archer

FORECASTING THE DISPERSION OF VOLCANIC ASH AND GAS

In the event of a volcanic eruption, it is crucial to be able to forecast the spread of ash. Concentrations of ash greater than 2mg/m^3 are considered dangerous to aircraft and can cause serious damage to their engines. Knowledge of the concentration of ash and its location is therefore critical to the aviation industry, as shown by the significant disruption to air traffic in the wake of the 2010 Eyjafjallajökull eruption.

Icelandic Met Office

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
Expert | Impartial | Innovative

Met Office

The National Centre for Atmospheric Science (NCAS), the British Geological Survey (BGS), the UK Met Office (UKMO) and the Icelandic Met Office (IMO) work under a Memorandum of Understanding on collaborative projects aimed at improving response to volcanic events. A dispersion modelling exercise led by the UKMO was conducted in June 2019 to improve the partners' awareness of the volcanic ash dispersion modelling capabilities at each institution and test the ability of each institution to run its dispersion models.

Dispersion modelling exercise

The exercise began with the IMO issuing a VONA (Volcano Observatory Notice for Aviation) to the participating institutions. The VONA contains information on the location of the eruption and the expected (or measured, when observed) height of the volcanic plume. The latter is essential for forecasting models as it is closely linked to the emission rate.

In this exercise, the erupting volcano was taken to be Katla, in southern Iceland, and the plume height was given as 18 km. Each institution ran their forecast models based upon this information. Models included those that are freely available to the volcanological community plus in-house developments (such as the Weather Research and Forecasting (WRF) model used on ARCHER – see Figure 1 overleaf).

Plots of ash concentration were produced and these plots would (in the case of a real eruption) be of significant interest to aviation authorities. Work is ongoing to determine the similarities, and differences, between model results. Differences can be attributed to model configuration, for example the amount of ash (and ash type) each model releases. Subsequent meetings and teleconferences between group members have resulted in a plan to standardise the visualisation of model output, allowing a much easier comparison of results. Further exercises are planned, the next being in Spring 2020.

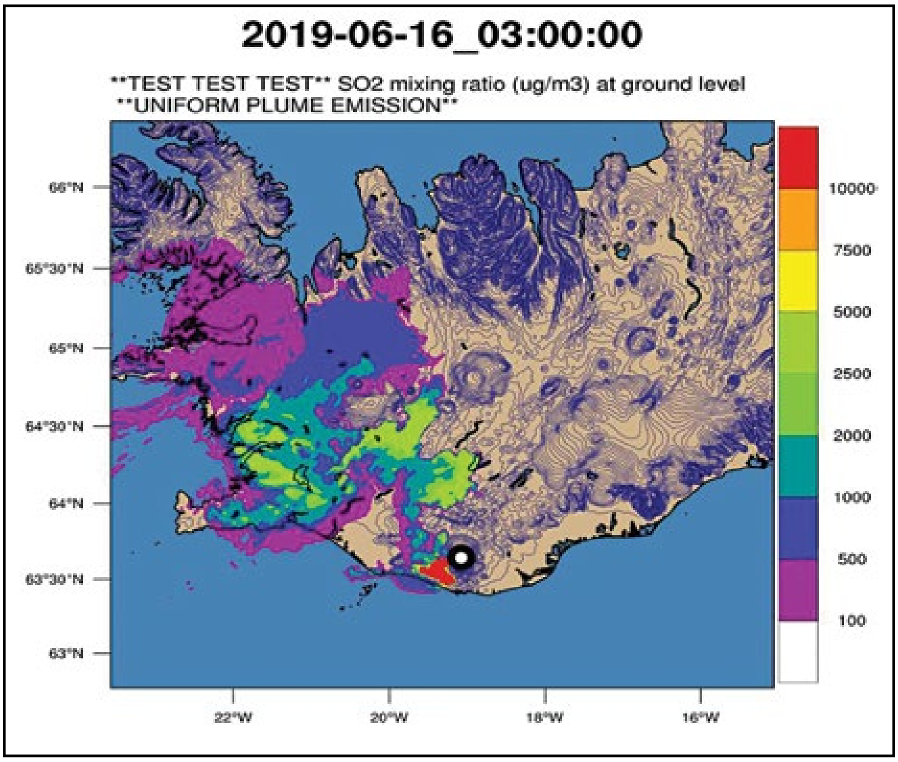

Figure 1. Weather Research and Forecasting (WRF) model simulation of the concentration of sulphur dioxide in Iceland, 42 hours after the start of the eruption. The location of the eruption, Katla, is marked with a white circle. Note the complex pattern of gas dispersion, associated with the topography of Iceland and the prevailing meteorological conditions.

Volcanic eruptions may also produce significant amounts of hazardous gases, for example sulphur dioxide. NCAS used the Weather Research and Forecasting (WRF) model to simulate the release of volcanic gas from the eruption. WRF is a state-of-the art weather prediction model with over 30,000 registered users in 150 countries. The WRF model has been modified by NCAS so that dense gases can be tracked as they flow through the complex topography of Iceland pinpointing the locations that may experience dangerous levels of volcanic gas (see Figure 1). Due to the complex nature of this simulation and memory requirements, a large number of processors were required: during the exercise this work was performed using 192 ARCHER processors. The significant number of processors is associated with the need to capture dispersion patterns on small scales (of the order of a kilometre). Without the access to ARCHER this work would not have been completed in such detail, nor so quickly (the resolution of small features and the response time are, of course, crucial here). Furthermore, the proven reliability of ARCHER is of huge importance if this modelling work is ever performed in a real-life emergency. The development work and testing of this new modification to WRF also took place on ARCHER.

Additionally, work is underway on ARCHER to parellelise the UKMO Numerical Atmospheric-dispersion Modelling Environment (NAME) model, also used in the exercise. See https://www.ARCHER.ac.uk/community/eCSE/eCSE09-10/eCSE09-10.php.

Contact:

Sara Barsotti (IMO), sara@vedur.is

Frances Beckett (UKMO), frances.beckett@metoffice.gov.uk

Ralph Burton and Stephen Mobbs (NCAS), ralph.burton@ncas.ac.uk and stephen.mobbs@ncas.ac.uk

Fabio Dioguardi (BGS), fabiod@bgs.ac.uk

About ARCHER

ARCHER is the UK National Supercomputing Service. The service is provided to the UK research community by EPSRC, UoE HPCx Ltd and its subcontractors: EPCC and STFC's Daresbury Laboratory, and by Cray Inc. The Computational Science and Engineering (CSE) partners provide expertise to support the UK research community in the use of ARCHER. The ARCHER CSE partners are EPSRC and EPCC at the University of Edinburgh.

The eCSE Programme

The Embedded CSE (eCSE) programme provides funding to the ARCHER user community to develop software in a sustainable manner to run on ARCHER. Funding enables the employment of a researcher or code developer to work specifically on the relevant software to enable new features or improve the performance of the code.

The Case Study Series

This case study has been produced as part of the ARCHER CSE service, supported by EPSRC research grant number EP/N006321/1.

www.archer.ac.uk