

## **Pre-earthquake anomaly study from space: SAFE and LIMADOU-science Projects**

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Swarm is a three-satellite constellation by the European Space Agency (ESA) launched on November 2013 and still in orbit. Its main objective is the monitoring of the geomagnetic field as better as possible. SAFE ("Swarm for Earthquake study") project (funded by ESA in the framework of "STSE Swarm+Innovation") deals with the integrated analysis of more physical parameters whose abnormal variations have been found to be possibly associated with impending earthquakes, and most of its analyses are made on Swarm satellite data.

We will show the most recent results of a systematic multiyear analysis of magnetic and electron density Swarm satellite anomalies in the whole space-time interval of interest, avoiding high magnetic latitudes (1 Jan 2014-31 Aug. 2017,  $|\text{geomagnetic latitude}| \leq 50^\circ$ ) which are correlated with earthquakes by means of a superposed epoch approach. Both magnetic and plasma data analyses show that the anomaly concentrations are larger than random anomaly distributions by a factor of more than 2.5, and a deviation from the random mean by more than 40 times the standard deviation, supporting the hypothesis for a lithosphere-atmosphere-ionosphere coupling in the preparation phase of earthquakes.

CSES (China Seismo-Electromagnetic Satellite), launched on 2 February 2018, is the first satellite of a space monitoring system proposed in order to investigate the topside ionosphere and designed in order to gather world-wide data of the near-Earth electromagnetic environment. Its scientific program has been developed in the framework of a collaboration between the China National Space Administration (CNSA) and the Italian Space Agency (ASI). The analysis of the scientific data will be performed by China Earthquake Administration (CEA), together with several Chinese institutes, and some Italian universities and research institutes, among which the INGV. The CSES satellite mission with dedicated scientific payload for pre-earthquake anomaly detection will let us available more electromagnetic data for applying the same SAFE strategy for searching precursors of future earthquakes.

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