



## **Seismo-ionosphere relation: TEC over Japan during seismically active period in May - August 2008**

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The Earth's ionosphere is known to be an irregular structure, which state is determined mainly by the solar radiation. Besides natural ionospheric variability by diurnal, seasonal or latitudinal fluctuations, enhance of pre-seismic processes a few days before an earthquake in the area of future epicenter can produce alterations of the ionosphere parameters as well. At present, pre-seismic ionosphere anomalies seem to be very well analyzed, theoretically substantiated and described in numerous papers. However, the key question remaining disputable is comparability of the ionosphere effects from "above" and from "below". Knowing that the decisive role in the ionosphere state is played by space weather effects, we analyzed TEC changes during the period of enhanced seismic activity in May-August 2008, when 22 earthquakes with  $M > 5.0$  (including three large events of  $M = 6.8-7.0$ ) occurred around the Tohoku area of Japan. For this purpose we performed a detailed analysis of the ionosphere TEC above Japan using data of Japanese dense array of GPS receivers (GEONET). This allows us to make a step forward in the problem of observations of earthquake precursors in the ionosphere TEC.

It should be noted that the considered period falls on the minimum of solar activity, so that the space weather influence was minimum at this time. However, in order to distinguish TEC variations caused by pre-seismic effects from those of solar and geomagnetic origin, we compared the estimated TEC values with time series of the interplanetary magnetic field component  $B_z$ , F10.7 solar flux, index of geomagnetic activity  $Dst$  and planetary index  $K_p$ . Besides, due to local TEC anomalies were reported to reflect global variations of TEC (Afraimovich and Astafyeva, 2008, *Earth, Planets and Space*, 60, 961), we bring out data of global TEC as well. At the same time, the analyzed period of 101 day is long enough to exclude planetary waves appearance in the ionosphere TEC which are known to have a period about 2, 5, 10, 16 days (Shalimov, *Cosmic Research*, 2001, 39, 6, 559) and which can be taken by mistake as precursory signals.

The occurred earthquakes differ by mechanisms (on-land and underwater) and by the hypocenter depth (from 8 km to 111 km). This provides us an opportunity to compare effects of possible precursors in the ionosphere TEC not only concerning their appearance but also by distinctions in pre-quake TEC caused by preparation of different types of earthquakes.