Global Dust Optical Depth Climatology Derived from CALIOP And MODIS Aerosol Retrievals on Decadal Time Scales: Regional and Interannual Variability

MODIS-VIIRS Atmosphere Discipline Meeting

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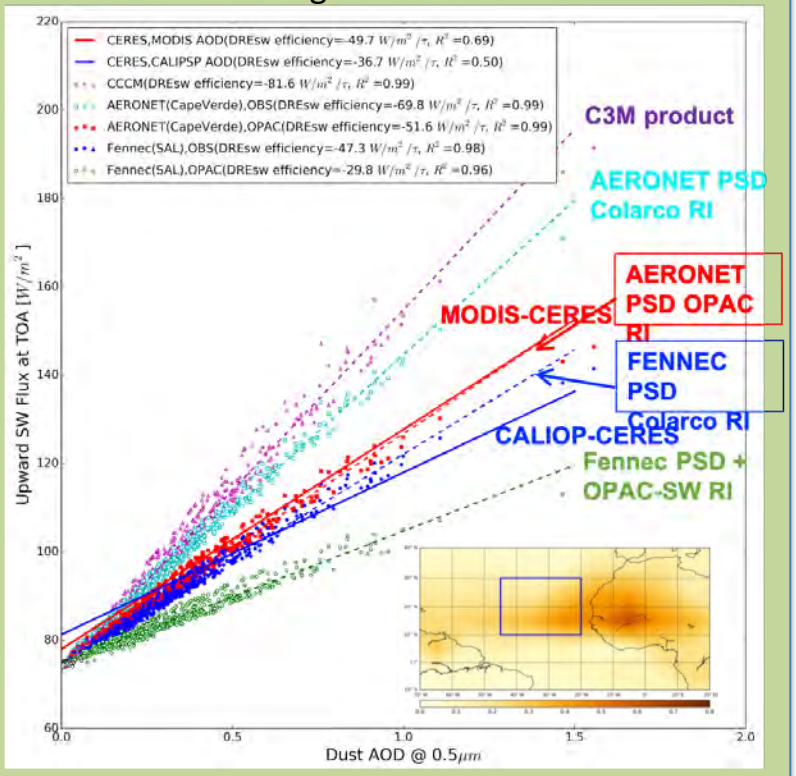
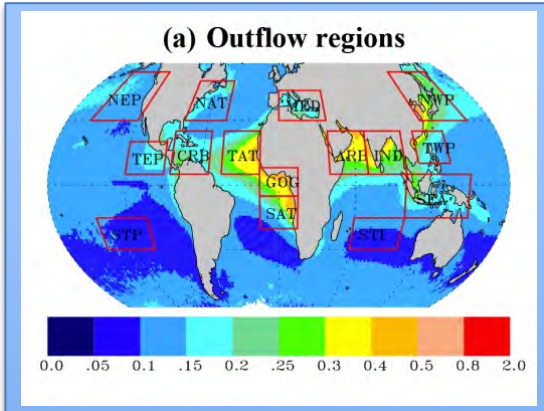
UMBC

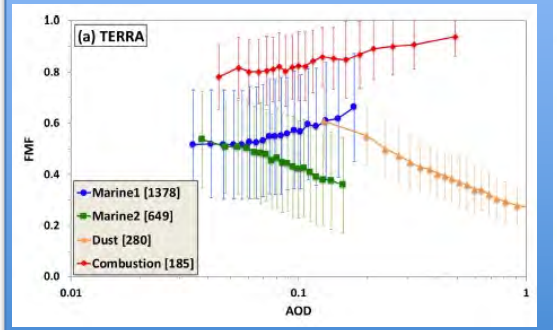
Image credit (NASA GSFC)

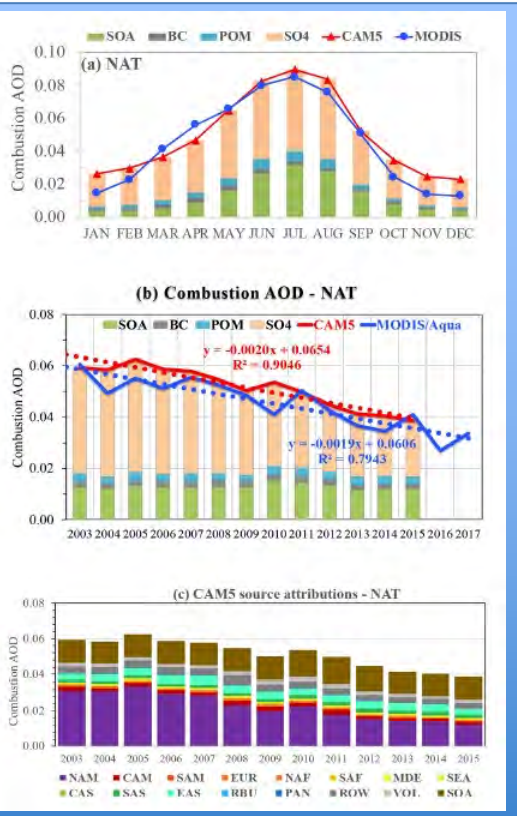
Background and Motivation

Song et al. 2018









Yu et al. 2020

Long-term satellite-based **dust** AOD observations are needed for studying the DRE, the **seasonal/interannual variabilities**, and climatological trend of dust aerosols

Methodology and Objectives

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; Pu and Ginoux, 2017
CALIOP	Globe	Profiles of backscatter and depolarization ratio	**Yu et al. 2015a**

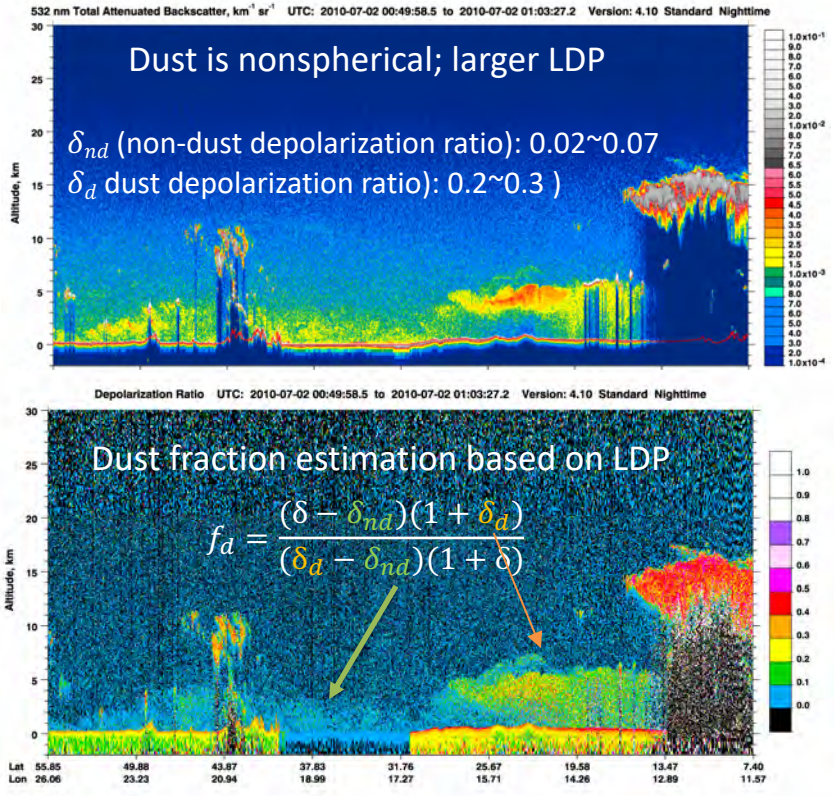
We produced a decadal (2007-2019) **climatological data** of DAOD and dust extinction vertical profile on a **global scale** based on CALIOP observations. (Publicly available)

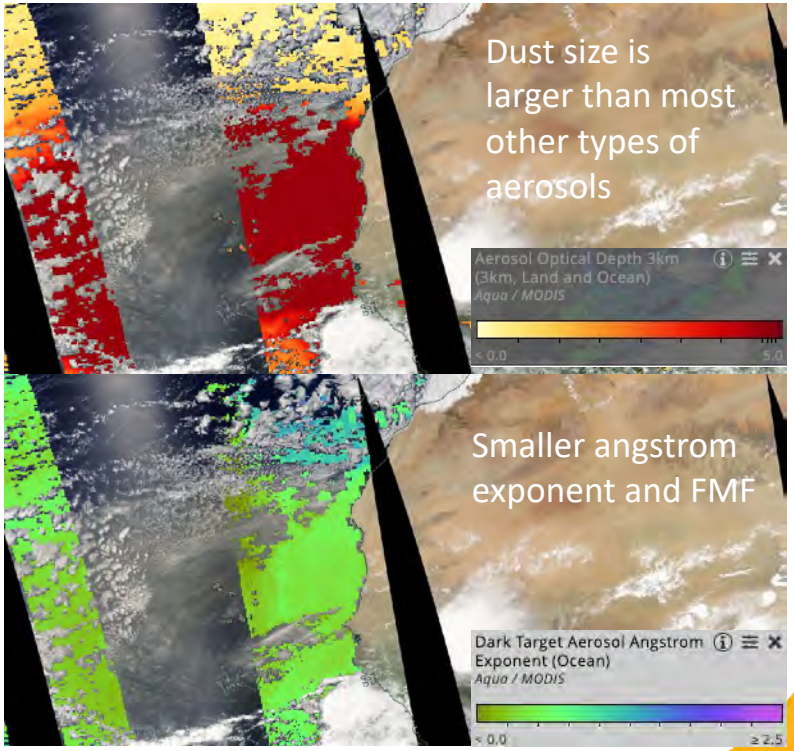
Scientific Questions:

- How are **shape-based CALIOP and size-based MODIS DAOD** retrievals different from each other?
- What are the potential reasons for the differences?
- What are the seasonal and interannual (**decadal trends**) **of DAOD** based on the two DAOD retrievals?

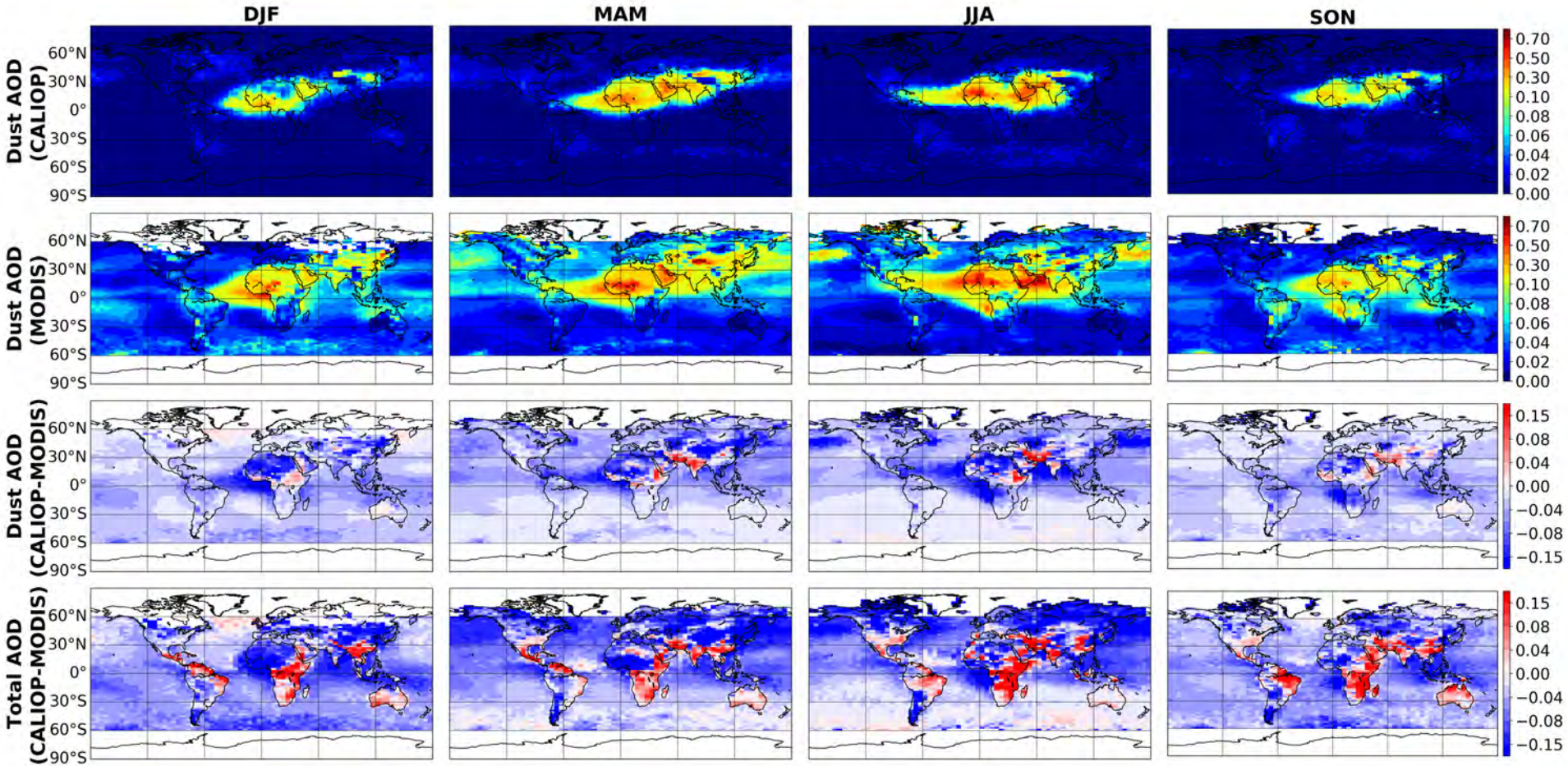
Dust Detection and AOD Partition

CALIOP (Shape) v. MODIS (Size)

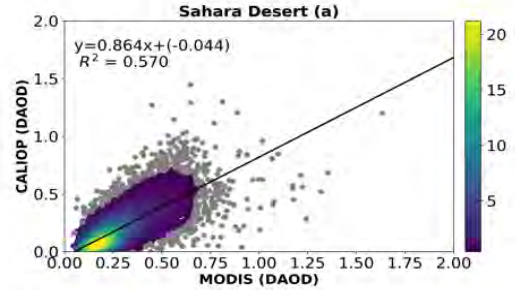


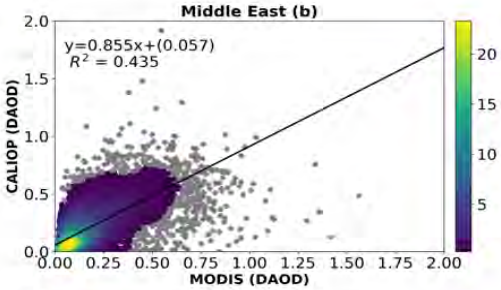


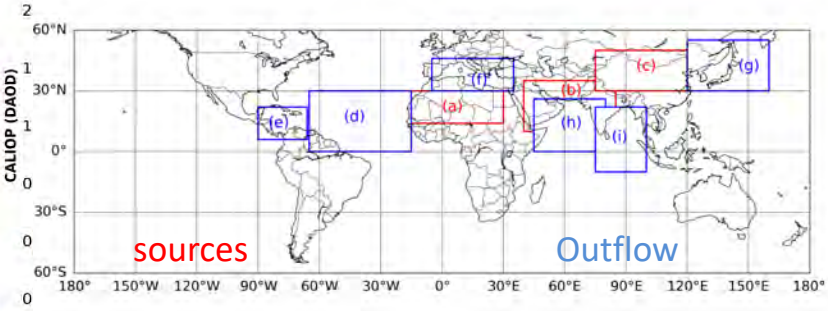
DAOD comparison

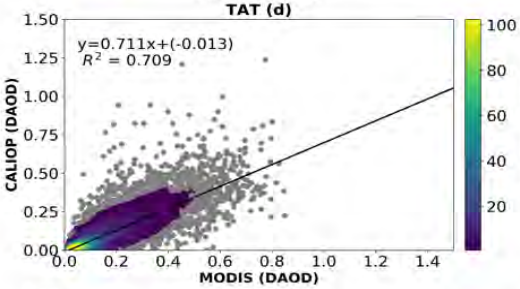


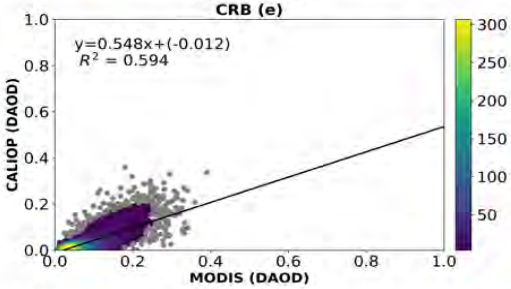
DAOD comparison

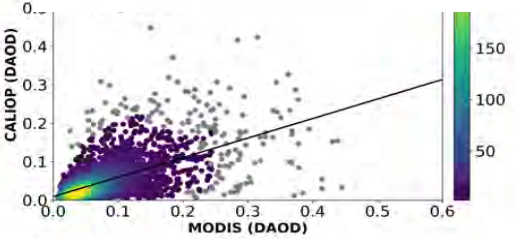


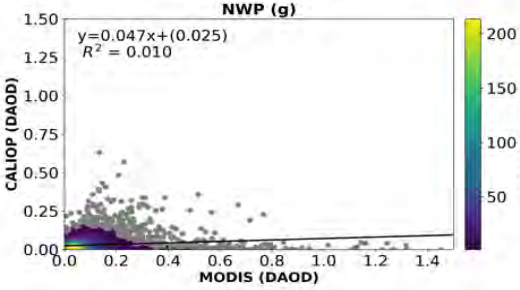


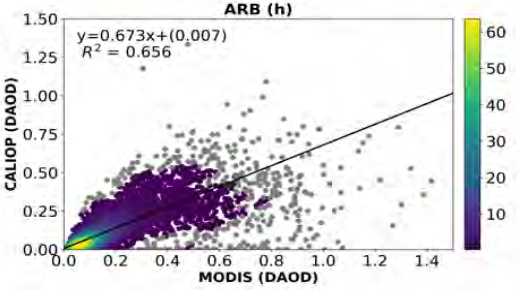


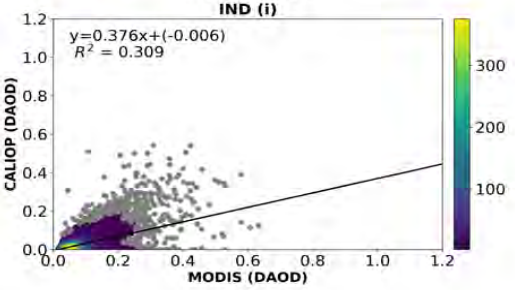




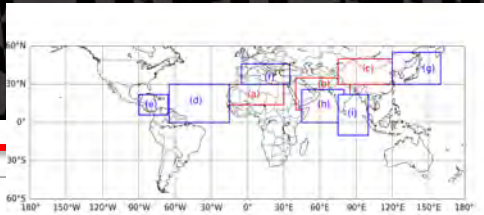


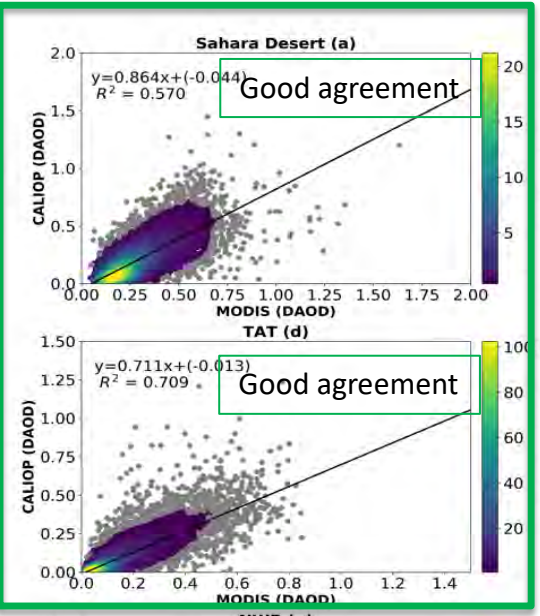


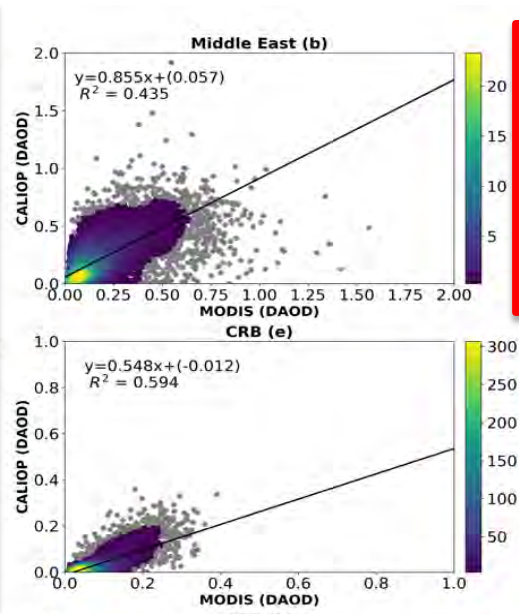


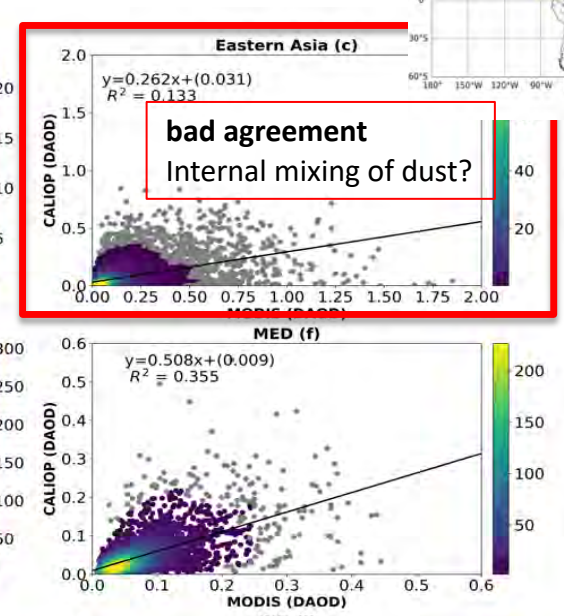


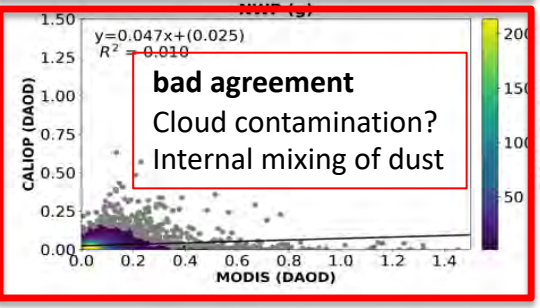
DAOD comparison

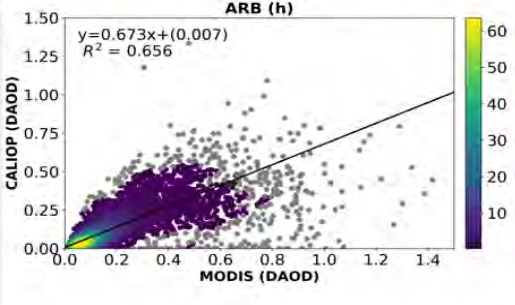


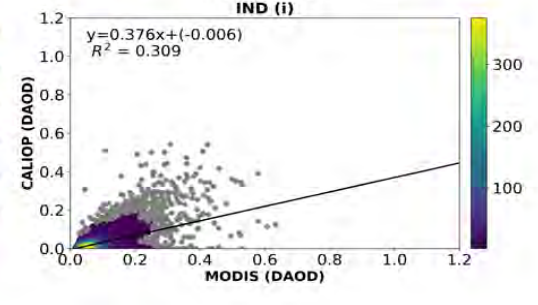










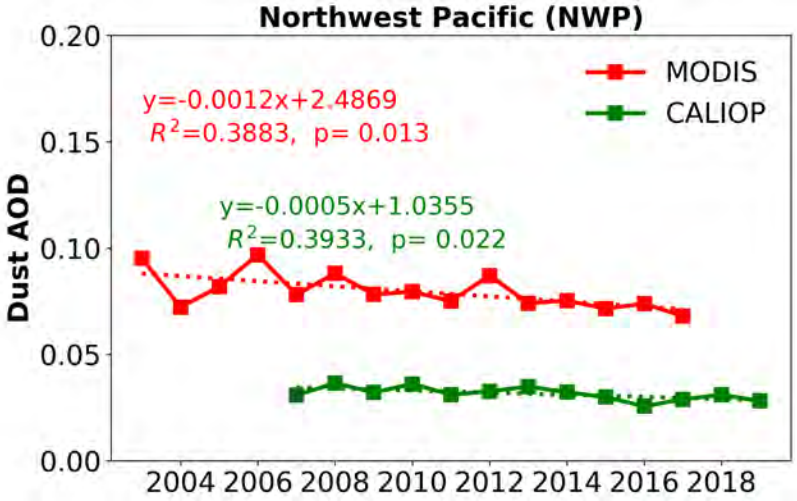


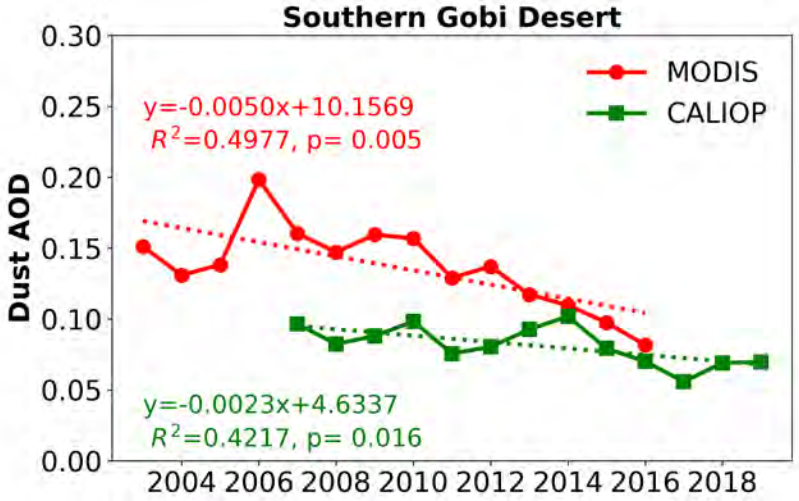
Decadal DAOD Trend

None of the 9 dust-laden regions shows a clear DAOD trend except for the NWP region. In **NWP**, both MODIS- and CALIOP-based DAOD show a decreasing trend of $-1.50\%\ yr^{-1}$ and $-1.58\%\ yr^{-1}$, respectively.

Further analysis shows that this **DAOD decreasing trend in NWP** is mainly attributed to the decrease of DAOD in **spring** season at a rate of $-2.6\%\ yr^{-1}$ based on MODIS and $-3.0\%\ yr^{-1}$ based on CALIOP.

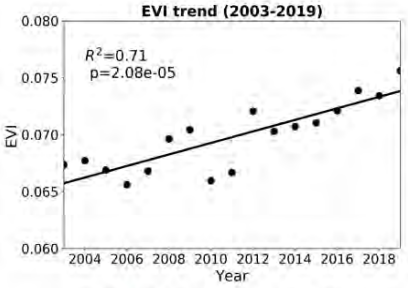
We found an obvious declining trend of DAOD in EAS-5 (**Southern Gobi Desert**) at a rate of $-3.7\%\ yr^{-1}$ based on MODIS and $-2.8\%\ yr^{-1}$ based on CALIOP.

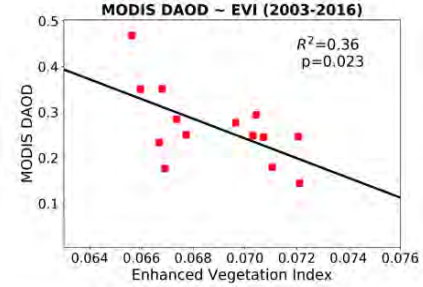


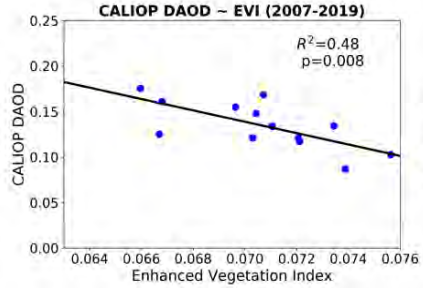


Decadal DAOD Trend

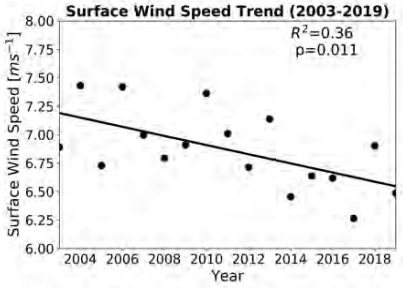
EVI

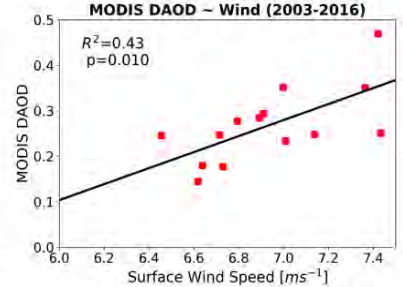


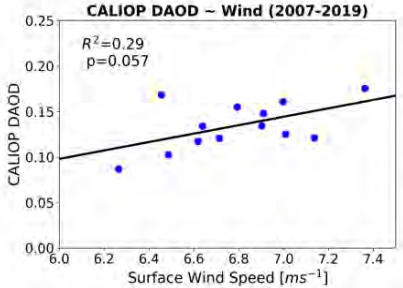




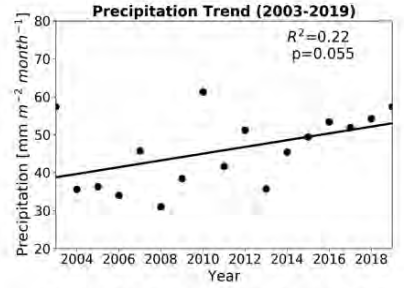
Wind

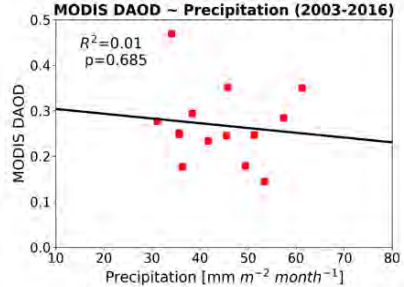


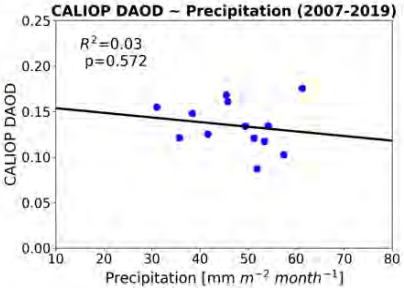


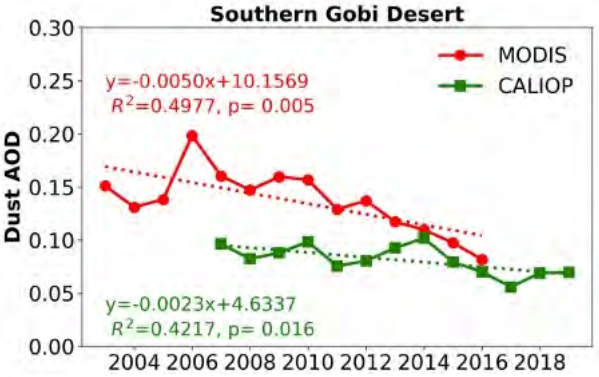


Precip.









Summary

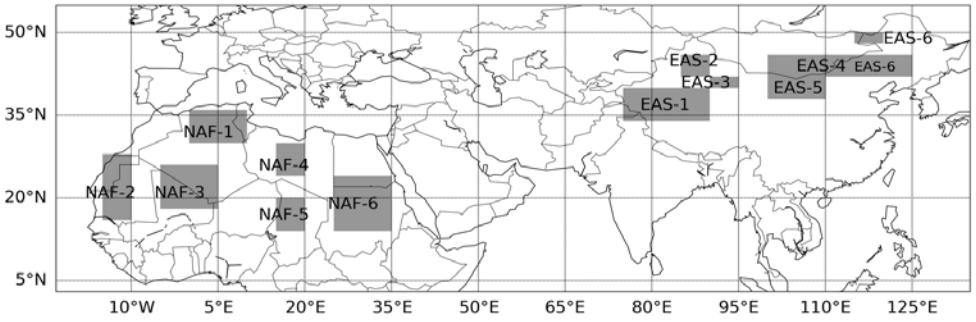
- We produced a climatological data of Dust AOD and extinction profile based on CALIOP observation on a global scale.
- CALIOP and MODIS are based on different characteristics of dust aerosols to separate dust aerosol from others, and then retrieve DAOD. **CALIOP is shape-based; MODIS is size-based**.
- DAOD values retrieved from two sensors are different. It has two major uncertainty sources: 1) uncertainties in TAOD retrievals 2) different dust partition methods based on different dust characteristics
- The correlation of DAOD retrieved from CALIOP and MODIS is generally good in dust-laden regions.
- The interannual variability based on two DAOD retrievals show that there is a **decreasing trend of DAOD in NWP**, which is mainly attributed to the decline of DAOD in **spring season**. The decreasing of DAOD in NWP is mostly due to the decline of DAOD in **Southern Gobi Desert**. This change of DAOD is significantly correlated with the change of **vegetation** in the area.

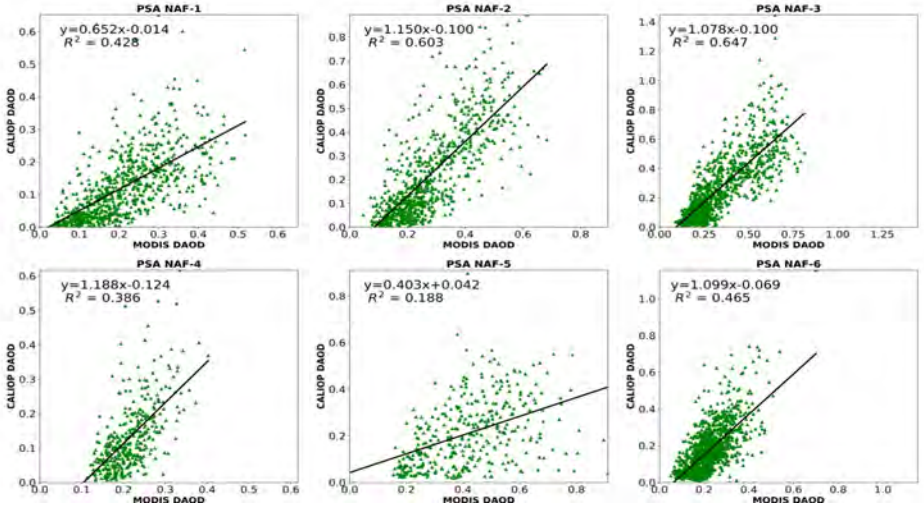
Questions?

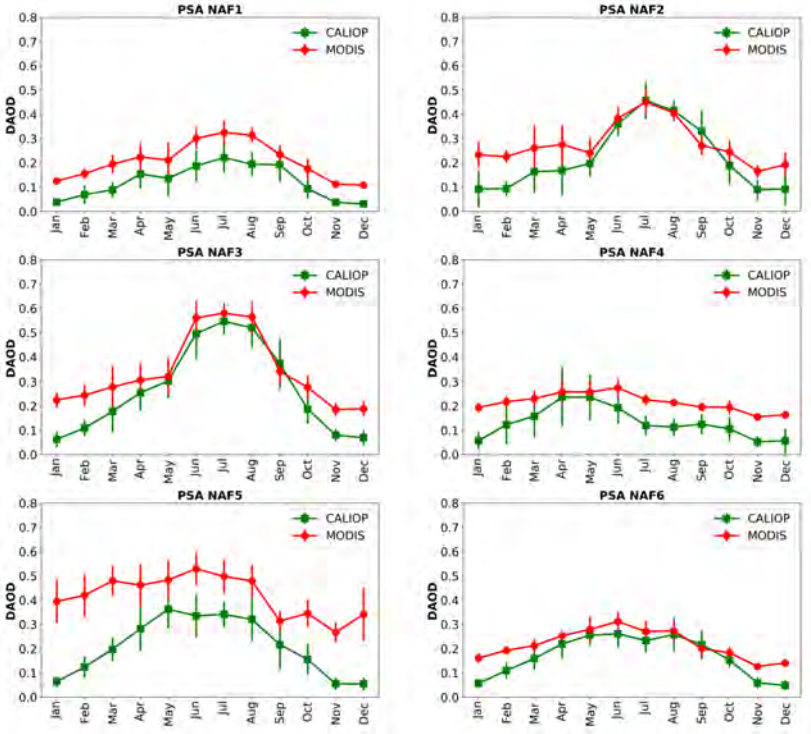
Great to see everyone online

Stay healthy and safe!

DAOD in the Source Regions







Dust AOD w.r.t. total AOD