Modeling the thermosphere ionosphere system and space weather impacts

*Timothy J Fuller-Rowell[1]

1.University of Colorado Boulder

The thermosphere-ionosphere-plasmasphere system has several direct impacts on space weather. Uncertainty in thermospheric neutral density affects satellite drag, orbit prediction, and collision avoidance. Variations in total electron content, together with steep gradients in plasma density, disrupts GNSS navigation signals and positioning accuracy, affecting a range of users including civil aviation. Changes in ionospheric layers modifies HF propagation due to absorption in the D-region and changes in reflection from F-region positive and negative storm phases. During a geomagnetic storm these changes can be dramatic. The modeling challenges are significant and diverse. The response of the system to geomagnetic storms has to capture dynamic neutral density changes, huge increases in storm-enhanced plasma densities by a factor of five, followed by extreme negative phases where the ionosphere can be severely depleted. During geomagnetically quieter conditions the day-to-day changes can be more subtle. The impact of waves propagating from instabilities in stratospheric jets or convective storms in the troposphere, produce persistent ionospheric variability perturbing HF propagation. Predicting the day-to-day variability of equatorial ionospheric irregularities, and their impact on satellite communication and navigation, remains a challenge, although there are hints that variability of lower atmosphere waves may be playing a role. Improvement in thermosphere-ionosphere and whole atmosphere models show promise in being able to simulate the response of the system to solar, geomagnetic, and lower atmosphere forcing with a goal of mitigating some of the impacts of space weather on operational system.

Keywords: Thermosphere-Ionosphere Modeling, Space Weather, Satellite drag, Geomagnetic storms

