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Aircraft in situ and remote sensing measurements of emissions from Etna volcano, Sicily

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Volcanoes emit particles (silicates and sulphate aerosol) and gases (e.g., water and sulphur dioxide) which influence the radiative balance of the atmosphere. The rate at which sulphur dioxide oxidises to sulphate aerosol is poorly constrained and measurements of downwind abundance are required to quantify the rate at which this process occurs.

During July and November 2011, a series of measurements were performed in emissions from Etna Volcano, Sicily, using the University of Applied Sciences (Dusseldorf) research aircraft. Both in situ and remote sensing instrumentation was simultaneously deployed to quantify the down-wind characteristics of gases and particles in the plume emitted by the volcano. In situ particle characteristics were measured using a Grimm 1.109 optical particle counter (microparticles 0.25-32 microns) and Grimm 1320 diffusion electrometer (nanoparticles 25-300 nanometers). Column abundance of sulphur dioxide was measured using a vertically-pointing differential optical absorption spectrometer (DOAS). These measurements were compared to horizontal pathlength-integrated measurements of sulphur dioxide from the Airborne Volcanic Imaging Object Detector (AVOID).

Down-wind plume dispersion was discriminated through a series of aircraft transects below and through the volcanic plume. The emissions contained large amounts of nanoparticles relative to microparticles, which reflects gas-phase nucleation of sulphate aerosol. The AVOID system discriminated horizontal layering of volcanic aerosol at altitudes of up to 12,000 ft from a detection range of $>$50 km. Plume boundaries were discriminated using a combination of the in situ and DOAS measurements in order to compare to the pathlength-integrated measurements from AVOID.