Comparing MSTIDs Generated from Tropospheric Weather to the Hooke Model

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The formation and development of Medium Scale Traveling Ionospheric Disturbances (MSTIDs) has long been of interest to the radio science community because of their practical implications for the disruption of communications and geolocation. MSTIDs are propagating ionospheric density disturbances, which are often described as wave-like and have horizontal scales sizes of 100-200 km. It is well known that gravity waves generated from deep convection and jet instabilities can propagate into the ionosphere and generate structures such as MSTIDs. These ionospheric structures have been described in the literature as early as the 1950s, but the unpredictable nature of their occurrence and lack of global measurements have complicated efforts to obtain a comprehensive understanding of how and why these features form in the ionosphere.

In this study, a high resolution, first-principles ionosphere model, SAMI3/ESF is driven by specifications of the neutral atmosphere that include forcing from below to quantify the effect of the wave perturbations on the ionosphere. Gravity waves predicted by an extended altitude version of the Navy's mesoscale numerical weather prediction system, COAMPS (Coupled Ocean-Atmosphere Mesoscale Prediction System) are propagated to ionospheric altitudes using a Fourier ray model. The perturbed thermospheric gravity wave fields are used to drive MSTIDs in the SAMI3/ESF ionosphere model.

The simulated MSTIDs are compared to the Hooke model, which is a standard analytical electron density perturbation model designed to capture the main features of MSTIDs. The Hooke formula depends on the perturbation in the field-aligned thermospheric neutral wind. The field-aligned winds derived from the COAMPS-ray system will be used to calculate the Hooke perturbation. The resulting structures will be compare with first-principles, SAMI3/ESF simulation to determine how well the Hooke model can represent an outbreak of MSTIDs driven from gravity waves.