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Estimation of volcanic ash emissions from satellite data using trajectory-based 4D-Var

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An accurate determination of emission parameters are crucial to the volcanic ash forecast for aviation, health and climate interests. In this study, we reconstruct the vertical profile of the volcanic ash emission from satellite ash mass loading data using trajectory-based 4D-Var (Trj4DVar) approach with Eyjafjallajökull 2010 eruptive event and the corresponding SEVIRI data as a study case. Since the Eyjafjallajökull eruption in April 2010, besides ash mass loadings retrieved from satellite data, the additional information of plume height and mass eruption rate is always available from volcanic ash detections and observations. Modifications is made in Trj4DVar to integrate the additional information into the data assimilation system to improve the estimation of volcanic ash emissions and achieve a better initial condition for quantitative predictions.

The modified Trj4DVar has been tested in twin experiments designed based on the study case, and shows significant improvement on straightforward Trj4DVar since it has great correction impact to recognize the injection height and produce more accurate emission estimation and reliable initial field of volcanic ash loading. To apply the approach to the real case with SEVIRI data, two strategies was proposed: observational mask matrix and separate time windows. The results produced a better initial condition and predictive forecast that were more fitter the SEVIRI ash mass loading fields, which showed a great potential of applying the method in practice.