Project Details

ROSES ID: NNH10ZDA001N
Selection Year: 2011
Program Element: Focused Science Topic

Topic: Low-To Mid-Latitude Ionospheric Irregularities and Turbulence

Project Title:
Modeling of gravity wave and tidal influences on low- and mid-latitude plasma dynamics

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Summary:
The central objectives of this proposal are to advance our understanding of gravity wave (GW) and tidal motions, their interactions, and their influences on plasma dynamics and instabilities, specifically traveling ionospheric disturbances (TIDs), equatorial plasma bubbles (EPBs), and sporadic-E layers and their coupling to the F layer, occurring in the low and mid-latitude E and F regions. Specific objectives include:

1. How does GW propagation and filtering induced by tides enable neutral and plasma perturbations having orientations conducive to plasma bubble seeding at the bottomside F layer, and what are the plasma responses?

2. How do GWs, perhaps via tidal filtering, contribute neutral perturbations that trigger TIDs at low- and mid-latitudes, and what are the plasma responses to these neutral motions?

3. How do tides and GWs contribute to descending shear layers that induce neutral turbulence, and how do these contribute to sporadic-E-layer formation and coupling to the F layer?

We will employ a versatile, anelastic code describing 2D or 3D neutral GW dynamics spanning multiple scale heights and a local representation of tidal motions providing the GW propagation environment. The neutral fields generated by this code will be employed as inputs to the SAMI3 and SAMI3/ESF plasma models to examine the plasma responses to these neutral fields. Initial efforts will focus on the larger-scale dynamics in objectives 1 and 2. Capabilities for modeling of small-scale neutral shear layers are in place and will support plasma studies of sporadic E layers as the plasma code achieves a potential for higher spatial resolution. Our anelastic code is the only code at present that has the ability to define these nonlinear dynamics spanning multiple scale heights and dynamical scales in 3D. SAMI3 is likewise the only plasma code capable of simulating plasma bubble development on a global scale.

Additionally, we will perform direct comparisons of our model results with observations and work with the community addressing the Focused Science Topic "Low- to Mid-Latitude Ionospheric Irregularities and Turbulence" in addressing the following science objectives:

1. understanding the connection between large-scale ionospheric processes and the development of electron density irregularities;

2. quantifying the role of E and F region coupling on these instabilities; and

3. improving models of F region plasma instabilities.

Our proposed studies will address three topics that are poorly understood at present and which are central to an improved characterization of neutral-plasma interactions at multiple latitudes, altitudes, and spatial scales. We expect our results to significantly advance both our understanding of, and our modeling capabilities for describing, these dynamics in a quantitative

manner.

Publication References:

Summary: no summary

Reference: Hysell, D. L.; Jafari, R.; Fritts, D. C.; Laughman, B.; Gravity wave effects on postsunset equatorial F region stability, Journal of Geophysical Research: Space Physics, Volume 119, Issue 7, pp. 5847-5860, doi: 10.1002/2014JA019990

Summary: no summary

Reference: Wu, T.-W.; Huba, J. D.; Krall, J.; Fritts, D. C.; Laughman, B.; (2015), Seeding equatorial spread F with turbulent gravity waves: Phasing effects, Geophysical Research Letters, Volume 42, Issue 1, pp. 15-21, doi: 10.1002/2014GL062348