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Reconstruction of 23 November 2013 Etna Eruption Source Parameters through a multidisciplinary approach

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On 23 November 2013, Mt. Etna erupted producing the 17th paroxysmal episode of 2013. The eruption generated a buoyant plume that reached more than ∼10 km a.s.l. The volcanic cloud was dispersed by a wind oriented north-eastwards which drove the erupted tephra over an extending area starting from the slopes of the volcano (scoria and lapilli) to the Calabria and up to Puglia region (ash particles). The field samples were collected in proximal area but also in Calabria (∼160 km) and tephra sedimentation was reported in Salento, in Puglia region (∼400 km). Another source of information is the transmission of a pilot who reported the presence of volcanic ash over the Adriatic sea (∼30 km southwards the Albanian coasts) between 10.9 and 11.5 km a.s.l. on 23 November 2013 at 13:50 which likely corresponds to the top of the volcanic cloud made of aerosol and gas.

This study aims at reconstructing the Eruption Source Parameters (ESP) of the paroxysm phase such as, the eruptive column height, the eruption duration, the Mass Eruption Rate (MER), the Total Erupted Mass (TEM), and the Total Grain-Size Distribution (TGSD) making use of a multidisciplinary approach. Tephra dispersal simulations were performed using the model Fall3D constraining the results against field deposits, ground-based Radar measurements, and the satellite (MSG-Seviri) retrievals. The three sets of observations are complementary covering the full range of the erupted particle sizes from centimetre to micrometre particles, allowing for a robust assessment of the ESP. Indeed, among the multidisciplinary procedure, the field observations helped to approximate the erupted mass and the coarse fraction of the TGSD, whereas the radar measurements provided an estimation of eruptive column height and MER, and the satellite was crucial to quantify the fine ash fraction (i.e. PM10) by tracking the evolution of the plume and its mass. The best-fit results are in agreement with previous estimations recently published the literature and return a column height of ∼11.3 km a.s.l., a MER of ∼2.9×106 kg/s, a TEM of ∼8.2×109 kg, and a PM10 content of ∼2.0% with respect to the TEM. Results were also compared with the AERONET aerosol network to investigate the ultra-fine ash (i.e. few microns).

Keywords: Etna, Tephra dispersal modelling, Bulk granulometry, Aviation hazard, PM10