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# INTEGRATING OF GIS AND GPS FOR IONOSPHERIC PERTURBATIONS IN D- AND F-LAYERS USING VLF RECEIVER

## ABSTRACT

Regular monitoring of the D- and F-layers of ionosphere over Central Asia territory is being performed on the permanent basis starting year 2008 when one Very Low Frequency (VLF) receiver and two SuperSID receivers were provided to Uzbekistan IHY cite by Stanford University. The results obtained at Tashkent IHY (International Heliophysical Year) station are applied to earthquake electromagnetic precursors, lightning, and Solar flares and to ionospheric disturbances originating from gamma ray flares of Soft Gamma-Ray Repeaters.

Regular monitoring of the D-layer of ionosphere over Central Asia territory has been performed on the permanent basis. Several Solar events are observed and the analysis has shown that there is simultaneous correlation between the times of change of amplitude of the waves and the Solar flares. Features of the lightning discharge generated by radio atmospherics are studied and its effectiveness in D-region ionosphere diagnostics is examined.

We have mainly analyzed GPS derived TEC disturbances from two GPS stations located in Tashkent and Kitab, for possible earthquake ionospheric precursors. The solar and geomagnetic conditions were quiet during occurrence of the selected more than 30 earthquakes. We produced TEC time series over both sites and apply them to detect anomalous TEC signals preceding or accompanying the earthquakes. The results show anomalous enhancements which are examined in the earthquakes.

**KEYWORDS:** GPS, ionosphere, total electron content (TEC)

## INTRODUCTION

The ionizing action of the radiation of Sun on the upper atmosphere produces free electrons. Above about 60 km the number of these free electrons is sufficient to affect the propagation of electromagnetic waves. This “ionized” region of the atmosphere is a plasma and is referred to as the ionosphere. Rishbeth and Garriott in year 1969 have divided the ionosphere in to several layers. The lowest **D layer** varies from 60 to 90 km with the electron concentration $10^1$–$10^4$ per cm$^3$. D layer ionization is a function of the solar flow. The ions are formed by the ionization of atmospheric neutrals by X-ray radiation and solar Lyman α radiation. This region vanishes at night due to the combination of the ions and electrons. High-frequency (HF) radio waves are not reflected by this region, the main impact of which is absorption of HF radio waves. **E layer** is from 90 to 150 km with the electron concentration $10^5$ per cm$^3$. Similarly, to the D layer, the E layer shows a diurnal behavior with a maximum of ionization at local noon. In this region, ions consist primarily of $O_2^+$ produced by the absorption of solar radiation, and $NO^+$ formed by charge transfer collisions with other ions ionized by coronal X-rays. In auroral region, solar particle precipitation can produce radio scintillation effects in the E layer. The upper **F layer** is from 120 to 800 km with the electron concentration $10^5$ per cm$^3$. This layer is formed by ionization

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