Multi-scales study of plasma horizontal and vertical transportation around cusp region using joint-observations with GCI-Cusp project

No. 2018_0005

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Short Summary

Investigating and understanding the basic processes of the horizontal and vertical transportation of polar cap patches in multi-scales around the cusp regions from the joint-observation measurement campaigns using multiple instruments especially over Svalbard islands.

I Project

The purpose of this proposal is focusing on the transportations of polar cap patches in multi-scales from both horizontal and vertical directions around cusp region and their impacts on M-I-T coupling processes and space weather through coordinated investigations of multiple observations (including data from GNSS Receivers, ISRs, SuperDARN, all sky imagers, in-situ rockets, as well as DMSP/MMS/SWARM satellites, etc.).

In order to achieving our research goals, we have identified the investigation themes which will exploit the coordinated observations, which draw on the expertise of our team. Specific scientific questions relating to these themes are described below:

1). How do plasma transport in multi-scales and influence the cusp dynamical processes taking place from subauroral to polar latitudes?

Topics which will be addressed with coordinated data from multiple instruments are: dominant formation mechanism; MLT and IMF Bz, By occurrence; full evolution during various solar wind and IMF conditions; mechanism modulating patch plasma exiting the polar cap; internal plasma features; the mechanisms of keeping their high density during patch evolution.

2). What is the relative importance of ionospheric processes and of coupling from the magnetosphere and thermosphere in determining the formation, evolution and characteristics of polar cap patches and its impacts on the M-I-T coupling?

Topics which will be accessed by theoretical, simulations and observational studies are: how does the E×B drift transport the patch along the convection stream lines from dayside to nightside? The relationship between patches/aurora and other irregularities (e.g. SED, TOI, SAPS, etc.) and the associated dynamical processes, the ion upflow and their acceleration mechanisms, the impacts on the M-I-T coupling processes and the solar wind.

II Contribution to SIOS

Based on the expertise of applicants, we are confident to provide contributions to the SIOS/ESS/observing system as follows:

1). Observations: The team members will apply the operation time of all sky imagers at Chinese Yellow River station and EISCAT Svalbard Radar to support GCI-cusp rockets launching and flights, and also enable to access multiple datasets, such as the global GPS TEC and SuperDARN datasets, etc. These joint measurements and datasets can be used to making sure the GCI-cusp rockets launch time, as well as to conjugate observation the ionospheric conditions during the rocket flight.

2). Data archive: after deliberately processed, the data can be archived under multi-levels, including the raw data and the second level and more. It will offer a convenient way to access for public users who are interested in.

3). Scientist analysis: the continued work to processing the observed data and then researching the physics questions will be carried out on time, sufficiently releasing the value of these hard-earned measurements.

III Method

In order to deeply understand the basic physics associated with plasma transportation in multi-scale (polar cap patches and aurora) around cusp region, a couple of steps has been proposed to investigate, which are descripted as follows:

1). Processing the observational data taken with ground-based and space-based instruments during the designed joint observations over Svalbard region;

2). Archiving the processed data into the SIOS data center and making it available to access;

3). Scientific analysis of the observations , following and then exploring the basic physic processes.

IV Expected outputs

Based on GCI-Cusp project and the multiple ground-based and space-based observations as well as theory and simulations experience, we expect to advance our understanding of polar cap patch formation and interaction with other regions, specifically:

1). Investigating the role of the E×B drift for patch transportation.

2). Exploring the relationship between the motions of patches and the processes in the ionosphere/thermosphere even solar wind.

3). Advancing the wave propagation and turbulence to transfer energy from the solar wind.

V Background

The aims of our proposed project can also be fulfilled due to we are always working on the polar ionosphere. The polar ionosphere group at Institute of Space Science, Shandong University, China has rich experience on the study of polar region, especially on the polar cap patches and aurora and O^+ upwelling and also scintillations. A series of high-quality papers had been published, which were done on the basis of the multiple measurement over the polar region [e.g., *Ma et al.*, 2018; *Wang et al.*, 2016, 2018; *Xing et al.*, 2018; *Zhang et al.*, 2011, 2013a, 2013b, 2015, 2016, 2017]. Our group includes experts in the observations of GPS TEC/scintillation, ISR, SuperDARN, and all-sky imagers, together with space-based expertise. From these stated advantages, it can be certainly asserted that the observing system will be benefited from our expertise on many aspects, such as analysis of existing data, integration datasets, creating new data products that are made available if apply for. We can also provide the all-sky data from Yellow-river station of China and apply for the observation time of ESR radar to support this proposal through national cooperation.

VI Briefly references

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