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The 3 December 2015 paroxysm of Voragine crater at Etna: insights from Doppler radar measurements

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After a progressive intensification of Strombolian activity inside the Voragine crater in the evening of December 2 2015, Mount Etna produced a short but violent paroxysm in the night of 3 December 2015, the most intense of the last two decades at Voragine. Lava fountains, observed with the network of thermal and visible cameras of INGV-OE, reached well over 1 km in height with some jets of incandescent material reaching 3 km. A tephra column several kilometers high was produced and pyroclastic material was dispersed by winds in altitude to the NE, causing ash fallouts to affect many towns in Sicily and Reggio Calabria.
A 23 cm-wavelength Doppler radar (VOLDORAD 2B), located about 3 km from NSEC at the Montagnola station and integrated into the INGV-OE instrumental network, has been continuously monitoring the explosive activity of Mt. Etna's summit craters since 2009. The radar beam probes 13 successive volumes 150 m deep aligned northward above the summit craters, providing two sets of parameters (echo power and velocity) at a rate of 0.2 s. We analyze the paroxysmal event of Voragine using the radar echoes and Doppler signals coming from volumes inside the lava fountain feeding the tephra column in combination with thermal and visible imagery and satellite data.
The radar range gating allowed us to immediately discriminate the central craters as the source of the tephra emission and to estimate the lava fountain width between 300 and 450 m. The backscattered power, which is related to the erupted tephra mass load in the beam, and Doppler velocities help to mark the transition from Strombolian activity to lava fountaining, providing onset and end times of the fountain. The tephra flux into the radar beam started to increase after 02:00 UTC with a strong increase at 02:20 UTC marking the transition to continuous lava fountaining. The climax was reached between ca. 02:35 and 03:15 UTC with maintained high echo power and ejection velocities of 190 m/s in average, with peaks at 290 m/s. Then signals decreased to the detection threshold at 03:30 UTC. MSG-SEVIRI satellite imagery (HOTVOLC Observation System) shows the volcanic SO_2 cloud dispersion reaching Greece and the Aegean Sea within 24 hours.