EISCAT_3D サイエンスワーキンググループ（SWG）活動報告

（2011 年 05 月 24 日更新、2011 年 06 月 2 日に再更新　　文責　小川泰信）

EISCAT_3D Preparatory Phase project の中の1つであるWorking Package 3 “Science Planning and User Engagement” における活動について更新情報を赤色でご報告します。

経過：

2010年10月のPreparatory Phaseの開始と同時に、Working Package 3（WP3）の活動も開始。
Working Package 3のコンビーナーは Dr. Anita Aikio と Dr. Ian McCrea。
このWP3内にサイエンスワーキンググループ（SWG）を立ち上げ、初期メンバーを選出し、4年間の活動が終わるまでに様々な研究分野を包括するようにメンバーを交代することを想定。

2010年11月にサイエンスワーキングメンバーの選出。
メンバー（7名）は以下の通り、

Dr. Anita Aikio (University of Oulu, Finland, co‐convenor)
Dr. Ian McCrea (STFC Rutherford Appleton Lab., UK, co‐convenor)
Dr. Yasunobu Ogawa (National Institute of Polar Research, Japan)
Prof. Kjellmar Oksavik (UNIS, Norway)
Prof. Asta Pellinen‐Wannberg (IRF Kiruna, Sweden)
Dr. Mark Clilverd (British Antarctic Survey, UK)
Prof. Markus Rapp (IAP Kuhlungsborn, Germany)

このサイエンスワーキンググループによる初めのミーティングを 2011 年 1 月 14 日にフィンランド気象研究所（FMI）にて開催。Dr. Kirsti Kauristie (chair of the EISCAT Council) や Dr. Olaf Amm、Dr. Pekka Verronen も招待者としてミーティングに参加。
ミーティングでは、それぞれのメンバーが考えている EISCAT_3D への科学的アイデアやレーダーのスペックについて、まとめて発表がありました（私はイオン流出について話しました）。
その他に、新規ユーザーコミュニティの開拓のため、コンタクトリストの作成を行った。（ただし、集まった名前のリストは、SWG メンバーに公開されていません。EISCAT 本部の Esa さんは持っている様子。）

このミーティング後に、電子メールベースで EISCAT_3D レーダーのスペックに関する表を作成開始。2011 年 2 月 21 日のバージョンをメールに添付してお送りします（日本の EISCAT_3D ホームページ　http://polaris.nipr.ac.jp/~eiscat/eiscat3d/introduction.html　に 3 月 7 日に掲載しています）。この表が SOC 会議でも公開され、現在コメントを受け付けています。

5 月 17 日の EISCAT_3D ユーザー会議の前日にウプサラ・スウェーデンにて、ワーキンググループメンバーが集まり、EISCAT_3D science case の初版（Ian McCrea さんと Mike Kosch さん作成・編集）の改訂作業を行いました。特に、大気やオーロラなどの各研究分野と宇宙プラズマ物理、ソーラーシステム科学のキークエスチョンの設定にも重点を置きました。現在までにまとめましたキークエスチョンを文末に列挙します。
なお、今回の会合では、他の会議と重なり不参加となった Markus Rapp さんに代わり Norbert Engler さん（IAP）が、また、ホストの IRF ウプサラから Stephan Buchert さんと Thomas Leyser さんが加わり、EISCAT_3D science case の改訂作業やキークエスチョンの設定にご協力頂きました（体調を崩された Asta Pellinen-Wannberg さんは急遽欠席なさいました）。

この EISCAT_3D science case やキークエスチョンに関して、EISCAT_3D ユーザー会議時に Cesar さんから「重要な問題を挙げるだけではなく、EISCAT_3D でどのように理解が深まるかという視点も必要だ。」とのコメントがあり、そのような観点も含めて改訂を現在も行っています。

次のステップとして、2011 年 7 月に EISCAT_3D science case の改訂版をリリースし、ユーザーコミュニティからのコメントや提案を受けたいと考えています。また、次の 2011 年 11 月のサイエンスワーキンググループミーティングでは、新しいメンバー（宇宙天気やモデリングコミュニティを含む）で SWG を再構成し、ミーティングを行う予定です。EISCAT_3D science case の書類の中の、宇宙天気やモデリングについて内容を深められるようにしたいと聞いています。また、2012 年 5 月に行われる 4 回目の EISCAT_3D ユーザー会議@ウプサラに合わせてサイエンスワーキンググループミーティングを行う予定です。

報告は以上です。

The Science Case Document:

A. Atmospheric physics and global change

B. Space and plasma physics

C. Solar system science

D. Space weather and service applications

E. Radar techniques, coding and analysis

Appendix A: Table of EISCAT_3D radar performance requirements by science topics

今回の SWG では、A, B, C を中心に議論と Science Case 書類の改訂を進めました。その中で挙げられたキークエスチョンを以下に抜粋します。

A. Atmospheric physics and global change:

A1. Dynamical coupling in the atmosphere

What is the three-dimensional structure of the wave fields propagating upwards from the troposphere? How do their characteristics change as they move upwards to thermospheric heights?

How does atmospheric turbulence form and evolve? How is this process different in the different atmospheric layers?

What is the relationship between changes in chemistry and changes in dynamics?

How do waves and turbulence interact to modify the global-scale circulation of the middle atmosphere? What effects are seen when the normal circulation is disrupted?

What is the relationship between the waves generated in the upper atmosphere and the processes which cause them?

A2. Solar-terrestrial effects on chemistry

What are the durations and extents of the energetic particle events which modulate chemistry?

How does the wave and tidal climatology change when the heat balance of the middle atmosphere is modulated, for example by changes in chemistry?

What processes link these changes to apparent effects at lower altitudes?

Can high-resolution continuous observations help validate chemical/dynamical models of the D region?

Can we improve our models through targeted active experiments?

A3. Dynamical and chemical coupling in the mesosphere (mesospheric thin layers)

How much small-scale structure is contained in mesospheric thin layers? Is this linked to wave activity, or plasma physics, or both?

What explains the aspect sensitivity of PMSE and PMWE layers?

What is the horizontal and vertical structure of the dust size in PMSE layers, and how does this vary?

Are PMWE layers linked to both dust and turbulence, or only to turbulence? How do they form, and what determines when they appear?

Are mesospheric thin layers signs of global change, connected to human activity?

A4. Stratosphere and troposphere

How does turbulence in the troposphere and stratosphere form and develop?

How do stratospheric warming events affect the atmosphere at other heights and latitudes?

What are the effects of turbulence and wave dissipation on energy exchange between atmospheric layers?

How do stratospheric warming events affect the atmosphere at other heights, and at other latitudes?

Can the upper atmosphere exert a downward control on the troposphere, and if so how?

A5. Short-term and long-term change

How does long‐term change in the troposphere affect its energy exchange with the other atmospheric layers?

Is greenhouse warming of the lower atmosphere resul8ng in longterm cooling of the upper atmosphere? If so, what effect is this having?

What are the problems with our current models of the upper atmosphere, and what implica8ons might these have for predictability?

Can we use EISCAT_3D data as a basis to make improved predictions of shorter‐term varia8ons in the Earth's upper atmosphere, such as those connected to the solar cycle?

B. Space and plasma physics

B1. Plasma convection and multiscale coupling

How plasma convection is structured and what implications that has on large-scale global models that are averages over hundreds of km?

Do bursty bulk flows play a major role in magnetic flux transport in the magnetotail and can ionospheric observations play a key role in specifying their spatial dimension and occurrence rate?

What kind of zoo of flow channels exist in the ionosphere and how they are created?

B2. Current systems, Joule heating and heating by particles

How energy is deposited in the thermosphere in 3D by Joule heating and by precipitating particles?

Do atmospheric gravity waves generated by geomagnetic disturbances propagate downwards to affect the lower atmospheric layers?

Under which situations the inductive electric fields that are created due to the temporal variations of ionospheric currents become significant and how the effects (e.g. associated FACs) are fed back to the magnetosphere?

Does closure of ionospheric currents take place within the 3D ionosphere?

B3. Magnetospheric substorms

What is the role of oxygen oublow in the triggering of the substorm onset?

It has been suggested that ionospheric conductivity controls substorm onset. Can EISCAT_3D verify this?

B4. Aurora and their small - scale structures

What are the electrodynamics of auroral arcs at different spatial scales?

What are the generation mechanisms of auroral arcs?

How sub-structure in arcs is formed and what are the generation mechanisms for black aurora and different types of small - scale structures?

B5. Ion outflows

How large mass flux of ions is escaping from the ionosphere to the magnetosphere?

Which are the most important generation mechanisms of ion oublows?

Can we predict what will happen to the composition and density of our atmosphere in the long-term future?

B6. Naturally enhanced ion acoustic lines (NEIALs)

What is the plasma physics behind generation of NEIALs?
Under which geophysical conditions do they occur and how they are related to optical aurora?

B7. Plasma physical phenomena by artificial heating

Can multiple‐scale EISCAT_3D observations be used to solve the problems of turbulence and energy cascade in space and time and can the results be used in applied plasma physics?
What is the relative importance of various mechanisms for formation of ionospheric irregularities?
How pump-induced Langmuir turbulence can produce intense artificial aurora?
Can EISCAT_3D be used as D‐region heater?

C. Solar system science

C1. Meteoroids

What is the meteoroid mass flux into the Earth's atmosphere and its temporal variation?
What kind of orbits meteoroids have and what they tell about meteoroid/cometary dynamics?
What is the mechanism behind the meteor head echoes?

C2. Planets and asteroids

What kind of subsurface geochemical properties planets and asteroids have and what they tell about the formation of the planetary system?

C3. Structures in the solar wind (IPS)

How rapidly the solar wind is accelerated aner leaving the Sun?
How streams of different speeds can interact to produce complex solar wind structures?