Pre-Earthquake ionospheric signatures detected by Swarm satellites

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Swarm three-satellite mission, launched on 22 November 2013 and still in operation at around 500km of altitude, is an ESA Earth Explorer space mission with the main objective to measure the geomagnetic field at its best way. Preliminary analysis for an earthquake case study (the 2015 Nepal earthquake) showed some indications of coupling between the solid earth and the above atmosphere [1]. In this contribution, we show the systematic analysis of several years of Swarm satellite magnetic and electron density data in correspondence with M5.5+ earthquakes all over the world. When we compare the real data anomalies with 100 analogous but random simulations, homogeneous in space and time, we find that the real ones are more concentrated and statistically related to the occurrence of earthquakes [2]. Finally, performing the analysis for different ranges of magnitude (with mean value M) we focused to the Rikitake empirical law (T is the precursor time in days, a and b are two constant parameters):

$$\log T = a + bM. \quad (1)$$

This law was introduced for ground precursors [3] and now we confirmed also for satellite data, in particular between ionospheric anomaly precursor time and earthquake magnitude, and proposed a stress diffusion model in the lithosphere to explain the given relationship [2].

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References

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