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A multiparametric and multilayer approach to analyze the June 15, 2019, M7.2 Kermadec Islands (New Zealand) earthquake from ground to space

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Earthquakes are powerful phenomena that occur in the lithosphere, releasing a huge amount of energy. Since part of such energy is released some time before the fault rupture, a comprehensive study of the earthquakes preparatory phase is of particular interest. For this reason, the earthquake-related processes that occurred during the preparation phase of the M7.2 Kermadec Islands (New Zealand) large earthquake occurred on June 15, 2019 as the result of shallow reverse faulting within the Tonga-Kermadec subduction zone, are investigated in this study. Our multiparametric and multilayer approach consisted in analyzing seismic (earthquake catalogues), atmospheric (climatological archives) and ionospheric data (from ground to space, mainly satellite) in order to disclose the possible Lithosphere-Atmosphere-Ionosphere Coupling (LAIC). For what concern the ionospheric investigations, we analysed and compared the observations from the Global Navigation Satellite System (GNSS) receiver network and those from space. Specifically, the data from the European Space Agency (ESA) Swarm satellite constellation and from the China National Space Administration (CNSA, in partnership with Italian Space Agency, ASI) China Seismo-Electromagnetic Satellite (CSES-01) are used in this study. An interesting comparison is made with another subsequent earthquake with comparable magnitude (M7.1) that occurred in Ridgecrest, California (USA) on July 6 of the same year. Both earthquakes showed several multiparametric anomalies that occurred at almost the same times from each earthquake occurrence, evidencing a chain of processes that points to the moment of the corresponding mainshock. In both cases, it is demonstrated that a multiparametric and multilayer analysis is fundamental to better understand the LAIC in complex phenomena such as the earthquakes.