14.1 RETRIEVING VOLCANIC MASS ERUPTION RATE FROM GROUNDBASED X-BAND AND L-BAND MICROWAVE RADARS DURING MT. ETNA EXPLOSIVE ERUPTION

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Mt. Etna, one of the most active volcanoes in Europe, is located on the east coast of Sicily (Italy). Lava fountains are one of the most distinctive characters of Mt. Etna, relevant for the large amount of ash discharge rate. Within the INGV experimental site near the Mt. Etna volcano, a large set of instrumentation is installed, including seismic sensors, an optical lidar, a microwave radar, an infrasound array, a video camera. In the morning of 23 November 2013 an explosive lava fountain erupted from the New Southeast Crater (NSEC), lasting for about 1 hour. The lava fountain was clearly observed from two ground-based radars, an X-band polarimetric microwave weather radar (Marzano et al., 2013) and an Lband Doppler radar named Voldorad (Donnadieu, 2012) as well as from a video thermal-infrared camera.

The capability of the ground-based radars to probe the lava fountain and to estimate the volcanic mass eruption rate, a crucial parameter to describe the volcanic eruption intensity and to initialize ash dispersion numerical models, is still under discussion (e.g., Marzano et al., 2016). From the L-band Voldorad both radial velocities and the power backscattered by tephra particles can be derived, whereas from X-band microwave weather-radar polarimetric observables, by extending the VARR (Volcanic Ash Radar Retrieval) methodology, we can identify the lava fountain altitude and derive the tephra mass eruption rate (MER). The latter can be estimated from 3 main techniques: 1) the surface-flux approach (SFA), physically relating MER to the tephra exit velocity and density as well as the vent geometry; 2) top-plume approach (TPA), using semi-empirical parametric models ingesting the top plume altitude and eruption geophysical parameters; 3) mass-continuity approach (MCA), based on the mass continuity equation solved within the erupted plume volume including the volcano vent as surface boundary condition.

In this work we show how SFA, TPA and MCA retrieval techniques can be formulated within VARR and how the mass eruption rate can be retrieved from both X-band weather radar and L-band Voldorad data. This intercomparison shows that there is a consistency between these approaches when applied to both X-band and L-band data, once most of the uncertainties are taken into account and model parametrizations are constrained. Moreover, the radar-based estimates well compare with total erupted mass estimates derived from field campaigns aimed at sampling ash loadings at ground after 23 November 2013. The analysis of this case study indicate that ground-based polarimetric microwave weather radars can be exploited to provide a self-consistent monitoring of the timevarying activity of explosive volcanic eruptions.

References

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