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Assessing ionospheric activity by long time series of GNSS signals: the search of possible connection with seismicity

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The modifications of some atmospheric physical properties prior to a high magnitude earthquake were recently debated in the frame of the Lithosphere-Atmosphere-Ionosphere (LAI) Coupling model. Among this variety of phenomena, the ionization of air at the ionospheric levels due to leaking of gases from earth crust through the analysis of long time series of GNSS (Global Navigation Satellite System) signals was investigated in this work. Several authors used the dispersive properties of the ionospheric strata towards the GNSS signals to detect possible ionospheric anomalies over areas affected by earthquakes and some evidences were encountered. However, the spatial scale and temporal domains over which such disturbances come into evidence is still a controversial item. Furthermore, the correspondence by chance between ionospheric disturbances and relevant seismic activity is even more difficult to model whenever the reference time period and spatial extent of investigation are confined. Problems could also arise from phenomena due to solar activity (now at culmination within the 11 years-long solar cycle) because such global effects could reduce the ability to detect disturbances at regional or local spatial scale.

In this work, two case studies were investigated. The first one focuses on the M = 6.3 earthquake occurred on April 6, 2009, close to the city of L'Aquila (Abruzzo, Italy). The second concerns the M = 5.9 earthquake occurred on May 20, 2012, between the cities of Ferrara and Modena (Emilia Romagna, Italy). To investigate possible connections between the ionospheric activity and seismicity for such events, a five-year (2008-2012) long series of high resolution ionospheric maps was used. These maps were produced by authors from GNSS data collected by permanent stations uniformly distributed around the epicenters and allowed to assess the ionospheric activity through the analysis of the TEC (Total Electron Content). To avoid the influence of solar activity, only nighttime hours were considered. Moreover, to de?ne the temporal domain of potential ionospheric disturbances and separate local from global effects, results from local observations were compared with regional TEC series. The whole analysis shows episodes where anomalies in the ionospheric activity were detected in the vicinity of the mentioned shocks. However, their statistical significance and the temporal correlation with seismic activity are still controversial.