Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MSD04-01 Room:101A Time:May 24 09:00-09:30

Toward cutting edge of geospace and atmospheric sciences with EISCAT and EISCAT_3D

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The European Incoherent Scatter(EISCAT) radar system in northern Scandinavia and Svalbard has been playing a pivotal role in advancing cutting edge sciences in various areas including atmospheric, ionospheric and geospace studies, space weather and global change. Affiliated in the EISCAT scientific association in 1996, Japanese science community has jointly contributed to achieve further understanding of the magnetosphere-ionosphere-thermosphere coupling processes using the integrated ground-based instruments and rocket/satellite simultaneous observations with EISCAT radars. In this paper, an overview on several key scientific issues will be presented in order to stimulate further discussions for the new EISCAT_3D project more productive.

Keywords: EISCAT, EISCAT 3D, geospace science, atmospheric science, cutting-edge sciences

Japan Geoscience Union Meeting 2013
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MSD04-02 Room:101A Time:May 24 09:30-10:00

The AMISR Radars

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The planned EISCAT_3D radar system is, in many ways, an extension of the AMISR radar systems developed for the U.S. National Science Foundation. Like 3D, AMISR is a phased array with pulse-to-pulse steering capability, flexible waveform capabilities, and similar scientific goals. This talk will present a survey of the capabilities of AMISR as well as some data examples from that system. Special emphasis will also be given to the new capabilities of the EISCAT_3D radar and many of the interesting scientific contributions that should result from its use.

Keywords: incoherent scatter radar, phased array

Japan Geoscience Union Meeting 2013
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MSD04-03 Room:101A Time:May 24 10:00-10:15

Scale-dependent reflection process of shear Alfven wave coupling to the 3D-ionospheric current system

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Interaction between shear Alfven wave and 3-dimensional ionosphere coupling to the auroral acceleration region (AAR) is discussed. In the conventionally established global M-I coupling process via shear Alfven wave, the ionosphere had been treated as a height-integrated conducting layer. This assumption can be validated under the condition that the ionospheric potential structure has no altitudinal dependence. However as shown by Lesserd and Knudsen [2002], the small scale shear Alfven wave (of which scale length is several km) incident from the magnetosphere to the ionosphere is almost absorbed into the ionosphere for any realistic condition of ionospheric conductances. Furthermore, existence of AAR also brings about scale-dependent reflection process of shear Alfven wave when the scale length is smaller than the resistive scale length (that is roughly 1000km for typical ionospheric conditions).

Composite effect of AAR and 3-dimensional current closure is very important because it is closely related to the physics of confinement of Hall current divergence in the ionosphere. From theoretical analysis, we found that characteristic scale length of effective conducting layer is controlled by the ratio of Pedersen to parallel conductivity. When the horizontal scale length of FAC is smaller than this characteristic scale, an effective ionospheric conductivity becomes small and FAC only closed via small fraction of ionospheric current. This means that the FAC closure is accomplished at the upper ionospheric E-layer or F-layer not at the all over the E-layer.

Our results strongly suggest that in a large scale M-I coupling process that is larger than ˜1000 km, the confinement of Hall current divergence in the ionosphere is controlled by the ratio of Alfven conductance to Pedersen conductivity but for small scale M-I coupling smaller than 1000 km is effectively confined in the ionosphere, which means the polarization electric field is efficiently produced for generation of Cowling effect.

Keywords: Alfven wave, 3 dimensional ionosphere, Magnetosphere-Ionosphere coupling

Japan Geoscience Union Meeting 2013
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MSD04-04 Room:101A Time:May 24 10:15-10:30

A study of electro-dynamical coupling between E and F regions

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Electro-dynamical coupling between E and F regions is one of important subjects for the ionospheric study. Recently, horizontal structures of sporadic E layer (Es) is required to be observed in order to understand effects of Es on generation and propagation of Medium-Scale Traveling Ionospheric Disturbances (MSTIDs), which are wavy structures of the plasma density in the F region. Whereas MSTIDs have been considered to be generated by atmospheric gravity waves, recent studies suggest that electro-dynamical process including polarization electric fields could play an important role in generating nighttime MSTIDs. The Perkins instability, which is a plasma instability operating at mid-latitudes, could explain most of features of the observed MSTIDs, but two major discrepancies between the observations and theory for the Perkins instability are pointed out. First, the growth rate predicted by the theory is too small (on the order of 10^{-4} s^{-1}) to explain the observations. Second, the instability theory cannot explain the equatorward and westward propagation of the MSTIDs. According to the Perkins instability theory, the structures generated by this instability should propagate at the same velocity as the background ExB drift, which is almost always to the east. However, this propagation direction is opposite to that of the observed MSTIDs. These two discrepancies could be resolved by considering E- and F-region coupling processes. However, horizontal structures of Es with scale-sizes of several hundred kilometers corresponding to the horizontal wavelength of the nighttime MSTIDs have not been revealed due to the limitation of instruments. EISCAT_3D is expected to observe the horizontal structures of Es and reveal the E- and F-region electro-dynamical coupling operating in the MSTID generation and propagation.

Keywords: EISCAT_3D, EISCAT, MSTID, sporadic E, ionospheric disturbance

Japan Geoscience Union Meeting 2013
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MSD04-05 Room:101A Time:May 24 10:30-10:45

EISCAT simultaneous scanning observations of ionospheric parameters

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We compare ionospheric parameters along the same grate circle observed by two radars. The two European incoherent scatter (EISCAT) radars are located at Tromso (67 MLAT) and Longyearbyen (75 MLAT). This observation was planned to inter-calibrate the two radars and then to study the latitudinal profiles of the ionospheric parameters including conductance. The radars scan the ionosphere along a great circle with the elevation angles larger than 23 and 30 deg for Tromso and Longyearbyen radars, respectively. The radars are separated by 996 km along a great circle, which is nearly meridian. The midpoint of the two radar sites is geodetic (lon, lat) = (18.0, 73.9) deg. The two radars observe the midpoint at 300 km altitude with the elevation angle of 30 deg. This operation was conducted between 11-19 UT (12-20 LT) on March 30, 2012, including 1625 UT when the solar zenith angle is the same at the two radar sites. We will discuss the results after additional operations planned in March 2013.

Keywords: ionospheric conductivity, ionosphere, EISCAT, incoherent scatter radar

Japan Geoscience Union Meeting 2013
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MSD04-06 Room:101A Time:May 24 11:00-11:30

EISCAT_3D-N: A proposal to the Research Council of Norway to finance EISCAT_3D

Cesar La Hoz[1*]

[1]University of Tromso, Norway

I describe in this presentation the proposal of the Department of Physics and Technology of the University of Tromso in Norway to the Research Council of Norway to partially fund the construction of EISCAT_3D (E3D). E3D is an international project on The European Strategy Forum on Research Infrastructures (ESFRI) roadmap. E3D will be a world-class radar facility for investigations of the geospace environment. It will replace the present EISCAT facilities in northern Norway, Sweden and Finland. E3D will use the incoherent scattering (IS) technique to make 3-dimensional vector measurements across a wide field of view of key parameters in the auroral atmosphere by taking advantage of technological advances in radio, radar, computing, and signal analysis. E3D will have 20 times better sensitivity and one order of magnitude better resolution than all other radar facilities in the world. E3D will allow us to understand the flows, sources, sinks, and interactions of energy, momentum and mass in the auroral atmosphere. E3D will provide synergies towards relevant areas of increasing socioeconomic importance; including atmospheric precursors of climate change and vulnerability of modern technological infrastructures due to space weather and space debris. E3D can study auroral particle precipitation that depletes ozone in the stratosphere, and atmospheric tides and sudden stratospheric warming events that bring disturbances to the ionosphere from below. Real-time measurements from E3D will be provided to monitoring services dealing with space weather and space debris, a key focus of ESA's Space Situational Awareness (SSA) programme. E3D will also contribute to science and engineering education at all levels. The project will create opportunities to national industry and services of the member countries in communications hardware and software and information technologies. This E3D project is backed by all major universities in Norway (Tromso, Bergen, Oslo, UNIS and NTNU), Andoya Rocket Range, and the Norwegian Space Centre).

Keywords: Incoherent Scatter Radar, Ionosphere physics, Polar ionosphere, Space weather

Japan Geoscience Union Meeting 2013
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MSD04-07 Room:101A Time:May 24 11:30-12:00

EISCAT_3D in Sweden: national science targets, roadmap and funding plan

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EISCAT_3D will be a multistatic radar capable of imaging volumes in the Earth's atmosphere and geospace. Presently, five radar sites are foreseen to be located in northern Scandinavia, including one site with a 10 MW transmitter. EISCAT_3D is designed to use several different measurement techniques never before combined together in a single radar system: volumetric imaging, aperture synthesis imaging, multistatic imaging, scanning, tracking and adaptive experiments, and the possibility for continuous monitoring of the ionosphere and neutral atmosphere.

EISCAT_3D is on the roadmap of the European Strategy Forum on Research Infrastructures (ESFRI) since 2008. It is identified as a major step in the development of EISCAT, which must be taken to stay on the scientific forefront. The planning of EISCAT_3D is currently financed by the EU Commission and the Swedish Research Council (VR). This presentation gives an overview of the Swedish science targets, roadmap and funding plan to support the EISCAT_3D construction, as proposed to VR by the Swedish scientific community on March 26, 2013.

Japan Geoscience Union Meeting 2013
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MSD04-08 Room:101A Time:May 24 12:00-12:15

Study of the lower thermospheric wind dynamics

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The lower thermospheric wind dynamics has been paid attention for several decades to understand the Magnetosphere-Ionosphere-Thermosphere coupling. In particular, it has been an issue how the lower thermosphere will response to the solar wind energy input. IS radar measurements of the polar lower thermosphere begun about 40 years ago by a pioneer work of Brekke et al. [JGR, 78, 8235, 1973], and significant number of studies have been published since then. However, our understanding of the lower thermosphere is still limited. One of reasons is that the lower thermosphere is significantly influenced by atmospheric waves propagating from below. Thus, the day-to-day variability is very prominent. Owing to high running cost, long run of IS radar had not been conducted a decade ago. In 2007-2008, EISCAT Svalbard radar was operated almost continuously for 1 year. However, only about 20 % of the data sets can be used for deriving the ion velocity vector. If we have wind velocity datasets on daily basis like meteor and MF radars usually made for the mesospheric wind measurements, our understanding of the lower thermosphere wind dynamics will be much more progressed. EISCAT 3D can make it possible. I will overview works of the lower thermospheric wind and propose what kind of run we desire.

Keywords: EISCAT 3D, Lower thermosphere, polar region

Japan Geoscience Union Meeting 2013
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MSD04-09 Room:101A Time:May 24 12:15-12:30

Toward EISCAT_3D observation of three-dimensional wind velocity in the

Jun-ichi Furumoto[1*], Mamoru Yamamoto[1], Hiroyuki Hashiguchi[1], Toshitaka Tsuda[1]

[1]Research Institute of Sustainable Humanosphere, Kyoto University

Both of IS and ST radars is the high-power atmosphere radars at the VHF- or UHF- frequencies. In the IS radar measurement, clear-air echoes in the troposphere and stratosphere is able to detect, although most of research are not interested in measurements. This paper introduces the MST radar technique to IS radar measurement for lower atmosphere measurements. The radar imaging technique originally developed for turbulence technique will be helpful for measurement of upper atmosphere measurement also. This paper discusses the feasibility of various MST radar techniques to EISCAT_3D.

Keywords: EISCAT_3D

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MSD04-10 Room:101A Time:May 24 12:30-12:45

The momentum balance of the neutral atmosphere in the lower thermosphere estimated by a GCM.

Yasunobu Miyoshi[1*], Ayumi Oda[1], Hitoshi Fujiwara[2]

[1]Kyushu University, [2]Seikei Univeristy

The polar lower thermosphere neutral winds show significant variations due to the energy inputs from the solar UV/EUV flux and from the magnetosphere. The EISCAT radar observation revealed that the neutral wind at an altitude of 118 km exceeds 500m/s during strong energy input. They estimated the momentum balance of the neutral wind and concluded that the major driving force was the horizontal pressure gradient force induced by the Joule heating. However the direct observation of the neutral density and pressure were not performed. The absence of these parameters may cause a serious error in the momentum balance of the neutral wind. In this study, we examined mechanism for the generation of high speed neutral wind in the lower thermosphere using a whole atmosphere general circulation model. We performed a series of GCM experiments under various conditions (Cross polar potential: 30, 90 120 and 150kV). We obtained the enhancement of the neutral wind with the magnitude of 500 m/s under the disturbed condition. This enhancement of the neutral wind obtained in this study is comparable to the observed. Analysis of the momentum balance of the neutral wind indicates that the fluctuations of the wind under the quiet and disturbed condition are mainly caused by the pressure gradient force which is generated by the Joule heating. In particular, the enhancement of the wind under the disturbed condition coincides with the increase of the pressure gradient force. We also found that the molecular diffusion was not negligibly small and attenuated the high speed neutral wind under the disturbed condition

Keywords: momentum balance, Joule heating, Numerical simulation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MSD04-11 Room:101A Time:May 24 14:30-14:45

Mesoscale flow dynamics related to a southeastward-moving auroral transient in the cusp

Satoshi Taguchi[1*], Yasunobu Ogawa[2], Keisuke Hosokawa[1]

[1]University of Electro-Communications, [2]National Institute of Polar Research

In this paper we focus on a mesoscale phenomenon that moves in the southeastward direction on the poleward side of the stable cusp precipitation region, using data from a high-sensitivity all-sky imager and the EISCAT radar at Longyearbyen, Svalbard. During an interval of weakly southward IMF on 13 January 2013 EISCAT northwestward-directed low-elevation measurement detected an enhanced southeastward flow accompanied by the clear increase both in the ion and electron temperatures. The all-sky imager shows that a mesoscale aurora form is detached from the poleward boundary of the stable cusp precipitation region at ˜1130 MLT, and that it moves rapidly in the direction expected from the radar observation. When this aurora form reaches the local noon, it slows down, and then diminishes. We present detailed characteristics of the mesoscale flow dynamics related to this auroral form, and discuss whether or not this phenomenon can fall in the category of the usual poleward-moving auroral form.

Keywords: aurora, cusp, particle precipitation, plasma flow, solar wind magnetosphere interaction

Japan Geoscience Union Meeting 2013
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MSD04-12 Room:101A Time:May 24 14:45-15:00

Sub-relativistic electron precipitation associated with the diffuse aurora; EISCAT observations

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[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]Graduate School of Science, Nagoya University

The diffuse/pulsating aurora are caused by precipitations of tens keV electrons, and the whistler chorus wave-particle interactions have been expected to be a possible candidate for the pitch angle scattering. The numerical simulation on the wave-particle interactions predicts that sub-relativistic electrons of more than 100 keV should precipitate simultaneously with tens keV electrons because the whistler mode waves can resonate with higher energy electrons at high-latitude along the magnetic field line. Therefore, if precipitations of sub-relativistic electrons are confirmed associated with the diffuse/pulsating aurora, it is evidence that whistler mode chorus cause diffuse/pulsating aurora. In November 2012, we conducted the European Incoherent Scatter (EISCAT) observations at Tromso, Norway to measure the electron density above 60 km associated with the diffuse/pulsating aurora. The EISCAT VHF radar observations confirmed that the electron density enhancements at 80 km due to ˜200 keV electron precipitations. The pulsating aurora was observed in the equatorward side of the EISCAT. In this presentation, we will compare the electron density profile measured by EISCAT with the computer simulation on the precipitated electrons by whistler mode chorus and discuss the possible mechanism of the density enhancement at 80 km.

Keywords: aurora, wave-particle interactions, EISCAT

Japan Geoscience Union Meeting 2013
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MSD04-13 Room:101A Time:May 24 15:00-15:15

The science of high-speed imaging of aurora

Ryuho Kataoka[1*]

[1]Tokyo Institute of Technology

Pulsations, irregularly switching on and off in the brightness with typical durations of an order of 2 to 20 s, are a fundamental characteristic of post-midnight aurora. Although the pulsating aurora is weak compared with those of quiet arcs or breakups, a cutting-edge sensitive high-speed camera is now capable of detecting the faint aurora with more than several hundred frames per second. In fact, it has been found that a fastest-ever-observed fluctuation is superimposed on a pulsating aurora, which is more than an order of magnitude faster than well-known 3 Hz modulation [1]. The generation mechanism remains unknown, and two different possibilities of the modulation source arise at the equatorial magnetosphere and at the magnetosphere-ionosphere coupled region. The new science of high-speed imaging of aurora will be discussed, including the latest results obtained from the high-speed imaging of aurora at subauroral latitude (AUGO2, Alberta), combined with earlier results obtained at high latitude (PFRR, Alaska) [2, 3].

[1] Kataoka, R., et al. (2012), Pulsating aurora beyond the ultra-low-frequency range, J. Geophys. Res, 117, A08336.

[2] Kataoka, R., et al. (2011b), Ground-based multispectral high-speed imaging offlickering aurora, Geophys. Res. Lett., 38, L14106.

[3] Kataoka, R., et al. (2011a), Turbulent microstructures and formation of folds inauroral breakup arc, J. Geophys. Res., 116, A00K02.

Japan Geoscience Union Meeting 2013
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MSD04-14 Room:101A Time:May 24 15:15-15:30

Magnetosphere-ionosphere coupling model for evolution of auroral arcs

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Our recent modeling studies on evolution of auroral arcs and the related nonlinear wave activities are presented. The model basically treats Alfven wave dynamics driven by the magnetosphere-ionosphere coupling process and covers a narrow dipole flux tube in the auroral region. The magnetospheric plasma is described by the reduced-MHD equations of electric and magnetic perturbations in a background convection field. The ionospheric plasma motion is described by the compressible two-fluid equations and is characterized by the Pedersen and Hall currents. The field-aligned current of the Alfven wave flows into the ionosphere, producing an internal uniformity of plasma density or conductivity, which in turn triggers new wave propagation to the magnetosphere. The three-dimensional simulations reproduce auroral structuring such as splitting of arc and vortices, along with field line oscillatory behaviors. In this talk, we introduce results of these simulations and provide implications to future planning observations as EISCAT-3D.

Keywords: magnetosphere-ionosphere coupling, auroral arc, Alfven wave

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MSD04-15 Room:101A Time:May 24 15:30-15:45

Expectation of EISCAT_3D observation for the sounding rocket campaign

Takumi Abe[1*]

[1]Japan Aerospace Exploration Agency

The Institute of Space and Astronautical Science (ISAS) of Japan Aerospace Exploration Agency (JAXA) has continued to launch the sounding rockets for a study of the upper atmospheric physics not only inside Japan but in Scandinavian country. The purpose of Japanese sounding rocket experiments in the high latitude region is mainly to investigate various polar upper atmospheric phenomena related to the auroral activity. In such experiments, simultaneous observations by the ground-based instruments are indispensable to make a comprehensive measurement of the science target, and have been conducted so far as the international collaboration. Among them, EISCAT radar plays a primary role and has provided essential support for the sounding rocket campaign. We strongly expect that further powerful support will be provided by EISCAT_3D. In this presentation, our expectation for significant contribution of EISCAT_3D to the sounding rocket campaign in Scandinavian countries will be given.

One of the noticeable performances of EISCAT_3D is three-dimensional measurement capability of the upper atmosphere, by which essential information on the upper atmosphere near the rocket trajectory can be provided with a sufficiently small spatial resolution. In particular, two-dimensional information on the observation is expected to be available in the vicinity of the rocket position, while it was basically one-dimensional information until now. It will be possible to make a direct and essential comparison between the sounding rocket and radar observations.

We also expect the high spatial resolution data provided by EISCAT_3D, which is essential for the detailed comparison between the sounding rocket observation and the ground-based measurement. In addition, it is very important to know the latest condition of the upper atmosphere for the rocket trajectory in advance, when we determine whether the launch condition is satisfied. This capability is particularly important when the science target is small scale phenomena. Furthermore, if space-time ambiguity is resolved due to simultaneous multiple beam capability of EISCAY_3D, major obstacle for upper atmospheric research by the sounding rocket can be overcome.

Thus, when observations of the polar upper atmosphere by EISCAT_3D are available, significance of the ground-based support for the sounding rocket experiment will be much increased.

Keywords: Sounding rocket, coordinated observation, ground-based support, ionosphere, lower thermosphere

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MSD04-16 Room:101A Time:May 24 15:45-16:00

EISCAT-Japan collaborative studies drived by EISCAT_3D radars

Hiroshi Miyaoka[1*], Satonori Nozawa[2], Yasunobu Ogawa[1], Shin-ichiro Oyama[2], Takuji Nakamura[1], Ryoichi Fujii[2], Craig Heinselman[3]

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The EISCAT(European Incoherent SCATter) Scientific Association is an international research organization, which operates incoherent scatter radars at 931MHz, 224MHz and 500MHz in northern Scandinavia and Svalbard for studies of physical and environmental processes in the middle/upper atmosphere and near-Earth space. Since 1996, National Institute of Polar Research, in collaboration with STEL of Nagoya University has promoted the EISCAT project for the user community in Japan to use the EISCAT facility for their scientific subjects.

EISCAT_3D is the major upgrade of the existing EISCAT radars in the northern Scandinavia. With a multi-static phased array system composed of one central active (transmit-receive) site and several receive-only sites, the EISCAT_3D system is expected to provide us 10 times higher temporal and spatial resolution and capabilities than the present radars.

In this presentation, we will overview our scientific activity and achievements with the EISCAT facility, then our strategic plan of national funding for EISCAT_3D as well as the science targets which we expect to be unraveled by EISCAT_3D.

Keywords: Incoherent scatter radar, EISCAT, Ionosphere, Thermosphere, Mesosphere, 3D imaging observation