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Ensemble-based data assimilation of volcanic aerosols using FALL3D+PDAF

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Modelling atmospheric dispersion and deposition of volcanic ash is becoming increasingly valuable for understanding the potential impacts of explosive volcanic eruptions on infrastructures, air quality and aviation. The generation of high-resolution forecasts depends on the accuracy and reliability of the input data for models. Uncertainties in key parameters such as eruption column height injection, physical properties of particles or meteorological fields, represent a major source of error in forecasting airborne volcanic ash. The availability of nearly real time geostationary satellite observations with high spatial and temporal resolutions provides the opportunity to improve forecasts in an operational context. Data assimilation (DA) is one of the most effective ways to reduce the error associated with the forecasts through the incorporation of available observations into numerical models. Here we present a new implementation of an ensemble-based data assimilation system based on the coupling between the FALL3D dispersal model and the Parallel Data Assimilation Framework (PDAF). The implementation is based on the last version release of FALL3D (versions 8.x) tailored to the extreme-scale computing requirements, which has been redesigned and rewritten from scratch in the framework of the EU Center of Excellence for Exascale in Solid Earth (ChEESE). The proposed methodology can be efficiently implemented in an operational environment by exploiting high-performance computing (HPC) resources. The FALL3D+PDAF system can be run in parallel and supports online-coupled DA, which allows an efficient information transfer through parallel communication. Satellite-retrieved data from recent volcanic eruptions were considered as input observations for the assimilation system.