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Case Study: Met Office

Atmospheric expertise accelerates UK's volcanic ash response

The challenge

On 14th April 2010 Icelandic volcano Eyafyallajokull erupted, releasing large quantities of ash into the atmosphere, which reached UK airspace the following day. Based on a zero threshold for airborne ash, the International Civil Aviation Organisation (ICAO) announced that commercial air travel would not be permitted in affected areas. This closure of airspace has been estimated to have cost the airline industry £400m a day.

Days later, the Civil Aviation Authority (CAA) and engine manufacturers agreed on revised procedures, allowing flights in areas with ash concentrations below 2000 μgm^{-3}. The Met Office Volcanic Ash Advisory Centre (VAAC) was responsible for providing maps of the affected areas to the CAA, and used its Numerical Atmospheric-dispersion Modelling Environment (NAME) model to do this.

New limits on flying challenged the predictive capability of the Met Office NAME model, since forecasts now had to identify the concentration boundary rather than simply the presence of the ash. This required accurate quantitative measurements of ash concentrations for validation and development purposes. Soaring daily costs to the airline industry meant that verification of the NAME predictions were of critical importance.

> "Without a doubt, the strong and close working relationship that exists between The University of Manchester and the Met Office was a significant benefit to us, the CAA, the aviation industry and the general public as it allowed swift state-of-the-art validation of model forecasts and satellite retrievals."
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> *Professor Jim Haywood, Aerosol Research Manager, The Met Office*

The University of Manchester solution

Over the last decade The University of Manchester's Centre for Atmospheric Science (CAS), which hosts part of the NERC National Centre for Atmospheric Science, has developed world leading capability in the measurement of cloud and aerosol properties using the UK Facility for Airborne Atmospheric Measurement (FAAM), a collaboration between the Met Office and the Natural Environment Research Council (NERC). Given their unique measurement expertise, Manchester's scientists were asked to help verify the ash cloud concentrations provided by the NAME dispersion model.

Met Office

The Met Office is the UK's national weather service, employing more than 1,800 at 60 locations worldwide. It is recognised as one of the world's most accurate forecasters, producing over 3,000 tailored forecasts and briefings a day.

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- Installed with an extensive analytical suite of CAS imaging probes, the FAAM aircraft flew eleven missions to measure ash properties and collect samples for analysis.
- Measurements taken by Manchester's scientists and instrumentation provided the Met Office with important data sets, crucial to testing the validity of its own ash forecasts, contributing significantly to the decision to reopen commercial airspace.
- In addition to the aircraft measurements, the first detection of ash over the UK was made by Manchester's Light Detection and Ranging (LiDAR) remote sensing technology which was quickly installed at the Met Office Cardington observing site. Validation from airborne measurements showed that a network of ground-based LiDARs could provide effective monitoring for future incidents, and plans for this are being progressed by the Met Office.

> "The response to the Icelandic eruption demonstrates our strong relationship with the Met Office, and the ability of the team to respond on short timescales to a national civil emergency using our world-leading expertise in LiDAR, aerosol and cloud measurement."

Professor Hugh Coe,
School of Earth, Atmospheric and Environmental Sciences,
The University of Manchester

The benefits

The strategic collaboration between The University of Manchester and the Met Office was instrumental in verifying forecasts of the ash cloud released by the Eyafyallajokull eruption.

Measurements taken by Manchester's research team contributed significantly to constraining the Met Office model predictions and its satellite retrieval algorithms, and were crucial in assessing and developing the performance of the NAME model. The rapid response to deploy resources and the ability to deliver quality assured data played a critical role in minimising disruption to airspace.

- New knowledge and capability have been developed for emergency responses. The CAA has now provided funds for conversion of a dedicated twin engine aircraft for dealing with civil contingencies, which includes instrumentation that was informed by measurements taken by Manchester's airborne probes and surface LiDAR retrievals. This aircraft is now fully operational.
- Manchester scientists advised the Government of the issues and risk related to the ongoing volcanic ash event, as well as recommending future courses of action for similar events. Experts at Manchester continue to report to the Department of Transport as part of their continuous risk assessment.
- The partnership has been highly beneficial to the research team, resulting in considerable further research activities, which has led to the award of more than £3m of research income from NERC and the Met Office since 2010.