Project Details

ROSES ID: NNH21ZDA001N
Selection Year: 2021
Program Element: Focused Science Topic

Topic: Pathways of Cold Plasma through the Magnetosphere

Project Title:
Understanding warm plasma cloak in the magnetosphere

PI Name: Chih-Ping Wang
PI Email: cat@atmos.ucla.edu
Affiliation: University of California, Los Angeles
Project Member(s):
- Lin, Yu;Co-I;Auburn University
- Wang, Xueyi;Co-I/Institutional PI;Auburn University

Summary:
Science goals and objectives:
The warm plasma cloak (ions of a few eV to hundreds of eV and bidirectional field-aligned) is one of the two major cold magnetospheric populations (the other one being cold plasmasphere) and it plays important roles in several key magnetospheric processes. There is an important aspect of plasma cloak ions that is missing from the previous observational and simulation studies. It is quite often to observe large enhancements (up to a factor of 10) in the cold field-aligned ion fluxes (cloak ions and outflow ions) on a time scale of a few minutes to tens of minutes with a spatial extent of a few RE, and the enhancement can exhibit an energy-dispersion feature. This mesoscale enhancement shows a dynamic aspect of the formation of the cloak ions that have not been explored and understood. Therefore, the overreaching science goal of this study is to establish a better understanding of the strong mesoscale enhancements of the plasma cloak ions from observations and to investigate the responsible physical processes with global kinetic simulations. Our two objectives are: (1) Objective 1. Establish observational understanding of mesoscale enhancements of plasma cloak ions using THEMIS data. (2) Objective 2. Establish physical understanding of plasma cloak mesoscale enhancements using 3D global hybrid simulations.
Methodology:
Observation data: We will use satellite data from THEMIS (2007 to 2020) to investigate plasma cloak ions and outflow ions.
Observation Tasks: (1) Investigate each mesoscale enhancement of field-aligned cold ions observed by THEMIS and characterize its temporal variation (field-aligned type and energy-dispersion types), spatial extent, and the corresponding plasma sheet conditions. (2) Statistically determine the mesoscale enhancements of field-aligned cold ions according to their characteristics in energy-dispersion, field-aligned type, spatial extent, their dependences on MLT sectors and the plasma sheet conditions.
Simulation: We will use the 3D global hybrid code (ANGIE3D) developed at Auburn University to self-consistently simulate ion kinetic processes for the formation of H+, He+, and O+ plasma cloak in a realistic and dynamic magnetosphere. ANGIE3D has been used to study the ion dynamics within the Earth's magnetosphere.
Simulation Tasks: The proposed simulation runs will be conducted in two different ways: (1) Artificially specify and control the outflow ions. We will run simulations with factors controlling the ionospheric sources. And we will run simulations with steady and disturbed plasma sheet conditions. (2) Using empirical outflow models driven self consistently by the simulated magnetosphere. We will conduct two simulation runs, one with steady and one with disturbed plasma sheet, using the empirical outflow driven self-consistently.
We will conduct observation-simulation comparisons to determine which physical processes can contribute to the observed mesoscale enhancements of cloak ions.
Relevance: Our proposed study of the plasma cloak is directly relevant to the Focused Science Topic (FST) #2 Pathways of Cold Plasma through the Magnetosphere". Our goal is directly relevant to the goal of FST #2 make significant progress towards understanding and predicting the complex feedback between ionosphere outflows and magnetospheric plasma". Our two objectives are relevant to the objectives of FST #2 Provide a better understanding of the origin of the warm plasma cloak; and to understand the factors controlling these sources." Our results can contribute to the Science Team's effort to improve the characterization of cold plasma composition and distributions" and advance the self-consistent modeling of cold plasma processes and processes controlled by the cold plasma" Our study directly addresses a goal from Heliophysics Decadal Survey, Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere".

Publication References:

no references