Is the near-spherical shape the "new black" for smoke?

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Polarization lidar measurements have shown that particle linear depolarization ratio (PLDR) of smoke particles can exhibit a wide range of values. This variability may be related to the age of the particles, the presence of other aerosol types inside the smoke layers or even the particle water uptake due to different relative humidity conditions. Over the last few years there have been studies presenting PLDR values of smoke that exceed the typical range while also presenting a strong decrease from the UV to the Near-IR [1–3]. Since PLDR is a property indicative of shape, size and composition of the particles, there is an increasing interest in these non-typical values but also in this spectral variation.

Motivated by the recent Canadian wildfires of 2017, that introduced large amounts of smoke into the lower stratosphere, we examine multi-wavelength lidar measurements of the stratospheric plumes that reached above central Europe. These plumes presented PLDR values of the order of 22, 18, and 4% at 355, 532, and 1064 nm respectively, and thus a strong wavelength dependence.

In an attempt to interpret these results, we apply the hypothesis that smoke particles have near-spherical and/or more complicated shapes. Scattering calculations with the T-matrix code [4] support other findings in the literature [5– 7], showing that the near-spherical shape (or closely similar shapes) is the only shape that has been shown to reproduce the observed PLDR and lidar ratio values of the stratospheric smoke particles at the three measurement wavelengths, while this was not possible for the complex structures used in the study.

References

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