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Supplement of

Characterisation of a stratospheric sulfate plume from the Nabro volcano using a combination of passive satellite measurements in nadir and limb geometry

M. J. M. Penning de Vries et al.

Correspondence to: M. J. M. Penning de Vries (marloes.penningdevries@mpic.de)

1. Radiative Transfer Model calculations of UV Aerosol Index viewing angle dependence

To investigate the line-of-sight (LOS) dependence of UVAI, we performed RTM calculations using the Monte Carlo model McArtim (Deutschmann et al., 2011). Several aerosol scenarios were tested and settings were chosen close to the circumstances of the measurements on June 14, 2011, presented in the paper: a solar zenith angle of 20 degrees and UV surface albedo of 0.1; the aerosol phase function was parameterized with a Henyey-Greenstein asymmetry parameter of 0.6 (consistent with the limb retrieval).
Whereas aerosols that do not or hardly absorb UV radiation (here termed “scattering aerosols”) show negative UVAI values throughout most of the swath, high positive UVAI may be found in the easternmost pixels (LOS zenith angle>45) if the aerosol layer is at altitudes > 10km. The effect scales with aerosol optical thickness (AOT), as shown in panel a. Varying the single-scattering albedo (SSA) or asymmetry parameter (g; data not shown) raises or lowers the UVAI, but does not affect the shape of the viewing angle dependence.

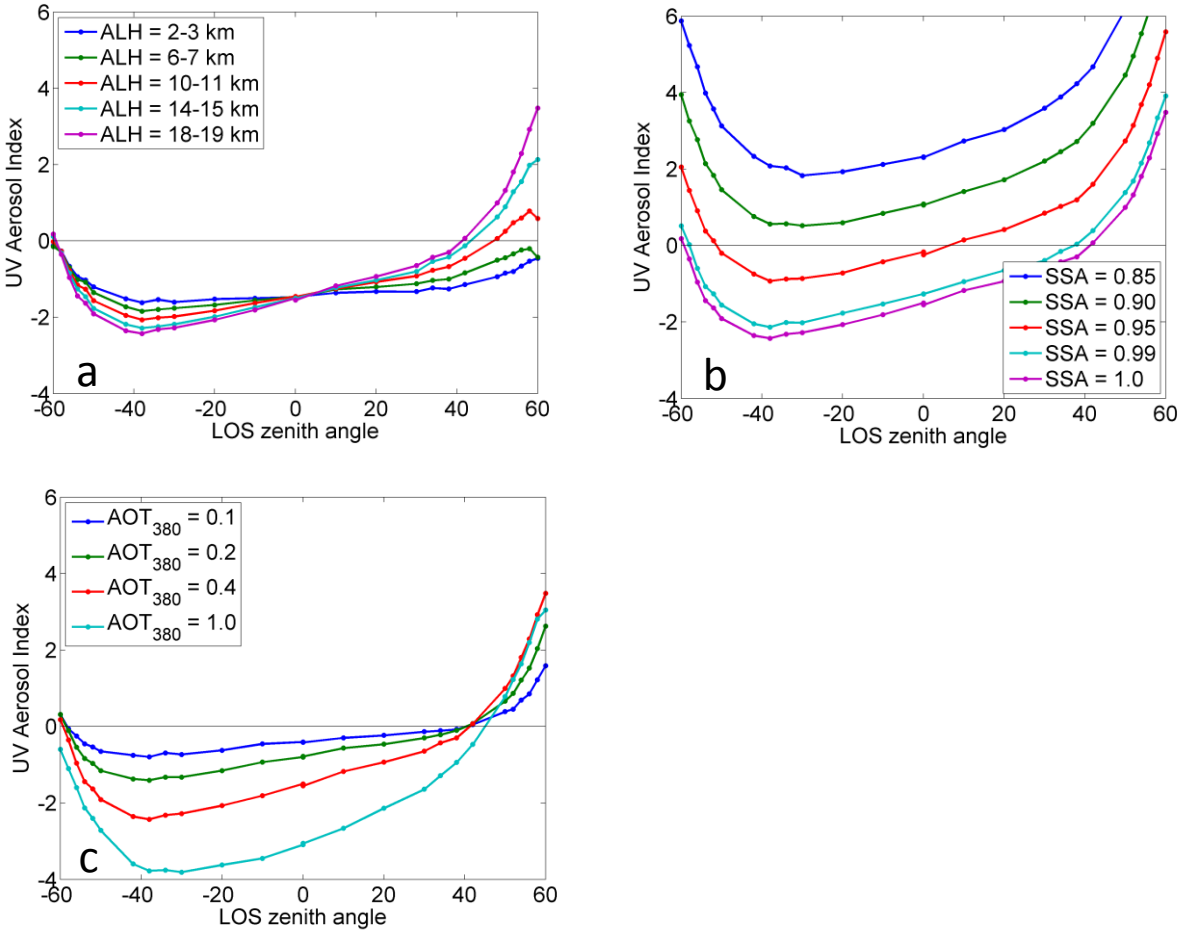

Fig. S1. Modelled line-of-sight dependence of UVAI for various aerosol scenarios. RTM calculations were performed with McArtim; solar zenith angle was set to 20 degrees and surface albedo 0.1. Aerosols have g = 0.6 and Ångström coefficient 1.5 (AOT given at 380 nm).
a, Aerosols with AOT 0.4 and SSA = 1.0 and varying layer altitude; b, Aerosols with SSA = 1.0 at 18-19 km with varying AOT; c, Aerosols with AOT=0.4 at 18-19 km with varying SSA.

Different cloud scenarios were also tested. The cloud phase function was parameterized with a Henyey-Greenstein asymmetry parameter of 0.87 and cloud optical thickness (COT) values between 1 and 50 were investigated.
The LOS dependence of these simple clouds is less pronounced than for aerosols – but it is still very obvious for clouds with COT<20 at 18-19 km. This finding is, however, not relevant to the measurements shown in the paper, as clouds do not generally form at such high altitudes.

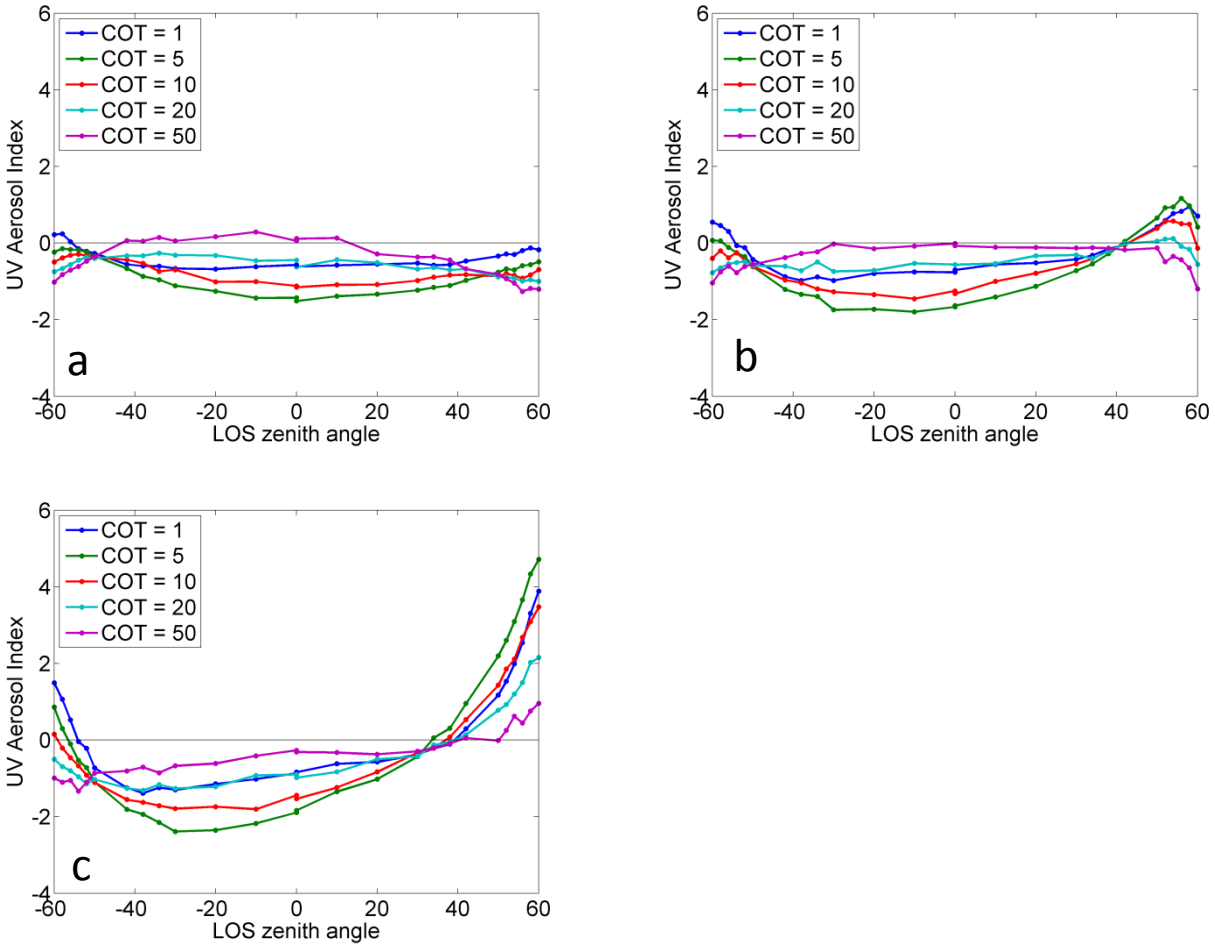

Fig. S2. Modelled line-of-sight dependence of UVAI for various cloud scenarios. The same settings were used as for Fig. S1. Clouds have g = 0.87 and wavelength-independent optical thickness.
a, Clouds at 2-3 km with varying COT; b, Clouds at 10-11 km with varying COT; c, Clouds at 18-19 km with varying COT.

2. Particle extinction profiles from SCIAMACHY limb measurements on June 15 - June 17

We here present the extinction profiles determined from all SCIAMACHY limb measurements corresponding to nadir pixels with enhanced nadir SO_2 column density and belonging to the first Nabro plume (see the paper for details). After June 17, different volcanic plumes overlap, making a simple assignment of (approximate) emission time based on the observed nadir SO_2 pattern difficult.

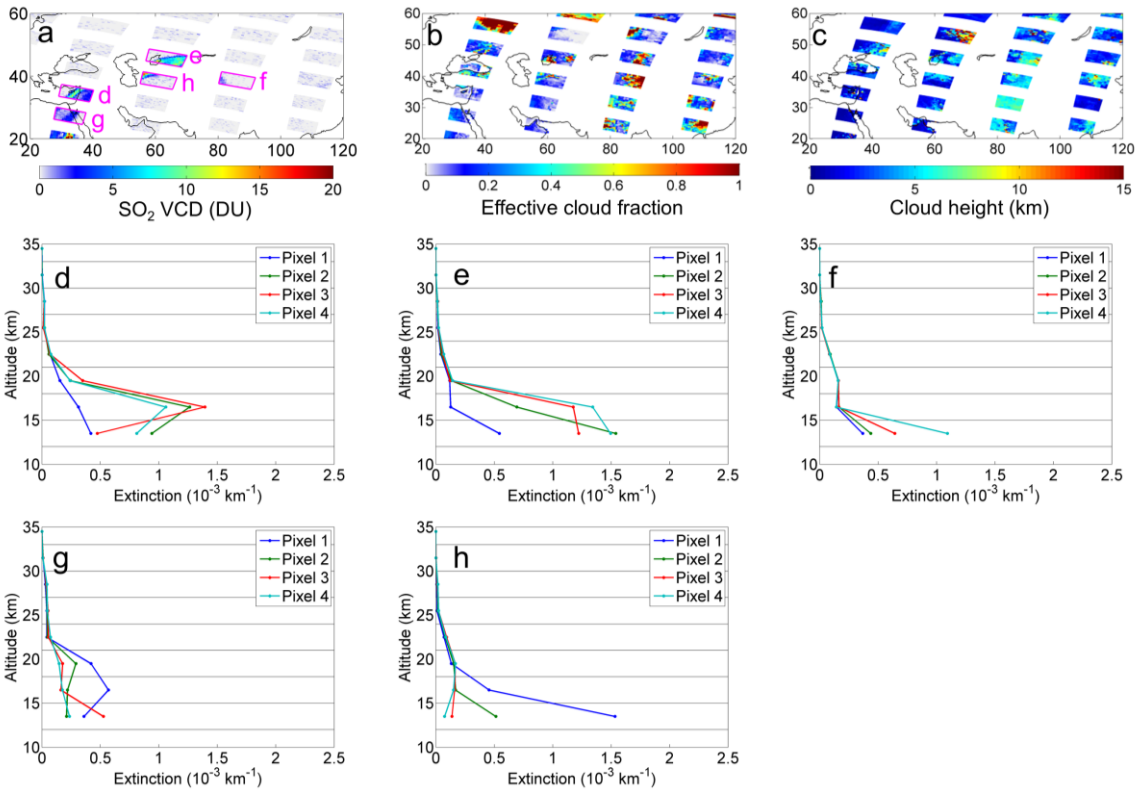

Figure S3. SCIAMACHY data of the eruption plumes from Nabro, measured on June 15, 2011. Top row: SO_2 VCD (panel a), FRESCO+ effective cloud fraction (b) and cloud height (c). Lower rows (panels d-h): extinction profiles from SCIAMACHY limb measurements for each pixel within the states outlined in pink and marked by the corresponding panel number in panel a.

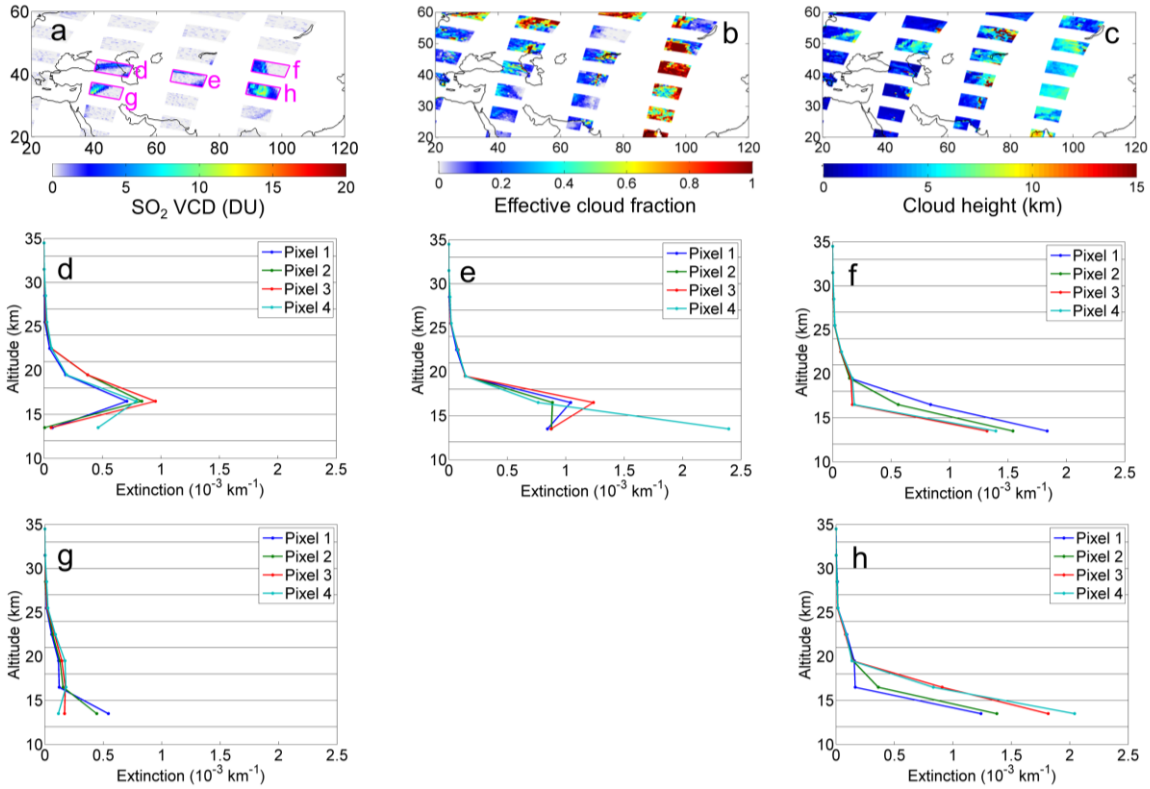

Figure S4. As in Fig. S3, but for June 16, 2011.

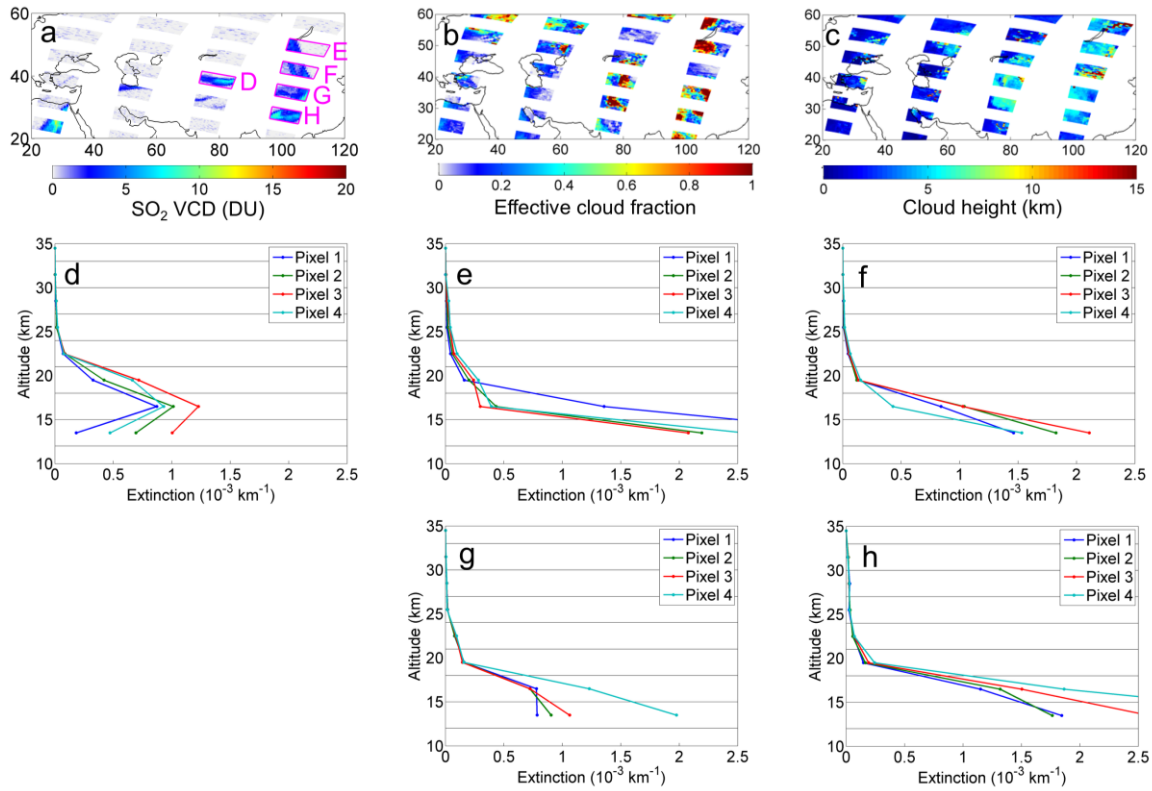

Fig. S5. As for Fig. S3, but for June 17, 2011.