silica), and probably obsidian (rhyolitic glass), which are not common in ambient aerosol particles, and might be related to volcanic origin. This study shows that volcanic ash particles (tephras) in ice cores can be distinguished from normal dust storm particle using this approach.

Abstract

Dr. Catherine Ritz

Submission ID	170
Name:	Dr. Catherine Ritz
Institution:	Laboratoire de Glaciologie et Géophysique de l'Environnement UGA/CNRS
Country:	France
Presentation Title:	Did the domes and ice divides of Antarctica move in the past ?
Full Author List:	C. Ritz1,2 and D. Pollard3
Author Affiliations:	CNRS, France Univers. Grenoble Alpes, Grenoble, France Pennsylvania Sate University, University Park, PA, USA

ABSTRACT

Reconstructing trajectories of ice particles is important for interpretation of deep ice cores. For instance, the location of ice origin of each particle affects the reconstruction of its past temperature and thermo-mechanical history, which is necessary to understand some physical characteristics of the ice core. The difficulty comes from the fact that ice-sheet topography has changed in the past, and that the origin inferred from present topography could be substantially different from its real one. In the context of the search for "Oldest Ice locations" the question of past topography is even more crucial. One of the criteria for the existence of old ice is to have a low velocity (< 1-2 m/yr), because it minimizes origin effects and (hopefully) basal disturbances. This criterion selects regions around domes (and ice divides), but the domes may have changed location depending on the evolution of the ice sheet. Ice-sheet modelling is the only tool available to tackle this question, because most domes are far from outcrops where one could find geomorphological indicators. We propose to revisit ice-sheet simulations and to focus on dome and divide positions on time scales as long as several glacial-interglacial cycles (up to 5 million years). Preliminary analysis indicate that the modelled domes do not move very much, but that at the end of glacial-interglacial cycles simulations (i.e., present time) there are significant differences from observed locations. However, these differences can be corrected by adjusting the model's basal drag map for instance, allowing ice sheet models to reproduce present topography including dome locations very well. Here, current work is described that analyses various types of simulations (paleo, present calibrated, ...) in order to understand the processes involved in past dome migration and improve estimates of their possible movements in the past.

Abstract

Dmitry V. Divine, Dr.

Submission ID	171
Name:	Dmitry V. Divine, Dr.
Institution:	Norwegian Polar Institute
Country:	Norway
Presentation Title:	Event-based observations of stable water isotopes in precipitation in Ny-Ålesund to support interpretation of Svalbard ice core data
Full Author List:	D.V. Divine1, T. Martma2 and E. Isaksson1
Author Affiliations:	Norwegian Polar Institute, Tromsø, Norway Tallinn University of Technology, Tallinn, Estonia.

ABSTRACT

Ice core records of stable water isotopes ratios are known to store valuable information about previous climate. The analysis relies on δ18O and δD in precipitation because of their relationship to the condensation temperature of the water vapor. The final isotopic composition of precipitation is however a result of a range of processes and variations in the distillation history of an air mass forming precipitation may cause considerable variations of the T- δ18O (or δD) gradient on a range of time scales. The program of event-based snow sampling in Ny-Ålesund initiated in 2010 is aimed at providing a better understanding of factors controlling the isotopic signature of precipitation to support the analysis and interpretation of Svalbard ice core data. Preliminary results from two winter seasons suggest a lack of pronounced seasonal curve in stable water isotopes and a lack of correlation between SAT and δ18O/ δD in precipitation, moreover the slope of the δ18O /SAT relationship seems to vary on the interannual scale. Deuterium excess in turn shows a reasonably good (about -0.5) negative correlation with the ambient temperature during precipitation. It signifies the effect of a local moisture contribution to Ny-Ålesund precipitation. Negative correlation between the air temperature and d is indicative of a stronger kinetic fractionation during evaporation from a relatively warm ocean exposed to a cold Arctic air. The analysis is planned to be further extended using trajectory modeling and regional climate simulations with the embedded stable water isotope module.

Abstract

Dr. Shugui Hou

Submission ID	172
Name:	Dr. Shugui Hou
Institution:	Key Laboratory of Coast and Island Development of Ministry of Education, School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing 210093, China
Country:	China
Presentation Title:	Slight glacier reduction over the northwestern Tibetan Plateau despite the significant recent warming
Full Author List:	Yetang Wang1, Shugui Hou 2, *, Wenling An2, Hongxi Pang2, Yaping Liu3
Author Affiliations:	1 College of Geography and Environment, Shandong Normal University, Jinan 250014, China 2 Key Laboratory of Coast and Island Development of Ministry of Education, School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing 210093, China 3 State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China

ABSTRACT

Glacier reduction shows different spatial patterns despite increasing temperatures on the Tibetan Plateau. Remote sensing images showed that Zangser Kangri glacier reduced by only 2.26% in area since the 1970s, similar to the reduction rates of adjacent glaciers over the northwestern Tibetan Plateau. However, the glacier area reduced by 34.14% for the Tienshan Mountains, 15.63% for the Himalayas, and 17% for the northeastern Tibetan Plateau during the past decades. Significant positive correlation was found between winter precipitation and temperature over the northwestern Tibetan Plateau, while weak positive or negative correlations existed over the Tienshan Mountains, the northeastern Tibetan Plateau and the Himalayas. It seems that, with strengthening westerlies, glacier reduction over the northwestern Tibetan Plateau resulting from increasing temperature could be partly offset by more accumulation from increased winter precipitation.

Abstract

Nerilie Abram

Submission ID	173
Name:	Nerilie Abram
Institution:	The Australian National University
Country:	Australia
Presentation Title:	Climate variability and environmental change on the Antarctic Peninsula during the last millennium
Full Author List:	N.J. Abram1, and R. Mulvaney2
Author Affiliations:	1. The Australian National University, Canberra, Australia 2. British Antarctic Survey, Cambridge, UK

ABSTRACT

The Antarctic Peninsula has experienced rapid climate and environmental changes over recent decades. A highly resolved ice core record from James Ross Island (JRI) on the northeastern Antarctic Peninsula has provided valuable perspectives on these changes; showing that the rate of warming over the last century has been unusually fast and has caused an acceleration in the amount of summer ice melt to levels that are higher than at any other time over the last millennium.

In this study we use the JRI ice core to further explore the features and drivers of climate variability on the Antarctic Peninsula during the last millennium. We find that temperature variability on the Antarctic Peninsula has significant and persistent decadal-scale variability, which appears to be intensified at times when the mean climate is cooler than usual. Using the sea salt and methanesuphonic acid records from the JRI ice core, alongside CMIP5 climate simulations, we discuss the likely processes that caused natural climate variability in this region in the past and give additional context to the environmental changes observed along the Antarctic Peninsula in recent decades.

Abstract

Dr Patricia Martinerie

Submission ID	174
Name:	Dr Patricia Martinerie
Institution:	Laboratoire de Glaiologie et Géophysique de l'Environnement
Country:	France
Presentation Title:	The smoothing effect of progressive gas trapping on greenhouse gas signals in ice cores
Full Author List:	P. Martinerie1, E. Witrant2, X. Fain1, K. Fourteau1, J. Chappellaz1, R.H. Rhodes3,6, E.J. Brook3, M. Sigl4,7, J.R. McConnell4, T. Blunier,5
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ABSTRACT

Gas trapping occurs in a 5 to 15 meters depth range at the bottom of polar firn. At the very arid central Antarctic plateau sites, this process can take more than a thousand years. Only a few studies investigated the smoothing effect of firn on gas signals in ice cores due to the difficulty to extrapolate modern firn site characteristics to paleo-climatic conditions.

We propose a novel method to evaluate the smoothing effect of firn mostly constrained by the snow accumulation rate. The method uses log-normal age distributions in ice extrapolated from those calculated by the LGGE-GIPSA model of gas transport in firn at modern firn air pumping sites. The "convolution" approach or log-normal smoothing is rigorous and has a unique mathematical solution when converting an atmospheric trend into an ice core signal. However log-normal smoothing can lead to biased results when used to convert an ice core signal into another one. The "de-convolution": reconstructing an atmospheric trend from ice core signals is an inverse problem with multiple solutions. The method characteristics are evaluated using known artificial atmospheric signals such as sinusoids with different periods.

High resolution records of methane are used to compare the recordings of the same atmospheric event in different ice cores and its simulation with our model. We will present the results obtained for the methane peak around 1500 AD and possibly (in an oral presentation) the last deglaciation and Dansgaard-Oeschger events of the last glaciation.

Abstract

Dr. Li Zhang

Submission ID	177
Name:	Dr. Li Zhang
Institution:	State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China
Country:	China
Presentation Title:	Estimating ice accumulation rate of a 109.91m ice core at Dome A, Antarctica, using 10Be
Full Author List:	L. Zhang1,2, G. M. Raisbeck3, S. Hou4, Z. Wu1,2, W. Zhou1,2,5
Author Affiliations:	1 State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China 2 Shaanxi Key Laboratory of Accelerator Mass Spectrometry Technology and Application, Xi'an AMS Center, Xi'an, China. 3 CSNSM, CNRS, Université Paris-Saclay, Bats 104-108, 91405 Campus, Orsay, France 4 Key Laboratory of Coast and Island development of Ministry of Education, School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing, China 5 School of Human Settlement and Civil Engineering, Xi'an Jiaotong University, Xi'an, China

ABSTRACT

Obtaining « old ice » (> 1.5 My) is one of the four scientific goals of IPICS. When we initiated this work, one of the sites that was considered very favourable for recovering such ice was Dome A. This was because of its very low average temperature, and some preliminary studies which had suggested that the ice accumulation rate (one of the most important parameters controlling the age vs depth relationship in an ice core) was as low as 1 cm/yr. We thus undertook to measure a 10Be profile in ice chips from the 109.91 m core drilled near Dome A by the Chinese National Antarctica Research Expedition in January 2005. By correlating the 10Be profile with that of the ^{14}C record in tree rings (on centennial time scales, the variability of both these isotopes is due mainly to variations in solar activity), we were able to deduce the chronology of the core, and thus the ice accumulation rate (the thinning function in the upper parts of ice sheets near domes is close to unity and can be reliably estimated). The results give an age at the bottom of the core of ~3200 years, and an average ice accumulation rate of 2.31 g H_2O/cm^2 yr). This is intermediate between that observed at Dome C and Vostok and, together with more recently obtained information on the ice stratigraphy at depth, suggests that it is unlikely that > 1 My ice can be obtained at this site.

Abstract

Prof. Eric Wolff

Submission ID	178
Name:	Prof. Eric Wolff
Institution:	Department of Earth Sciences, University of Cambridge
Country:	UK
Presentation Title:	Fire proxies in polar and non-polar ices: A review
Full Author List:	M. LEGRAND1 and E. WOLFF2
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ABSTRACT

Biomass burning is a major source of gases and aerosols that strongly influence the chemistry of the atmosphere and the regional climate. In addition to the study of charcoal in sediments, the ice cores offer the possibility to reconstruct past fire activity and its response to climate change by examining ice records of numerous chemical species that were emitted or produced in combustion plumes. In addition to inorganic species like nitrogen species (ammonium, nitrate), soluble submicron potassium, and HCl, ice cores have trapped numerous organic species (or group of species) that are also produced during combustion. They include monosaccharide anhydrides (levoglucosan), and various acidic species like p-hydroxybenzoic and dehydrobietic acids, phenolic acid (vanillic acid), short-chain (C1-C5) mono- and di-carboxylic acids, and acidic oligomers (Humic like substances). Finally, though to be emitted in smaller quantities than organic aerosol (OC), black carbon (BC) is also produced during combustion.

We here review attempts made to reconstruct past fire activity using chemical records of ice cores extracted from polar ice sheets and a few mid-latitude glaciers (Alps, central Asia, Kamchatka) that have been published in the literature since the early 90's. We discuss on the quality of the various investigated fire proxies archived in ice. We will see that, in addition to flame conditions (flaming/smoldering) that influence emission factors of species, the proxy quality strongly depends on the considered time period (anthropocene/pre-industrial), and on the ratio of event to background depending on the environment in the vicinity of drill sites (Antarctic, Greenland, mid-latitude glaciers).

Abstract

Anaïs Orsi

Submission ID	179
Name:	Anaïs Orsi
Institution:	Laboratoire des Sciences du Climat et de l'Environnement, (IPSL-LSCE, CNRS-CEA-UVSQ)
Country:	France
Presentation Title:	The last thousand years at Talos Dome
Full Author List:	A. Orsi 1, A. Landais 1, B. Stenni 2
Author Affiliations:	1 Laboratoire des Sciences du Climat et de l'Environnement, CNRS-CEA-UVSQ, Gif sur Yvette, France 2 Department of Environmental Sciences, Informatics and Statistics - Ca' Foscari University of Venice, Venice, Italy

ABSTRACT

Talos Dome (15°11' E, 72°49' S, 2315m a.s.l.) is a peripheral dome located in the South Pacific/Ross Sea sector of the East Antarctic Plateau. It receives air masses mainly from the Indian and secondarily from Pacific sectors of the Southern Ocean. As a result, its climate presents similarities both to West Antarctica (Pacific air masses) and to the East Antarctic plateau sites of Dome C and Vostok (Indian air masses).

We present a temperature reconstruction at Talos Dome for the last 1000 years, from the analysis of inert gas isotopes (δ15N and δ40Ar). In addition, we measured the triple isotopic composition of water to explored changes in air mass properties.

Inert gas isotopes indicate a long term cooling trend at the site. Second order parameters (d-excess and 17O-excess) show that the partitionning between Ross and Indian air masses likely has changed over this period, with a decrease in the Ross sea contribution.

These results provide new constraints on the changes in the circulation associated with the Little Ice Age cooling in West Antarctica.

Abstract

Dr. Joel Savarino

Submission ID	180
Name:	Dr. Joel Savarino
Institution:	LGGE, CNRS
Country:	France
Presentation Title:	A reconstruction of terrestrial volcanism over the last 2500 years using sulfur isotopes in ice-cores
Full Author List:	J. Savarino1 E. Gautier1 J. Farquhar2 A. Lanciki1 J. Erbland1
Author Affiliations:	LGGE/CNRS/UJF, Grenoble, France University of Maryland, College Park, USA

ABSTRACT

Ice cores provide an opportunity to reconstruct a history of Earth's volcanic activity. Many attempts have been made in the past to build a robust volcanic climate-forcing model based on the ice records, but the robustness of this model depends on discriminating between large distant eruptions and closer, smaller eruptions. Additionally, ice cores provide the most easy way to access stratospheric sulphate aerosols (SSA) allowing to test the theories and lab experiments proposed so far to explain the mass independent sulphur isotope fractionation (S-MIF).

In 2010-2011, five 100m-long ice cores from Dome C, Antarctica, were collected to reconstruct the history of volcanism over the last 2500 years. Drilling 5-cores at one site is unusual and provides the opportunity to: 1- test the statistical representativeness of a single core, 2- produce a robust proxy of historical stratospheric eruptions and 3- produce the most extensive database of S-MIF on SSA.

Sulfate concentration analysis of the 5-cores reveals that local scale variability, essentially attributed to snow drift and surface roughness at Dome C, can lead to a non-exhaustive record of volcanic events when a single core is used as the site reference with a bulk probability of 30 % of missing volcanic events and 60 % uncertainty on the volcanic flux estimation.

We use the isotopic signature ($\Delta^{33}S$) of volcanic sulfate to identify stratospheric volcanic eruptions, recorded in Dome C, Antarctica, over the last 2600 years. Through this method, we confirm most of the time the tropical origin of volcanic events as reported in the literature. Few discrepancies reveal high latitude stratospheric events, but the synchronization between north and south pole records is not questioned. We also present oxygen isotopic composition ($\Delta^{17}O$) of the largest peaks recorded in our cores, and confirm that large

volcanic eruptions can be associated with significant changes in the oxygen isotopic composition, probably in relation with the altitude of injection.
Finally, the large number of samples allows for better constraining the Δ33S vs. Δ36S and Δ33S vs. δ34S slopes, which directly reflects the feature of S-MIF mechanism in the stratosphere. Implications on current atmospheric chemistry are evaluated through the set of trends obtained in our samples. We use a simple model implemented with fractionation factors available in the literature to account for the isotopic pattern observed on volcanic sulfate deposition. Through this tool, we evaluate the significance of the different mechanisms assumed to take part in the oxidation process (mass dependent vs. mass independent processes, self-shielding vs. spectra isotopic shift) needed to reproduce natural data, in the current state of experimental knowledge.

Abstract

Yang Yang

Submission ID	181
Name:	Yang Yang
Institution:	Jilin University
Country:	China
Presentation Title:	Ice and Subglacial Bedrock PDM Corer with the Use of Hot-Water Drill System
Full Author List:	Yang Y.1, Cao P.2, Zhang N.3, Fan X.4 ,Wang R.5, Liu G.6, Talalay P.G.7
Author Affiliations:	Polar Research Center, Jilin University, Changchun, China

ABSTRACT

Subglacial observation of the base of the Antarctic ice sheet addresses a wide range of interdisciplinary research goals of the international scientific community. These include tectonic and geomorphological studies from ice-covered geologic provinces of Antarctica, measuring of thermal gradient, heat flow, ice accumulation history, ice-sliding processes, and microbiological studies of microorganisms that may be present at the base of the ice sheet. Hot-water drill systems are well-known and one of the most common rapid access approaches and can be considered as the fastest way to reach the surface of the subglacial bedrock. Even sampling of the ice cores at targeted depths with these systems is possible, subglacial sampling is a challenging task. For subglacial bedrock core sampling with a hot-water drill system, it is suggested installing a positive displacement motor (PDM) that rotates core barrel instead of the hot-water nozzle. A PDM converts hydraulic pressure of hot-water flow into rotation and torque. However, rotation of the downhole motor will require using of reliable anti-torque system. PDM corer will have modular concept and come in two modifications. The first one is designed and suitable for ice core drilling. In this case, hot-water will be used to melt ice chips created during the cutting process. The drill thus requires no chips chamber. The version for sampling of debris-rich ice or bedrock contains sedimentation barrel. The detailed concept of ice and subglacial bedrock PDM corer is being worked out.

Abstract

Prof. Dr. Frank Wilhelms

Submission ID	182
Name:	Prof. Dr. Frank Wilhelms
Institution:	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung
Country:	Germany
Presentation Title:	A Basler BT-67 deployable deep drilling system
Full Author List:	F. Wilhelms1,2, J. Tell1, M. Hüther1, J. Brozek1, B. Broy1, A. Frenzel1
Author Affiliations:	1 Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (AWI), Bremerhaven, Germany 2 Department of Crystallography, Geoscience Centre, University of Göttingen, Germany

ABSTRACT

Upcoming deep ice coring operations, like e.g. Beyond EPICA in response to the IPICS Oldest Ice Core challenge envisage drilling in the interior of the East Antarctic Plateau. In such remote areas logistic requirements are outrageous and even on surface traverses the transportation cost is so high that more costly weight reduced equipment generally immediately pays off. On the other hand the Basler BT-67 has become a workhorse in the DROMLAN and AWI logistics as well as other Antarctic programs, like. e. g. the US or Australia.

We overwork a Hans Tausen type drill design with the aim to design unit sizes as small as possible to attain handy equipment that can be transported by small aircraft and be handled on high altitude without the need for heavy vehicles. Especially for the surface infrastructure this implies a complete re-design of the tower, the winch, drill handling and ice core retrieval systems.

We will present the basic concept, detailed designs, already performed tests and envisaged operational procedures. Major components have been tested and a system that can be deployed with a Basler BT-67 appears to be realistic. Maybe even deployment by Twin Otter DHC-6 seems to be possible, where the efficiency on the Antarctic Plateau in terms of payload to range considerations for such small aircraft is questionable. Finally, we are convinced to work towards an efficient system for the implementation of an oldest ice core drilling whatever logistic frame will be available for its implementation.

Abstract

Anna Kozachek

Submission ID	183
Name:	Anna Kozachek
Institution:	Arctic and Antarctic Research Institute
Country:	Russia
Presentation Title:	Climate controls on the isotopic composition of precipitation in the Caucasus highlands as revealed from ice core studies
Full Author List:	A.V.Kozachek1, A.A.Ekaykin1,2, V.N.Mikhalenko3, V.Ya. Lipenkov1
Author Affiliations:	1. Arctic and Antarctic Research Institute, St. Petersburg, Russia 2. Saint-Petersburg State University, St. Petersburg, Russia 3. Institute of Geography, Moscow, Russia

ABSTRACT

Here we present the results of isotopic investigations of several ice cores obtained in the Caucasus mountains in southern Russia, Mount Elbrus and Mount Kazbek. There is a distinct seasonal cycle in the isotopic composition record of these cores. We discuss the isotopic composition of the upper part (150 m) of the Elbrus deep ice core (182 m) obtained in 2009 as well as several shallow cores. This part of the deep core was dated using annual layers counting and it covers the period from 1840 till 2012.

These values were compared with available meteorological records from 13 weather stations in the region, and also with atmosphere circulation characteristics, back-trajectories calculations and GNIP data. We worked out the possible mechanisms of the formation of the isotopic composition of precipitation and of ice deposits in the Caucasus region.

It was shown that in the summer season, the isotopic composition depends on the local temperature, while in winter, it depends on the atmospheric circulation. The snow accumulation rate correlates well with the precipitation rate in the region all year round. We reconstructed the precipitation record at the Caucasus highlands from 1840 till 1930 when the meteorological observations at high elevation began.

The research was supported by Russian Foundation for Basic Research grant 14-05-31102 mol_a.

Abstract

Emily Doyle

Submission ID	184
Name:	Emily Doyle
Institution:	Pennsylvania State University
Country:	USA
Presentation Title:	Preliminary results of a new extraction/analytical technique for measuring the elemental and isotopic composition of trapped gases in ice.
Full Author List:	E. Doyle, T. Sowers
Author Affiliations:	Pennsylvania State University, State College, PA, USA

ABSTRACT

A new gas extraction method has been developed at Pennsylvania State University (PSU) for the unprecedented analysis of δ15N, δ18O, δO2/N2, methane (CH4), and total air content (TAC) on air from a single ~68g ice core sample. Ten samples are processed simultaneously with a melt/refreeze technique, and the released gas is quantitatively collected and analyzed using isotope-ratio mass spectrometry and gas chromatography. This advancement allows the direct correlation of gas properties, improving solubility and equilibration corrections and increasing the accuracy of δ15N, δ18O, CH4, and TAC measurements. A unique correction was determined for each ice sample based on sample mass, headspace volume, and the difference between measured δO2/N2 values and calculated δO2/N2 values at full equilibration. δ15N measurements of four WAIS ice samples (220-240 mbs) averaged 0.302 ±0.006‰, with a pooled error of 5.1 +/- 1.7 permeg for each 10-sample run. Results agree with those from Scripps (δ15N = 0.300 ±0.006‰; pooled error ≤ 5 permeg), though a ~30 permeg data spread across each run shows further refinement is needed. TAC precision increased by a factor of 2.5 from the previous PSU method, with results of 0.1171 ±0.0018 cc/g, which is ~ 0.008 cc/g higher than data from Oregon State University (OSU) and most likely due to the improved solubility and equilibration corrections. We are currently assessing the nature of the PSU CH4 blank. Preliminary results on WAIS ice samples have good reproducibility (±10 ppb) with shows that mean values are in good agreement with corresponding CH4 measurements from OSU.

Abstract

Dr. Johannes Freitag

Submission ID	185
Name:	Dr. Johannes Freitag
Institution:	Alfred Wegener Institute Helmholtz center for Polar and Marine Research
Country:	Germany
Presentation Title:	Bubble observations and analysis of the Renland ice core
Full Author List:	J. Freitag1,C. Schaller1,S.Kipfstsuhl1,B. Vinther2,A.Svensson2
Author Affiliations:	1Alfred Wegener Institute,Bremerhaven,Germany 2Nils Bohr Institute,Copenhagen,Denmark

ABSTRACT

Bubbles in ice cores store various information about climate conditions during densification and pore close-off in former times. Very recently it was shown that bubbles can additionally be used as marker for cumulated strain within the ice. Bubble studies on the Renland ice core are from particular interest: the Renland ice core includes the oldest bubbly ice retrieved so far in ice core drilling projects and it contains bubbly ice that has been exposed to tremendous deformation and thinning. The Renland ice core of 584 m length was drilled through the ice cap during May-June 2015 in the framework of RECAP (Renland ice cap drilling project). The ice shows no clathrate formation. Preliminary considerations suggest Holocene and Glacial ice with Eemian ice close to bedrock.

Core sections of the Renland ice core from selected depth intervals are measured with the means of X-ray computer tomography using the core-scale AWI-ICE CT. The measurements are performed with a spatial resolution of 15μm and provide 3d- bubble arrangements. Different bubble shape factors, bubble volume (porosity), bubble centre distributions and bubble next neighbor functions are derived. We present first depth profiles of these parameters and discuss the results in context of deformation mechanism and paleo climate. It will contribute to reconstruct the complex deformation history of the Renland ice cap.

Abstract

Dr. Sepp Kipfstuhl

Submission ID	186
Name:	Dr. Sepp Kipfstuhl
Institution:	Alfred Wegener Institute Helmholtz center for Polar and Marine Research
Country:	Germany
Presentation Title:	Physical Properties of the Renland (East Greenland) ice core
Full Author List:	S.Kipfstuhl1,I. Weikusat1,J. Freitag1,A. Svensson2,B. Vinther2
Author Affiliations:	1Alfred Wegener Institute,Bremerhaven,Germany 2Nils Bohr Institute,Copenhagen,Denmark

ABSTRACT

The Renland ice cap is located in the alpine zone of central East Greenland, independent of the Greenland ice sheet and sensitive to climate and sea ice changes in the North Atlantic Ocean and Greenland Sea. The drilling site was chosen from Radar Echo Sounding to recover well-stratified glacial and Eemian ice lying close to the bedrock. A 584 m deep ice core was drilled at Renland ice cap in May-June 2015, repeating and extending the climate record recovered from a 325 m ice core drilled in 1988. The deglacial transition was found at 533 m depth, below which the glacial section is approximately 20 m thick and Eemian section of approximately 20 m thickness.

During processing we took linescan images along the entire core. After processing we analyzed thick and thin sections for grain size, presence of subgrain boundaries, c-axis orientation and air bubbles properties. We present an overview of the visual stratigraphy and the layering in the core and first results of our microstrural analyses.

Abstract

Rita Traversi

Submission ID	188
Name:	Rita Traversi
Institution:	University of Florence, Dept. of Chemistry
Country:	Italy
Presentation Title:	Nitrate record from EPICA-Dome C ice core at the time of Laschamp geomagnetic excursion
Full Author List:	R. Traversi1, S. Becagli1, S. Poluianov2, M. Severi1, S.K. Solanki3,4, I.G. Usoskin2,5, R. Udisti1
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ABSTRACT

The potentiality of polar nitrate records for obtaining paleoclimatic information has never been tested by a direct comparison with the established proxies of such variability measured along the same ice core. Here we present the first direct comparison of cosmogenic 10Be and chemical parameters in the period of 38-45.5 kyr BP spanning the Laschamp geomagnetic excursion (41 kyr BP) from the EPICA-Dome C (EDC) ice core. A principal component analysis (PCA) allowed to identify and to group different components as a function of the main sources, transport and deposition processes affecting the atmospheric aerosol at Dome C. The evident preferential association of 10Be with nitrate rather than with other chemical species, marks the presence of a distinct source, which we tentatively label as “cosmogenic”. Moreover, a wavelet analysis highlighted the high coherence and in-phase relationship between 10Be and nitrate around the Laschamp event. Both the PCA and wavelet analyses ruled out a significant role of calcium in driving the 10Be and nitrate relationship, which is particularly relevant for a plateau site such as Dome C, especially given the high dust amount in the glacial period during which the Laschamp excursion took place. The evidence that the nitrate record from the EDC ice core is related the Laschamp event suggests that this marker is potentially useful for studying galactic cosmic ray flux variations and thus also major geomagnetic field excursions at pluri-centennial-millennial time scales.

Abstract

Dr. Mirko Severi

Submission ID	189
Name:	Dr. Mirko Severi
Institution:	Chemistry Dept. "Ugo Schiff" - University of Florence
Country:	Italy
Presentation Title:	Holocene volcanic history as recorded in the sulfate stratigraphy of the TALDICE ice core.
Full Author List:	M. Severi, S. Becagli, R. Traversi, R. Udisti
Author Affiliations:	Chemistry Dept. "Ugo Schiff", University of Florence, Italy

ABSTRACT

Volcanism is a natural climate forcing able to cause short-term variations in temperatures at local or global scales. Histories of volcanic eruptions are needed to quantify their role in climate variability and assess human impacts. A detailed history of Holocene volcanism was reconstructed using the sulfate record of the TALDICE (TD05) ice core reconstructed by Fast Ion Chromatography. In order to obtain a high dating accuracy, our sulfate record was preliminary synchronised with annually resolved records (i.e. WAIS ice core). Once the record was synchronised, we detected all the volcanic events recorded in the TALDICE ice core by using a threshold method based on a running median and the median of the absolute deviations (MAD) of annual concentrations from the median. In this way we pointed out all the volcanic events exceeding a threshold value and we calculated the sulfate flux at the deposition site. This complete Holocene volcanic record provides a reliable database to be compared with long records from Antarctic and Greenland ice cores in order to evaluate the spatial variability in sulfate deposition and to provide a basis for improving existing time series of volcanic forcing. The results obtained on this ice core in terms of sulfate fluxes have been compared with the data available in literature in order to evaluate the variability of sulfate deposition at regional and continental scale.

Abstract

Research Assistant Professor Michelle Koutnik

Submission ID	190
Name:	Research Assistant Professor Michelle Koutnik
Institution:	University of Washington
Country:	USA
Presentation Title:	Holocene accumulation and ice flow near the West Antarctic Ice Sheet Divide ice-core site
Full Author List:	M. Koutnik1, T.J. Fudge1, H. Conway1, E. Waddington1, T. Neumann2, K. Cuffey3, C. Buizert4, K. Taylor5
Author Affiliations:	1. University of Washington, Seattle, WA, USA 2. NASA Goddard Space Flight Center, Greenbelt, MD, USA 3. University of California, Berkeley, CA, USA 4. Oregon State University, Corvallis, OR, USA 5. Desert Research Institute, Reno, NV, USA

ABSTRACT

The West Antarctic Ice Sheet (WAIS) Divide Core (WDC) provided a high-resolution climate record from near the Ross-Amundsen Divide in Central West Antarctica. In addition, radar-observed internal layers in the vicinity of the WDC site have been dated directly from the ice core to provide spatial variations in the age structure of the region. Using these two datasets together, we first infer a high-resolution Holocene accumulation-rate history from 9.2-kyr of the ice-core timescale and then confirm that this climate history is consistent with internal structure upstream of the core site. We evaluate histories of accumulation rate by using a flowband model to generate internal layers that we compare to observed layers. Results show that the centennially averaged accumulation rate was over 20% lower than modern at 9.2 kyr before present (BP), increased by 40% from 9.2–2.3 kyr BP, and decreased by at least 10% over the past 2 kyr BP to the modern values. Throughout the Holocene the regional accumulation pattern has likely remained similar to today, and the ice-divide position has likely remained on average within 5 km of its modern position. Since modeled layer depths are sensitive to assumptions about the ice-flow field in addition to the accumulation-rate pattern and history, we compare modeled layers using a plausible range of flow-model parameter values. The solution sensitivity to poorly constrained aspects of the flow field must be considered when evaluating internal layer depths observed at any site, even near the ice divide.

Abstract

Dr Takuro Kobashi

Submission ID	191
Name:	Dr Takuro Kobashi
Institution:	Climate and Environmental Physics, University of Bern
Country:	Switzerland
Presentation Title:	Greenland temperatures over the Holocene
Full Author List:	T. Kobashi1,2, M. Döring1,2, A. Jeltsch-Thoemmes1,2, P. Pfister1,2, M. Leuenberger1,2, H. Wanner2
Author Affiliations:	Climate and Environmental Physics, University of Bern, Switzerland Oeschger Centre for Climate Change Research, University of Bern, Switzerland

ABSTRACT

Precise understanding of the Holocene climate is critical as the future climate and societal evolution will occur under the Holocene boundary conditions. However, it has been difficult to reconstruct multidecadal to centennial temperature variations owing to the facts that many paleoclimate proxies are not well constrained in their chronologies that results in smoothing of multidecadal to centennial variabilities, and that proxy-temperatures are often affected by large seasonal insolation changes that occurred during the Holocene. Here, we reconstruct Greenland temperatures over the Holocene using argon and nitrogen isotopes in GISP2 ice core, which overcomes these drawbacks of paleo-temperature proxies, and provides seasonally unbiased estimates of multidecadal to millennial temperature changes (Kobashi et al., 2015). Our preliminary temperature reconstructions indicate that Greenland underwent gradual warming from the beginning of the Holocene to approximately 9500 B.P., experienced warmest temperatures in the Holocene from 9000 to 6000 B.P., and then slightly cooled towards present. The temperature record shows significant correlations with stalagmite $\delta^{18}O$ records from Dongge (Wang et al., 2005) and Oman caves (Fleitmann et al., 2003) in a multi-centennial time scale, indicating a hemispheric-wide coherent climate variability. We will also employ an intermediate complexity climate model (Bern3D-LPX) with chronologically consistent solar, volcanic, and orbital forcing with ice-sheet boundary conditions to interpret the Greenland temperature variability, and results will be presented at IPICS.

Abstract

Peter Neff

Submission ID	192
Name:	Peter Neff
Institution:	University of Rochester
Country:	United States
Presentation Title:	Amundsen Sea Coastal Domes: Targeted Holocene Ice Core Sites
Full Author List:	P.D. Neff1, N.A.N. Bertler2,3, T.J. Fudge4, E.J. Steig4, H. Conway4
Author Affiliations:	1 University of Rochester, Rochester, NY, USA 2 Victoria University of Wellington, Wellington, NZ 3 GNS Science, Lower Hutt, NZ 4 University of Washington, Seattle, WA, USA

ABSTRACT

Modern observations of the Amundsen Sea Embayment (ASE) and surrounding areas clearly capture rapid and ongoing change. The complex interaction of ice, ocean, and atmospheric dynamics has significant consequences for the regional environment, local ecosystems, and global sea level rise. The longer-term context for recent ice-ocean-atmospheric interactions cannot be constrained by satellite, airborne or ground-based observations that span only a few decades. Understanding of critical questions remains incomplete: What initiated the onset of ice-shelf retreat in the ASE, and when did it occur? Are recent rates of change exceptional, or are they typical of decadal variability even in the absence of forcing? To what extent does remote forcing (e.g. tropical teleconnections) versus radiative forcing and local feedbacks dominate the behavior of the system? Ice cores represent a continuous, long-term observational platform that—when combined with modern observations—can elucidate aspects of past oceanic and atmospheric change while also constraining past ice dynamics changes. The growing database of geophysical observations in the ASE and along the greater Amundsen Coast facilitates site surveys at a number of ice domes and ice rises that constitute potentially ideal ice coring locations. Calculations constrained by NASA Operation IceBridge airborne radar-derived ice thickness and snow accumulation rates suggest that obtaining 200 to 2000 year-long ice core records is achievable at a number of sites, with records in excess of 6000 years possible at some. Members of the ice coring community are exploring the feasibility of future ice coring along the Amundsen Coast, and developing a cooperative approach to achieve goals in this logistically challenging region.

Abstract

Research Professor Joseph R. McConnell

Submission ID	193
Name:	Research Professor Joseph R. McConnell, Research Professor
Institution:	Desert Research Institute, Nevada System of Higher Education
Country:	United States
Presentation Title:	A 3,300 year record of total organic carbon, black carbon, and other burning tracers from three Northern Greenland ice cores
Full Author List:	J.R. McConnell1, M.M. Arienzo1, N. Chellman1, J.P. Steffensen2, E. Thompson3, A. Wilson3, A. Yau1
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ABSTRACT

Open burning and fossil-fuel combustion emit black carbon (BC), organic carbon (OC), and other radiatively important chemical compounds but at very different mixing ratios; the climate impact depends on those ratios. Ice core chemical and elemental records offer the possibility of reconstructing detailed, very precisely dated information on burning emissions and mixing ratios extending decades to millennia into the past. Biomass burning tracers such as vanillic acid, levoglucosan, organic acids, and ammonium, as well as industrial emissions tracers such as toxic heavy metals and non-sea-salt-sulfur, have been used to interpret ice-core BC records and develop understanding of past emissions sources as well as climate and other drivers of those emissions. However, various issues largely related to very low concentrations as well as contamination during sample collection, handling, and storage have precluded quantitative use of total organic carbon (TOC) or dissolved organic carbon (DOC) measurements in ice cores to reconstruct past mixing ratios and so assessment of overall climate impacts. Here we present and discuss a 3,300 year composite record of TOC, BC, ammonium, and other biomass burning and industrial tracers from northeast Greenland developed from three northern Greenland ice cores using new sample handling and measurement protocols.

Abstract

Monica Arienzo

Submission ID	194
Name:	Monica Arienzo
Institution:	Desert Research Institution
Country:	USA
Presentation Title:	Artic and Antarctic ice core records of Nuclear Weapons Testing
Full Author List:	M. M. Arienzo1, J. R. McConnell1, N. Chellman1, A. Criscitiello2, M. Curren3,4, S. Kipfstuhl5, M. Nolan6, M. Sigl7, J.P. Steffensen8
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ABSTRACT

The artificial, radioactive chemical element Plutonium, first produced in 1940, is present in the environment as a result of Nuclear Weapons Testing (NWT) conducted from 1945 to 1980. It is estimated that ~ 6 tons of 239Pu was globally released during atmospheric NWT. To study temporal trends in Pu, here we present semi-quantitative, continuous measurements of 239Pu from four Arctic ice cores and five Antarctic ice cores. Longitudinal samples from the ice cores were analyzed for 239Pu and a broad range of elements using the Desert Research Institute's (DRI's) continuous ice-core melter system coupled to two Inductively Coupled Plasma Mass Spectrometers (ICP-MS). All eight ice cores were independently dated using the strong seasonality in many parameters which allows for annual-layer counting with minimal uncertainty in the high snow accumulation sites. Annual-layer counting was further constrained by volcanic synchronization in the ice cores.
The 239Pu profile from the four Arctic ice cores reflect the overall global trends in NWT from 1953 to 1965 and the records are in good agreement to Pu profiles from lower latitude ice cores. The 239Pu concentration measurements in the Antarctic ice cores are lower than those observed in the Arctic and the greatest concentrations were observed from 1955 to 1957, coincident with low latitude NWT. The composite Antarctic and Artic 239Pu concentration profiles are compared to ice cores with less constrained age dating to use the 239Pu profile to further constrain the ice core age.

Abstract

Joseph R. McConnell

Submission ID	195
Name:	Joseph R. McConnell
Institution:	Desert Research Institute, Nevada System of Higher Education
Country:	USA
Presentation Title:	Antarctic-wide array of high-resolution ice core records documents pervasive lead pollution began in 1889 and persists today
Full Author List:	J. R. McConnell1, O. J. Maselli1, M. Sigl1, P. Vallelonga2, T. Neumann3, H. Anschütz4, M.A.J. Curran5, S.B. Das6, R. Edwards7, S. Kipfstuhl8, E.R. Thomas9
Author Affiliations:	1Desert Research Institute, Reno, USA 2The Niels Bohr Institute, Copenhagen, Denmark 3NASA Goddard Space Flight Center, Greenbelt, USA 4Norwegian Geotechnical Institute, Oslo, Norway 5Australian Antarctic Division, Hobart, Australia 6Woods Hole Oceanographic Institution, USA 7Curtin University, Perth, Australia 8Alfred Wegener Institut, Bremerhaven, Germany 9British Antarctic Survey, Cambridge, UK

ABSTRACT

Interior Antarctica is among the most remote places on Earth and was thought to be beyond the reach of human impacts when Amundsen and Scott raced to the South Pole in 1911. Here we use detailed measurements from an extensive array of 16 ice cores so show substantial toxic heavy metal lead pollution at South Pole and throughout Antarctica by 1889 – beating polar explorers by more than 22 years. Unlike the Arctic where lead pollution peaked in the 1970s, lead pollution in Antarctica was as high in the early 20th century as at any time since industrialization. The similar timing and magnitude of changes in lead deposition across Antarctica, as well as the characteristic isotopic signature of Broken Hill lead found throughout the continent, suggest that this single emission source in southern Australia was responsible for the introduction of lead pollution into Antarctica at the end of the 19th century and remains a significant source today. An estimated 660 t of industrial lead have been deposited over Antarctica during the past 130 years as a result of mid-latitude industrial emissions, with regional-to-global scale circulation likely modulating aerosol concentrations. Despite abatement efforts, significant lead pollution in Antarctica persists into the 21st century.

Abstract

Dr Christopher Fogwill

Submission ID	196
Name:	Dr Christopher Fogwill
Institution:	University of New South Wales Australia
Country:	Australia
Presentation Title:	Evidence for a substantial West Antarctic ice sheet contribution to meltwater pulses and abrupt global sea level rise
Full Author List:	C.J. Fogwill1, C.S.M. Turney1, N. Golledge2,3, D. Etheridge4, M. Rubino4, D.P. Thornton4, J. S. Phipps1, Woodward5, K. Winter5, T.V. Ommen6,7, A. Moy6,7, M. Curran6,7, C.M. Rootes8, A.N. Rivera9. H. Millman1, M. Bird10, N. Munksgaard10,11.
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ABSTRACT

During the last deglaciation (21,000 to 7,000years ago) global sea level rise was punctuated by several abrupt meltwater spikes triggered by the retreat of ice sheets and glaciers world-wide. However, the debate regarding the relative timing, geographical source and the physical mechanisms driving these rapid increases in sea level has catalyzed debate critical to predicting future sea level rise and climate.

Here we present a unique record of West Antarctic Ice Sheet elevation change derived from the Patriot Hills blue ice area, located close to the modern day grounding line of the Institute Ice Stream in the Weddell Sea Embayment. Combined isotopic signatures and gas volume analysis from the ice allows us to develop a record of local ice sheet palaeo-altitude that is assessed against independent regional high-resolution ice sheet modeling studies, allowing us to demonstrate that past ice sheet elevations across this sector of the WSE were considerably higher than those suggested by current terrestrial reconstructions. We argue that ice in the WSE had a significant influence on both pre and post LGM sea level rise including MWP-1A (15.2-14.4 ka) and during MWP-1B (11.7-11.6 ka), reconciling past sea level rise and demonstrating for the first time that this sector of the WAIS made a significant and direct contribution to post LGM sea level rise and ice sheet-ocean climate feedbacks at this time.

Abstract

Dr Ailie Gallant

Submission ID	198
Name:	Dr Ailie Gallant
Institution:	Monash University
Country:	Australia
Presentation Title:	Can we use the ERA 20th century reanalysis for extended ice core comparisons with the observational record?
Full Author List:	E. Duran, T. Vance, J. Roberts
Author Affiliations:	Monash University, Melbourne, Australia University of Tasmania, Hobart, Australia University of Tasmania, Hobart, Australia Australian Antarctic Division, Kingston, Australia

ABSTRACT

Ice cores are useful proxies for interpreting past climate, particularly for those areas where instrumental data are short and/or scarce, such as Antarctica. However, ice core proxies cannot be used in complete isolation and interpretation of proxy data is often complemented by an examination of the climate through instrumental observations or reanalysis data. In Antarctica, much of the instrumental data, including reliable reanalysis data, is limited to the post-satellite era (~post-1978). This poses problems when decadal-to-multidecadal scale features are being examined.

Recently, several reanalysis products have become available that assimilate only surface measurements, thereby extending reanalyses throughout the 20th Century. This extension helps with the interpretation of ice core proxies for decadal-to-multidecadal scale features, but is reliant on the skill of these reanalysis products over Antarctica, which we test here for the first time.

This study examines the skill of one of the newer 20th Century reanalysis data sets, the ERA-20C by comparing it to radiosonde measurements of temperature, geopotential height, wind speed and direction over Antarctic stations from 1957–2010. The radiosonde data provides an independent comparison as only surface measurements have been assimilated into the ERA-20C reanalysis. The results demonstrate variation in skill with meteorological variable, with season and over time, which are attributable to a number of factors.

Abstract

Dr David Mark Etheridge

Submission ID	199
Name:	Dr David Mark Etheridge
Institution:	CSIRO Oceans and Atmosphere
Country:	Australia
Presentation Title:	Carbon monoxide concentrations in the southern hemisphere during the past century: reconstructed record and model simulations
Full Author List:	D. Etheridge1, C. Trudinger1, R. Langenfelds1, L.P. Steele1, X. Fain2, J. Chappellaz2, P. Martinerie2, M. Woodhouse1, A. Luhar1, M. Rubino1,4, P. Krummel1, P. Fraser1, S. Coram1, P. Uhe1, L. Stevens1, M. Thatcher1, D. Thornton1, R. Gregory1, R. Howden1 an
Author Affiliations:	1 CSIRO Oceans and Atmosphere, Aspendale, Victoria, Australia 2 Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE), Grenoble, France 3 Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Australia 4 Dipartimento di matematica e fisica, Seconda Università di Napoli, Caserta, Italy

ABSTRACT

Carbon monoxide (CO) has significant roles in tropospheric chemistry, including being a major sink for the hydroxyl radical which in turn controls the lifetimes of reactive greenhouse gases and ozone depleting gases. Significant changes in CO concentration are expected over the past century but atmospheric measurements began only in 1979 and the high quality Antarctic firn air measurements published so far extend that by only about 10 years older and are available from only one site.

We reconstructed CO concentrations in the high latitude southern hemisphere over the past century from measurements of firn air, ice core air and atmospheric observations. Measurements of firn air from multiple Antarctic sites (Law Dome, South Pole, EPICA Dome C, Berkner Island, Fletcher Promontory and Aurora Basin North), with different characteristics help exclude the possibility of artifacts from in situ processes and sampling methods. The Law Dome samples provide high air age resolution and preserve decadal atmospheric variations. Firn air models are used to derive the atmospheric CO concentrations that are consistent with the measurements from these sites. The firn air reconstruction compares well with the atmospheric records over recent decades from nearby Casey and Mawson stations. CO increased about 30% with most of the increase occurring between about 1945 and the early 1990s.

The CO measurements are compared to simulations from the ACCESS-UKCA Earth System model. The causes of the CO increase from the main sources inferred from the model simulations and the reconstructed record will be discussed.

Abstract

Professor David John Prior

Submission ID	201
Name:	Professor David John Prior
Institution:	University of Otago
Country:	New Zealand
Presentation Title:	Measuring elastic and acoustic properties of ice with resonant ultrasound spectroscopy
Full Author List:	D.J. Prior 1, M. Vaughan 1, K. van Wijk 2, P.J. Langhorne 1
Author Affiliations:	University of Otago, Dunedin, New Zealand University of Auckland, Auckland, New Zealand

ABSTRACT

Understanding the elastic properties of ice is crucial if we are to use acoustic data to constrain the internal structure and fabric of ice bodies and their environmental conditions. There is a need to develop our understanding of elastic properties and wave propagation in ice to invert better seismic data sets to constrain ice fabric, ice temperature and ice density (e.g. sea ice).

Resonant Ultrasound Spectroscopy (RUS) is a technique that has the potential to provide elastic property data in the laboratory, and is sufficiently fast and portable that it could be applied in remote field sites (in Antarctica for example), negating the need to send large sample volumes back to the laboratory. Application in the field is particularly important for complex systems like sea ice, where the physical properties are likely to change as a function of time and temperature.

Resonant Ultrasound Spectroscopy (RUS) is used to measure the resonant modes of samples in the lab, from which we can invert for the full elastic tensor, and estimate the attenuation quality factor (Q). After having developed and applied this successfully to rock samples, an extension of RUS to ice cores shows great promise. For example, we successfully inverted for the isotropic parameters (bulk and shear modulus) of crystalline man-made ice, and estimated Q. We monitored changes in these properties as a function of temperature. The resultant data are consistent with published results from other approaches in the laboratory and the field.

Abstract

Bernhard Bereiter

Submission ID	202
Name:	Bernhard Bereiter
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	Mean ocean temperature change over the last transition based on atmospheric changes in heavy noble mixing ratios
Full Author List:	B. Bereiter1, J. Severinghaus1, S. Shackleton1, D. Baggenstoss1, K. Kawamura2
Author Affiliations:	Scripps Institution of Oceanography, La Jolla, USA National Institute of Polar Research, Tokyo, Japan

ABSTRACT

On paleo-climatic timescales heavy noble gases (Krypton and Xenon) are passively cycled through the atmosphere-ocean system without seeing any significant sink or source. Since the solubility in water of each gas species is characterized by a specific temperature dependency, mixing ratios in the atmosphere change with changing ocean temperatures. In this study, we use this fact to reconstruct mean global ocean temperatures (MOT) over the course of the last glacial transition based on measurements of trapped air in the WAIS Divide ice core. We analyzed 70 ice samples with a recently developed method which determines the isotopic ratios of N_2, Ar, Kr (and in some cases also of Xe, thought with less precision) and the elemental ratios of Kr/N_2, Xe/N_2 and Xe/Kr. We use the isotope ratios to correct the elemental ratios for gravitational enrichment and thermal fractionation in the firn column. The corrected elemental ratios are then used in a simple box model to reconstruct MOT. The three elemental ratio pairs are first interpreted as independent measures of MOT and then combined to a single MOT record with an average uncertainty of 0.27°C. We find a clear link to Antarctic temperatures and a LGM-Holocene change in MOT of 2.4°C which is in good agreement with results from ocean sediment cores (which, however, go along with an uncertainty of 1°C). To our knowledge, this is the first time that MOT is reconstructed in such great detail.

Abstract

Bernhard Bereiter

Submission ID	204
Name:	Bernhard Bereiter
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	An improved method to analyze heavy noble gas mixing ratios in trapped air in ice samples
Full Author List:	B. Bereiter, J. Severinghaus
Author Affiliations:	Scripps Institution of Oceanography, La Jolla, USA

ABSTRACT

The atmospheric mixing ratios of heavy noble gases (Krypton and Xenon) in the atmosphere has been shown to be a unique proxy for mean ocean temperatures (MOT). The basic principle behind is that noble gases are conserved in the ocean-atmosphere system whereas their relative distribution between the two reservoirs (ocean and atmosphere) is modulated by the ocean temperature due to the temperature sensitivity of the gas solubility in water. However, the analytical challenge behind is huge. Firstly, that the full amplitude associated with a glacial-interglacial change is only a few per mill which requires excellent sample handling to avoid contamination and excellent precision in mass spectrometry to reach a useful signal-to-noise ratio. Secondly, heavy noble gases are only trace gases with concentrations in the order of 1 ppm or less for which reason one ice sample needs to be as heavy as 800g. A first method has been developed a couple of years ago which showed the feasibility of these measurements, however, the signal-to-noise ratio was only about 3:1 for the full glacial-interglacial change, and only a few samples per week could be processed. We present here an improved version of this previous method that reaches about a three times better signal-to-noise ratio and allows us to process up to two samples a day. The core of this improvement is a new concept for the most time-consuming step in the method (splitting of the sample air), whereas we use a voluminous bellow built in a temperature homogenized box.

Abstract

Bernhard Bereiter

Submission ID	205
Name:	Bernhard Bereiter
Institution:	University of Bern
Country:	Switzerland
Presentation Title:	Analytical bias in the oldest section of the Dome C CO_2 record
Full Author List:	B. Bereiter1, S. Eggleston1, J. Schmitt1, C. Nehrbass-Ahles1, T. F. Stocker1, H. Fischer1, S. Kipfstuhl2, J. Chappellaz3
Author Affiliations:	University of Bern, Bern, Switzerland Alfred Wegener Institute, Bremerhaven, Germany Laboratoire de Glaciologie et Géophysique de l'Environnement, Saint Martin d'Hères Cedex, France

ABSTRACT

The EPICA Dome C (EDC) ice core has allowed to reconstruct atmospheric CO_2 concentrations for the last 800,000 years. Here, we revisit the oldest part of the EDC CO_2 record using different air extraction methods and sections of the core. For our standard system, we found an analytical artifact, which increases over the deepest 200 m and reaches 10.1 ± 2.4 ppm in the oldest/deepest part. The mechanism behind is not unambiguously known yet, but it is related to insufficient gas extraction of our standard system, suboptimal storage of one section of the core, and structural changes of the ice with depth. Based on the re-measurements presented here we derive a correction for the original data to account for the analytical bias and revisit previous conclusions drawn from the biased data by Lüthi et al. (2008). First, the record low CO_2 concentration ever found in an ice core in the period MIS 16 still remains as such, but requires slight correction by 2 ppm. Second, the period from MIS 16 to 19 as a whole does not show any more unexpected low CO_2 concentrations as expected from the CO_2-temperature relation of MIS 1 to 15. Based on the corrected data of this study, this previous finding applies only for the periods MIS 16 and 17, but not for 18 and 19.

Abstract

Dr. Pavlina Pavlova

Submission ID	206
Name:	Dr. Pavlina Pavlova
Institution:	Paul Scherrer Institut
Country:	Switzerland
Presentation Title:	Effect of percolating melt water on the distribution of organic pollutants in a temperate ice core
Full Author List:	Pavlova, P.A.1,2,3,5, Schmid, P.2, Bogdal C.4, Steinlin C.4, Schwikowski M.1,3,5
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ABSTRACT

In the frame of an interdisciplinary research project, aiming at understanding the role of glaciers in the fate of persistent organic pollutants (POPs) in the environment, we studied the temperate Silvretta glacier in the Swiss Alps. We analysed the uppermost 49 m water equivalent (weq), containing the years 1930-2011 for ^{3}H, ^{210}Pb, black carbon (BC) and polychlorinated biphenyls (PCBs). A particular challenge was dating the ice core, since melt water percolation affects the traditionally used parameters. Therefore, we additionally counted the summer peaks of particulate BC in the ice core, adding missing years determined by a negative local mass balance (LMB) data in the corresponding year (17 years in total). The BC annual layer counting was constrained with the 1963 horizon as derived from ^{3}H measurements. Another independent dating proxy - ^{210}Pb experienced higher variability in the Silvretta glacier, due to enrichment in particle layers. Once the age-depth relationship was established, we analysed PCBs and observed the maximum of PCBs concentrations in the 1970s in the Silvretta ice core coincides with the peak of emissions. Similar to BC and ^{210}Pb, enrichment layers of particle-bound PCBs are formed, in layers underlying the negative LMB years. In order to examine the effect of melting on the redistribution of legacy pollutants in Alpine glaciers, we compared the Silvretta PCBs record to two cold ice cores. We show that partial melting typical for temperate glaciers results in relocation, refreezing and release of organic pollutants significantly reducing the total PCB burden in the ice archive.

Abstract

Alexey Ekaykin

Submission ID	207
Name:	Alexey Ekaykin
Institution:	Arctic and Antarctic Research Institute
Country:	Russia
Presentation Title:	The climate variability in Indian Ocean sector of East Antarctica over the past 350 years
Full Author List:	A.A. Ekaykin1,2, D.O. Vladimirova1,2, V.Ya. Lipenkov1
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ABSTRACT

The temperature and snow accumulation rate anomaly records over the past 350 years were reconstructed based on geochemical data from 6 deep and shallow ice cores and snow pits in the Indian Ocean sector of East Antarctica. The stacked isotopic record for the whole Sector was produced. We then transformed it into the record of air temperature anomaly using the covariation between the isotope time-series, instrumental temperature data from weather stations and ERA-40 reanalysis data. Our stacked regional record demonstrates the overall warming over the past 350 years with a relatively colder period between 1750 and 1900. Especially prominent is a cold event in the 1840s, which is observed in all the individual ice core series.

We also compared the Indian Ocean sector stacked record with various climatic indices of Southern Hemisphere. The best correlation is observed with the Indian Ocean Dipole Mode Index, which can be interpreted as a moisture source conditions influence.

Abstract

Khanghyun Lee

Submission ID	208
Name:	Khanghyun Lee
Institution:	Korea Polar Research Institute
Country:	Korea
Presentation Title:	Deposition of atmospheric selenium to the northern Greenland ice sheet during the 1900-1970 AD
Full Author List:	K. Lee1, Y. Han1, J.I. Moon1, S.J. Jun1,2, S.D. Hur1, S. Hong2
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ABSTRACT

Selenium is one of the trace elements which are essential for human and animals health. Previously, numbers of researches have been carried out with various environmental samples, and it has been known that atmospheric transport of selenium plays important role in its bio-geochemical cycle (Wen and Carignal, 2007). Most of previous researches focused on spatial distribution and/or changes over short period less than one year (Ellis et al., 1993; Kagawa et al., 2003; Ranville et al., 2010). Only one record showing long-term changes in atmospheric selenium was reported 40 years ago from Greenland ice core (Weiss et al., 1971). This study, however, did not follow clean protocols essential for analysis for trace metals in ice core, and thus the reliability of data was not confirmed.

In This research, past changes in atmospheric selenium during 1900-1970s are recovered from the Greenland NEEM ice core. The selenium concentrations increases from 1900 to 1940, and then decreased until 1970s. The largest natural and anthropogenic sources for atmospheric selenium are marine bioactivity and coal combustion, respectively. The selenium record of Greenland NEEM ice core is rather similar to that of chlorophyll concentration in North Atlantic, while global coal consumption record did not show decrease (Boyce et al., 2010; Roser, 2015). Therefore, it can be inferred that the input of atmospheric selenium during the 20th century was controlled by the marine bio-activity in North Atlantic.

Reference

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Abstract

Alexey Ekaykin

Submission ID	209
Name:	Alexey Ekaykin
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Country:	Russia
Presentation Title:	Non-climatic signal in ice core records: Lessons from Antarctic mega-dunes
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ABSTRACT

We present the results of glaciological investigations in the mega-dune area located 30 km to the east from Vostok Station (central East Antarctica) implemented between January 2013 and January 2015. Snow accumulation rate and isotope content (δD and $\delta^{18}O$) were measured along the 2-km profile across the mega-dune ridge accompanied by precise GPS altitude measurements and GPR survey. It is shown that the spatial variability of snow accumulation and isotope content covaries with the surface slope. The accumulation rate regularly changes by 1 order of magnitude within the distance < 1 km, with the reduced accumulation at the leeward slope of the dune and increased accumulation in the hollow between the dunes. The snow isotope content is in negative correlation with the snow accumulation, which could be explained by post-depositional snow modification and/or by enhanced redistribution by wind of winter precipitation comparing to summer precipitation. Using the GPR data, we estimated the dune drift velocity (5.5 ± 1.3 m yr-1). The full cycle of the dune drift is about 340 years. We simulated a vertical profile of isotope content with such a non-climatic variability in a virtual ice core, using the data on the dune size and velocity. Then we drilled a 20-m firn core and obtained a good correspondence of the simulated and the real isotope profiles. The obtained results are discussed in terms of interpretation of ice core data obtained in non-mega-dune areas.

Abstract

Alexey Ekaykin

Submission ID	210
Name:	Alexey Ekaykin
Institution:	Arctic and Antarctic Research Institute
Country:	Russia
Presentation Title:	Strong post-depositional changes of the snow stable water isotope content observed in laboratory experiments
Full Author List:	A.A. Ekaykin1,2, T. Hondoh3, V.Ya. Lipenkov1, A. Miyamoto3, E. Barkan4
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ABSTRACT

One of the processes that disturb the climatic signal recorded in the isotopic composition of ice cores is the post-depositional alteration of the initial isotope content of the precipitation due to mass- and isotopic exchange of the upper snow thickness with atmosphere. Here we present the results of the laboratory experiments set up to quantitatively describe this process. A snow sample was subjected to sublimation in isothermal conditions, and the isotopic content of the remaining snow was monitored during and at the end of the experiment. In total 8 experiments were made with the temperature varying from -5 to -35°C. We observe strong isotopic modifications. In all cases the remaining snow showed increased heavy isotope content (δD and $\delta^{18}O$), decreased deuterium excess value and increased ^{17}O excess value. As expected, the intensity of the post-depositional processes is positively related with temperature. Also we note that the changes in the snow isotopic content are proportional to the sublimated/remaining snow mass ratio. We use the obtained results in order to estimate possible influence of the post-depositional processes on a deep ice core isotopic profile.

Abstract

R Wang

Submission ID	211
Name:	R Wang
Institution:	Jilin University, Polar Research Institute of China
Country:	China
Presentation Title:	Rapid Intermediate Ice Drilling Technology with Air Reverse-Circulation
Full Author List:	R. Wang 1，2; P. Talalay 1
Author Affiliations:	1. Polar Research Center, Jilin University, Changchun, China 2. Polar Research Institute of China, Shanghai, China

ABSTRACT

Rapid access drilling to bedrock of glaciers offers unique opportunities for examining processes how glacier acts at the bed. Logistical issues press to accomplish this task within several hours. With this aim in view it is proposed to use ‘dry’ drilling technology with continually transported cuttings and cores by air reverse-circulation. Supposing that the rate of penetration would be close to 180 m h–1 and accounting for the additional time for making connections, coring a 500–600-m deep hole could be accomplished within 10–12 h. The maximum achievable depth is limited by the compressor/vacuum pump capacity and borehole closure. Two options are considered to obtain ice cores and cuttings at non-stop drilling mode. When double-wall drill pipe is used, air goes down to the bottom of the hole through the gap between the inner and outer tube, and then carrying ice core and ice chips back to the surface from the drill pipe center channel. The compressed air should be dried and cooled before injection. In case of single wall drill pipe is used, the cuttings and cores go out from the center of pipe with suction function of the vacuum pump. To drill through ice, a special cutter drill bit is used, but for subglacial bedrock sampling, the hollow-through DTH hammer is needed to connect with the double-wall drill rod. Calculations of the air flow rate/pressure drop and simulation analysis of the process of air reverse circulation are presented on.

Abstract

Alexey Ekaykin

Submission ID	212
Name:	Alexey Ekaykin
Institution:	Arctic and Antarctic Research Institute
Country:	Russia
Presentation Title:	Extending the Vostok isotopic record back to 800,000 years BP?
Full Author List:	A.A. Ekaykin1,2, V.Ya. Lipenkov1, A.V. Kozachek1, D.O. Vladimirova1,2, D. Raynaud3
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ABSTRACT

The Vostok climate record, covering the past 420,000 years, was the longest ice-core climate series before the 800,000-year EPICA-DC record was obtained. The age of 420,000 years was reached in the Vostok core at a depth of 3310 m. Below 3539 m, the core consists of accreted Lake Vostok ice that does not contain climatic information. The interval 3310-3539 m is composed of atmospheric ice deposits that should be older than 420,000 years. Recent investigations carried out as part of the VOICE (Vostok Oldest Ice Challenge) initiative suggest that the deepest layers of this ice may be older than 1 Ma, although this assertion is yet to be confirmed.

In this study we present new high-resolution (10 cm) isotopic records obtained from two replicate 5G-1 and 5G-3 cores, which cover the deepest section of the meteoric ice at Vostok. Using the extrapolated glaciological timescale, as well as the data on the ice crystal size, we attempt to match the extended Vostok isotopic record to the well dated 800,000-year EPICA record. We note that the amplitude of the isotope content variations in the deep Vostok ice is considerably attenuated, reflecting the cumulative effect of ice mixing and diffusive smoothing. We attempt to reconstruct the undisturbed Vostok time series using a back-diffusion model.

Finally, we discuss the possibility to obtain the undisturbed oldest isotopic record from an ice core that would be drilled at Ridge B ice divide upstream from Vostok Station.

Abstract

Rusheng Wang

Submission ID	213
Name:	Rusheng Wang
Institution:	Jilin University, Polar Research Institute of China
Country:	China
Presentation Title:	Multi-functional Cold Workshop for Ice Drilling Tests
Full Author List:	R. Wang1, 2; P. Talalay1; Y. Sun1; Y. Li 2
Author Affiliations:	1. Polar Research Center, Jilin University, Changchun, China 2. Polar Research Institute of China, Shanghai, China

ABSTRACT

It is essentially important to test ice drilling systems prior field operations in Polar Regions because it can save money and logistical efforts of the ice-core production. It is a big challenge to simulate the environment of Polar Regions (first of all, low temperature and big ice masses) in the laboratory. In order to solve this problem, a multi-functional cold workshop is designed and under construction now in which many types of ice drilling systems can be tested throughout the year, no matter in winter or in summer. Low temperature ice drilling workshop consists of several systems: 1) ice pond system, 2) freezing system, 3) heat preservation building system, 4) cooling system, 5) drilling platform, 6) system imitated ice borehole with anti-torque slot. The temperature of ambient air in the workshop can be controlled with the range of -10 to -20 □C without the influence of the outside temperature; the temperature of ice to be drilled can be adjusted from -5 to -30 □C. The shaft with artificial ice has inner diameter of 1 m and is sunk to the depth of 12 m. The cold workshop is allowed to carry out tests with different drill systems: electromechanical drills suspended on cable, hot-water drills, shallow drills, thermal drills, rapid air drills, and so on. In addition, sampler and corer for subglacial lakes investigations can be tested by imitating certain conditions.

Abstract

Dr. Hongxi Pang

Submission ID	214
Name:	Dr. Hongxi Pang
Institution:	School of Geographic and Oceanographic Sciences, Nanjing University
Country:	China
Presentation Title:	Response of the Indian summer monsoon to the Southern Annular Mode: evidence from a Himalayan ice core stable isotopic record
Full Author List:	H. Pang1, S. Hou1, S. Kaspari2, P. Mayewski3, V. Masson-Delmotte4, C. Risi5, Z. Li5, H.C. Steen-Larsen4, J. Jouzel4
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ABSTRACT

The Southern Hemisphere Annular Mode (SAM) is the dominating atmospheric circulation pattern in the Southern Hemisphere. Recent studies based on instrumental observations and reanalysis data indicated that the Asian summer monsoon could be affected by the SAM. However, the brevity of observations limits our understanding of long-term relationship between the Asian summer monsoon and the SAM. In this study, relationships on multi-time scales between the Indian summer Monsoon (ISM) and the SAM were investigated based on the annual-dated deuterium records (δD) in a 108.8 m ice core recovered from the East Rongbuk Glacier of Mt. Qomolangma (Everest) and the reconstructed annual SAM index during 1534 AD to present. On annual to decadal time scales, the ISM was controlled by the El Niño-Southern Oscillation (ENSO) and the role of the SAM was slight. On multi-decadal to centennial time scales, the influence of the SAM on the ISM was more significant than that of the ENSO. The results indicate that long-term variations of the ISM may be also affected by the SAM.

Abstract

Christoph Nehrbass-Ahles

Submission ID	216
Name:	Christoph Nehrbass-Ahles
Institution:	Climate and Environmental Physics, Physics Institute & Oeschger Centre for Climate Change Research, University of Bern, Switzerland
Country:	Switzerland
Presentation Title:	High Resolution Holocene CO_2 Record from the TALDICE Ice Core
Full Author List:	C. Nehrbass-Ahles1, B. Bereiter1, T. Stocker1, and H. Fischer1
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ABSTRACT

A compilation of currently existing CO_2 records (Bereiter et al., 2015) shows that the data resolution and quality is not yet sufficient for studying decadal scale variations throughout the entire Holocene. Only ice cores with a sufficiently high accumulation rate are useful to produce such high-resolution records, but CO_2 measurements are often hampered in the so-called bubble to clathrate transition zone (BCTZ; Lüthi et al., 2010). A promising candidate is the TALDICE core where we find a good balance between still quite high accumulation rate (2-3 times higher as the currently used EDC core) and the position of the BCTZ is located below 11000 yr BP (Neff 2014). We believe that this core represents presently the best option to reconstruct CO_2 between 2000 and 9000 yr BP, since other cores show either a lower accumulation rate (EDC, Vostok, EDML, Dome F, Dome A) or the measurements are hampered by the BCTZ or long storage (Byrd, Siple Dome, South Pole, Taylor Dome, WAIS Divide, Law Dome). Furthermore, these data would allow for CO_2 inter-comparison among other existing ice core records and future records from the currently drilled SPICE ice core, as fairly large offsets exit between existing ice cores, while its underlying cause still remains elusive. Accordingly, here we will present the first CO_2 record covering the entire Holocene using ice from the TALDICE ice core.

Abstract

Roberto Grilli

Submission ID	218
Name:	Roberto Grilli
Institution:	Laboratoire de Glaciologie et Geophysique de l'Environment (LGGE, CNRS-UJF)
Country:	France
Presentation Title:	Studying atmospheric delta 13 of cabon dioxide evolution during rapid changes of the past, using a novel high resolution optical spectrometer
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ABSTRACT

Nowadays, a better understanding of the coupling between climate and carbon cycle is required for a better prediction of future climate changes. Current observation of atmospheric CO_2 changes and associated fluxes are not sufficient for fully understanding the mechanisms involved in these slow (millennia) feedbacks.

The past evolution of atmospheric CO_2, covering the last 800,000 years, is today well known. However, delta 13C measurements of CO_2 will give us information about the exchange between atmosphere, continental biosphere and oceans, important for constraining the sources of CO_2, and restricting the range of scenarios able to explain - for instance - the 40% increase of atmospheric CO_2 during the last glacial-interglacial transition.

For this propose, an instrument based on the Optical Feedback - Cavity Enhanced Absorption Spectroscopy (OF-CEAS) technique has been developed. The instrument relies on the injection of a quantum cascade laser at 4.4 micrometer into an optical cavity and it will allow for non-destructive continuous-flow measurements on small gas volumes, with a simple sample preparation. Continuous measurements will ensure higher temporal resolution, providing a robust and fast method for ice core analysis.

The optical spectrometer can measure 16O-12C-18O, 16O-13C-16O and 16O-13C-18O simultaneously with a precision below 0.1‰ within few minutes of integration. Our goal consists on revisiting the last climatic transition with a much better analytical precision, as well as extending the work over other past episodes of relatively rapid CO_2 changes. Preliminary results will be presented.

Abstract

Sakiko Ishino

Submission ID	219
Name:	Sakiko Ishino
Institution:	Tokyo Institute of Technology
Country:	Japan
Presentation Title:	Seasonal variation of triple oxygen isotopic composition (Δ17O) of oxy-anions in the atmosphere at Dumont d'Urville, coastal Antarctica
Full Author List:	S. Ishino1, S. Hattori1, J. Savarino$_2$, B. Jouedain2, S. Preunkert2, M. Legrand2, N. Yoshida1
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ABSTRACT

Triple oxygen isotopic composition ($\Delta^{17}O = \delta^{17}O - 0.52 \times \delta^{18}O$) of oxy-anions in the atmosphere depends on the relative importance of ozone (O_3; $\Delta^{17}O = 20 \sim 30‰$) and other oxidants ($\Delta^{17}O \fallingdotseq 0$ ‰) in their formation processes (Thiemens, 2006). Therefore, there is a great interest to use $\Delta^{17}O$ of nitrate (NO_3^-) and sulfate (SO_4^{2-}) in the polar ice to reconstruct the oxidative capacity of the past atmosphere (Alexander and Mickley, 2015). For the interpretation of these records, the whole processes from their formation in the atmosphere to deposition and preservation in the ice have to be understood.

In this study, we investigated seasonal variation of $\Delta^{17}O$ of NO_3^- and SO_4^{2-} in aerosols and O_3 collected at French Antarctic Station Dumont d'Urville (66°40'S, 140°01'E) throughout the year 2011. $\Delta^{17}O(NO_3^-)$ and $\Delta^{17}O(SO_4^{2-})$ exhibited clear seasonal variations with summer minimum and winter maximum. This trend is mainly attributed to the change in the relative importance of OH and O_3 in their formation due to the change of photochemical cycle. Additional analysis of $\delta^{15}N$ of nitrate suggested strong contribution of NOX emitted by post depositional process of NO_3^- in surface snow in spring/summer season. Although SO_4^{2-} is thought to have no post depositional process, annual record of $\Delta^{17}O(SO_4^{2-})$ estimated by our measurement showed disagreement with $\Delta^{17}O(SO_4^{2-})$ in ice cores reported previously (e.g. Sofen et al., 2014). In the poster, we will discuss the possible mechanisms explaining this gap.

Abstract

Associate Professor Paul Vallelonga

Submission ID	220
Name:	Associate Professor Paul Vallelonga
Institution:	University of Copenhagen
Country:	Denmark
Presentation Title:	Halogen-based reconstruction of past sea ice extent from Law Dome ice cores
Full Author List:	P. Vallelonga1, A. Spolaor2,3, R. Edwards4, M. Curran5,6, A. Moy5,6
Author Affiliations:	1. Centre for Ice and Climate, Copenhagen, Denmark 2. Ca'Foscari University of Venice, Venice, Italy 3. Institute for the Dynamics of Environmental Processes IDPA-CNR, Venice, Italy 4. Curtin University, Perth, Australia 5. Australian Antarctic Division, Kingston, Australia 6. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart,, Australia.

ABSTRACT

Sea ice is an important parameter in the Earth climate system, with particular influence on polar albedo and exchange of heat and gases between the ocean and atmosphere. Reconstructions of sea ice extent are required due to the limited period of observational data available (a few decades) and the limited spatial coverage of low-resolution marine sediment records. Ice cores can play a decisive role in the production of detailed spatial and temporal reconstructions of polar sea ice through the use of quantitative and stable sea ice proxies. Law Dome is a coastal dome located in East Antarctica, featuring high accumulation steadily distributed through the year. The site is of particular relevance to sea ice reconstruction because it is the location of a two-century sea ice reconstruction based on Methansulphonic Acid (MSA).

Of the demonstrated proxies of sea ice extent MSA is the most selective and has been used extensively for reconstructing decadal-scale variability around the Antarctic coast. The halogen elements bromine (Br) and iodine (I) are being actively investigated as potential sea ice proxies, due to their close links to sea ice: Br is enriched above the seasonal sea ice surface and I is emitted by algal communities hosted under the sea ice. Here we present an analysis of bromine and iodine deposition and seasonality at Law Dome and the applicability to reconstructing past sea ice extent in Eastern Antarctica.

Abstract

Dr. Vasilii Petrenko

Submission ID	222
Name:	Dr. Vasilii Petrenko
Institution:	University of Rochester
Country:	USA
Presentation Title:	Ice core measurements of $^{14}CH_4$ show no evidence of methane release from methane hydrates or old permafrost carbon during a large warming event 11,600 years ago
Full Author List:	V.V. Petrenko1, J. P. Severinghaus2, A.M. Smith3, K. Riedel4, E.J. Brook5, H. Schaefer4, D. Baggenstos2,6, C. Harth2, Q. Hua3, C. Buizert5, A. Schilt6, X. Fain7, L. Mitchell5,8, T. Bauska5, A. Orsi2,9, and R. F. Weiss2
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ABSTRACT

Thawing permafrost and marine methane hydrate destabilization have been proposed as large sources of methane to the atmosphere in response to both past and future warming. We present measurements of 14C of paleoatmospheric CH4 over the Younger Dryas – Preboreal (YD – PB) abrupt warming event (≈11,600 years ago) from ancient ice outcropping at Taylor Glacier, Antarctica. The YD – PB event was associated with a ≈ 50% increase in atmospheric CH_4 concentrations. 14C can unambiguously identify CH_4 emissions from "old carbon" sources, such as permafrost and CH_4 hydrates. The only prior study of paleoatmospheric 14 CH_4 (from Greenland ice) suggested that wetlands were the main driver of the YD - PB CH_4 increase, but the results were weakened by an unexpected and poorly understood 14 CH_4 component from in situ cosmogenic production directly in near-surface ice. In this new study, we have been able to accurately characterize and correct for the cosmogenic $^{14}CH_4$ component. All samples from before, during and after the abrupt warming and associated CH_4 increase yielded 14 CH_4 values that are consistent with 14C of atmospheric CO_2 at that time, indicating a purely contemporaneous methane source. These new measurements rule out the possibility of large CH_4 releases to the atmosphere from methane hydrates or old permafrost carbon in response to the large and rapid YD - PB warming, and confirm that wetlands were the main driver of the CH_4 increase.

Abstract

Dr. Vasilii Petrenko

Submission ID	223
Name:	Dr. Vasilii Petrenko
Institution:	University of Rochester
Country:	USA
Presentation Title:	The potential of 14CO in glacial ice as a tracer for past cosmic ray flux and atmospheric hydroxyl radical abundance
Full Author List:	V. V. Petrenko1, B. Hmiel1, P. Neff1, A.M. Smith2, C. Buizert3, D. Etheridge4 and M. Dyonisius1
Author Affiliations:	1University of Rochester, Rochester, USA 2Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Heights, Australia 3Oregon State University, Corvallis, USA 4CSIRO Oceans and Atmosphere, Aspendale, Australia

ABSTRACT

The amount of 14C-containing carbon monoxide (14CO) in glacial ice is determined by trapping of atmospheric 14CO into air bubbles in the ice and in situ cosmogenic production of 14CO in relatively shallow ice and firn. Earlier studies of 14CO in ice cores showed large disagreements with regard to rates of in situ cosmogenic production as well as with regard to whether 14CO produced in the firn layer is well retained or largely escapes to the atmosphere via the interconnected pore space. We have reviewed previously published work that included 14CO measurements in ice or firn air, and compared with our more recent high-precision measurements on very large ice and firn samples. The available evidence suggests that very little in situ cosmogenic 14CO is retained in the diffusive part of the firn (the upper $\approx$ 40 – 100m). In situ cosmogenic 14CO production rates below the firn diffusive zone are non-negligible, with production due to deeper-penetrating muons. At sites with low snow accumulation rates, the in situ cosmogenic 14CO component is expected to be larger than the trapped atmospheric component. This potentially allows to use ice core 14CO measurements from such sites to improve our understanding of past cosmic ray flux variations. In contrast, at sites with very high accumulation rates, trapped atmospheric 14CO is expected to be dominant over the in situ cosmogenic component. This potentially allows 14CO records from such sites to be used for reconstructions of past atmospheric hydroxyl radical (OH) variations.

Abstract

Dr. Duncan A. Young

Submission ID	225
Name:	Dr. Duncan A. Young
Institution:	University of Texas Institute for Geophysics, University of Texas at Austin, Austin Texas
Country:	United States of America
Presentation Title:	Status of detailed ICECAP aerogeophysical surveying for old ice at Dome C
Full Author List:	D. A. Young1, J. L. Roberts2,3, D. D. Blankenship1, T. van Ommen2,3, M J. Seigert4, M. G. P. Cavitte1, C. Ritz5, F. Parrenin5, E. Quartini1, Massimo Frezzotti6, F. Habbal1, and G. Ng1.
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ABSTRACT

Extending our record of greenhouse gases beyond the transition into the mid-Pliocene may be key for understanding large scale climate forcing in a higher CO_2 world. Finding stratigraphically intact ice older than 800 kyrs will be challenging, requiring finding the sweet spot of stable ice dynamics, low accumulation, smooth bed and low geothermal heat flow. We report here on an international effort in the 2015/16 field season targeting a suspected site of such ice, located to the south of Dome C. Our survey plan, using the ICECAP Basler, targets this site with tight (1-2 km) line spacing to characterize the bed topography, bed reflectivity, surface elevation and englacial structure of this site, and connect it to the current 800 kyr record at EPICA-Dome C.

Abstract

Ms. Sarah Shackleton

Submission ID	227
Name:	Ms. Sarah Shackleton
Institution:	Scripps Institution of Oceanography
Country:	United States
Presentation Title:	The role of ocean-atmosphere heat exchange through Termination II and the MIS 5-4 transition
Full Author List:	S. Shackleton1, B. Bereiter12, J.A. Menking 3, D. Baggenstos21, E.J. Brooks3, J.P. Severinghaus1
Author Affiliations:	Scripps Institution of Oceanography, San Diego, United States

ABSTRACT

Today, the world oceans have taken up more than 90% of the 'excess heat' (or integrated change in radiative forcing) of the last 50 years, and about 30% of anthropogenic CO_2 (1,2). The immense heat capacity of the ocean has and will continue to play a significant role in future sea level rise through thermal expansion of the ocean, the inertia of global temperature response to anthropogenic greenhouse gas forcing, and CO_2 uptake (3,4). While modern observations of oceanic temperature change provide insight into the ocean's response to this heat influx, limitations in record length and spatial coverage complicate the interpretation of trends. For integrated, long-term oceanic temperature patterns, we look to the paleo-archive. Here we present mean ocean temperature reconstructions of Termination II (~136 – 129 ka) and the MIS5-4 transition (~80 – 60 ka) from Taylor Glacier, Antarctica δKr/N2 and δXe/N2. By comparing the relative timing and magnitude of ocean temperature change during these periods, we gain insight into the role of ocean-atmosphere heat exchange and its relation to global temperature and CO_2 during climate transitions in two distinctly different climate states. We anticipate these findings will advance our understanding of the ocean's influence on climate during transient states.

1) Church J.A. et al. GRL (2011)
2) Le Quéré et al., Global Biogeochem. Cycles (2010)
3) Levitus S. et al. GRL (2012)
4) Knutti, R. et al. GRL (2008)

Abstract

Dr Anna J. Bourne

Submission ID	228
Name:	Dr Anna J. Bourne
Institution:	Swansea University and Queen Mary, University of London
Country:	UK
Presentation Title:	Developing a tephra framework for Greenland: the potential for hemispheric synchronisation of palaeoclimatic records
Full Author List:	Bourne, A.J.1*, Albert, P.G. 1+, Cook, E.1, 2, Abbott, P.M. 1, Davies, S.M.1, Rasmussen, S.O. 2, Seierstad, I.K. 2, Svensson, A.2
Author Affiliations:	1 Swansea University, Swansea, UK 2 Centre for Ice and Climate, Niels Bohr Institute, Copenhagen, Denmark * Present Address: Queen Mary, University of London, London, UK + Present Address: Oxford University, Oxford, UK

ABSTRACT

Tephra deposits preserved within the Greenland ice-cores are crucial for the independent synchronisation of these high-resolution records to other palaeoclimatic archives. Here we present a new and detailed tephrochronological framework for the last 130,000 yrs b2k that brings together results from 3 deep Greenland ice-cores. In total, over 300 tephra deposits, the majority of which are preserved in cryptotephra form, are described from the NGRIP, NEEM, and GRIP records. Basaltic composition tephras dominate these records and indicate frequent eruptions from the Grimsvötn, Katla and Kverkfjöll volcanoes in Iceland.

However, sixteen tephra deposits identified have a distinct geochemical signature, characteristic of a subduction tectonic setting, most likely the Pacific arcs. Four tephra layers can be tentatively correlated to specific eruptions and a further four attributed to a volcanic system, whilst the source for the remaining eight is unknown. The dispersal of these far-travelled tephra deposits to Greenland is consistent with the dominant dust transport pathway from East Asia to Greenland during the last glacial period. Repeated deposition of far travelled ash to Greenland opens the door for INTIMATE (INTegration of Ice-core, MArine and TErrestrial records) style correlations of Pacific marine sequences with the North Atlantic region, allowing the hemispheric synchronisation of palaeoclimate records.

In addition, tephra deposits can be correlated between ice-core records and have been used to provide an independent test of the chemostratigraphic matching of ice-core records, Therefore supporting the GICC05 timescale transfer from NGRIP to the GRIP and NEEM ice-cores (Rasmussen et al., 2013; Seierstad et al., 2014).

Abstract

Dr. Sune Olander Rasmussen

Submission ID	229
Name:	Dr. Sune Olander Rasmussen
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	A unified ice-core–speleothem time scale?
Full Author List:	S.O. Rasmussen
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ABSTRACT

Climate proxy data need time scales to be useful, but time scales inconsistencies often prevent robust parallel analysis of records from different sources. Several approaches to handle this problem have emerged, combining chronological information from several ice-cores [Seierstad et al., 2014; Bazin et al., 2013] and in some cases including data from other archives, most notably radiometrically dated speleothems.

Annually layered ice cores are among the most precisely dated records of past climate, but due to the accumulation of counting errors down-core, the accuracy of annual-layer-based ice-core chronologies is not very high when going back to glacial times. The absolute uncertainty can be reduced by combining the high precision of ice-core annual layer counting with accurate speleothem dates. For example, Buizert et al. [2015] applied the high-accuracy radiometric dating of the Hulu cave record to identify a likely 0.6% bias in the annual layer counting procedure of the Greenland Ice Core Chronology 2005 (GICC05).

In this presentation, I will discuss some of the challenges inherent to the construction of unified ice-core time scales, and describe why I think a coordinated effort to create a unified ice-core–speleothem time scale is timely. I will also present a possible strategy for such work with the purpose of stimulating the debate in the ice-core community about how to best proceed.

L. Bazin et al., Clim. Past 9, 1715–1731, 2013, www.clim-past.net/9/1715/2013/
C. Buizert et al., Clim. Past 11, 153–173, 2015, www.clim-past.net/11/153/2015/
I.K. Seierstad et al., Quat. Sci. Rev. 106, 29-46, 2014, http://dx.doi.org/10.1016/j.quascirev.2014.10.032

Abstract

Dr. Nicole Spaulding

Submission ID	230
Name:	Dr. Nicole Spaulding
Institution:	University of Maine Climate Change Institute
Country:	United State of America
Presentation Title:	What's in a signal? Examining ultra-hgh resolution LA-ICP-MS signals for the reconstruction of European climate
Full Author List:	N.E. Spaulding1,2, P. Bohleber2,3, S.B. Sneed1, P.A. Mayewski1,2,4, M. McCormick2, A.V. Kurbatov1,2,4, and D. Wagenbach3,*
Author Affiliations:	University of Maine, Orono, USA Harvard University, Cambridge, USA University of Heidelberg, Heidelberg, DE

ABSTRACT

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) offers minimally destructive ice core impurity analysis at unsurpassed sub-mm resolution. This method is uniquely suited for exploring the closely spaced layers of ice within samples collected at low accumulation sites or in regions of highly compressed and thinned ice. Here we report a thorough assessment of the signal structure observed quasi-continuously throughout 30 meters of ice collected in 2013 at the Alpine glacier saddle Colle Gnifetti (4450m asl, Monte Rosa, Swiss-Italian Alps). The signal structure, as well as an analysis of its spatial representativeness given varying particle content, is discussed in the context of establishing an age-depth relation partially via annual layer counting. Having demonstrated the applicability of this technique to the Colle Gnifetti ice core, we probe the laser-derived signal of six elements (Ca, Al, Fe, Na, Cu, Pb) from several exceptional climatic peaks for insights not found in traditional CFA or liquid based (i.e., low-resolution) ICP-MS measurements. This analysis forms the backbone of a collaborative project, between the University of Maine Climate Change Institute's Keck Laser Ice Facility and the Initiative for the Science of the Human Past at Harvard, which seeks to explore the impact of climate on human civilizations throughout Europe.

Abstract

Nathan J. Chellman

Submission ID	231
Name:	Nathan J. Chellman
Institution:	Desert Research Institute
Country:	USA
Presentation Title:	Using paired ice core and sediment core records to evaluate Holocene black carbon flux and fire history across the Northern Hemisphere
Full Author List:	Nathan J. Chellman1, Joseph R. McConnell1, Monica Arienzo1, Alan Heyvaert1, Boris Vannière2
Author Affiliations:	1Desert Research Institute, Reno, NV, USA 2UMR Chrono-Environnement, Besançon, France

ABSTRACT

Ice core records of black carbon (BC) can be used as proxies for biomass burning and industrial emissions. BC, formed during incomplete combustion of fossil or bio-fuels, is emitted from large wildfires and industrial sources to the atmosphere, where it can be transported and deposited globally. The BC aerosol has recently been recognized as a major climate forcer, thus understanding past and present BC emissions and transport is critical for quantifying and modeling climate change. Existing ice core records of BC extend back 130 kyr, the age of the oldest ice recovered from Greenland, though most ice core records are limited to the Holocene. Lake sediment cores provide an alternative to ice cores to obtain long-term global BC records with the potential to extend BC records back millions of years through dozens of global climate cycles. Using a new method for measuring BC in sediment cores, we have measured BC in Northern Hemisphere lakes from different regions, spanning mid to high latitudes, and different time periods, ranging from 250-1700 years before present. Each lake BC record can be evaluated against nearby ice core BC records from either ice sheets or glaciers. Here we present initial results from these paired records, setting the foundation for future research on BC in lake sediments. These results will lead to a more comprehensive understanding of past fire and climate forcing from BC across a diverse selection of Northern Hemisphere geographies.

Abstract

Ji-Woong Yang

Submission ID	232
Name:	Ji-Woong Yang
Institution:	School of Earth and Environmental Sciences, Seoul National University
Country:	Republic of Korea
Presentation Title:	Millennial-scale methane variability and North Atlantic climate change during te Early Holocene
Full Author List:	J.-W. Yang1, Y. Ryu1, E.J. Brook2, J. Ahn1
Author Affiliations:	1Seoul National University, Seoul, Republic of Korea 2Oregon State University, Corvallis, USA

ABSTRACT

The early Holocene had been considered as a climatically calm period. However, recent studies revealed several short-period climatic anomalies superposed on a long-term climate trend. Here we present a high resolution methane (CH_4) record from Siple Dome (Antarctica) and compare it with other climate proxies. The CH_4 record was obtained by a melting-refreezing gas extraction system at Seoul National University. In order to isolate millennial phenomena, we high-pass filtered the CH4 record at 1/1800 yr-1, and observed four CH_4 local minima with a mean duration of 2-300 years at 8.2, 9.2, 10.3 and 11.0 ka. The CH_4 minima are coincident with those of NGRIP $\delta^{18}O$ record implying a close link to North Atlantic climate. Further, the CH_4 minima are correlated with proxies for the Inter-Tropical Convergence Zone (ITCZ) mean position, strength of East Asian summer monsoon, and solar activity, within age uncertainty. As previous studies suggested for other time periods, the CH_4 minima might have been caused by decreased CH_4 source strength in the Northern tropics which was controlled by cooling in the North Atlantic and subsequent southward ITCZ migration and finally decreased precipitation in the northern tropics.

Abstract

Dr. Shuji Fujita

Submission ID	233
Name:	Dr. Shuji Fujita
Institution:	National Institute of Polar Research, Research Organization of Information and Systems
Country:	Japan
Presentation Title:	Densification of layered firn of the ice sheet at Dome Fuji, Antarctica
Full Author List:	Shuji Fujita1, 2, Kumiko Goto-Azuma1, 2, Motohiro Hirabayashi1, Akira Hori3, Yoshinori Iizuka4, Yuko Motizuki5, Hideaki Motoyama1, 2 and Kazuya Takahashi5
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ABSTRACT

In order to better understand the densification of polar firn, firn cores from three sites within approximately 10 km of Dome Fuji, Antarctica, were investigated, using surrogates of density: dielectric permittivities epsilon(v) and epsilon(h) at microwave frequencies with electrical fields in the vertical and the horizontal planes, respectively. Dielectric anisotropy (= epsilon(v) - epsilon(h)) was then examined as a surrogate of the anisotropic geometry of firn. We find that layered densification is explained as a result of complex effects of two phenomena that commonly occur at the three sites. Basically, layers with initially smaller density and smaller geometrical anisotropy deform preferentially throughout the densification process due to textural effects. Second, layers having a higher concentration of Cl- ions deform preferentially during a limited period from the ice sheet surface until smoothing out of layered Cl- ions by diffusion. We hypothesize that Cl- ions dissociated from sea salts softened firn due to modulation of dislocation movement. Moreover, firn differs markedly between the three sites in terms of strength of geometrical anisotropy, mean rate of densification, and density fluctuation. We hypothesize that these differences are caused by textural effects resulting from differences in depositional conditions within various spatial scales.

Abstract

Dr Christopher Fogwill

Submission ID	235
Name:	Dr Christopher Fogwill
Institution:	UNSW Australia
Country:	Australia
Presentation Title:	New high-resolution record of Holocene climate change in the Weddell Sea from combined biomarker analysis of the Patriot Hills blue ice area
Full Author List:	Fogwill, C.J.1, Turney, C.S.M.1, Baker, A1., Ellis, B.2, Cooper, A.3, Etheridge, D.4 Rubino, M.5, Thornton, D.4, Fernando F.J.6, Bird, M.7, Munksgaard, N.8
Author Affiliations:	1. UNSW, Sydney, Australia 2. ANU, Canberra, Australia 3. University of Adelaide, Adelaide, Australia 4. CSIRO, Melbourne, Australia 5. University di Napoli, Naples, Italy 6. Univeridad Andres Bello, Vina del Mar, Chile 7. James Cook University, Cairns, Australia 8. Chales Darwin University, Darwin, Australia

ABSTRACT

We report preliminary analysis of biomarkers (including dissolved organic matter (DOM) and DNA) from the Patriot Hills blue ice area (BIA), from the Ellsworth Mountains in the Weddell Sea Embayment. Preliminary isotopic and multiple gas analysis (CO_2, CH4, N2O and CO) demonstrate that the Holocene comprises more than 50% of the 800m long BIA record, and in combination isotopic and biomarker analysis reveals a remarkable record of centennial variability through the Holocene in this sector of the Weddell Sea.

Analysis using a Horiba Aqualog - which measures the fluorescence of DOM by producing a map of the fluorescence through an excitation-emission matrix (EEM) - identifies the presence of two marine protein-like components in both modern snow pit samples and within the Holocene part of Patriot Hills BIA transect. Intriguingly, the modern seasonal trends in DOM, recorded in contemporary snow pits, have relatively low signals compared to those recorded in the mid-Holocene record, suggesting a reduction in DOM signal in contemporary times.

Given that the δD excess data suggests the source of precipitation has remained constant through the Holocene, the biomarker signal must relate to multi-year marine productivity signals from the Weddell Sea. The marked variability in DOM between the mid-Holocene and contemporary times can only relate to periods of sustained, enhanced biological productivity in the Weddell Sea associated with shifts in Southern Annular Mode, sea ice variability or changes in ventilation or polynya activity. Here we discuss the possible drivers of these changes and describe how this approach at this BIA could benefit conventional ice core records regionally.

Abstract

Dr. Shuji Fujita

Submission ID	236
Name:	Dr. Shuji Fujita
Institution:	National Institute of Polar Research, Research Organization of Information and Systems
Country:	Japan
Presentation Title:	Volcanic synchronization of Dome Fuji and Dome C Antarctic deep ice cores over the past 216 kyr
Full Author List:	S. Fujita1,2,*, F. Parrenin3,4,*, M. Severi5, H. Motoyama1,2, E. Wolff6
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ABSTRACT

Two deep ice cores, Dome Fuji (DF) and EPICA Dome C (EDC), drilled at remote dome summits in Antarctica, were volcanically synchronized to improve our understanding of their chronologies. Within the past 216 kyr, 1401 volcanic tie points have been identified. DFO2006 is the chronology for the DF core that strictly follows O2/N2 age constraints with interpolation using an ice flow model. AICC2012 is the chronology for five cores including the EDC core, and is characterized by glaciological approaches combining ice flow modelling with various age markers. A precise comparison between the two chronologies was performed. The age differences between them are within 2 kyr, except at Marine Isotope Stage (MIS) 5. DFO2006 gives ages older than AICC2012, with peak values of a difference of 4.5 kyr and 3.1 kyr at MIS 5d and MIS 5b, respectively. Accordingly, the ratios of duration (AICC2012/DFO2006) range between 1.4 at MIS 5e and 0.7 at MIS 5a. When making a comparison with accurately dated speleothem records, the age of DFO2006 agrees well at MIS5d, while the age of AICC2012 agrees well at MIS5b, supporting their accuracy at these stages. In addition, we found that glaciological approaches tend to give chronologies with younger ages and with longer durations than age markers suggest at MIS 5d-6. Therefore, we hypothesize that the causes of the DFO2006/AICC2012 age differences at MIS 5 are: (i) overestimation in surface mass balance at around MIS 5d-6 in the glaciological approach and (ii) an error in one of the O2/N2 age constraints by ~3 kyr at MIS 5b. Overall, we improved our knowledge of the timing and duration of climatic stages at MIS 5. This new understanding will be incorporated into the production of the next common age scale.

Additionally, we found that the deuterium signals of ice, deltaDice, at DF tends to lead the one at EDC, with the DF lead being more pronounced during cold periods. The lead of DF is by +710 years (maximum) at MIS 5d, -230 years (minimum) at MIS 7a and +60-+126 years on average.

Abstract

Marie Cavitte

Submission ID	237
Name:	Marie Cavitte
Institution:	University of Texas at Austin Institute for Geophysics
Country:	USA
Presentation Title:	Old ice and the stability of the Byrd-Totten Glacier divide region
Full Author List:	Marie G.P. Cavitte1, Don D. Blankenship1, Duncan A. Young1, Frédéric Parrenin2, Catherine Ritz2, Jason L. Roberts3, Tas van Ommen4, Dustin M. Schroeder5, Martin J. Siegert6, Emmanuel Le Meur2
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ABSTRACT

We use existing airborne radar sounding data collected along the Byrd-Totten glacier divide region over several seasons by the University of Texas Institute for Geophysics as well as a CReSIS transect. Our work focuses over the Wilkes, Aurora and Vostok subglacial basins, using ICECAP and ICEBRIDGE airborne RES datasets collected with the collaboration of UK, US, French and Australian teams, and a Multichannel Coherent Radar Depth Sounder (MCoRDS) transect which was flown between Dome C and Vostok sites. Depending on the upcoming season's success, this could be augmented by new radar data as well.

We obtain a detailed and dated radar internal stratigraphy for the region, and establish depth and age uncertainties for each reflection mapped. The ages of the isochrones are constrained by the Vostok and EPICA Dome C ice cores tied to these surveys, and based on the AICC2012 timescale (Veres et al., 2013; Basin et al., 2013), and span the last two glacial cycles. The obtained stratigraphy is used to run "simple" 1D modeling experiment to investigate the flow history of the region, across the multiple glacial cycles sampled by the mapped reflections. The community's quest for million-year-old ice in the area relies on the relative stability of the divide through time, to ensure the retrieval of a stratigraphically ordered ice core with a preserved old ice record.

Abstract

Mr. Philip F. Place

Submission ID	238
Name:	Mr. Philip F. Place
Institution:	University of Rochester
Country:	United States
Presentation Title:	A 40-year record of Northern Hemisphere atmospheric carbon monoxide concentration and isotope ratios from the firn at Greenland Summit
Full Author List:	P.F. Place Jr.1, V.V. Petrenko1, I. Vimont2, C. Buizert3, P.M. Lang4, J.S. Edwards3, C. Harth5, B. Hmiel1, J.E. Mak6, P.C. Novelli4, E. Brook3, R.F. Weiss5, B.H. Vaughn2 and J.W.C. White2
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ABSTRACT

Carbon Monoxide (CO) is an important atmospheric trace gas that affects the oxidative capacity of the atmosphere and contributes indirectly to climate forcing by being a major sink of tropospheric OH. A good understanding of the past atmospheric CO budget is therefore important for climate models attempting to characterize recent changes in the atmosphere. Previous work at NEEM, Greenland provided the first reconstructions of the Arctic atmospheric history of CO concentration and stable isotope ratios (δC18O and δ13CO) from firn air, dating into the 1950s. In this new study, firn air was sampled from eighteen depth levels through the firn column at Summit, Greenland (in May 2013), yielding a second, independent record of Arctic CO concentration and isotopic ratios. Carbon monoxide stable isotope ratios were analyzed, on replicate samples, using a newly developed system with improved precision allowing for a more robust reconstruction. The new CO concentration and stable isotope results overall confirm the earlier findings from NEEM, with a CO concentration peak around the 1970s and higher δC18O and δ13CO values associated with peak CO. Future work will extend the atmospheric reconstruction of CO by measuring part of the Greenland ice core record (recently collected in June 2015). Firn gas modeling and interpretation of the data are in progress.

Abstract

Associate Professor Russell Drysdale

Submission ID	239
Name:	Associate Professor Russell Drysdale
Institution:	The University of Melbourne
Country:	Australia
Presentation Title:	Speleothem-based chronologies for Greenland ice cores
Full Author List:	R.N. Drysdale1,2, J.C. Hellstrom1, P. Bajo1, E. Corrick1, I. Couchoud2
Author Affiliations:	1. The University of Melbourne, Melbourne, Australia 2. Université de Savoie-Mont Blanc, Le Bourget du Lac, France

ABSTRACT

In this paper we compare radiometrically dated speleothem records of millennial climate events of the Last Glacial period to determine the extent to which the timing of these events is synchronous between cave sites. The data from each cave record has been re-processed (using common isotope decay constants, etc.) and new age models run using a single Bayesian Monte Carlo approach. We evaluate whether or not speleothem chronologies can be used to provide anchor points for Greenland ice records, and explore the reasons why some speleothem records appear complacent in terms of sensitivity to millennial climate events. We conclude by providing a set of recommendations that may be used to guide ongoing and future speleothem research in this area.

Abstract

Spruce W. Schoenemann

Submission ID	242
Name:	Spruce W. Schoenemann
Institution:	University of Washington
Country:	United States
Presentation Title:	On the seasonality of 17O-excess in Antarctic precipitation: insights from an intermediate complexity isotope model and high-resolution firn-core data
Full Author List:	S.W. Schoenemann1, E.J. Steig1
Author Affiliations:	1. Department of Earth and Space Sciences, University of Washington, Seattle, USA

ABSTRACT

An intermediate complexity isotope model (ICM) is used to investigate the sensitivity of water isotope ratios in precipitation to climate variations in the Southern Hemisphere. The model is based on that of Kavanaugh and Cuffey (2003), and includes the addition of δ17O, 17O-excess, and dln. It also includes updates to the equilibrium fractionation factors for temperatures below zero, and kinetic fractionation factors for evaporation over the ocean and condensation during snow formation. The ICM is forced with boundary conditions from seasonal NCEP/DOE II reanalysis data. Perturbations to the surface temperature and humidity fields are used to investigate the isotopic sensitivity. We find that the response of 17O-excess to a uniform temperature change is insignificant over the ocean, while there is a large magnitude response over the ice sheet, particularly in East Antarctica. A decrease of ocean surface relative humidity produces increased 17O-excess and d-excess, with a coherent response over both the ocean and Antarctica. For interior East Antarctica, the model simulates a seasonal cycle in 17O-excess that is positively correlated with δ18O and of large magnitude (~50 per meg), consistent with the observations from Vostok (Landais et al., 2012). The seasonal cycle in 17O-excess for WAIS Divide is predicted to be considerably smaller in magnitude (12 per meg), and is negatively correlated with δ18O.

Analysis of high precision, laser-spectroscopic 17O-excess measurements produced from a high-accumulation firn core near the West Antarctic Ice Sheet Divide exhibits a negative 17O-excess−δ18O relationship and seasonal amplitude of 14 per meg, in very good agreement with the model simulations. Compositing of the upper ~10 years of record show peak 17O-excess values occurring in Austral winter and peak d-excess lagging by ~2 months. We note that like d-excess, 17O-excess seasonality in firn is affected by diffusion, which will tend to create an artificial signal in phase with δ18O. Our data do not, therefore, appear to be significantly affected by diffusion.

Abstract

Matthew Osman

Submission ID	244
Name:	Mr. Matthew Osman
Institution:	Massachusetts Institute of Technology
Country:	United States
Presentation Title:	Coastal firn core records of west Greenland sea-surface variability
Full Author List:	M.B. Osman1, S.B. Das2, M.J. Evans3, K.E. Frey4, L.D. Trusel2, M. Hatch3, F. Smock3, B.E. Smith,5,6, A. York4
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ABSTRACT

Marine processes play a significant role in modulating Greenland Ice Sheet mass balance and outlet glacier dynamics. Observations of these processes, however, are largely limited to the past few decades. If robust proxies can be developed, ice-cores from coastal localities can provide key insights into regional ocean-ice coupling well beyond the satellite era. We present here preliminary results from an array of high-resolution, intermediate depth firn cores from coastal ice cap and ice-sheet sites adjacent to Disko and Ummannaq Bays in west-central Greenland, collected in 2014 and 2015. We utilize remote-sensing and regional reanalysis products to investigate recent variability in marine and atmospheric conditions adjacent to these sites, including primary productivity, sea-ice extent and concentration, sea-surface temperature, and meteoric conditions. Glaciochemical measurements of methanesulfonic acid (MSA), soluble sea-salt impurities (e.g., Na+, NH4+, PO43-), and δ18O and δD in our ice core records show prominent seasonal behavior, as well as interannual variability over the corresponding satellite era, which will ultimately be used to develop proxies for past regional sea-surface variability. Notably, we also find bi-annual (late spring/early fall) peaks in MSA in recent years, in contrast to prior ice-core records that have typically displayed a single MSA peak corresponding to the spring phytoplankton bloom. We hypothesize this may be driven by the onset of secondary, late-summer phytoplankton blooms around west Greenland, which in turn are likely linked to increased glacial meltwater runoff and/or declining regional sea-ice extent.

Abstract

Prof. Dorthe Dahl-Jensen

Submission ID	245
Name:	Professor Dorthe Dahl-Jensen
Institution:	Centre for Ice and Climate, Niels Bohr insitutte, University of Copenhagen
Country:	Denmark
Presentation Title:	NEEM flow properties show differences over Dansgaard-Oeschger events
Full Author List:	D, Dahl-Jensen1, N. Azuma2, K. Keegan1, S. Kipfstuhl3, M. Montagnat4, C. Panton1, S.G. Sheldon1
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ABSTRACT

The NEEM borehole has been logged to the bed since 2010 for temperature, inclination, azimuth, diameter and pressure. The logging data from 2015 was obtained in May before the closure of the NEEM camp.

The 2015 diameter and inclination records show very clear differences in closure rates and inclination over the Dansgaard-Oeschger events as well as the discontinuities before and after the Eemian ice. The shear deformation rates as well as the horizontal velocity profile are reconstructed from the borehole data and it is seen that the major part of the deformation happens in the ice below the Eemian ice. The differences in deformation properties are related to the material properties and impurity concentration of the ice. A detailed study of ice crystal properties and orientation is made over one of the Dansgaard Oeschger events and the discontinuity at 2200 m depth.

The NEEM diameter changes, mapping deformation changes over the abrupt climate changes in the ice from the glacial period, contains information that we have not seen from other boreholes. Together with the high resolved ice core measurements of cfa we have a very unique opportunity to advance our knowledge on the difference of deformation of the ice from different climate period – information that can be used to advance ice flow modelling and understand the big structures of buckling and folding ice near the bed.

Abstract

Prof. Dorthe Dahl-Jensen

Submission ID	246
Name:	Prof. Dorthe Dahl-Jensen
Institution:	Centre for Ice and Climate, Niels Bohr insitutte, University of Copenhagen
Country:	Denmark
Presentation Title:	EGRIP – a new deep drilling adventure in Greenland
Full Author List:	On behalf of the EGRIP community, D. Dahl-Jensen
Author Affiliations:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Juliane Maries Vej 30, 2100 Copenhagen, Denmark

ABSTRACT

new international deep ice core drilling project, EGRIP, on the North East Greenland Ice Stream (NEGIS) has had the first field season in 2015. The equipment for the NEEM camp including the main dome has been hauled 500 km over the ice to the position (77.45N 51.06W).

The main goals of the project is to get good climate records from the last 30.000 years and to study the flow of ice in an ice stream from the ice core and from borehole observations. The surface velocity is 55 m/yr at the EGRIP site so it will be a challenge to drill and log the borehole.

The EGRIP camp is a gateway to a very inaccessible part of the Greenland ice sheet and we hope to attract other project groups to enhance the research of the NEGIS ice stream.

The presentation will also give an overview of the time line and logistical innovations for the EGRIP camp.

Abstract

Yuansheng Li

Submission ID	248
Name:	Yuansheng Li
Institution:	Polar Research Institute of China
Country:	China
Presentation Title:	Recent progress on Chinese deep ice-core drilling project at Dome A
Full Author List:	Y.S. Li1, N. Zhang2, C.L. An1, G.T. Shi1, X.P. Fan2, C. Yang2, B. Li2, D. Gong2, C.J. Li3, Z.Y. Hu2, J.F. Liu3, S.M. Wang3, P. Talalay2, Y.H. Sun2
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ABSTRACT

The oldest ice core now extends over 0.8 Ma years into the past indicating that we are currently living in a relatively mild interglacial phase within a series of warm/cold oscillations occurring every 100 ka. We need to understand what caused the length of the cycles to change. Therefore, the search for ice core climate record extending at least 1.2 Ma. One of the most promising areas for retrieving the longest possible Antarctic ice core climate record is Dome A. The Kunlun Station was officially set up at Dome A in January 2009. The station is located where the thickest ice occurs on the gently sloping summit region of Dome A. There is no consensus about the age of the near-bottom ice at Kunlun Station. First estimation of a depth–temperature distribution with a steady-state ice-dynamics model indicates that the near-bottom ice might be >1.1 Ma old. Recent modelling found that the Kunlun site would provide a record of the past only 0.6–0.7 Ma. The real situation is planned to be revealed by deep ice-core drilling, and China started deep drilling project at Dome A in season 2011-12, when the pilot hole was drilled and casing pipes were installed. In season 2012-13, the deep ice-core drilling system was set down. After filling the hole with drilling fluid, wet ice-core drilling was started. During last season 2014-15 drilling was continued to a depth of 303 m. Drilling to the bedrock is planned to be completed during a further four seasons.

Abstract

Dr. Edward J. Brook

Submission ID	249
Name:	Dr. Edward J. Brook
Institution:	Oregon State University
Country:	USA
Presentation Title:	Abrupt CO_2 variations during the last deglaciation and marine isotope stage 3: results from WAIS Divide and Taylor Glacier
Full Author List:	E. Brook1, S. Marcott2, T. Bauska3, A. Buffen1, J. Edwards1, J. Ahn4, R. Rhodes5, J. Severinghaus6, V. Petrenko7, A. Menking1, M. Kalk1
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ABSTRACT

Past variations in atmospheric CO_2 provide information about feedbacks between the carbon cycle and climate. The WAIS Divide ice core, from central West Antarctica, provides an unparalleled view of CO_2 variations during the last ice age, due to high accumulation rate, low gas age-ice age difference, minimal smoothing due to gas enclosure processes, and high-resolution sampling. We focus here on new data from marine isotope stage 3 and the published record from the last deglaciation. As observed in previous records, on millennial time scales CO_2 and Antarctic temperature are closely related, and Antarctic warming and CO_2 increases lead warming in Greenland. Small (5-10 ppm) concentration increases occurred synchronously with many of the abrupt methane changes that mark Dansgaard-Oeschger warming. Additional abrupt shifts occurred during some Heinrich Stadials (cold periods in Greenland during which Heinrich events occurred). We confirm a very abrupt shift of CO_2 of ~ 10 ppm during Heinrich Stadial 4, at the same time as an abrupt change in atmospheric methane potentially linked to Heinrich Event 4. We now also show that a very similar event occurred during Heinrich Stadial 5, and have previously reported an abrupt CO_2 change associated with Heinrich Stadial 1. Isotopic data from WAIS Divide are forthcoming, but $\delta^{13}C$ results from Taylor Glacier suggest that the abrupt CO_2 changes during Heinrich stadials are associated with net release of isotopically light carbon to the atmosphere, and abrupt shifts associated with warming in Greenland have a neutral or slightly positive $\delta^{13}C$ signature.

Abstract

Alexandra Touzeau

Submission ID	253
Name:	Alexandra Touzeau
Institution:	LSCE-IPSL
Country:	France
Presentation Title:	Changes in the isotopic composition of the snow after deposition: evidences from the crime scene and investigation of a suspect…
Full Author List:	A. Touzeau1, A. Landais1, B. Stenni2, R. Uemura3, K. Fukui4, S. Fujita5, S. Guilbaud6, A. Ekaykin7, M. Casado1, O. Magand8, J. Savarino8, I. Bourgeois8, M. Baroni9, Andrew Moy10,11, Mark Curran10,11 and the ABN Team10,11, S. Morin12
Author Affiliations:	1 LSCE-IPSL, Gif-sur-Yvette, France 2 Universita Ca'Foscari, Venezia, Italy 3 University of the Ryukyus, Okinawa, Japan 4 Tateyama Caldera Sabo Museum, Toyama, Japan 5 National Institute of Polar Research, Research Organization of Information and Systems, Tokyo, Japan 6 Université du Littoral Côte d'Opale, Dunkerque, France 7 Arctic and Antarctic Research Institute, Saint Petersburg, Russia 8 LGGE, Grenoble, France 9 CEREGE, Aix-en-Provence, France 10 Australian Antarctic Division, Kingston Tasmania, Australia 11 Antarctic Climate and Ecosystems Cooperative Research Centre-University of Tasmania, Hobart, Australia. 12 Centre d'Etudes de la Neige –Météo-France, Saint-Martin-d'Hères, France

ABSTRACT

The East Antarctic plateau exhibits very low accumulation rates. Snow removal and re-deposition by the wind and vapor diffusion in the snow mantle may lead to an isotopic signature in the snow layers different from the one initially present in the precipitated snow. To investigate these differences, we have use a data-model approach. The δ18O, d-excess and 17O-excess of snow were measured in precipitation and surface snow and at 3 cm resolution in 5 snow pits from East Antarctica (four plateau sites and one site at its periphery, at the Aurora Basin North). We focused on the relationships between these isotopic parameters to determine and understand the processes at each site. Under a climatic control, the distillation process causes an opposition between δ18O and d-excess, and the kinetic fractionation leads to a positive correlation between 17O-excess and δ18O. While well fulfilled in the precipitation and in the surface snow, these relationships are however no longer the same in the snow from snow pits. At Dome C, the link between d-excess and

δ18O disappears; at Vostok, the positive correlation between 17O-excess and δ18O is replaced by a negative one. Thus, other processes than distillation are probably active. Several likely candidates exist to account for the observed changes. Here we incorporate water isotopes in the snow model CROCUS, in order to simulate the effect of snow-vapor exchange and vapor transfer on the isotopic composition of the snow, and compare the model outputs to the observations.

Abstract

Bradley R Markle

Submission ID	254
Name:	Bradley R Markle
Institution:	University of Washington
Country:	USA
Presentation Title:	Moisture transport to West Antarctica constrained by shared water-isotope and ice- impurity variability at millennial to orbital time scales
Full Author List:	Bradley R. Markle1, Eric J. Steig1, Joe R. McConnell2, T.J. Fudge1
Author Affiliations:	1: University of Washington, Seattle, USA 2: Desert Research Institute, Reno, USA

ABSTRACT

Stable isotopes of water as well as a variety of impurities are routinely measured at high resolution in polar ice cores. Water isotope ratios record integrated fractionation processes and are a well-established proxy for ice core site temperature. Changes in the terrestrial impurity content of Antarctic ice are thought to reflect some combination of changes in dust transport, aridity, windiness, and land cover of dust source regions such as South America. We examine the relationships between the high-resolution records of both water isotopes and impurities from the WAIS Divide ice core, as well as the independent snow accumulation record. Concentrations of dust and related impurities, such as Ca, in ice are not only extremely well correlated with each other, but are also strongly anticorrelated to ice core $\delta^{18}O$. Analysis of the spectral coherence among the data shows that impurities and water isotopes are more tightly linked with each other, and at finer timescales, than is either to local snow accumulation.

Much previous research has focused on changes in the dust source region as the dominant driver of impurity variability through time. In such interpretations, the link between the water isotope and ice-impurity variance is indirect and through the general coupling of disparate aspects of the climate system. However, our analysis suggests that a single mechanism that directly relates $\delta^{18}O$ and impurity variability is a far more parsimonious explanation for the data. Specifically, we show that the integrated rain-out of precipitation from air masses en route to Antarctica may dominate variations in both $\delta^{18}O$ and Ca, at millennial to orbital time scales. Cloud formation and rain scavenge airborne impurities, which act as condensation nuclei. Precisely the same condensation processes drive water isotope fractionation. We support our arguments with simple models of isotope fractionation and impurity transport. Such a direct mechanism correctly predicts the logarithmic and inverse relationship between $\delta^{18}O$ and impurities and reconciles the magnitude of impurity concentration changes over large climate shifts for a given range of water isotope variability. It also accounts for the relationship between dust concentration change in ice cores and those at lower latitudes, as

archived in marine sediment cores.

Our analysis improves the understanding of the physical relationship between the strength of the Southern Hemisphere water cycle, ice core water isotope ratios, and impurities. We propose that the shared variance among these records could be used to quantitatively constrain changes in poleward atmospheric moisture transport, a key component of global energy balance, through time. Further, variability in either $\delta^{18}O$ or Ca that deviates from the covarying relationship expected due to rain-out, may be used to determine the magnitude of other sources of variability, such as changes in dust source regions.

Abstract

Bradley R. Markle

Submission ID	255
Name:	Bradley R. Markle
Institution:	University of Washington
Country:	United States
Presentation Title:	Atmospheric teleconnections between the tropics and high southern latitudes during abrupt climate change
Full Author List:	Bradley R. Markle1*, Eric J. Steig1, 2, Christo Buizert3, Spruce W. Shoenemann1, Cecilia M. Bitz2, T.J. Fudge1, Joel B. Pedro4, Qinghua Ding5, Tyler Jones6 James W.C. White6, Todd Sowers7
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ABSTRACT

Abrupt, large amplitude Dansgaard-Oeschger temperature oscillations occurred in the North Atlantic region during the last glacial period. Antarctic temperatures show a lagged and out-of-phase response, suggesting that Dansgaard-Oeschger climate anomalies were propagated to the Southern Hemisphere high latitudes through changes in ocean circulation. Here, we use a high-resolution deuterium excess record from West Antarctica to show that moisture sources for Antarctic precipitation changed in phase with abrupt shifts in Northern Hemisphere climate, and significantly before Antarctic temperature change. This observation suggests that Southern Hemisphere mid-latitude storm tracks migrated north- and southwards within decades of rapid North Atlantic warming and cooling, respectively, in parallel with the well-established migrations of the intertropical convergence zone. Both ocean and atmospheric processes, operating on different timescales, are critical to the global expression of abrupt climate change.

Abstract

Dr Mark Curran

Submission ID	256
Name:	Dr Mark Curran
Institution:	AAD and ACCE CRC
Country:	Australia
Presentation Title:	The Law Dome MSA sea ice proxy record: Analysis of modern satellite data and re-examination of archival satellite imagery.
Full Author List:	M.A. Curran1,2, T.D. Van Ommen1,2, J. Stroeve3, T.R. Vance2, A.D. Moy1,2, J. Roberts1,2, J. Lieser2 Samuel Poynter2,4, C. Plummer5, D. Gallaher3, G. Campbell3 and W. Hobbs2.
Author Affiliations:	1. Australian Antarctic Division, Kingston, Australia; 2. Antarctic Climate & Ecosystems Cooperative Research Centre, Hobart, Australia; 3. National Snow and Ice Data Center, University of Colorado, Boulder, USA; 4. Physics and Astronomy, Curtin University, Perth, WA, Australia 5. Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia

ABSTRACT

Understanding the long term trends in sea ice coverage is important, particularly in the context of recent reports of increases in Antarctic sea ice extent. Prior to the satellite era, ice core records have been used as a proxy for past sea ice extent in Antarctica, allowing investigations of the natural variability of Antarctic sea ice extent. The Law Dome MSA sea ice proxy has been recognised as an important tool for reconstructing sea ice, however not without it's limitations. Here, we present an updated record for the Methanesulphonic acid (MSA) data from the Law Dome site (to 2013) and investigate the recent changes in Antarctic sea ice extent. We also extend the proxy calibration period further back in time by including reanalysis of old Nimbus I satellite information from the mid 1960s to the mid 1970s. Our data suggests that recent reports of increases in Antarctic sea ice extent remain within natural variability, a result consistent with attribution and detection studies for this region.

Abstract

Hou Shugui, Dr.

Submission ID	257
Name:	Hou Shugui, Dr.
Institution:	School of Geographic and Oceanographic Sciences, Nanjing University
Country:	China
Presentation Title:	Possible recent warming hiatus at high elevation indicated by a Tibetan ice core stable isotopic record
Full Author List:	S. Hou1, W. Zhang1, W. An1, S. Wu2, H. Xu1, H. Pang1, Y. Wang3
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ABSTRACT

The global surface temperature has experienced relatively little change since the late 1990s, a period often termed as “the global warming hiatus”. However, the status of the warming hiatus at high elevation regions remains elusive. Here we present a stable isotopic record of an ice core recovered in 2012 from the Chongce glacier (58.82m in length, 35°14’N, 81°7’E, 6010m above sea level) in the northwest Tibetan Plateau, a region where stable isotopes in precipitation have been shown to be a good indicator for temperature. The ice core was annually dated back to 1953 at the depth of 10.0m. The dating was verified by β activity horizons. The δ18O values correlated significantly with air temperature records of nearby meteorological stations, the whole China, and the northern Hemisphere. The annual δ18O in the record peaked in 1998, and started to decrease ever since. Our results seem to suggest a recent onset of warming hiatus at high elevation, which is likely caused by changes in local energy budget, as a result of such factors as decreasing surface albedo, increasing low-level cloud cover and decreasing wind speed since 1980.

Abstract

Jacopo Gabrieli

Submission ID	258
Name:	Jacopo Gabrieli
Institution:	Institute for the Dynamics of Environmental Processes, National Research Council (IDPA-CNR)
Country:	Italy
Presentation Title:	High-resolution record of European trace element deposition over the past 2,000 yr from the Colle Gnifetti firn/ice core
Full Author List:	J. Gabrieli1, P. Vallelonga2, M. Schwikowski3, M. Sigl3, C. Barbante1,4
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ABSTRACT

A new melting device for on-line decontamination and continuous analysis of alpine firn/ice cores was designed, built and tested in the CNR-IDPA Venice laboratory. The device pumps melt water from inner ice core sections to an ICP-QMS and a conductivity micro-cell for continuous measurements of trace element concentrations and conductivity, respectively. We also analyzed discrete samples for trace elements, Pb isotopes and 239Pu determinations using ICP-SFMS. These analyses resulted in high resolution profiles of 24 elements and more than 42,000 individual measurements.

All profiles demonstrate pronounced seasonal variations including both crustal (e.g. Mg, Al, Ba) and anthropogenically enriched elements (e.g. Pb, Cu, Zn, Cd). For example, Pb concentrations progressively increased from the 18th century to the first decade of 20th century, reaching a maximum in the 1920s. During the 1920s Pb concentrations suddenly halved and remained low (hundreds of ppt) for the next two decades. After the Second World War, Pb depositions increased dramatically with the introduction of Pb additives in gasoline, peaking in the mid-1970s. From 1975 until the present, Pb concentrations in Colle Gnifetti ice began to decrease in accordance with the first environmental policies in Europe that limit pollutant emissions. Before the 18th century, the anthropogenic fluxes of Pb and other heavy metals exceeded the natural fluxes only during the Roman era (200 BC – 400 AD) and in the Late Middle Ages (800-1300 AD) as consequence of local mining and metallurgic activities.

Abstract

Sentia Goursaud

Submission ID	260
Name:	Sentia Goursaud
Institution:	Laboratoire de Glaciologie et Géophysique de l'Environnement, BP 96, 38402 St Martin d'Hères 13 Cedex, France
Country:	France
Presentation Title:	Interannual variability of atmospheric biogenic sulfur and sea-salt aerosols at the coastal Antarctic site of Dumont d'Urville.
Full Author List:	S. PREUKERT1, M. LEGRAND1, and S. GOURSAUD1,2
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ABSTRACT

Analysis of aerosol filters collected at the coastal site of Dumont d'Urville (DDU, East Antarctica) provides now a complete year-round record of sea-salt, MSA and biogenic sulfate (non-sea-salt sulfate or excess sulfate) over the 1991-2014 years. These bulk aerosol records are complemented since 1999 by in situ year-round measurements of gaseous DMS and sometimes by studies of the size-segregated aerosol composition.

The observed significant inter-annual aerosol changes are discussed with respect to climate related indices including sea ice extend, the southern atmospheric circulation pattern, and local meteorological parameters. Furthermore, the simultaneous record of DMS, MSA and sulphate, which covers almost 15 years, reveals several successive years of low concentrations of MSA and DMS around 2008 followed by the recovery of higher values after 2010. These temporal changes are examined with respect to marine bio-productivity as derived from analysis of oceanic satellite data.

Finally, we compare these unique atmospheric aerosol records obtained at DDU with the chemical composition of snow layers covering the recent decades along a firn core extracted at a few kilometres from DDU.

Abstract

Pat Wongpan

Submission ID	261
Name:	Pat Wongpan
Institution:	Department of Physics, University of Otago
Country:	New Zealand
Presentation Title:	Integrated EDS, EBSD and micro-CT analyses of sea ice structure near an ice shelf
Full Author List:	P. Wongpan1, D. J. Prior2, K. Lilly2, P. J. Langhorne1
Author Affiliations:	Department of Physics, University of Otago, Dunedin, New Zealand Department of Geology, University of Otago, Dunedin, New Zealand

ABSTRACT

Antarctic landfast sea ice is increasingly recognised as an important component in the global climate and biogeochemical system. Platelet ice is a sea ice type found near the coastline of Antarctica that occurs due to the ice shelf-ocean interaction which has been shown as an indicator of the health of the ice shelves around Antarctica. It hosts the highest concentration of sea ice algae on Earth. Scanning electron microscope (SEM) coupled with energy dispersive spectroscopy (EDS), electron backscattered diffraction (EBSD) and micro-CT have been used to determine the microstructural location of impurities (e.g. within ice crystals, at boundaries or at triple junctions) and to measure the crystallographic orientation of grains in sea ice. With image processing, preliminary results show the impurity distribution, microstructure and crystal orientations of platelet sea ice in three dimensions. This has never been achieved before and leads to an improved an understanding of the distribution of algal biomass in sea ice.

Abstract

Giuliano Dreossi

Submission ID	262
Name:	Giuliano Dreossi
Institution:	Università Ca' Foscari di Venezia
Country:	Italy
Presentation Title:	Water stable isotope records of deep ice cores and superficial samplings from the Eastern Alpine site of Mt. Ortles, Italy
Full Author List:	G. Dreossi*1, 2, C. Barbante1,2, L. Carturan3, F. De Blasi3, J. Gabrieli2, P. Gabrielli4, R. Seppi5, A. Spolaor2, B. Stenni1, L.G. Thompson4 and T. Zanoner6
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ABSTRACT

The Eastern Alps paleoclimatic potential remains largely unexploited, and considering the rate at which the temperature has been increasing, the chance of finding a suitable drilling site in the region has dramatically shrunk. In autumn 2011 four ice cores were drilled (three down to bedrock) from the Alto dell'Ortles glacier, at 3859 m a.s.l., on Mt. Ortles (South Tyrol, Italy); other glacial archives were retrieved since 2008 in the same area: two shallow firn cores and several snow pits.

Water stable isotopes have been widely used as climate proxies for about half a century, but the processes altering the snow isotopic composition after it settled, and how much of the pristine signal is retained within the glacier, remain mostly unclear. Snow pits, dug at the beginning and at the end of the ablation season, can provide useful information on how the snow isotopic content is affected by warm summer conditions.

An Automatic Weather Station (AWS) was installed in proximity of the drilling site in October 2011, but reconstructed temperatures from nearby weather station data extend the instrumental coverage of the area to 1864.

Recent snow sample (snow pits) and deep core isotope data, compared with temperature records, can give us a hint on how the isotope content has changed through the years, following the warming and the consequential evolving conditions at the drilling site, considering that the Alto dell'Ortles glacier was cold until few decades ago, but under current climate conditions, the top part of the glacier has become temperate.

Abstract

David Russell-Head

Submission ID	263
Name:	David Russell-Head
Institution:	Russell-Head Instruments
Country:	Australia
Presentation Title:	Recent developments in fabric analyser instrument for ice
Full Author List:	D. S. Russell-Head
Author Affiliations:	Russell-Head Instruments, Melbourne, Australia

ABSTRACT

A major improvement in the illumination system for the ice fabric analyser allows relatively thick thin-sections to be routinely analysed. The system uses three monochromatic light sources in the red, green and blue wavelengths to obtain retardation values for nine directions through the ice section. These nine independent retardations determine the optical orientation of the ice lattice at each 5um pixel.

As the instrument system has the potential to capture and analyse a 10x10mm area at 5um resolution in 15 seconds, large area thin-sections can be processed in reasonable time. The precision of the retardation values allows for detailed mapping of the crystal lattice within an individual grain. Now that the section can be several millimetres thick, a partial three dimensional reconstruction of the grain boundary becomes possible.

The combination of high-speed capture, precision lattice orientation imaging, and thick sections suggests that fabric analysis can be extended from c-axis textures to intra-grain orientation and grain boundary shape characterization.

Abstract

Motohiro Hirabayashi

Submission ID	265
Name:	Motohiro Hirabayashi
Institution:	National Institute of Polar Research
Country:	Japan
Presentation Title:	Variability of trace halogen species in ice core from NEEM, Greenland
Full Author List:	M. Hirabayashi1, K. Goto-Azuma1, A. Wegner2, M. Hansson3, B. Twarloh2, P. Vallelonga4, J. P. Steffensen4, D. Dahl-Jensen4, H. Motoyama1
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ABSTRACT

In the northern hemisphere, especially Greenland, it is considered that ocean and stratosphere are major sources of halogen species. However, there is little data about halogen species contained in snow and ice in Greenland. In this research, trace inorganic species (Br-, BrO3-, I-, IO3-,) in Greenland ice core were analyzed.

The ice core samples were drilled at NEEM, Greenland (77°45'N, 51°06'W, 2500 m). The quantitative analyses of ion species were performed using an ion chromatograph mass spectrometer (IC-MS). The IC-MS system consists of a single quadrupole type mass spectrometer connected to an ion chromatograph. IonPac AS11-HC was used as the separation column of the ion chromatograph. 14 anion species including halogen species (Br-, BrO3-, CH3COO-, CH3SO3-, Cl-, C2O42-, F-, HCOO-, I-, IO3-, NO_2-, NO3-, PO43-, SO42-) were analyzed.

Average concentration of Br- below 1500m was 0.6 ng/ml. The maximum concentration of Br- was ca. 1 ng/ml. Average concentration of I- below 1500m was 0.01ng/ml. The maximum concentration of I- was ca. 0.03 ng/ml. Average concentration of IO3- below 1500m was 0.1ng/ml. The maximum concentration of IO3- was ca. 1 ng/ml. It seems that Br- concentration shows variations associated with Dansgaard-Oeschger (DO) events. Further results and discussion about the behavior and origin of halogen ion species in snow will be presented.

Abstract

Damiano Della Lunga

Submission ID	266
Name:	Damiano Della Lunga
Institution:	Royal Holloway University of London
Country:	United Kingdom
Presentation Title:	Evidence of sub-annual stadial to interstadial switch around Greenland stadial 22 (GS-22) inferred from high resolution UV-LA-ICPMS dust records in deep NGRIP ice
Full Author List:	D. Della Lunga1, W. Müller1, S.O. Rasmussen2, A.S. Svensson2
Author Affiliations:	1) Earth Science department - Royal Holloway University, London, UK 2) Niels Bohr Institute - Centre for Ice and Climate, Copenhagen, Denmark.

ABSTRACT

Dansgaard-Oeschger (DO) events are rapid temperature shifts of 5-16°C recorded in Greenland ice cores throughout the last glacial period as oscillations of $\delta^{18}O$, but also reflected in other proxies such as terrestrial dust and sea salt.

By applying cryo-cell UV-LA-ICPMS (Ultra-Violet Laser-Ablation Inductively-Coupled-Plasma-Mass-Spectrometry) directly to frozen ice from the Greenland NGRIP ice core, we investigated elemental proxies of dust and sea salt (nssCa, Al, Fe; Na, ssMg) at an unprecedented spatial resolution of $\leq$200 μm while maintaining ppb-detection limits. We investigated DO event 22 at ~2700m core depth (GI-22/GS-22 and GS-22/GI-21 transitions: 87.60-84.70 ka, as well as the GI-21.2 event: 85.06-84.96 ka) achieving approximately bi-monthly time-resolution. Using a series of suitably homogenous ice standards specifically prepared during this project, we achieved quantitative concentration calibrations.

Our high resolution dataset for the main GS22 transitions and the GS21 precursor shows (1) the phasing of dust, sea salt and temperature proxies, where dust precedes temperature change by three to ten years, (2) the ~ten-fold change in dust concentrations within one year at the GS21.2 and GI21 warming events, (3) a transient phase from interstadial to stadial lasting several decades and characterized by high amplitude oscillations before the onset of the cold phase ('flickering of climate signal'), (4) the confirmation that dust and sea salt proxies vary significantly even during short climatic events, (5) the quantification of rapid changes in dust provenance as deduced from elemental ratio signatures and (6) the different partitioning of soluble and insoluble impurities between grain boundaries and interiors in ice layers with different content of particles.

Abstract

Prof. Karl Kreutz

Submission ID	270
Name:	Prof. Karl Kreutz
Institution:	University of Maine
Country:	USA
Presentation Title:	Potential impact of volcanic aerosols on the position of the ITCZ and Southern Hemisphere westerlies over the past 2000 years
Full Author List:	K.J. Kreutz1 B.G. Koffman2 A. Kurbatov1 N. Dunbar3 M. Wells1
Author Affiliations:	University of Maine, Orono, USA Dartmouth College, Hanover, USA New Mexico Institute of Mining and Technology, Socorro, USA

ABSTRACT

Observational and modeling studies have shown that Twentieth century anthropogenic sulphate aerosol emissions are associated with greater Northern Hemisphere (NH) cooling compared to the Southern Hemisphere (SH), resulting in southward migration of the Intertropical Convergence Zone (ITCZ), drying at NH low latitudes, and more rainfall at SH low latitudes. Recent research also demonstrates that this same asymmetric cooling effect occurred following the injection of sulphate aerosols into the stratosphere following large volcanic eruptions over the last 100 years (based on instrumental data) and 500 years (based on stalagmite rainfall proxy data). These studies collectively demonstrate that over the last few centuries NH aerosols (volcanic and anthropogenic) forced the ITCZ to the south by cooling the NH relative to the SH, and that SH eruptions forced northward ITCZ migration. If correct, such movement of the ITCZ should have had effects on Hadley circulation, and by extension the SH Polar Front and westerlies. Here we test this hypothesis using records from the WAIS Divide ice core with very high (sub-seasonal) resolution for the past 2000 years. The published WAIS Divide laser-based dust particle size record has been calibrated versus instrumental data and used to interpret changes in the strength and position of the SH westerlies. The published WAIS Divide sulfate record contains the most detailed record of SH volcanic activity yet developed. Details and results of our comparison of the WAIS Divide dust and sulfate records will be discussed, and used to evaluate the volcanic influence on SH atmospheric circulation.

Abstract

Hun-Gyu Lee (Jinho Ahn)

Submission ID	271
Name:	Hun-Gyu Lee (Jinho Ahn)
Institution:	Seoul National University
Country:	Republic of Korea
Presentation Title:	Abrupt atmospheric CO_2 increases during the last glacial termination
Full Author List:	Hun-Gyu Lee1, Jinhwa Shin1, Edward J. Brook2 and Jinho Ahn1
Author Affiliations:	1School of Earth and Environmental Sciences, Seoul National University, Seoul, Republic of Korea 2College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, USA

ABSTRACT

Ice cores from Antarctica have revealed that atmospheric CO_2 is strongly linked with climate over the last 800,000 years. During the last glacial termination atmospheric CO_2 increased by ~80 ppm and experienced large changes associated with abrupt climate events such as Bølling-Allerød and Younger Dryas. Precise and high-resolution CO_2 records during the events may help us better understand climate-carbon cycle feedbacks. Recently, a CO_2 record with an unprecedented temporal resolution was obtained from West Antarctic Ice Sheet (WAIS) Divide ice core which has a relatively small gas age distribution by small gas mixing in the firn layer. The WAIS Divide record shows three abrupt CO_2 increases during the last glacial termination. Each one has a magnitude of 10-15 ppm in less than 200 years. However, the extracted air from the WAIS Divide ice core was originally in a form of air hydrates and the results haven't been confirmed with other ice cores. Here we present a new high-resolution atmospheric CO_2 record from the Siple Dome ice core, in which air is preserved only in bubbles. We obtained the data with an average time resolution of 65 years at Seoul National University. Our Siple Dome records show abrupt CO_2 increases of ~ 10 ppm within 100-200 years at 11.7, 14.7 and 16.3 ka, confirming the rapid CO_2 increases in the WAIS Divide record. The rapid CO_2 increases are coincident with the end of Younger Dryas event, onset of Bølling-Allerød event and Heinrich event 1. Those rapid increases may be related with change in the Atlantic meridional overturning circulation and sea level change, but exact CO_2 control mechanisms remain unclear. Possible governing mechanisms will be discussed during the presentation.

Abstract

Associate Professor Ross Edwards

Submission ID	273
Name:	Associate Professor Ross Edwards
Institution:	Curtin University
Country:	Australia
Presentation Title:	Dating Antarctic ice cores using high-temporal resolution black carbon records
Full Author List:	R. Edwards1, P. Vallelonga2, J. R. McConnell3, N.A.N. Bertler4,5, M. A. J. Curran6,7, M. Sigl3, T.J.Fudge8, H. Anschuetz2, P. D. Neff4, D. Emanuelsson4, M. Bisiaux3, 1. D. Goodwin9, Andrew Smith10, K. C. Taylor3, A. Moy6,7, W. Fetieng11, A. Ellis1, V. H.
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ABSTRACT

Black carbon aerosols (BC) emitted by fires in the Southern Hemisphere (SH) are transported to Antarctica and preserved in the Antarctic ice sheet. Recent efforts to develop ice core records of BC deposition to Antarctica show variability in BC over a broad range of time scales. The ~ monthly-resolution BC record from the WAIS divide deep ice core displayed strong seasonal variability in modern sections of the record consistent with the timing of SH biomass burning. The record was subsequently used as an annual layer dating proxy in conjunction with other chemical species. If the emissions and transport of BC to Antarctica are stable over long periods of time it may be useful as an annual layer proxy at sites other than WAIS. To date, a rigorous comparison of Antarctic ice core BC seasonality from different locations have not been conducted. Here we present a comparison of BC ice core data from the top sections of the WAIS divide deep core, the Roosevelt Island RICE core, and the Law Dome DSS1213 core. The RICE and Law Dome sites are separated from WAIS by large distances and experience different atmospheric circulation and climate regimes. A detailed description of the data uncertainties and its use in annual layer counting will be discussed.

Abstract

Bréant Camille

Submission ID	274
Name:	Bréant Camille
Institution:	Laboratoire des Sciences du Climat et de l'Environnement, UMR8212, CEA-CNRS-UVSQ/IPSL
Country:	France
Presentation Title:	Variability of polar snow densification over the terminations 1, 2 and 3: cases of Vostok and Dome C
Full Author List:	C. Bréant1,2, A. Landais1, P. Martinerie2, L. Arnaud2, A. Orsi1, N. Caillon2, J. Severinghaus3
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ABSTRACT

The transformation of snow into ice is a complex natural phenomenon difficult to model. Depending on surface temperature and accumulation rate, it may take several decades to millennia for gas to be entrapped in ice. Gas is thus always younger that the surrounding ice by centuries to millennia. The resulting gas-ice age difference strongly impacts the uncertainties in the phasing between CO_2 and temperature increase especially during deglaciations.

Several models have been developed for describing the snow to ice transformation and we concentrate here on the LGGE thermo-mechanical model of firn densification that includes the formulation of mechanical processes, thermal properties, and gas trapping criteria. The model performances have been tested against measurements of present-day density and temperature profiles, and trace gas data in ice cores (15N, 40Ar, CH4).

Wide discrepancies have been observed in central Antarctica between densification model outputs and isotopic measurements of inert gases trapped in ice: over deglaciations, densification models predict a decrease of the firn depth while δ15N data suggest an increase in firn depth. Such opposite behaviours generate important uncertainties in past climate reconstructions.

We have developed new parameterizations of the LGGE model enabling to reconcile data and model such as incorporation of the dust influence on densification , incorporation of temperature dependence of activation energies, trapping criteria, influence of insolation.... We tested the influences of these new parameters at steady state and in a dynamic mode over deglaciations.

Here, we concentrated on antarctic sites with the strongest discrepancies between the model outputs and the δ15N data, i.e. Vostok and Dome C. We chose to focus more particularly on the terminations 1, 2 and 3 because the phasing between temperatures and calcium concentration during these periods is very different. Indeed during terminations 1 and 2, temperature and calcium concentration increase in concert. On the opposite, for termination 3, the increase of the concentration in calcium occurred several millennia earlier than the temperature increase. These different sequences permit to test the relative influence of temperature and dust content on firnification during the different deglaciations. We thus confront here new high-resolution data of δ15N for the termination 2 and 3 of Dome C and Vostok to simulation of δ15N supplied by the LGGE model using different parameterizations

Abstract

Dr. Nanna B. Karlsson

Submission ID	276
Name:	Dr. Nanna B. Karlsson
Institution:	Centre for Ice and Climate, University of Copenhagen
Country:	Denmark
Presentation Title:	The representativeness of ice core accumulation records: Case study from NEEM
Full Author List:	N. B. Karlsson1, O. Eisen2, L. T. Nielsen1, S. Kipfstuhl2, J. Freitag2, A. Winter2, D. Dahl-Jensen1
Author Affiliations:	1 Centre for Ice and Climate, University of Copenhagen, Copenhagen, Denmark 2. Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

ABSTRACT

Ice core records contain information on past accumulation rates, but they always only provide information for a single location. A key question when interpreting accumulation rates retrieved from ice cores is therefore the representativeness of the core site on regional scales. This is especially true for locations in the flank-flow regime, i.e. from transient ice divides or positions away from an ice dome.

Here, we present spatially distributed accumulation rates from the area around the NEEM (North Greenland Eemian Drilling) ice core drill site. The accumulation rates have been reconstructed using ice-penetrating radar, firn core measurements and inverse methods, and we are able to retrieve both spatial and temporal changes in the accumulation. We investigate the stability of the accumulation pattern over the past several hundred years, and we address the question of how well the measured accumulation rates at NEEM capture the regional variations in accumulation.

Abstract

Zhiheng Du

Submission ID	277
Name:	Zhiheng Du
Institution:	State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences
Country:	China
Presentation Title:	Distribution and biogeochemical behaviour of iron in the Barrow land-fast sea ice, Alaska
Full Author List:	Z.H. Du1,2*, C.D. Xiao1,3*, M. Shafer4, T.F. Dou2, J. J. Schauer4, H. Eicken5, A. R. Mahoney5
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ABSTRACT

Samples of the coastal land-fast ice were collected and processed for iron (Fe) and trace elements analysis in Barrow, Alaska. Dissolved and total trace element concentrations were measured together with relevant physical and chemical parameters. The most striking feature is that the concentrations of Al, Fe, Mn, and Co covaried with the concentration of phosphorus (P), implying that these metals released from melting ice increased phytoplankton production in spring and summer. In particular, the dissolved (DFe) and total Fe (TFe) concentrations at the top of “dirty” sea ice, of which was drilled from the near-coast, were two to three orders of magnitude higher than those measured at the bottom of sea ice, while the iron fractional solubility (DFe/TFe) at the top of samples was clearly lower than these of ratios at the bottom samples. This result indicates that the source of dissolved iron were mainly controlled by sedimentary input in shallow region. However, the distribution of DFe/TFe in the other two ice cores, which was relatively far away from the coast, the iron fractional solubility at the top samples is higher than these of ratios at the bottom samples. This demonstrates that the wind-blown dust may be taken as another a source of dissolved iron.

Abstract

Camilla Marie Jensen

Submission ID	278
Name:	Camilla Marie Jensen
Institution:	Centre for Ice and Climate, The Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	Sulphate detection technique for the CFA system based on Raman spectroscopy
Full Author List:	C.M. Jensen1, P. Vallelonga2
Author Affiliations:	1. Centre for Ice an Climate, The Niels Bohr Institute, Denmark 2. Centre for Ice an Climate, The Niels Bohr Institute, Denmark

ABSTRACT

Concentrations of sulphate ions found in ice cores indicate aerosol sources and different processes in the atmosphere. Volcanic eruptions can cause sulphate peaks in ice core records because large amounts of acids is emitted into the atmosphere. The detection of sulphate therefore is a very important tool for dating of ice cores, if the volcanic event is historically determined or if the dust particles from the volcanic eruption can be traced back to the source. Additionally, sulphate concentration in the atmosphere during the last centuries can be interesting to study in order to understand anthropogenic impacts on the climate system. It is therefore of great interest to have a well-functioning sulphate detection technique for the continuous flow analysis (CFA) system, but also a technique suitable for field work.

We here present of a new continuous flow analysis system for sulphate based on Raman spectroscopy in development at the Centre for Ice and Climate in Copenhagen. The idea of using Raman spectroscopy is that the technique can be used directly on the melted ice stream in the system without further mixing with other chemicals opposed to how current techniques work. We will here present the ideas and results from the different stages of the development of the technique.

Abstract

Jean Jouzel

Submission ID	279
Name:	Jean Jouzel
Institution:	LSCE/IPSL, CEA-CNRS-UVSQ), CEA Saclay Orme des Merisiers, 91191 Gif-sur-Yvette
Country:	France
Presentation Title:	An improved North-South synchronization of ice core records around the 41 K beryllium 10 peak
Full Author List:	G.M. Raisbeck1, J. Jouzel2, F. Yiou 1, A. Cauquoin2, A. Landais2, J-R. Petit3, V.Y. Lipenkov4, J. Beer5, H-A. Synal6, H. Oerter7, S.J. Johnsen8#, J.P. Steffensen8, A. Svensson8
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ABSTRACT

We have previously shown how ^{10}Be records during the period of the Laschamp geomagnetic excursion (40.7 ka) can be used to correlate the GRIP and EDC ice cores with a resolution of ~200 years. This was mainly due to limitations of the GRIP record (sample resolution, missing samples, corrections for ^{10}Be loss on filters). Using higher resolution samples from the NGRIP core, and additional samples from the EDML and Vostok 5G cores, we propose here a correlation with an estimated precision of ~20 years. The results can be used to improve estimates of the difference between ice and enclosed gas of the same age (delta depth), difference between age of ice and enclosed gas at the same depth (delta age), ice accumulation rates in the EDC and EDML cores in and around AIM-10, as well as the phasing between Dansgaard/Oeschger -10 (in NGRIP) and AIM-10 (in EDML and EDC).

Abstract

Kaitlin Keegan

Submission ID	280
Name:	Kaitlin Keegan
Institution:	Center for Ice and Climate, University of Copenhagen
Country:	Denmark
Presentation Title:	Deformation of NEEM, Greenland Basal Folded Ice
Full Author List:	K. Keegan, D. Dahl-Jensen, M. Montagnat, I. Weikusat
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ABSTRACT

Deep Greenland ice cores and airborne radio echo sounding (RES) images have recently revealed that basal ice flow of the Greenland Ice Sheet is very unstable. In many locations, a basal layer of disturbed ice is observed. At the NEEM, Greenland site this folding occurs at the boundary between the Eemian and glacial ice regimes, indicating that differences in physical properties of the ice play a role in the disturbance. Past work in metallurgy and ice suggests that impurity content controls grain evolution and therefore deformation. We hypothesize that the differences in ice flow seen deep in the NEEM ice core are controlled by differences in the impurity content of the ice layers. Here we present results of fabric, grain size, impurity content, and deformation studies from samples above and below this unstable boundary in the ice sheet.

Abstract

James Andrew Menking

Submission ID	281
Name:	James Andrew Menking
Institution:	Oregon State University
Country:	USA
Presentation Title:	Stable isotopes of carbon dioxide during the last glacial inception
Full Author List:	J. A. Menking1, A. Buffen1, T.K. Bauska2, S. Shackleton3, E.J. Brook1, J.P. Severinghaus3, R.H. Rhodes4, M. Dyonisius5, V.V. Petrenko5
Author Affiliations:	1. Oregon State University, Corvallis, USA; 2. University of Cambridge, Cambridge, UK; 3. University of San Diego, San Diego, USA; 4. British Antarctic Survey, Cambridge, UK; 5. University of Rochester, Rochester, USA

ABSTRACT

Roughly half of the interglacial-glacial drop in atmospheric CO_2 occurred abruptly 70 ka ago during the marine isotope stage (MIS) 5/4 transition, suggesting a significant carbon cycle adjustment. The ~40 ppm drop in CO_2 is coincident with significant changes in dust flux and sea level, hinting at possible mechanisms. The stable isotopic ratio of CO_2 in the atmosphere traces carbon cycle processes because it is a function of various sources and sinks with unique isotopic imprints. We present high-resolution, high-precision measurements of the carbon-13/ carbon-12 of CO_2 preserved in a horizontal ice core at Taylor Glacier, McMurdo Dry Valleys spanning the abrupt CO_2 decrease at the last glacial inception. The record is used to infer changes in carbon cycle processes that occurred in association with global cooling and the expansion of ice sheets.

Abstract

Dr. Shuji Fujita

Submission ID	282
Name:	Dr. Shuji Fujita
Institution:	National Institute of Polar Research Research, Organization of Information and Systems
Country:	Japan
Presentation Title:	Glaciological conditions of the ice sheet at Dome Fuji, Dronning Maud Land, East Antarctica
Full Author List:	Shuji Fujita1,2, Kumiko Goto-Azuma1,2, Kenji Kawamura1,2 and Hideaki Motoyama1,2
Author Affiliations:	1, National Institute of Polar Research, Research Organization of Information and Systems, Tokyo, Japan 2, Department of Polar Science, The Graduate University for Advanced Studies (SOKENDAI), Tokyo, Japan

ABSTRACT

To better understand the glaciological environment in Dronning Maud Land (DML), East Antarctica, for the site survey of the ice coring, Japanese glaciologists have investigated wide area near Dome Fuji for more than 30 years. Accumulated various data are on the surface mass balance (SMB), depositional environments, firn properties, englacial conditions, subglacial conditions, bed topography, a lot of shallow (~100-m long) ice cores and two very deep ice cores . In this talk, we will present a summary of updated knowledge. In this area of East Antarctica, the large-scale distribution of the SMB depends on the surface elevation and continentality, and that the SMB differs between the windward and leeward sides of ice divides for strong-wind events. The SMB is highly influenced by interactions between the large-scale surface topography of ice divides and the wind field of strong-wind events that are often associated with high-precipitation events. Local variations in the SMB are governed by the local surface topography, which is influenced by the bedrock topography. As a result of high spatial variability of the depositional environment, we have found that textural properties of firn differ markedly from one location to another. In DML, approximately two-thirds of the investigated area using radar sounders was found to have a temperate bed. The beds of the inland part of the ice sheet tend to be temperate, with the exception of subglacial high mountains.

Abstract

Dr Robert Mulvaney

Submission ID	283
Name:	Dr Robert Mulvaney
Institution:	British Antarctic Survey
Country:	UK
Presentation Title:	The Fletcher Promontory ice core drilling project
Full Author List:	R Mulvaney 1 E Capron 1 R Duphil 2 L Fleet 1 R Hindmarsh 1 E Ludlow 1 J Triest 1,2
Author Affiliations:	1. British Antarctic Survey, Cambridge, UK 2. Laboratoire de Glaciologie et Géophysique de l'Environnement CNRS, Grenoble, France

ABSTRACT

Following on from the successful UK/France drilling projects recovering ice cores to bedrock from Berkner Island and James Ross Island in the Weddell Sea region of Antarctica, we attempted to drill to bedrock through ice over 650m thick on Fletcher Promontory in a single field season. A team of six driller/scientists plus one field support assistant set up camp and the drilling infrastructure in November 2011 at a site identified with a well-developed Raymond cupola evident in radar isochrones from an earlier radar survey. Modelling of the age/depth relationship through the Raymond cupola structure suggested ice close to the bed could potentially reach well back into the last glacial period. Drilling from a tent covered wooden platform on the surface we successfully drilled in a partially fluid-filled borehole to the bedrock at 654.3m depth in 37 days. Following drilling, the borehole was logged for temperature, then the fluid recovered from the borehole, and the entire drilling infrastructure removed from the site by early February 2012.

The scientific motivation for drilling a bedrock core from this site lay in the challenge of determining whether ice remained from the last interglacial period (LIG - around 125 kyears before present). There has been suggestions that the West Antarctic Ice Sheet (WAIS) might have collapsed or substantially retreated during the LIG, contributing to the observed 6 – 9m of sea-level rise. Should the WAIS have collapsed during the LIG then the small ice cap on Fletcher Promontory might have thinned or even disappeared.

Abstract

Jon S Edwards

Submission ID	285
Name:	Jon S Edwards
Institution:	Oregon State University, College of Earth Ocean and Atmospheric Sciences
Country:	United States
Presentation Title:	Millennial scale climate and total air content in the NEEM, GISP2 and WAIS Divide ice cores
Full Author List:	J.S. Edwards1, E.J. Brook1, C. Buizert1, J.E. Lee1, L.E. Mitchell2, J.M. Fegyveresi3,4, T. Sowers3, R.B. Alley3, J.P. Severinghaus5
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ABSTRACT

The analysis of ancient air bubbles trapped in ice is integral to the reconstruction of climate over the last 800 ka. While mixing ratios and the isotopic composition of greenhouse gases are being studied in ever increasing resolution, one aspect of the gas record that has received less attention is the total air content (TAC) of the trapped bubbles. Published records of TAC are too low in temporal resolution to adequately capture millennial scale variability. Here we present high-resolution TAC records covering the last glacial period from cores in both Greenland (NEEM and GISP2) and Antarctica (WAIS Divide), measured at Oregon State and Penn State Universities.

We observe that TAC records in Greenland have a distinct imprint of Dansgaard-Oeschger (D-O) events, with D-O warming corresponding to a decrease in total air content. A similar, but more subtle relationship between the stable isotope temperature proxy and TAC is observed in the WAIS Divide core. Changes in total air content from polar ice cores have been interpreted as primarily recording changes in mean atmospheric pressure arising from changes in ice-sheet elevation or atmospheric circulation; however we find that the millennial scale variability observed from cores in Greenland and Antarctica is much too large to be explained by changes in elevation or atmospheric pressure. We instead argue that physical processes relating to the closure of air bubbles in the firn are the primary control on TAC on these time scales.

Abstract

Dr Robert Mulvaney

Submission ID	286
Name:	Dr Robert Mulvaney
Institution:	British Antarctic Survey
Country:	UK
Presentation Title:	Sixty years of climate and accumulation in the Pine Island glacial basin
Full Author List:	R. Mulvaney 1 R. Tuckwell 1 E. Ludlow 1 H. Northrop 1 R. Rhodes 1 J. Rix 1
Author Affiliations:	1 British Antarctic Survey, Cambridge, UK

ABSTRACT

Prior to satellite observation, little was known about the rates at which ice sheets would respond to climate change. During the past two decades measurements from successive Earth-orbiting satellites have provided valuable insight about the behaviour of Antarctica's large ice sheets. The surface topography of the glaciers draining the West Antarctic Ice Sheet towards the Amundsen Sea have suggested substantial thinning and mass loss over recent decades, with the implication that this might be a response to a warming climate, and warming oceans.

The UK Natural Environment Research Council has carried out linked ocean and ice sheet research into the dynamics of the Pine Island glacial basin under its iSTAR (Ice Sheet Stability) programme. On the glacier itself, two oversnow traverses in 2013/14 and 2014/15 recovered radar, seismic, strain, GPS and near-surface ice density data, and collected a series of ice cores.

Whilst satellite observations, using a range of technologies, allow us to estimate how much ice is being lost to the ocean, they cannot distinguish changes in ice density from changes in mass; or distinguish changes due to mass ice loss from changes due to the motion of the underlying solid Earth; or separate changes in surface elevation due to trends in snow accumulation rate.

From ten 50m ice cores recovered from the second traverse of the Pine Island Glacier, we are able to derive the snow accumulation history of the past 60 years, as well as the changes in the local climate.

Abstract

Dr. Fabrice Lambert

Submission ID	287
Name:	Dr. Fabrice Lambert
Institution:	Catholic University of Chile
Country:	Chile
Presentation Title:	Ice Core Science in Chile
Full Author List:	F. Lambert1,2, F. Fernandoy3, G. Casassa4, M. Leppe5
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ABSTRACT

Chile is a new member of IPICS and this presentation aims to give a brief overview of the ice-core science currently being conducted in Chile, the available infrastructure, and the analytical capabilities in Chilean institutions.

Most of the Andean cryosphere is located within Chile's country borders. However, a large number of these glaciers have been retreating since the industrial revolution. Several studies are currently being conducted to investigate the major source regions of moisture and contamination (e.g. black carbon) that may impact on glacier mass balance.

The proximity of the Chilean mainland to the West Antarctic Peninsula makes Chile (and the Chilean O'Higgins research station) an ideal base from were to conduct investigations. Current research involves water isotope measurements along the West Antarctic ice sheet to investigate moisture source areas in this critical region.

Recently, the GAIA Antarctic Research Center has been approved to be constructed in Punta Arenas. This new center will host a cold storage room and a wide array of ice-coring and analytical instruments. It will act as a logistic and analytical center for local and foreign scientists during high-latitude expeditions.

Abstract

Prof. Eric J Steig

Submission ID	289
Name:	Prof. Eric J Steig
Institution:	University of Washington
Country:	USA
Presentation Title:	The water isotope record from the West Antarctic Ice Sheet Divide ice core: implications for Antarctic temperature variability on interannual to orbital timescales
Full Author List:	E. J. Steig1, JW.C. White2, T.R. Jones3, S.W. Schoenemann1, B.R. Markle1, V. Gkinis3, E,C. Kahle1, T.J. Fudge1, C. Buizert4, K.M. Cuffey5 B.H. Vaughn2, A.J. Schauer1
Author Affiliations:	University of Washington, Seattle, USA University of Colorado, Boulder, USA University of Copenhagen, Copenhagen, Denmark Oregon State University, Corvallis, USA University of California, Berkeley, USA

ABSTRACT

We present the 68000-year long stable isotope records from the West Antarctic Ice Sheet (WAIS) Divide ice core: both discrete triple-isotope-ratio measurements (including $\delta^{17}O$) and continuous $\delta^{18}O$ and δD. We use the isotope records in combination with borehole thermometry, annual-layer counting, and firn densification modeling, to reconstruct Antarctic temperature variability with unprecedented resolution and accuracy. Borehole temperatures inversions constrained by the $\delta^{18}O$ profile indicate a glacial-interglacial temperature change of ~14°C, larger than inferred from other Antarctic records. Independently, the temperature-dependence of supersaturation, which largely determines the ^{17}O-excess variability, also requires a large glacial-interglacial temperature change. While greater deglacial temperature change in West Antarctica than East Antarctica is a common feature of general circulation model simulations, this is largely owing to the large (and probably unrealistic) West Antarctic elevation changes used as last-glacial-maximum boundary conditions. Calculations of the differential isotope diffusion length from the very-high-resolution $\delta^{18}O$ and δD records are consistent with the borehole temperature data, but also indicate greater magnitude millennial-scale variability. Comparison of the temperature and annual-layer thickness histories show that the snow accumulation/temperature scaling on century-to-millennial timescales is more complex than expected from simple thermodynamic arguments. Finally, our results confirm the rapid late 20th century warming in West Antarctica first identified by Steig et al. (2009). Taken together, our results suggest that general circulation models -- as currently implemented -- tend to underestimate the magnitude of high-latitude temperature variability across a range of timescales, as well as underestimating the sensitivity of snow accumulation rates to temperature change.

Abstract

Dr Jérôme Chappelaz

Submission ID	290
Name:	Dr Jérôme Chappelaz
Institution:	CNRS Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE
Country:	France
Presentation Title:	Initiating an ice core heritage repository from non polar glaciers for future generations of ice core scientists
Full Author List:	J. Chappellaz (1), C. Barbante (2), P. Ginot (1,3), J. Gabrieli (2), A.C. Ohlmann (4)
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ABSTRACT

Due to global warming, many glaciers throughout the World are in danger of disappearing during the coming decades. For those which are not temperate yet and which could be already used to recover ice cores for geochemical investigations, there is an increasing risk that they soon experience systematic summer melting followed by percolation of the meltwater through depth. Once this process starts, the glaciers become unsuited for proper records of climate/environmental reconstructions.

Joining the efforts of two nations as a start, but with the aim of involving several other nations on the mid and long terms, we intend to launch an ambitious international project to tackle this major problem. The aim of the project is to handle new drilling operations down to bedrock, with a main focus on glaciers that have already proved their potential for ice core science applications. For this starting initiative involving French and Italian glaciologists, we target three sites in the French Alps (including the col du Dome and the Frand Combin) and one site in Bolivia (Illimani). One of the cores core will be used for measuring various signals which can help to determine for instance the depth/age relationship, and other critical information for future users of the cores. Two other cores would be kept untouched for decades to centuries, becoming part of an ice core heritage repository without any individual/laboratory/national property.

Our aim is to build the international repository in the East Antarctic plateau, the safest (and natural) freezer in the World. The target is Concordia Station, jointly run by France and Italy, and as such the only international station on the plateau. The cores will be kept in a cave below the snow surface at temperature around -50°C, in anticipation of the needs of future generations of ice core scientists. The cave will be big enough to receive several ice cores

drilled by different international teams. The long-term management of this unique repository will be handled under the IPICS umbrella and further support from UNESCO which has already labeled the initiative.

Abstract

Emma C. Kahle

Submission ID	291
Name:	Emma C. Kahle
Institution:	University of Washington
Country:	USA
Presentation Title:	The South Pole High-Resolution Water Isotope Record
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ABSTRACT

We present water-isotope data from the upper ~550-meters of a new ice core at South Pole (SPICEcore), corresponding to an age of about 7100 years before present. SPICEcore will ultimately reach the IPICS 40,000 year target at 1500 m depth. Water isotope-ratio measurements in SPICEcore are a collaborative project between the University of Washington and University of Colorado. We use a continuous flow analysis system, originally built for the WAIS Divide ice core, to obtain continuous high-resolution analyses of δ18O and δD. The system has been updated to include longer standard runs, better filter protocol, improved depth registration, and measures of long-term system performance. The core was sampled at that U.S. National Ice Core Lab in summer 2015, using minimal ice volume (1.3 x 1.3 cm cross section). One-meter-long ice sticks are introduced to the melt system continuously, using a carousel with the cores mounted in acrylic tubes. Isotopic measurements are performed with a Picarro L2130-i CRDS instrument. Using the data generated thus far, we assess the amount of diffusion at varying depths in the ice core using a number of different methods. As expected, the diffusion length increases through the upper 50 meters and then decreases due to compression of the firn. The character of the spectrum is consistent from meter to meter, and deuterium excess has low variance, attesting to the high quality of the data. Complementing the high-resolution measurements, low-resolution (discrete) measurements of δ18O, δ17O and 17Oexcess are being made, using an automated fluorination system and a Picarro L2140-i.

Abstract

Michael Dyonisius

Submission ID	293
Name:	Michael Dyonisius
Institution:	University of Rochester
Country:	USA
Presentation Title:	Constraining the sources of the CH4 increase during the Oldest Dryas-Bølling abrupt warming event using 14CH4 measurements from Taylor Glacier, Antarctica
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ABSTRACT

Methane (CH4) is an important greenhouse gas with both natural and anthropogenic sources. Understanding how the natural CH4 budget has changed in response to changing climate in the past can provide insights on the sensitivity of the natural CH4 emissions to the current anthropogenic warming. Low latitude wetlands are the largest natural source of CH¬4 to the atmosphere. It has been proposed, however, that in the future warming world emissions from marine CH4 clathrates and Arctic permafrost might increase significantly. CH4 isotopes from ice cores in Greenland and Antarctica have been used to constrain the past CH¬4 budget. 14CH4 is unique in its ability to unambiguously distinguish between “old” CH4 sources (e.g. marine clathrate, geologic sources, old permafrost) and “modern” CH4 sources (e.g. tropical and boreal wetlands). We have successfully collected six large volume (~1000 kg) samples of ancient ice from Taylor Glacier, Antarctica that span the Oldest Dryas – Bølling (OD-BO) CH4 transition (~14.5ka). The OD-BO is the first large abrupt CH4 increase following the Last Glacial Maximum, with atmospheric CH4 increasing by ≈30% in the span of ≈ 200 years. All samples have recently been successfully measured for 14CH4, δ13C-CH4, and δD-CH4. 14CH4 measurements of accompanying procedural blanks show that effects from extraneous carbon addition during processing are small. Results are currently undergoing corrections for in-situ cosmogenic 14C based on 14CO measurements in the same samples. We will present the corrected 14CH4 results and preliminary interpretation with regard to causes of the OD-BO CH4 increase.

Abstract

Jung-Ho Kang

Submission ID	295
Name:	Jung-Ho Kang
Institution:	KOPRI
Country:	South Korea
Presentation Title:	Record high levoglucosan concentrations in the Geenland snow due to long-range transport after biomass burning
Full Author List:	Jung-Ho Kang1, Heejin Hwang1, Sangbum Hong1, Soon Do Hur1, Gum-Yong Kang2, and Je-Hyun Baek2
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ABSTRACT

Biomass burning casused by wildfires, is a major source of greenhouse gases and aerosols, which can influence regional to global climate change. We use the biomarker levoglucosan (1,6-anhydro-β-D-glucopyranose) as a source-specific proxy of past fire activity in snowpits. The snowpit samples are performed by using liquid chromatography/negative ion electrospray ionization-tandem mass spectrometry (SCIEX QTRAP 5500) with the isotope-dilution and multiple reaction monitoring method. We analyse the snow samples collected from a 3.2-m depth snowpit at NEEM (North Greenland Eemian Ice Drilling), Greenland (77°26´N, 51°03´W, 2461 m a.s.l.). The snow levoglucosan profile shows the high record at the depth of 240 – 250 cm corresponding to fall 2004. The oxalate and ammonium concentration are also exhibited in the same layer of the snowpit. The levoglucosan deposited at NEEM was strongly influenced by long-range atmospheric transport. The back trajectory analysis suggest that major contributor was air mass from North America. The profile of levoglucosan can help determine the past biomass burning contribution in the Greenland snowpits and ice cores.

Abstract

Luke D. Trusel

Submission ID	297
Name:	Luke D. Trusel
Institution:	Woods Hole Oceanographic Institution
Country:	United States
Presentation Title:	Variability and rise in west Greenland surface melting over the last several decades
Full Author List:	L. D. Trusel1, S. B. Das1, M. B. Osman1, M. J. Evans2, A. V. York3, K E. Frey3, B. Noël4, M. R. van den Broeke4
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ABSTRACT

Expanding and intensifying surface melting across Greenland in recent decades has accelerated sea level contributions from the ice sheet. Prior to the modern satellite (1978-) and reanalysis (1958-) eras, few records of melt variability exist. This observational paucity limits the understanding of climatic processes driving melt and the degree of anomaly of recent melt increases. To better characterize recent melt evolution, we integrate analyses of refrozen melt layers from multiple well-dated west Greenland firn and ice cores with microwave satellite-detected and modeled melt from the regional climate-snowpack model RACMO2.3. Cores collected in 2014-2015 from 1300 to 2600m elevation span the melt spectrum, and at all but the lowest elevation site, we identify discrete melt events recording interannual melt intensity variability. To discern the potential broader spatial representation of each site, we examine spatial correlations between the ice core melt records and our satellite and modeled melt datasets. We find high correlation lengths exist for cores within the Greenland ice sheet percolation zone, indicating these cores broadly represent ice sheet surface melt variability. In contrast, our ice core collected from an ice cap on Nuussuaq Peninsula correlates most strongly with melt variability in the southwest Greenland ablation zone. We interpret this as indicative of more localized, maritime influences on melt variability at this site and along the southwestern Greenland margin. Owing to strong correlations with ablation zone melt variability, the Nuussuaq Peninsula ice core may therefore provide unique inference into past melt variability where few similar melt records are preserved today.

Abstract

Benjamin Hmiel

Submission ID	299
Name:	Benjamin Hmiel
Institution:	University of Rochester
Country:	United States
Presentation Title:	Understanding the production and retention of in situ cosmogenic 14C in polar firn
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ABSTRACT

Radiocarbon in CO_2, CO and CH4 trapped in polar ice is of interest for dating of ice cores, studies of past solar activity and cosmic ray flux, as well as studies of the paleoatmospheric CH4 budget. The major difficulty with interpreting 14C measurements in ice cores stems from the fact that the measured 14C represents a combination of trapped paleoatmospheric 14C and 14C that is produced within the firn and ice lattice by secondary cosmic ray particles. This in situ cosmogenic 14C component in ice is at present poorly understood. Prior ice core 14C studies show conflicting results with regard to the retention of cosmogenic 14C in polar firn and partitioning of this 14C among CO_2, CO and CH4. Our new study aims to comprehensively characterize the 14C of CO_2, CO, and CH4 in both the air and the ice matrix throughout the firn column at Summit, Greenland. We will present measurements of 14C in Summit firn air (the first phase of this study) and discuss the implications for in situ cosmogenic 14C production and retention from initial modeling studies. Preliminary results from firn air indicate a 14CO increase with depth in the lock-in zone resulting from in situ production by muons, as well as a lock-in zone $14CO_2$ bomb peak originating from nuclear testing in the late 1950s and early 1960s. A decrease in 14CH4 with depth is observed in the lock-in zone that is in agreement with observations of increasing atmospheric 14CH4 over the past several decades.

Abstract

Dr. Sarah B Das

Submission ID	300
Name:	Dr. Sarah B Das
Institution:	Woods Hole Oceanographic Institution
Country:	USA
Presentation Title:	New coastal West Greenland ice core records from Disko Island, Nuussuaq Peninsula, and the western Greenland ice sheet
Full Author List:	S. B. Das1, M. J. Evans2, K. E. Frey3, M. B. Osman4, B. E. Smith5, L. D. Trusel1, A. York3
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ABSTRACT

Climate in West Greenland is changing rapidly as characterized by atmospheric warming, decreasing sea ice, and shifting ocean circulation. These conditions are in turn having a dramatic effect on local ice cap and ice sheet mass balance, including rapid outlet glacier retreat and speedup, and increased rates of surface melting. The short satellite and instrumental period, however, restricts our ability to characterize the ice response to climate variability, as well as understand coupled ocean-ice dynamical relationships, over time periods longer than recent decades. This motivated our current study to identify new ice core sites within this climatically sensitive region to provide unique high-resolution records of past coastal Greenland climate, sea surface variability and adjacent ice sheet variability. Over two field seasons in 2014 and 2015 we collected and analyzed snow pit samples (1-2 m), shallow hand-augured firn cores (5-10 m), and intermediate depth cores (up to 140 m) from multiple high altitude maritime ice caps (1300-2000 m a.s.l.) on Disko Island and the Nuussuaq Peninsula (10-30 km from the coast), as well as complementary sites in the western Greenland ice sheet accumulation zone (between 2400-2600 m). Airborne and ground-based geophysical observations provided additional constraints on ice thickness, internal layering, ice flow and temperature, and to guide site selection. Here we will present highlights of our most recent findings from this ongoing study.

Abstract

Malte Nordmann Winther

Submission ID	301
Name:	Malte Nordmann Winther
Institution:	Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen
Country:	Denmark
Presentation Title:	Measurements of N2O isotopomers during the Holocene from the NEEM ice core
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Author Affiliations:	[Centre for Ice and climate, Niels Bohr Institute, University of Copenhagen], [Copenhagen], [Denmark] [Institute for Marine and Atmospheric Research Utrecht, Utrecht University], [Utrecht], [The Netherlands]

ABSTRACT

Nitrous oxide N2O is an important greenhouse gas which have increased strongly in concentration since the 1750's. N2O is primarily produced from bacterial nitrification and denitrification in the terrestrial and oceanic realm. Determination of the position of the 15N isotope in the N2O isotopomers, has been shown to be a tool to distinguish the source of the specific N2O molecule via the site preference. Previously measured ice core records of the Dansgaard-Oeschger events, has in some cases shown an increasing concentrations of N2O before the offset of CH4 and δ18O. The discovery of this earlier increase in N2O is the reason for an increasing interest in determination of the site preference of N2O. The reason for these increasing trends are investigated by looking at the site preference of the N2O isotopomers measured from ice cores. The site preference of N2O will help getting a better understanding of the DO-events by determining the site preference. To get a first impression of the stability of the site preference of N2O in the ice cores we present the first measurements of the N2O isotopomer measurements from the NEEM ice core. We have performed measurements of three sections of the NEEM ice core namely the Early- Mid- and Late Holocene. The measurements has been performed using IRMS measurements of δ15N (N2O), δ18O (N2O) and the δ15N (NO+ fragment). Having these three d-values we have calculated the isotopomers of N2O and found the site preference to be stable within the measured sections of the Holocene.

Abstract

Mr Jack Triest

Submission ID	302
Name:	Mr Jack Triest
Institution:	LGGE / CNRS
Country:	France
Presentation Title:	Design of the continuous in-situ sampling system for the SUBGLACIOR probe
Full Author List:	J.Triest1 O.Alemany1 J.Chappellaz1 The SUBGLACIOR team2,3,4
Author Affiliations:	CNRS LGGE, St Martin d'Heres, France CNRS LIPhy, St Martin d'Heres, France DT-INSU, Plouzane, France LSCE, Gif sur Yvette, France

ABSTRACT

In response to the 'oldest ice' challenge, initiated by the International Partnerships in Ice Core Sciences (IPICS), the ICE&LASERS / SUBGLACIOR projects are contributing to ice core research with the design and construction of a drill system capable of continuous in-situ measurements. The SUBGLACIOR probe is designed to drill down the ice sheet in one run and measure, in real time, profiles of the isotopic composition of the melt-water and methane concentration of the trapped gas, using embedded laser technology.

The probe, with a length of 10 m and a diameter of 106 mm, will electromechanically drill down, to a maximum depth of 3500 m, and sample continuously using a forward pointing melt-probe. Key challenges in the design are the melt-probe, the handling of the water- and gas-sample flows and the optimal recovery of the water vapour and gasses for analysis by an integrated OFCEAS spectrometer. We present the technological solutions for each of these elements, which have to work in an extreme environment, within a limited space and with minimal power and control while providing accurate measurements for correct data interpretation.

The technology will allow to obtain sufficient information to confirm the age and stratigraphic order of the deepest ice within one austral season. The system is scheduled for initial testing at Dome Concordia, Antarctica in 2016.

Abstract

Dr Eliza Cook

Submission ID	303
Name:	Dr Eliza Cook
Institution:	Centre for Ice and Climate, Niels Bohr Institute
Country:	Denmark
Presentation Title:	An initial tephrochronology of the Renland ice core
Full Author List:	Cook, E
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ABSTRACT

An initial tephrochronological framework from the last 3000 years will be presented for a new ice core, drilled in 2015 from the coastal Renland ice sheet, East Greenland. The core was retrieved as part of the ERC Ice2Ice project in which tephrochronology will form key role in synchronising Greenland ice core records with North Atlantic and Arctic marine climate records. The aim of the project is to understand how and why sea ice changed during specific intervals and how the associated changes in climatic conditions forced the Greenland Ice Sheet to respond.

Tephra is an excellent chronological tool and acts as a marker horizon in archives owing to its very rapid deposition, low residence time in the atmosphere (weeks, rather than months) and deposition over wide geographical areas, creating an isochronous surface between distal locations from which climate proxy records can be compared and synchronicity assessed. Glass shards are representative of the bulk geochemistry of magma and each volcanic centre has a specific geochemical signature that is traceable to a geographical region.

The identification of visible and invisible (cryptotephra) ash deposits in Renland is based on a high resolution (11 cm), continuous sampling approach for the last 3000 years, specifically incorporated into the ice cutting stage to improve method efficiency. When complete, this approach will record all tephra deposits present within the ice and will lead to the construction of a complete tephrochronology framework of explosive eruptions. From this, an attempt will be made to identify common tephras in marine cores retrieved from the East Greenland margin in 2015 and synchronise records to Greenland.

Abstract

Dr Steven J Phipps

Submission ID	305
Name:	Dr Steven J Phipps
Institution:	Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia
Country:	Australia
Presentation Title:	Solar and volcanic forcing of the Southern Hemisphere climate over the past 2000 years
Full Author List:	S. J. Phipps1, M. A Curran2,3, J. L. Roberts2, 3, C. T. Plummer1,3
Author Affiliations:	Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia Australian Antarctic Division, Kingston, Tasmania, Australia Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Australia

ABSTRACT

The past 2000 years provides a valuable opportunity to study the role of external forcings in driving the global climate. Significant changes have taken place within the climate system over this period, and proxy data that records these changes covers a wide geographical area and has high temporal resolution. Natural and anthropogenic forcings are also reasonably well constrained. While previous detection and attribution studies have found a significant role of volcanic eruptions in driving the pre-industrial Northern Hemisphere climate, the drivers of the Southern Hemisphere climate are much less well understood. Here, we use a climate system model to simulate the evolution of the global climate over the past 2000 years. Different combinations of natural and anthropogenic forcings are applied, including changes in the Earth's orbital parameters, solar irradiance, volcanic emissions and anthropogenic greenhouse gases. The simulations are then compared with reconstructions of Southern Hemisphere temperature. We find strong solar and volcanic influences on the Southern Hemisphere climate during the pre-industrial period, with the anthropogenic signal becoming increasingly dominant after 1850 CE. However, the results are sensitive to the specific reconstructions of solar and volcanic activity that are used to drive the model. The choice of volcanic reconstruction is particularly critical, and we find that the dating of major eruptions can impact significantly upon the agreement between the model and the proxy record. If we are to learn all that we can from the climate of recent millennia, a critical challenge is therefore to develop better reconstructions of past climatic forcings - particularly volcanic eruptions.

Abstract

Yeongcheol Han

Submission ID	306
Name:	Yeongcheol Han
Institution:	Korea Polar Research Institute
Country:	Korea
Presentation Title:	Detection of seasonal variations in 17O-excess from Antarctic snowpack using cavity ring-down spectroscopy
Full Author List:	Y. Han1, J.-Y. Ham1,2, S. Kim1,2, J. Lee2, H. Kwak1,3, J.-H. Kang1, S.D. Hur1
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ABSTRACT

The relationship between temporal records of water isotope composition preserved in Antarctic snowpack and meteorological parameters has been an important issue. In addition to the conventional applications of δ18O, δD and deuterium excess (DE = δD - 8·δ18O), 17O-excess (17Oxs = ln(δ17O+1) - 0.528·ln(δ18O+1)) has been recently introduced for better understanding the life of water vapor from the production at the sea surface to the deposition on the Antarctic snowpack. Although 17Oxs in Antarctic snow is very low at a level of 10-6 – 10-4, recent development of the laser-based technique is shown to provide sufficient precision for observing its temporal changes. We applied wavelength-scanned cavity ring-down spectroscopy (WS-CRDS; L2140-i, Picarro) to GISP and an in-house working standard and determined 17Oxs calibrated to the VSMOW-SLAP scale. External reproducibility better than 10 per meg (1σ) were achieved for both solutions. Using this value, an optimal strategy for detecting the seasonality of 17Oxs was investigated and, as an example, applied to a 3-m snow pit excavated at GV7 in northern Victoria Land, Antarctica.

Abstract

Heidi A. Roop

Submission ID	307
Name:	Heidi A. Roop
Institution:	GNS Science
Country:	United States
Presentation Title:	Reconstructing 1,350 years of mid-to-high latitude atmospheric circulation using varved sediments and ice cores
Full Author List:	H.A. Roop1,2, R. Levy1, G.B. Dunbar2[2], M.J. Vandergoes,1, A. Lorrey3, J. Howarth1
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ABSTRACT

Here we present a 1,350-year record of regional circulation derived from an annually laminated sediment record from Lake Ohau, South Island, New Zealand (44.23°S, 169.85°E). Utilizing the annually resolved Lake Ohau hydroclimate record, we generate a circulation index for the Western South Island of New Zealand. This index uses temperature and precipitation anomalies defined by the Regional Climate Regime Classification scheme (Kidson, 2000) to assign synoptic scale circulation patterns to 25-year intervals from 900-2000 AD. This mid-latitude circulation record, when compared to ice core records from Antarctica, and high-resolution records from the Tropics, provides a unique perspective on Southern Hemisphere circulation over the last 1,350 years. The Lake Ohau circulation index shows significant periods of change, most notably 835 – 985 AD when northerly airflow dominated and from 1385 – 1710 AD when strong southerly airflow persisted. Comparisons with regional Southern Annular Mode (SAM) reconstructions show that dry, warm conditions at Lake Ohau are consistently associated with strengthened tropical teleconnections to New Zealand and a positive SAM, while cold and wet conditions are driven by increased southerly airflow and negative phase SAM. A persistent negative SAM dominates the Little Ice Age (LIA; ~1385-1710 AD) interval in the Western South Island. Similar comparisons through the development of additional circulation indices across the Southern Hemisphere mid- and high-latitudes offer a unique opportunity to better constrain hemispheric-scale changes that currently remain poorly resolved.

Abstract

Anna Wegner

Submission ID	309
Name:	Anna Wegner
Institution:	Alfred Wegener Institute
Country:	Germany
Presentation Title:	Five centuries of trace element deposition at the top of the Himalaya: natural background vs. anthropogenic pollution
Full Author List:	Anna Wegner1,3, Roxana Sierra1, Paolo Gabrielli 1,2, Emilie Beaudon1, Joel D. Barker1, Lonnie G. Thompson1,2
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ABSTRACT

South East Asia is one of the fastest developing regions on Earth and has experienced a recent large increase in atmospheric pollution. Glaciers of the nearby Himalayan mountains represent a unique archive that provides the potential to be used to determine the strength and timing of the onset of anthropogenic atmospheric pollution in the region.