Geophysical Research Abstracts
Vol. 20, EGU2018-9283, 2018
EGU General Assembly 2018

Improving Global Ionospheric Electrodynamics Based on Low-Earth Orbiting Satellite Observations

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The morphology of ionospheric electrodynamic fields, such as electric field and currents, depends strongly on the solar wind and interplanetary magnetic field as well as geomagnetic activity. Although there exist several empirical models that are capable of capturing the general behaviors of ionospheric electrodynamic fields under given solar wind and geomagnetic conditions, they often fall short in representing the true ionospheric state in real events, especially under disturbered geophysical conditions. Low-Earth orbiting (LEO) satellites are valuable assets to monitor ionospheric electrodynamics. This paper showcases how the LEO satellites, together with ground-based instruments, can be used to better specify the global distributions of ionospheric electric fields and currents. More specifically, we demonstrate the utility of magnetic field perturbations measured by the Iridium satellite (available via AMPERE) and Swarm constellations in helping reconstruct the global ionospheric electric field and current patterns during the St. Patrick's Day geomagnetic storm in March 2015. Ionospheric electrodynamical fields have a profound impact on the upper atmosphere, and they serve as important upper boundary inputs for global thermosphere-ionosphere general circulation models. This paper will also highlight some salient thermospheric neutral density and ionospheric electron density variations associated with the storm based on numerical simulations as well as Swarm and other observations.