

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

Moritz Haarig

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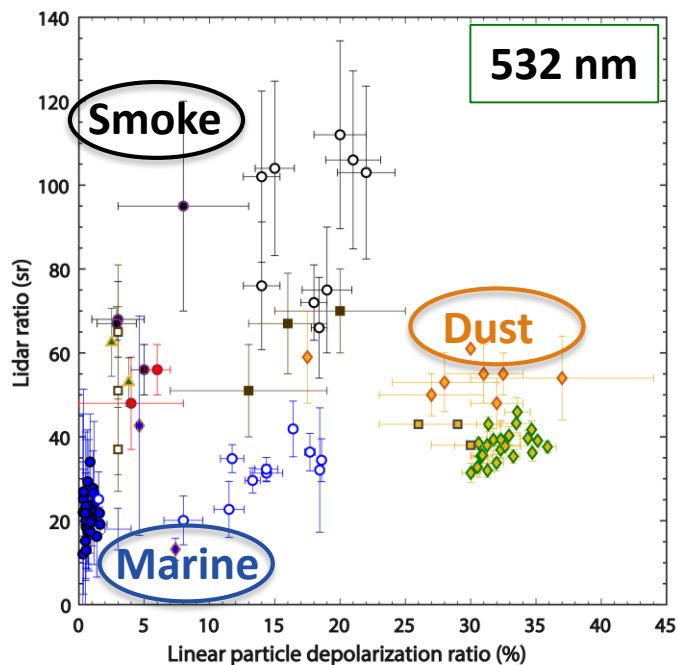
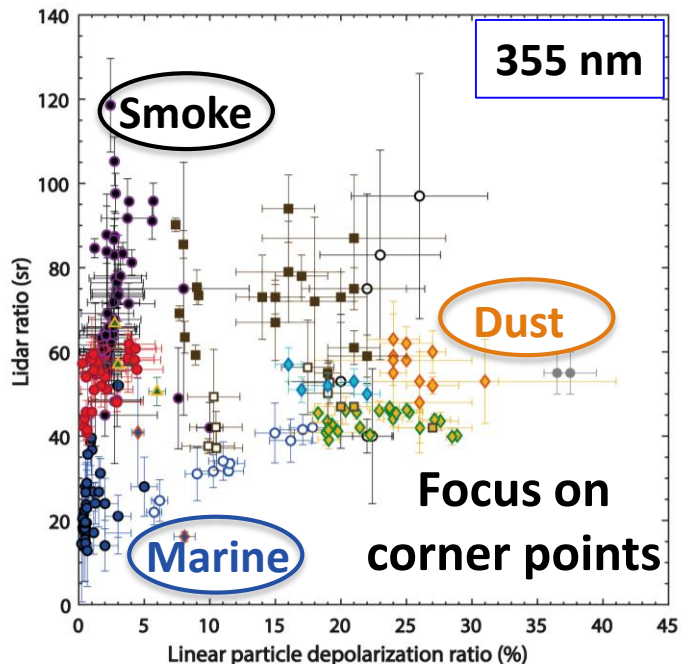


CALIPSO V5 Aerosol Lidar Ratio Workshop
9 – 11 March 2021



Lidar ratio vs depolarization ratio

- Collection of field studies from PollyNET



And at **1064 nm**?

...

Baars et al., ACP 2016

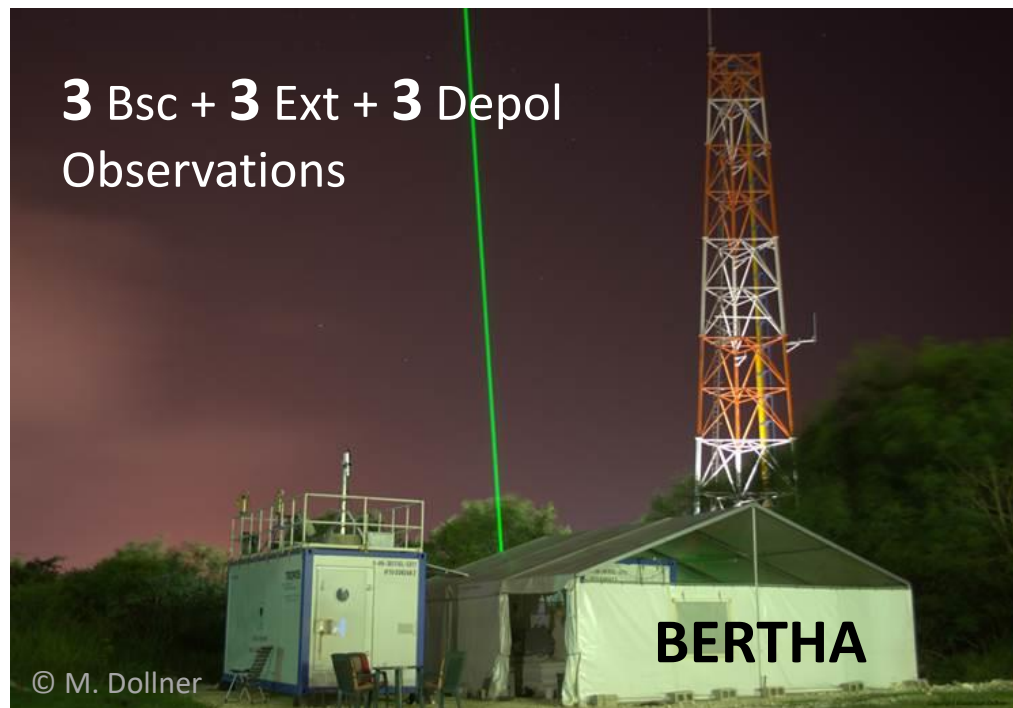
Floutsi et al., in preparation

TROPOS

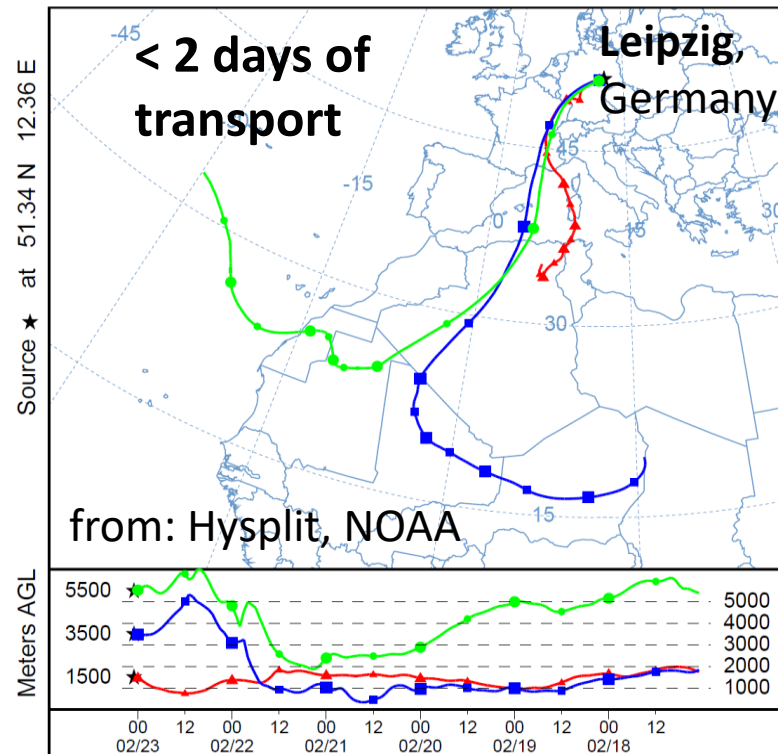
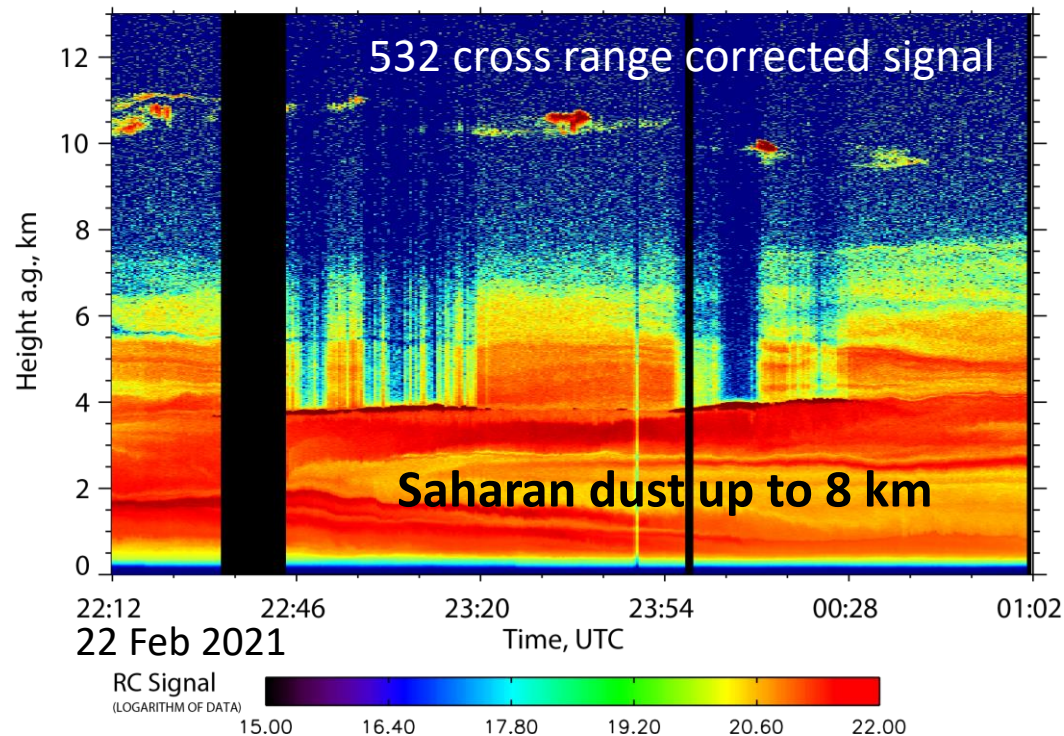
- ◆ Dried marine (PS)
- Clean marine (PS, SAMUM-2, North Atlantic)
- Marine mixture (PS)
- Ash (Eyjafjalla)
- Smoke (Amazonia, South Africa, Punta Arenas, Canada, Siberia, North America)
- Stratospheric smoke (Punta Arenas, Leipzig)
- ◆ Saharan dust (SAMUM-2)
- ◆ Central Asian dust (CADEX)
- Middle Eastern dust (Cyprus)
- Dust & smoke (SAMUM-2, Europe, Africa, South Africa, Canada)
- Pollution (EARLINET, South Africa)
- Dust & pollution (EARLINET)
- ◆ Dust & marine (SAMUM-2)
- ▲ Central European Background (Leipzig)

Motivation and outline

1. Case study:
Recent Saharan dust outbreak
2. Spectral slope of
 - Mineral dust
 - Marine aerosol
 - Smoke
3. Summary



Saharan dust – A recent case study 2021-02-22

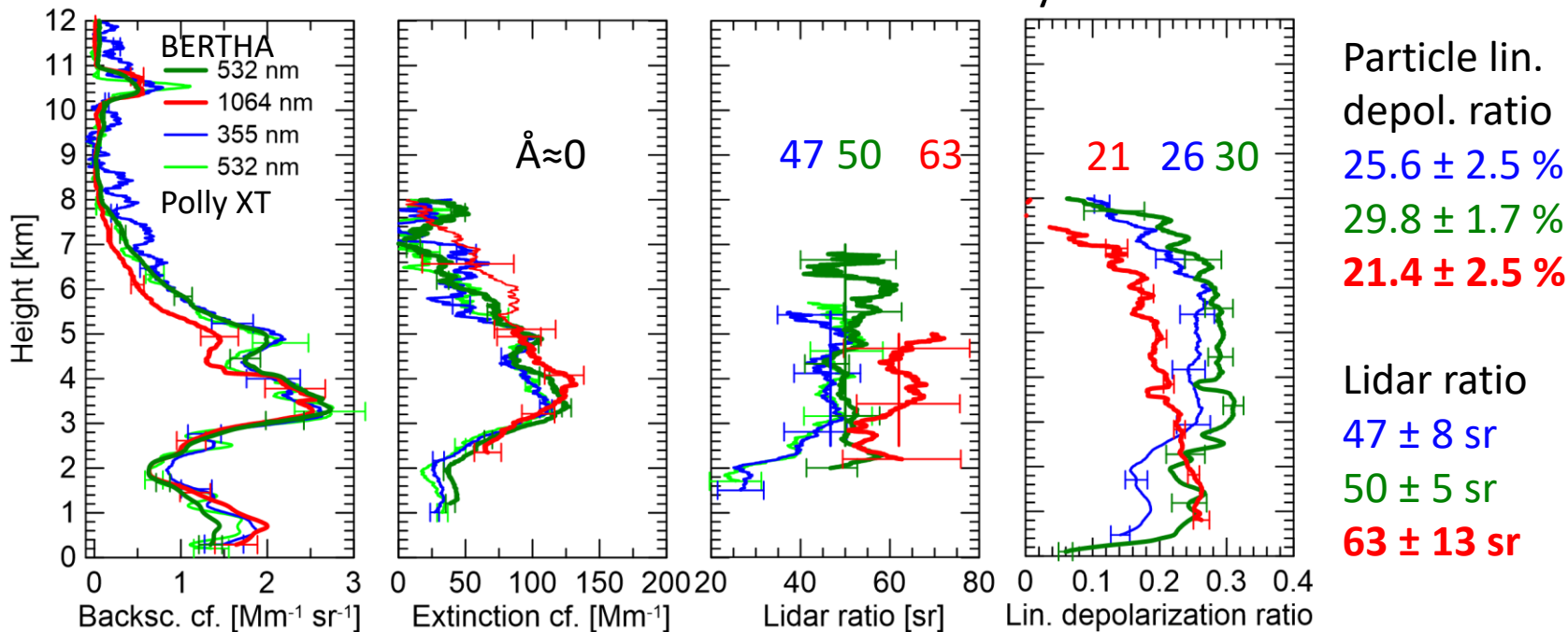


Moritz Haarrig, TROPOS, 10 March 2021, CALIPSO V5 lidar ratio workshop:
The spectral dependence of the lidar ratio and the depolarization ratio up to 1064 nm



Saharan dust – a recent case study 2021-02-22

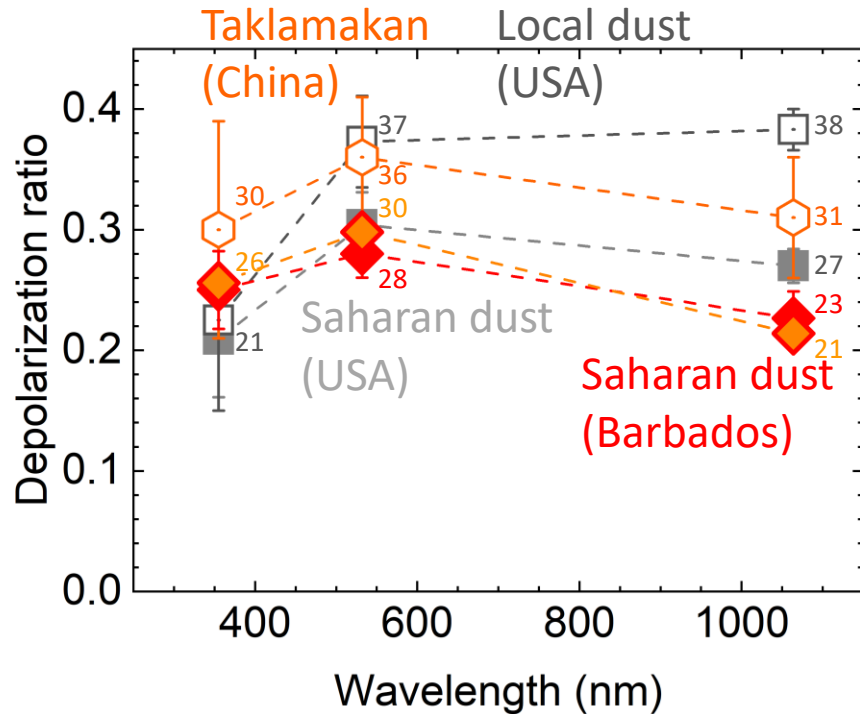
First results – Preliminary



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

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

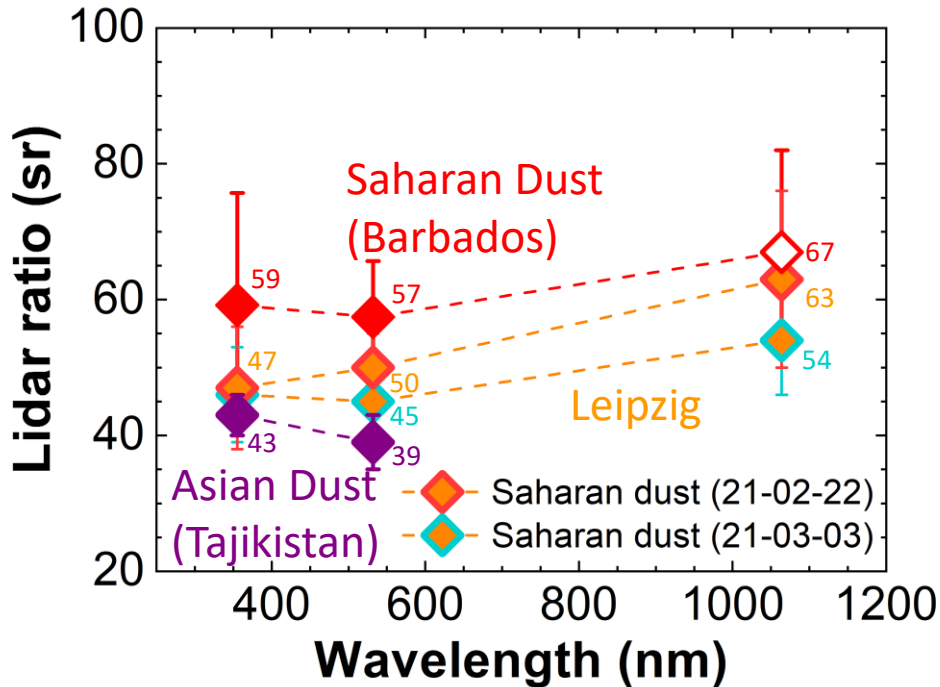
Haarig et al., ACP 2017a

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

own observations

similar to Groß et al., ACP 2015

LR 1064 nm estimated using lidar and AERONET
Mamouri & Ansmann, AMT 2017

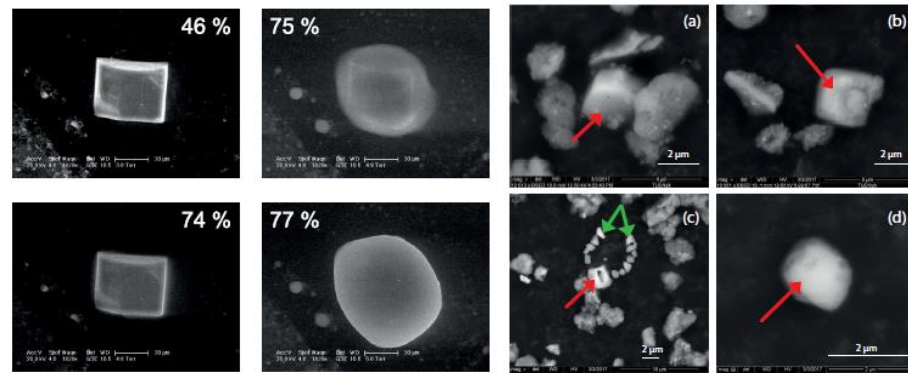
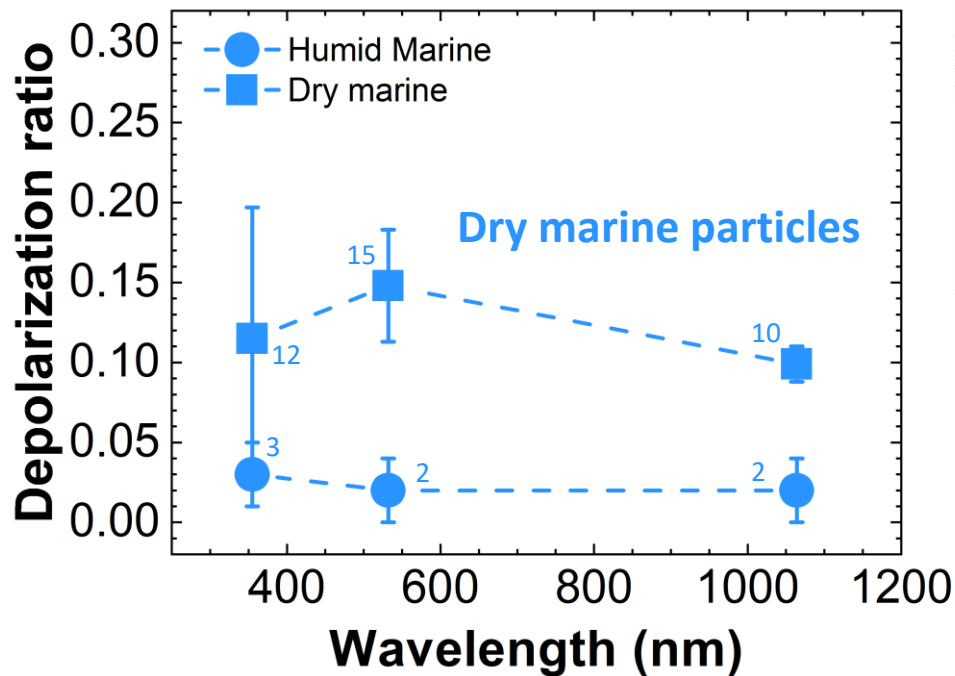
Hofer et al., ACP 2020



Marine Aerosol – Depolarization ratio

Lab conditions

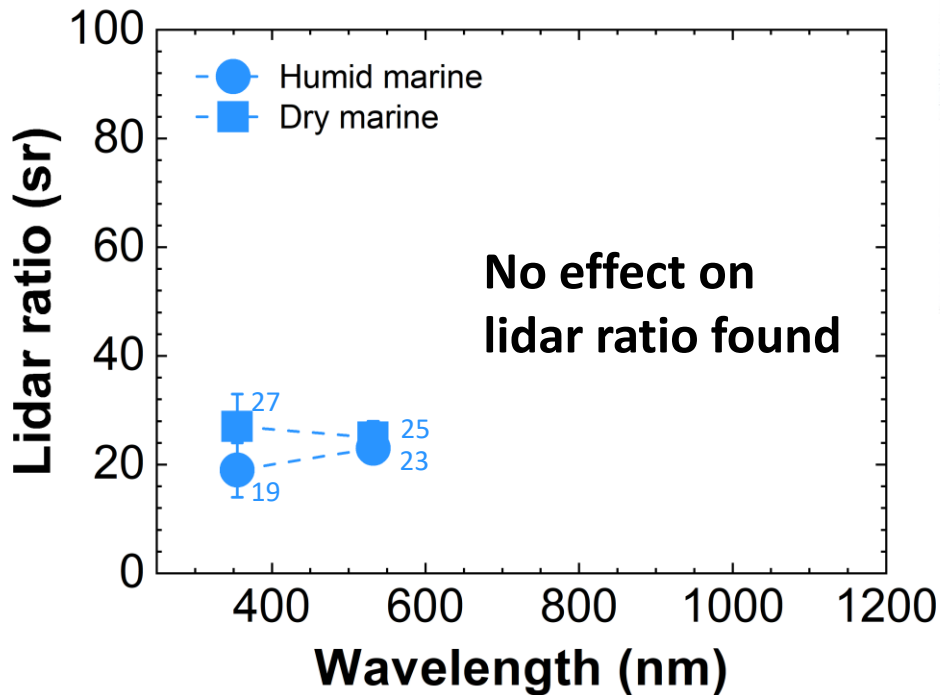
Atmosphere



- **Spherical shape** for humid marine particles (RH > 75 %)
 - **Cubic-like shape** for dry marine particles (RH < 50%)
- < 5%

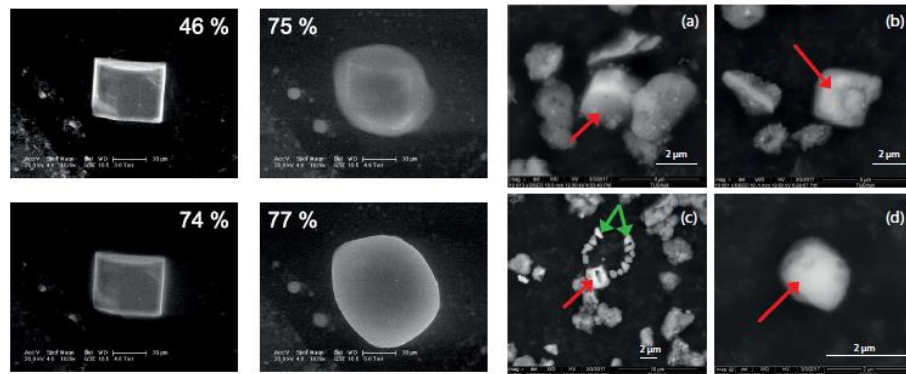
Haarig et al., ACP 2017b

Marine Aerosol – Lidar ratio



Lab conditions

Atmosphere

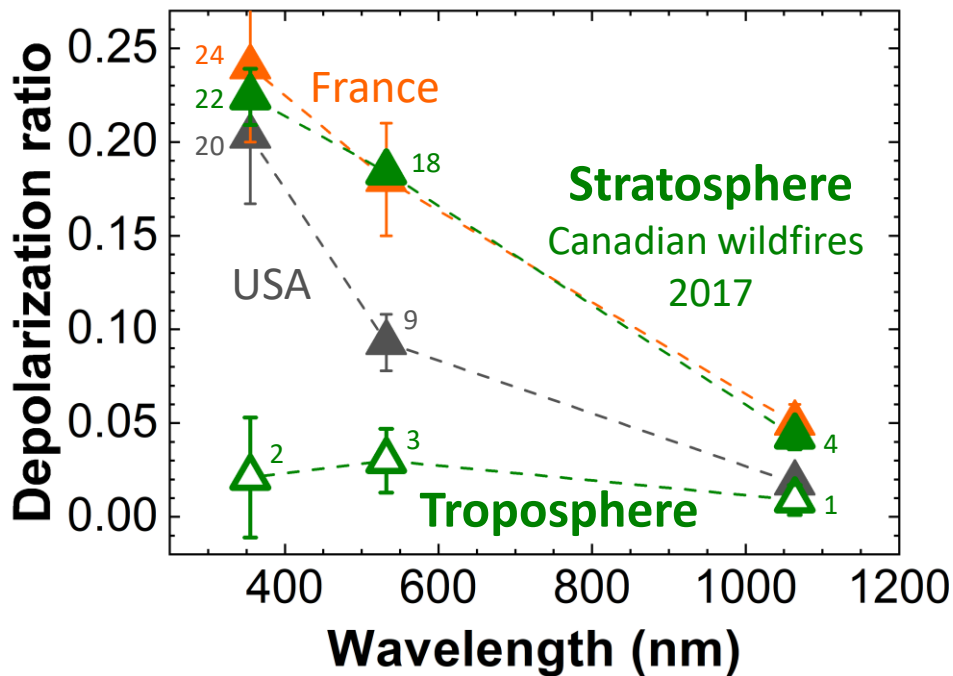


- **Spherical shape** for humid marine particles (RH > 75 %)
- **Cubic-like shape** for dry marine particles (RH < 50%)
- Lidar ratio 15-30 sr (UV, VIS)

Haarig et al., ACP 2017b



Smoke – Depolarization ratio



< 5%

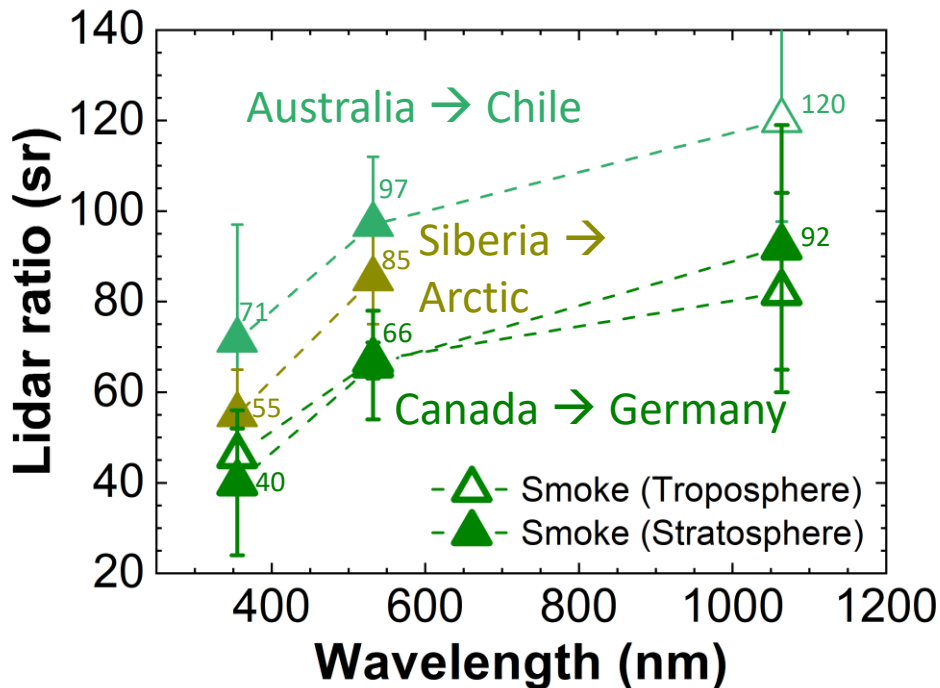
- Low depolarization ratio (< 5%) for tropospheric (aged) smoke
- **Strong spectral slope** for smoke in **upper troposphere / lower stratosphere** if linked to **PyroCb** events

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

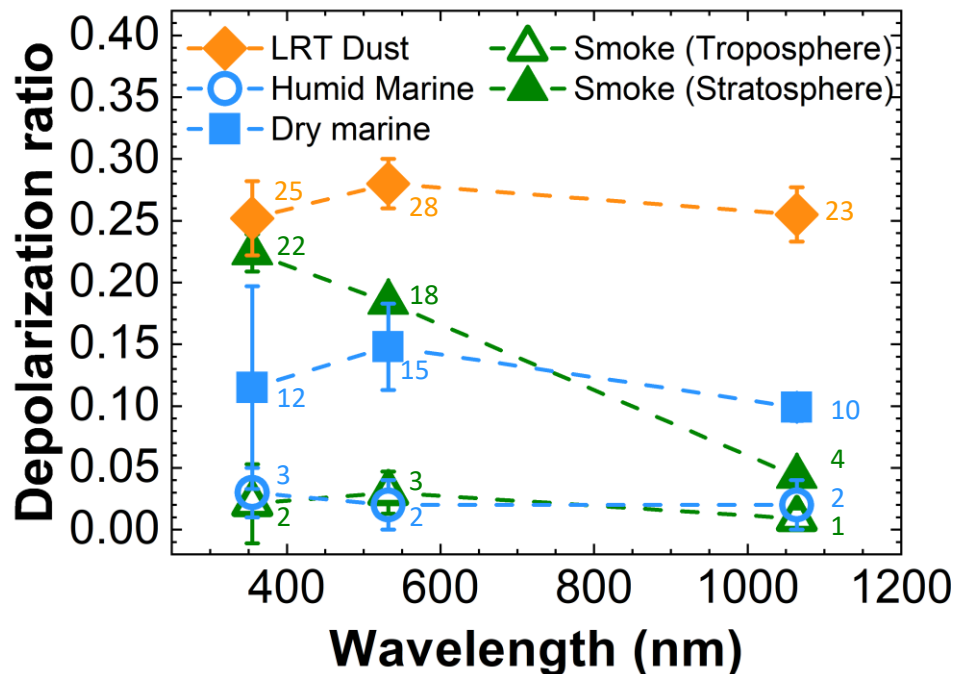
Ohneiser et al., ACP 2020

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

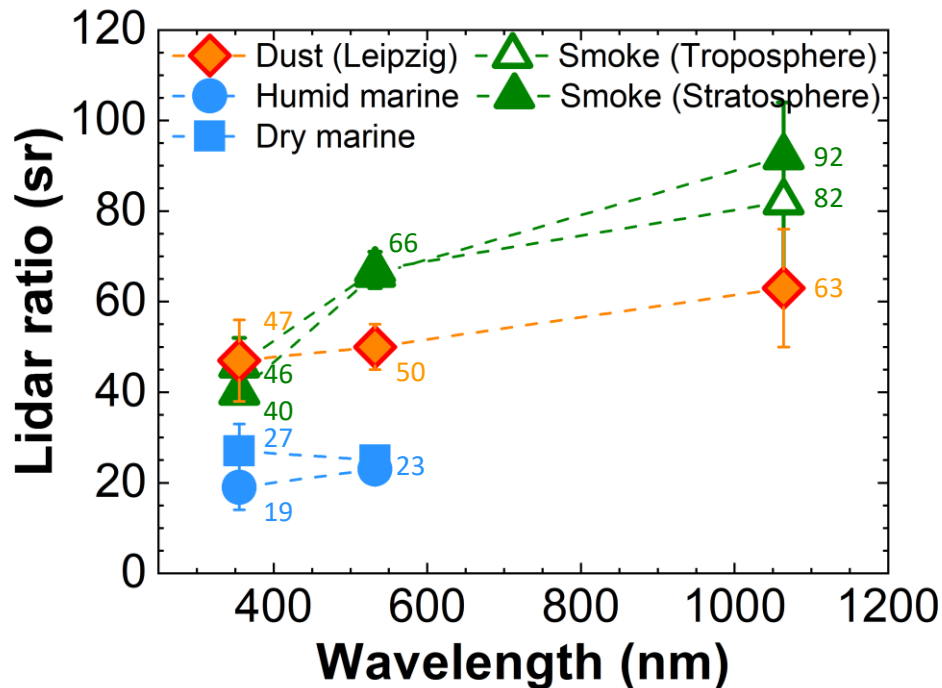
Haarig et al., ACP 2017a

Haarig et al., ACP 2017b

Haarig et al., ACP 2018

TROPOS

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

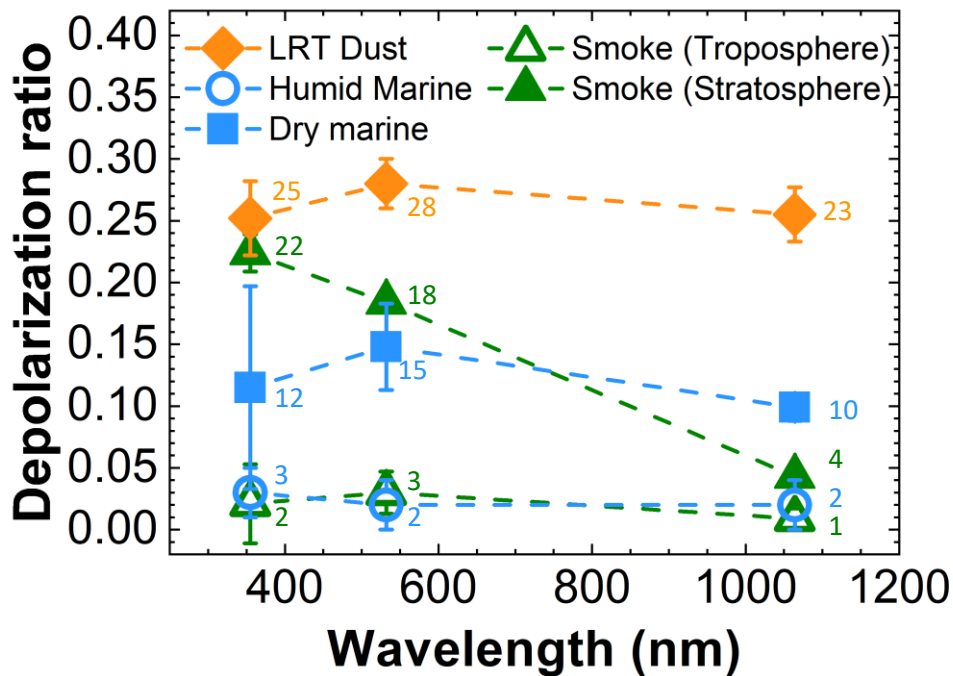
- RH does not matter
- No data at 1064 nm yet
→ wait for new 3+3+3 lidar at Cabo Verde
(to be installed in 2021)

Haarig et al., ACP 2017b

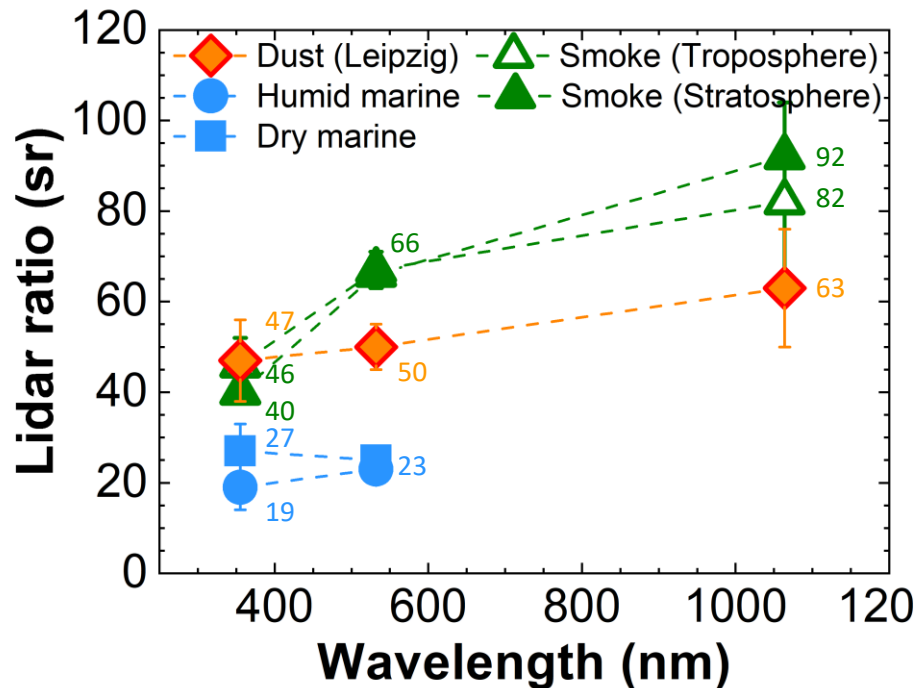
Haarig et al., ACP 2018



Summary



Thank you for your attention!



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