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Airborne lidar observations of volcanic ash during the eruption of Eyjafjallajökull in Spring 2010

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The London Volcanic Ash Advisory Centre (VAAC), based at the Met Office, provided forecast guidance for the Civil Aviation Authority during the eruption of Eyjafjallajökull in April-May 2010. Besides providing daily forecasts using the Numerical Atmospheric-dispersion Modelling Environment (NAME), a series of observational activities were carried out by the Met Office, involving ground-based lidars, the exploitation of satellite data, and research flights using the Facility for Airborne Atmospheric Measurements BAe-146 research aircraft (FAAM, www.faam.ac.uk), on which this talk is focused. Due to safety restrictions, aircraft sampling has only been performed in areas where ash concentrations where forecasted to be less than 2000 μg/m^3.

Volcanic ash layers were observed using an elastic backscatter lidar on-board the FAAM aircraft operating at 355 nm, which allowed detailed mapping of the plumes. A flight on 4 May overpassed the ground-based lidar in Aberystwyth a few times. This provided ground truth validation of the on-board lidar and of its data inversion procedure. The ash layer during this flight was found to be in patches of short horizontal extent, but despite the strong horizontal inhomogeneity the two lidars showed excellent qualitative and quantitative agreement. Moreover, radiative transfer computations using the lidar-derived profiles of aerosol extinction led to a good reconstruction of observed radiance spectra with on-board spectrometers.

Aircraft in situ measurements of the particle size-distribution permitted the evaluation of a coarse extinction fraction (ranging 0.5-1) and a coarse mode specific extinction (0.6-0.9 m^2/g) for six research flights. These quantities were then used to convert the lidar-derived aerosol extinction to ash concentration (with an estimated uncertainty of a factor of two).

The combination of lidar and in-situ sampling of aerosol properties has thus offered us the opportunity to compile a dataset of the airborne Eyjafjallajökull ash: whereas the in-situ instrumentation provided a good insight into the microphysics, the lidar permitted mapping the ash layers with excellent detail in two dimensions (the vertical and the along-track horizontal). As data of airborne volcanic ash concentrations are rather limited, this dataset is considered invaluable for validation of dispersion models and satellite products. We will briefly show here how these estimates of ash concentration compare with forecast maps obtained with the NAME model and with satellite retrievals of ash column load obtained with IASI and SEVIRI.

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