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Windfield stochastic variability integrated in an ash transport and dispersal model

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In explosive volcanic eruptions, a large amount of ash may be injected into the atmosphere. The ash clouds extend over large areas and can travel thousands of kilometers from the source volcano, disrupting air traffic and posing a significant hazard to air travel. To predict the likely position of the ash cloud, mathematical models of advection and dispersion are used. These models require input data on source conditions such as eruption plume height, as well as the windfield.

In this contribution, we extend a previous work on uncertainty quantification in the volcanic input parameters by considering the variability in the windfields. The puff trajectory model is used to hindcast the motion of the ash cloud for the eruption of Eyjafjallajokull, Iceland which had a peak ash emission in the period 14-18 April 2010. Windfields along with source parameters (vent radius, vent velocity, mean grain size and grain size variance) represent major sources for uncertainties in ash transport and dispersion simulations. Based on our lack of knowledge of the exact conditions of the source, probability distributions are assigned to the parameters which are later sampled in a Monte Carlo fashion. For windfields, ensemble methods are considered to be an effective way to estimate the probability density function of future states of the atmosphere by addressing uncertainties present in initial conditions and in model approximations. We are using the Global Ensemble Forecast System (GEFS) generated by the National Centers for Environmental Prediction (NCEP), which is a weather forecast model made up of 21 separate ensemble members. Output statistics are then computed by properly summing the weighted values of the output parameters of interest. The results are presented as forecast envelope and show how volcanic source term uncertainty and windfield stochastic variability can affect the forecast. Thus, we produce a complete probabilistic forecast of ash cloud position.