

Intepretation of polarimetric radar measurements at X band for volcanic plume monitoring.

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In recent years, several works have investigated the potential role played by ground-based microwave weather radars for the monitoring of volcanic ash clouds. The goal of this work is to show the potentiality and drawbacks of the X-band dual polarization radar measurements (DPX) through the data acquired during the latest Grímsvötn (Iceland) and Etna (Italy) volcanic eruptions that took place in 2011 and 2012. The analysis is enriched by the comparison with observations from the satellite Special Sensor Microwave Imager/Sounder (SSMIS) and a C-band single polarization (SPC) radar for the Icelandic eruption. The C-band, X-band radars and SSMIS radiometer cover a large range of the microwave spectrum. The comparison is made in terms of total columnar concentration (TCC). The latter is estimated from radar observables using the volcanic ash radar retrieval (VARR) algorithm for dual-polarization X-band and single polarization C-band systems and from SSMIS brightness temperature (BT) using a linear BT–TCC relationship.

VARR also include a detection module for distinguishing ash from meteorological targets. This module is based on the instantaneous analysis of radar polarimetric volumes and geographical information following a fuzzy logic approach. The decision between meteo and ash target is made from a Probability of Ash Detection (PAD) index, which is the output of the detection module. Performances of PAD will be presented for analyzed case studies.

The BT–TCC relationship has been compared with the analogous relation derived from SSMIS and SPC radar data for the same case study. Results show that DPX radar data identify an evident volcanic signature, even though the interpretation of the polarimetric variables is not always straightforward, likely due to the possible formation of ash and ice particle aggregates and the radar signal impairments like depolarization or non-uniform beam filling that might be caused by turbulence effects within the ash column.