2019 Workshop: E region challenges

Long title
E-region challenges for observations and simulations: density, dynamics and energy
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Description

The ionosphere/thermosphere (I/T) at E-region altitudes (100 to 150 km) is a complex and observationally challenging part of Earth's upper atmosphere, but a key layer for atmosphere-ionosphere-magnetosphere (AIM) coupling. At mid- and low-latitudes, the E-region dynamo drives the electrodynamics and produces the equatorial ionospheric anomaly (EIA) and electrojets. At high latitudes, auroral energy is mostly deposited in this atmospheric layer, producing peak ionospheric conductivity. Field-aligned currents (FACs) are therefore closed through ionospheric currents in the E region. This region is under strong influence of solar irradiation and magnetospheric energy inputs from above and waves from below (e.g. atmospheric gravity waves (AGW), planetary waves and tides). The energy and momentum inputs into this region affect neutral composition and dynamics as consequences of gravity wave breaking and vertical transport of heavy molecular species.

Despite the well-known significance of the E-region layer, direct observations and physical understanding of their properties are still very limited. This workshop will identify the challenges to specify the E-region density, momentum and energy through both observations and numerical/theoretical simulations.

Justification

Proposed challenge questions:

Our overarching goal is to understand ionosphere/thermosphere coupling processes in the E-region and create a community-wide discussion of the gaps in our knowledge. Specifically, we propose to focus on the questions below:

(a) How can we improve the specification of E-region density, momentum and energy in both observations, simulations, nowcasts and forecasts? (

b) How does the E-region density and neutral wind influence the ionospheric currents, which feedback to the high-latitude FACs?

(c) What is the relative significance of the different forcing terms, including solar irradiation, electromagnetic energy inputs, and tides and waves, to the E-region dynamics at both high and low-latitudes?

(d) How does high latitude E-region neutral wind evolve in response to auroral and orographic forcing?

(e) How large are the vertical shears in the neutral wind and what is the consequence for thermospheric and ionospheric structures at all scales?

(f) What is the spatial distribution of auroral energy deposition in the E-region? How important is small- and mesoscale-scale energy input for triggering gravity waves locally?

(g) What mechanisms create the large thermospheric temperature gradient in the E-region?

Relevance to the Decadal Survey and CEDAR Strategic Plan:

This proposed workshop will evaluate fundamental coupling physics of the M-I-T system and thus will address the Decadal Survey Key Science goal 2: "Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs". The proposed study meets three of the strategic trusts in the CEDAR Strategic Plan 2011: (1) Encourage and Undertake a Systems Perspective of Geospace, (2) Explore Exchange Processes at Boundaries and Transitions in Geospace, (3) Explore Processes Related to Geospace Evolution.

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