Multi-sensor determination of eruption source parameters: the example of the 10 April 2011 paroxysm at Mount Etna

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The near real-time determination of Eruptive Source Parameters (ESPs) is one of the main challenges of modern volcanology. Strategies are now being developed to refine quantitative measurements of erupted mass, total grain-size distribution and plume height from ground sampling and remote sensing methods. However, each method has its own limitations and, therefore, ESPs remain poorly constrained.

Between 2011 and 2015, Etna volcano has produced 49 paroxysmal episodes characterized by the emission of fountain-fed tephra plumes whose heights reached up to 15 km (above sea level). In this work, we take advantage of the complementary set of remote sensing data available at Etna for assessing the quantification of ESPs and their associated uncertainties based on ground deposit sampling, Doppler radar data, visible imagery and satellite observations. In particular, we have considered the 10 April 2011 as a case study of the weakest paroxysms given that some of the strongest paroxysms have already been studied to develop and enhance remote sensing and monitoring strategies at Etna (e.g. 23 November 2013 and 3 December 2015). Satellite thermal infrared and weather radar observations for this weak paroxysm show tephra plume altitudes of 6 to 9 km (a.s.l.), in agreement with simulations with HYPLIT model. The erupted mass determined with all these sensors show a large variability that reflects the sensibility of each method to different grain sizes (e.g. from blocks and lapilli seen by L-band radar to very fine ash seen by satellite thermal-infrared). Our multi-sensor strategy shed some lights on the importance of intercomparing data from various approaches and studying their applicability limits for near real-time quantification of ESPs and monitoring purposes at Etna.