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Correlation between ground weather radar and satellite observations at microwaves for the Grímsvötn volcanic eruption on May 2011

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The potential use of passive and active microwaves sensors to provide quantitative information about near-source volcanic ash cloud parameters during an eruptive event is analyzed in this work from an experimental point of view. To this aim ground-based microwave (MW) weather radar and satellite MW radiometer observations are used together. The target area where the collected measurements are compared is the Icelandic subglacial volcanic region and the analyzed case study is that of the Grímsvötn eruption on May 2011.
The analyzed weather radar data include those of the Keflavík (Iceland) site (260 km far from the volcano vent) operating at single polarization and working at the frequency of 5.6 GHz with a range resolution of 2 km and that of a portable radar system positioned 70 km far from the volcano vent with polarimetry capabilities (i.e. able to measure signals from both the orthogonal polarizations of the backscattered power as well as the phase shift returns) and working at the frequency of 10 GHz with a range spatial resolution of 0.25 km. On the other hand, the measurements from the satellite passive radiometer are derived from the Special Sensor Microwave Imager/Sounder (SSMIS) in terms of brightness temperature. SSMIS is a conically scanning passive microwave radiometer aboard of a low-earth- orbit platform with several channels (from about 19 GHz to 189 GHz) and with a ground resolution variable from 12.5 and 25 km depending from the frequency channel used.
The diversity in terms of spatial scale, frequency, polarization and observation point of view of the collected data gives an original contribution to the characterization of the near source parameters of the Grímsvötn eruption in May 2011 highlighting the advantages and drawbacks of microwave sensors used for volcanic purposes. Traditionally, the monitoring of ash plumes is performed exploiting thermal infrared (TIR) and optical channels of spaceborne radiometers. These measurements can be obtained from sensors aboard geosynchronous-earth-orbit (GEO) and low-earth- orbit (LEO) satellites, thus offering different spatial and temporal resolutions for ash cloud remote sensing. For GEO platforms the advantage of rapid sampling of the earth scene is paid with lower resolution (typically larger than few kilometers), whereas for LEO the revisit time may be even longer than 12 hours. Moreover, TIR and optical channels may suffer from strong ash cloud opacity (very often mixed with water cloud) due to the significant radiation extinction especially in the proximity of the volcanic source. In this respect, the exploitation of the microwave (MW) passive sensors may represent a good opportunity due to their capability to sound the ash cloud, though with some inherent limitations.
The results of this work will be shown in terms of correlation between the passive satellite-based brightness temperatures and active ground based retrievals of ash content. The latter is obtained applying the Volcanic Ash Radar Retrieval (VARR) technique both on single and dual polarization mode. The advantage of using the ground based radar orthogonal-polarization measurements will be preliminarily discussed.