Geophysical Research Abstracts
Vol. 17, EGU2015-11842-3, 2015
EGU General Assembly 2015

Multi-variable X-band radar observation and tracking of ash plume from Mt. Etna volcano on November 23, 2013 event

Mario Montopoli (1), Gianfranco Vulpiani (1), Matteo Riccci (1), Stefano Corradini (2), Luca Merucci (2), and Frank S. Marzano (1)

(1) Sapienza University of Rome - DIET, Rome, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy

Ground based weather radar observations of volcanic ash clouds are gaining momentum after recent works which demonstrated their potential use either as stand alone tool or in combination with satellite retrievals. From an operational standpoint, radar data have been mainly exploited to derive the height of ash plume and its temporal-spatial development, taking into account the radar limitation of detecting coarse ash particles (from approximately 20 microns to 10 millimeters and above in terms of particle's radius). More sophisticated radar retrievals can include airborne ash concentration, ash fall rate and out-flux rate. Marzano et al. developed several volcanic ash radar retrieval (VARR) schemes, even though their practical use is still subject to a robust validation activity. The latter is made particularly difficult due to the lack of field campaigns with multiple observations and the scarce repetition of volcanic events.

The radar variable, often used to infer the physical features of actual ash clouds, is the radar reflectivity named ZHH. It is related to ash particle size distribution and it shows a nice power law relationship with ash concentration. This makes ZHH largely used in radar-volcanology studies. However, weather radars are often able to detect Doppler frequency shifts and, more and more, they have a polarization-diversity capability. The former means that wind speed spectrum of the ash cloud is potentially inferable, whereas the latter implies that variables other than ZHH are available. Theoretically, these additional radar variables are linked to the degree of eccentricity of ash particles, their orientation and density as well as the presence of strong turbulence effects. Thus, the opportunity to refine the ash radar estimates so far developed can benefit from the thorough analysis of radar Doppler and polarization diversity.

In this work we show a detailed analysis of Doppler shifts and polarization variables measured by the X band radar working at Catania airport (Sicily, Italy) and observing the Mt. Etna fountains about 33 km far away. Collocated infrared satellite observations will be shown as well to complete the investigation. The case study on November 23rd, 2013 is taken as reference case due to its strength and its well-defined narrow plume, which is transported by the prevailing wind hundred kilometers away. For this case study, the X-band radar in Catania tracked the ash-signal from 9:40 UTC to 10:30 UTC every 10 min providing, at each acquisition step, the following variables, abbreviated as ZDR, RHV, VEL, SWD KDP and ZHH. The latter stand for differential reflectivity, correlation coefficients, radial velocity, spectral width, specific differential phase shift and reflectivity, respectively.

The outcomes of this analysis reveal that the interpretation of polarization diversity and Doppler shifts might introduce new insights in the estimates of the fraction of ash mass loading due to larger particles and its rate of mass flux. This would be an important achievement for the APhoRISM Project in witch this work is framed. APHORISM is a 3 years FP7-EU project started on December 2013 that aims to develop innovative products to support the management and mitigation of the volcanic and the seismic crisis.