Characterisation of dust aerosols from ALADIN and CALIOP measurements

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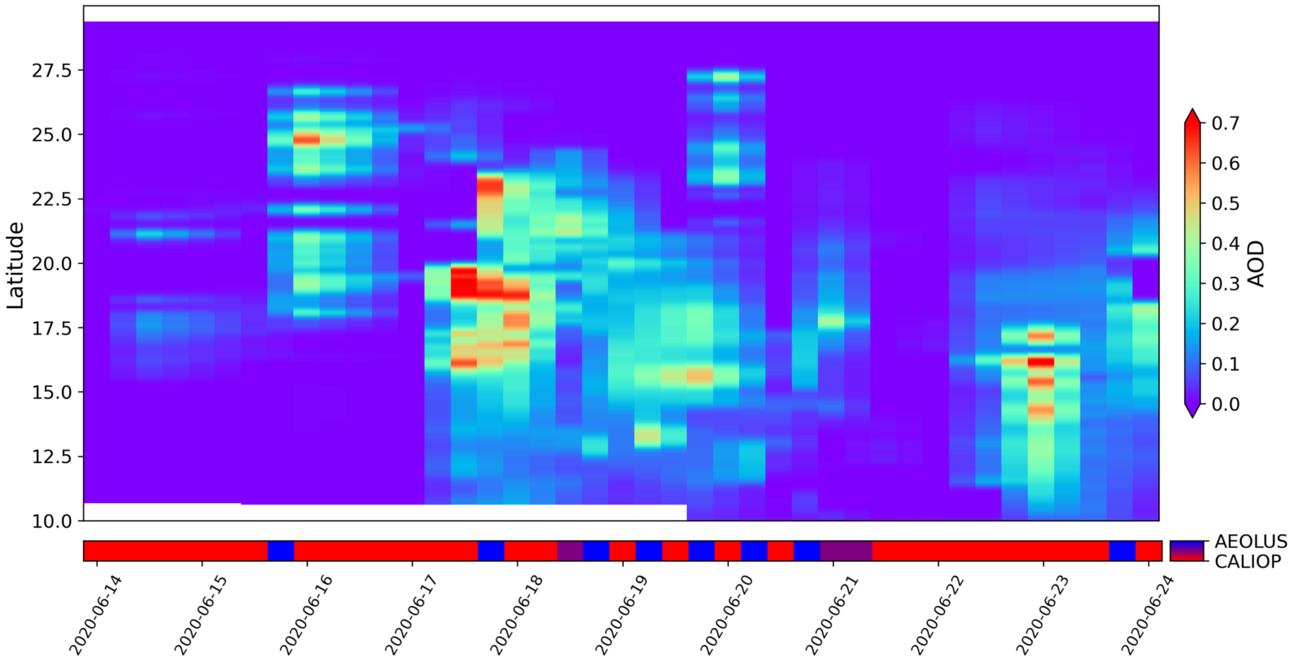
Takeaway messages:

- SEVIRI can provide a useful cloud mask for ALADIN observations
- Lidar ratios retrieved by ALADIN can be applied to CALIOP to improve agreement with independent observations



Aerosol optical depth (AOD) from combination of ALADIN and CALIOP over 4.5–6.5 km altitude, between 40°W and 20°W, during 14 to 24 June 2020. Fig. 12 of doi:10.5194/amt-17-2521-2024

National Centre for Earth Observation — Natural Environment Research Council

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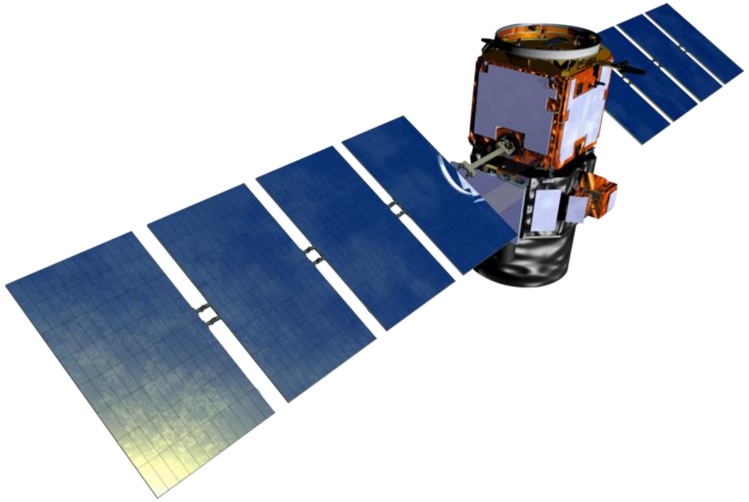
Synergistic application of orbital lidars

Image by SkywalkerPL from https://commons.wikimedia.org/wiki/File:ADM-Aeolus_model.jpg

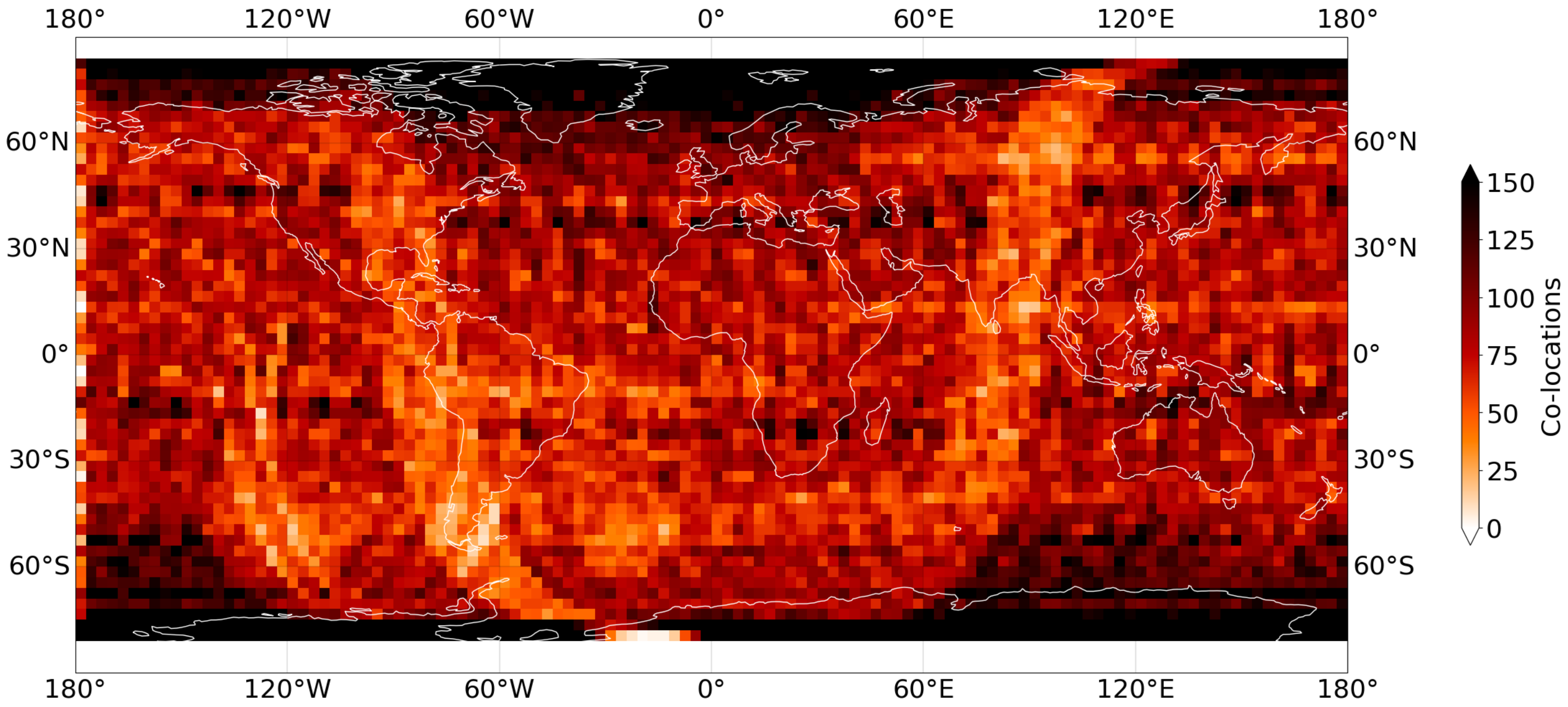
- ALADIN on Aeolus
  - High-spectral resolution lidar
    - Measures lidar ratio but cloud contaminated
  - 355 nm from Aug 2018 – Apr 2023
  - 250 m vertical, 87 km horizontal resolution



- CALIOP on CALIPSO
  - Depolarisation lidar
    - Directly identifies dust but assumes lidar ratio
  - 532 & 1064 nm from Apr 2006 – May 2023
  - 30 m vertical, 1 km horizontal resolution

Image by NASA from https://en.wikipedia.org/wiki/CALIPSO#/media/File:CALIPSO_spacecraft_model.png

Synergistic application of orbital lidars



Global distribution of collocated ALADIN and CALIOP profiles from 30 June 2019 to 28 September 2021. This data is constrained to a temporal disparity of no more than 9 hr and has been regridded to 3°×3° globally. Fig. 1 of doi:10.5194/amt-17-2521-2024

Cloud and dust masking ALADIN profiles

17 June 2020 at 19:12 UTC (a) SEVIRI dust RGB composite (8.7, 10.8, and 12 µm), where shades of pink to violet denote dust. (b) SEVIRI CLM, with identified clouds in grey. (c) CM SAF cloud mask. (d) Generated dust flag using the method proposed by Ashpole and Washington (2012) with Aeolus footprint in dots.

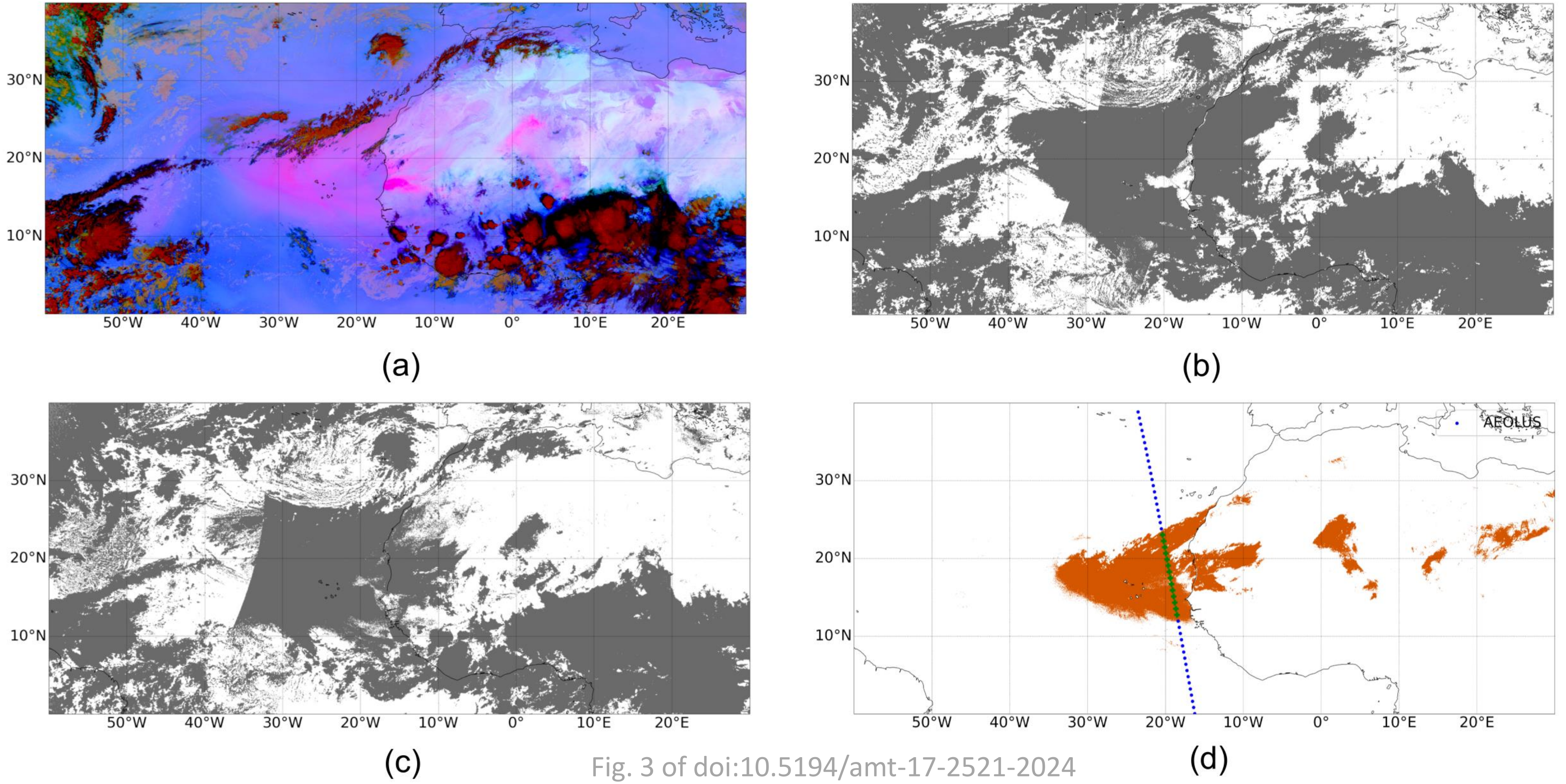


Fig. 3 of doi:10.5194/amt-17-2521-2024

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Comparison of backscatter profiles

Comparison of aerosol backscatter coefficients between (a) CALIOP and (b) ALADIN for the Saharan dust event spanning 14 to 24 June 2020. Coloured contours represent the density distribution of data, while red curves indicate the average backscatter coefficient profile. (c) Mean depolarization ratio at 532 nm from CALIOP measurements, with standard deviation shaded.

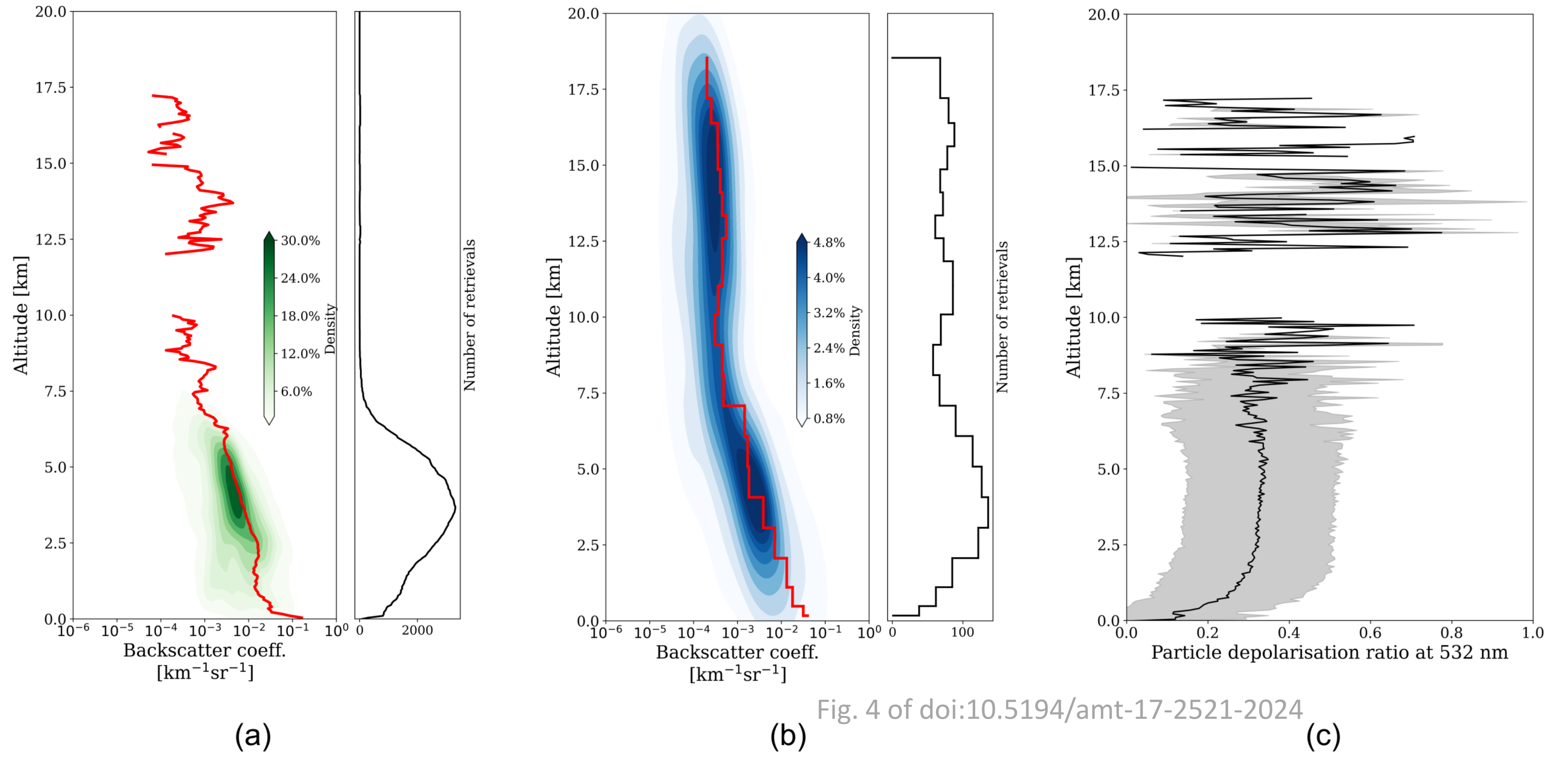

Fig. 4 of doi:10.5194/amt-17-2521-2024

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Comparison of extinction profiles

Comparison of aerosol extinction coefficients between (a) CALIOP and (b) ALADIN for the Saharan dust event spanning 14 to 24 June 2020. Coloured contours represent the density distribution of data, while red curves indicate the average backscatter coefficient profile. (c) Replotting of the mean profiles from (a) and (b) on a linear scale.

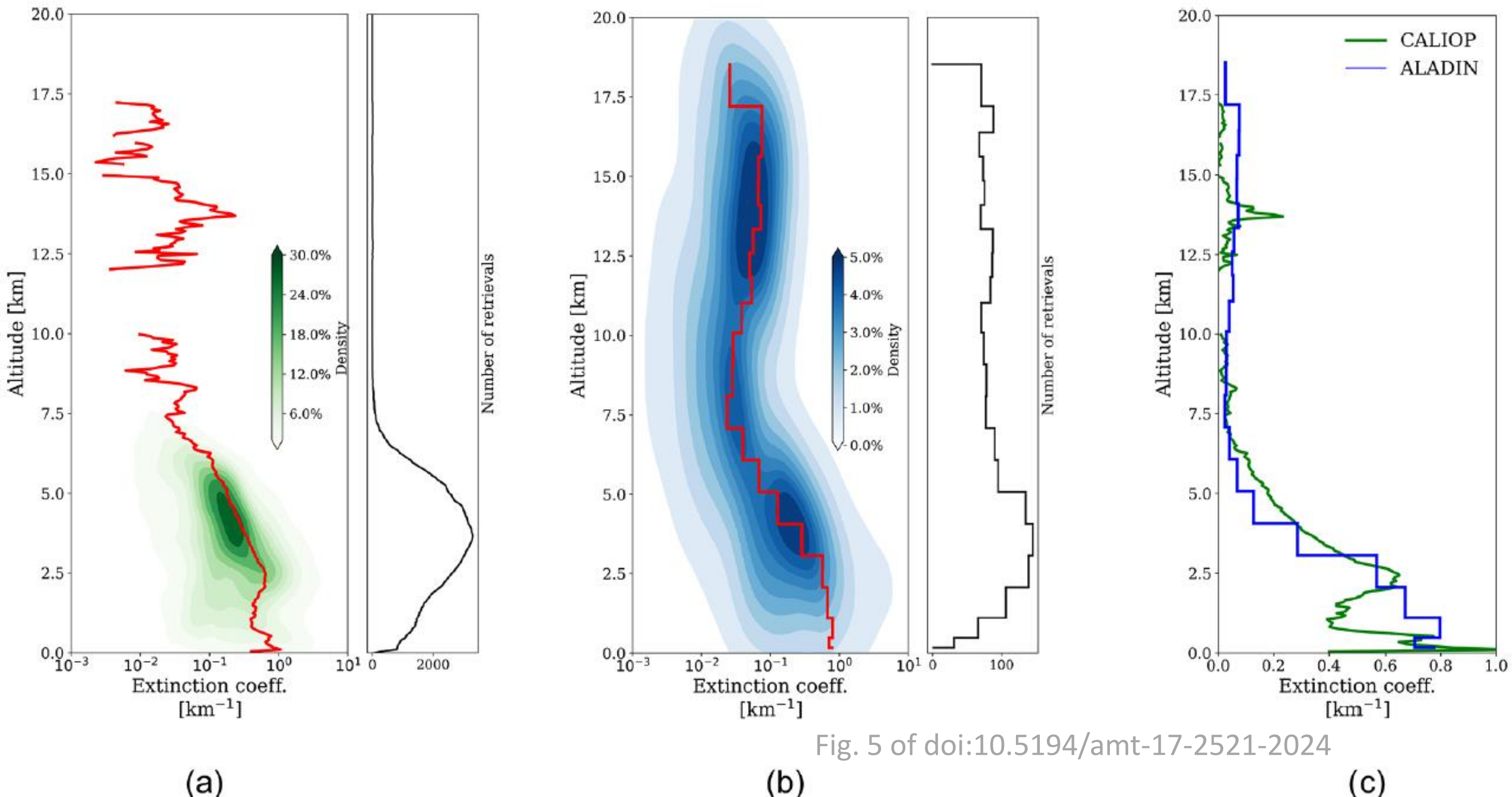

Fig. 5 of doi:10.5194/amt-17-2521-2024

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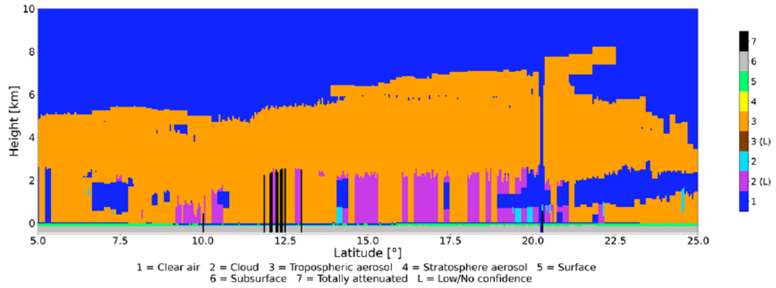
Comparison of extinction fields

Aerosol extinction coefficient from collocated orbits on 24 June 2020 at (b) 3 km, (e) 4 km, (c) 5 km, and (f) 6 km. SEVIRI dust RGB composites are overlaid with the (a) Aeolus and (d) CALIOP orbits. CALIOP feature mask is shown right for vertical context, showing the layer observed is almost entirely desert dust.



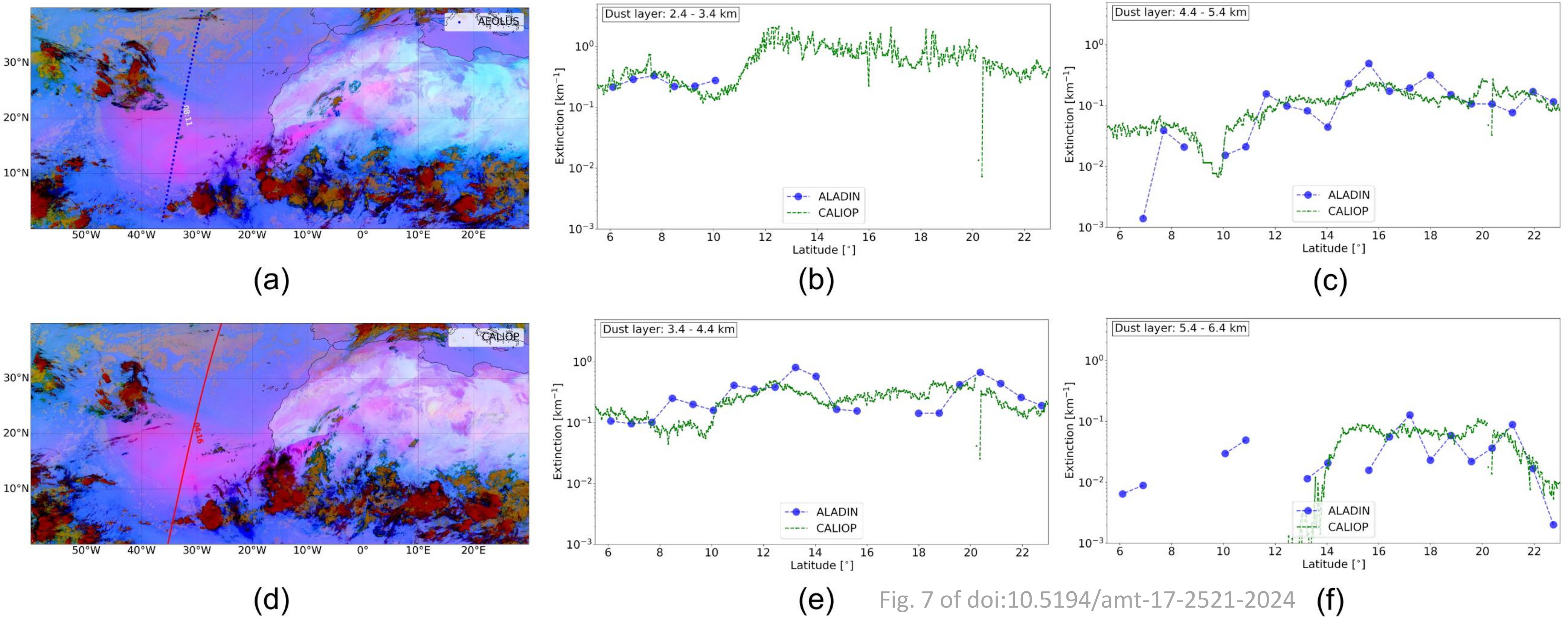
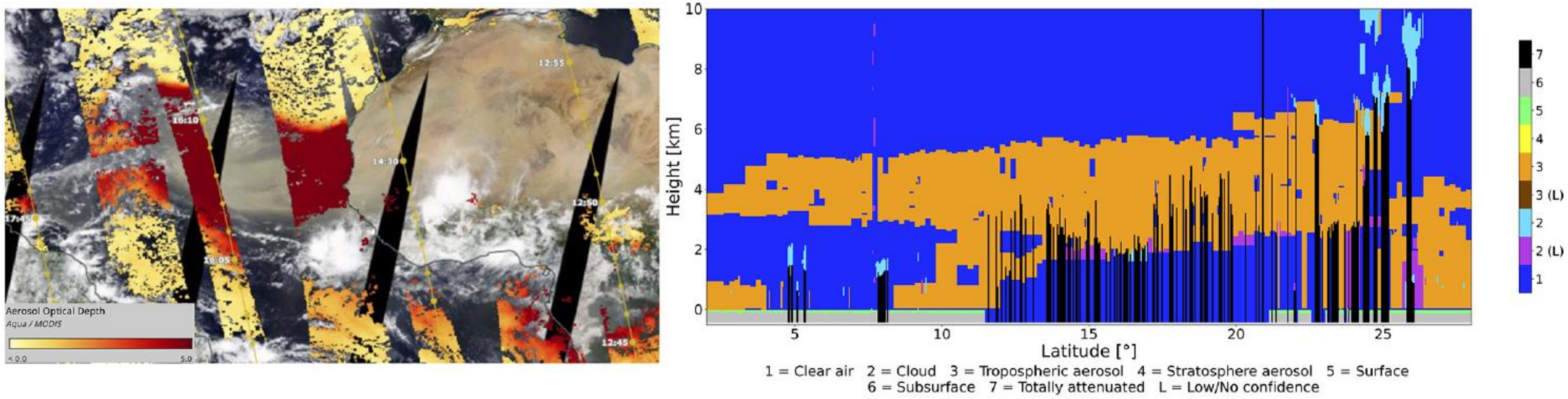


Fig. 7 of doi:10.5194/amt-17-2521-2024

A plume also observed by MODIS Aqua

Observations of 18 June 2020 (a) AOD at 3 km from MODIS Aqua overlaid with CALIOP footprint 50 min later. (b) Feature mask from CALOP. (Right) Lidar ratio profiles derived from CALIOP (green) and ALADIN (blue), highlighting the underestimation of dust lidar ratios typical of the CALIOP retrieval.



(a) Fig. 8 of doi:10.5194/amt-17-2521-2024 (b)

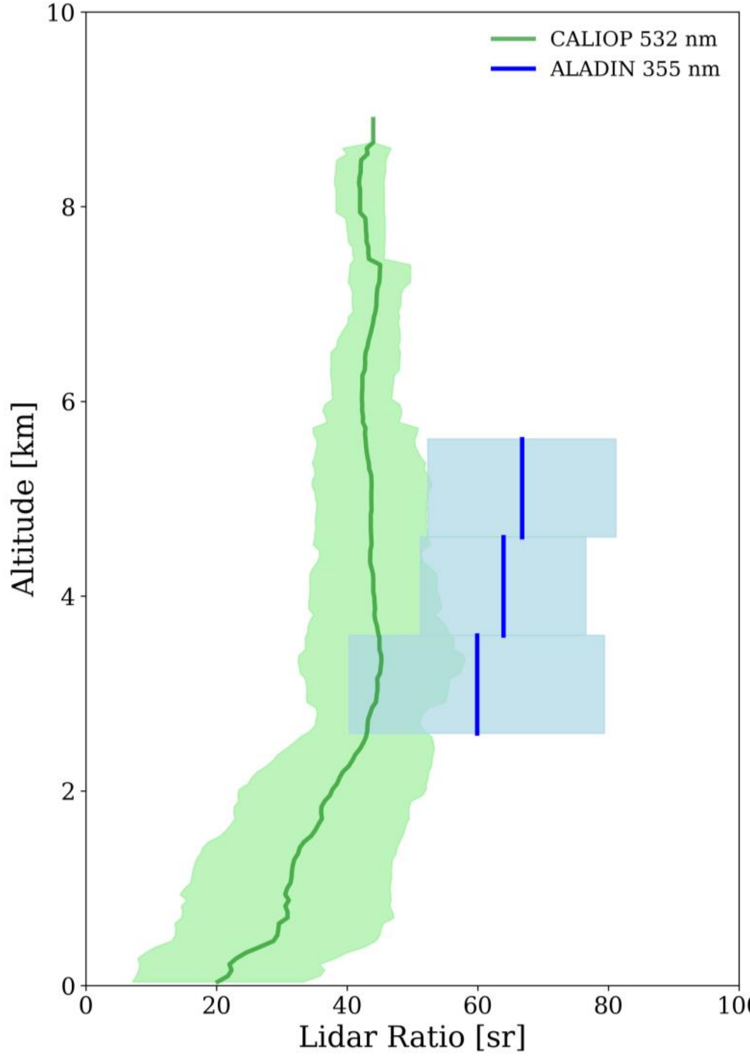


Fig. 10 of doi:10.5194/amt-17-2521-2024

A plume also observed by MODIS Aqua

Observations of 18 June 2020 (Right) Lidar ratio profiles derived from CALIOP (green) and ALADIN (blue), highlighting the underestimation of dust lidar ratios typical of the CALIOP retrieval. (Below) AOD from MODIS (black), standard CALIOP retrievals (red) and CALIOP after correction using the ALADIN lidar ratio (green).

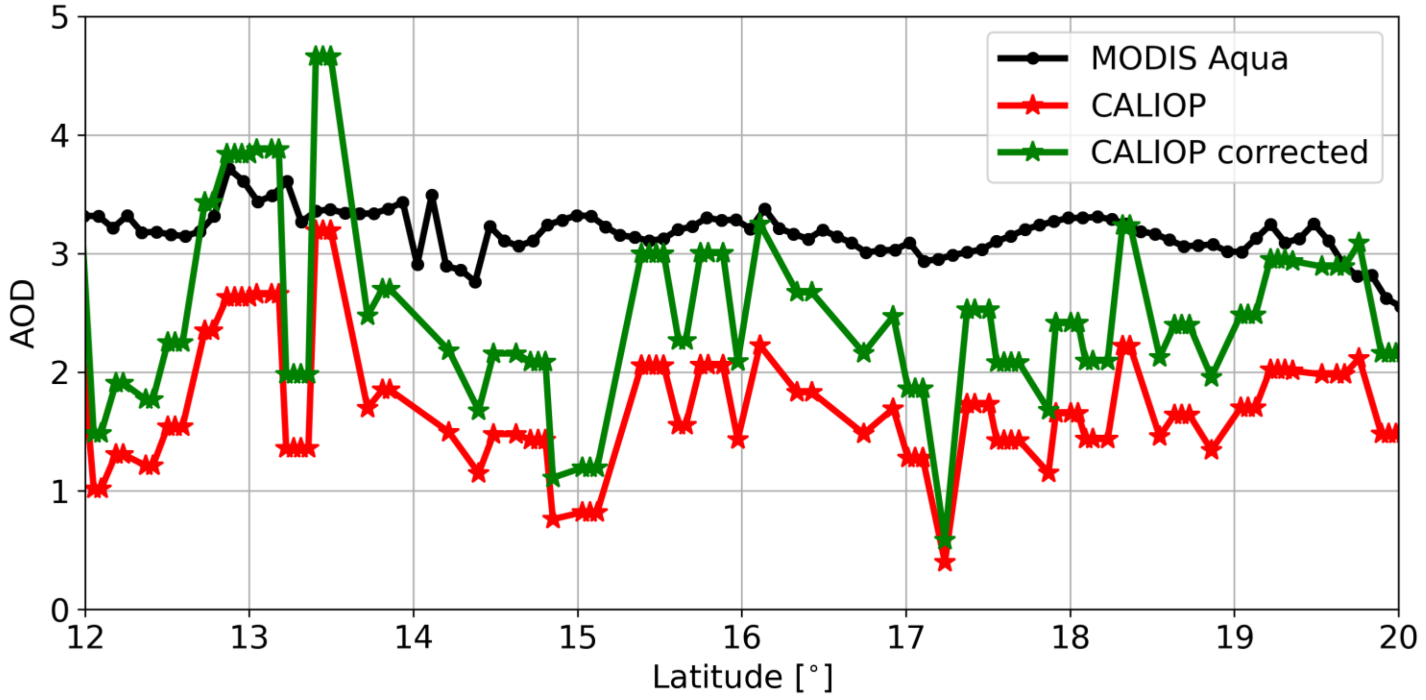


Fig. 9 of doi:10.5194/amt-17-2521-2024

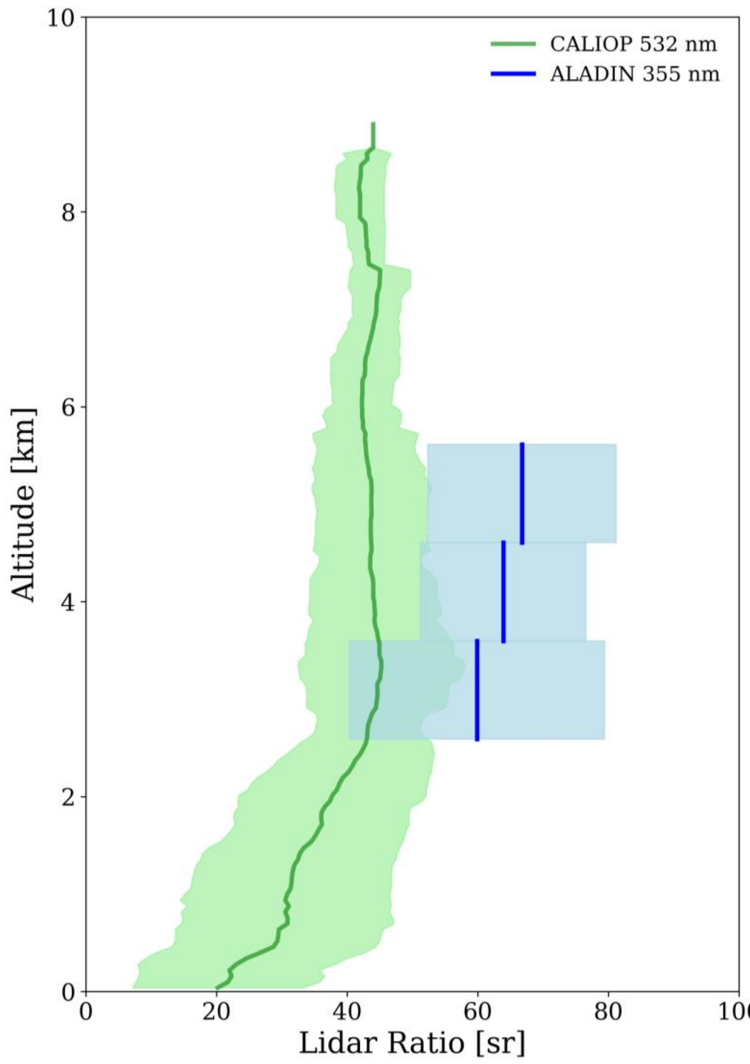
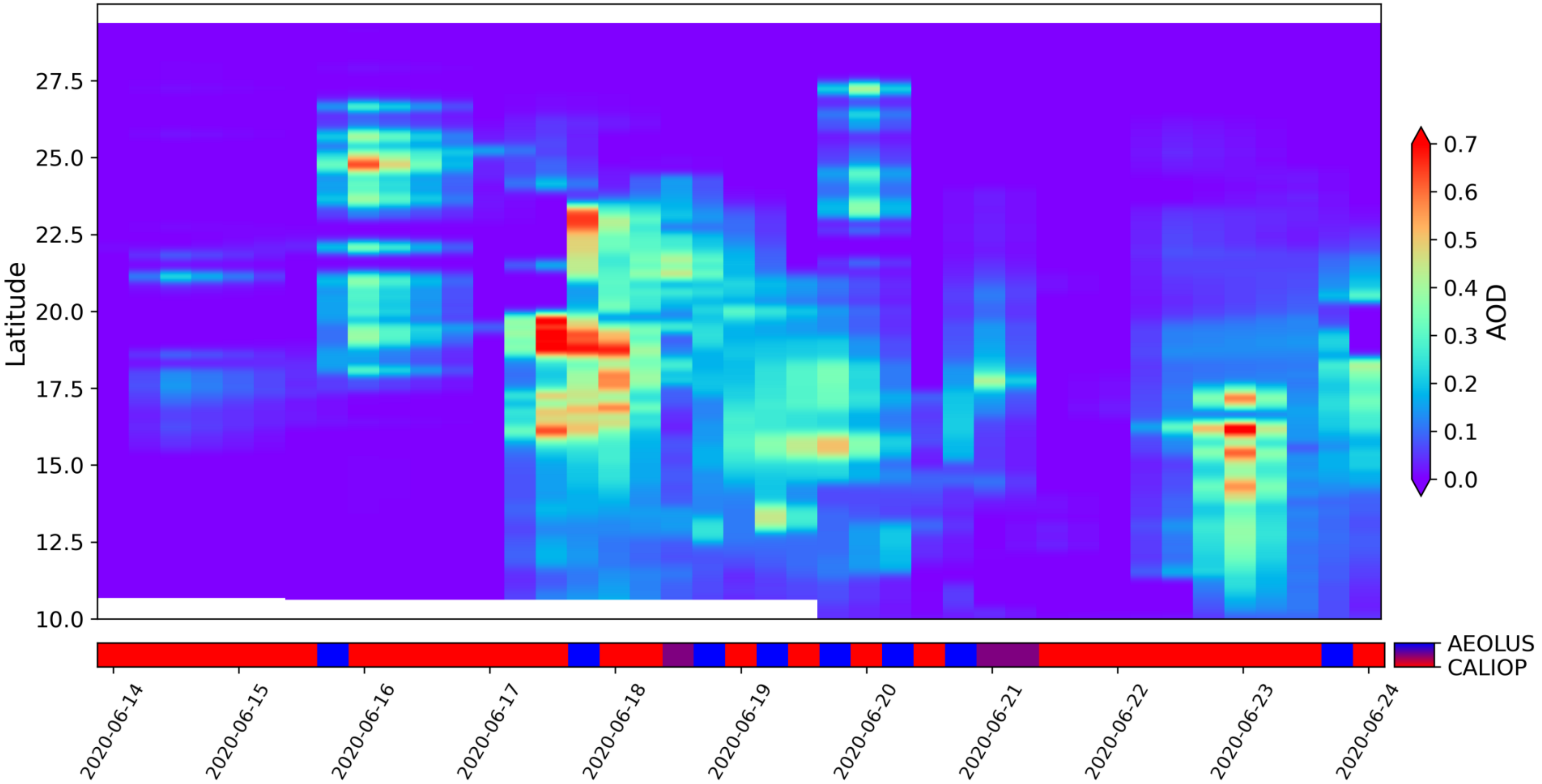


Fig. 10 of doi:10.5194/amt-17-2521-2024

Synergistic observation of desert dust

Aerosol optical depth (AOD) from combination of ALADIN and CALIOP over 4.5–6.5 km altitude, between 40°W and 20°W, during 14 to 24 June 2020. Fig. 12 of doi:10.5194/amt-17-2521-2024



Summary

- Orbital lidar provides a unique perspective on desert dust plumes
- SEVIRI can provide a useful cloud mask for ALADIN observations
- Lidar ratios retrieved by ALADIN can be applied to CALIOP to improve agreement with independent observations

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Characterization of dust aerosols from ALADIN and CALIOP measurements

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Abstract. Atmospheric aerosols have pronounced effects on climate at both regional and global scales, but the magnitude of these effects is subject to considerable uncertainties. A major contributor to these uncertainties is an incomplete

spaceborne HSRL in directly obtaining the lidar ratio, significantly reducing uncertainties in extinction retrievals.