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Observing Sarychev Peak volcanic aerosols with high-resolution infrared limb emission spectra from the MIPAS-E instrument: plume transport and stratospheric sulphate signatures.

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Volcanic eruptions can release large volumes of sulphur dioxide (SO_2), mineral ash, water vapour, sulphate aerosols and other atmospheric constituents directly into the upper troposphere and lower stratosphere (UTLS). On the 11^{th} of June 2009, Sarychev Peak volcano (48ºN, 153ºE) located on Kuril Islands, Russia, began a series of eruptions ejecting ash plumes into the atmosphere and resulting in a widespread stratospheric aerosol layer forming across the Northern Hemisphere. The Sarychev Peak eruptions provide an excellent opportunity to observe and model the full sulphuric acid (H_2SO_4) spectrum and in particular we present the first hemispheric observations of thermal infrared emission spectra of H_2SO_4.

Many nadir remote sensors have provided essential measurements on the transport and dispersion of volcanic plumes (e.g. OMI, MODIS, AVHRR). Prominent among these are nadir infrared sounders that make dedicated SO_2 retrievals using simple spectral detection methods (e.g. IASI). Such instruments cannot give accurate injection heights and cannot easily separate stratospheric and tropospheric effects due to their broad vertical resolution. Limb sounding instruments and space-based Lidar such as NASA's CALIPSO mission provide alternative methods which can give more detailed height information.

The thermal infrared spectrum from 700 to 1200 cm^{-1} ($\sim$14 to 8.3 microns) captures the distinct emission/absorption signatures of ash, SO_2, H_2SO_4 aerosols and ice. Limb sounding Fourier Transform spectrometers provide high-resolution thermal emission spectra with typically 2 to 3 km vertical resolution in the UTLS making them well suited to study volcanic events. Not only do such measurements detail the vertical distribution and transport pathways but the emission spectra themselves can reveal details about plume composition with the potential to distinguish aerosol particle radius size and formation/conversion timescales.

One such instrument is the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS-E) launched on ESA's ENVISAT platform in March 2002. With a spectral resolution of 0.0625 cm^{-1} (unapodised) and nominal 1.5 km vertical sampling, MIPAS-E spectra encapsulate volcanic signatures well into the stratosphere. A particle-detection algorithm designed at the University of Leicester has successfully identified volcanically influenced measurements by accounting for the strong aerosol, ice and cloud absorption signals that manifests in MIPAS-E spectra. In this investigation the algorithm is applied to reprocessed MIPAS-E (version 5) level 1b spectra from June to August 2009 and the following results will be presented:

- Plume and cloud top heights for June to August 2009 capturing the initial plume injection as high as 22 km and hemispheric transport over this period.
- Comparison of MIPAS to the 532 nm total backscatter measurements from the CALIOP instrument for a verification of plume height and Northern Hemisphere stratospheric aerosol layer.
- Observations of the evolving H_2SO_4 emission spectra to identify volcanic aerosol signatures in the high resolution MIPAS measurements and mapping their changing characteristics during the conversion process.