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ZAMG
Zentralanstalt für
Meteorologie und
Geodynamik

The Volcanic Ash Strategic Initiative Team (VAST) - operational testing of ash prediction services for global aviation

G. Wotawa¹, D. Arnold¹, S. Eckhardt², N. Kristiansen², C. Maurer¹, F. Prata², K. Stebel², A. Stohl² and C. Zehner³

¹ Zentralanstalt für Meteorologie und Geodynamik, Vienna, Austria

² Norwegian Institute for Air Research (NILU), Kjeller, Norway

³ ESA ESRIN, Frascati, Italy

1. Introduction

The project VAST performs its activities within the ESA strategic initiative to enhance the use of Earth Observation (EO) data in volcanic ash monitoring and forecasting. The VAST project aims at further exploring the suitability of EO data for such activities and to improve volcanic ash atmospheric transport forecasting services through exercises and demonstration activities in operational environments. The services include ensemble modelling as well as inverse modelling to determine source terms for volcanic ash during an event.



3. Ensemble modelling using ECMWF EPS system

The ECMWF Ensemble Prediction System (EPS) allows to consider meteorological forecast errors in volcanic ash simulations. However, according to operational considerations, the number of EPS members needs to be reduced from 50 to about 5-6. For this purpose, the 5-6 members that would influence the FLEXPART volcanic ash simulation most need to be identified beforehand. This identification is performed based on (i) wind fields around the main flight altitude (~30000 ft) and (ii) precipitation, taking into account the predicted movement of the plume in the unperturbed case. For this purpose, a cluster analysis algorithm was developed and validated (Klonner, 2013).

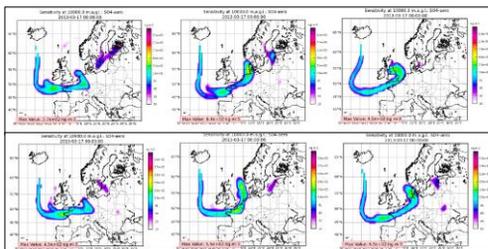


Figure: Test simulation for Eyjafjallajökull, 14 March 2013. The 6 cases shown are the most different FLEXPART simulations (72 hour forecast) fed with meteorology from the ECMWF EPS system

5. Event triggering

To trigger VAST operational testing, there are currently 3 pathways:

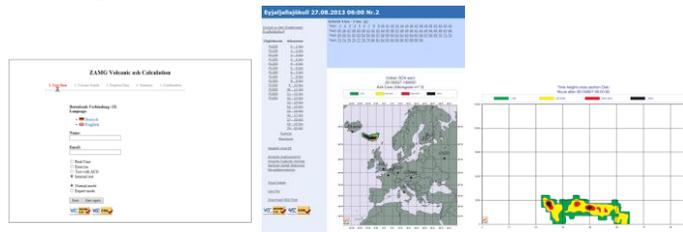
- Manual triggering in case an eruption becomes known
- Triggering by a notification of the ESA project SACS
- Triggering by ash retrievals from the SEVIRI instrument onboard the MeteoSat satellite

Notifications from SACS are provided by e-mail message. The message is in xml format following the Common Alerting Protocol (CAP), providing information on the position and size of the plume. Information on ash concentrations is not available yet.

Data from the EUMETSAT volcanic ash (VOLE) product are operationally received every 10 minutes. This data also contain information on ash loading. EUMETSAT VOLE data will also be used as operational input for the inverse modelling. Additional input data will come from the VAST project itself, based on improved SEVIRI retrievals and based on other available satellite instruments.

2. Volcano database and modelling tool

As part of the VAST Project, a volcanic ash modelling tool connected with a volcano database was installed at ZAMG to allow operational staff and on-call experts to start model runs. The tool includes default eruption parameters (release height, release duration, percentage of fine ash) for about 1500 volcanoes world-wide, based on the tables and formulas provided by USGS/Mastin et al. (2009). If more information becomes available, for example eruption heights from weather radar or pilot reports, or source term estimates from inverse modelling, this information can be used as well. The tool can produce many standard plots, like ash concentrations at certain flight levels and height levels, and time-height cross-sections at LIDAR stations, selected airports and mountain observatories.



4. Concept of operational testing

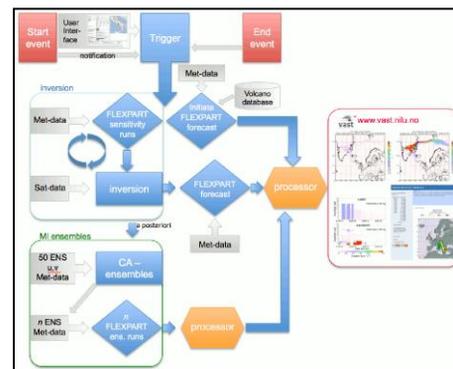


Figure: diagram of the operations procedure. The start of the event triggers the process via automatic notification or by hand. Once triggered, the system reads in an internal database to produce a first fast forecast and processed output. All the steps needed by the inversion are produced iteratively during the whole length of the event. The trigger also starts the cluster analysis of the 50 ECMWF EPS members to produce a sub-set of them for a multi input ensemble.

6. Summary and Outlook

The ESA Project VAST is now entering its second phase, where the operational testing activities are started. This includes event-based triggering of model simulations, quick operational model runs of volcanic ash, inverse modelling to get information on the ash source term based on the seamless integration of satellite data, and the subsequent start of corrected model runs. The system is complemented by a multi-input ensemble based on ECMWF EPS data as input for FLEXPART, and a prototype multi-model ensemble. Standard products will include ash concentrations in certain flight levels and time-height cross-sections of ash at selected airports. After the end of VAST, the components of the system will be available to the community, in particular the designated Volcanic Ash Advisory Centers (VAACs).

Literature:
Mastin, L. G., Guffanti, M., Servranckx, R., Webley, P., Barsotti, S., Dean, K., Durant, A., Ewert, J.W., Neri, A., Rose, W. I., Schneider, D., Siebert, L., Stuniger, B., Swanson, C., Tupper, A., Volentik, A., and Waythomas, C. F. (2009). A multidisciplinary effort to assign realistic source parameters to models of volcanic ash-cloud transport and dispersion during eruptions. J. Volcan. Geoth. Res., 186, 10-21. doi:10.1016/j.jvolgeores.2009.10.013
Klonner, R. (2013). Clustering ECMWF ENS ensemble predictions to optimise FLEXPART plume dispersion ensembles. Master Thesis at the University of Vienna, Institute for Meteorology and Geophysics