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A comparative analysis of the model calculated and GPS-observed TEC variations before the Haiti, 2010 and Japan, 2011 earthquakes

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Model simulations of the ionosphere Total Electron Content (TEC) variations have been performed for the Haiti January 12, 2010 and Japan March 11, 2011 earthquakes. Calculations have been carried out using the global numerical Upper Atmosphere Model (UAM). The seismogenic impacts in the model have been set as lower boundary conditions for the electric potential equation. Namely, the vertical electric currents of $\sim$ 20 nA/m^2 flowing from the ionosphere to the Earth have been set at the near-epicenter area of $\sim$ 250 by 2000 km. The simulated relative (%) TEC disturbances for both events have been compared to each other and to the corresponding GPS-observed data. The common features persisting at both observed and modeled TEC variations are: (1) the appearance of positive disturbances $20-40\%$ by magnitude at night hours for $2-4$ days before the earthquake, (2) the geomagnetic conjugation of the effects and (3) the lack of migration (movements) of the TEC deviations during their lifetime (of $\sim$ 8 hours). Main differences between the considered events (Haiti and Japan), both modeled and observed, are most evidently pronounced in the TEC disturbances' maximum location relative to the geomagnetic equator. In case of the Haiti earthquake the strongest by magnitude TEC disturbances are located near the magnetically conjugated to the earthquake's epicenter region at the Southern hemisphere, while in case of the Japan earthquake – near the epicenter at the Northern hemisphere. We have attributed this difference to the different seasons the events have taken place in. The asymmetry of the Haiti model TEC disturbances relative to the magnetic meridian of the earthquake's epicenter is in agreement with the GPS-observed one. In case of the Japan earthquake the asymmetry of the TEC deviations relative to the magnetic meridian of the earthquake's epicenter is negligible in the observations, while in the model results it is similar to the Haiti case. In order to remove this asymmetry in the modeled disturbances for Japan, a pair of the vertical electric currents of the opposite polarity has been switched on in the UAM calculations for the Japan case instead of the single sign currents previously used.