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Volcanic eruption source parameters from active and passive microwave sensors

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It is well known, in the volcanology community, that precise information of the source parameters characterising an eruption are of predominant interest for the initialization of the Volcanic Transport and Dispersion Models (VTDM). Source parameters of main interest would be the top altitude of the volcanic plume, the flux of the mass ejected at the emission source, which is strictly related to the cloud top altitude, the distribution of volcanic mass concentration along the vertical column as well as the duration of the eruption and the erupted volume. Usually, the combination of a-posteriori field and numerical studies allow constraining the eruption source parameters for a given volcanic event thus making possible the forecast of ash dispersion and deposition from future volcanic eruptions.

So far, remote sensors working at visible and infrared channels (cameras and radiometers) have been mainly used to detect, track and provide estimates of the concentration content and the prevailing size of the particles propagating within the ash clouds up to several thousand of kilometres far from the source as well as track back, a-posteriori, the accuracy of the VATDM outputs thus testing the initial choice made for the source parameters. Acoustic wave (infrasound) and microwave fixed scan radar (voldorad) were also used to infer source parameters.

In this work we want to put our attention on the role of sensors operating at microwave wavelengths as complementary tools for the real time estimations of source parameters. Microwaves can benefit of the operability during night and day and a relatively negligible sensitivity to the presence of clouds (non precipitating weather clouds) at the cost of a limited coverage and larger spatial resolution when compared with infrared sensors. Thanks to the aforementioned advantages, the products from microwaves sensors are expected to be sensible mostly to the whole path traversed along the tephra cloud making microwaves particularly appealing for estimates close to the volcano emission source. Near the source the cloud optical thickness is expected to be large enough to induce saturation effects at the infrared sensor receiver thus vanishing the brightness temperature difference methods for the ash cloud identification.
In the light of the introduction above, some case studies at Eyjafjallajökull 2010 (Iceland), Etna (Italy) and Calbuco (Cile), on 5-10 May 2010, 23rd Nov., 2013 and 23 Apr., 2015, respectively, are analysed in terms of source parameter estimates (manly the cloud top and mass flax rate) from ground based microwave weather radar (9.6 GHz) and satellite Low Earth Orbit microwave radiometers (50 – 183 GH). A special highlight will be given to the advantages and limitations of microwave-related products with respect to more conventional tools.