A ten-year global record of absorbing aerosols above clouds from OMI's near-UV observations

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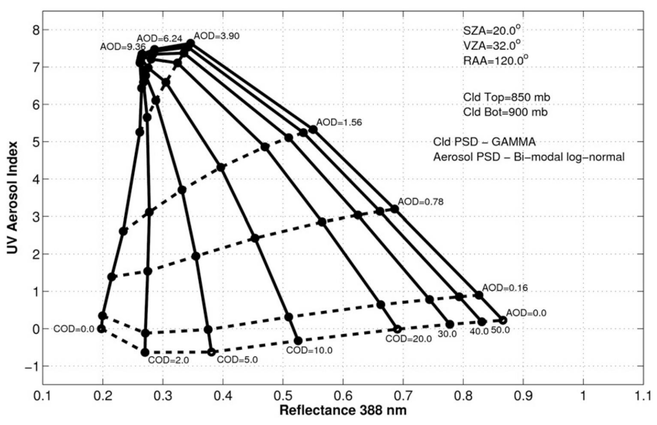
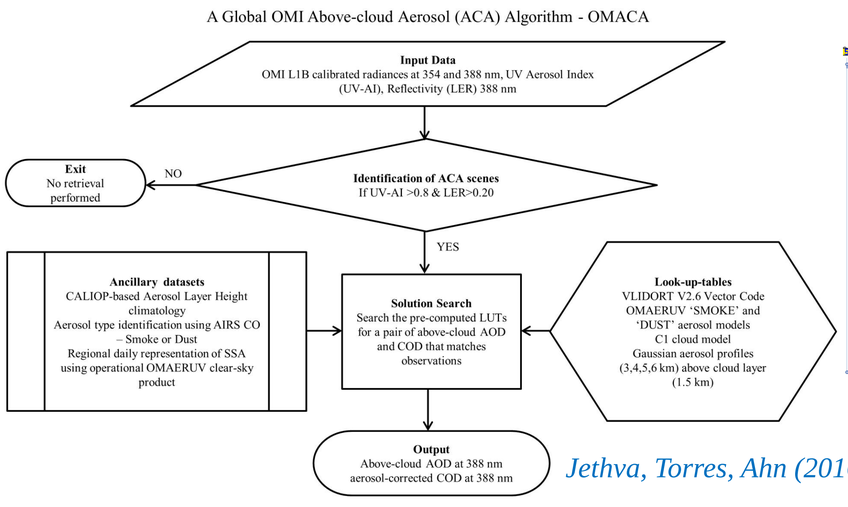
We introduce a novel product of the optical depth of absorbing aerosols above clouds retrieved from OMI's near-UV observations. The presence of absorbing aerosols above cloud reduces the upwelling radiation reflected by cloud and produces a strong 'color ratio' in the near-UV region, which can be unambiguously detected in the OMI measurements. This forms the physical basis of the algorithm, which retrieves the optical depths of aerosols and clouds simultaneously under a prescribed state of atmosphere. Results from a ten-year global record including regional and global climatology, time-series, and trend analysis of the derived parameters, validation activities, and future field campaigns will be presented.

The OMACA (OMI Above-cloud Aerosol) Algorithm

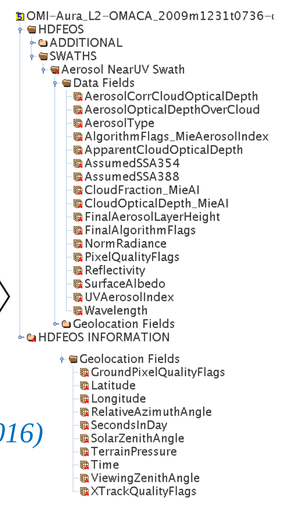
- The presence of absorbing aerosols above cloud decks reduces the amount of upwelling ultraviolet (UV), visible (VIS), and shortwave infrared radiation reaching the top of atmosphere and produces a strong color ratio effect in the spectral reflectance measurements. This is often referred to as "cloud darkening"—an effect caused by the spectral aerosol absorption.
- The CR technique employs reflectance measurements at TOA in two channels, 354 and 388 nm of OMI to retrieve above-cloud AOD and aerosol-corrected cloud optical depth at 388 nm, simultaneously.



Torres, Jethva, PK (2012)



Jethva, Torres, Ahn (2016)

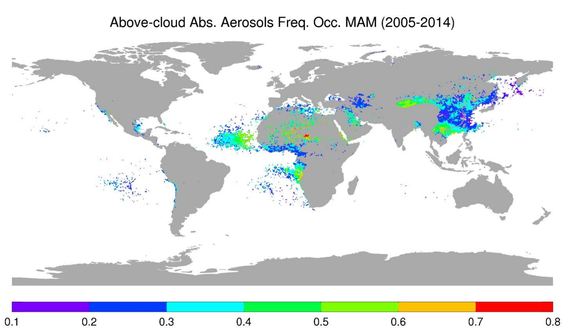


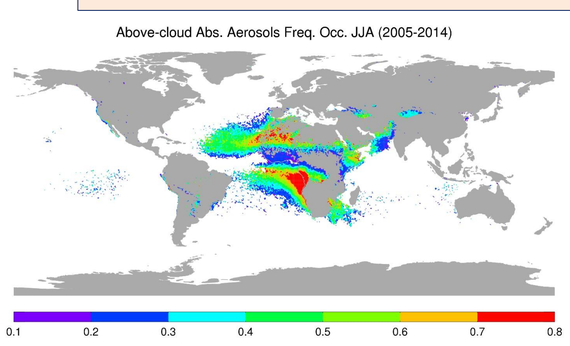
Algorithm Quality Flags	Observation Conditions	Description
0	UV-AI>1.3 & LER388>0.25	Best quality retrieval
1	1.3<UV-AI<4.3 & 0.20<LER388<0.25	Less confidence on the detection of total overcast pixels (Use of high-res sensors is recommended)
2	0.8<UV-AI <1.3 & LER>0.25	Less confidence on the detection of aerosols above cloud
3	Geometry-related artifacts *Only applies to AlgQF 0, 1, and 2*	Pixels with following geometry are flagged with QF=3 Solar Zenith Angle> 55 & Scattering Angle <100 & UV-AI<2 Solar Zenith Angle> 60 & Scattering Angle <130 & UV-AI<2 Viewing Zenith Angle> 55 & Scattering Angle <100 & UV-AI<2

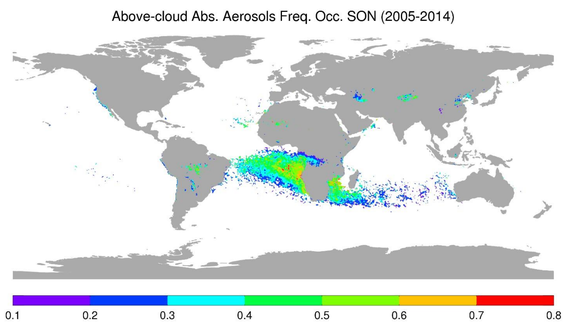
Seasonal Cloudy-sky Frequency of Occurrence of Above-cloud Absorbing Aerosols

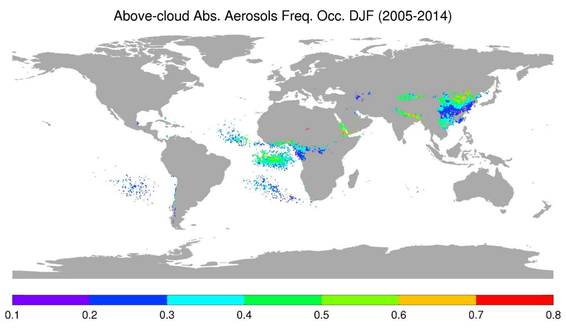
- Two-parameter approach to identify the presence of absorbing aerosols above cloud: Lambertian Equivalent Reflectivity or LER can distinguish clear-sky from cloud-sky and UV Aerosol is an excellent indicator of the presence of absorbing and/or elevated aerosol layers.

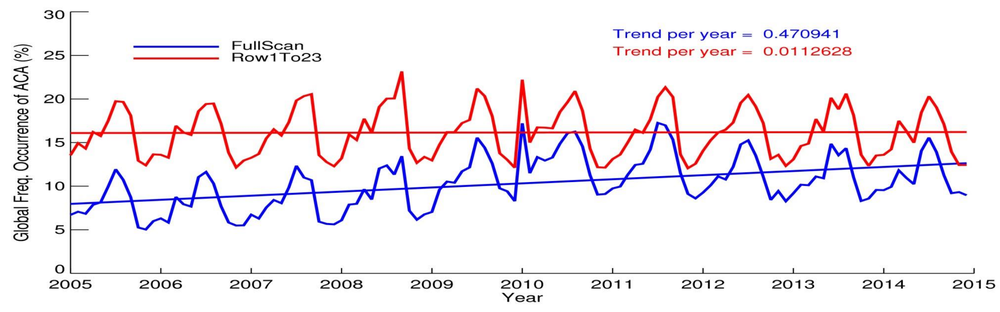
$$Freq.Occ.ACA = \frac{Number\ of\ days\ with\ UV\text{-}AI\ (Mie) > 1.3\ \&\ LER\ > 0.25}{Number\ of\ days\ with\ LER\ > 0.25}$$



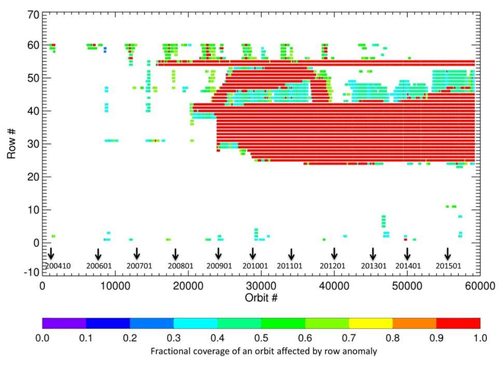


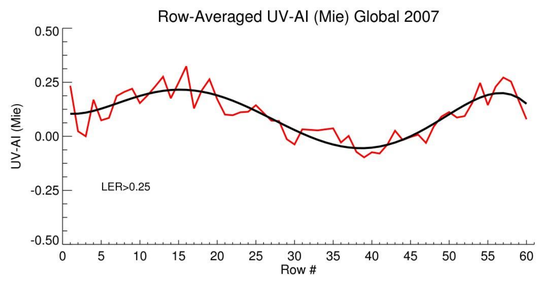




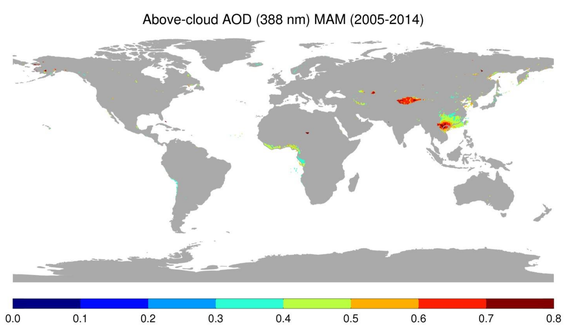


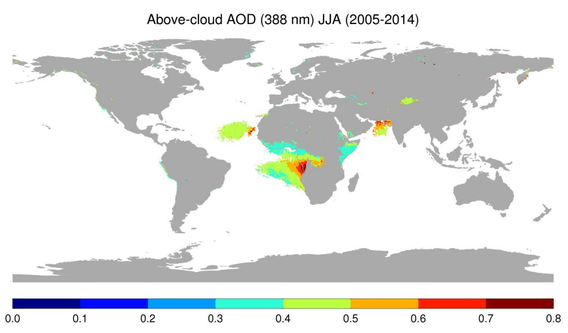
No significant trend in Freq. Occ. ACA when only first 23 rows of OMI sensors are used.

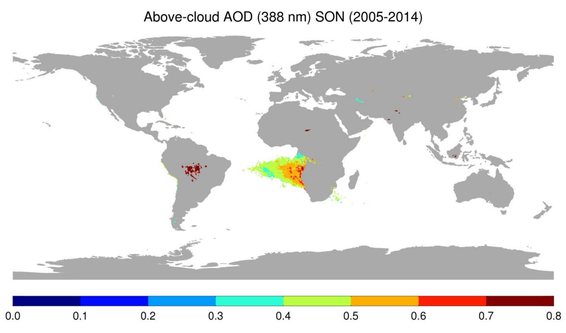


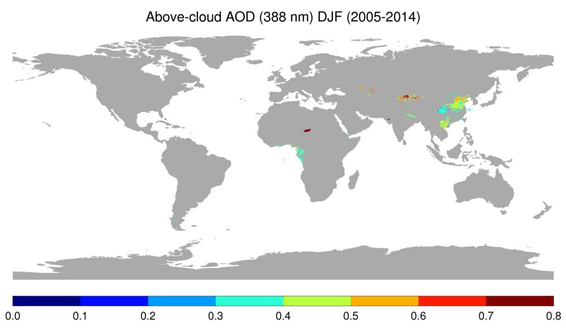


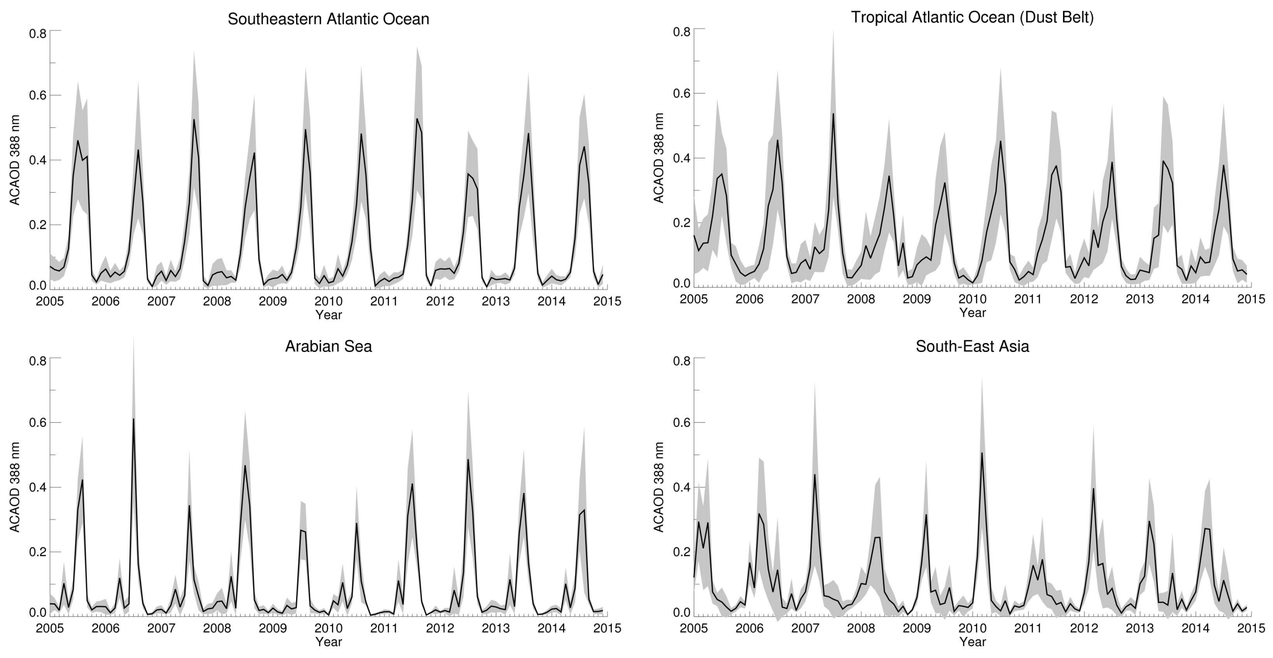
Seasonal Climatology of Above-cloud AOD (388 nm)











Possible Sources of Uncertainty

***SSA at 354 and 388*:**
Regional daily representation using cloud-free standard OMAERUV SSA

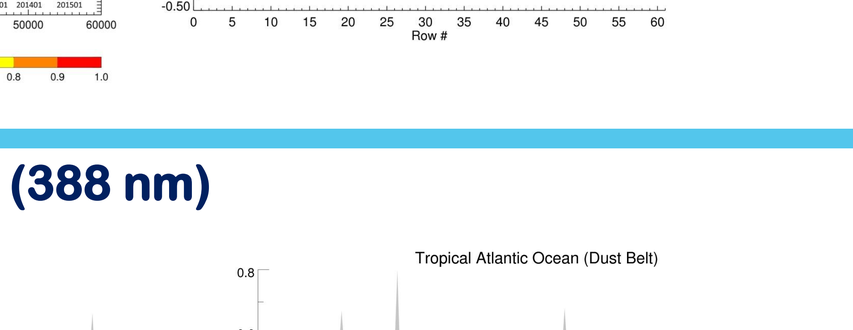
***Aerosol Layer Height*:**
Currently based on the 30-month OMI-CALIOP joint observations

***Aerosol size distribution*:**
Standard OMAERUV aerosol models

***Cloud droplet distribution*:** C1 cloud model with modified Gamma distribution

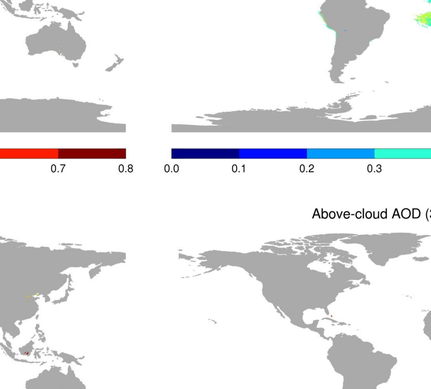
TABLE 2. Percentage error in retrieved AOD and COD associated with the uncertainty of the prescribed values of Z, SSA, and AAE.

	AOD = 0.5, COD = 5		AOD = 0.5, COD = 10	
	AOD	COD	AOD	COD
Z_{und} (2 km)	40	4	26	9
Z_{ovr} (2 km)	−19	−1	−12	−3
SSA_{und} (0.03)	−25	4	−23	1
SSA_{ovr} (0.03)	48	−5	43	−1
AAE_{und} (0.4)	23	3	19	14
AAE_{ovr} (0.4)	−14	−1	−65	−5



Preliminary Analysis of Radiative Effects of Above-cloud Aerosols

CERES SW fluxes on OMI footprint
Gupta et al., [2016] ACPD
Cloud-top fluxes parameterized using COD retrievals and CERES TOA SW fluxes for scenes with UV-AI<0.5



References

- Torres, O., H. Jethva, and P. K. Bhartia (2012), Retrieval of aerosol optical depth above clouds from OMI observations: Sensitivity analysis and case studies, J. Atmos. Sci., 69, 1037–1053, doi:10.1175/JAS-D-11-0130.1.
- Hiren Jethva, Omar Torres and Changwoo Ahn, " A ten-year global record of absorbing aerosols above clouds from OMI's near-UV observations ", Proc. SPIE 9876, Remote Sensing of the Atmosphere, Clouds, and Precipitation VI, 98761A (May 5, 2016); doi:10.1117/12.2225765; http://dx.doi.org/10.1117/12.2225765