National Institute of Information and Communications Technology

NICT Research and Operation for Space Weather

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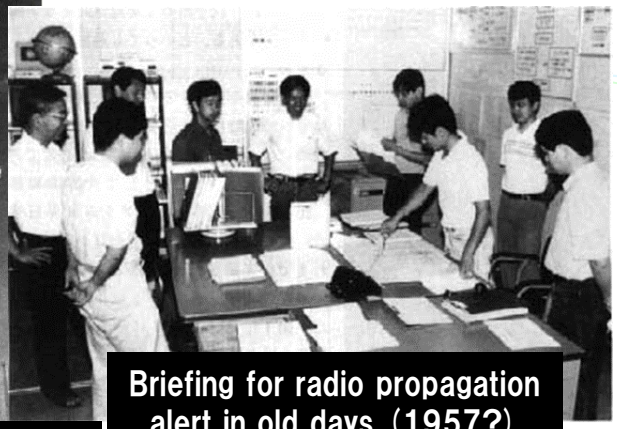
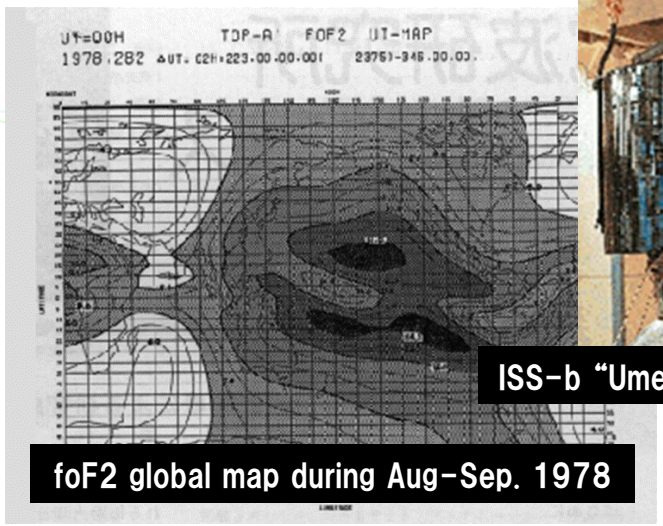
National Institute of Information and Communications Technology, Japan

NICT Space Weather Services

Solar radio spectrum antenna (70-500MHz)



Briefing for radio propagation alert in old days (1957?)



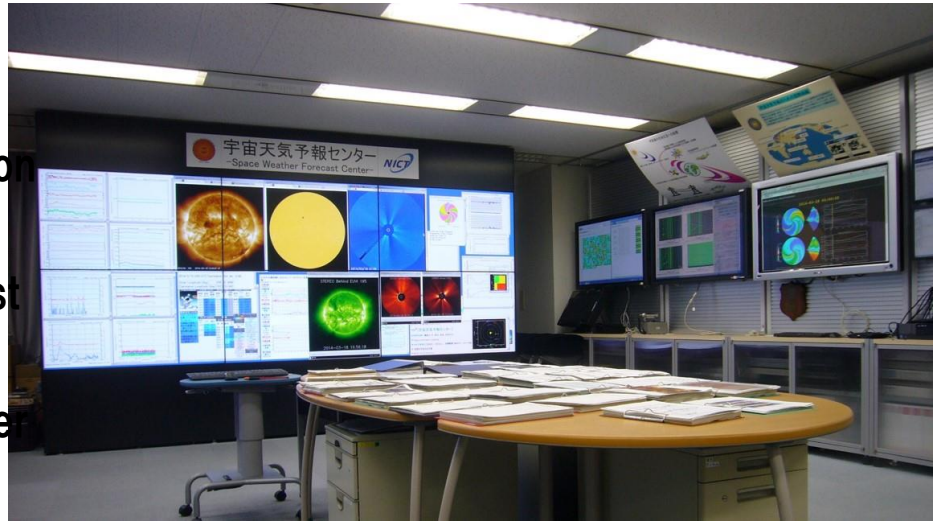
foF2 global map during Aug-Sep. 1978

ISS-b "Ume-2" satellite

Since 1952, NICT have operationally measured solar radio spectrum, and started operational alert service for radio propagation since 1957.

In 1978, NICT provided foF2 global map first in the world using satellite observation.

Now, NICT has been providing Space Weather forecast information including weekend, and plan to operate 24/7 since 2019.

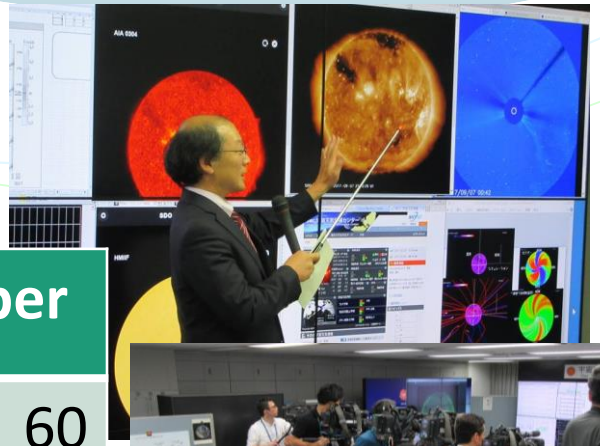


The present NICT Space Weather Center

The Solar Flare on Sep. 6, 2017

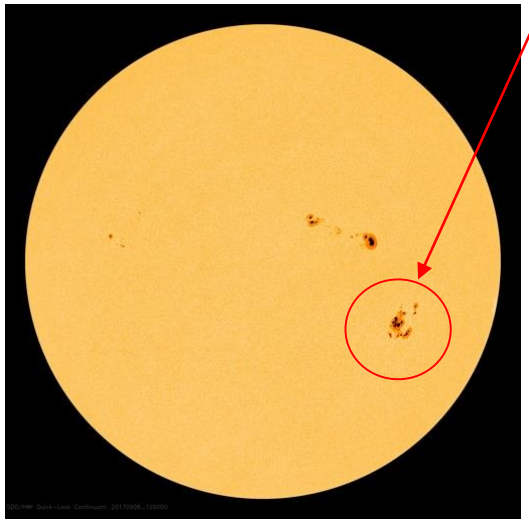
Detail of the event

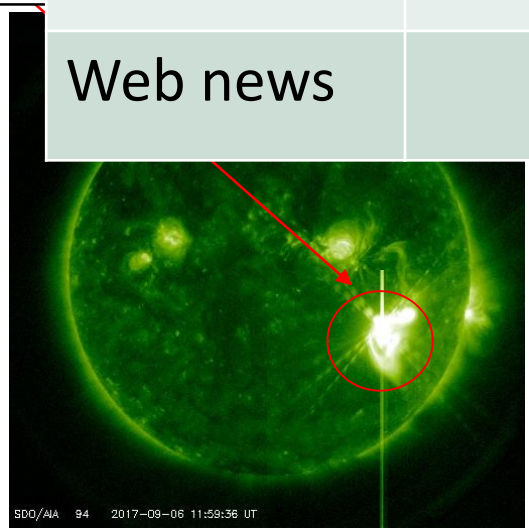
- A large scale solar flare (X9.3) was observed on 20:53JST Sep. 6, 2017, which has been 11 years since similar size event occurred.
- Coronal gas ejected simultane
would be forecasted to arrive
- The impact on GNSS, HF-cor
grid from geomagnetic and io
observed.



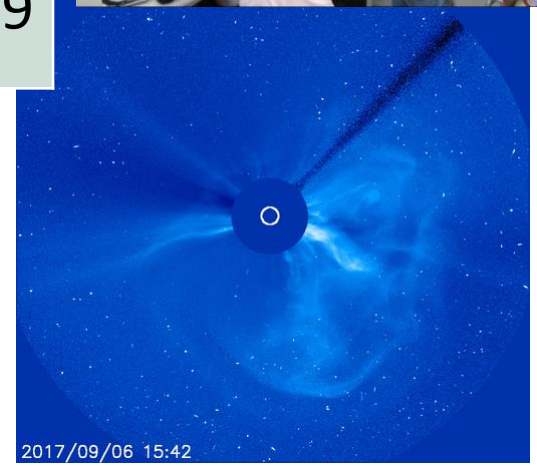
Media	Number
TV	60
Newspaper	271
Web news	779

Sun spot No.





Solar images observed by SDO satellite(Left:visible, Right:UV)



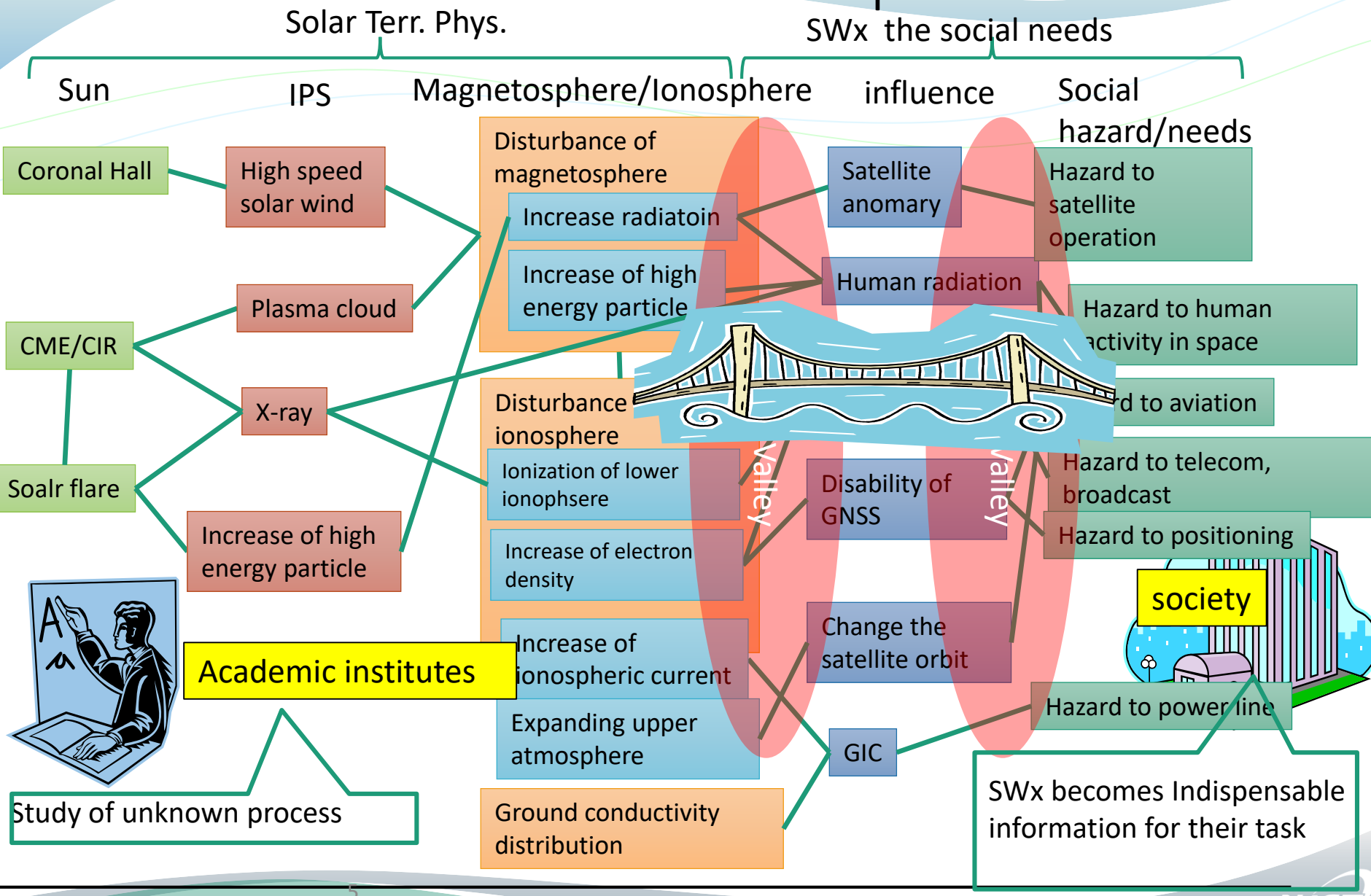
Colonal gas observed by SOHO satellite

After the Event on Sep. 6,, 2017

- A large scale solar flare (X9.3) was
  20:53JST Sep. 6, 2017, which has
  since similar size event occurred.
- Cabinet Office starts the discussic
  part of SSA in Aerospace Basic Ac
- NICT received additional budget f
  robust system of SWx services. NICT head ter
  locates in Koganei, Tokyo. It has been prepa ng a
  back up Center for SWx services at Future ICT Center,
  Kobe city.
- The Japanese law called wireless radio act was amended for including space weather as categories of expense.
- NICT succeeded to receive a continuous budget for operational SWx services including 24/7 human operation. The service will start on Dec. 2019.

NICT Koganei Campus

Relation of Needs-Seeds in Space Weather

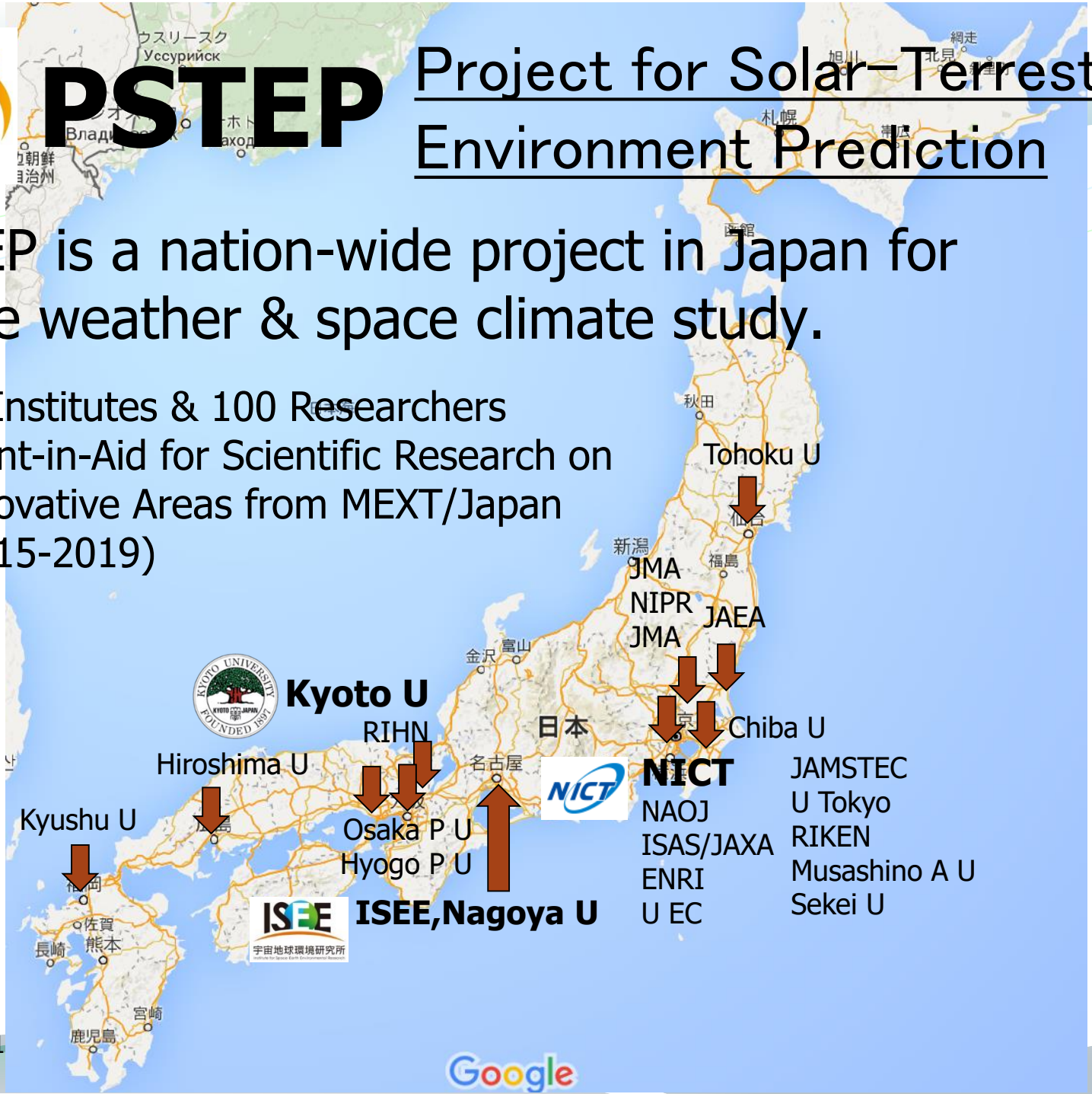


PSTEP

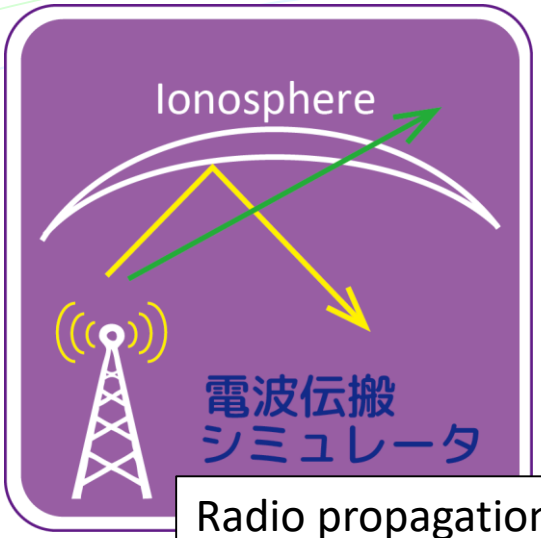
Project for Solar-Terrestrial Environment Prediction

PSTEP is a nation-wide project in Japan for space weather & space climate study.

- 20 Institutes & 100 Researchers
- Grant-in-Aid for Scientific Research on Innovative Areas from MEXT/Japan (2015-2019)



Product to be created

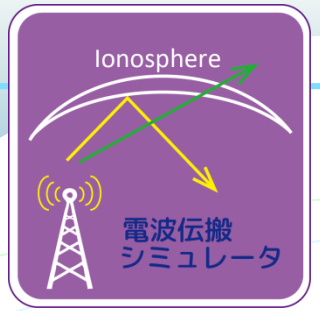


Radio propagation simulator

Human radiation estimation system

GIC hazardous warning system

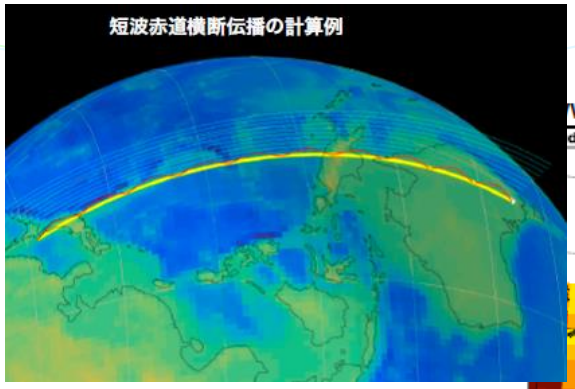
“Taylor-made Space weather” satellite Warning system



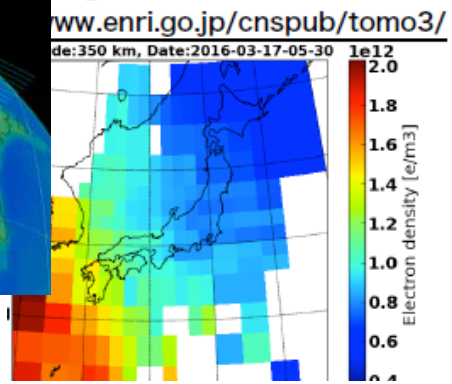
Developing Radio Propagation model

Radio propagation model is necessary to notice the usability of HF, VHF and GNSS at a particular point. We develop a new 3D radio propagation model “HF-START”

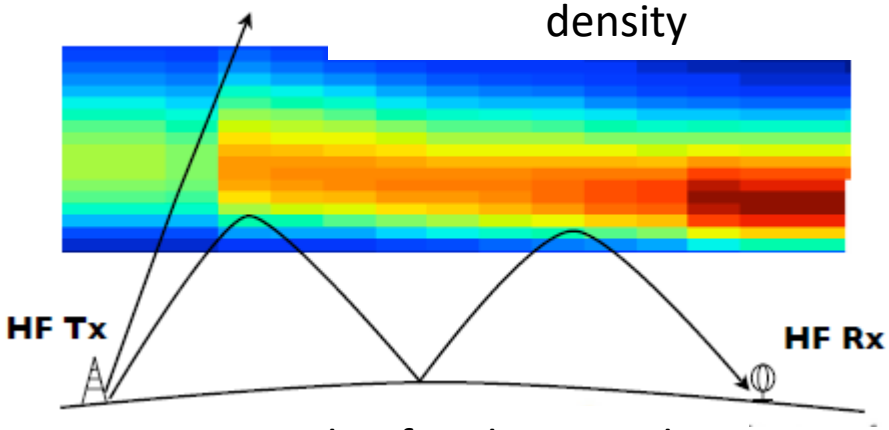
- The fundamental structure of radio propagation parameter for HF has completed. Validations of the model comparing with observational results are to be executed.
- The model for GNSS is planed to be build cooperated with CNES, France.
- Real time radio propagation model is to be possible by connecting the 3D tomography technique build by Kyoto Univ.



3D radio propagation simulator



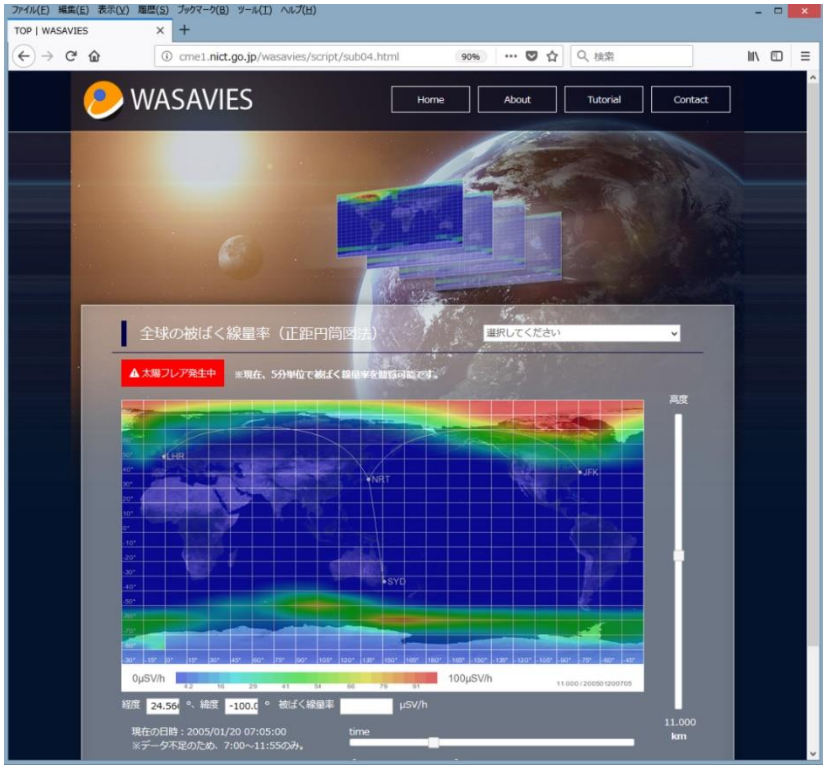
3D distribution of ionospheric electron density



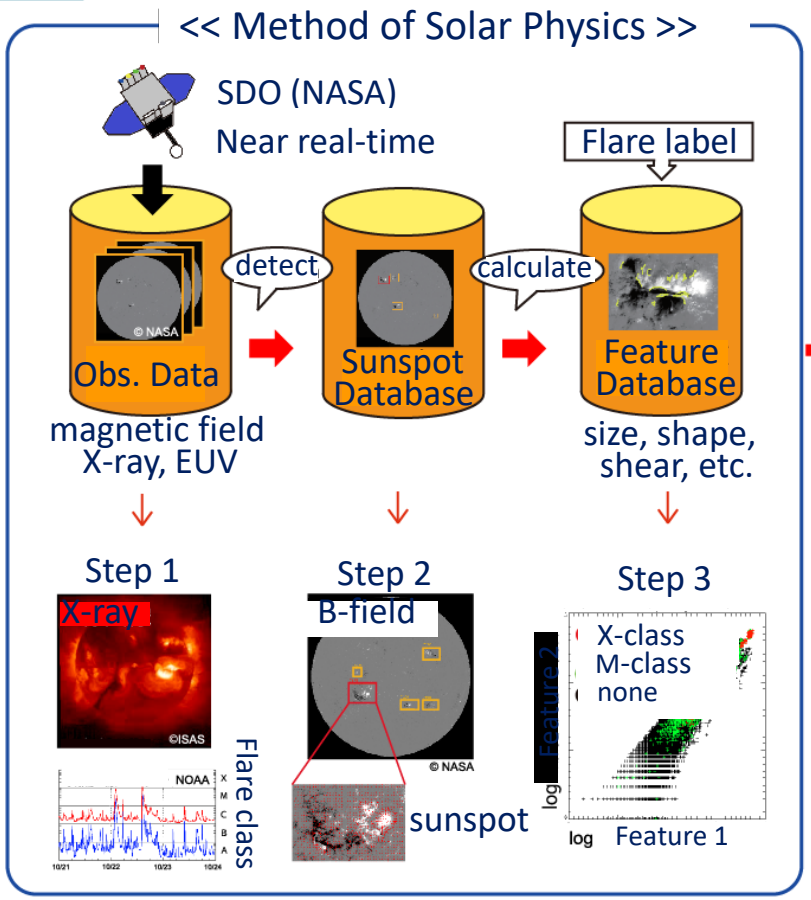
Example of real time radio propagation model

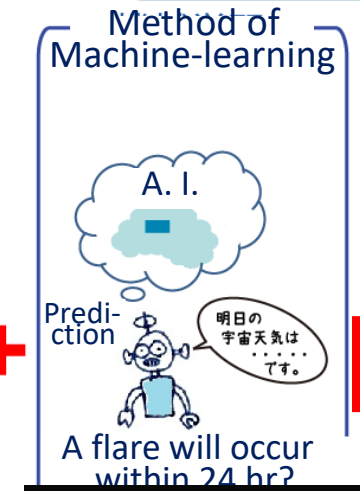
Purpose of Estimation system of human exposure

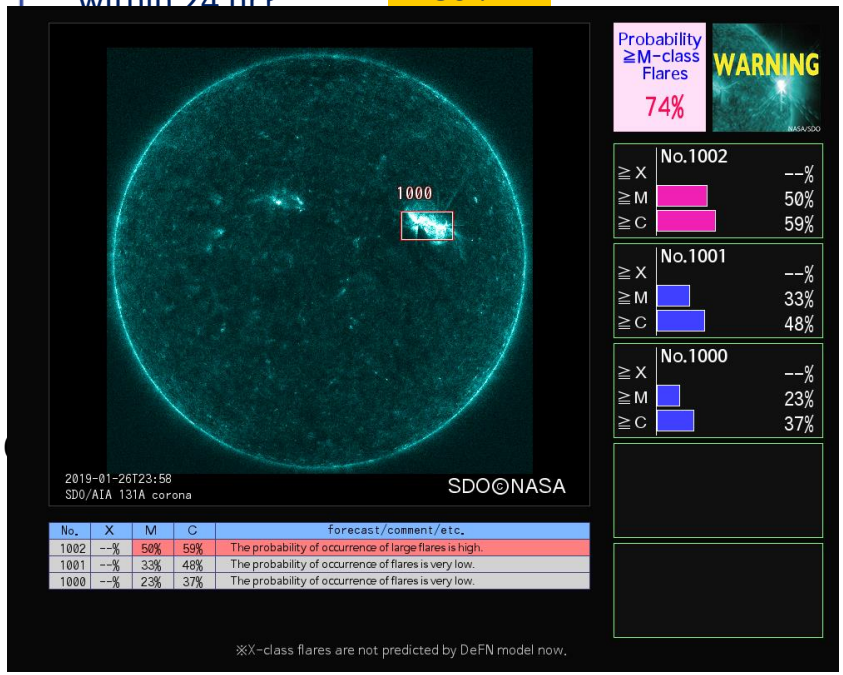
- Initial purpose
  - Is to establish the system for providing the present radiation level in the airplane when the large proton event is occurred to happen to the GLE events.
- Final goal
  - Is to develop the system to provide the forecast of temporal variation of human radiation in the airplane with several hours from the event occurred.
  - And to develop the system to estimate the nowcast and forecast of human radiation in ISS



Solar flare prediction model with AI



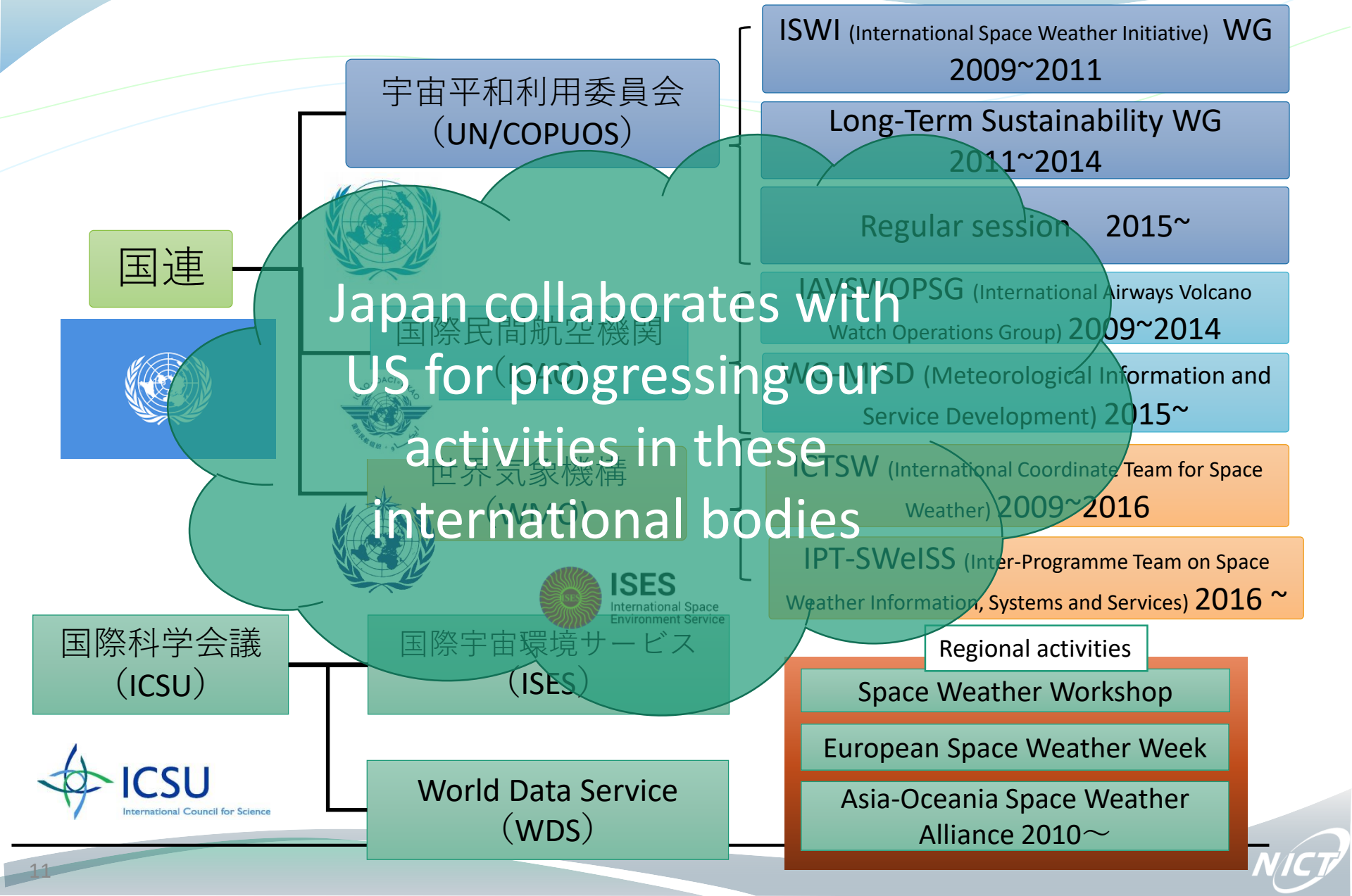




No.	X	M	C	forecast/comment/etc.
1002	--%	50%	59%	The probability of occurrence of large flares is high.
1001	--%	33%	48%	The probability of occurrence of flares is very low.
1000	--%	23%	37%	The probability of occurrence of flares is very low.

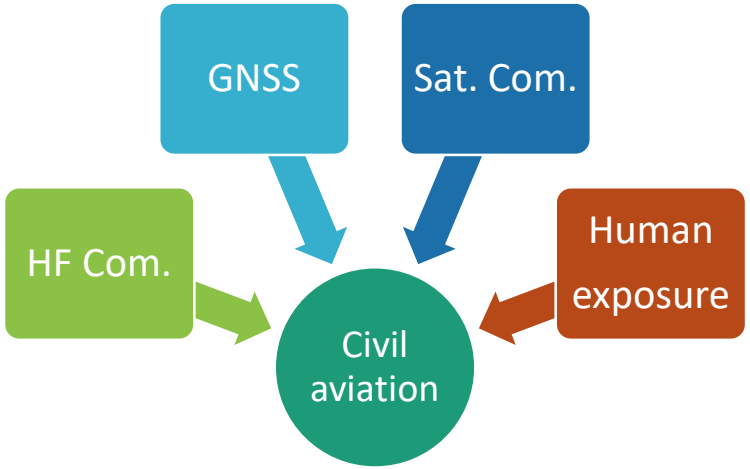
- The output is not only categorical prediction (X, M, non) but also the probability of flare occurrence at each region available.
- The real-time operation using **Deep Flare Net (DeFN) model** based on deep-learning method will start since September 2018.

Space Weather international bodies

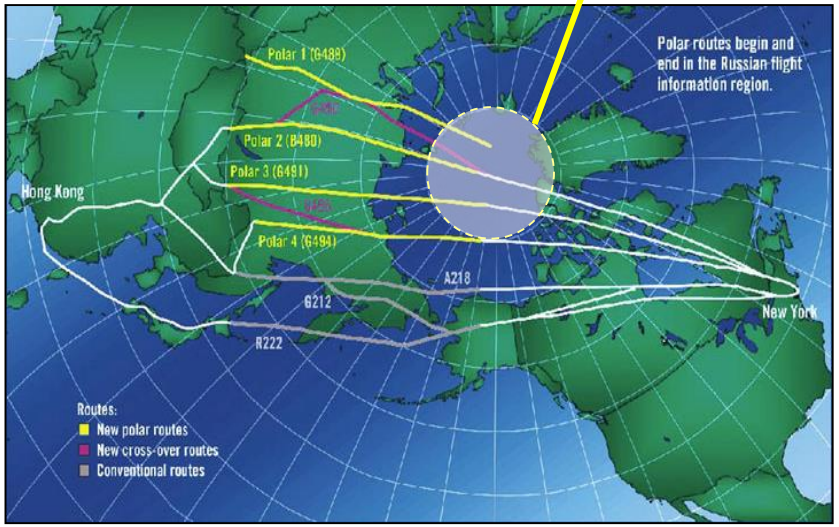


ICAO/WG-MISD (MET Information and Service Development)

- Annex 3 of ICAO is determined the mandatory information of meteorology for aviation.
- ICAO discusses to add SWx information in Annex 3 NOW.
- It is expected to use SWx as one of mandatory information for aviation on 2020s.



HF com. Is only way for telecommunication

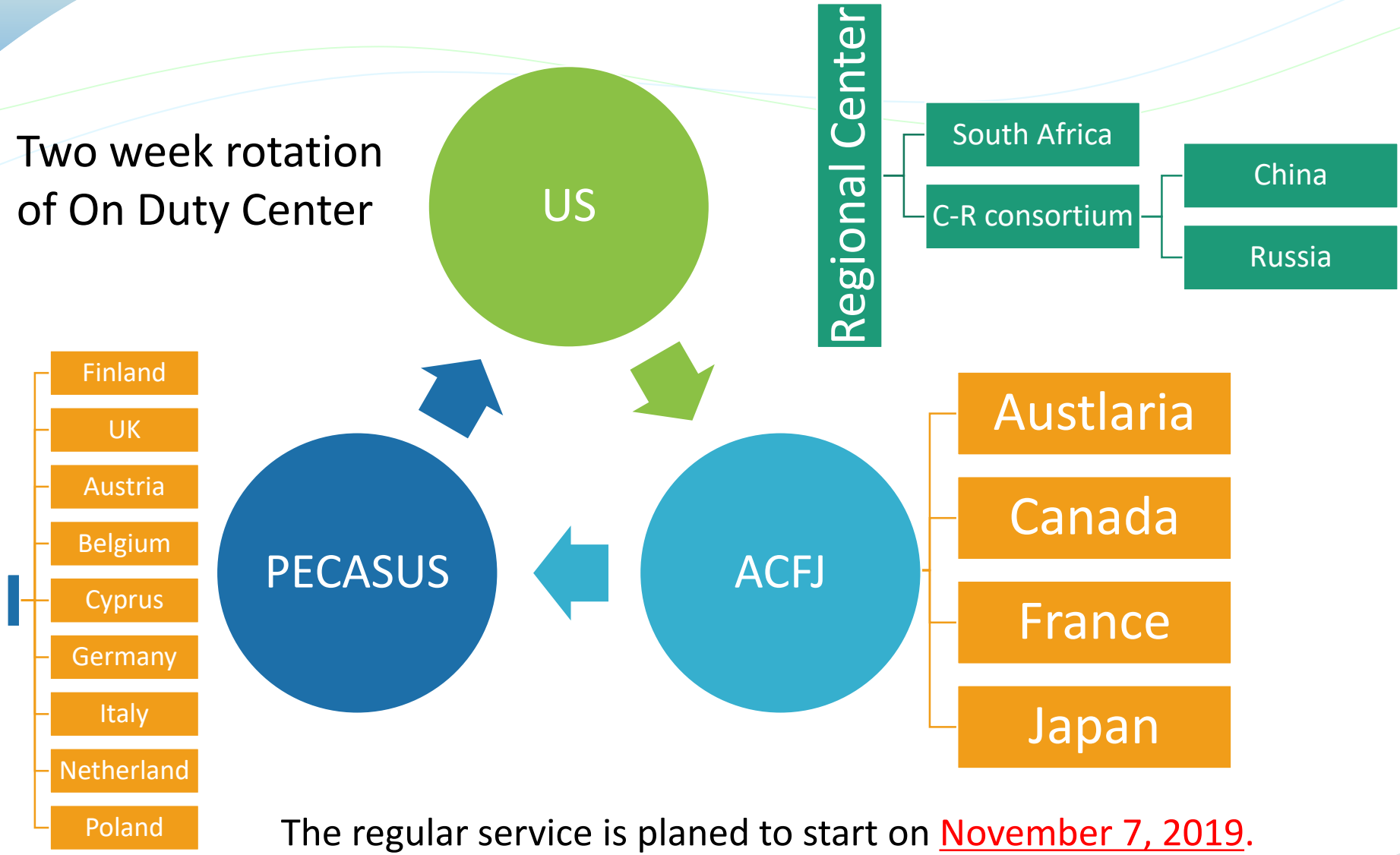


In 2018, The following three entities have assigned as ICAO Space Weather Global Center

- US
- ACFJ (Australia, Canada, France(leader), Japan)
- European Consortium(PECASUS: Austria, Belgium, Cyprus, Finland (leader), Germany, Italy, Netherland, Poland, UK)

ICAO Space Weather Services structure

Two week rotation of On Duty Center



The regular service is planed to start on November 7, 2019.

Table 3-2. Thresholds for space weather advisory

		Moderate	Severe
GNSS			
	Amplitude Scintillation (S4)(dimensionless)	0.5	0.8
	Phase Scintillation (Sigma-Phi)(radians)	0.4	0.7
	Vertical TEC (TEC Units)	125	175
RADIATION			
	Effective Dose (micro-Sieverts/hour)	30	80
HF			
	Auroral Absorption (Kp)	8	9
	PCA (dB from 30MHz Riometer data)	2	5
	Solar X-rays (0.1 - 0.8 nm)($W\text{-}m^{-2}$)	$1X10^{-4}$ (X1)	$1X10^{-3}$ (X10)
	Post-Storm Depression (MUF)*	30%	50%

2018 Space Weather as a Global Challenge

- International cooperative framework “Space Weather as a Global Challenge” is conducted on every year since 2016.
- The 3rd meeting of “Space Weather as a Global Challenge” was held at Japan Embassy on July 24, 2018 hosted by Japan Embassy, NICT, JAXA and DoS.
- 77 people attended from various countries.
- Discussing Theme
  - Japan’s Space Weather Efforts and Outlook
  - Perspectives from around the Globe
  - Toward Improved Space Weather Services and preparedness
  - Perspectives from the Private Sector
- Preparedness for severe space Weather disaster with international collaboration and activation of private sector were mainly discussed.

Asia-Oceania Space Weather Alliance (AOSWA)

- The Asia-Oceania Space Weather Alliance (AOSWA) established on 2010 for information exchange among Space Weather organizations in Asia and Oceania.
- Members: 27 organizations from 13 countries
- AOSWA workshop is held every one and a half years. The last one was hosted by LAPAN in Bandung, Indonesia in September, 2018.
- Electric newspaper “AOSWA link” is circulated


Issue5, March 2015

We hope the AOSWA framework helps our activities for ingroving space weather activities.

AOSWA Link

In this Issue...

- KASI's contributions to Space Weather
  Hyungsuk Cho,
  Group leader Solar and Space Weather Group,
  Korea Astronomy and Space Science Institute, Korea
- An Introduction to ANGKASA, UKM
  Nurul Hajijah Hair & Mardina Abdullah
  Space Science Centre (ANGKASA), Institute of Climate Change,
  Universiti Kebangsaan Malaysia, Malaysia.
- Internship Trainee Program at NICT
  Suhaila M. Buhari
  Universiti Kebangsaan Malaysia., Malaysia
- United Nations / Japan Workshop on Space Weather
  Akimasa Yoshikawa ,Lecturer
  International Center for Space Weather Science and Education, ICSWSE
  Department of Earth and Planetary Sciences, Kyushu University
- Domestic Collaborative Symposia supported by the Solar-Terrestrial Environment Laboratory, Nagoya University, Japan

Your contribution is always welcome!

If you should wish to submit an article, you are greatly appreciated. The articles should be approximately 500 words and contain either figures or pictures. Also it is available for use as a means of spreading information, such as upcoming conference and so on. Your feedback is always welcome.

Contact : sw-project-office@mi.nict.go.jp

AOSWA-5 @ Bandung in Sep. 19-21, 2018 hosted by LAPAN, Indonesia

Conclusion

•NICT has a long history for space weather forecast research and operation.
•We have both activities of observation and development of models for improving Space Weather forecast precision. Especially we have been developing “the bridge over the death valley” to provide useful SWx information to the users.
•We had large-scale solar flares on Sep. 2017, which has been 11 years since similar size event occurred. So many media reported in TV/newspaper. We have been preparing more robust SWx monitoring system against SWx disasters.
•We have close communication and collaboration with international partners for improving Space Weather research and operations.