The spectral dependence of the lidar ratio and the depolarization ratio (355, 532, 1064 nm)

Moritz Haarig
Ronny Engelmann, Albert Ansmann, Dietrich Althausen, Holger Baars, Ulla Wandinger, Julian Hofer, Kevin Ohneiser, Athena Floutsi

CALIPSO V5 Aerosol Lidar Ratio Workshop
9 – 11 March 2021
Lidar ratio vs depolarization ratio
- Collection of field studies from PollyNET

Baars et al., ACP 2016
Floutsi et al., in preparation

And at 1064 nm?
Motivation and outline

1. Case study: Recent Saharan dust outbreak

2. Spectral slope of
   • Mineral dust
   • Marine aerosol
   • Smoke

3. Summary

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm
Saharan dust – A recent case study 2021-02-22

Saharan dust up to 8 km

< 2 days of transport

from: Hysplit, NOAA

22 Feb 2021

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm
Saharan dust – a recent case study 2021-02-22

**First results – Preliminary**

 Particle lin. depol. ratio
25.6 ± 2.5 %
29.8 ± 1.7 %
21.4 ± 2.5 %

Lidar ratio
47 ± 8 sr
50 ± 5 sr
63 ± 13 sr

Extinction at 1064 nm by **rotational Raman** method

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm

Haarig et al., AMT 2016
Mineral Dust – Depolarization ratio

- Spectral slope with maximum at 532 nm and decrease towards 1064 nm
- Depol > 20% → dust
- Local (fresh) dust with higher depolarization ratio

Haarig et al., ACP 2017a
Burton et al., ACP 2015
Hu et al., ACP 2020
Mineral Dust – Lidar ratio

- Spectral slope with slight increase towards 1064 nm
- LR of Asian dust (35 – 45 sr) lower than for Saharan dust at 355 and 532 nm

---

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm

Hofer et al., ACP 2020

own observations
similar to Groß et al., ACP 2015
LR 1064 nm estimated using lidar and AERONET
Mamouri & Ansmann, AMT 2017
Marine Aerosol – Depolarization ratio

Lab conditions

Atmosphere

- Spherical shape for humid marine particles (RH > 75%)
- Cubic-like shape for dry marine particles (RH < 50%)

Haarig et al., ACP 2017b

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm
Marine Aerosol – Lidar ratio

- Spherical shape for humid marine particles (RH > 75 %)
- Cubic-like shape for dry marine particles (RH < 50%)
- Lidar ratio 15-30 sr (UV, VIS)

No effect on lidar ratio found

Haarig et al., ACP 2017b

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm
Smoke – Depolarization ratio

- Low depolarization ratio (< 5%) for tropospheric (aged) smoke
- Strong spectral slope for smoke in upper troposphere / lower stratosphere if linked to PyroCb events

Haarig et al., ACP 2018
Burton et al., ACP 2015
Hu et al., ACP 2019
Smoke – Lidar ratio

- Increase of lidar ratio with wavelength
- Canadian smoke: no difference in LR between stratosphere & troposphere
- LR in stratosphere depends on age, transport way and biomass burning source

Haarig et al., ACP 2018
Ohneiser et al., ACP 2020
Ohneiser et al., ACPD 2021

LR 1064 nm estimated using lidar and AERONET
Summary – Depolarization ratio

**Dust**
- High depolarization ratio (> 20%)
- Fresh dust even higher

**Smoke**
- Stratosphere: spectral slope (PyroCb)
- Troposphere: low values (aged)

**Marine**
- Dry marine: enhanced depol. ratio
- Humid marine: low depol. ratio

---

Haarig et al., ACP 2017a
Haarig et al., ACP 2017b
Haarig et al., ACP 2018
Summary – Lidar ratio

Dust
- Slight increase towards 1064 nm
- Mind origin (Asia vs. Sahara)

Smoke
- LR increases with wavelength in troposphere and stratosphere
- Mind age, lifting, origin

Marine
- RH does not matter
- No data at 1064 nm yet
- → wait for new 3+3+3 lidar at Cabo Verde (to be installed in 2021)

Haarig et al., ACP 2017b
Haarig et al., ACP 2018

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm
Summary

The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm.

Moritz Haarig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm

Haarig et al., ACP 2017a
Haarig et al., ACP 2017b
Haarig et al., ACP 2018
References I


References II


