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Airborne observations of volcanic ash in May 2010 from the FAAM research aircraft, using remote sensing and in-situ probes

Franco Marenco (1), Kate Turnbull (1), Ben Johnson (1), Jim Haywood (1), Stuart Newman (1), Alan Vance (1), James Dorsey (2), and Martin Gallagher (2)

(1) Observational Based Research, Met Office, United Kingdom, (2) University of Manchester, United Kingdom

Following the eruption of the Eyjafjallajokull, Iceland, in early 2010, volcanic ash was transported at long-range over the United Kingdom and Central Europe, resulting in a major disruption to air traffic.

Observations of volcanic ash during that period are of great interest for the validation of numericalprediction models, the improvement of observational methods, and have also been useful in real-time decision making concerning the closure of airspace.

The research aircraft Facility for Airborne Atmospheric Measurements, FAAM (http://www.faam.ac.uk/) was tasked with monitoring the volcanic plumes over the United Kingdom and the surrounding seas. In addition to aircraft navigational data, it carried on board several in-situ probes such as a cloud and aerosol spectrometer (CAS), a three-wavelength nephelometer, and other instruments yielding thermodynamic information (temperature, humidity, etc.) and trace gases such as sulfur dioxide, ozone, and carbon monoxide. Moreover, the FAAM aircraft carries the capability for launching dropsondes.

Volcanic ash, identified with the nephelometer and CAS, was found well-correlated with sulfur dioxide.

Two remote sensing instruments were also employed on the airborne platform, namely a Leosphere ALS450elastic backscatter lidar with depolarisation, operating in the near ultraviolet, and the infrared spectrometer ARIES (Airborne Research Interferometer Evaluation System) operating between 3.5 and 18 μm.

Complex atmospheric scenes have been observed in the lidar profiles, involving clouds and aerosol layers stacked on top of each other. In some cases, the depolarisation channel of the lidar permitted aerosol patches of a different nature than ash to be distinguished, with a likely candidate being secondary sulfate originated from sulfur dioxide of volcanic origin. In other cases, there is evidence of icecondensation on the volcanic ash particles, and the evolution of the latter into cloud. Large valuesof aerosol optical depth (AOD), up to 0.8, were deduced from the lidar data.

In a case study (17 May 2010), the spectral slope at 8 μm, deduced from ARIES brightness temperatures, has been found to be well correlated to the AOD deduced from the lidar. Moreover, radiative transfersimulations using the lidar profiles permit a very good reconstruction of the observed spectra. Thisopens the door to volcanic ash observations from satellites such as the Infrared Atmospheric SoundingInterferometer (IASI), which operates in the same spectral range.

Using the size-distributions measured with CAS an attempt is made to deduce mass concentrations (which is the quantity needed for modelling and aircraft safety purposes) from the lidar remote sensing of volcanic ash.