



## EARTHQUAKE PRECURSORS IN TEMPORAL AND SPECTRAL CHARACTERISTICS OF THE ELECTRIC FIELD ON TIEN-SHAN

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We present results of the atmospheric electric field monitoring at the high-altitude Tien-Shan station (43.02 N, 76.56 E, 3340 m above sea level, 20 km from Almaty) and the analysis of its temporal and spectral characteristics during the activation of seismic processes in the vicinity of Almaty since 2007 till 2014. During this period the most considerable seismic activity was observed on May 1-2, 2011 and January 28, 2013.

It is known that values of atmospheric electric field over continents are  $\sim 100\div 150$  V/m under fair weather conditions and depends on time of day and a season. Typical temporal changes of electric field during the day in summer and winter periods at high altitude Tien-Shan station are presented in figure 1.

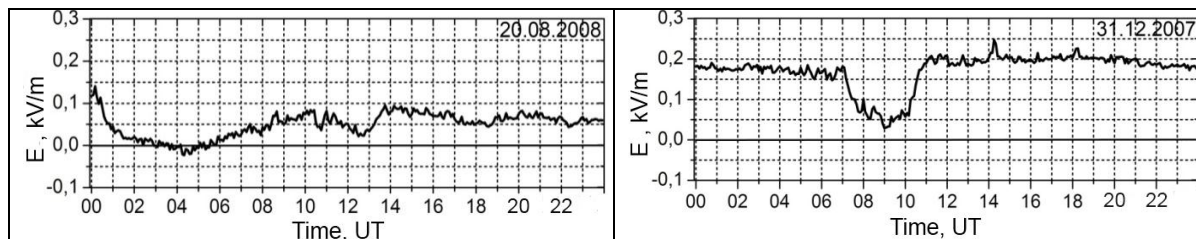


Figure 1. Diurnal variation of the electric field at the high mountain Tien-Shan station under fair weather conditions in summer and winter

Unusual temporal variations of the electric field with amplitude achieving the values of 6-7 kV/m were recorded as during series of earthquakes on May 1-2, 2011, and before them (April 28, 30). Eight events for 2 days with a magnitude of more than 4.0 occurred. The main shock of magnitude 5.4 occurred on May 1st at 02:31 UT, 76 km North East of Almaty. The duration of the electric field disturbances were 5-12 hours (5 hours on 28.04.2011 and 12 hours on 30.04.2011). Another the feature of the anomalous variations of the electric field was their positive polarity. Changes of the electric field before and during series of earthquakes on May 1, 2011 with concise description of meteorological conditions are presented in figure 2.

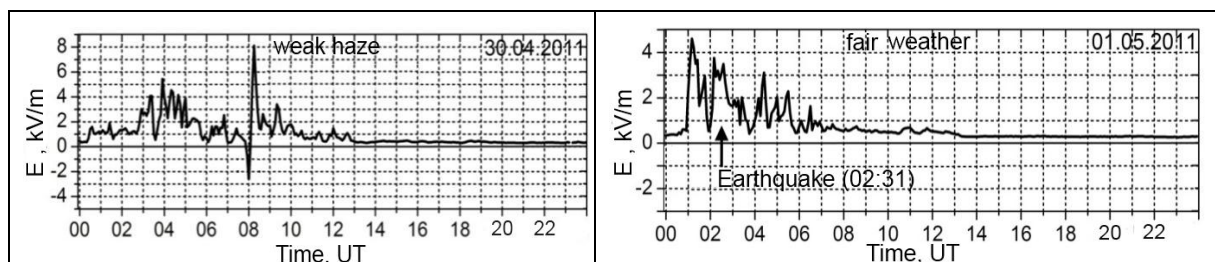


Figure 2. Changes of the electric field before and during series of earthquakes on May 1, 2011

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The analysis of meteorological and cosmophysical conditions was carried out for the purpose of identification of disturbance sources. It is shown that characteristics of temporal anomalous variations of the electric field don't correspond to these sources of disturbances. It was concluded that the cause of anomalous variations can be sources of the lithospheric origin only. Respectively, anomalies of the electric field can be considered as precursors of earthquakes.

We also registered anomalous duration temporal variations of the electric field with the amplitude achieving  $\pm 2$  kV/m before of the earthquake on January 28, 2013. The main shock of magnitude 6.1 occurred at 16:38 UT, 230 km. to the East from Almaty. The earthquake was felt in Almaty with intensity 4-5 points. In this event as positive variations and with the change of the polarity were recorded, figure 3. Apparently two different mechanisms impacts on atmospheric electric field in this event.

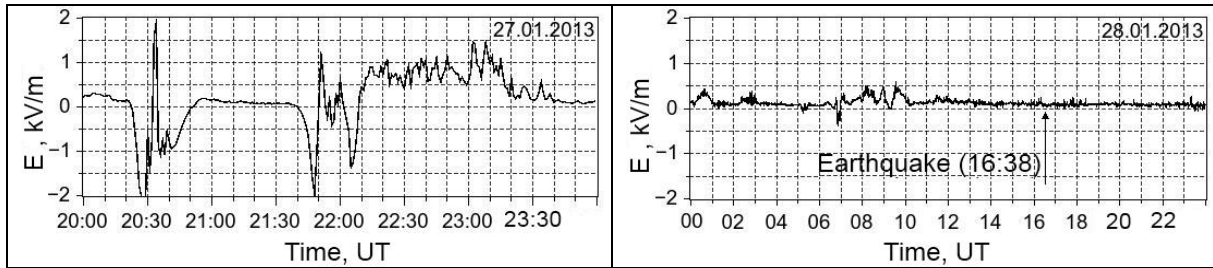


Figure 3. Changes of the electric field before of earthquake on January 28, 2013

Anomalous variations of the electric field were recorded on the eve of earthquake March 13, 2013 with the magnitude 5.4, which was classified as the aftershock of the event January 28, 2013.

Anomalous variations of electric field before of weaker earthquakes (magnitude  $< 4$ ) are recorded only for events with coordinates of the epicenter in close proximity to the detector (08.04.2009 and 27.09.2010).

Spectral components of atmospheric electric field variations, features of their dynamics in different meteorological, geophysical, cosmophysical conditions and during activation of seismic processes were studied. Found that the features typical for anomalous variations of the electric field on the eve of and during earthquakes are observed only in the low frequency range ( $10^{-4}$ – $10^{-3}$ )Hz. The dominating spectral peaks differing from the background are shown, figure 4. 7c spectral component revealed as before the earthquake, and in conditions of the fog.

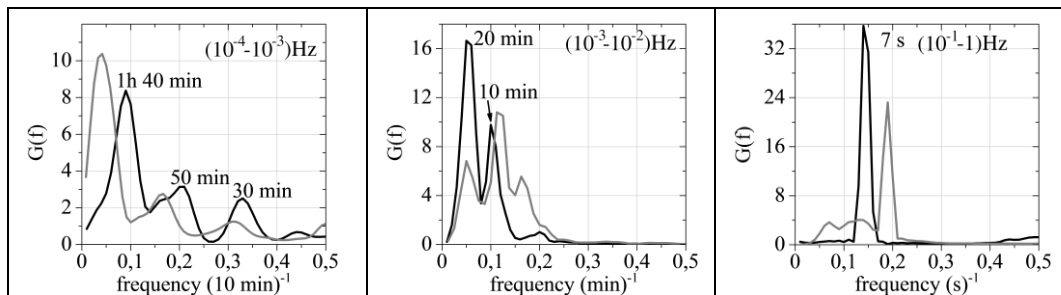


Figure 4. Typical estimates of the power spectra of anomalous variations of the electric field before earthquakes (black line) and background under fair weather conditions (grey line) for different frequency ranges

Thus we consider that the atmospheric quasi-static electric field variations are useful for a prediction of earthquakes.