Dust aerosols‘ mineralogy in the chemical transport model COSMO-MUSCAT during JATAC and comparison with lidar data

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Motivation

Can the modelled minerals explain the observed optical properties?
Example case: 16 Sept 2021, 22:15 – 23:39 UTC at Mindelo

Dust particle size and mineralogy are crucial for understanding the **interaction between dust aerosols and radiation** (Balkanski et al., 2007; Kok et al., 2023). Despite the well-known mineral variations in dust aerosols, most atmospheric models consider them to have uniform composition.

Iron oxide content in minerals is correlated with a distinct interaction with the UV/VIS spectral region and varies depending on the **source region** (Formenti et al., 2011; Veselovskii et al., 2020).

Summary & Outlook

Polly^{XT} lidar ratio (LR) vertical profile:

- **Differences between the LR at 355 nm and 532 nm are higher at 1 – 3 km than at 3.5 – 5 km.**

COSMO-MUSCAT :

- **Higher simulated iron oxide (hematite) mineral content at 1 – 3 km than at 3.5 – 5 km.**

Outlook

Compare modelled minerals to elemental chemical analyses and / or mineralogical measurements.

Investigating further the relationship between the iron oxide minerals and radiation.

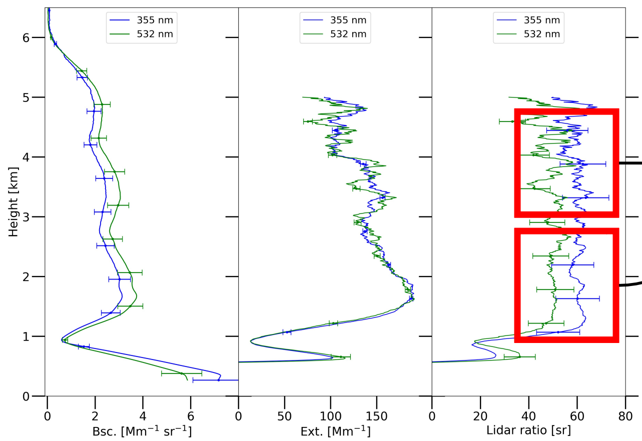


Fig. 1: Lidar ratio (extinction / backscattering) spectral difference is higher between 1 – 3 km than between 3.5 – 5 km.

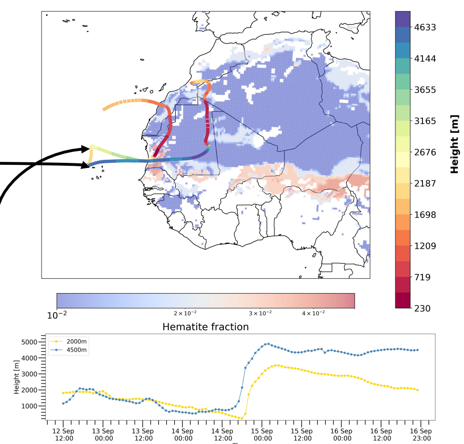


Fig. 2: Backtrajectory arriving at 2 km passes through a high hematite content mineral dust emission site.

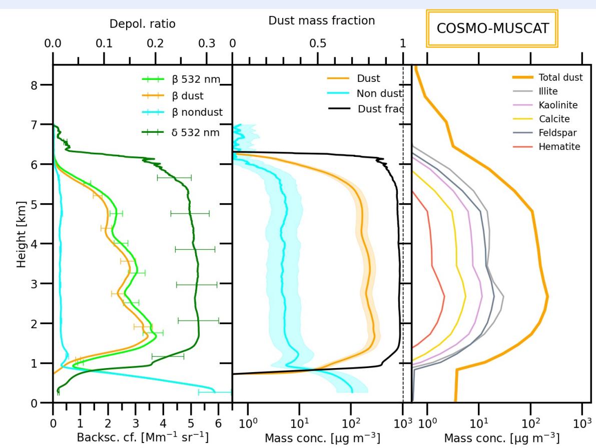


Fig. 3: Dust mass concentrations from applying the POLIPHON method compared to COSMO-MUSCAT‘s results. Higher simulated hematite content between 1 – 3 km.

Observations with the multi-wavelength polarization lidar, Polly^{XT} (3+3+3)

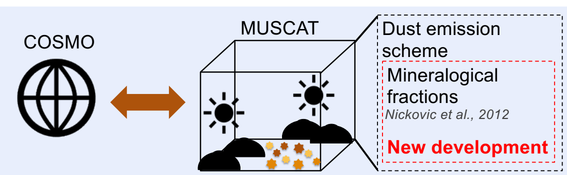
Fig.4 Polly^{XT} laser beam at OSCM, Mindelo. Edson Silva, Etfilmes/OSCM, July 2021

Retrieved particle parameters at three wavelengths (355 nm, 532 nm, and 1064 nm):

- Extinction coefficient
- Backscattering coefficient
- Lidar ratio
- Angstrom exponent
- Depolarization ratio
- Dust mass concentration (POLIPHON, Ansmann et al. (2019))

24/7 operation: https://polly.tropos.de/

Minerals estimations through COSMO-MUSCAT simulations



- Horizontal res: 0.25°x0.25°
- Vertical res: 40 sigma-p levels
- DWD meteorological fields

- Dust emission scheme follows Tegen et al., (2002)
- GMINER mineralogical database

COSMO-MUSCAT is a regional chemical and transport model used for:

- Emission, transport and deposition of dust in the Sahara Desert now considers mineral fractions (Gómez Maqueo Anaya, et al., *in prep*).
- Backtrajectories calculated using LAGRANTO help identifying source regions of the simulated minerals.

References

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