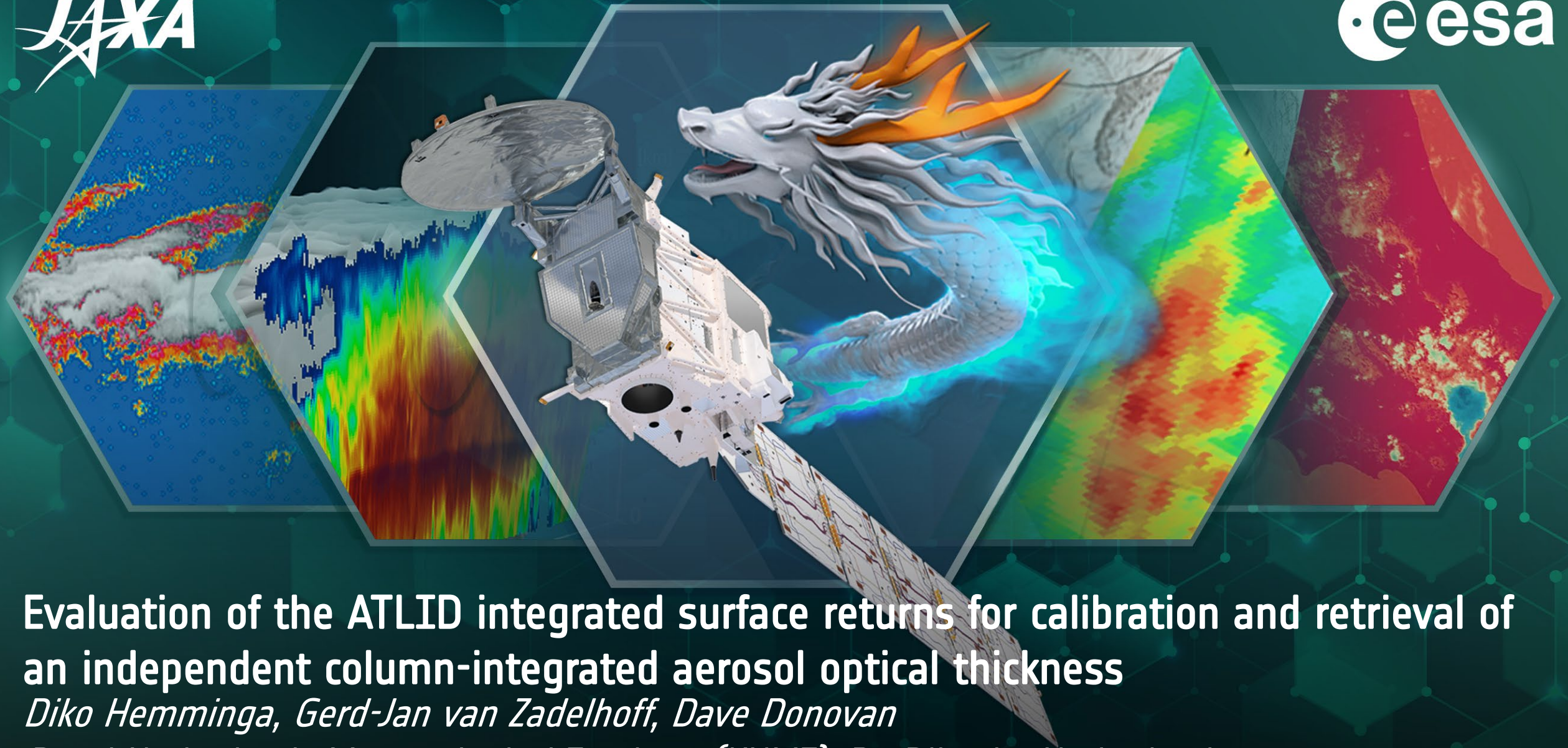


Evaluation of the ATLID integrated surface returns for calibration and retrieval of an independent column-integrated aerosol optical thickness

Diko Hemminga, Gerd-Jan van Zadelhoff, Dave Donovan

Royal Netherlands Meteorological Institute (KNMI), De Bilt, the Netherlands

2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

17 – 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy

Lidar surface return

- ATLID: EarthCARE's HSRL lidar of 355 nm at near-nadir incidence
- Vertical profiles of aerosols, clouds, and their optical properties
- Global, direct, measurement of UV surface reflectivity: lidar surface return
  - Part of the A-FM product
  - Mie co-polar, Mie cross-polar and Rayleigh co-polar channel
  - Over land and ocean

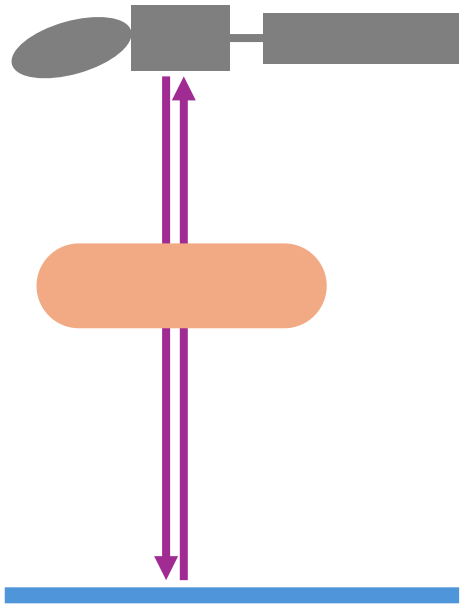
- Focus: ocean lidar surface returns in the co-polar Mie channel
  for retrieval of atmospheric transmission characteristics:
  aerosol optical depth
- Aerosol monitoring over ocean and inter-processor evaluation

Aerosol optical depth over ocean

- Column-integrated AOD over ocean from attenuated co-polar Mie backscatter
- Evaluation: Independent measure for evaluating the A-PRO, A-LAY and ACM-CAP retrievals

- Lidar surface return: Signal integrated over the surface pixels for any column where the surface is detected, on the ATLID native grid

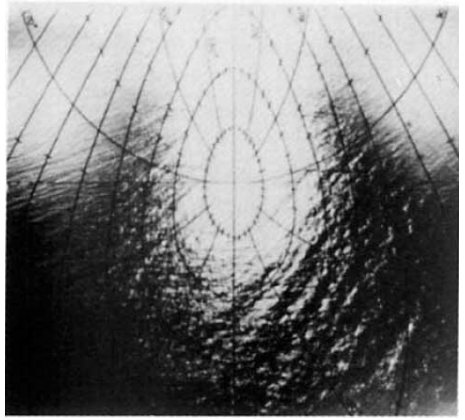
- AOD retrieval is based on a parametrization of the surface reflection



Aerosol optical depth over ocean (2)

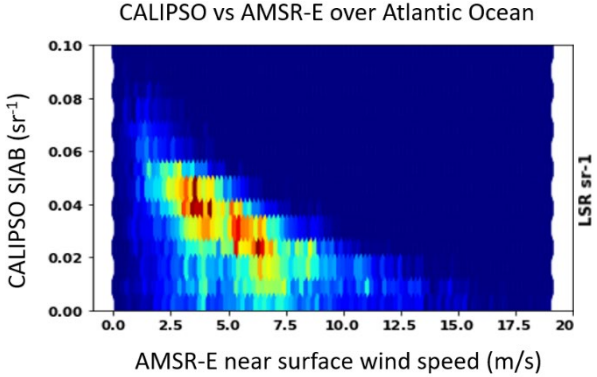
- Cox and Munk (1954): reflection from the ocean surface
- Relationship between sea surface slope and lidar backscattered signals: sea surface reflectance depends on 10-m wind speed

Cox and Munk, 1954

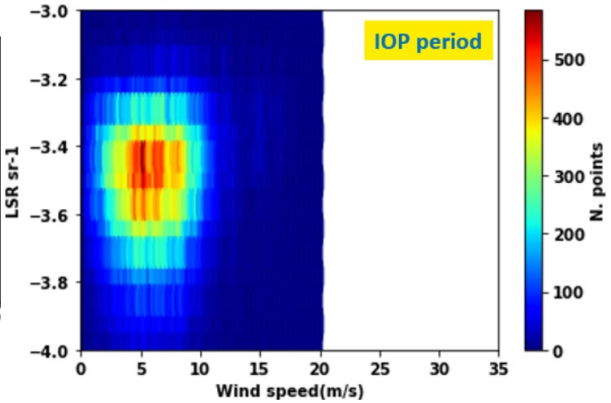


- CALIOP onboard CALIPSO: successful relation LSR ↔ wind speed
- ALADIN onboard Aeolus investigated by Lev Labzovskii (KNMI)
  - 35° incidence: no direct reflection
  - Insufficient sensitivity of LSR to wind speed for AOD retrieval

CALIPSO



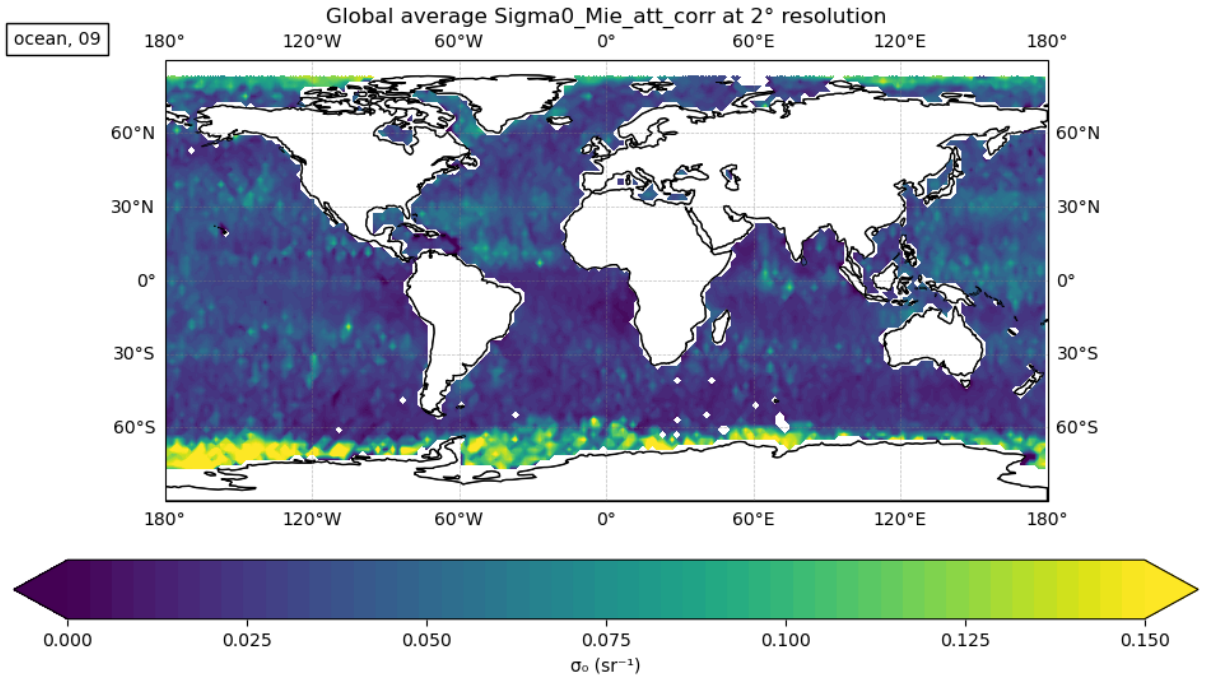
Aeolus

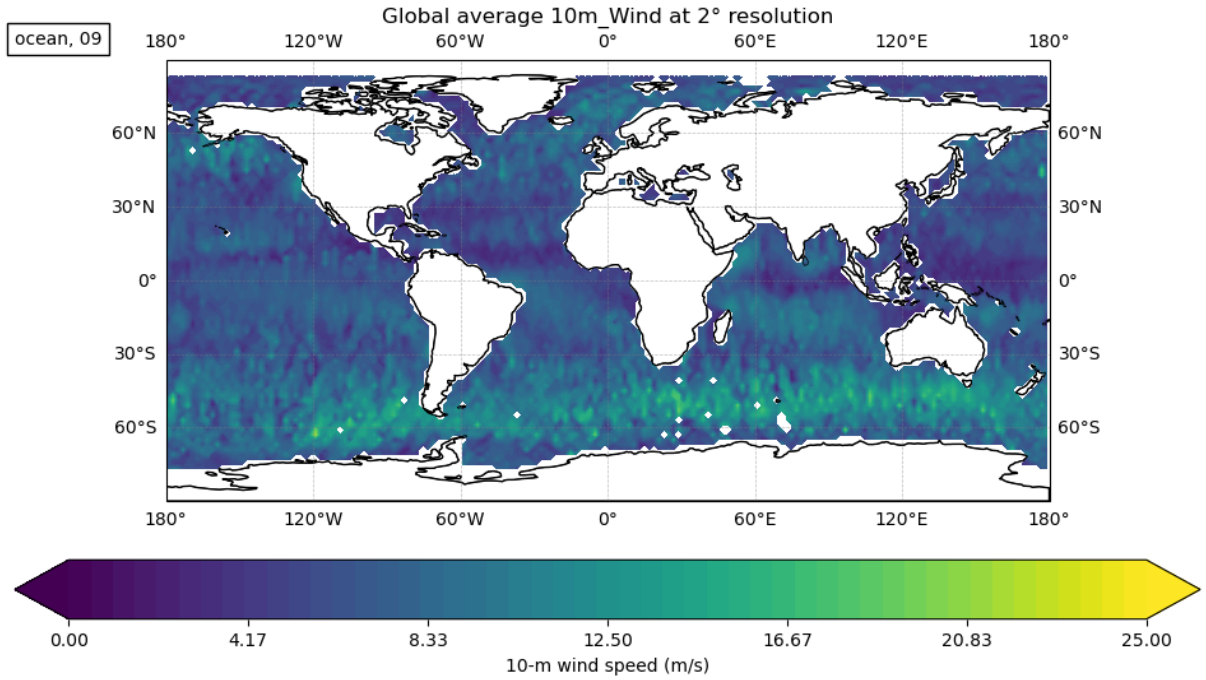


Co-polar Mie surface backscatter

Baseline AC

- Global co-polar Mie surface backscatter,
  corrected for molecular (Rayleigh) attenuation over ocean





- Global wind speed from X-MET product, based on ECMWF forecast

Co-polar Mie surface backscatter

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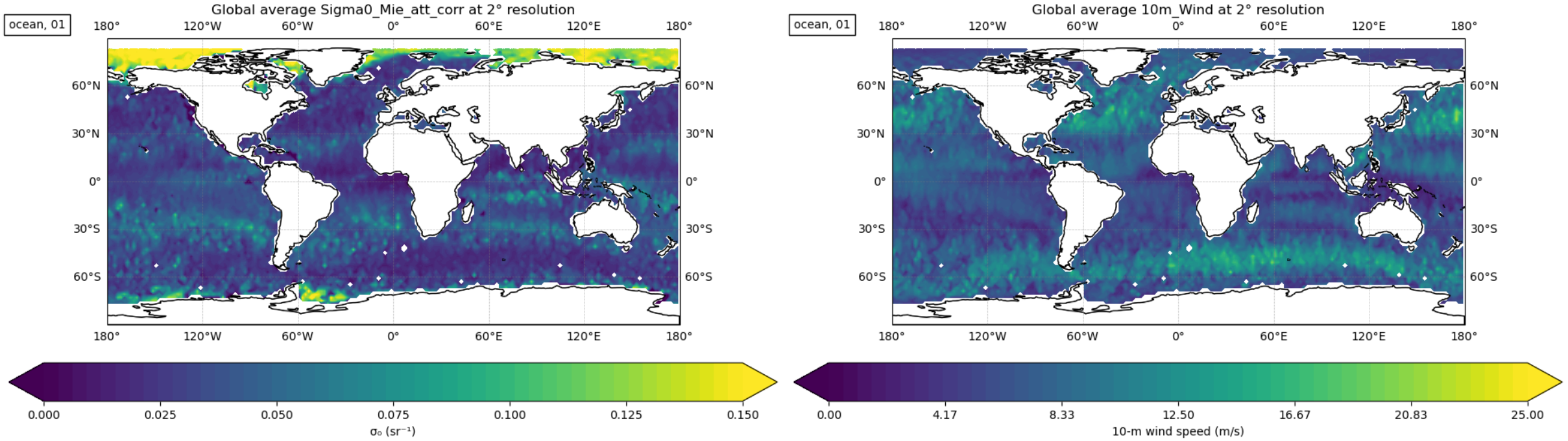
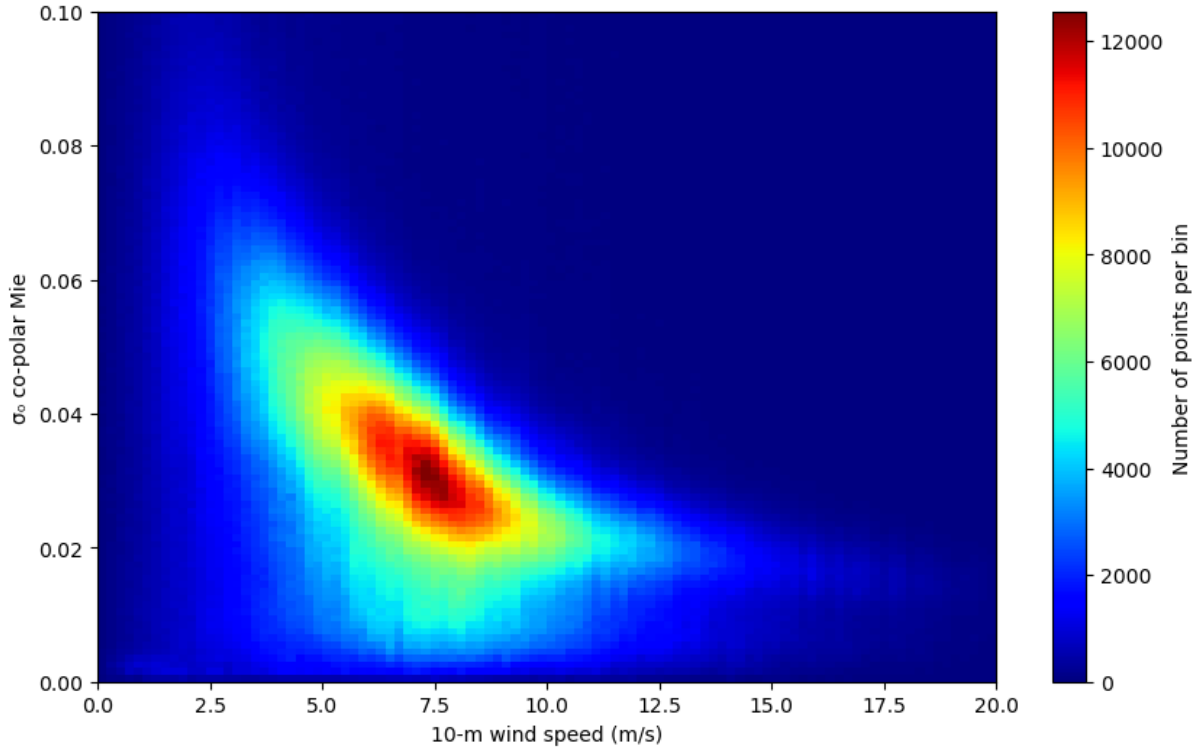


- Global wind speed from X-MET product based on ECMWF forecast

Relations between LSR, AOD and windspeed

Baseline AC

- Surface-integrated attenuated backscatter vs. 10-m wind speed



Relations between LSR, AOD and windspeed

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- Surface-integrated attenuated backscatter vs. 10-m wind speed
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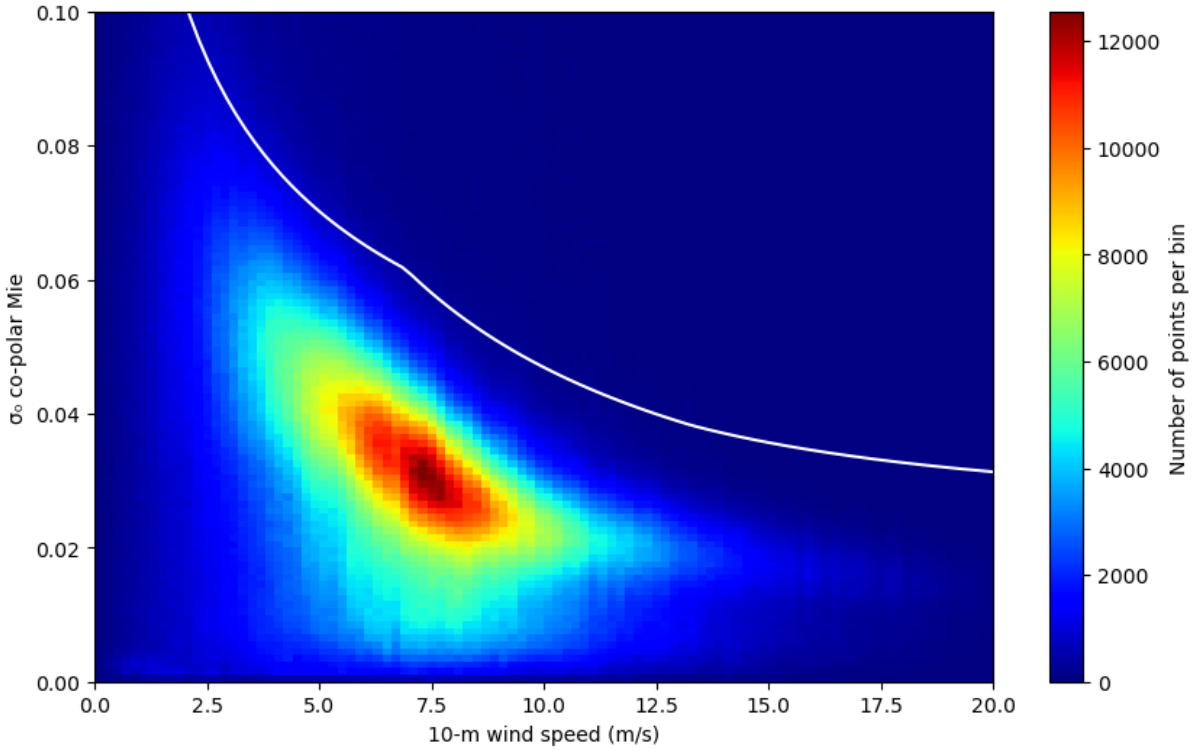
- Employ Lev Labzovskii's Lidar Aerosol Retrieval based on Information from Sea Surface of Aeolus (LARISSA) algorithm



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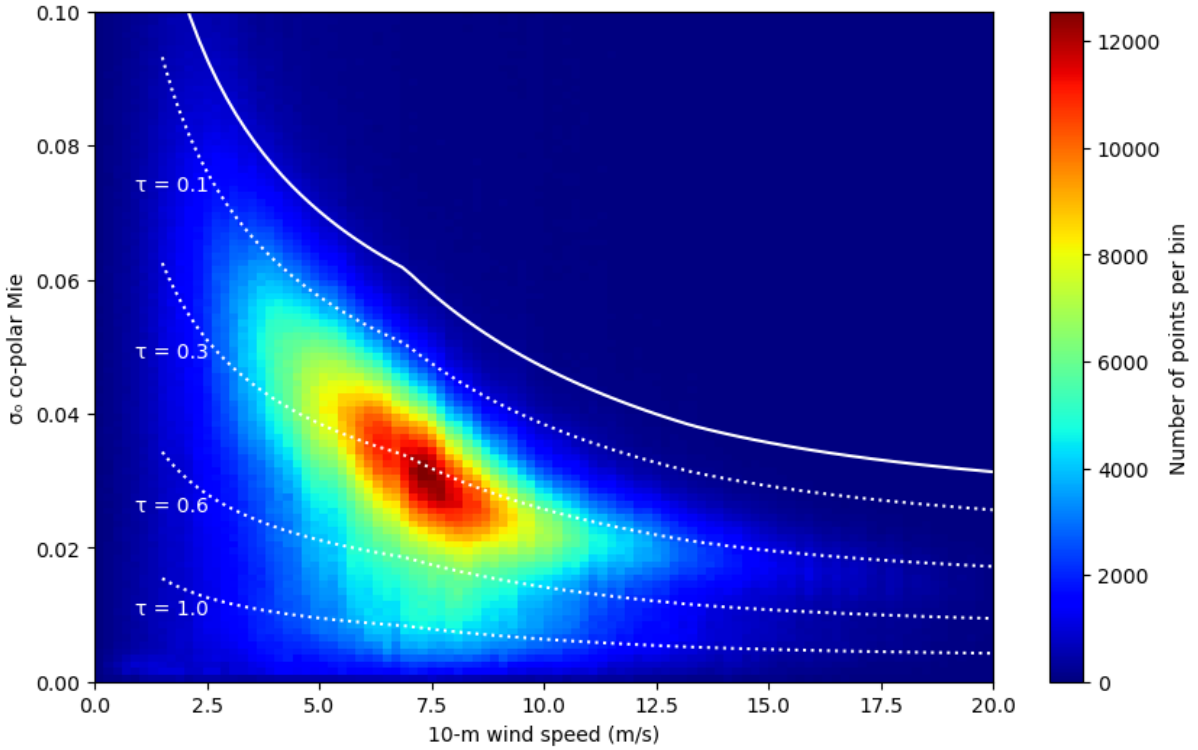
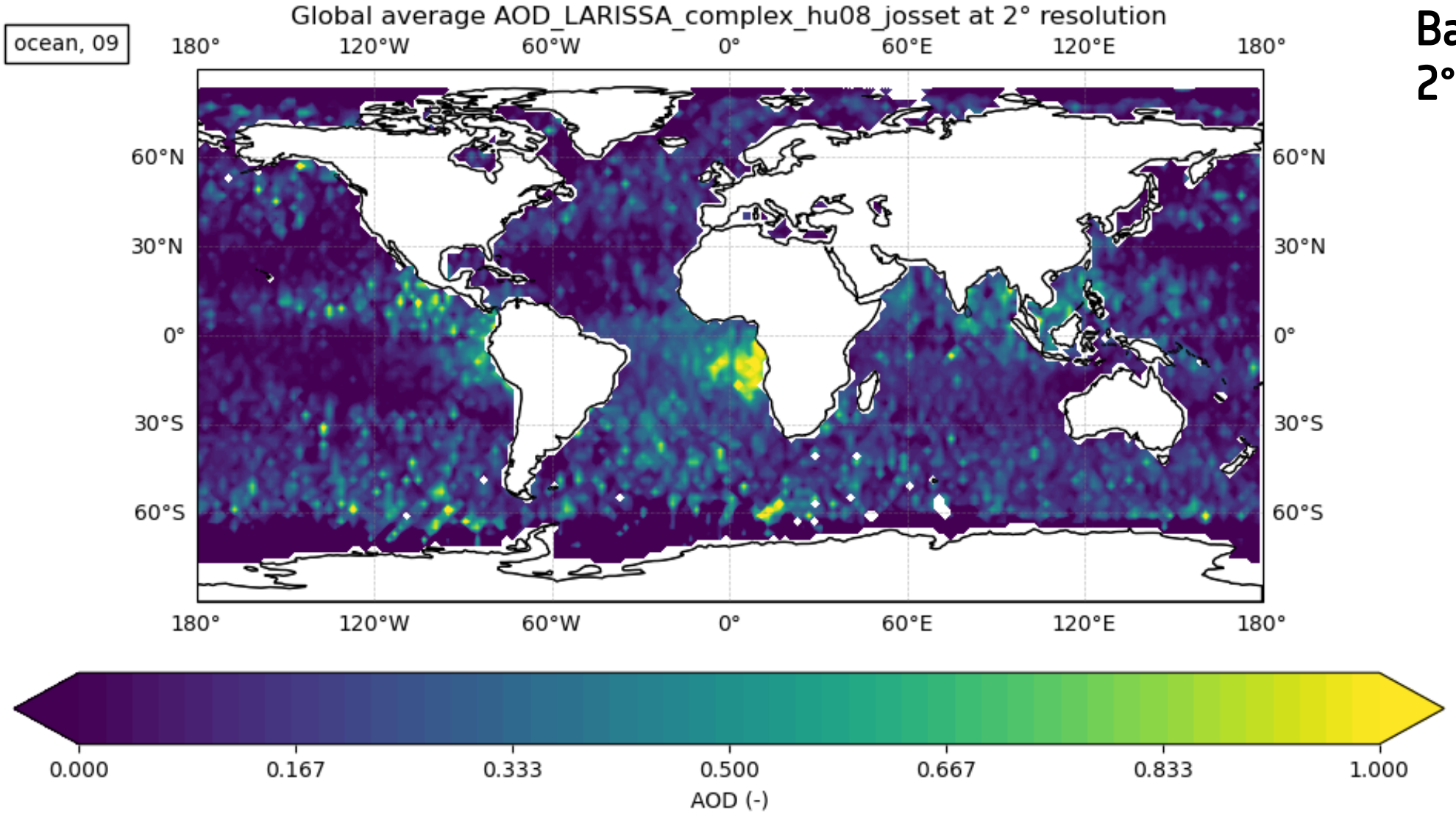
- Employ Lev Labzovskii's Lidar Aerosol Retrieval based on Information from Sea Surface of Aeolus (LARISSA) algorithm
- Current results may still contain thin clouds: total optical depth

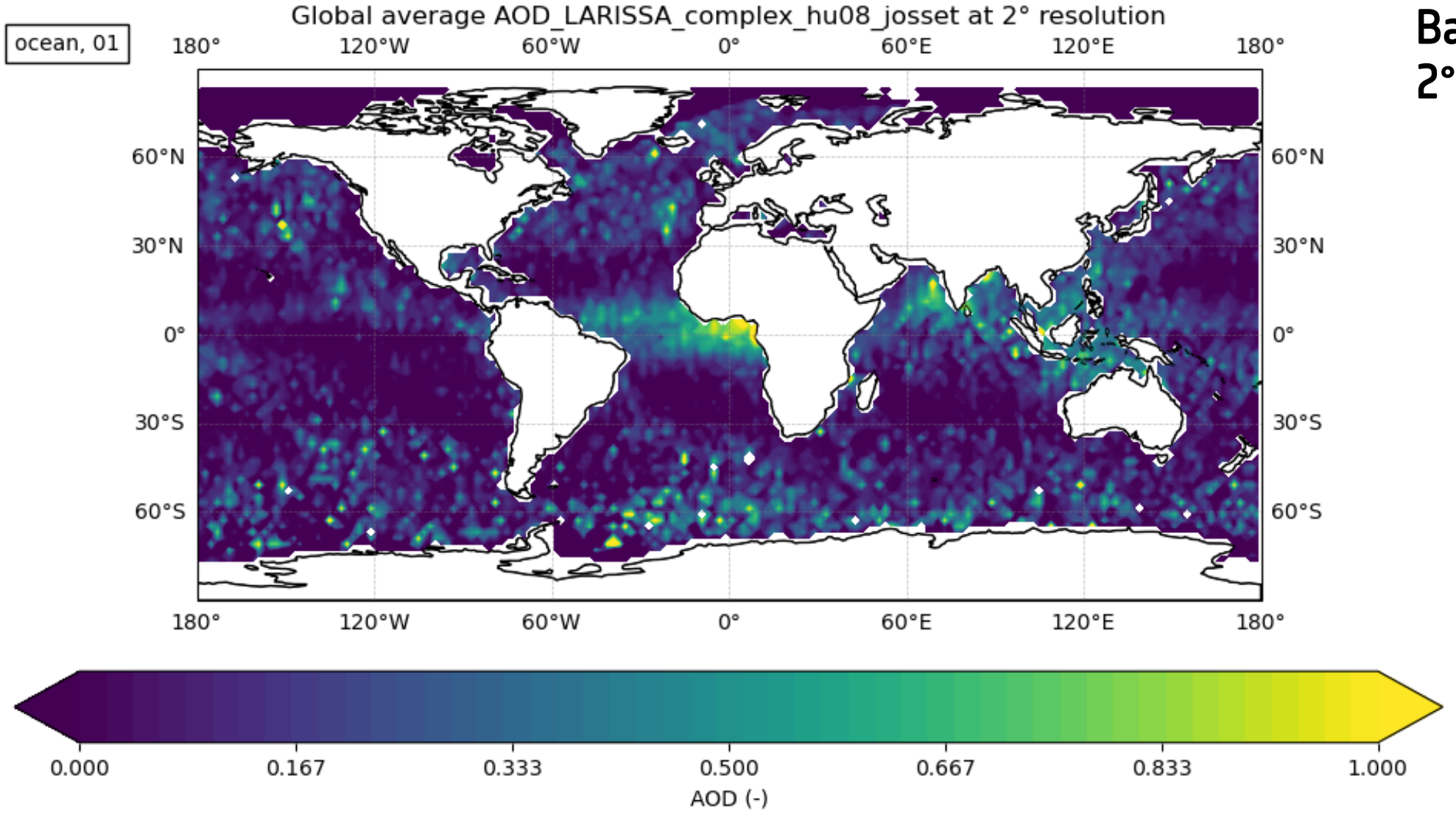


Global AOD based on ATLID LSR



Baseline AC
2°-by-2° grid

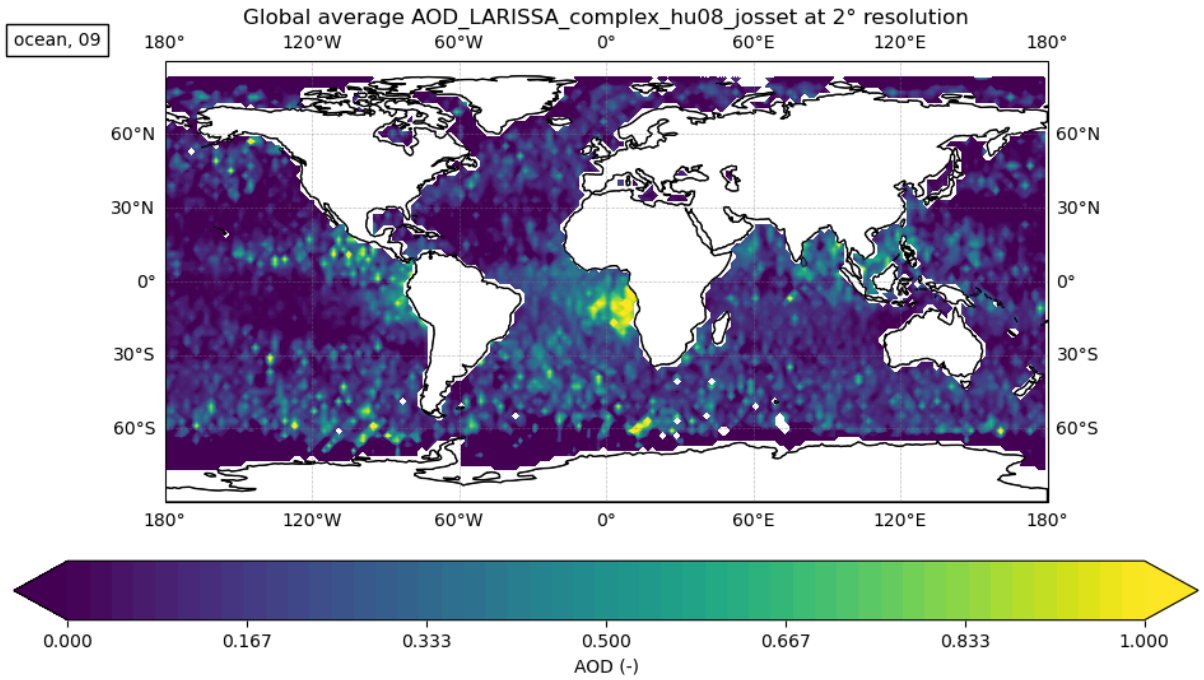
Global AOD based on ATLID LSR

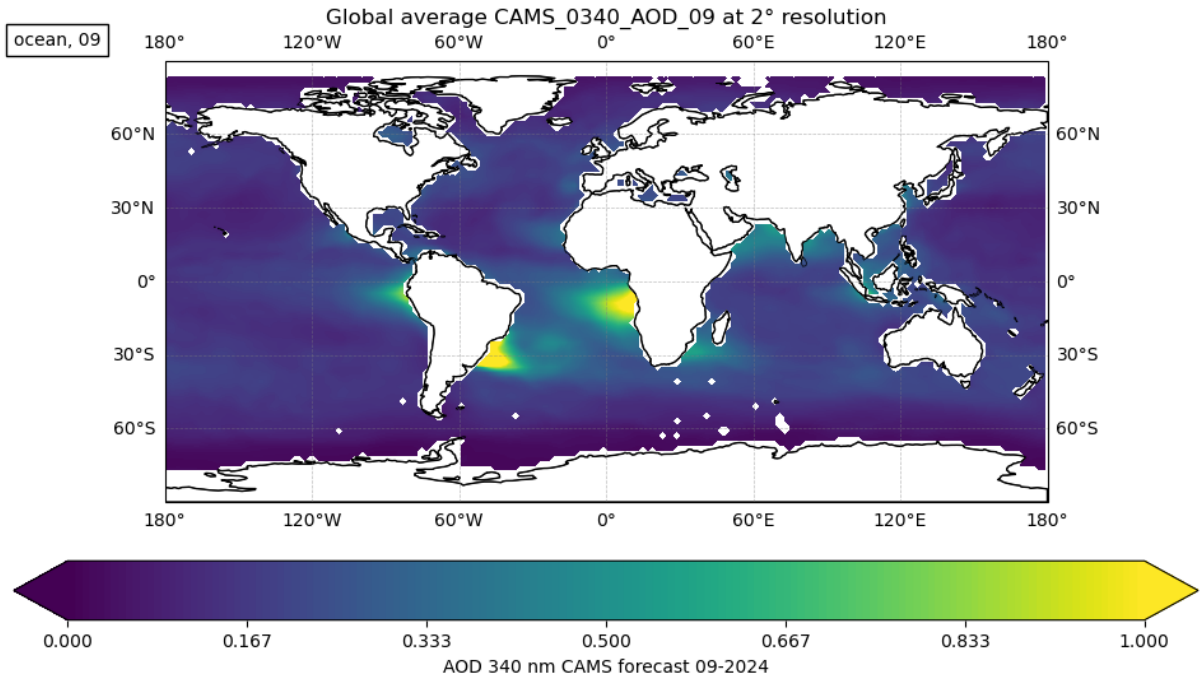


Baseline AC
2°-by-2° grid

Comparison to CAMS

- Copernicus Atmosphere Monitoring Service: Aerosol optical depth at 340 nm





The CAMS dataset may still include cloud-related sampling issues

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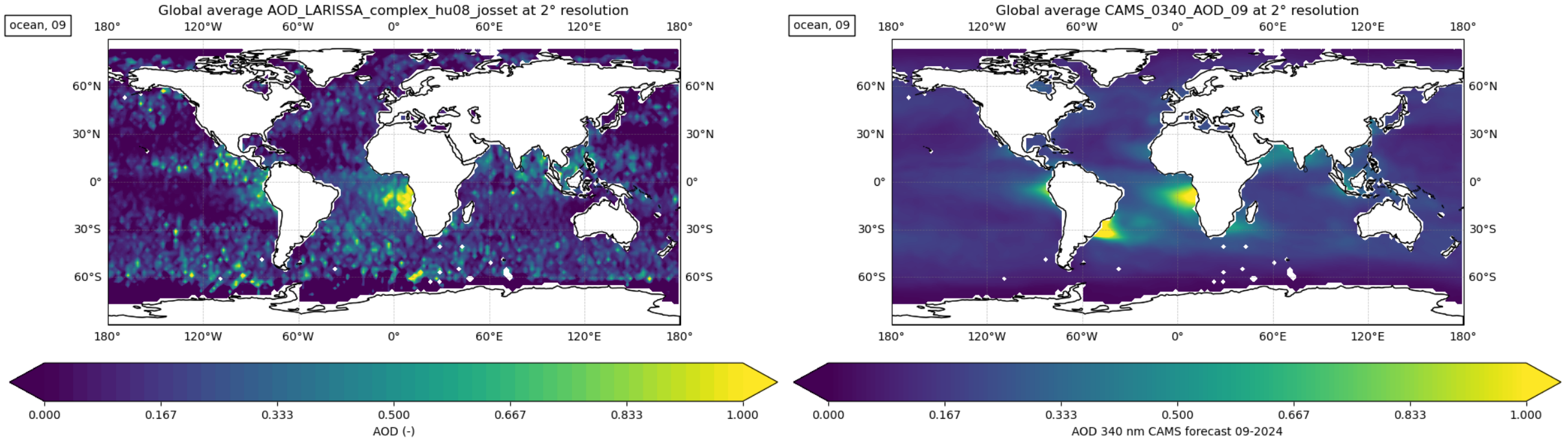


The CAMS dataset may still include cloud-related sampling issues

Discussion and future work

- Removal of cirrus clouds for AOD retrieval
- Different windspeed parametrizations are available

- Comparison with A-PRO, A-LAY and ACM-CAP retrievals
- Investigation of sub-surface scattering effects from Rayleigh channel return

Conclusion

- ATLID shows sensitivity of lidar surface returns to wind speed
- This enables independent retrieval of aerosol optical depth of the atmospheric column above the surface

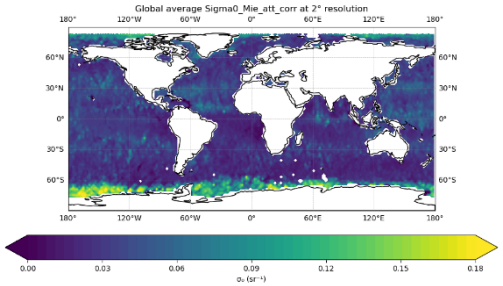
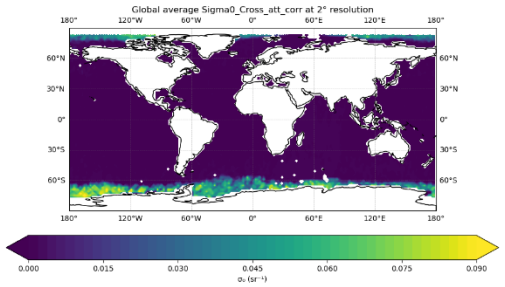
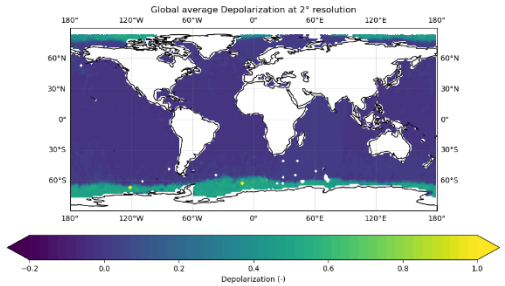
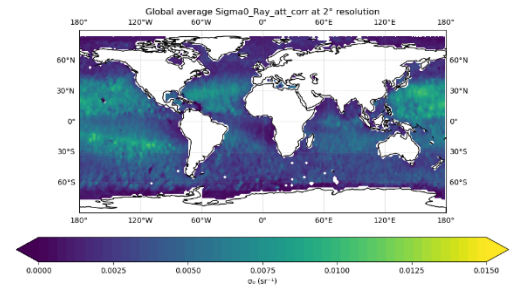
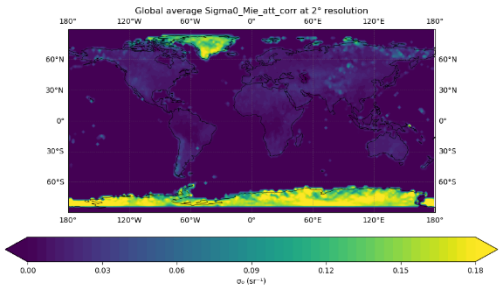
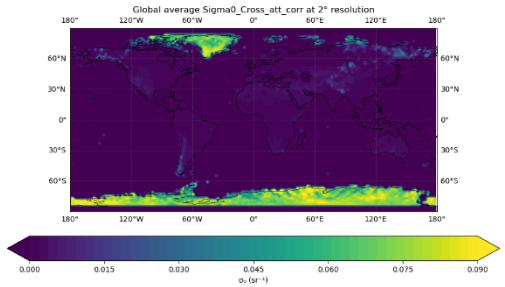
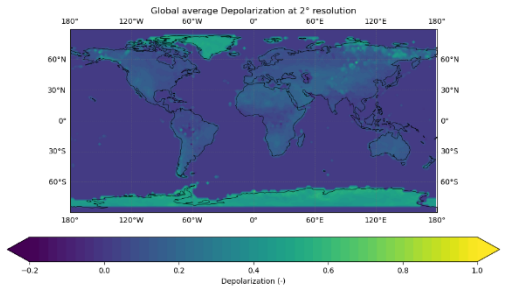
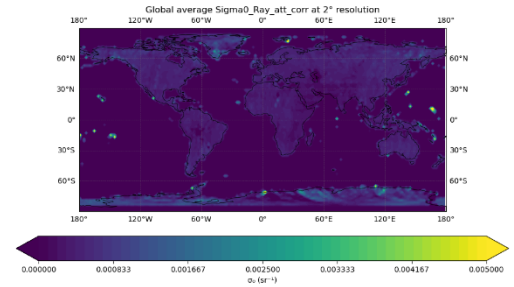
- Thanks to my coauthors, to Lev Labzovskii, to the KNMI-local EarthCARE team and the EarthCARE DISC

  and thank you for listening!


JAXA
esa

Lidar surface return (2)

Baseline AC
2°-by-2° grid

	Co-polar Mie	Cross-polar Mie	Depolarization	Rayleigh
Ocean				
Land				

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