2008/5/12 Wenchuan M7.9 earthquake, the 2011/3/11 Tohoku M9.0 earthquake and the 2012/4/11 Sumatra M8.6 earthquake have caused a significant impact to the human life.

On 26-May-2013, at 11:08 (LT), the M = 5.7 Bulung'ur earthquake occurred in Uzbekistan. The epicenter with Geographic Latitude (N) 39°92' and Longitude (E) 67°39' was located in the territory of the Bulung'ur district of Samarkand region at the distance less than one hundred kms from the GPS station operating in Kitab. Earthquake was not deep and had a local character. This favorable setting allowed us to test the capability of the GPS system to detect the ionospheric perturbations produced by a moderate size earthquake. High magnitude local earthquake have ionospheric precursors (the sample result is shown in Fig. 1).

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IONOSPHERIC EARTHQUAKE PRECURSORS OBSERVED USING TASHKENT AND KITAB GPS STATIONS DATA

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Anomalous variations of ionospheric total electron content (TEC) a few days before local earthquakes can be regarded as a precursory signals. We analyze data from two GPS stations operating in Tashkent and Kitab for the possible earthquake ionospheric precursors. We have studied GPS derived TEC disturbances related to the earthquakes which occurred in and around Uzbekistan in 2006-2010 years from two GNSS stations located in Tashkent and Kitab. The obtained results have revealed a fine agreement with the TEC anomalies observed during the strong earthquakes and we demonstrate the capabilities of the GPS technique to detect ionospheric perturbations caused by a local earthquake.

The Global Navigation Satellite System (GNSS) data can be used to measure the ionospheric TEC, the technique has received our attention as a potential tool to detect ionospheric perturbations related to the earthquakes. We have studied TEC disturbances which occurred in 2006-2010 around Uzbekistan using two Uzbekistan GNSS stations located in Tashkent and Kitab.

TEC is a frequently used quantity in ionospheric science. Since the number of electrons approximately equals to the number of positive ions, the TEC represents a suitable parameter for the degree of ionization. The TEC is defined as the integral over the electron density distribution Ne along a defined path s:

$$TEC = \int N_e ds. \qquad (1)$$

Since N_e is a volumetric density and TEC is defined by the integral over a path, the TEC can be thought as the total number of electrons that is contained in a volume with a cross section area being equal to 1 m^2 and length being equal to the path length. The common unit used for measuring the TEC is called Total Electron Content unit (TECU) and 1 TECU is equivalent to 10^{16} el/m^2. Depending on local time, Solar activity, geomagnetic conditions, region of the Earth, etc., the vTEC can vary from about 1 to 180 TECU.

We have analyzed GPS derived TEC disturbances from two GPS stations located in Tashkent and Kitab, for possible earthquake ionospheric precursors from year 2006 to year 2010 which occurred mostly in and around Uzbekistan in seismically active zones. We study TEC anomalies in the light of the earthquakes that occurred within 1000 km from the observing stations during the period of observation. We produce TEC time series over both sites and apply them to detect anomalous TEC signals accompanying the earthquakes.

To identify the anomalous values of TEC we calculated differential TEC (dTEC). dTEC is obtained by subtracting 15 days backward running mean of vTEC from the values of observed vTEC at each epoch. It removes normal variations in TEC. A thorough analysis of the data shows abnormal variations in TEC in the form of enhancements. For a detail study of the data, we have calculated dTEC values for all the months and

examined the anomalous TEC variations before the earthquakes (the sample results are shown in Fig. 1 and Fig. 2).

The results show anomalous enhancements which occur 2–5 days before the earthquakes. The obtained results have revealed a fine agreement with the TEC anomalies observed during the strong earthquake in Tashkent and we demonstrate the capabilities of the GPS technique to detect ionospheric perturbations caused by a local earthquake. The GPS based TEC measurements have been discussed in a number of recent papers as ionospheric precursors correlated with the earthquakes [1-6].

Concluding the Tashkent and Kitab GPS data analysis for years 2006- 2010 we can state that ionospheric data in F-layer obtained on ground based navigation stations in Tashkent and Kitab are used for analysis of earthquake precursors. In general the anomalies occurred 2-5 days before the earthquakes as precursors. The similar anomalies were detected in Kitab GPS station which is at the distance of about 350 kms from the epicentre.

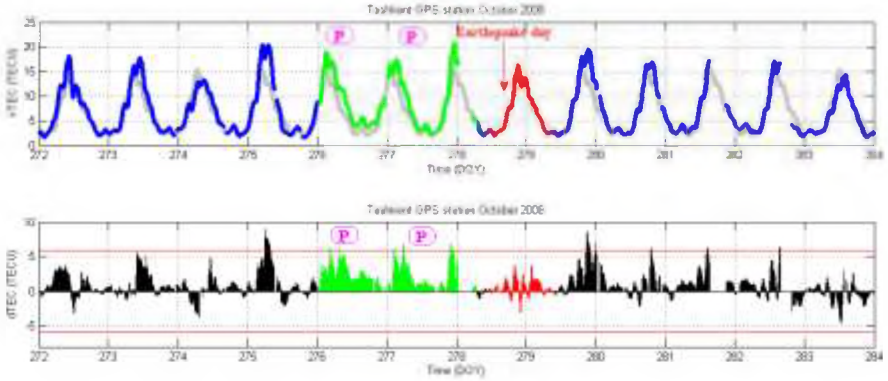

Fig.1. Tashkent station TEC and DTEC data for the 6.5 M Kyrgyzstan EQ occurred in October 5, 2008

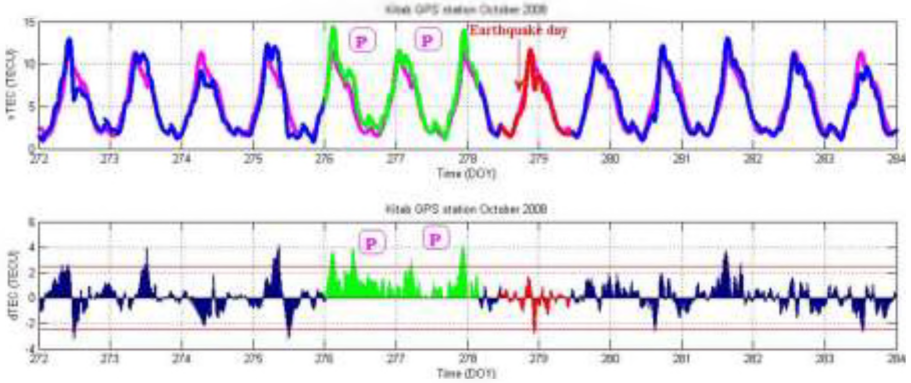

Fig.2. Kitab station TEC and DTEC data for the 6.5 M Kyrgyzstan EQ occurred in October 5, 2008

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