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The Geophysical Coupling Before Earthquakes From Multiparametric Studies

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Abstract

The scientific debate on the existence of possible precursors before large earthquakes has been wide and brought to not univocal conclusions. One observable alone is clearly insufficient to provide indications on the criticality of the seismic fault status. In particular, it's fundamental to investigate how critical is the accumulation of stress on a seismogenic fault and how we can predict an incoming earthquake. Considering that the Earth is a complex system in which the geo-layers (lithosphere, atmosphere and ionosphere) interact, it seems possible to understand better the Earth's system if we study it as a whole. This requires an integration of observations and data from several sources and instruments, from ground data to remote sensing satellites. Despite the technical obstacles, several works have been done in this direction in the last years, and they seem to confirm firstly that the geo-layers show alterations (i.e., anomalies) before earthquake occurrence; secondly, it seems that several mechanisms of coupling are possible. This last point is the present research topic, as further clarifications are required.

In the presentation, several examples of couplings before the earthquakes will be shown; for example, the recent investigation of the Lushan (China) 2013 earthquake, which shows three possible couplings by different geophysical mechanisms at very different times before the earthquake (130 days, 45 days, and 2 weeks).

For the more recent seismic event, it is possible to investigate the ionosphere layer with the precious data from China Seismo Electromagnetic Satellite (CSES-01), by its instruments such as Langmuir probes and magnetometers. The integration of CSES and ESA Swarm data allows us to define better the ionospheric disturbances possibly related to earthquake occurrence. These cases include Mw = 7.5 Indonesia 2018, Mw = 7.6 Papua New Guinea 2019, Mw = 7.7 Jamaica 2020 or Mw = 7.8 Turkey 2023 earthquakes.

Finally, we are still far from predicting earthquakes but several steps toward a better understanding of the phenomena eventually associated with seismic events seem to be not far.