Impact of strong ENSO on TEC activity disturbed by ultra-fast Kelvin waves

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Ultra-fast Kelvin waves (UFKW) are a subclass of Kelvin waves that they have the shortest periods (2-5 days) and thus can propagate into the ionosphere. UFKW relate to ionospheric variations have been reported, which include ionospheric minimum virtual height (h'F), F2 maximum critical frequency (foF2), total electron content (TEC), S4 scintillations, etc. In the study, we analyzed the UFKW activities using SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) temperatures and GIM (Global Ionospheric Maps) TEC from 2009 to 2011 to see how UFKW influence the ionosphere. The period 2009-2011 belongs to the strong ENSO period. Previous studies have shown that Kelvin waves were highly active in this period, especially in the early of 2010. Therefore, this study can implicitly reveal how the ionosphere responds to the ENSO. The wave signatures in SABER temperatures were extracted using the fast Fourier transform (FFT). Temperatures in the geographic equatorial latitudes were gridded into the day-altitude-longitude structure and then removed background to get temperature fluctuations. The two-dimensional FFT was applied to each 96-day data segment for each altitude and stepped forward in time by one day. Regarding TEC, the Lomb-Scargle periodogram was used to extract UFKW signatures. Because TEC has a strong local time variation and constrains by the geomagnetic configuration, TEC at 16 local time and low geomagnetic latitudes were selected. The background was removed firstly from the data and then fed TEC fluctuations into the Lomb-Scargle process, which also stepped forward in time by one day. The FFT and Lomb-Scargle process both outputted spectra, which revealed UFKW activities in the mesosphere and lower thermosphere (MLT) region (90-100 km) and the ionosphere (about 150-600 km). The results show that UFKW activities at two equatorial ionization anomalies (EIA) were almost identical, and both were higher than that at geomagnetic equator. Most of wave activities in the temperature field in the MLT region have corresponding activities in TEC. However, there are a lot of small amplitude activities only in TEC.

Keywords: ultra-fast Kelvin waves, ENSO, TEC

