Cities on Volcanoes 9
November 20-25, 2016
Puerto Varas, Chile
'Understanding volcanoes and society: the key for risk mitigation'

Ensemble Based Data Assimilation on volcanic ash dispersion: The Cordón Caulle eruption

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Keywords: Ash dispersion, Modeling, Data assimilation, Parameter Estimation

Source term quantification is the main factor of uncertainty of volcanic ash cloud forecasts. On one hand, it is commonly assumed that relevant volcanological parameters may remain constant during the forecasted period because of the lack of knowledge on the future behavior of an eruption. On the other hand, the volcanological data available during an eruption is often uncertain. Indirect measurements can cause large uncertainties in deterministic forecasts. Ensemble forecast combined with data assimilation (e.g. to keep the mean of an ensemble close to observations) is one of the best ways to deal with these uncertainties. Sequential data assimilation is an iterative process that corrects an a priori forecast whenever new observations become available in order to obtain an estimation of the current state (the "analysis") that is used as the initial condition for the following forecast step. Data assimilation can also be used for parameter estimation which in this particular application allows for an estimation of the uncertain source term parameters. In order to perform data assimilation in a numerical ash dispersion forecast, we coupled the Ensemble Transform Kalman Filter (ETKF) method with FALL3D ash dispersal model. We evaluated the ETKF-FALL3D system using an observing system simulation experiment (OSSE) approach in which synthetic observations of ash cloud total column mass are generated and assimilated every 6 hours. These synthetic observations mimic quantitative retrievals from satellite data. Our OSSE is performed for the 2011 Cordón Caulle eruption. In this experiment the ETKF-FALL3D is used to estimate not only the 3D distribution of ash within the domain, but also the column height and the mean of the grain size distribution at the source. Results show that the ETKF-FALL3D system might be adequate to produce an on-line optimization of the uncertain volcanological parameters as well as the volcanic ash dispersal patterns.