Geophysical Research Abstracts
Vol. 20, EGU2018-4626, 2018
EGU General Assembly 2018

Canadian wildfire smoke over central Europe: Optical characterization by means of tropospheric and stratospheric depolarization and lidar ratios at 355, 532, and 1064 nm

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Triple-wavelength polarization/Raman lidar observations of the optical properties of Canadian wildfire smoke were performed at Leipzig, Germany, in August 2017. Extremely high particle extinction coefficients, more than 20 times higher than after the Mt. Pinatubo eruption in 1992, were measured over Leipzig around 15–16 km height on 22 August 2017. Profiles of the particle depolarization ratio and lidar ratio at 355, 532, and 1064 nm in a tropospheric layer from 5–6.5 km height and the stratospheric layer from 15–16 km are presented and show rather contrasting features to volcanic aerosol optical properties. Layer mean particle lidar ratios of 40–45 sr (355 nm), and 65–80 sr (532 and 1064 nm) were observed in both layers, suggesting the same aerosol composition (and origin). A unique spectral behavior of the particle linear depolarization was observed. The tropospheric smoke showed almost no depolarization at all three wavelengths (<0.04), probably because of the spherical shape of the particles in the layer with comparably high relative humidity. In contrast, the depolarization ratio was 0.23 (355 nm), 0.18 (532 nm), and 0.04 (1064 nm) in the stratospheric layer. This is probably caused by the very low relative humidity in the stratosphere so that all particles dried and showed an irregular shape, and by the additional fact that the smoke particle size spectrum showed a pronounced accumulation mode (a coarse mode was almost absent) as accompanying AERONET sun photometer observations indicated. Lidar ratios at 1064 nm of smoke layers are measured for the first time by using the rotational Raman method to detect the extinction in the near infrared.