Improving the Ionospheric Specification in the Global Ionosphere Thermosphere Model

Aaron Ridley(1), Jie Zhu (1), Xianjing Liu(1) , Ankit Goel(1) , and Dennis Bernstein(1)
(1) University of Michigan, Ann Arbor, MI, 48109-2143

The Global Ionosphere Thermosphere Model (GITM) is a relatively new model that describes the new-Earth space environment in a different way than many of the other existing coupled models. First, it uses an altitude grid that stretches from 100 km to 500-800 km depending on F10.7, with roughly 1/3 scale-height resolution. Second, it solves the more-complete momentum equation in the vertical direction of the thermosphere, allowing non-hydrostatic solutions to form. Third, the code is parallel in such a way that the number of grid cells in the latitude and longitude direction can be specified at run-time, so that the resolution is highly adjustable. The ionosphere within GITM is treated in spherical coordinates, so is limited in altitude. Recently, the ionosphere has been modified in three ways: (1) the ion and electron temperatures have been improved; (2) a nightside EUV flux was implemented in the code; and (3) the Eddy diffusion has been modified to allow a more realistic electron density.

The electron temperature is driven by solar EUV, conduction, heat flux, ion-electron collisions, electron-neutral collisions and losses to different vibrational and rotational states of different species. Conduction, ion-electron collisions, ion-neutral collisions, and Joule heating drive the ion temperature. The neutral temperature equation was also modified to explicitly include the ion-neutral and electron-neutral heat transference through collisions. We will show how the electron, ion, and neutral temperatures are modified with the improvements.

The vertical velocity at the magnetic equator is strongly driven by the ionospheric conductance gradient, such that the dusk pre-reversal enhance can be controlled by this gradient. In addition, if the gradient in the conductance at the dawn terminator is not specified correctly, a dawn pre-reversal enhancement can also exist. The solar EUV input into GITM at the top of the model was modified to take into account of scattering in the plasmasphere into the thermosphere, allowing increased ionization at the terminator. This changed the behavior of the dusk and dawn vertical velocity enhancements.

Finally, the Eddy diffusion coefficient determines the mixing of molecular species in the 100-150 km region of the atmosphere. We show that GITM needs a solar-cycle-dependent Eddy diffusion coefficient in order to accurately capture the dayside total electron content as measured by ground-based GPS sensors. We will describe how this was determined and how it affected the model results. Further, we describe a method for automatically tuning this model parameter while the code is running using the GPS TEC data.