Geophysical Research Abstracts
Vol. 13, EGU2011-6342-1, 2011
EGU General Assembly 2011

Numerical simulation of ionospheric disturbances associated with daytime MSTIDs

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Several cases of daytime Medium-Scale Travelling Ionospheric Disturbances (MSTIDs) were observed simultaneously using TEC measurements by the US dense GPS network and plasma measurements by the DEMETER micro-satellite at 660km altitude. DEMETER data show quasi periodic disturbances of the electron density and velocity moving towards low latitude. They closely match, with variable time lags, the TEC variations that are mainly representative of the variations of the plasma density close to the peak of the F-layer. Using the SAMI2 ionospheric model we have simulated the ionospheric response to Atmospheric Gravity Waves (AGW) represented by simple periodic disturbances of the density and velocity in the upper atmosphere propagating in a geomagnetic plane towards low latitudes. The simulated variations of the electron density and ion velocity parallel to the Earth's magnetic field show a very good agreement with DEMETER observations and, in particular, explain the variable time lags between the peak disturbances in TEC, electron density and ion velocity. The disturbances in the topside ionosphere may be understood as resulting from two different regimes of propagation of the TID's. At altitudes lower than ~ 400 km, a collisional regime where the ionosphere responds to the combined effects of neutral density variations on the ionization rate and of the neutral velocity that couples to the ion velocity parallel to the magnetic field. At higher altitude, the very tenuous upper atmosphere has no effect on the plasma and the ionospheric disturbances arise from the propagation of the lower altitude plasma disturbances along magnetic field lines at a velocity representative of the ion acoustic velocity.