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Characteristic ionospheric variations over North America during geomagnetic quiet and storm conditions

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ABSTRACT

As part of a global GPS data processing system developed at MIT Haystack Observatory to provide continuously total electron content (TEC) observations with high spatial-temporal resolution, the regional network of GPS receivers over North America is particularly dense and fairly well distributed with large space coverage, allowing for detecting characteristic midlatitude, subauroral and high latitude ionospheric variations. This presentation will review some of these TEC variations during quiet and disturbed periods respectively, obtained recently using the long-term dataset since the year 2000:

(1) Midlatitude ionospheric longitudinal variations in TEC across the zero geomagnetic fields. These variations changes with local time, season and solar cycle, and the variability can be explained systematically in a combined zonal wind and geomagnetic declination effect. This conclusion is supported by long-term observations of the Millstone Hill incoherent scatter radar and Fabry-Perot Interferometer. Such longitudinal variability exists not only in North America but all in Asia sectors. Based on the 11+ year observations, an empirical TEC model for North America has been established to represent climatological variations including the characteristic longitudinal ionospheric variations (Figure 1).

(2) Storm-time longitudinal differences in North America exist also during geomagnetic storm conditions. Some of these differences are originated from the geomagnetic declination and storm-time zonal wind effect, in a similar fashion as for quiet magnetic activity.

(3) Storm enhanced densities (SEDs) and their associated plasma motion in shaping the thermosphere-ionosphere coupling during geomagnetic storms. Extensive stormtime TEC observations have indicated the highly structured plume of plasma density being formed across North America, moving northwestward from dusk at the subauroral/mid-latitudes sector to noon near the polar cusp. The associated strong plasma flow driving by M-I coupling electric fields has strong influences on the

thermosphere-ionosphere coupling. New evidence for abnormal thermospheric wind dynamics was observed from recent solar storms including the March 17-18, 2015 super storm.

Key words: GPS TEC, geomagnetic declination, ionosphere, longitudinal variations, and storm enhanced density

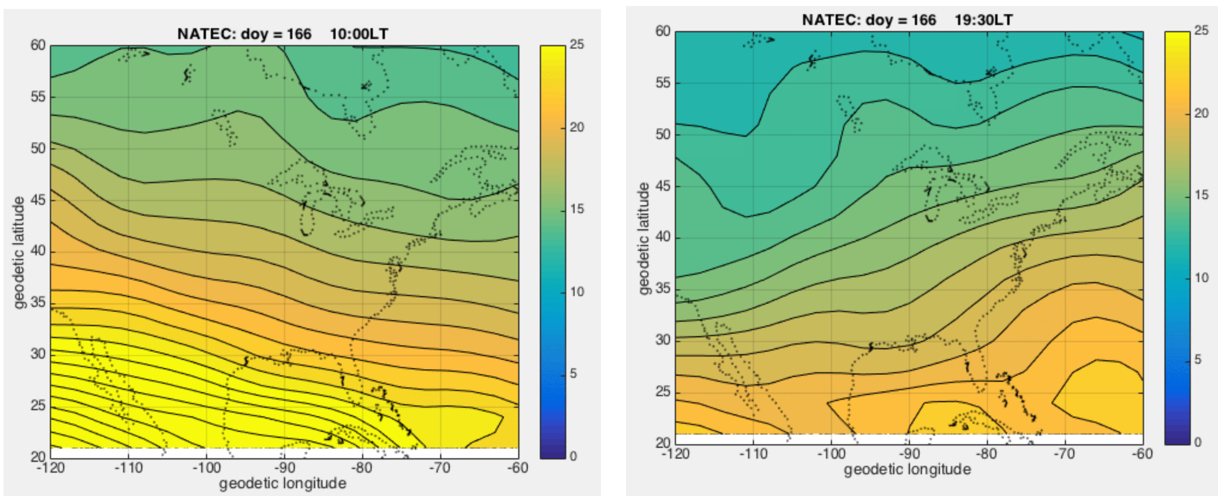

Figure 1. North America Regional TEC maps for median solar activity summer at local times 10LT (left) and 19LT (right), derived from the NATEC model, which is based on 12-year continuous GPS TEC data over North America, showing a combined effect of magnetic declination and zonal winds on the east-west ionospheric density differences.