2018 Workshop: High Latitude Winds and Plasma Drifts

Long title
Characterizing neutral wind/plasma dynamics at high latitudes below 350 km
Conveners
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Description

A number of recent NASA sounding rocket campaigns have sought to understand the interactions of the motions of neutral gases (i.e., winds) with those of the ionized gas using a variety of space based in situ measurements, vapor trail techniques, and ground-based observations including Fabry-Perot interferometers and radars. In some cases, all of these techniques have been used simultaneously. Some particularly innovative missions have involved the successful deployment of multiple vapor trails distributed in three dimensions on numerous “sub payloads” deployed simultaneously.

These recent measurements provide a new window on the highly dynamic neutral gas and its variations with altitude, often exhibiting large shears and significant flow amplitudes that change markedly with altitude. The data present a fresh perspective on our present understanding of not only the wind variations themselves, but more importantly, what drives these motions and, in particular, how does the ambient environment regulate the evolution and response of the neutral gas motions.

As an example, the Auroral Jets mission included two simultaneous rocket flights with different apogees (190 km and 331 km) over an initially stable auroral arc. By combining ground-based FPI array data, incoherent scatter radar, TMA releases, and in situ measurements, this straightforward experimental geometry provides new insights into neutral wind structures generated by auroral forcing. Results from other rocket campaigns to be reported at this workshop include data gathered from multiple sub-payloads which released either neutral or ionized vapor trails to provide, for the first time, a three dimensional picture of the complex, coupled

dynamic gas flows.

Whereas these recent rocket measurements helped to motivate this session, the main focus of the workshop is to incorporate ALL observational and modeling studies that address the highly dynamic and structured nature of ion-neutral coupling at high latitudes. In this regard, the ensemble of theory and data enable definitive tests of a variety of physics-based models and advance our understanding of how the thermosphere responds to auroral ionospheric electrodynamics as well as from forcing from below.

This workshop welcomes discussions of ground-based and rocket-related data as well as other research efforts that seek to explore neutral dynamics in the context of our present understanding of high latitude upper atmosphere/ionosphere physics and models. The goal of this workshop is to both present observational results and also to discuss data analysis and interpretive strategies to understand the data and to interpret future measurements of continuous ground-based measurements, in particular.

Agenda

R. Pfaff/Overview of the Auroral Jets Dual Sounding Rocket Mission

J. Clemmons/Observations Gathered on the Auroral Jets Rockets

M. Larsen/High Latitude Upper Atmosphere Winds and Remarks on the Auroral Jets Observations

R. Walterscheid/Theory and Model of Upper Atmospheric Winds Associated with Auroral Arcs

M. Conde/Ground and Rocket Based Studies of Small Scale Thermospheric Dynamics

K. Branning/Resolving height profiles of E-region winds using passive Doppler remote sensing: strengths and weaknesses

J. Elliott/Geophysical inversion inferred neutral winds for the night of March 2, 2017

S. Kaeppler/PFISR observations of upper atmosphere winds

Justification

Sounding rocket measurements of neutral and plasma gas dynamics carried out in conjunction with ground-based radar and Fabry-Perot measurements provide a powerful means to advance our knowledge of neutral winds and their variations with altitude using data that can not be obtained in any other way. Furthermore, many on-going CEDAR initiatives gather ground based observations of neutral winds and plasma drifts and develop state-of-the art models to interpret ion-neutral coupling at high latitudes. This workshop not only provides the CEDAR community with an opportunity to view the latest experimental results, but also it encourages a wide interpretation of the results by bringing together the larger ITM/MLT community, particularly those who focus on theory and modeling. In this manner, the workshop provides an opportunity for the experimentalists to expand their collaborations within the wider CEDAR community.

Science challenge:

How do the observational data contribute to and/or alter our understanding of the coupled high latitude ionosphere/upper atmosphere, particularly at lower altitudes below 350km?

i.) Associated questions to be addressed involve the coupling of the neutral winds with the plasma drifts of the lower auroral ionosphere and its coupling to the magnetosphere through currents and electric fields.

ii.) Existing resources include a variety of highly unique observation case studies and existing models. Planned/needed resources include more fully developed and capable models, as well as plans for understanding continuous ground-based measurements in cases where rocket launches are not present.

iii.) Progress metrics: We plan to use the data to test our understanding of the physics and how well the results are characterized by existing models. A metric for progress is the extent to which the models must be altered to characterize the data including how the models might be applied to address more extensive ground-based wind measurements apart from the rocket launches.

The challenge described in (a) is justified by the CEDAR strategic plan strategic thrusts #1, 2, 4, and 6: systems perspective, interfaces and boundaries, observational and instrumentation strategies, and geoscience data and models.

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