2016 Workshop: Exosphere impacts on the plasmasphere

Long title
What is the composition of the exosphere and how does it influence the topside ionosphere and plasmasphere?
CEDAR-GEM
Conveners
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Description

What is the composition of the exosphere and how does it influence the topside ionosphere and plasmasphere? Neutral hydrogen plays an important role in determining the state of the plasmasphere and its response to forcing from geomagnetic storms. Neutral oxygen plays an important role in the charge-exchange reaction that produces H+ in the topside ionosphere. The O+ component of the topside ionosphere acts as a barrier to the escape of H+ into the plasmasphere.

Variations in H and H+ with the solar cycle can be counterintuitive: not only is there more H in the thermosphere at solar minimum, reducing O+ or reducing the thickness of the O+ profile can lead to increased H+ in the topside ionosphere and plasmasphere. We will discuss interactions between the thermosphere/exosphere and the ionosphere/plasmasphere systems.

Interesting topics include:

- Are models that extend the thermosphere into the exosphere correct?

- How best to measure the composition of the exosphere?

- How does the composition of the exosphere affect the topside ionosphere and plasmasphere?

- How does the influence of the exosphere vary with the solar cycle?

- How much H is in the exosphere and what is its affect?

- What is the state of thermosphere/exosphere/ionosphere/plasmasphere modeling?

- What is the state of thermosphere/exosphere modeling?

- Where does H/O+ charge exchange happen?

Agenda

List of presented topics:

Jonathan Krall, Plasma Physics Division, U.S. Naval Research Laboratory, The effect of atmospheric O and H on the plasmasphere (pdf)

John Emmert, Space Science Division, U.S. Naval Research Laboratory, Ion and neutral mass fractions (pdf)

Alan Burns, High Altitude Observatory, National Center for Atmospheric Research, On the physical processes, controlling the supply of H in the thermosphere (pdf)

Ed Mierkiewicz, Department of Physical Sciences, Embry-Riddle Aeronautical University, Measurements and structure of the exosphere (pdf) (invited)

Rodney Viereck, National Oceanic and Atmospheric Administration, Exospheric hydrogen density estimates from GOES solar Lyman-alpha measurements (pdf)

Robert Schunk, Center for Atmospheric and Space Sciences, Utah State University, Polar outflows and their sensitivity to O and H in the exosphere (invited)

Daniel Weimer, Center for Space Science and Engineering Research, Virginia Tech, Strong correlations between oxygen in thermosphere, SABER measurements of CO_2 emissions, and the annual/semi-annual variations (pdf)

Jianqi Qin, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Accurate Quantification of the Atomic Hydrogen Density in the Terrestrial Thermosphere and Exosphere (Lyman alpha limb scanning) (pdf)

Richard Denton, Department of Physics and Astronomy, Dartmouth College, Mass density at geostationary orbit and apparent mass refilling (pdf)

Raluca Ilie, Climate and Space Sciences, University of Michigan, The effect of the exosphere on the lifetimes of ring current ions. (pdf)

Alex Glocer, Simulation result showing affect of 2x Hydrogen on a storm (pdf)

Susan M. Nossal, Department of Physics, University of Wisconsin, Solar cyclic and climatic influences on thermospheric hydrogen (pdf)

John Noto, The challenge and importance of learning the H distribution in the upper atmosphere (pdf)

Discussion: What are the implications for geospace?

Justification

We consider the following challenge: What is the composition of the exosphere and how does it influence the topside ionosphere and plasmasphere? We are motivated by the CEDAR strategic plan, particularly Strategic Thrust #1: Encourage and Undertake a Systems Perspective to Geospace, and Strategic Thrust #2: Explore Exchange Processes at Interfaces and Boundaries. Each of these focus on the space-atmosphere interaction region (SAIR). This challenge is timely because recent work has suggested that the H and O content of the exosphere may differ significantly from empirical models and that the flow of electrons into the plasmasphere may be particularly sensitive to exospheric composition.

This session will include all three implementation points of Strategic Thrust #2. Accordingly, we will

- Characterize sources and sinks internally and externally to the SAIR and their possible variations due to the coupling and complexity of the Sun-Earth system.

- Advance theories and coupled models that account for processes at transitions and across boundaries.

- Develop computational resources, techniques, and analyses enabling predictive capabilities that incorporate boundary and transitional effects.

This session is intended to raise as many science questions as it answers. Accordingly, progress will be measured by both the number of new, cogent, tractable science questions raised and by the degree to which data and models come into alignment.

Summary

Workshop Summary

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