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Simulating and observing Icelandic ash cloud movements toward Italy

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After almost one year the volcanic eruption occurred at Eyjafjallajokull Volcano in Iceland is still argument of several international discussions and subject of multidisciplinary studies. The large amount of ashes released by the volcano and its prolonged activity, more than three weeks, created a quite rare event for a deep investigation on plume dispersal dynamics.
In the present work we study this specific eruption, by looking at some instantaneous snapshots of volcanic cloud evolution in order to better describe and understand the complex dynamics of some eruptive events occurred on April and May 2010. To do this we combine numerical modelling technique and remote sensing retrieval obtaining an integration of their outcomes. We adopt the VOL-CALPUFF code (Barsotti et al. 2008) to simulate the aerial pattern followed by the volcanic cloud, during the first weeks of activity, that spread ashes all over European domain. It is a hybrid Eulerian-Lagrangian model that describes the release in atmosphere of a multi-phase and multi-component mixture and the atmospheric transport of the generated ash cloud. It describes the transient and three-dimensional character of atmospheric circulation by using quite refined NWP outcomes. In order to detect volcanic cloud presence and track its movement, two different inverting algorithms have been applied to satellite images acquired during the Icelandic crisis based on visible and thermal infrared spectral range. The analysis of ENVISAT acquisition of both AATSR and MERIS data offers the possibility to estimate and quantify plume altitude, its position and extension, other than optical depth, Angstrom coefficient (particle size) and mass concentration.
The comparison between simulation and satellite retrieval results highlights how different investigating techniques could be of support each other in better describing the complexity of plume atmospheric dispersal. We use the simulation to analyze the complex nature of ash cloud structure and to reproduce atmospheric dynamics causing not intuitive ash plume patterns as detected by satellites. Actually, on the base of model results, we notice how the irregularly shaped cloud, as detected by satellite retrieval, is mostly due to different sized particles populating it and their different responses to a quite strong vertical wind-shear. Moreover, quantitative comparisons of the main parameters characterizing ash cloud dynamics (vertical displacement, horizontal extension, particle concentration), as produced by both model and satellite elaboration, have been done at different temporal instants, and compared with available independent ash cloud measurements (LIDAR, direct estimation).
Finally, we investigate the necessity of reliable observed data (both close to and far from the vent) for defining and constraining initial volcanological parameters of numerical code, mostly for forecasting purposes during on-going eruption. In particular column heights estimated by remote sensing have been provided as input to VOL-CALPUFF code in order to show the effects of this volcanological input parameter on the simulation output at continental scale.
The outcomes of this study suggests a stronger collaboration and knowledge exchanging between different scientific communities in order to gain deeper understanding of such an hazardous natural phenomena could develop and evolve. Ultimately, this sharing should be done in order to create a more robust and reliable tool to be used for decision making activities during volcanic crisis, as demonstrated in the frame of FP7 - SAFER Project and GMES activities.