Project Details

ROSES ID: NNH19ZDA001N
Selection Year: 2019
Program Element: Focused Science Topic

Topic: Causes and Consequences of Hemispherical Asymmetries in the M-I-T System

Project Title:
The impact of the hemispheric asymmetry on the thermal structure and airglow in the Magnetosphere-Ionosphere-Thermosphere (MIT) system

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Summary:
MOTIVATION:
Remote sensing observations of airglow emission have been used to infer the dynamics and chemistry of the upper atmosphere and ionosphere. Airglow observations tend to pose challenges in their interpretation mainly because it is difficult to identify the various sources of airglow emission associated with photoelectrons, aurora precipitation, various excitation, production and loss mechanisms. To overcome these challenges, GLOW model has widely been used to reproduce the observed airglow. In spite of many successful previous studies owing to the availability of the model to the community, however, a considerable degree of uncertainty still exists because of the presence of the hemispheric asymmetry. One of the major cause of the uncertainty could be atributed to superthermal electrons (SE) originating from the conjugate hemisphere and the overall SE dynamics in the coupled MIT system generated by asymetric conditions of background atmosphere in the conjugate hemispheres. Very few studies have quantified the role of conjugate SEs in observations primarily due to lack of observations. Furthermore, even fewer studies have addressed the impact of conjugate SEs on airglow emission and the thermal structure of the MIT system.

SCIENCE GOALS AND OBJECTIVES:
The main objectives of this proposal are to quantify the impact of the hemispheric asymmetry of SEs in the coupled MIT system on airglow emission and thermal structure of the upper atmosphere, with a focus on elucidating the causes and the consequences of the hemispherical asymmetries. The proposal will address the following three specific science questions: (1) What is the role of the hemispheric asymmetry in the formation of SE fluxes in the MIT system?; (2) How much of the observed airglow can be attributed to the SE originating from the conjugate hemisphere and how MIT SE coupling impact on the overall airglow sources in both magnetically conjugate regions?; (3) To what degree do SE originating from the conjugate hemisphere play a role in the energetics of the ionosphere and plasmasphere and how much their energy can be lost in the magnetosphere and redistributed back to the IT system?

METHODOLOGY:
We will simulate MIT coupling effects by taken into account of hemispherical asymmetries in the MIT system based of the rigorous coupling of the two well documented codes: IPE and STET. The Ionosphere-Plasmasphere-Electrodynamics (IPE) model is a time dependent, three-dimensional, global model of the ionosphere and plasmasphere. Super Thermal Electron Transport (STET) model includes the full solution of the Boltzmann-Landau kinetic equation for SEs in the energy range of 1 eV to 50 KeV along the magnetic field line from the 90 km in the Northern hemisphere to the 90 km to magnetically conjugate region. STET code will be moved to the architecture of the IPE model with the adjustment of all input parameters of the IPE code including the realistic configuration of the magnetic field (IGRF) and statistical electron precipitation pattern based on NOAA measurements. The neutral and plasma densities structure that simulated by IPE code will be two way coupled with the STET simulations. The electron distribution function obtained from the coupled IPE-STET code will be used to calculate the thermal structure of ionosphere and plasmasphere and airglow emissions. Furthermore, we will compare model simulations with various NASA missions (e.g., FAST, GOLD) and supplementary ground-based observations with the focus on causes and the consequences of the hemispherical asymmetries.

Proposed Contributions to the Focused Science Team Effort:
We will plan to provide to the team such parameters including plasma densities and temperatures, energy flux, energy spectrum with emphasis on the low energy tail, as well as any improvements we will have made to the GLOW code obtained from our project in improving the emission calculation.

Publication References:

Summary: Blah

Reference: Obana, Y., Y. Miyashita, N. Maruyama, A. Shinbori, M. Nose, M. Shoji, A. Kumamoto, F. Tsuchiya, S. Matsuda, A. Matsuoka, Y. Kasahara, Y. Miyoshi, I. Shinohara, W. S. Kurth, C. A. Kletzing, C. W. Smith, R. J. MacDowall (2021), Field-Aligned Electron Density Distribution of the Inner Magnetosphere Inferred from Coordinated Observations of Arase and Van Allen Probes', J. of Geophys. Res.: Space Physics, https://doi.org/10.1029/2020JA029073

- **Investigation Type:** Other Investigations
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Reference: 10. Khazanov, G. et al., (2022), Electron Heat Fluxes Generated by Intense Whistler Waves at the Upper Ionospheric Altitudes, J. of Geophys. Res.: Space Physics, https://doi.org/10.1029/2022JA030753

- **Investigation Type:** Other Investigations
- Blah

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Reference: