Global DAOD climatology derived from CALIOP and MODIS aerosol retrievals on decadal time scales: regional and interannual variability

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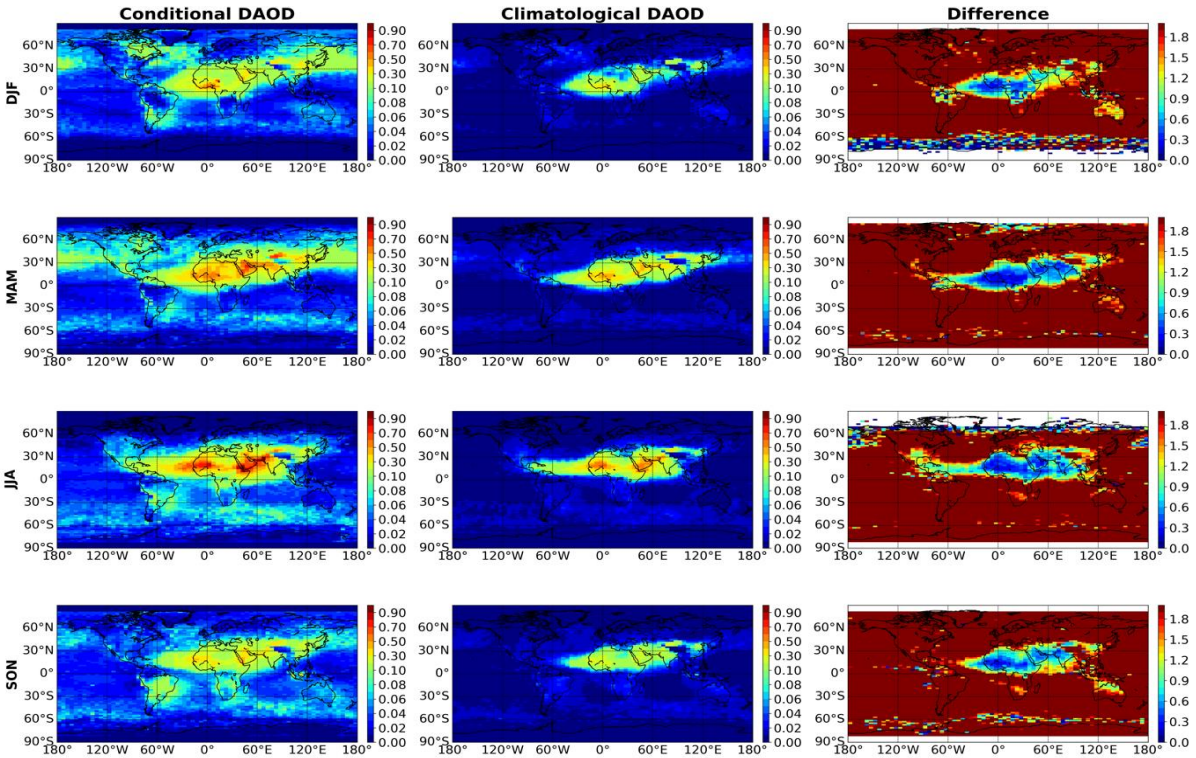
Sensors	Retrieve Scope	Relevant variables used to derive DAOD	References
MODIS	Ocean	AOD, fine mode fraction	Kaufman et al.2005 Yu et al.2009,2020
MODIS	Land	Spectral SSA, Angstrom exponent	Ginoux et al. 2010
CALIOP	Globe	Profiles of backscatter and depolarization ratio	Yu et al.2015a

Multi-wavelength observations from MODIS contains **aerosol size** information such as fine mode fraction and Angstrom wavelength exponent in the observed reflectance spectral pattern, which was used to separate dust aerosols from others in MODIS dust retrieval over ocean and land.

CALIOP uses observations of backscatter coefficient which contains dust **shape information** to separate dust aerosols from others.



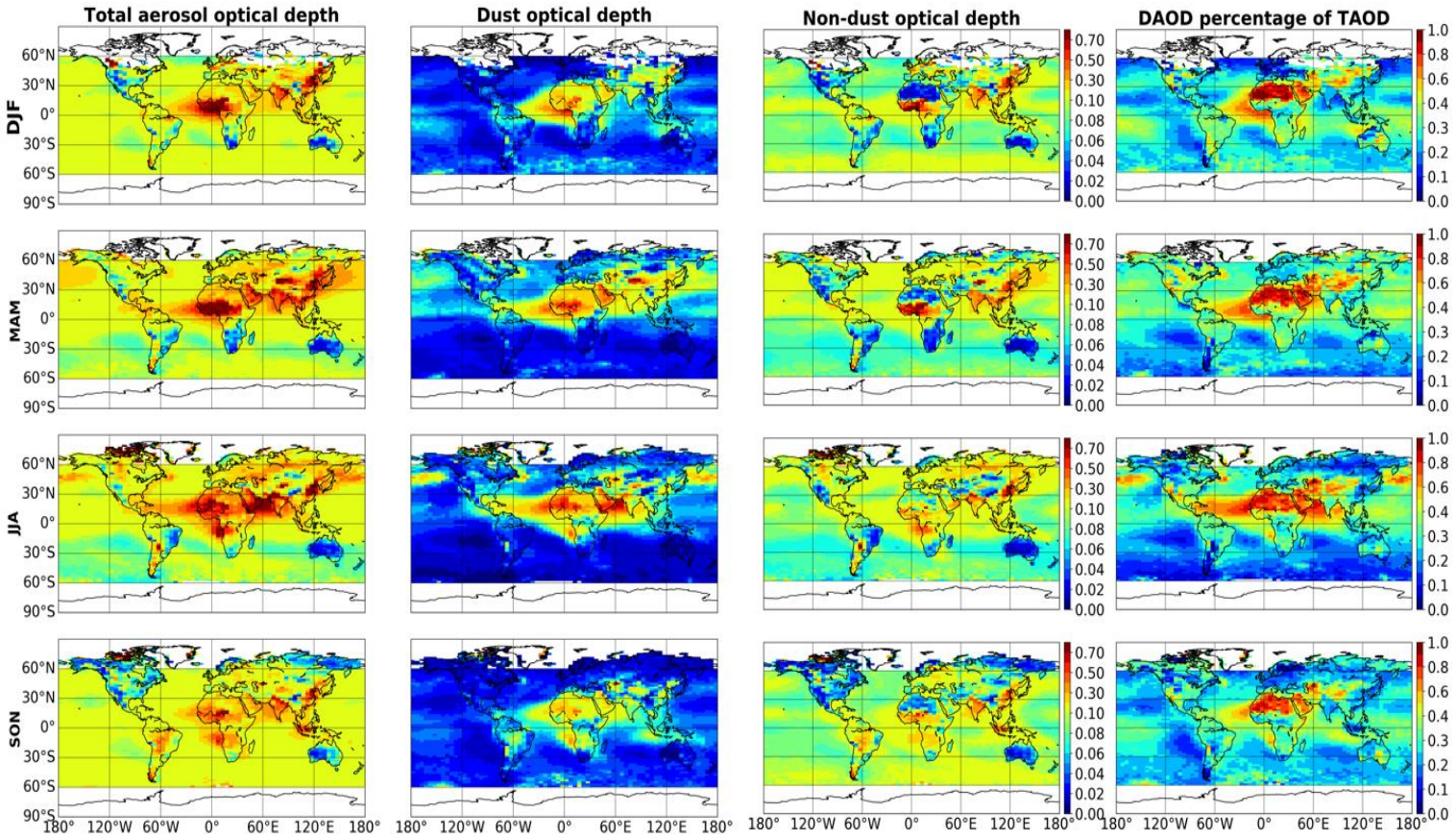
CALIOP dust climatology(2nd column) show high DAOD in 'dust belt' region, but DAOD value is rather low in some other regions known to be dusty in certain seasons. Those regions do stand out in MODIS DAOD plots (shown in slide 2).

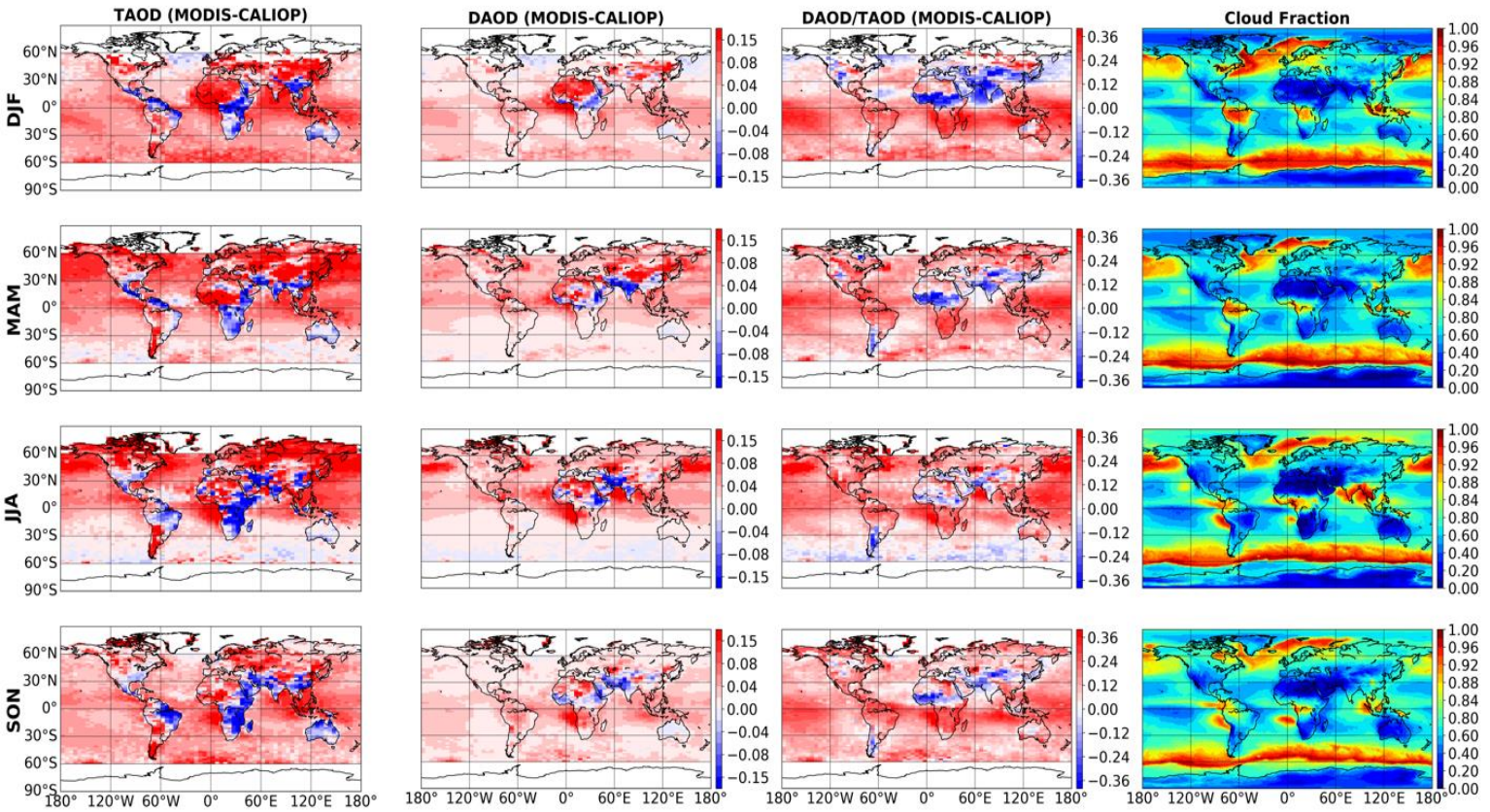
Climatological DAOD contains both dust frequency and dust intensity information, while conditional DAOD diminishes impacts from dust frequency by excluding dust-free cases in the average. It is mainly related to dust intensity.

The low difference between conditional and climatological DAOD indicates that dust activities over there are persistent.

The large difference in other regions suggest that dust activities in those regions are highly episodic and occur in relatively small scale.

. **DAOD climatology derived from MODIS dust retrieval**

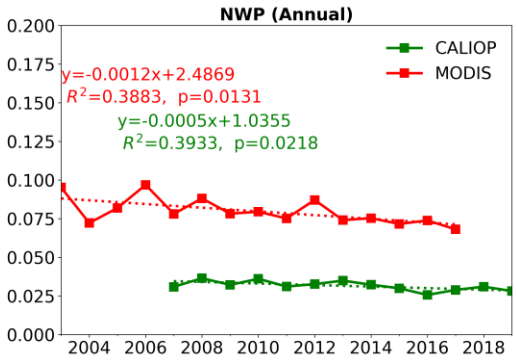


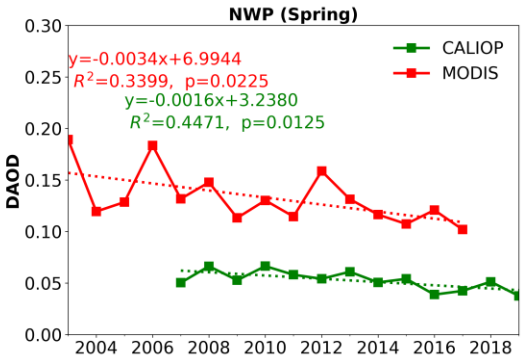


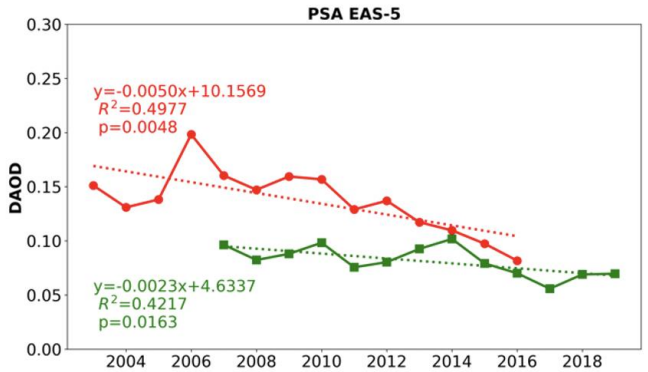
The difference between MODIS and CALIOP in 10-year (2007-2016) seasonal mean TAOD (1st column), DAOD (2nd column), the percentage of DAOD in TAOD (3rd column) and 10-year seasonal mean cloud fraction from MODIS L3 product (4th column).

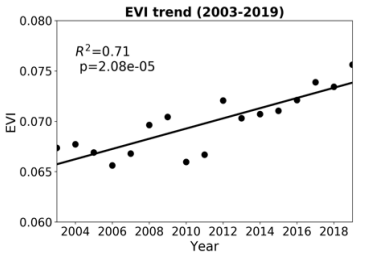
MODIS DAOD is generally larger than CALIOP DAOD due to :

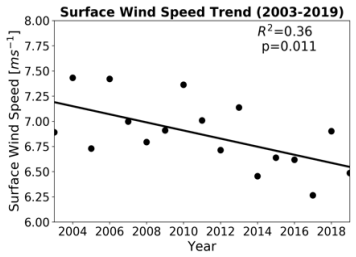
1. Uncertainty associated with TAOD retrieval.
2. Different dust detection and separation. CALIOP is based on dust shape, MODIS is based on dust size.

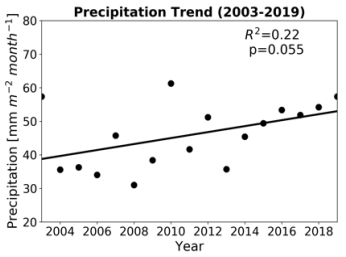


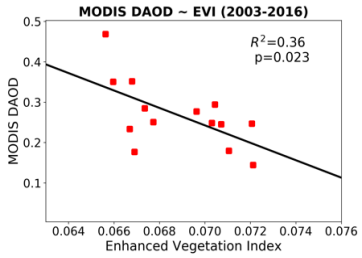


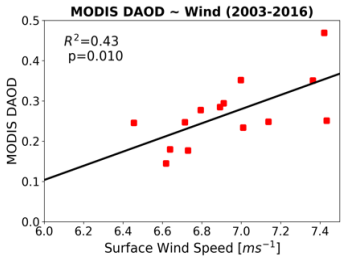


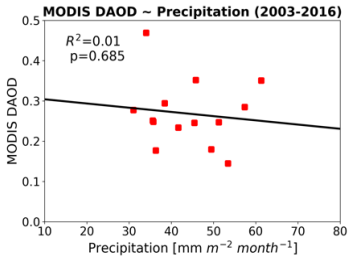


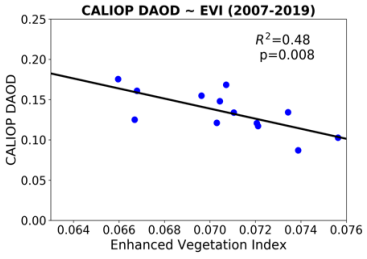


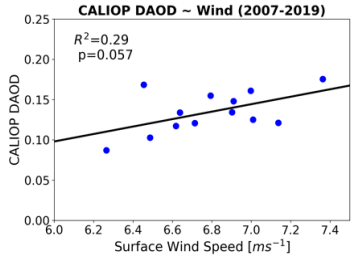


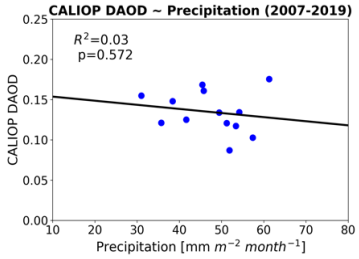












The interannual variability of DAOD over dust-laden regions show no clear trend except the NWP region with a decreasing trend of -1.5% yr^{-1} based on MODIS and CALIOP with $p < 0.05$.

This trend is mainly attributed to the decreasing trend in spring with a rate of 3.66%yr^{-1} based on MODIS and 2.82%yr^{-1} based on CALIOP.

Further investigation of DAOD trend in six dust source areas in Eastern Asian where NWP dust aerosols come from shows that there is an obvious decreasing trend in DAOD over Southern Gobi Desert based on both CALIOP and MODIS dust retrievals .

The decreasing trend of DAOD is correlated significantly with the vegetation index and surface wind speed in the area, whereas, there is almost no correlation with the precipitation .