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Operational source term estimation and ensemble prediction for the Grimsvoetn 2011 event

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The ESA-funded international project VAST (Volcanic Ash Strategic Initiative Team) includes focusing on a realistic source term estimation in the case of volcanic eruptions as well as on an estimate of the forecast uncertainty in the resulting atmospheric dispersion calculations, which partly derive from the forecast uncertainty in the meteorological input data.

SEVIRI earth observation data serve as a basis for the source term estimation, from which the total atmospheric column ash content can be estimated. In an operational environment, the already available EUMETCAST VOLE product may be used. Further an a priori source term is needed, which can be coarsely estimated according to information from previous eruptions and/or constrained with observations of the eruption column. The link between observations and the a priori source is established by runs of the atmospheric transport model FLEXPART for individual emission periods and a predefined number of vertical levels. Through minimizing the differences between observations and model results the so-called a posteriori source term can be depicted for a certain time interval as a function of height. Such a result is shown for a first test case, the eruption of the Grimsvoetn volcano on Iceland in May 2011.
Once the dispersion calculations are as optimized as possible with regard to the source term, the uncertainty stemming from the forecast uncertainty of the numeric weather prediction model used is still present, adding up to the unavoidable model errors. Since it is impossible to perform FLEXPART runs for all 50 members of the Integrated Forecasting System (IFS) of ECMWF due to computational (time-storage) constraints, the number of members gets restricted to five (maximum seven) representative runs via cluster analysis. The approach used is as of Klonner (2012) where it was demonstrated that exclusive consideration of the wind components on a pressure level (e.g. 400 hPa) makes it possible to find clusters and representative members, which reproduce the spread of the full ensemble. This approach was tested in three case studies. The horizontal wind can be considered as the most decisive factor for the dispersion of ash in this context. To focus the clustering on the area affected by a volcanic eruption only the area affected by the volcanic ash is considered in the clustering of the horizontal wind velocities. This area is the one where ash concentration becomes larger than a fix threshold using a FLEXPART run driven by the operational ECMWF-run as input. This area becomes artificially enlarged by an “uncertainty factor” to include all those regions, which could be affected taking all ensemble members as input. Finally FLEXPART runs with the a posteriori source are started for representative ECMWF-runs and the operational run and are plotted in such a way that the highest ash concentration of all runs at each grid point is given. Thus the user gets an impression in which area which maximal ash concentration can be anticipated with high probability.