2017 Workshop: Frontiers

Long title
Grand Challenge MLT-X: Frontiers in Science and Sensing
Conveners
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Description

This workshop will build from the experience gained at the Geospace Frontiers Quo Vadis? meeting in Boulder last year. The Quo Vadis? questions: 1) What major gaps in scientific understanding or engineering capability limit our ability to describe Sun-Earth connections? 2) Where is discovery science likely to occur? 3) How can we predict the occurrence of, and reaction to, space weather?

will be particularly focused on the Earth's 80-200 km altitude range. The driving science questions and the measurement needs of the future that have been articulated over the past three years of the Grand Challenge MLT-X workshops will be of particular emphasis. A panel discussion format is proposed to engage discussion around central topics of science and observing.

Justification

It has long been recognized that plasma-neutral coupling and wave- and turbulence-induced transport play major roles in establishing the structure, composition and circulation of the upper atmosphere. However, the lack of observational data of middle thermosphere neutral gas properties has severely limited progress in understanding and characterizing the impact of these processes, which in turn, has inhibited the advancement or verification of global circulation models of the upper atmosphere. Because of the relative inaccessibility of the near-space environment, the interaction of the upper atmosphere with space is not well-described, nor are its influences on the lower atmosphere understood well enough to incorporate them in weather and climate models. This Grand Challenge Workshop will help focus efforts of the community to acquire the necessary observations and improve existing models by characterizing these processes and their effects in the Earth’s upper

atmosphere. Observations of the middle thermosphere neutral gas properties are critical and need advancement beyond inferences and single altitude estimates. Science issues that require further investigation of the middle thermosphere neutral properties include: thermosphere mixing of composition, vertical shear in horizontal winds, gravity wave propagation and dissipation, sporadic E-layer formation, plasma instabilities, heat conduction, and Joule heating, to name a few. This Workshop will focus on establishing the future measurements, theory, and modeling of the neutral gas needed to address a broad class of processes in the 80-200 km region.

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

National Research Council 2013-2022 Decadal Strategy for Solar and Space Physics; A Science for a Technological Society The Workshop addresses primarily Key Science Goal #2 in the NRC report: Key Science Goal 2. Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.

However, two of the other three goals are relate-able: Key Science Goal 1. Determine the origins of the Sun’s activity and predict the variations of the space environment. 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.

Because the Workshop will include upper atmospheric dynamicists and chemists, and planetary aeronomers who will employ both observations and other correlative datasets and models to address the key scientific questions, the Workshop also contributes indirectly to the two remaining strategic thrusts.

Strategic Thrust 5. Fuse the knowledge base across disciplines to promote collaborations. Strategic Thrust 6. Manage, mine and manipulate geospace data and models to tap the vast resources of burgeoning geospace data.

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