Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM32-01 Room:201A Time:May 23 09:00-09:15

Gravity waves in the upper stratosphere - lower mesosphere observed by Rayleigh lidar at Syowa(2)

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The deposition of energy and momentum in the upper stratosphere and lower mesosphere (USLM) by gravity waves propagating upward from lower atmospheric sources strongly decelerates the polar night jet. The transfer of momentum into the background atmosphere induces large scale meridional circulation from the summer pole towards the winter pole. The existence of a stratopause over the winter pole is itself indicative of strong gravity wave dynamical forcing. A Rayleigh lidar was installed at Syowa, Antarctica (69S, 39E) in January, 2011. It has been operational since February and has measured temperature profiles between approximately 25 and 70 km for 115 nights in 2011. In this study, gravity wave activity in the USLM is investigated using the temperature data. The temporal and height variabilities of potential energy per unit mass of gravity waves with vertical wavelengths between 4 km and 20 km are analyzed. Gravity waves dissipate above 40-45 km during winter, while there is no dissipation in March-April and August in the USLM. As a result, the seasonal cycle of gravity wave activity shows single peak observed during winter in the upper stratosphere and double peaks observed in March-April and August in the lower mesosphere.

Keywords: middle atmosphere, atmospheric gravity wave, Antarctica, Reyleigh lidar, temperature

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PEM32-02 Room:201A Time:May 23 09:15-09:30

Initial results of daytime observation using an etalon for the Antarctic Rayleigh lidar (1)

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Monitoring the temperature from troposphere to mesosphere is vital, especially in the polar region for global warming and PMC. A Rayleigh lidar system was deployed at Syowa station for night-time temperature observation and started taking data. To upgrade the lidar for the daytime observation, we use an etalon as a simple and ultra narrow-band optical filter to reject a strong sunlight background. The test system has been built in Shinshu University. We report the initial results of the experiments.

Keywords: Antarctica, Rayleigh lidar, etalon, daytime observation

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PEM32-03 Room:201A Time:May 23 09:30-09:45

Simultaneous PMC and PMSE observations with a ground-based lidar and SuperDARN HF radar over Syowa Station, Antarctica

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A Rayleigh-Raman lidar system had been installed by the 52nd Japanese Antarctic Research Expedition on February, 2011 at Syowa Station Antarctica (69.0^{o}S, 39.5^{o}E). Polar Mesospheric Cloud (PMC) was detected by the lidar at 22:30UT (+3hr for LT) on Feb 4th, 2011, the first day of a routine operation. This event is the first time to detect PMC over Syowa Station by a lidar. In the same night, SuperDARN HF radar with oblique incidence beams also detected Polar Mesosphere Summer Echoes (PMSEs) during 21:30UT to 23:00UT. Although these signals were detected at different times and locations, PMC motion estimated using horizontal wind velocities obtained by a collocated MF radar strongly suggests that they have a common origin (i.e. ice particle). We consider that this event occurred in the end of PMC activity period at Syowa Station in the austral summer season (2010-2011), since the lidar did not detected any PMC signals on other days in February, 2011. This is consistent with satellite-born PMC observations by AIM/CIPS and atmospheric temperature observations by AURA/MLS instruments.

Keywords: polar mesospheric cloud, polar summer mesospheric echo, PMC, PMSE, lidar, HF radar

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PEM32-04 Room:201A Time:May 23 09:45-10:00

Study of mid-latitude ionospheric convection with SuperDARN Hokkaido radar

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Characteristics of ionospheric convection in the mid-latitude and sub-auroral regions have been studied by various kinds of observation instrument and computer experiments in the last few decades. Westward flows around midnight frequently observed at mid-latitudes have been extensively discussed. This kind of flow can be generated by so-called disturbance dynamo mechanisms working at mid-latitudes (Blanc and Richmond, JGR, 1980). Kumar et al. (2010, JGR) reported, using the data from Digisonde drift measurements at Bundoora (145.1 degrees E, 37.7 degrees S geographic, 49 degrees S magnetic), Australia, that the major storms affects the nighttime mid-latitude ionosphere for several tens of hours. In order to understand the influence of disturbances dynamo effects at the mid-latitude region, it is necessary to study the latitudinal distribution of westward flows.

The mid-latitude ionospheric convection characteristics have been studied extensively with the IS radar such as the Millstone Hill radar. However, most of the studies reported on the ionospheric convection characteristics at a fixed latitude with IS radar owing to the limitations of its operation. It is considered that it is more effective make two-dimensional observation such as the SuperDARN radar and the low-altitude satellite. Among them, the low-altitude satellite monitor the ionosphere with certain MLT / latitude region every 1 hour and 40 minutes approximately, so that monitoring of the ionospheric with high time resolution is impossible. On the other hand, most of the SuperDARN radars were set up in the high latitude region, and the observation of the HF radar in the mid-latitude region did not exist until recently. Because the mid-latitude region from 40 to 50 degree is not covered in the observation until the full deployment of the SuperDARN Hokkaido radar in December 2006, detailed study of the mid-latitude ionospheric convection using the SuperDARN was impossible.

In this study we use ionospheric echo data obtained by the SuperDARN Hokkaido radar for 5 years (since December 2006). The SuperDARN Hokkaido radar has been measuring line-of-sight velocities of ionospheric irregularities, which can be regarded as line-of-sight velocities of ionospheric convection, at mid-latitude (geomagnetic latitude: 40 to 60 degrees), which could not be monitored by using preexisting SuperDARN radars.We found the presence of westward flows around midnight at about 40 to 55 degrees geomagnetic latitude. In addition, the data showed that the westward flow around midnight was intensified under high geomagnetic activity (high Kp). This suggests that the disturbance dynamo is effective on the mid-latitude ionospheric convection.

Moreover, Superposed Epoch Analysis (SEA) has been performed in order to study the influences from the storm and substorm at mid-latitude ionospheric convection. We found during major storms (minimum Dst below -60nT), intense westward flows in the nighttime mid-latitude (geomagnetic latitude: 43 to 59 degrees) ionosphere were observed, lasting up to about 30 hrs after storm onset. However, A westward flow was observed even before the onset of storms, possibly due to the influence of substorm. In order to clarify the substorm effects in the next step, Superposed Epoch Analysis (SEA) is performed to study temporal and latitudinal dependence of the influences from substorms. From the analysis of 30 events of AL-defined substorms, we can see that the influence of substorms lasts up from 5 to 20 hours after the onset between 44 and 53 degrees geomagnetic latitude. The westward flow at mid-latitude grows to a maximum at 12 hours after the geomagnetic storm onset. This is consistent with the results of numerical simulation of the disturbance dynamo effect by Blanc and Richmond (1980).

Keywords: Hokkaido HF radar, SuperDARN, midlatitude ionospheric convection, disturbance dynamo, storm, substorm

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PEM32-05 Room:201A Time:May 23 10:00-10:15

Study of ionospheric disturbances during solar flare events with the SuperDARN Hokkaido Radar

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Ionospheric disturbances during solar flare events have been studied by various kinds of observation instrument in the last few decades. Hosokawa et al. (2000) showed that during solar flare events sudden fade-out of ionospheric backscatter echoes are registered by the high-latitude SuperDARN Radar. This indicates that electron densities in the E- and D-region ionosphere increase, leading to radio wave absorption. Kikuchi et al, (1986) reported on the positive Doppler shift in the HF Doppler system data during solar flare events, and indicated that there are two possible factors of Doppler shift, i.e., (1) apparent ray path decrease by changing refraction index due to increasing electron densities at D-region ionosphere, and (2) ray path decrease due to descending reflection point associated with increasing electron density at F-region ionosphere.

In this study, we use the SuperDARN Hokkaido Radar to investigate the detailed characteristics of solar flare effects on ionospheric disturbances.

We focus on positive Doppler shift of ground / sea scatter echoes just before sudden fade-out of echoes. Since the factors (1) and (2) discussed above have different dependence of Doppler velocities on echo range or elevation angle, we can analyze carefully Doppler velocity of radar echoes with their dependences on echo range and elevation angle to obtain information on the electron density changes in the D- and F-region ionosphere. Initial results of the analysis will be presented.

Keywords: solar flare, ionospheric disturbance, doppler shift, SuperDARN Hokkaido Radar

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PEM32-06 Room:201A Time:May 23 10:45-11:00

Variations in tweek reflection height observed at Kagoshima during magnetic storms

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Variations of the D- and lower E-region ionosphere at middle and low latitudes associated with magnetic storms have been investigated using satellites and ground VLF signals. Kikuchi and Evans (1989) reported unusual enhancements of energetic electron fluxes over Japan at L = 1.3 during a large magnetic storm based on NOAA-6 satellite data. Araki (1974) reported that the phase of trans-equatorial VLF signals from a transmitter changed anomalously at night during the main phase of two large magnetic storms. Peter and Inan (2004) reported that the occurrence rates of lightning-induced electron precipitation (LEP) events depend on geomagnetic activities. Ohya et al. (2006) reported the response of the nighttime D-region ionosphere to the great magnetic storm of 2?12 October 2000. The tweek reflection height significantly decreased by approximately 10 km at 15:50?16:50 UT on 2 October and at 12:50 UT on 3 October in the beginning of the storm. However, the response of the D-region during magnetic storms has not sufficiently known yet. In this study, we investigate variations in tweek reflection height during several storms observed at Kagoshima over 35 years from 1976 to 2011. The descent (rise) of the reflection height corresponds to increase (decrease) in electron density in the ionospheric D- and lower E-regions. The variations in the tweek reflection height observed at Kagoshima during magnetic storms correspond to the variations in electron density at low and middle latitudes in the lower ionosphere. For example, during a magnetic storm of 26 August- 6 September, 1978 (the peak of Dst index: -226 nT), the hourly tweek reflection height suddenly fell by about 5 km several times during the storm recovery phase. In the presentation, we show variations of in the tweek reflection height during several magnetic storms.

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PEM32-07 Room:201A Time:May 23 11:00-11:15

Global distribution of magnetic fluctuations in middle and low latitudes as observed by CHAMP satellite and their origin

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An preliminary analysis of the magnetic field observed by the CHAMP satellite shows the ubiquitous existence of small scale (1 nT - 5 nT) magnetic oscillations with period shorter than a few tens seconds along the satellites path. Followings are their characteristics.

1. The amplitude of magnetic fluctuations observed on the dayside is much larger than that on the nightside.
2. The amplitude in the East ? West component is largest.
3. The magnetic variation on the magnetic dip equator is very small.
4. The period tends to become longer with the decrease of latitude.
5. The dependence on geomagnetic activity is weak.
6. The dependence on the solar winds parameters is weak.
7. The global distribution of the amplitude depends on the season and suggests the effect of continent and ocean.

These characteristics cannot be explained by the known phenomena having solar winds and magnetospheric origin including Pc 3 micro-pulsations. It is interpreted as the spatial structure of small scale field-aligned currents with both edges on the ionosphere. The structure of the current system and its generation mechanism will be discussed.

Keywords: CHAMP statellite, magnetic variation with periods shorter than 30 seconds, the above layer of the ionosphere, field-aligned current, neutral oscillation in the ionosphere, the origin in the lower atmosphere

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PEM32-08 Room:201A Time:May 23 11:15-11:30

Four minutes acoustic resonance detected above the epicenter of the 2011 Tohoku earthquake

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Total electron content (TEC) oscillation in four minutes period was observed above the epicenter after the M9.0 Tohoku earthquake on March 11, 2011. It was observed by a GPS receiver array after the earthquake for four hours in the vicinity of the epicenter. The frequency of the dominant mode of the oscillation was 4.5mHz, 222 seconds of period, while there were minor oscillations whose frequency were 3.7mHz and 5.3mHz. These periods are consistent with the periods of the acoustic resonance between the ground surface and the lower thermosphere, predicted by a numerical model. The amplitude of the TEC oscillation showed gradual change of the amplitude. This would be generated by the beat of two modes of the resonance. The reflection height of the acoustic wave is considered around 100km altitude. The TEC oscillation would be caused by the acoustic wave that leaked from the reflection layer vertically. The two-dimensional distributions of TEC variations generated by this resonance showed wave frontal structures that stretched from northwest to southeast, and traveled to the southwest direction. These structures cannot be explained by the propagation of the acoustic wave. The interaction between the neutral wave and the ionized atmosphere would play a role in the formation of these frontal structures of TEC. The ionospheric variations above the epicenter after the earthquake will be presented.

Keywords: ionosphere, earthquake, acoustic resonance, 2011 Tohoku earthquake, GPS, total electron content

PEM32-09 Room:201A Time:May 23 11:30-11:45

Simulation of atmosphere-ionosphere variations associated with the Tohoku-oki earthquake

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Significant ionospheric variations were observed after the great Tohoku earthquake on March 11, 2011. The variations consist of oscillations with a period of about 4 minutes, traveling ionospheric disturbances with a speed of a few hundred meters to a few kilometers per second, impulsive enhancement of total ionospheric content (TEC) followed by a significant decrease of TEC near the epicenter. We used a two-dimensional model of nonhydrostatic atmosphere-ionosphere coupled model to study the behavior of the ionosphere after the earthquake. The model is able to reproduce overall behavior of the total electron content (TEC), indicating that the ionospheric variation is explained by a combination of acoustic waves generated directly at the epicenter and secondary gravity waves generated at the bottom of the thermosphere. However, various observations suggest that the ionosphere is also affected by acoustic and gravity waves generated by seismic waves and by propagating tsunamis. We will report simulation results of ionospheric variations caused by those processes.

Keywords: earthquake, tsunami, ionosphere, atmosphere, wave, simulation

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PEM32-10 Room:201A Time:May 23 11:45-12:00

The latitudinal distributions of the airglow observed by the Reimei satellite

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The latitudinal structures of the O airglow (557.7-nm wavelength) and the OH airglow (670-nm wavelength) observed by the Reimei (INDEX) satellite were studied. Optical observations of the airglow emission by the ground-based imagers has been carried out for a few decades. There are observations by the satellites such as UARS in 1990s and TIMED in 2000s. The observational data of the O airglow and the OH airglow taken by the Multi-spectral Auroral Camera (MAC) on the Reimei satellite are used in this study. Data observed in more than 1,000 paths for each wavelengths taken from March 2008 to January 2011 are used in this study. The Reimei satellite observes the airglow emissions in the region from 45^{o}N to 15^{o}N. Maxima of the volume emission rate around 30^{o}N in the airglow observations are found from the statistical study. Observational data taken in the region from 90^{o}E to 180^{o}E where large number of observational data exists are used in these statistical studies. It can be said the number density of O and OH molecules are affected by the atmospheric tide from this study. Volume emission rate of the source is also affected by the atmospheric gravity wave.

Keywords: satellite observation, limb observation, airglow, latitudinal structure

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PEM32-11 Room:201A Time:May 23 13:45-14:00

Mesospheric gravity wave propagation observed by OMTI multi-station network

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Atmospheric gravity waves significantly contribute to the wind/thermal balances in the mesosphere and lower thermosphere (MLT) through their vertical transport of horizontal momentum. It has been reported that the gravity wave momentum flux preferentially associated with the scale of the waves; the momentum fluxes of the waves with a horizontal scale of 10-100 km are particularly significant.

Airglow imaging is a useful technique to observe two-dimensional structure of small-scale (<100 km) gravity waves in the MLT region and has been used to investigate global behavior of the waves. Solar-Terrestrial Environment Laboratory, Nagoya University has made long-term airglow imaging observations in the world using the Optical Mesosphere and Thermosphere Imager (OMTI) system. All-sky airglow imagers of OMTI have interference filters on rotating wheels to observe airglow emissions in the vicinity of the mesopause (OI 557.7-nm, emission height ~96 km; OH Meinel-bands, ~86 km) and the ionosphere (OI 630.0-nm, ~250 km). In the Far East region, four OMTI stations are now up and running: from north to south, Yoyaguni (24.5N, 123.0E), Sata (31.0N. 130.7E), Shigaraki (34.9N, 136.1E) , Rikubetsu (43.5N, 143.8E), Japan, and Paratunka (53.0N, 158.2E), Russia. This multi-station network covers an area elongating from southwest to northeast (~25x25 degrees, including almost all part of Japan) and allows us to identify the horizontal extent of gravity wave propagation in much wider range than ever. Based on the long-term measurements of OMTI since 1997, we found some events showing gravity waves widely prevailing over Japan.

In the presentation, we will report observational results of the OMTI multi-station measurements concerning small-scale gravity waves in the MLT heights.

Keywords: atmospheric gravity waves, airglow imaging observation, mesosphere and lower thermosphere, OMTI

PEM32-12 Room:201A Time:May 23 14:00-14:15

Observational results with the Tromsoe sodium LIDAR from September 2011 to March 2012

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On October 1, 2010, the new sodium LIDAR installed at Ramjordmoen, Tromsoe (69.6N, 19.2E), where the EISCAT radars, MF radar, meteor radar (NIPR), FPI, aurora imagers have been operated, started observations of neutral temperature in Mesosphere-Lower Thermosphere (MLT) region (80-110 km). During the 1st season from October 2010 to March 2011, the LIDAR provided neutral temperature data with time resolution of 10 min - 20 min in total about 255 hours. For September and October, 2011, we upgraded the LIDAR system. They are (1) higher laser power output (about 2.7W), (2) reduction of loss of power in the laser system, (3) easy monitor of field-of-view of the telescopes, and (4) improvement of operation programs.

This talk will give an overview of results obtained with the sodium LIDAR over about 6 months (September 2011 - March 2012) for the second season of the LIDAR observation at Tromsoe. We operated the sodium LIDAR with five beam modes from September 21 to October 5, 2011 and October 22-26, 2011. On the other hand, vertical (1-beam) mode from November 9, 2011 to March 13, 2012 (planed) is used. Between November 7, 2011 and March 13, 2012, at least one of operates run the LIDAR every night-basis. During the second season, we made simultaneous observations with EISCAT radars for about 20 nights. By February 16, 2012, we have obtained about 760 hrs of temperature data. Time resolution is 6 min.

We will summarize observational results between September 2011 and March 2012. In particular, we focus on wave variabilities and simultaneous observational results with the EISCAT radars.

Keywords: sodoum LIDAR, polar mesosphere and lower thermosphere, EISCAT, atmospheric wave

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PEM32-13 Room:201A Time:May 23 14:15-14:30

Study on upward propagating atmospheric gravity waves in the polar MLT region using the Tromsoe sodium LIDAR data

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Atmospheric gravity waves (AGWs) propagating upward from the lower atmosphere dissipate and provide significant amount of energy and momentum into the upper mesosphere and the lower thermosphere. These mechanisms play an important role for momentum balance and energy budget in the upper mesosphere and (possibly) lower thermosphere (MLT). Additionally at high latitudes, dissipation of the electromagnetic energy from the magnetosphere comes into play. Both contributions are equivalently important for energy balance in the polar MLT region. However, effects from the lower atmosphere can be dominant for periods of geomagnetically quit condition. In this case energy/momentum dissipation by upward propagating AGWs is one of major mechanisms to take atmospheric balance in the MLT region. However, our knowledge about AGWs in the polar MLT region has not yet reached maturity because of few observations.

Temperature variations measured with a sodium LIDAR installed at Tromsoe (69.6 deg N, 19.2 deg E), Norway showed wave-like structures on October 29, 2010 in the height region from 80 to 105 km during geomagnetically quit periods. Spectral analysis provided oscillation period and vertical wavelength of about 4 hours and about 8.8 km, respectively. The amplitude had a peak at 85 km with 15 K. Of particular interest is temporal development of the height where AGWs reach. While wavelike structures appeared to propagate up to about 95 km from 1630 UT to 2100 UT, they seemed to propagate to higher level (at least 100 km) from 2100 to 0030 UT. Two candidate mechanisms to produce the temporal development were evaluated: wave dissipation and wind filtering. The temperature in the wave dissipating region increase from the background level, resulting in atmospheric instability, which can be evaluated by the Brunt-Vaisala frequency and the Richardson number. The wind filtering process works at which the phase velocity of AGWs is equal to the background wind velocity (this height is called critical layer). AGWs do not propagate further upward beyond the critical layer. Comparison of these two mechanisms from 1700 UT to 2400 UT concluded that wind filtering effect was predominant for this event rather than the wave dissipation process.

Theoretical predication regarding the wind filtering and wave dissipation processes has already proposed. However, we need more observational works to assess the validity of the theory, particularly at high latitudes. This study presented a clear example that LIDAR-derived AGWs are successfully explained by the theory at high latitude.

Keywords: gravity wave, filtering effect, sodium LIDAR, MLT region

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PEM32-14 Room:201A Time:May 23 14:30-14:45

Study of the lower thermospheric wind in the polar cap using EISCAT data obtained in 2 solar cycles

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We will report results of the lower Thermospheric wind in the polar region by using EISCAT data. We have analyzed wind data obtained for 25 years from November 1986 to February 2012 by the EISCAT UHF radar at Tromsoe (69.6 deg N, 19.2 deg E) and for about 13 years from July 1998 to February 2012 by the EISCAT Svalbard radar (ESR) at Longyearbyen (78.2 deg N, 16.0 deg E). The data of about 300 days are analyzed, and mean winds and tides were derived. We also derived quasi-two day wave (Q2DW) for consecutive datasets (at least 8 days long). By using the data sets, we investigated the lower Thermospheric wind dynamics in the polar region. In particular, special attentions are paid to seasonal variation, solar activity dependence, geomagnetic activity dependence, and latitudinal difference of those between Tromsoe and Longyearbyen.

Keywords: EISCAT radar, tidal wave, quasi two wave, latitudinal variation

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PEM32-15 Room:201A Time:May 23 14:45-15:00

EISCAT_3D (Next-Generation IS Radar Project for Atmospheric and Geospace Science) and EISCAT: Current status and roadmap

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The EISCAT Scientific Association (current member countries: China, Finland, Japan, Norway, Sweden and United Kingdom) is actively preparing for the construction of its next-generation radar, which will provide comprehensive 3D monitoring of the lower/middle/upper atmosphere and ionosphere. The EISCAT_3D radar will consist of multiple phased arrays, using the latest signal processing and beam-forming techniques to achieve ten times higher temporal and spatial resolution than the present radars. EISCAT_3D will be a volumetric radar, capable of imaging an extended spatial area with simultaneous full-vecter drift velocities, designed for continuous operation modes, short-baseline interferometric capabilities for sub-beamwidth imaging, real-time data access and extensive data archiving facilities. The highly modular and expandable design envisages a system with at least one circular active array comprising 16,000 antennas. This central site will also include outlying antennas for imaging applications. At least four smaller remote sites, comprising receiving arrays of some 8,000 antennas will be located between 50 and 150km from the central site.

In 2008, the European Strategy Forum on Research Infrastructures (ESFRI) selected EISCAT_3D for inclusion in its roadmap of large-scale European environment research infrastructures for the next 20-30 years. In 2010, the EISCAT_3D Preparatory Phase Program (2010-2014) started following the EISCAT_3D Design Study Program(2005-2009), funded by EU.

In this paper, we present the current situation of the EISCAT and the EISCAT-3D project including the scientific capabilities in order to call for interests and to form consortium among the domestic user communities.

Keywords: Incoherent scatter radar, Ionosphere, Thermosphere, Mesosphere