2019 Workshop: Atmosphere Ionosphere Coupling

Long title
Atmosphere-Ionosphere Coupling: Wave, Instabilities, Turbulence, Transport
Conveners
Dave Fritts
Dave Hysell
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Description

This Session will include short talks as well as time for detailed discussion. Contributed talks sharing recent scientific results, from experiments, observations (especially multi-instrument or multi-site), theory, or modeling, of MTI dynamics are welcome. These include, e.g., neutral dynamical processes that may lead to coupling with or disturbances to the ionosphere, e.g., via atmospheric waves, instabilities, or turbulent dynamics at small-scale/short-period. Also highly relevant are measurements of the ionosphere for the purpose of diagnosing the underlying dynamics of the atmosphere. This Workshop Session will be organized to complement the earlier scheduled Session on New Imaging and Modeling of Gravity Waves and Instabilities; we hope that attendees and speakers can remain to participate in our discussion!

The Objectives of this workshop include to: a. Communicate new or evolving measurement and modeling capabilities and experiments, b. Foster new collaborations employing more comprehensive measurements of diverse dynamics at individual sites and at correlative sites where beneficial, c. Identify and target important/achievable goals; e.g., links across scales, character of instability transitions and responses, coupling in altitude and into the ionosphere, d. Facilitate and enhance collaborations between measurement and modeling teams to extend their potential to guide, explain, and quantify new measurements, and e. Coordinate team efforts in preparing papers or paper sets where beneficial.

Agenda

Yuxin Zhao: Simulation of Tropical Cyclone Induced Gravity Wave Perturbations in the Upper Atmosphere

Erin Lay: AGW Correlations with TIDs and Evidence for Cascades in Irregularities

Andriy Zalizovski: "AGW/TID over the Antarctic Peninsula and Eastern Europe as Observed by Multi-Position HF DOPPLER and GNSS-TEC Techniques

Roberto Sabatini: Infrasound Scattering Through Turbulence in the Stratosphere and Thermosphere-Ionosphere

Fan Yang: Stability Characteristics of the Mesopause Region above the Andes

Katrina Bossert: High Resolution Lidar Measurements of Small-Scale Instabilities and GW breakdown

Dominique Pautet: TdF, Argentina, Mountain Wave Signatures

Dave Fritts: Workshop Discussion of Events for Collaborative Analysis (including: Neil Hindley: AIRS Imaging)

Justification

Waves, instabilities, and turbulence play major roles throughout the neutral atmosphere and ionosphere. Their roles are diverse, complex, and central to the large- and small-scale structure and variability from Earth's surface to 1000 km and above. Neutral atmosphere waves, especially gravity waves (GWs), efficiently transport energy and momentum from sources in the troposphere and stratosphere into the mesosphere, thermosphere, and ionosphere (MTI, aka ITM).

Deposition of energy and momentum accompanying instabilities and turbulence in the neutral atmosphere largely accounts for the large-scale circulation and thermal structure of the mesosphere and lower thermosphere (MLT), including the cold summer mesopause, the warm winter mesosphere, the closure of the mesospheric zonal mean jets, and the residual circulation that accounts for descent of tracers from the MLT to much lower altitudes in winter.

GWs, their induced instabilities and turbulence, and their deposition of energy and momentum in the thermosphere also account for Space Weather responses to tropospheric weather. Ionospheric responses now believed to be induced by GWs and their instabilities include equatorial plasma bubbles and "valley" echoes, low- and mid-latitude spread F, traveling ionospheric disturbances, modulations of equatorial and auroral electrojets, and plasma turbulence at high altitudes.

Importantly, without instabilities and turbulence in the MTI, energy and momentum deposition and MTI structure and variability would be dramatically different. The largest and smallest scales are inextricably linked, and we must achieve a better understanding of these interdependencies in order to understand and predict the overall system.

The CEDAR community is poised for major advances in understanding these small-scale dynamics having large-scale influences due to continuing advances in measurement and modeling capabilities. Current and rapidly-evolving measurement capabilities are providing unprecedented imaging and quantification of neutral waves driving instabilities and turbulence in the neutral atmosphere and of plasma responses at larger and smaller scales in the ionosphere. Newer systems promise extensions of these capabilities to 3-D volumetric imaging. Advancing neutral atmosphere and plasma modeling capabilities, and especially the emergence of linked or coupled models of the neutral atmosphere and ionosphere, are achieving unprecedented resolution and providing insights into previously unexplained processes and phenomena.

This Workshop Session proposal is directly relevant to the following CEDAR Strategic Goals:

Goal 1. Encourage and undertake a systems perspective of geospace – “The ultimate goal is to contribute to a holistic model of the Earth system that includes all interacting components – from the Earth’s core to geospace…”; and

Goal 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. Studying these transitions and boundaries in terms of physical processes enables new knowledge about the nature of space-atmosphere interaction regions applicable to Earth and other planetary bodies.”

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