2018 Workshop: Polar Workshop

Long title
Polar AIM Coupling, Composition, and Neutral Dynamics
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Description

Recent years several lidar-centered observational campaigns, network of airglow imagers, magnetosphere-ionosphere observational chains, various radar installations, 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. Simultaneous multiple metal species (e.g., Na and Fe) observations shed light to addressing intriguing science questions of cosmic dust. 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 lidar, ISR and sounding rocket measurements have been used to estimate the energy dissipation in the upper atmosphere and space system for a variety of magnetic activity levels. Combined with modeling efforts, these studies allow for the characterization of the Atmosphere-Ionosphere-Magnetosphere (AIM) electrodynamic and neutral dynamic 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 general circulation, meteoric metal layers, atmospheric waves, turbulence, and AIM 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

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? What new understanding on the general circulation can be gained?

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

Wednesday Session (1:30-3:30pm @ Mesa A/Hilton)

1. Bob Robinson, "Auroral Precipitation and High Latitude Ionospheric Electrodynamics" (pdf)

2. Zhonghua Xu, "St. Patrick's day storm analysis" (pdf)

3. Geonhwa Jee, “Simultaneous observations for neutral winds and ion drifts in the polar cap region” (pdf)

4. David Kenward, “Rocket Experiment for Neutral Upwelling (RENU2): Observations of the Cusp during a Poleward Moving Auroral Form Event” (pdf)

5. Chihoko Cullens, “Wave study using high-resolution models and observations in Antarctica” (pdf)

6. Xian Lu, “Latitudinal Double-Peak Structure of Stationary Planetary Wave 1 in the Austral Winter Middle Atmosphere” (pdf)

7. Andy Gerrard, “PEDC instruments across the Antarctic: Status updates from SPA, MCM, Palmer, and the AGOs” (pdf)

Thursday Session (1:30-3:30pm @ Mesa A/Hilton)

1. Yue Deng, “Specification of high-latitude electrodynamics: electric field and particle precipitation”

2. Dan Weimer, "Polar Energy Flux, Thermosphere Temperatures, and Nitric Oxide: Tools and Techniques” (pdf)

3. Zhonghua Xu, “Polar region magnetometer review and future” (pdf)

4. Erich Becker, “Gravity wave dynamics in the southern middle atmosphere at high latitudes”

5. Jian Zhao / Ian Geraghty / Zimu Li, “Lidar observations of gravity waves over McMurdo” (pdf)

6. Xian Lu, “Heat fluxes induced by 12-h tidal waves from the Na Doppler lidar in Boulder” (pdf)

7. Scott Palo / John Marino, “McMurdo meteor radar progress report” (pdf)

8. Xinzhao, “Updates on Fe and Na lidar observations at McMurdo” (pdf)

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 observations and modeling? What new understanding can be gained on the general circulation?

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 two 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- and radar-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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