# Case Study of the TEC Modifications before the New Zealand Earthquake, Nov. 22, 2004: Simulation Results

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The paper presents the case study of the anomalous ionospheric TEC (total electron content) variations as pre-earthquake signatures for the strong seismic event of Nov. 22, 2004, 20.26UT (07.26LT), New Zealand (46.69 S; 164.78 E), M 7.1 and is a further development of our previous work [1].

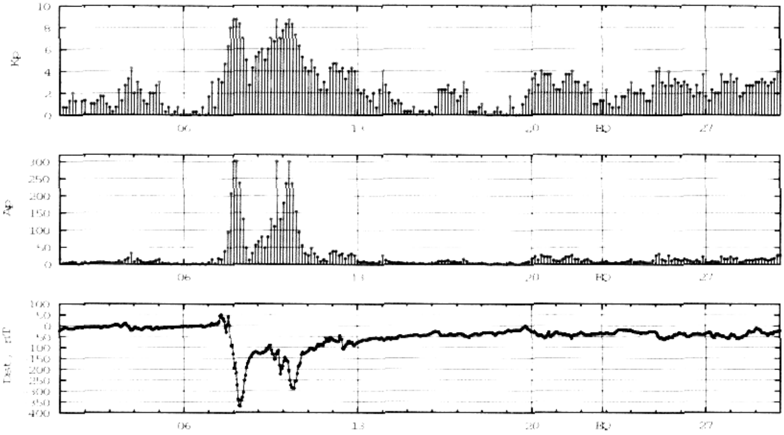

Fig.1 Kp, Ap and Dst-indexes for the Nov. 1-30, 2004.
EQ- the New Zealand earthquake release time

Geomagnetic situation was quiet for Nov. 15-22, 2004, i.e. till the earthquake release moment. We neglect the possible influence of the disturbances happened before Nov. 13, 2004 (i.e. more than a week before the main seismic event) on the investigated TEC anomalous variations. That allow as to interpret the observed disturbances as a result of the ground impact propagating through the near-surface atmosphere layer.

We define anomalies as the local long-living TEC deviation from the quiet non-disturbed level at the near-epicenter area. To discriminate this TEC seismo-signatures we have built differential TEC maps for a few days before and after the seismic event using NASA IONEX products[2].

The observed anomaly looks like the TEC reduction by ~40% at the near-epicentral area of about ~40 degrees in longitude and ~25 degrees in latitude.

In this paper we check the previously set hypothesis on the vertical drift of the F2-layer ionospheric plasma under influence of the zonal electric field of presumably seismic origin as the main reason for the observed TEC disturbances. We test this hypothesis in case of the New Zealand earthquake by carrying out numerical calculations by means of the global time-dependent 3D self-consistent Upper Atmosphere Model (UAM) [3-4].

We try to reproduce the TEC disturbances using additional electric sources. We modified the modeling scheme in comparison with previous calculations: 1) we saved the electric potential during first "non-disturbed" run; 2) then we loaded the electric potential during "disturbed" run and performed numerical calculations with gradually increasing modification of electric field over expected seismic event area, solving all the equations together with this new potential. In our previous work we just fixed the electric potential value at the given points during whole model run. Such "trick" allow us to reduce numerical instability at the modified electric potential nodes and flexibly set the additional electric potential's distribution.

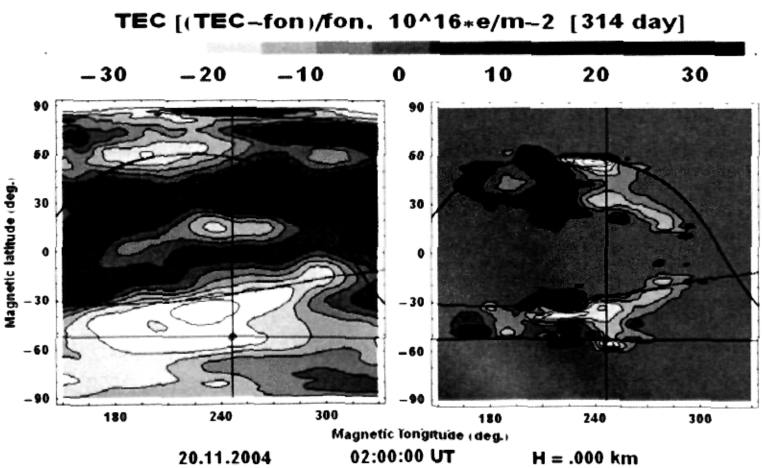


Fig.2 Differential TEC map for 21.11.2004, 02UT. Left panel – GPS TEC observations deviation relative to the non-disturbed level. Right panel – numerical calculation with UAM. EQ Black dot – the EQ epicenter position.

Model results reveal better agreement with observations than in previous case and reproduce well the observed TEC behaviour in the southern hemisphere.

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4. A.A. Namgaladze, O.V. Martynenko, A.N. Namgaladze, *Global model of the upper atmosphere with variable latitudinal integration step*, International Journal of Geomagnetism and Aeronomy 1 (1), 1998, pp. 53-58.