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Assimilation of satellite-retrieved data to improve forecasts of volcanic ash concentrations

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Since the 2010 Eyjafjallajökull volcano eruption caused a big problem to aviation and economy, improvement on volcanic ash forecast has been put onto the research agenda. Satellite-based measurements are considered as the most common and cheapest type of volcanic ash observations. However, due to its intrinsic functionality, satellite-retrived two-dimensional data can not be easily and directly combined with a three-dimensional volcanic ash model to improve volcanic ash forecasts continuously.

Here we propose a satellite observational operator to transfer 2D volcanic ash mass loadings to 3D concentrations. The uncertainties of reconstructed 3D ash concentrations are also quantified. Sequential data assimilation is used to continuously assimilate the reconstructed volcanic ash concentrations. The results are evaluated in a multi-observational network including satellite-based measurements and aircraft in-situ measurements.

Here we show for long-time assimilating satellite-based measurements, Ensemble Squre Root Filter (EnSR), as a common sequential data assimilation technique, is more efficient than Ensemble Kalman Filter (EnKF) because the ensemble size required for EnSR is considerable less than the ensemble size of EnKF for a comparable assimilation performance. Moreover, the forecast after assimilation is validated to be accurate and valid within 15 hours.