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

MSD04-P01 Room:Convention Hall Time:May 24 16:15-17:30

An Observation of Polar Cap Aurora with RISR and OMTI: A Feasibility Study for EISCAT_3D

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One of the primary scientific objectives of the planned EISCAT_3D would be "3D imaging of aurora", especially 3D imaging of dynamically moving auroral arcs at the time of substorm expansion phase onset. In order to discuss the specification of the EISCAT_3D system, we have to know how such an effort of 3D imaging of aurora is being made by using currently-working IS radar systems. For this purpose, we introduce an event of isolated auroral arc in the polar cap region which was simultaneously observed by an all-sky imager of OMTIs (Optical Mesosphere Thermosphere Imagers) and RISR (Resolute Bay Incoherent Scatter Radar) at Resolute Bay, Canada (74.7 N, 265.0 E, 82.9 MLAT) in winter/2009. By using the data during this event, we visualized the plasma structure near the arc in 3D fashion. In particular, we tried to reproduce the 3D structure of electric field and corresponding electric current through a quantitative estimation of horizontal plasma velocity along the arc. As a result, ion velocity around the arc was found to show a shear reversal flow across the arc at 200-400 km altitudes; -1500 m/s on the dusk-side of the arc and 1000 m/s on the other side of the arc. This reversed flow corresponds to an electric field (i.e., Pedersen current) structure converging towards the center of the arc. Such a converging Pedersen current is consistent with upward field-aligned currents (FACs) within the arc which are possibly carried by precipitating electrons leading to the generation of the arc. Possible 3D structure of electric field and electric current including FAC around the arc will be discussed as a feasibility study for the EISCAT_3D system.

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Application of Generalized Auroral Computed Tomography to the EISCAT_3D project

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Aurora Computed Tomography (ACT) is a method for retrieving three-dimensional (3-D) distribution of auroral luminosity from auroral images obtained simultaneously by the multi-point observation. As a next step of the ACT, we have developed Generalized - Aurora Computed Tomography (G-ACT) that reconstructs the energy and spatial distributions of precipitating electrons from multi-instrument data, such as ionospheric electron density from the EISCAT radar, cosmic noise absorption (CNA) from imaging riometer, as well as the auroral images. This method is compatible with 3-D ionospheric data observed by the EISCAT_3D radar, because the tomography method essentially assumes that the observational data are the projection of the 3-D data.

In this study, we examine how the G-ACT method can contribute to the EISCAT_3D project by numerical simulation. We first obtained auroral images observed by ALIS (Aurora Large Imaging System) and the electron density distribution observed with the EISCAT_3D radar by assuming spatial and energy distribution of incident electrons and then applied the G-ACT to these data. The results showed a possibility that the G-ACT can interpolate the electron density distribution observed with the EISCAT_3D radar at a higher spatial resolution. On the other hand, the 3-D aurora distribution reconstructed from only optical images was improved by a use of the EISCAT 3-D data. Furthermore, we suggest where new imagers should be installed for simultaneous observation with the EISCAT_3D radar.

Keywords: aurora tomography, EISCAT_3D, inverse problem, 3 dimensional structure, aurora imager, ionospheric electron density

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Report of the STEL optical observation at the Tromsoe EISCAT radar site by March 2013 and the contributions to EISCAT_3D

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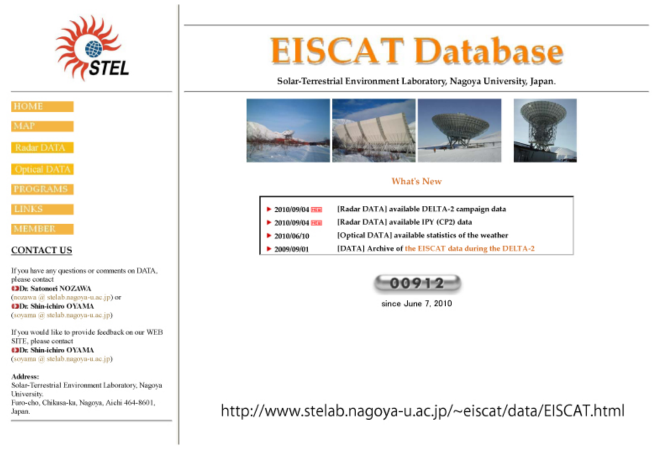
Solar-Terrestrial Environment Laboratory (STEL) has been operating various kinds of optical instruments for more than 10 years at the Tromsoe EISCAT (European Incoherent Scatter) radar site in Norway (69.6^{o}N, 19.2^{o}E), which is one of the state-of-art observatories at high latitudes. Five instruments are now in automatic operation regularly from October to March: (1) three-wavelength photometer (427.8 nm, 630.0 nm, and 557.7 nm), which is fixed to look along the magnetic field line, (2) digital camera for monitoring weather and aurora, (3) proton all-sky camera (486.1 nm), (4) multi-wavelength all-sky camera (557.7 nm, 630.0 nm, OH band, 589.3 nm, 572.5 nm, and 732.0 nm), and (5) Fabry-Perot interferometer (557.7 nm, 630.0 nm, and 732.0 nm). The quick looks are available on the web at www.stelab.nagoya-u.ac.jp/~eiscat/data/EISCAT.html. While these instruments are programmatically operated, they have contributed to many campaign observations with the EISCAT radars, rockets, satellites, and other ground-based instruments by adjusting the observation mode. In particular, simultaneous observation with the EISCAT_3D is quite important to give new insights to our understanding of spatiotemporally developments in the auroral ionosphere and thermosphere. This paper reports activity of the optical instruments and planning of the simultaneous observations with the EISCAT_3D.

Keywords: Aurora, Airglow, Optical instrument, Ionosphere, Thermosphere, Polar region



MSD04-P04 Room:Convention Hall Time:May 24 16:15-17:30

Coordinated observation between Reimei and EISCAT radar of N2+ emission and ion upflow in the polar topside ionosphere

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The upflow and outflow of heavy ions, such as N2+ and NO+, has been examined with immense interests since it is considered that heavy ions hardly escape from terrestrial gravity. It is considered that the generation process of N2+ outflow is the charge exchange between O+ and N2 at topside ionosphere. Recently, optical measurement data taken by a satellite showed N2+ 1st negative band emissions in the sunlit region suggesting the existence of N2+ upflow. To clarify the process of ion upflow, we carried out the coordinated observations between the Reimei satellite and the EISCAT/ESR radar during the winter solstice periods from 2005 to 2012, except for 2011 due to the problem on Reimei attitude system.

The field-of-view (FOV) of the multi-spectral auroral camera (MAC) on Reimei was directed toward the earth's limb in order to observe the height profile of N2+ emission intensity produced by resonant scattering. In this case, the altitude resolution and range in the image data obtained with Reimei/MAC are approximately 5 km and 300 km, respectively. N2+ emission image was taken with every 1 second. On the other hand, ion upflow speeds near the FOV of MAC are simultaneously observed by the EISCAT/ESR radar with the fast scan mode or fixed mode toward the magnetic zenith. In the scan mode, the azimuthal scan range is 120 degrees centering the geomagnetic north direction, and time resolution is about 3 min.

Using the Reimei data, we examined the relationship among N2+ 1st negative and OI green line emissions, ion upflow and geomagnetic activity. We found good correlation between N2+ emission intensities at 300 and 400km altitude and Kp indices. At these altitudes, N2+ emission intensities were 100-600R greater than OI intensities when Kp was greater than 3+. This suggests that N2+ density increase, or ion upflow occurs in the topside/upper ionosphere when geomagnetic activity increased.

From the statistical analysis based on the coordinated measurement data between Reimei and EISCAT/ESR radar, we found no significant relationship between ion up/down flow and and N2+ emission. Considering the fact that the dayside heating region (cusp/cleft and auroral oval) is expected to be shifted toward lower-latitudes, far from the ESR-site during the disturbed conditions, it is suggested that N2+ enhancement measured by Reimei was not generated locally at the field line threading Reimei, but may be transported from the dayside heating region. In this presentation, we will present the recent results on the coordinated observations, and give the future subject for the EISCAT-3D project.

Keywords: Reimei, EISCAT, ion upflow, aurora, ionosphere

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Study on ion upflow and outflow with EISCAT_3D

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An important phenomenon of magnetosphere-ionosphere coupling is the formation of upwelling ions in the topside polar ionosphere. These upflows can be a significant loss of atmospheric gasses into interplanetary space and a significant source of magnetospheric plasma, which may also affect the dynamics of the magnetosphere. Key processes for upward ion flows in the topside ionosphere are suggested to be frictional heating, ambipolar diffusion driven by a heated electron gas, and transverse ion acceleration produced by plasma waves. It is critical to determine the relative importance of the different mechanisms in operation and to understand the 3D distribution and composition of the upflowing ions and neutrals. Moreover, there are several transitions of upflowing ions, for examples, from chemical to diffusion dominance at 500-800 km altitude, from subsonic to supersonic flow at 1000-2000 km altitude, and from collisional to collisionless region at 1500-2500km altitude. EISCAT_3D is one of the most suitable measurements to investigate such transitions because of its wider height coverage (up to about 2000 km) along the field line. EISCAT_3D will have more transmitter power density and higher sensitivity than those of the current Tromso UHF radar, and will give information of accurate thermal ion velocity, upward flux, and ion composition (O+, H+, and hopefully NO+). In this paper, potential investigations of ion upflow and outflow using the EISCAT_3D are shown, and desirable specifications of the EISCAT_3D are discussed.

Keywords: Polar ionosphere, EISCAT_3D, ion outflow

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Coordinated observations with Na resonance scattering lidar and EISCAT radar at the EISCAT Tromsoe site

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We have been operating a sodium (Na) resonance scattering lidar at the EISCAT Tromsoe site (69.6N, 19.2E) since 2010, in cooperation with the EISCAT radar. The Na resonance scattering lidar is capable to measure neutral temperature, neutral wind velocity, and sodium density. On the other hand, as a well-known fact, the EISCAT radar is a powerful tool for ionospheric measurements. Thus coordinated observations with the Na resonance scattering lidar and EISCAT radar will be an important key to resolve the atmosphere-ionosphere coupling process. In this presentation, we introduce the Na resonance scattering lidar observations at the EISCAT Tromsoe site, and then report some recent results, such as sporadic Na/E-layer event which is an aspect of ion-neutral dynamical and chemical interactions. Hopefully these results would be good examples to discuss possibilities of further collaborative observations using the Na resonance scattering lidar and the EISCAT/EISCAT 3D.

Keywords: Na resonance scattering lidar, EISCAT/EISCAT_3D, Tromsoe, Sporadic Na layer, Sporadic E layer

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Polar aeronomy with EISCAT_3D and GCM simulations

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The EISCAT radar system has had great contributions to probing the polar upper atmosphere in collaboration with observations from optical and radar instruments, magnetometers, rockets, and satellites more than 30 years. For the next stage, the EISCAT radar system seems to be still expected to undertake a role of the research center for the auroral atmosphere. The global warming and the resultant cooling in the upper atmosphere are one of the most important issues for aeronomy in the 21st century. In order to understand the long-term variations of the upper atmosphere, continuity of observations is necessary and the EISCAT observations will have great contributions to the topics. Challenges to unknown phenomena are also important for the new EISCAT radar system (EISCAT_3D). For example, the EISCAT_3D system and some instruments installed around the site will capture the turbulence which would be generated by breaking of atmospheric waves. This comprehensive monitoring of the atmospheric phenomena and space weather will enable us to predict the weather in the upper atmosphere with GCM simulations. In this presentation, we will show our research activity to date and future research plans with EISCAT_3D and GCM simulations.

Keywords: polar region, upper atmosphere, radar, GCM