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Distributed Fiber Optic Sensing and Artificial Intelligence: preliminary results on the Campi Flegrei caldera unrest

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Since 2005 the Campi Flegrei caldera (Southern Italy) has been experiencing a long-term unrest characterized by a recent increase in seismicity and ground uplift rate. In August and September 2023, the unrest showed a sudden intensification in the number and maximum magnitude of earthquakes, culminated with the occurrence of a Md 4.2 event. In an effort to strengthen the monitoring activity, two Distributed Acoustic Sensing (DAS) devices were connected from October 2023 to telecommunication fiber optic cables in the densely populated Campi Flegrei area. The DAS interrogators are set up inside two TELECOM central offices in the city center of Naples and in Bagnoli. Dynamic strain rate data are continuously acquired with a gauge length of 10 m at an average spatial sampling of 4 and 5 m. In this framework, an automated real-time workflow has been implemented comprising both DAS data downsampling and transferring to INGV data processing center.

From the beginning of the DAS acquisition (19 October 2023), more than 300 seismic events have been recorded by the INGV local seismic network, including a Md 3.0 earthquake occurred on 23rd November 2023. Unknown cable installation conditions, poor coupling of the fiber optic cable with the ground, intense traffic and anthropogenic activities make the DAS data highly noisy and, hence, pose challenges for the application of traditional seismic data processing algorithms. In this study, we propose and apply AI based algorithms to improve and fasten earthquake detection and seismic phase picking on the large data volume associated with the high number of DAS channels. In particular, the compared algorithms cover recently published state-of-the-art deep learning networks. We show preliminary results that demonstrate the ability of the synergy between DAS and AI to contribute to the rapid response to volcanic crises.

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