

The spectral slope of the linear depolarization ratio measured with a triple-wavelength polarization lidar

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Mission

- Optical properties at all classical lidar wavelengths: 355, 532, and 1064 nm
- New: Improved lidar technology to measure linear depolarization ratio and extinction coefficient at 1064 nm
- Comprehensive input for inversions and particle shape models
- Depolarization ratio $\delta = \beta_{\perp} / \beta_{\parallel}$
- Depolarization parameter $d = 2\delta / (1 + \delta)$

$$3\beta + 3\alpha + 3\delta$$

Saharan Dust

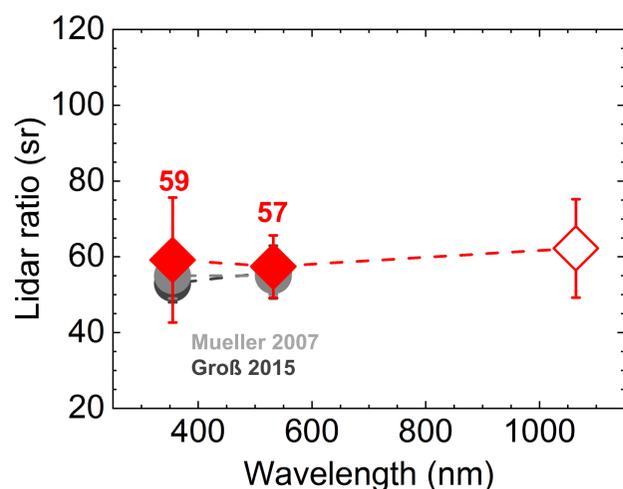
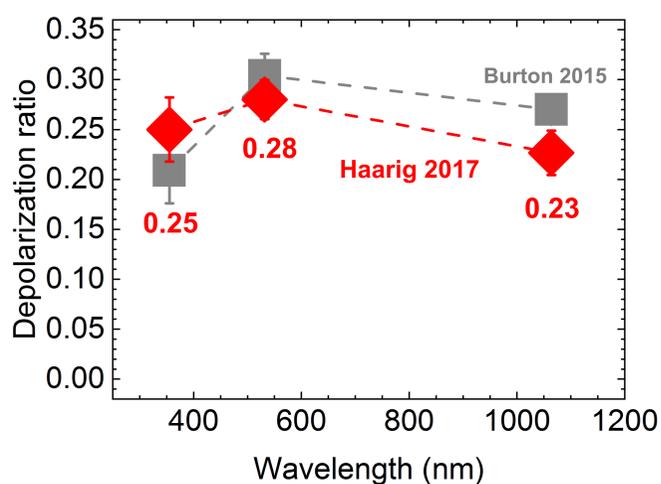
Saharan dust at Barbados
21 cases from SALTRACE, 2013 & 2014 (Haarig), over USA (Burton)

$$d_{355} = 0.40$$

$$d_{532} = 0.44$$

$$d_{1064} = 0.37$$

Haarig, M., et al.: Triple-wavelength depolarization ratio profiling of Saharan dust over Barbados during SALTRACE in 2013 and 2014, ACP, 17, 10767–10794, 2017.



Wildfire Smoke

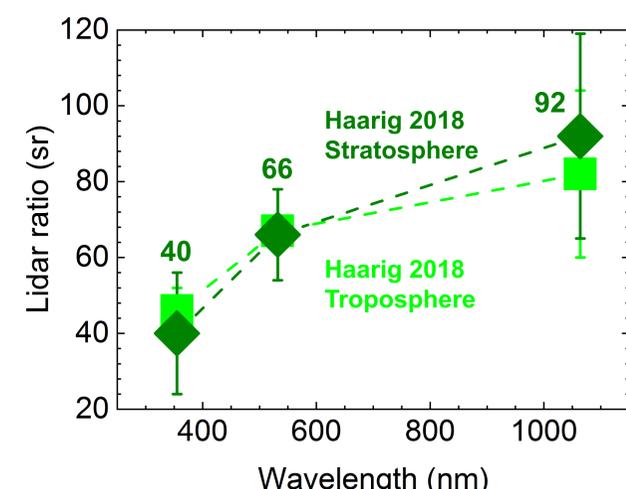
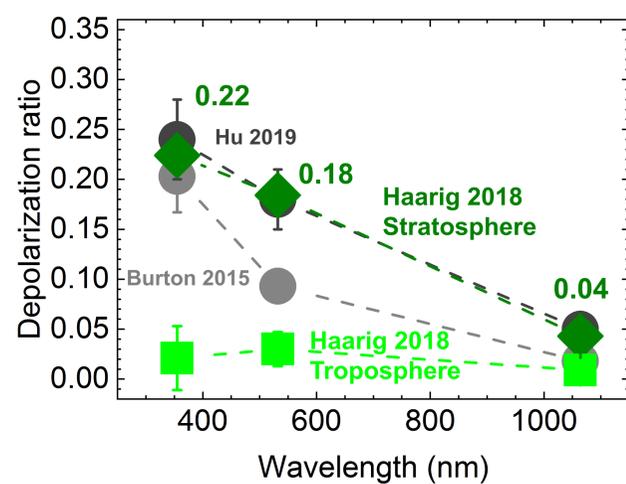
Canadian smoke in the Stratosphere and Troposphere, August 2017 (Haarig & Hu)
Smoke over USA (Burton)

$$d_{355} = 0.37$$

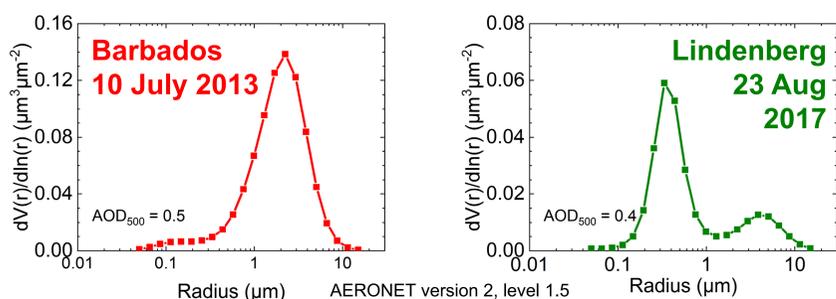
$$d_{532} = 0.31$$

$$d_{1064} = 0.08$$

Haarig, M., et al.: Depolarization and lidar ratios at 355, 532, and 1064 nm and microphysical properties of aged tropospheric and stratospheric Canadian wildfire smoke, ACP, 18, 11847–11861, 2018.



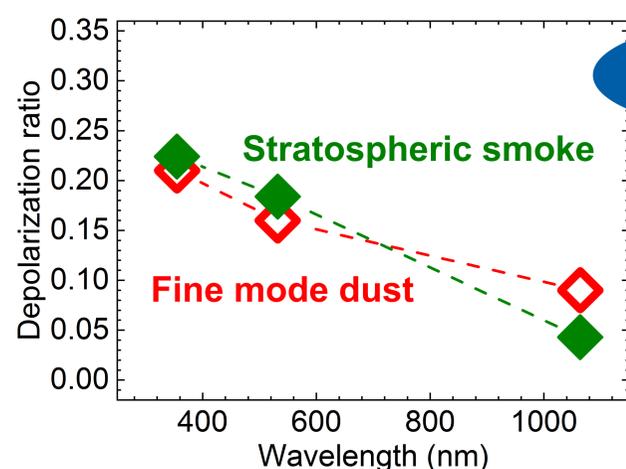
Columnar size distribution



Coarse-mode dominated dust versus fine-mode dominated smoke

Burton, S. P., et al.: Observations of the spectral dependence of linear particle depolarization ratio of aerosols using NASA Langley airborne High Spectral Resolution Lidar, ACP, 15, 13453–13473, 2015.
Groß, S., et al.: Optical properties of long-range transported Saharan dust over Barbados as measured by dual-wavelength depolarization Raman lidar measurements, ACP, 15, 11067–11080, 2015.
Hu, Q., et al.: Long-range-transported Canadian smoke plumes in the lower stratosphere over northern France, ACP, 19, 1173–1193, 2019.
Mamouri, R.-E. and Ansmann, A.: Potential of polarization/Raman lidar to separate fine dust, coarse dust, maritime, and anthropogenic aerosol profiles, AMT, 10, 3403–3427, 2017.
Müller, D., et al.: Aerosol-type-dependent lidar ratios observed with Raman lidar, JGR, 112, D16202, 2007.

Non-spherical fine mode aerosol



Conclusion

Similar spectral dependence of linear depolarization ratio for fine-mode dust* and stratospheric smoke

* review of laboratory studies in Mamouri and Ansmann, AMT 2017