2017 Workshop: Polar Workshop

Long title
Neutral Dynamics and Ionosphere-Thermosphere Coupling at High Latitudes
Conveners
Xinzhao Chu
Xian Lu
Mike Taylor
Description

Recent years several lidar-centered observational campaigns, network of airglow imagers, magnetosphere-ionosphere observational chains, and coordinated campaigns with rockets and ISR have been conducted or are ongoing worldwide including Antarctica and Arctic. Plus many other observations being continued by CEDAR researchers on regular basis, new and exciting data are being provided to the CEDAR science community with unprecedented coverage, precision and resolution. For example, lidar measurements of the neutral atmosphere from the ground up to nearly 200 km open a new door to explore the space-atmosphere interactions, complementing radar and magnetometer observations of the plasma. In the meantime, the dramatic improvements of resonance lidar efficiency have enabled new science inquires such as eddy flux measurements in the mesopause region and detection of tenuous metal layers in the thermosphere of 100-200 km. The understanding of polar atmospheric waves including their characteristics, distribution, sources, and impacts has been significantly advanced by the lidar, airglow imager, combining with other observations. Concurrent observations of both ISR and sounding rocket measurements have been used to estimate the energy dissipation in the IT system for a variety of magnetic activity levels. Combined with modeling efforts, these studies allow for the characterization of the Magnetosphere-Ionosphere-Thermosphere (MIT) electrodynamic processes on spatial scales from meters to hundreds of kilometers and temporal scales from seconds to days. Collaborative studies among lidar, airglow imager, rocket, radar, Fabry-Perot interferometer, ionosonde, magnetometer, riometer, etc. and with satellite measurements have provided new potentials for multi-dimensional studies of the global upper atmosphere and space. Numerical models of meteoric metal layers, atmospheric waves, turbulence, and MIT couplings as well as the development of

empirical geospace models provide good tools for CEDAR community to tackle science questions together.

This workshop aims to bridge the neutral atmosphere communities with the ionosphere and magnetosphere communities to address the following challenges:

1) What are the roles of neutral atmosphere-ionosphere-magnetosphere (AIM) coupling and wave dynamics in shaping the compositions and structures in the space-atmosphere-interaction region and their responses to geomagnetic and solar activities?

2) What new aspect of the source, propagation and dissipation schemes of the atmospheric waves can be revealed by collaborative studies with multiple instruments?

3) What are the influx magnitude, velocity and mass distribution of the global cosmic dust and how does the cosmic dust impact the Earth’s atmosphere and space environment?

4) How to advance remote sensing technologies and numerical models to transform the CEDAR research on space-atmosphere interactions and the whole atmosphere?

This workshop will provide a platform for the newest observational and modeling results to be presented and discussed, stimulating new science collaborations among observations, data analysis and modeling, and seeking new science potentials and technology innovations. We encourage short presentations and discussions to address the above science questions.

Agenda

Antarctica: the South Pole, McMurdo, Syowa, Jang Bogo, King Sejong, Akademik Vernadsky, and Palmer

Arctic: Tromsø and Poker Flat

Monday, 4-6pm, Part A @ Torreys III&IV

Xinzhao: Introduction to the polar workshop (5 min)

Mike Taylor: Investigating an unusually large 28-day oscillation in temperature during 2014 using high-latitude ground-based and satellite measurements (15 min)

Jian Zhao: Are the dominant gravity waves in the stratosphere the direct source of persistent waves in the McMurdo MLT? (18 min)

Xian Lu: Observations of planetary waves from 30 to 110 km over McMurdo (15 min)

Erich Becker: Importance of secondary gravity waves for the residual circulation in the austral winter MLT (18 min)

Dominique Pautet: Unexpected occurrence of mesospheric frontal events over South Pole (90^{o}S) (15 min)

Masaru Kogure: Rayleigh/Raman lidar observations of gravity wave activity in the middle atmosphere over Syowa (69°S, 40°E), Antarctica (12 min)

Geonhwa Jee: Initial observations of polar ionosphere using VIPIR at Jang Bogo Station, Antarctica (12 min)

Denise Thorsen: Arctic radar-lidar coordinate measurements on wave-driven circulation (10 min)

Thursday, 10am-12pm, Part B @ Crestone III&IV

Xian/Mike: Introduction to Part B of the polar workshop (5 min)

Sharon Vadas: The Excitation, Propagation, and Dissipation of Primary and Secondary Gravity Waves during Wintertime at McMurdo (20 min)

Qian Wu: New FPI observations from King Sejong and Palmer Stations (15 min)

Andriy Zalizovskyy: Response of ionospheric sporadic structures over the Antarctic Peninsula (Akademik Vernadsky) on geomagnetic and meteorological activities (pdf) (15 min)

Manbharat Dhadly: Large-scale seasonal response of geomagnetic active time northern high-latitude upper thermospheric winds (15 min)

Art Richmond: High-latitude Ionosphere-Thermosphere Interactions (20 min)

Toru Takahashi: Chemical response of mesospheric Na to auroral precipitation observed by Na lidar at Tromsø, Norway (69.6° N, 19.2° E) (15 min)

Xinzhao Chu: Lidar observations and TIFe modeling studies of metal layers and thermal structures in Antarctica (15 min)

Justification

Challenges: 1) What are the roles of neutral atmosphere-ionosphere-magnetosphere (AIM) coupling and wave dynamics in shaping the compositions and structures in the space-atmosphere-interaction region and their responses to geomagnetic and solar activities? 2) What are the influx magnitude, velocity and mass distribution of the global cosmic dust and how does the cosmic dust impact the Earth's atmosphere and space environment? 3) What new aspect of the source, propagation and dissipation schemes of the atmospheric waves can be revealed by collaborative studies with multiple instruments? 4) How to advance remote sensing technologies and numerical models to transform the CEDAR research on space-atmosphere interactions and the whole atmosphere?

Significance and fit with the decadal survey and strategic plan: The coupling between the magnetosphere and ionosphere plasma and neutral thermosphere and mesosphere gas, and the wave coupling among different atmosphere/space regions lead to very complicated processes that govern the space-atmosphere-interaction region (SAIR). These processes and the states of SAIR are far from being sufficiently described and understood, but they are critical to fully understanding the whole atmosphere and to improving space weather and climate models. Two major roadblocks are the starvation of sufficient observations that measure the neutral gas and plasma properties in large ranges with adequate accuracy, resolution and overlap, and the lack of coordinated studies of observations with various instruments, data analyses and numerical modeling. Lidar measurements of neutral atmosphere winds, temperatures and species in the thermosphere, mesosphere and stratosphere are critically needed, but very challenging, to complement radar observations of the plasma. This joint CEDAR workshop will encourage the community to tackle these issues through making unprecedented measurements and through multi-dimension studies using model, data analysis and observation.

The principal scientific goals of this Workshop are consistent with the goals and recommendations of recent community scientific surveys and strategic plans

The Workshop helps address three of the four key scientific goals articulated in the NRC report. They are:

Key Science Goal 2. Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.

Key Science Goal 4. Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

In addition, the Workshop goals are consistent with four of the scientific goals identified by the NRC Panel on Atmosphere-Ionosphere-Magnetosphere Interactions (AIMI). They are:

AIMI Science Goal 1. Global Behavior of the Ionosphere-Thermosphere: How does the IT system respond to, and regulate magnetospheric forcing over global, regional and local scales?

AIMI Science Goal 2. Meteorological Driving of the IT System: How does lower atmosphere variability affect geospace?

AIMI Science Goal 3. Ionosphere-Thermosphere-Magnetosphere Coupling: How do high-latitude electromagnetic energy and particle flows impact the geospace system? What are the origins of plasma and neutral populations within geospace?

AIMI Science Goal 4. Plasma Neutral Coupling in a Magnetic Field: How do neutrals and plasma interact to produce multiscale structures in the AIM system?

CEDAR: The New Dimension, Strategic Vision for the NSF Program on Coupling, Energetics and Dynamics of Atmospheric Regions [May 2011]

The Workshop is highly relevant to the NSF Coupling Energetics and Dynamics of Atmospheric Regions (CEDAR) program. The new CEDAR strategic vision, released in 2011, focused on the science of the space-atmosphere-interaction region and advocated the development of a systems perspective to study this region. The Workshop contributes directly to the first four of the CEDAR Strategic Thrusts:

Strategic Thrust 1. Encourage and undertake a systems perspective of geospace to understand global connectivities and causal relationships involving the SAIR and to determine their influences on the interaction region and the whole Earth system.

Strategic Thrust 2. Explore exchange processes at boundaries and transitions in geospace to understand the transformation and exchange of mass, momentum and energy at transitions within the ITM and through boundaries that connect with the lower atmosphere and the magnetosphere.

Strategic Thrust 3. Explore processes related to geospace evolution to understand and predict evolutionary change in the geospace system and the implications for Earth and other planetary systems.

Strategic Thrust 4. Develop observational and instrumentation strategies for geospace system studies capable of measuring system properties necessary to examine the coupling mechanisms and complexity within the SAIR.

How the questions will be addressed?

Observations and data analyses with unprecedented capabilities

Coordinated observations with multiple instruments

Coordinated studies of numerical simulations and data analyses

Technology innovations to push the detection limits

What resources exist, are planned, or are needed

Recent years several lidar-centered observational campaigns, magnetosphere-ionosphere observational chains, and lidar-involved multi-instrument observational campaigns have been conducted or are ongoing worldwide. Excellent data have emerged or are emerging. Numerical models and empirical models are being developed with promising results produced. New technologies are being actively pursued with some breakthroughs, and more ideas are emerging. Analyzing these observational data creatively, collaborating with numerical modeling to address these topics, and pushing detection technologies further forward are desperately needed.

Progress will be measured by:

Analyzing existing and new observational data and turning the data into meaningful science results for these topics

Publishing new science findings and understandings into journal papers

Sharing new ideas of technologies and producing new observational capabilities

Planning observing campaigns and developing new strategies to advance this area of research

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