Geophysical Research Abstracts
Vol. 17, EGU2015-8768-1, 2015
EGU General Assembly 2015

Ground-based microwave weather radar observations and retrievals during the 2014 Holuhraun eruption (Bárðarbunga, Iceland)

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During an eruptive event the real-time forecasting of ash dispersal into the atmosphere is a key factor to prevent air traffic disasters. The ash plume is extremely hazardous to aircraft that inadvertently may fly through it. Real-time monitoring of such phenomena is crucial, particularly to obtain specific data for the initialization of eruption and dispersion models in terms of source parameters. The latter, such as plume height, ash concentration, mass flow rate and size spectra, are usually very difficult to measure or to estimate with a relatively good accuracy.
Over the last years different techniques have been developed to improved ash plume detection and retrieval. Satellite-based observations, using multi-frequency visible and infrared radiometers, are usually exploited for monitoring and measuring dispersed ash clouds. The observations from geostationary orbit suffer from a relatively poor spatial resolution, whereas the low orbit level has a relatively poor temporal resolution. Moreover, the field-of-view of infrared radiometric measurements may be reduced by obstructions caused by water and ice clouds lying between the ground and the sensor's antenna.

Weather radar-based observations represent an emerging technique to detect and, to a certain extent, mitigate the hazard from the ash plumes. Ground-based microwave scanning radar systems can provide the three-dimensional information about the detected ash volume with a fairly high spatial resolution every few minutes and in all weather conditions. Methodological studies have recently investigated the possibility of using single-polarization and dual-polarization ground-based radar for the remote sensing of volcanic ash cloud. In this respect, radar observations can be complementary to satellite observations.

A microphysical electromagnetic characterization of volcanic ash was carried out in terms of dielectric properties, composition, size and orientation of ash particles. An extended Volcanic Ash Radar Retrieval (VARR) algorithm for single-polarization and double-polarization systems, shown in previous work, has been applied to C-band and X-band weather radar data.

In this work we show radar based estimations of eruptive source parameters for Holuhraun events in the fall of 2014.

This extremely gas-rich eruption was characterized by sustained lava fountaining in the first months. At the same time some ash-rich episodes were reported from the field together with minor tephra fallout occurring close to the eruption site. Since the beginning of the eruption, the Icelandic Meteorological Office (IMO) monitored the volcanic plume using two ground-based radars: a C-band weather radar (5.5 GHz) in Egilsstaðir and an X-band polarimetric mobile radar (9.4 GHz) located at Vaðalda, about 20 km away from the eruption site. The VARR algorithm has been applied to few specific events and the radar products, such as top plume height, concentration, ash load and mass flow rate, derived from the two radars, are here discussed in terms of retrievals and inter-comparisons with available in-situ information. Both radar-based estimations show a presence of volcanic particles in the observed plume. Also, airborne fine ash particles are identified at low levels of plume probably due to a wind-induced re-suspension of dust and ancient volcanic ash deposited in the area around Holuhraun.