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A new multi-parametric climatological approach to the study of the earthquake preparatory phase: the 2016 Amatrice-Norcia (Central Italy) seismic sequence

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Based on observations prior to earthquakes, recent theoretical considerations suggest that some geophysical quantities reveal abnormal changes that anticipate moderate and strong earthquakes, within a defined spatial area (the so-called Dobrovolsky area) according to a Lithosphere-Atmosphere-Ionosphere coupling (LAIC) model. One of the possible pre-earthquake effects could be the appearance of some climatological anomalies in the epicentral region, weeks/months before the major earthquakes. An ESA-funded project, SAFE (Swarm for Earthquake study) was dedicated to investigate the LAIC from ground to satellite.

In this work, the period of two months preceding the Amatrice-Norcia (Central Italy) earthquake sequence that started on 24 August 2016 with an M6 earthquake, and some months later produced other two major shocks, i.e. an M5.9 on 26 October and then an M6.5 on 30 October, was analyzed in terms of some climatological parameters. In particular, starting from a date preceding of about two months the first major shock, we applied a new approach based on the comparison of the thirty-seven year time series at the same seasonal time of three land/atmospheric parameters, i.e. skin temperature (skt), total column water vapour (tcwv) and total column of ozone (tco3), collected from European Center Medium Weather Forecast (ECMWF), and the year in which the earthquake sequence occurred. The originality of the method stands in the way the complete time series is reduced, where also the possible effect of global warming is properly removed.

A confutation/confirmation analysis was undertaken where these parameters were successfully analyzed in the same months but considering two seismically “calm” years, when significant seismicity was not present, in order to validate the technique. We also extended the analysis to all available years to construct a confusion matrix comparing the climatological anomalies with the real seismicity. This latter analysis has confirmed the potentiality of two climatological parameters, i.e. skt and tcwv, in anticipating the occurrence of large earthquakes in Central Italy.

The simultaneous analysis of the three climatological parameters related to the Amatrice-Norcia seismic sequence showed the presence of persistent contemporary anomalies in all of them, thus reinforcing the idea of considering such behaviour an effective tool for an integrated system of future earthquake prediction.