Sentinel 5-P Mission: 5 Years Anniversary

A Second-Generation UV-VIS Aerosol Algorithm: Application to S5P-TROPOMI Observations

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Presentation Outline:

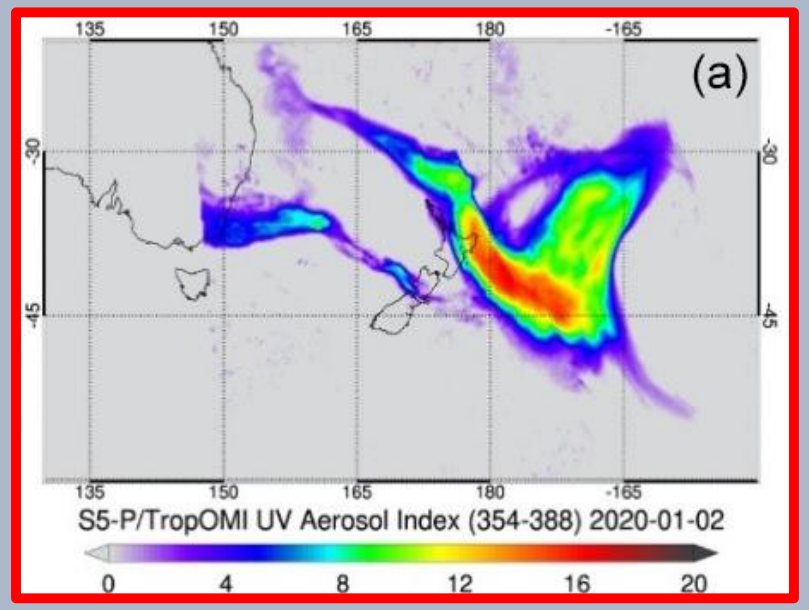
TROPOMAER aerosol products: Current Status

A new generation TROPOMI UV-VIS aerosol algorithm

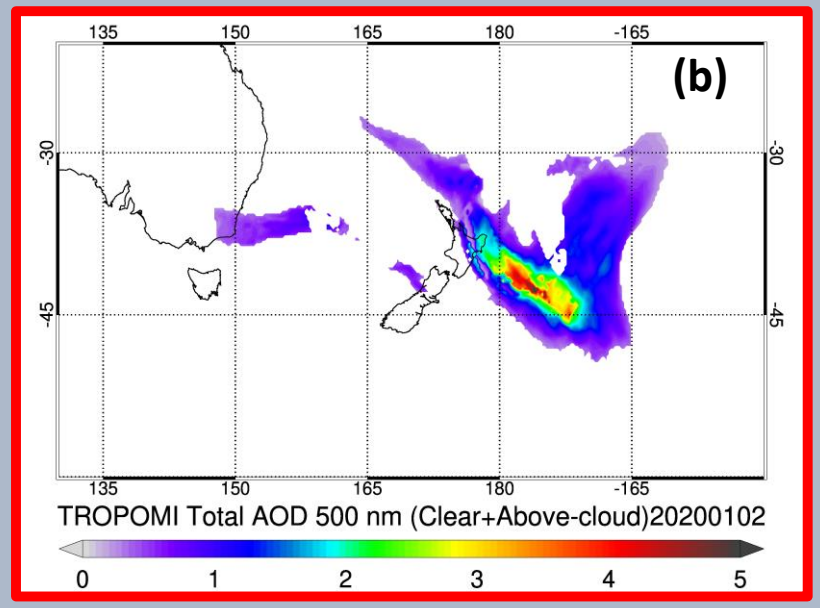
TROPOMAER Aerosol Products

-OMI Heritage : OMAERUV algorithm. Uses observations at 354 and 388nm to derive quantitative (AOD SSA), above-cloud aerosols (ACAOD) and qualitative (UVAI) products. Like OMAERUV, it uses a CALIOP-based Aerosol Layer Height (ALH) climatology
-TROPOMAER extends OMAERUV's 22-year record.

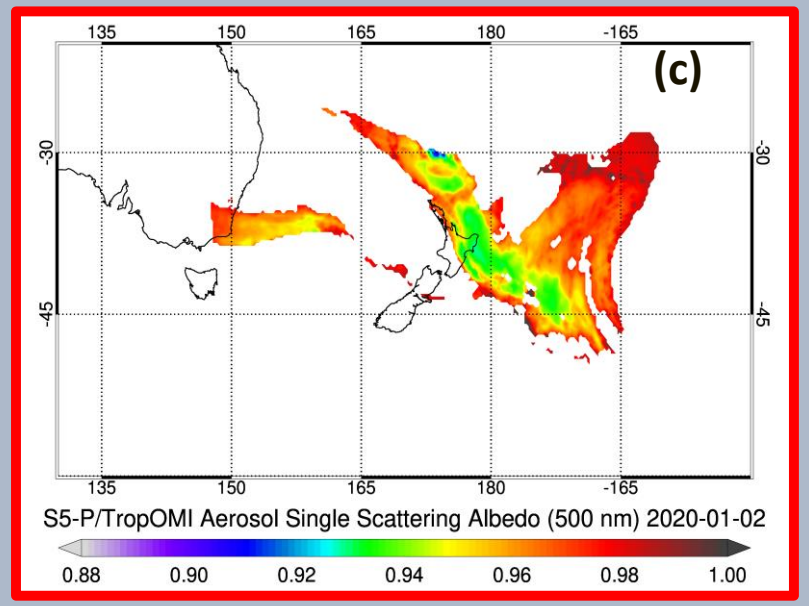
UV Aerosol Index



Optical Depth and above-cloud-optical depth



Single Scattering Albedo

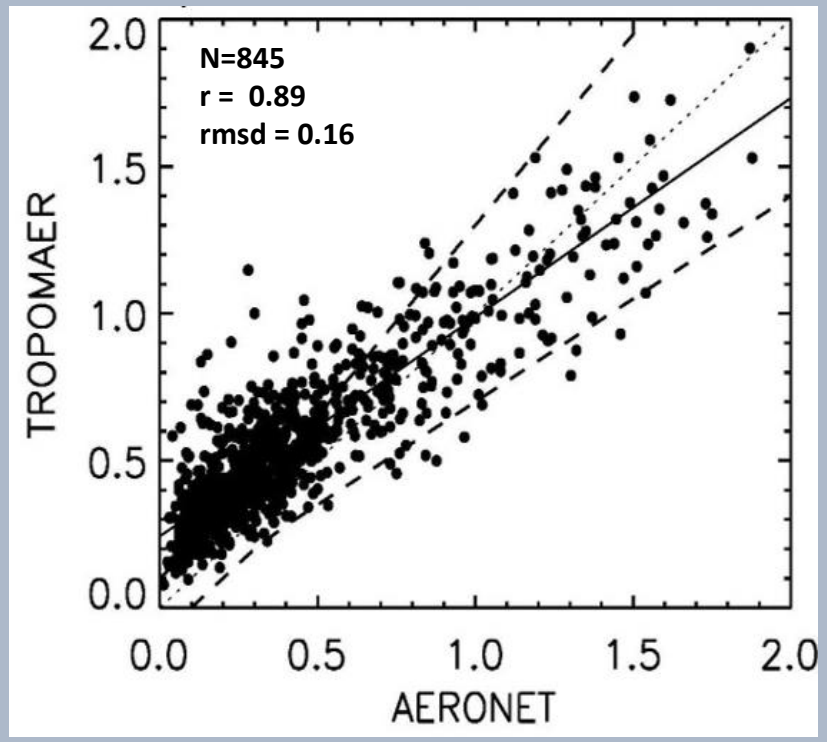


TROPOMAER Detection and Characterization of the Australian PryroCb on January 2, 2020

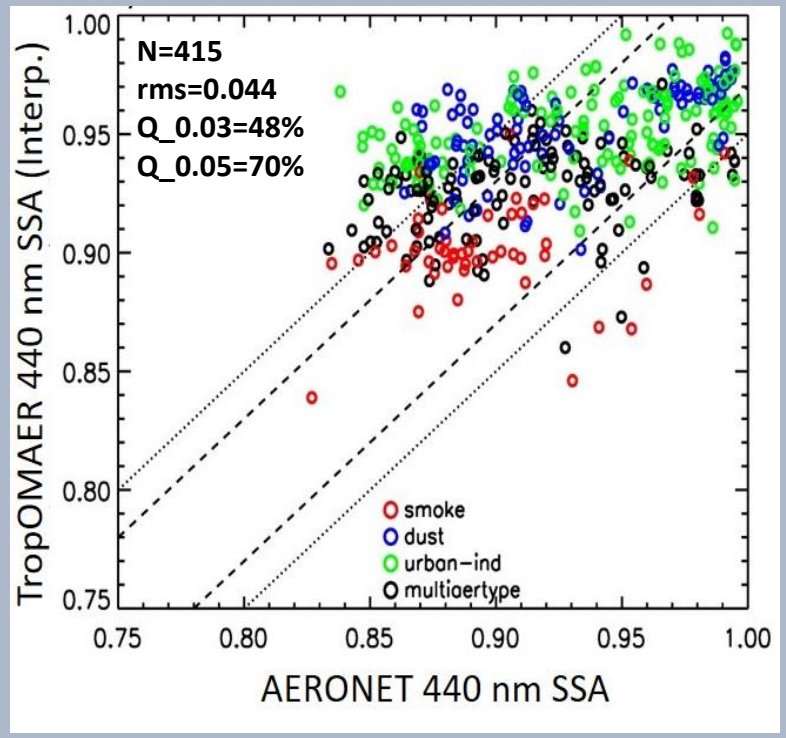
TROPOMAER observations were used to obtain the first estimate (as much as 764 Kt) of stratospheric carbonaceous aerosols injected by a series of pyroCb's in Australia [Torres, et al., AMT, 2020]

Evaluation of TROPOMAER Aerosol Products

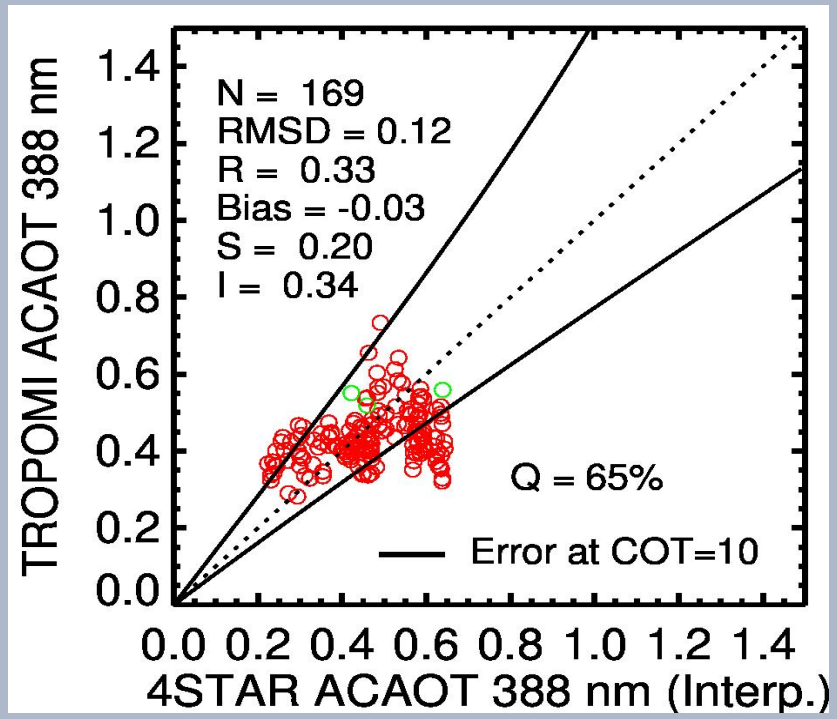
AOD (388 nm)



SSA (440 nm)



Above Cloud AOD (388 nm)



AOD/SSA Evaluation carried out at 12 representative AERONET sites representative of different aerosol types.

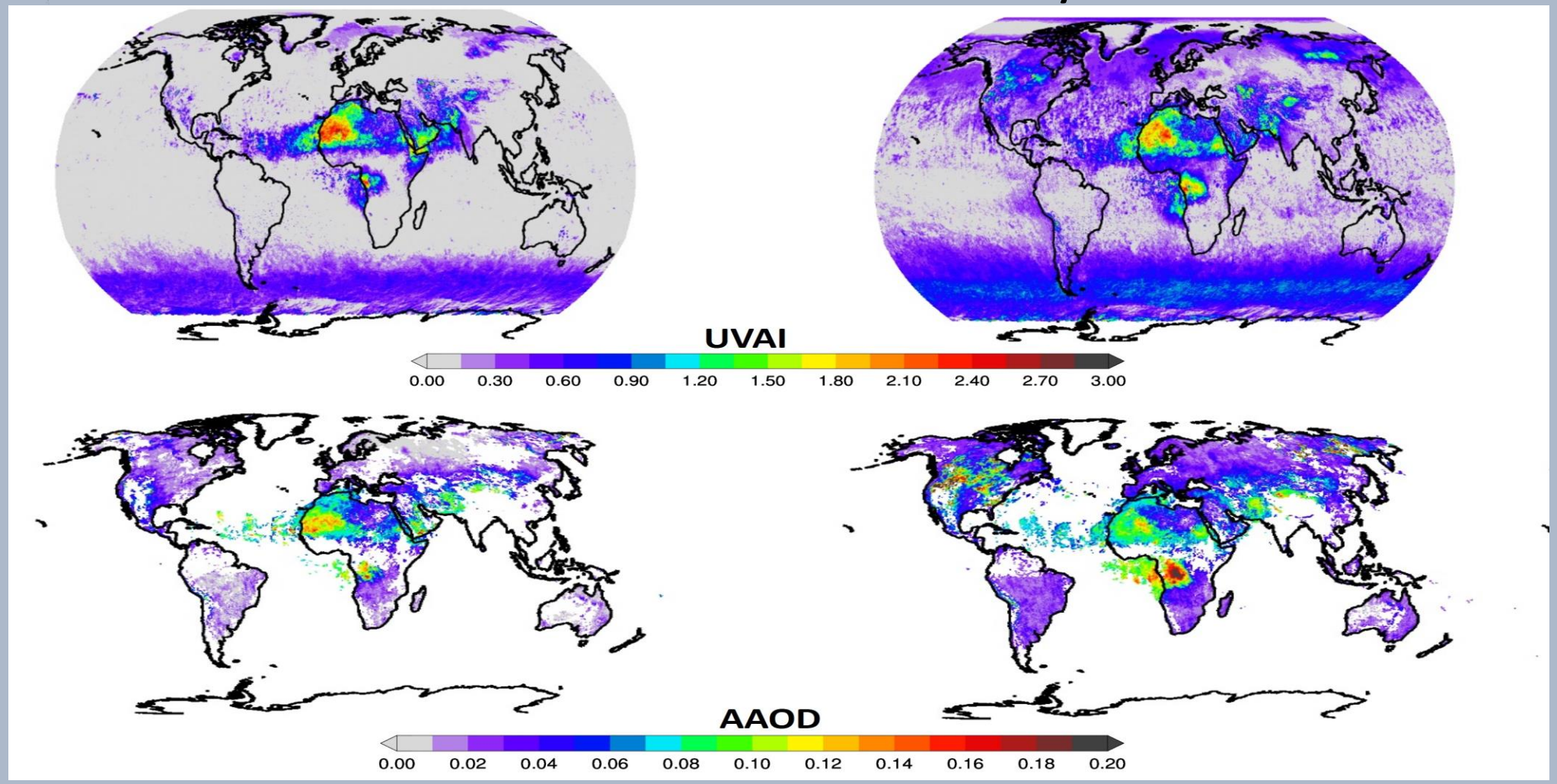
ORACLES (South. Atl. Ocean) Sept.-Oct. 2018

Improved accuracy in relation to OMI is due to TROPOMI's finer spatial resolution and availability of VIIRS cloud mask (Torres et al., AMT, 2020)

Impact of TROPOMI Spectral Calibration Drift on TROPOMAER Product

July 2018

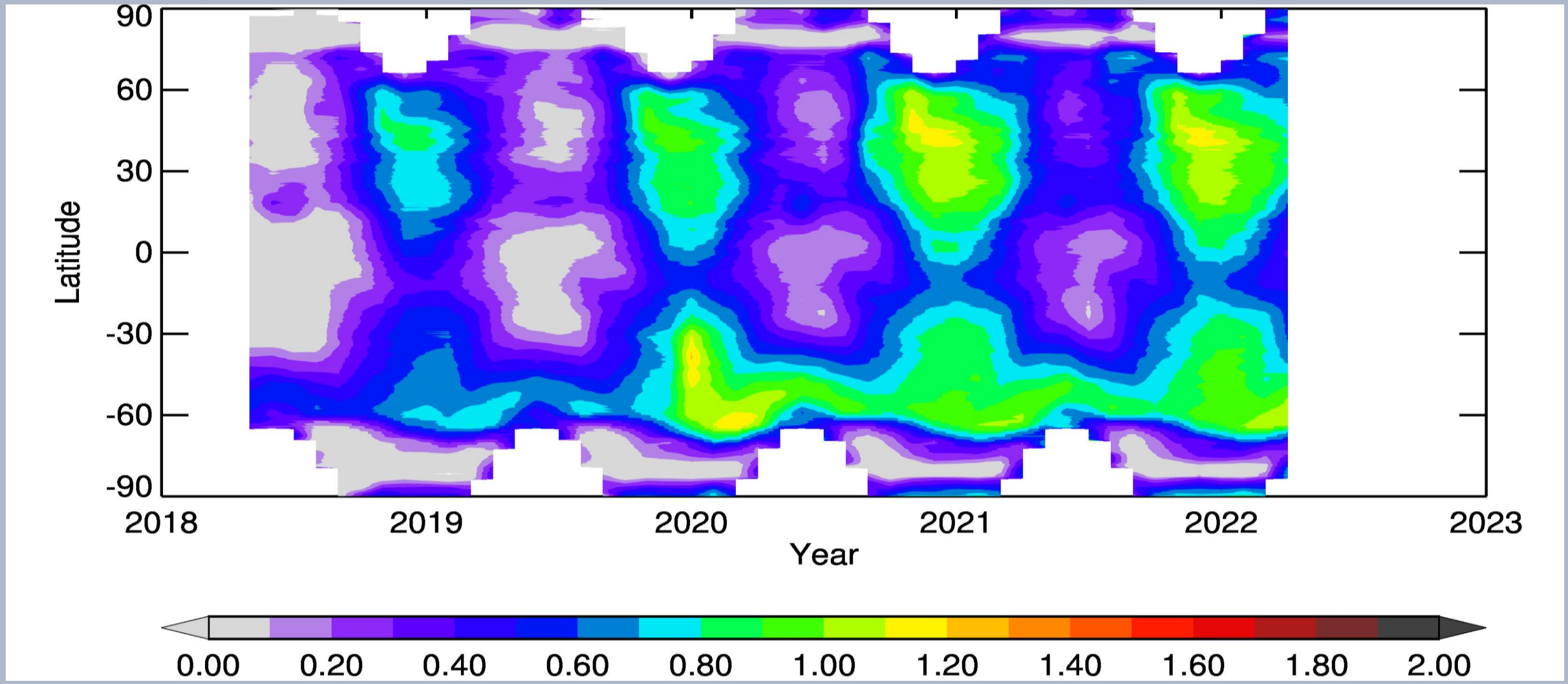
July 2021



-A clear effect on the UVAI (top maps) is observed at mid and high latitudes in both hemispheres.

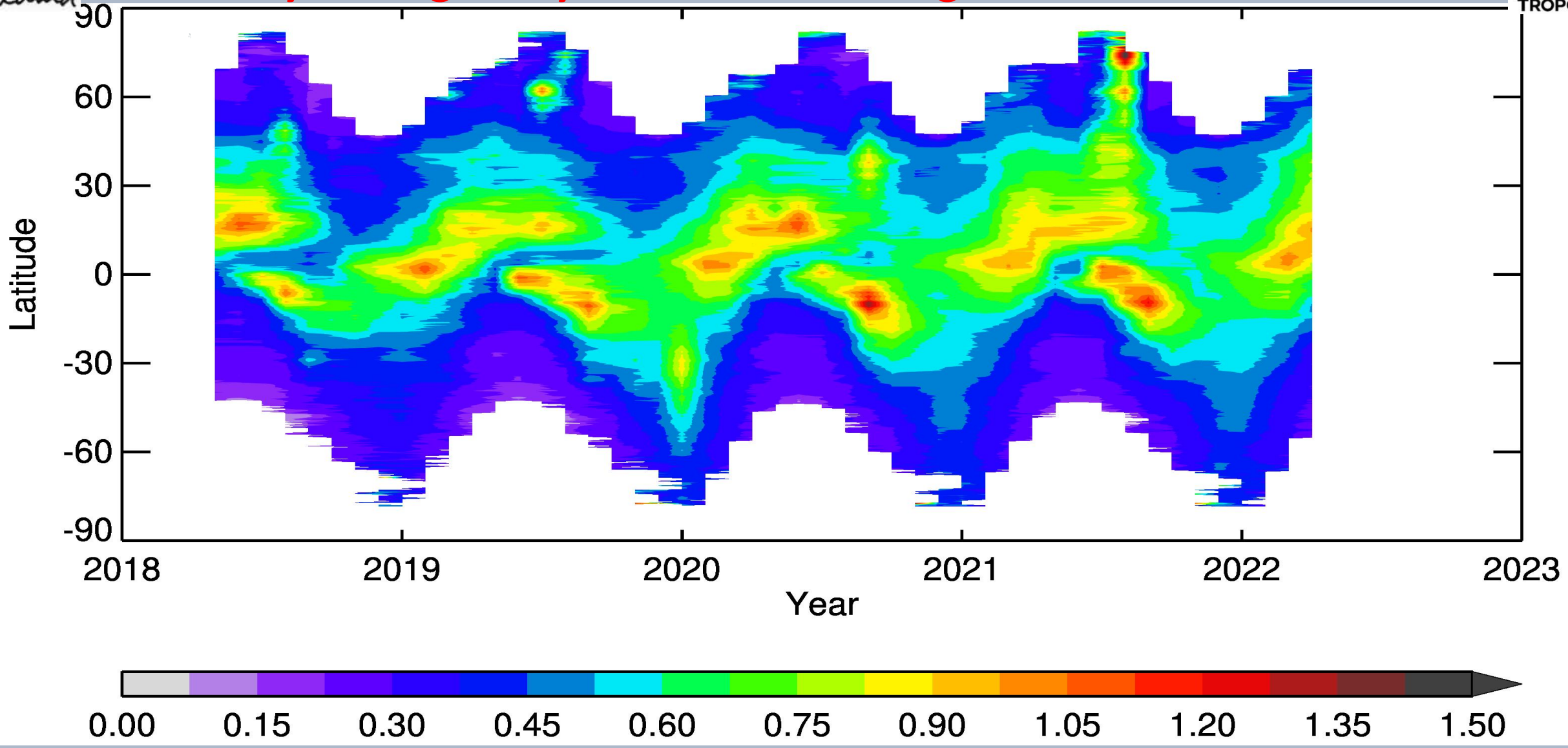
-Although, also affected by calibration drift, the AAOD product shows well know features of the global aerosol load.

Zonally Averaged 4-year TROPOMAER global UVAI record



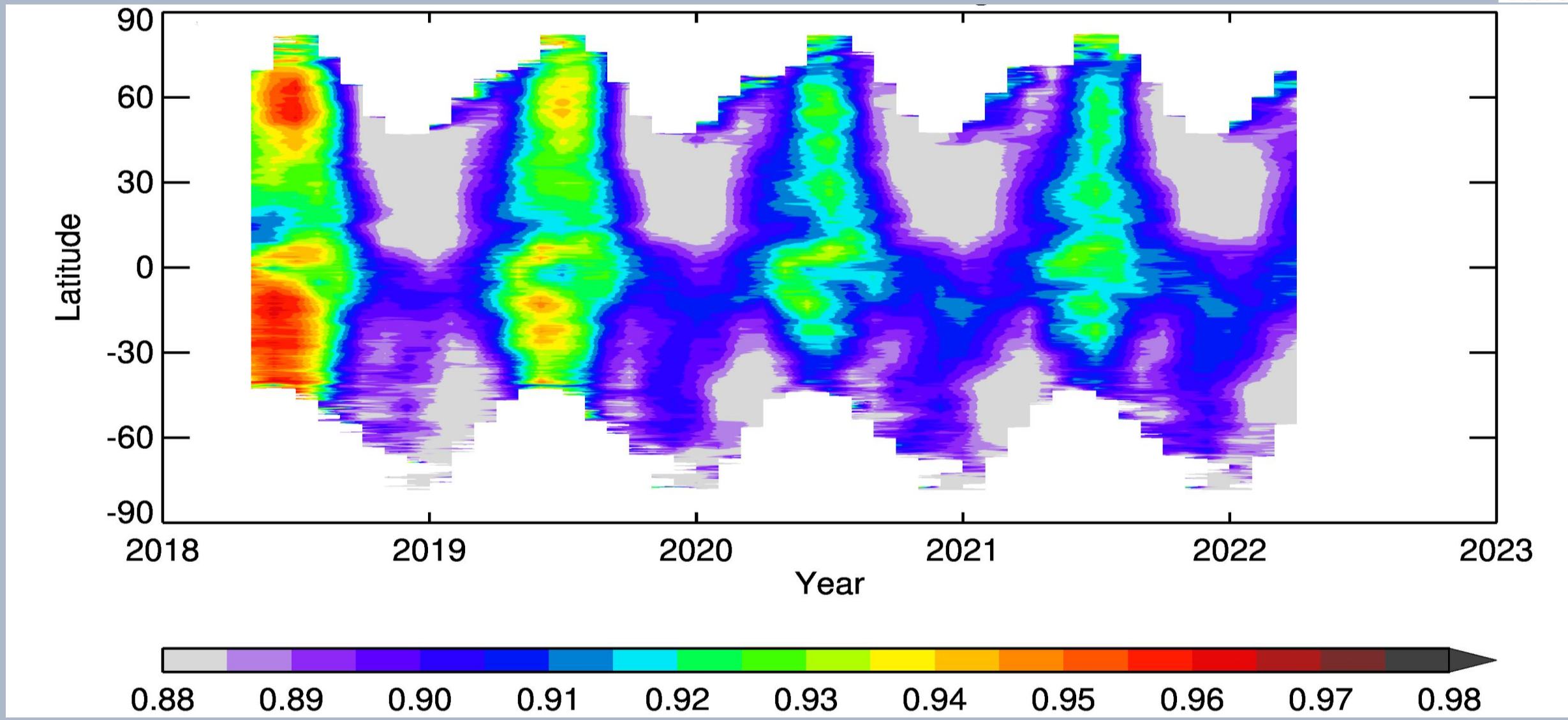
The effect of calibration drift is quite apparent in the UVAI record

Zonally Averaged 4-year TROPOMAER global 388 nm AOD record



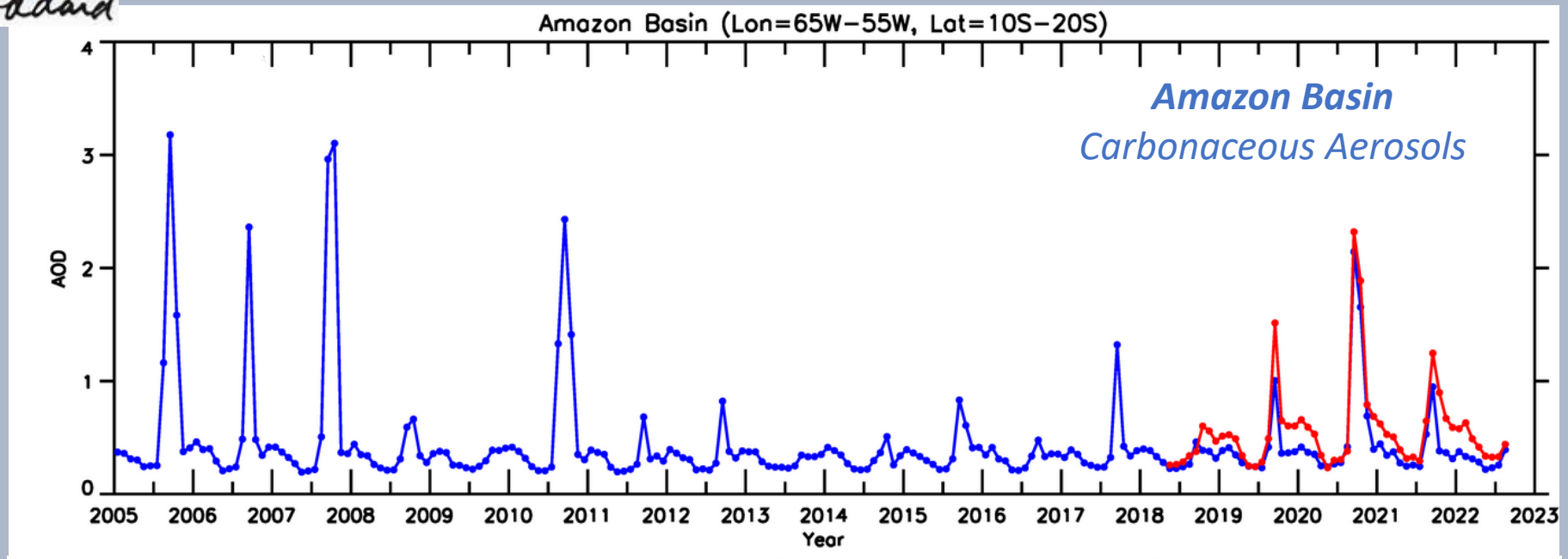
A slight increasing trend can be observed in the global AOD temporal record

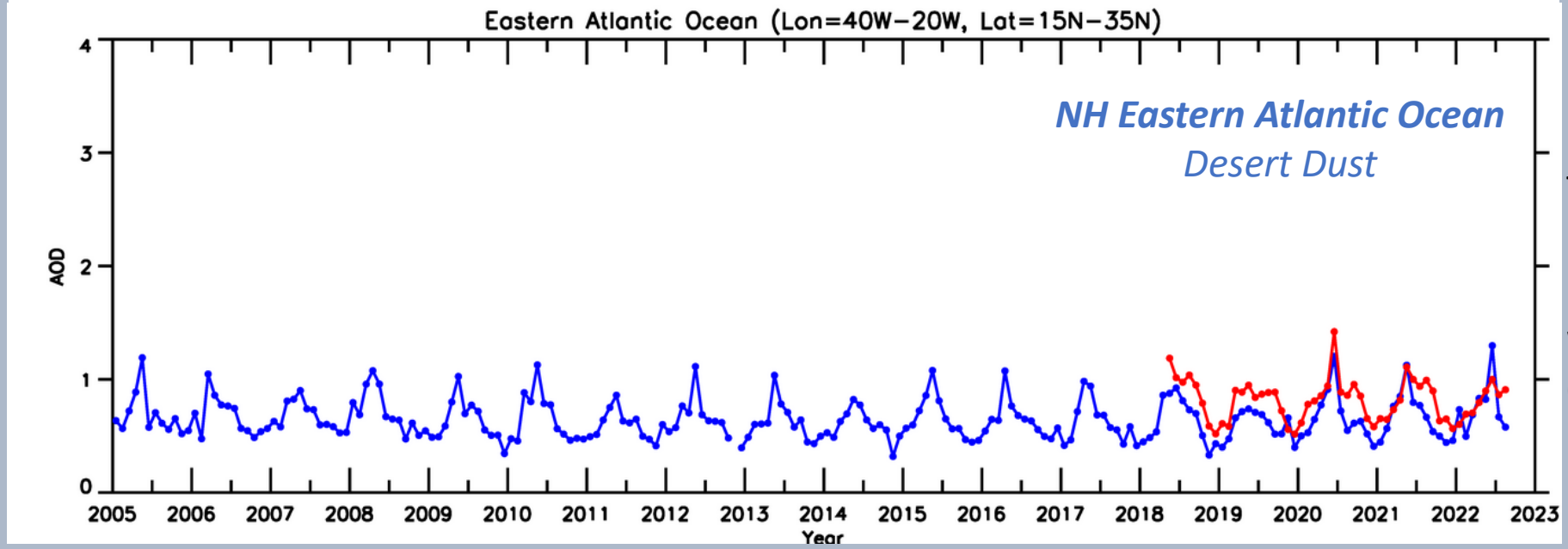
Zonally Averaged 4-year TROPOMAER global 388 nm SSA record



The observed SSA trend is consistent with that of the UVAI parameter

OMI /TROPOMI long-term regional record of 388 nm Aerosol Optical Depth





After a decade of reduced biomass burning, the Amazon region becomes again a prominent source of smoke aerosols.

TROPOMI AOD observations over the last 5-years over the Atlantic Ocean are consistent with the OMI remarkably steady quasi-bidecadal AOD record.

A new generation UV-VIS aerosol retrieval algorithm

Sensors with combined UV-VIS (including O_2B) observing capabilities

Agency	Sensor	Satellite	Spectral range of observations (nm)	Resolution	Period
NASA	EPIC	DSCOVR	318,340, 388, 443,551,680,688,764,780	~ 18 km	2015-Present
EU (Copernicus)	**TROPOMI**	**Sentinel 5 Precursor**	**270-500; 675-775 & 2305-2385 (Hyp.)**	**3.5X5.5 km**	**2018-Present**
NASA-SAO	TEMPO	TBD (GEO)	290-490 & 540-740 (Hyp.)	2.1x4.7	2023 (Sched.)
NASA	OCI	PACE	340-890 nm (5nm steps)	1 km	2024?

TROPOMI is one of several recently deployed sensors with UV-VIS spectral observing capability at moderate spatial resolution, including O2A/B bands, that enables the use of visible observations including aerosol layer height retrieval capability.

Use of UV-VIS Satellite Observations for retrieving aerosol properties

Recent Advances:

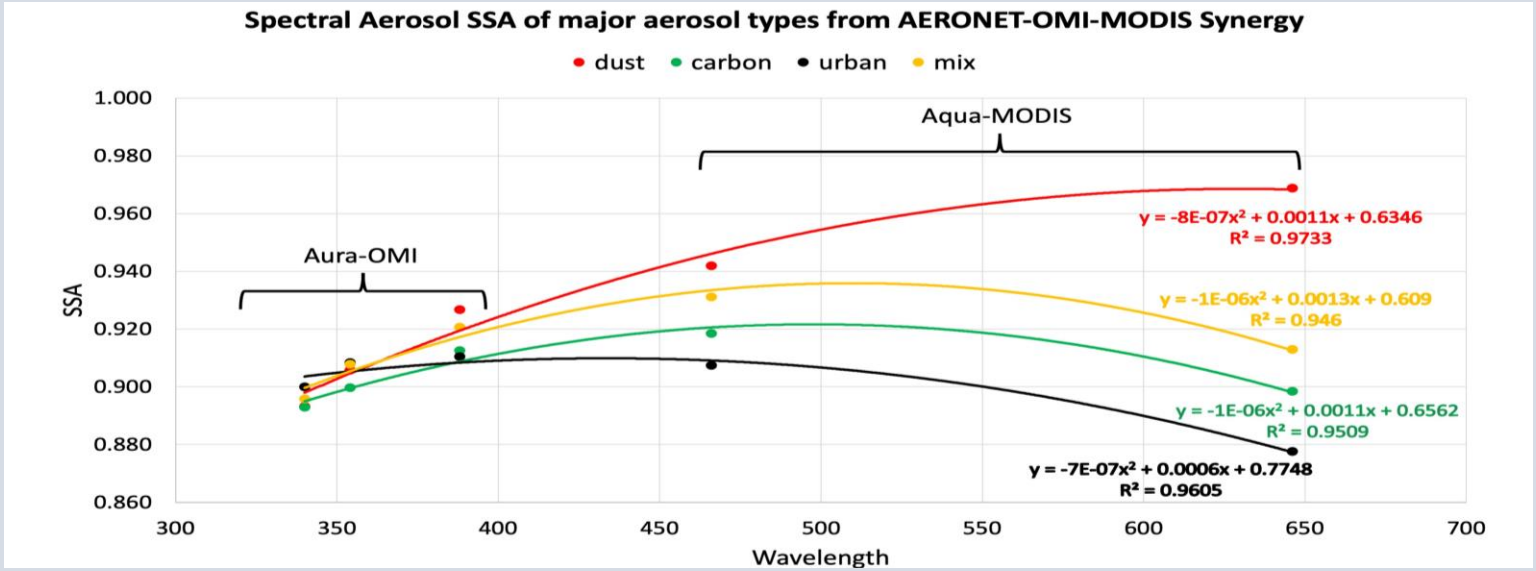
- Climatological data set of UV–visible aerosol absorption using AERONET and OMI–MODIS synergy (Kayetha et al., 2022)

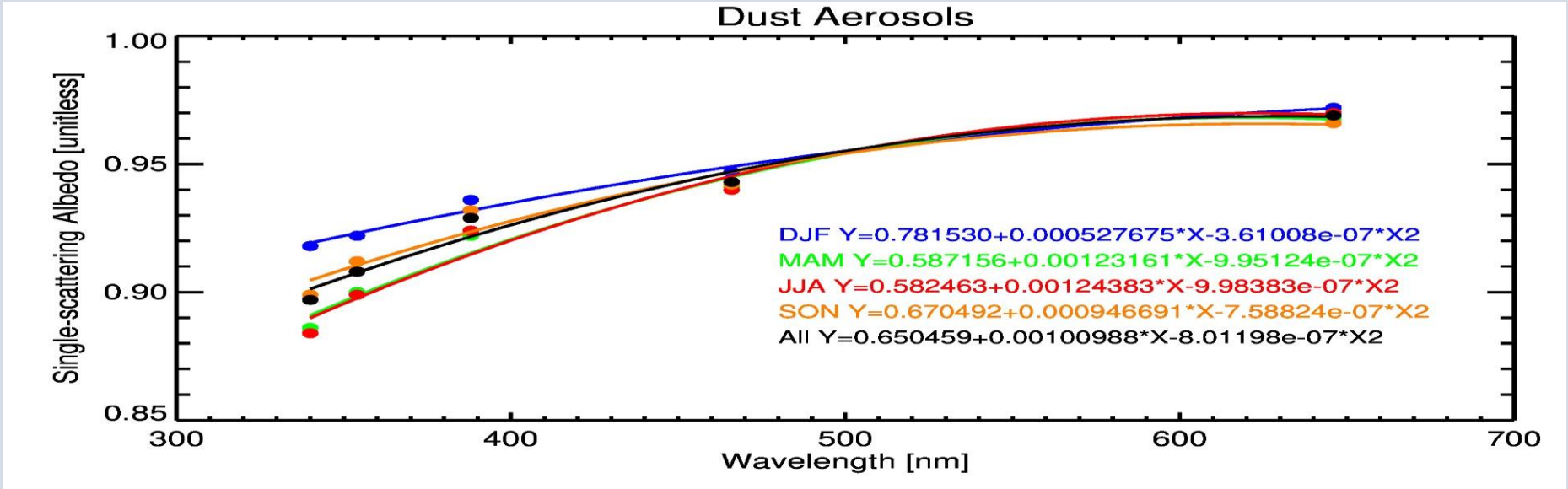
-Availability of 466 nm GLER Surface Albedo Product (Qin et al., 2019; Fasnacht et al., 2019)

-Oxygen-B band observations in the latest generation of hyper-spectral sensors offers, for the first time, the possibility of a complete characterization of the aerosol load in terms of AOD, SSA, and ALH (Xu et al., 2017; Xu et al., 2019)

These advances are currently being integrated into a second-generation algorithm that retrieves aerosol properties at UV and visible wavelengths along with aerosol layer height.

Inferring visible aerosol absorption from UV-retrieved single scattering albedo

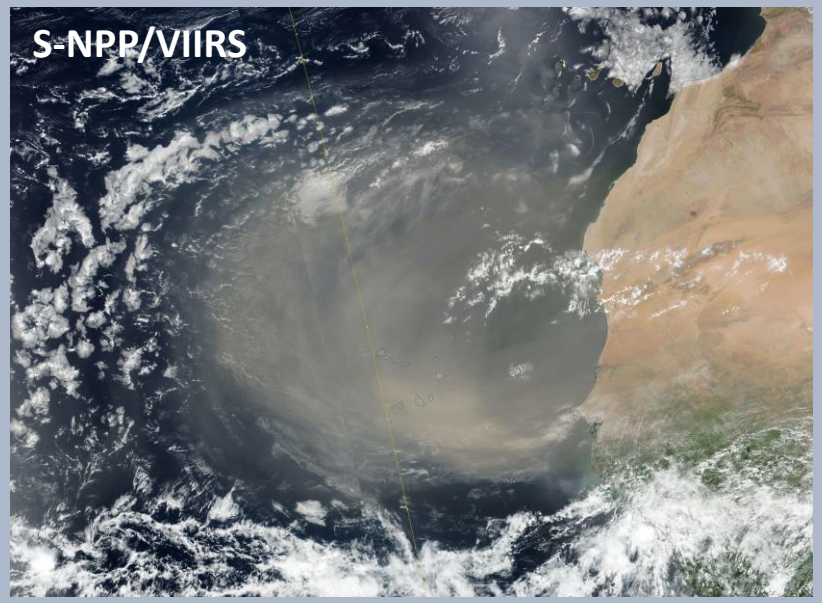


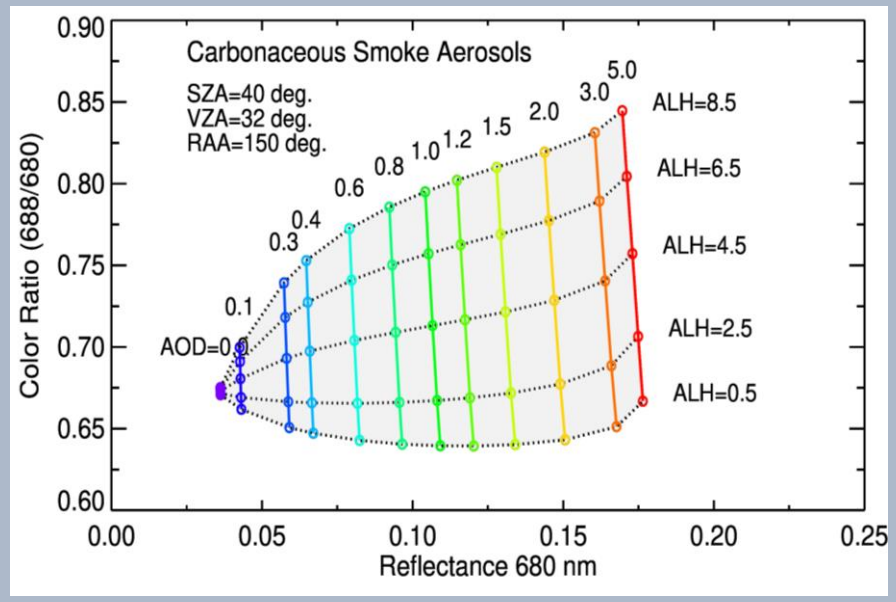


Kayetha et al., 2022

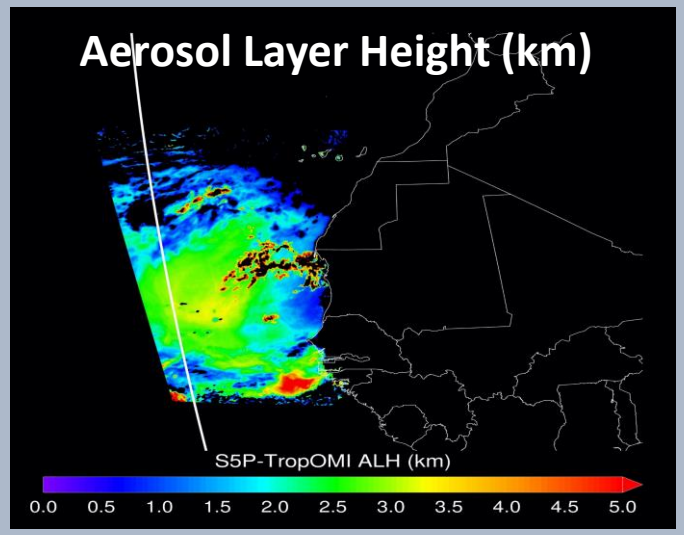
These polynomial representations of spectral single scattering albedo can be used to infer SSA in the visible from retrievals at 388 nm.

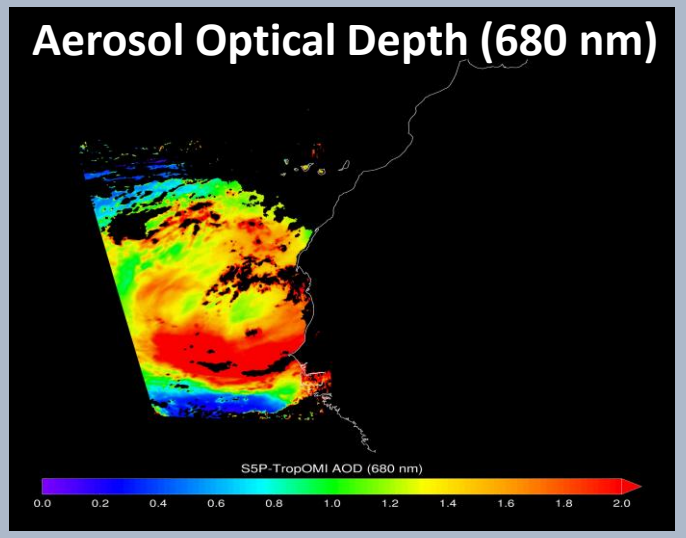
Retrieval of Aerosol Layer Height from TROPOMI Oxygen-B band observations





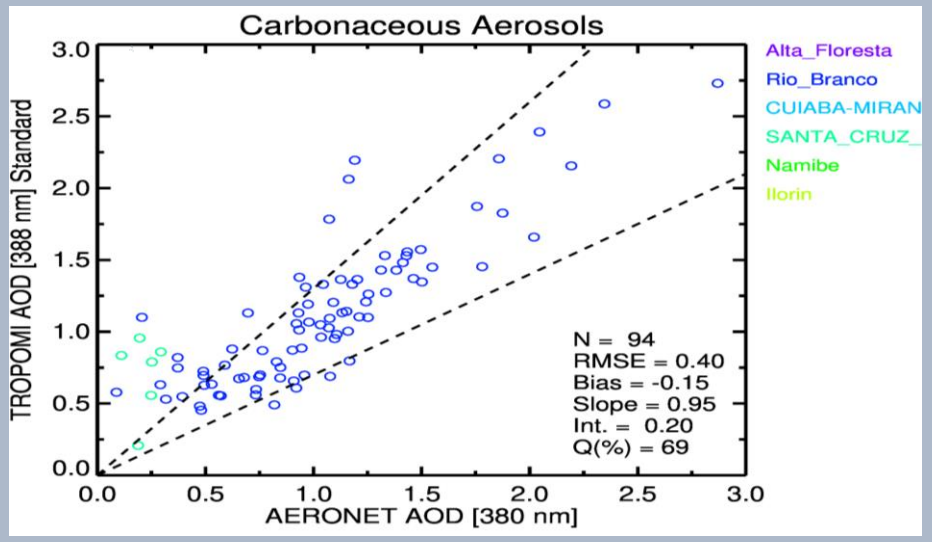
July 31, 2018

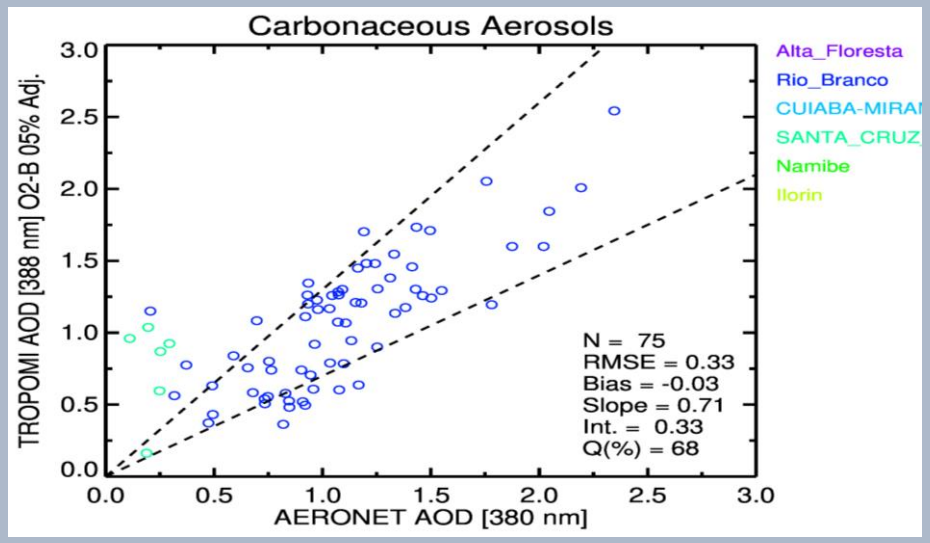


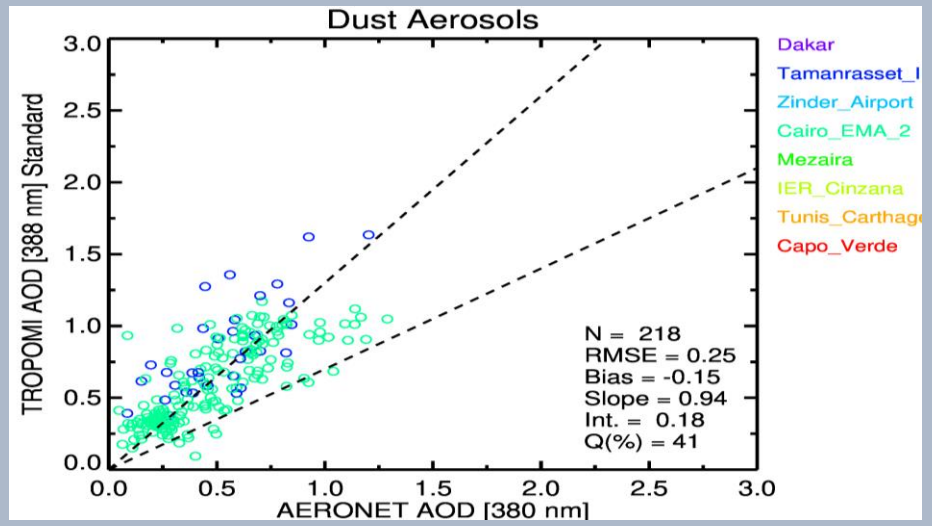


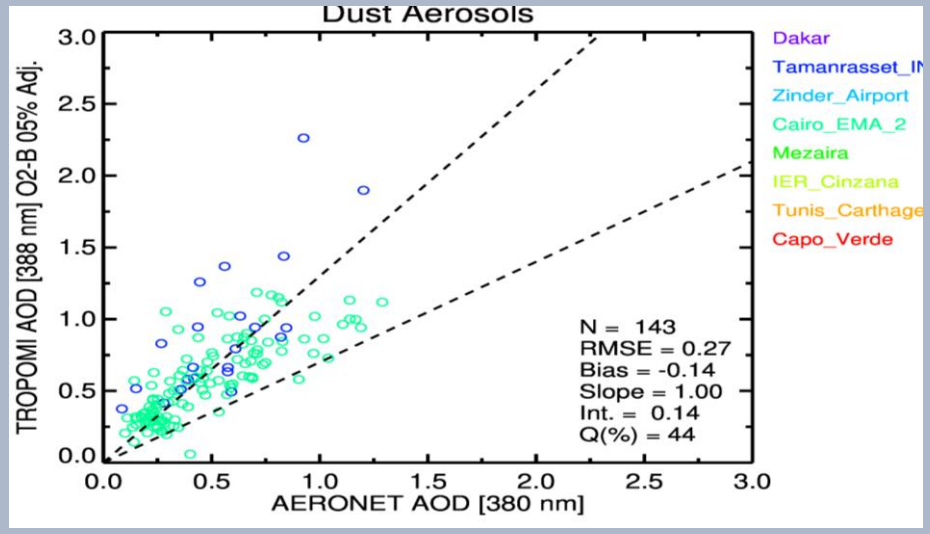
The availability of ALH will reduce the uncertainty of retrieved near UV AOD & SSA

Effect of using O_2B derived ALH on retrieved 380 nm aerosol optical depth









Caveat: This analysis includes TROPOMI 2019 data which is likely affected by sensor's known degradation.

Marginal improvement in statistics when using O_2B ALH.

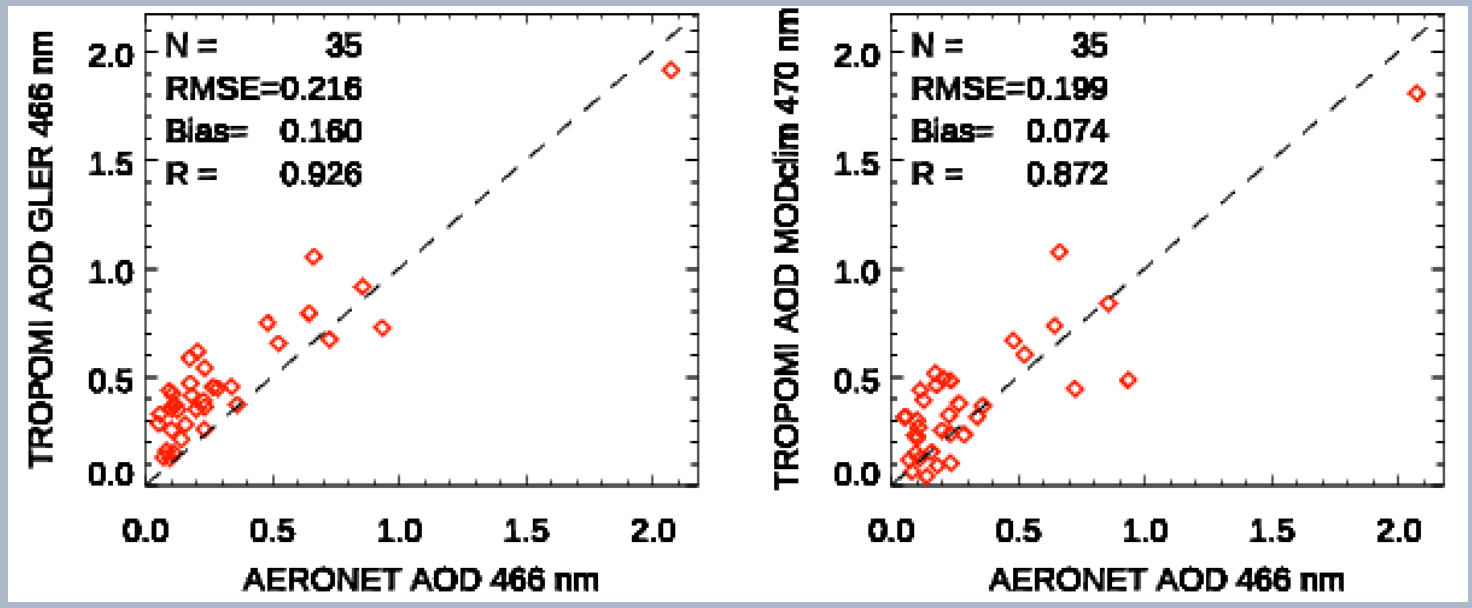
An unexpected result of deriving ALH using the 688/680 ratio is an apparent reduction in cloud contamination.

Evaluation of TROPOMAER Retrieved 440 nm AOD (2018)

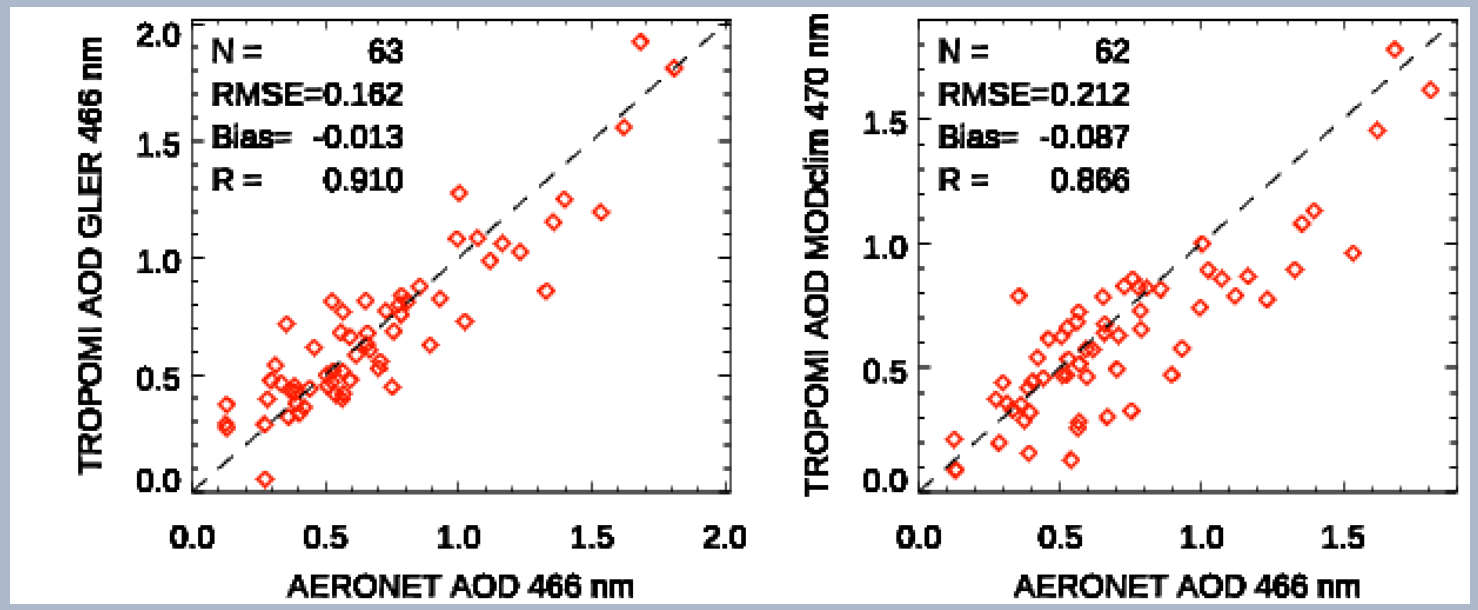
GLER

LER Climatology

Beijing, China (40N, 116E)



Lumbini, Nepal (27N, 83E)



Summary and Conclusions

-OMI Heritage UV aerosol algorithm have been successfully applied to TROPOMI observations (TROPOMAER)

-TROPOMAER results show improvements associated with TROPOMI's finer spatial resolution and availability of dedicated VIIRS-based cloud mask.

-A new TROPOMAER version that derives aerosol layer height and extends AOD retrievals to the visible is currently under development.

-The TROPOMAER version 1 aerosol record is available at

https://disc.gsfc.nasa.gov/TROPOMAER