Interaction of the Sub-Auroral Boundary Region with the Equatorial Dynamo

Stanley C. Solomon(1), Wenbing Wang(1), and Michael Wiltberger (1)
(1) National Center for Atmospheric Research, High Altitude Observatory
Boulder, Colorado, USA

Magnetospheric currents that close within the ionosphere create an electric potential at high latitude that drives ion and neutral dynamics in the polar region. During disturbed conditions and major storms, this potential system also interacts with the low-latitude dynamo potential generated within the thermosphere-ionosphere system by solar tides, a phenomenon sometimes known as the "penetration electric field." The combination of these current systems has a significant effect on the distribution of the F-region ionosphere, primarily caused by changes in vertical ion motion driven by the zonal electric field. These effects can be dramatic in the mid-latitude region, where enhanced electron densities are seldom expected but sometimes observed. Additional complexities in the mid-latitude ionosphere include the generation of sub-auroral polarization streams, and plumes that appear to be related to plasmapause dynamics. However, describing this interaction region with coupled magnetosphere-ionosphere-thermosphere models has been challenging, in part because of the difficulty in combining the electric potential driven by the magnetosphere at high latitude with that generated within the ionosphere at low latitude. Even a completely self-consistent solution needs to make distinctions with regard to the boundary between high and low latitude control, and between open and closed field lines. In a model such as the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM), the high-latitude potential is externally specified (either by an empirical model, by a data assimilation procedure, or by a magnetospheric model) while the low-latitude potential is solved self-consistently. This necessitates a merging between the two regimes. Specification of the cross-over latitudes and the width of the merging region has a significant effect on mid-latitude dynamics as well as the response of the equatorial electrojet. In this paper, we will present results from stand-alone and coupled models, demonstrating their ability to reproduce some ionospheric features during storms, but also showing the sensitivity to these boundary decisions, and the challenges for an integrated approach describing the global ionospheric electric field.