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Array analyses of tremor wavefield during the 2004 Mt. Etna eruption

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On September 7, 2004, a new effusive eruption began at mount Etna volcano. Lava flows outpoured from a fracture system located on the eastern flank of the South-East crater, at 3000 m above sea level. Differently with the last eruptive episodes, the 2004 eruption was not preceded by any significant variation in seismic activity. On early summer, 2004, two small-aperture arrays were deployed on the North and the South-West flank of the volcano, at elevations of about 2800 m a.s.l.. Each array is composed by short-period (1 Hz), vertical-component sensors cable-connected to 6-channel data loggers recording continuosly at a sampling rate of 125 samples/second/channel. This work focus on the analysis of array recordings spanning the time-interval August 1^{st}-October 10^{th}, 2004. During this period, the seismicity is dominated by a background volcanic tremor, to which are overimposed several low-energy volcano-tectonic earthquakes probably associated with stress changes induced by magma migration and outflow. Tremor spectra show multiple peaks common to the two sites and concentrated in the band 0.5-5 Hz. This observation may be interpreted in term of a source effect or, alternatively, of a path effect associated with propagation in media depicting similar velocity structures. At both arrays, correlation analysis for seismograms filtered over narrow frequency bands demonstrates that significant wavefield coherence is maintained throughout the 0.5-1.5 Hz frequency band. For this particular frequency band, propagation azimuths and apparent velocity of tremor waves are retrieved by searching for those slowness vectors which maximise the multi-channel Semblance coefficient. We applied the analysis to short (2 s) data windows spanning the complete

set of tremor recordings, thus obtaining continuos, 70-day-long time-series of propagation parameters for tremor waves recorded by the two arrays. At both arrays, the most representative values of ray parameter are in the 0.5-1 s/km range, corresponding to apparent velocities between 1 and 2 km/s; these values are consistent with a wavefield composed by both surface- (Rayleigh) and body- (P-SV) waves. Propagation azimuths are clustered over the 230°-270° and 20°-50° intervals for the SW and N arrays, respectively. In agreement with several previous studies, these data indicate a tremor source located beneath the summit craters and extending from the surface down to a depth of 1-2 km. At the onset of the eruption, both arrays detected a new component of the tremor wavefield whose propagation parameters are consistent with a shallow source located in correspondence of the eruptive fissure. Further analyses are needed in order to gain additional insights about the nature and wavefield properties of volcanic tremor at Etna. Nonetheless, this study represents the very first effort toward the tracking of tremor sources on an active volcano over such a long time interval.