AERONET measurements and applications in the Philippines

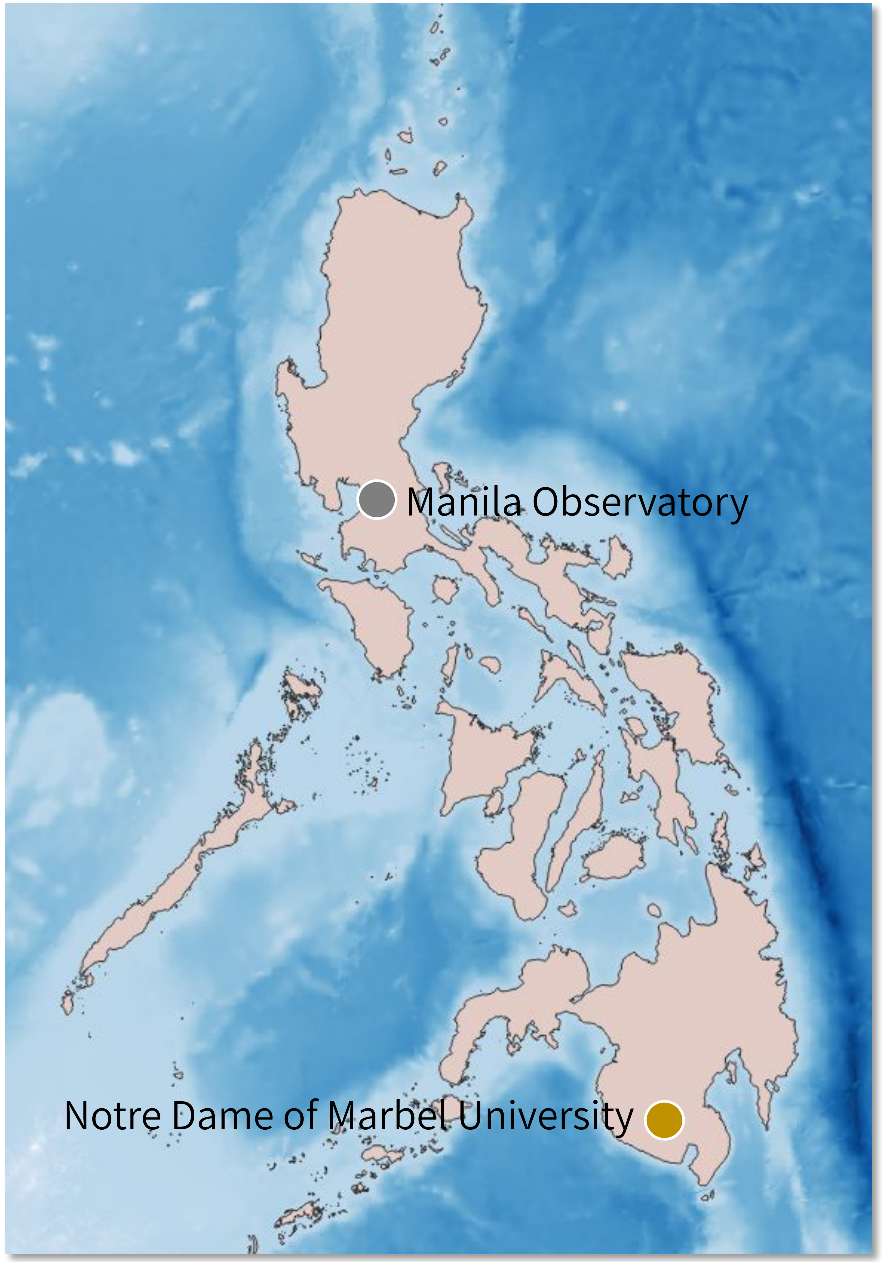
Melliza T. Cruz[1], Sherdon Niño Y. Uy[1], Nofel Lagrosas[2], Victorino R. Tobias Jr.[3], Susana Dorado[3], Genevieve Rose H. Lorenzo[4], John Leo Algo [5], Maria Obiminda L. Cambaliza [1,5], James Bernard B. Simpas[1,5]

[1]Manila Observatory, Quezon City, Philippines
[2]Kyushu University, Fukuoka, Japan
[3]Notre Dame of Marbel University, Koronadal City, Philippines
[4]University of Arizona, Tucson, Arizona, USA
[5]Ateneo de Manila University, Quezon City, Philippines

OUTLINE

- Overview of measurements at the Manila Observatory & NDMU sites.
- Aerosol climatology in Metro Manila based on AERONET data.
- Clustering of volume size distribution derived from AERONET measurements.
- Classification of dominant aerosol types from AERONET data.
- Ways forward.

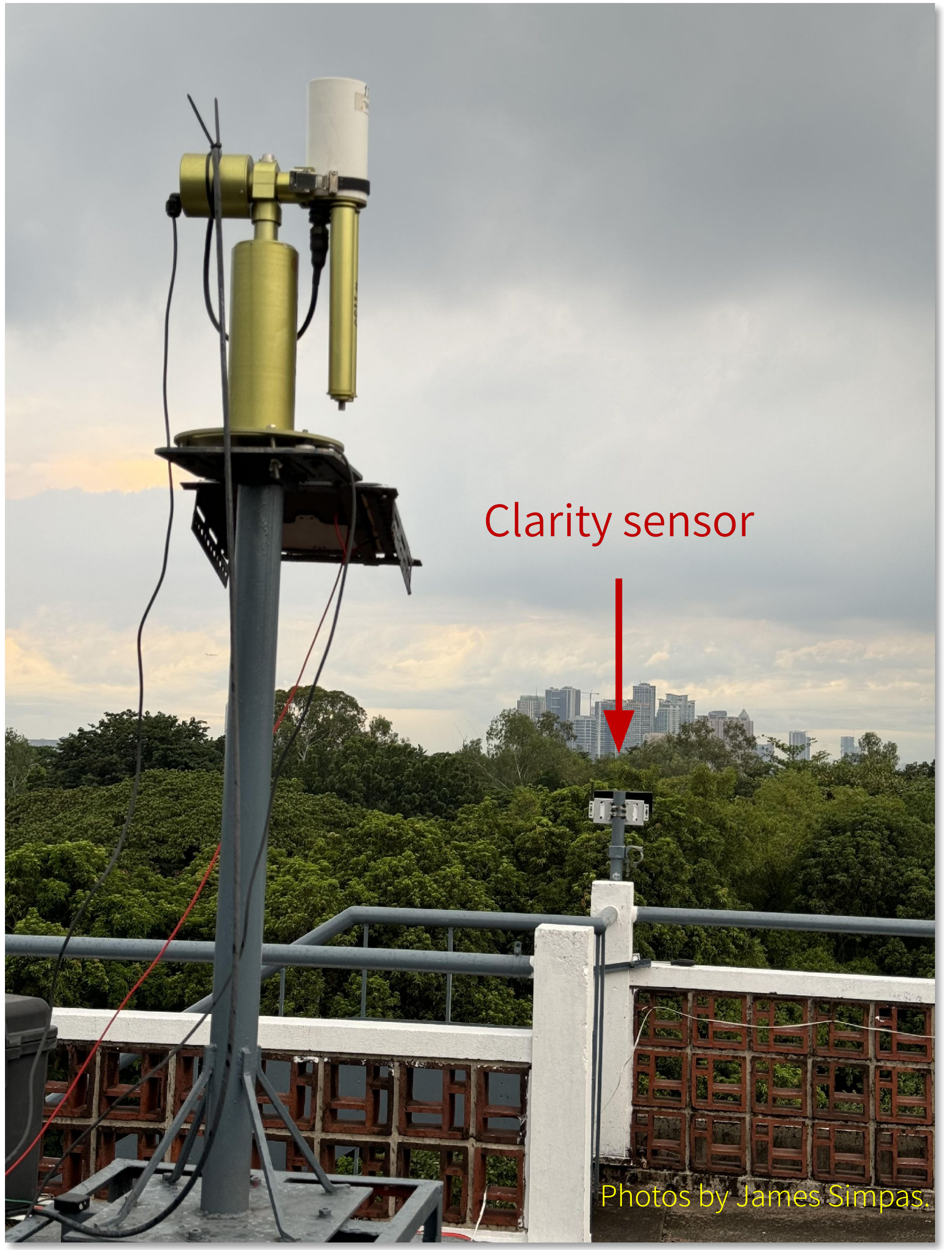
AERONET SITES IN THE PHILI



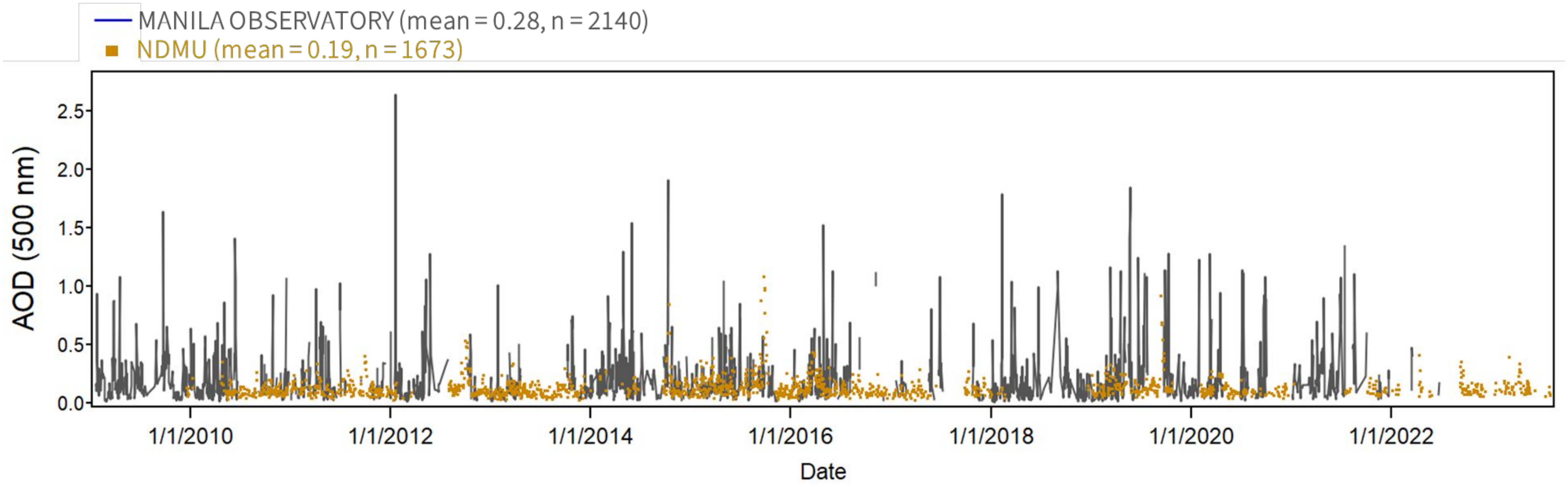
Notre Dame of Marbel University (NDMU)

Manila Observatory (MO)

MANILA OBSERVATORY SITE



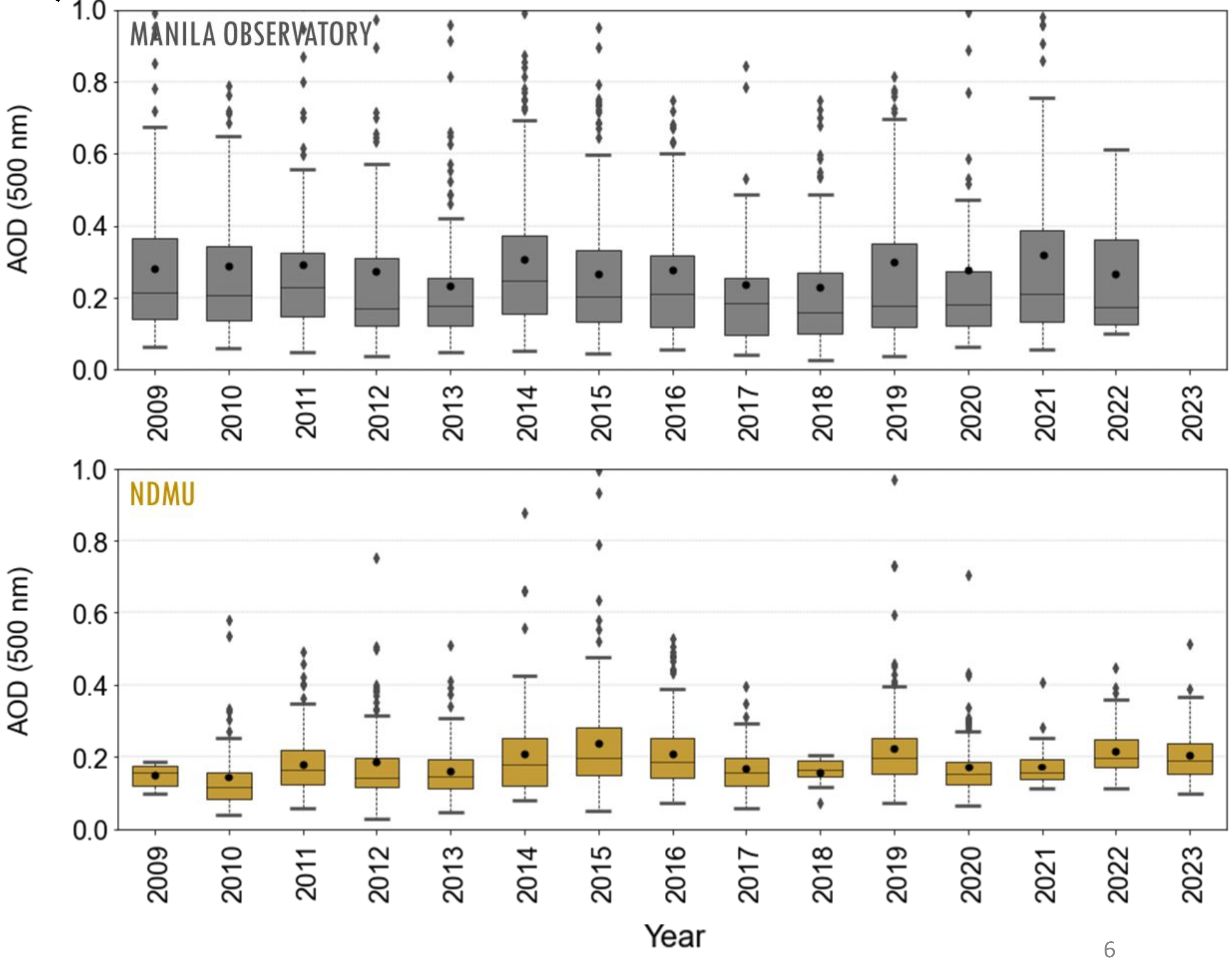
AEROSOL OPTICAL DEPTH (500 nm)



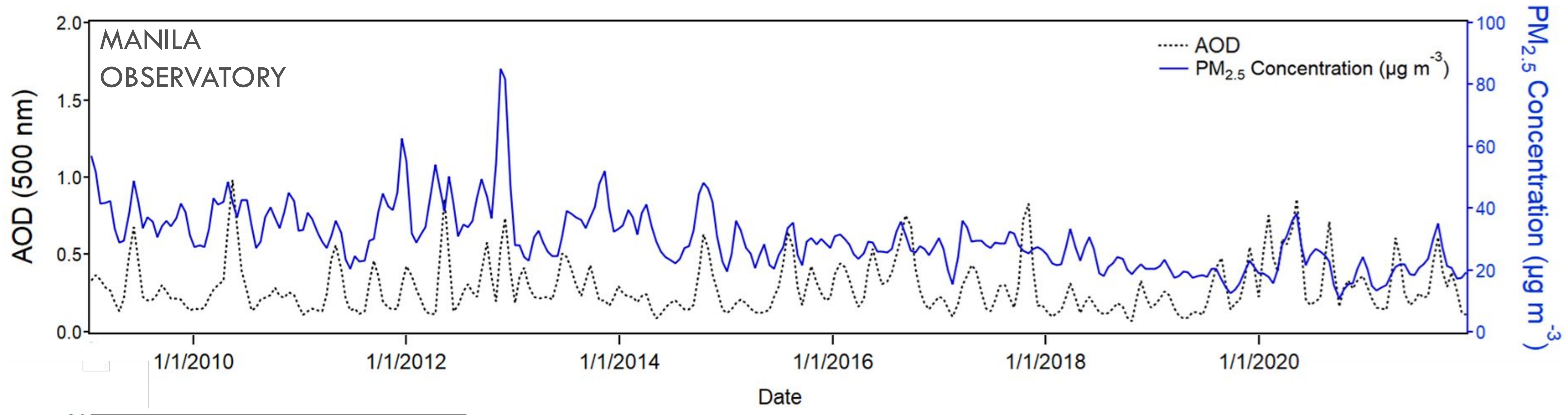
Manila Observatory (MO)
- generally had higher AOD than NDMU
- had more occurrences of elevated AOD than NDMU

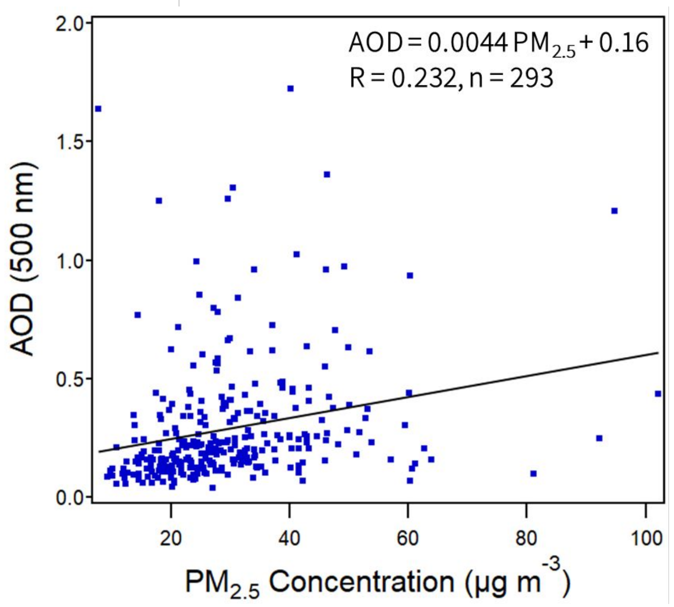
ANNUAL AOD (500 nm)

- Annual mean AOD in MO is always higher than in NDMU.
- AOD in MO had more variability and extremely high values.
- No clear increasing or decreasing trend in both sites.
- MO: Highest annual AOD (0.321) in 2021.
- NDMU: One of 3 highest annual AOD (0.216) in 2022.



AOD (500 nm) - $PM_{2.5}$ CONCENTRATIONS



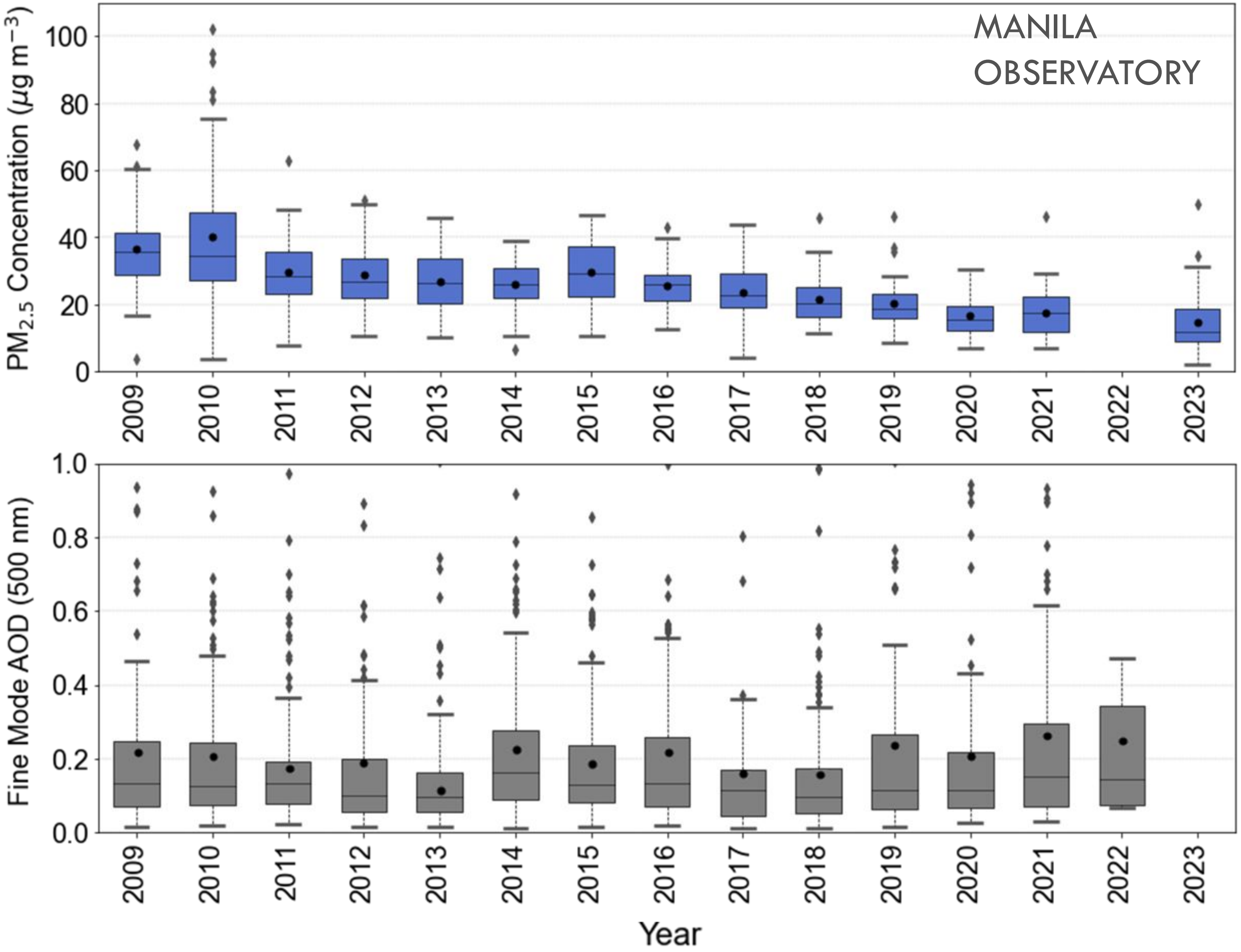


- Some peaks in AOD coincided with increased $PM_{2.5}$ concentrations but $PM_{2.5}$ – AOD correlation remained low.
- A number of high AOD events were not associated with high surface $PM_{2.5}$ concentration.

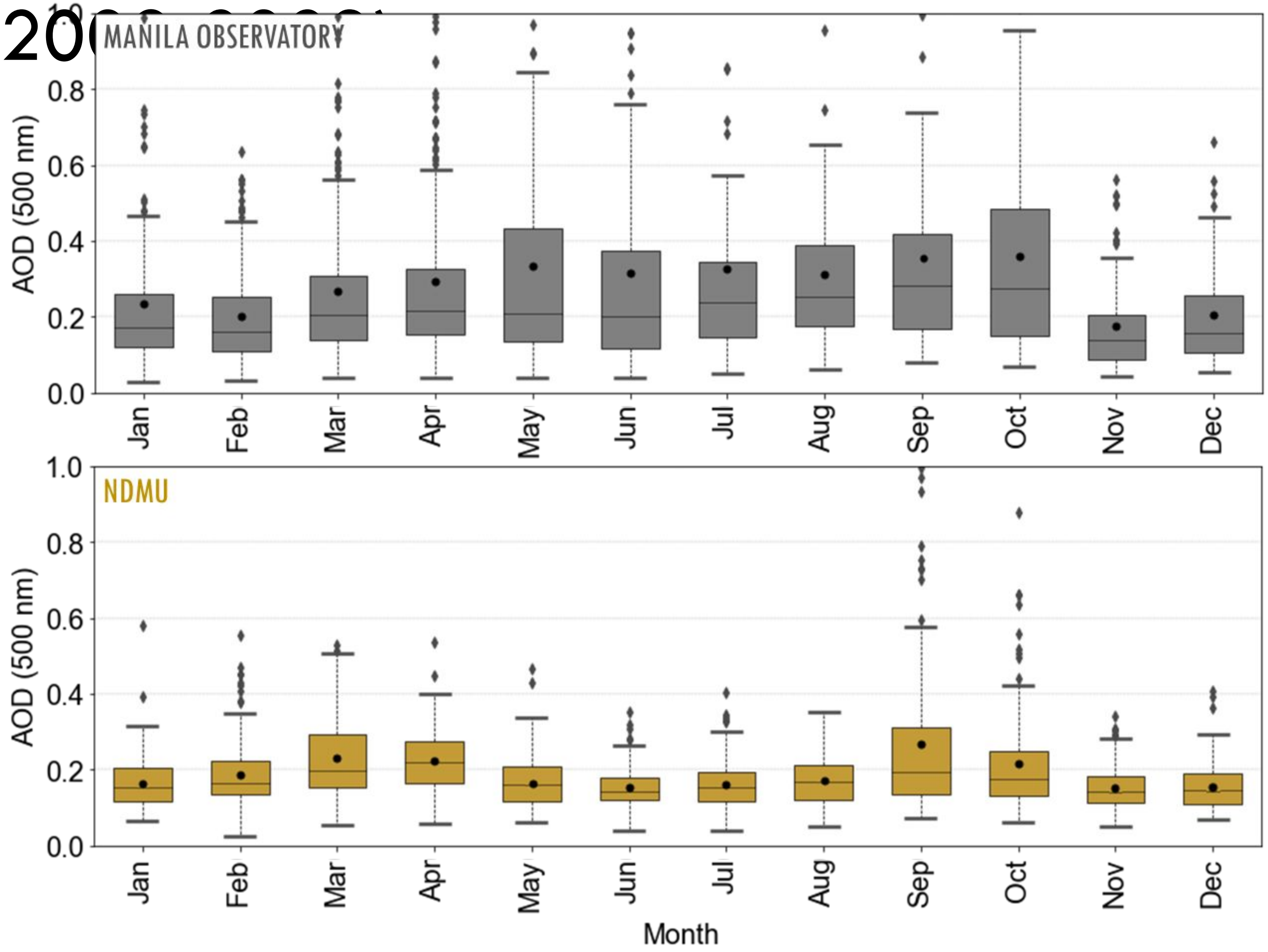
FINE MODE AOD (500 nm) - $PM_{2.5}$ CONCENTRATIONS

- Decreases in $PM_{2.5}$ concentrations attributed to policy interventions:
  2008 - Euro 2
  2010 - stricter emission standards for new, in-use, rebuilt, and imported used motor vehicles
  2016 - Euro4
  Cambaliza et al. (2023)

- Decreasing trend not evident in fine mode AOD.

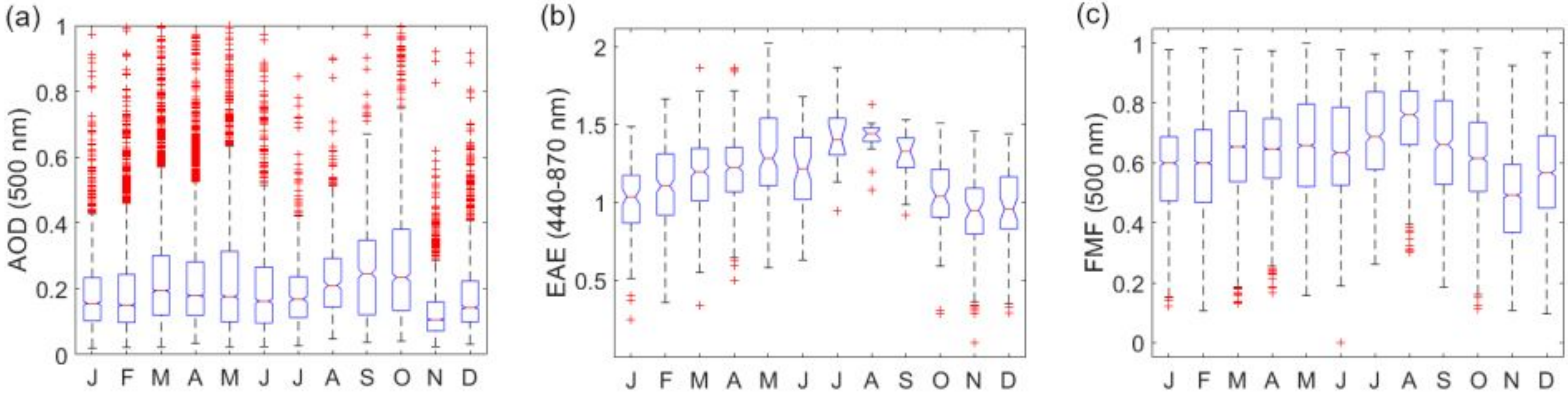


MONTHLY AVERAGE AOD (500 nm, 20



- MO: Wet season from June – October
- NDMU: Rainfall evenly distributed throughout the year.
- Potential influence of other factors such as meteorology (e.g., relative humidity) and transported aerosols.

AEROSOL CLIMATOLOGY (JAN 2009 – OCT 2018)

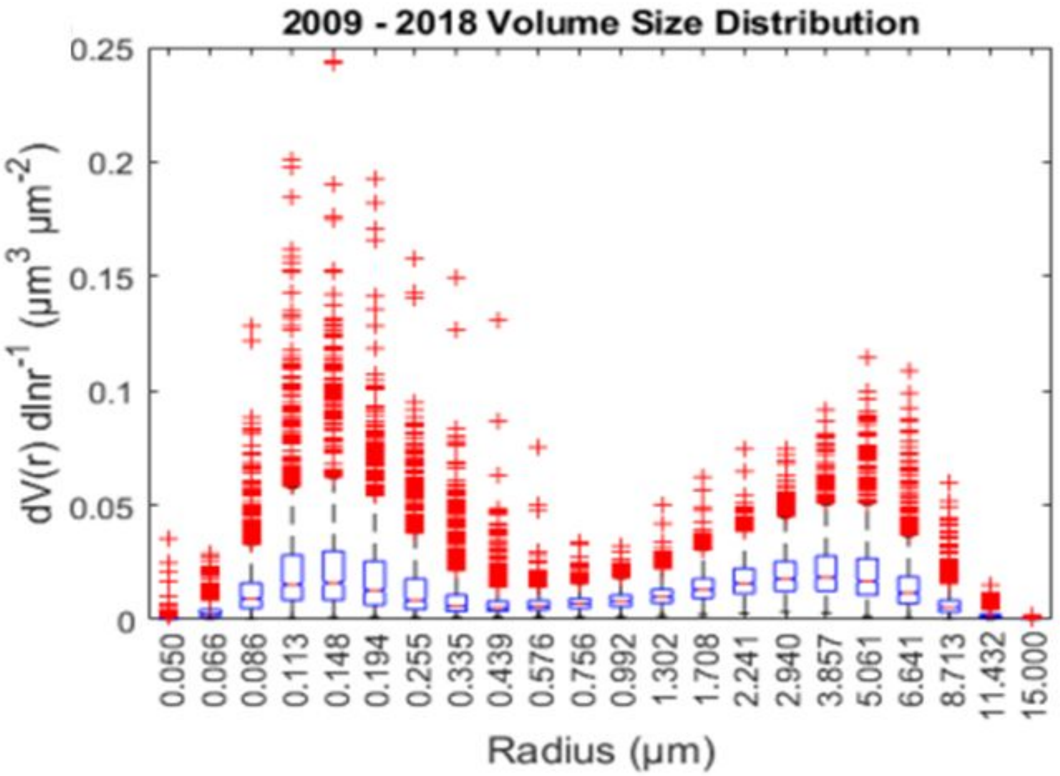


Lorenzo et al. (Atmos. Chem. Phys., 2023)

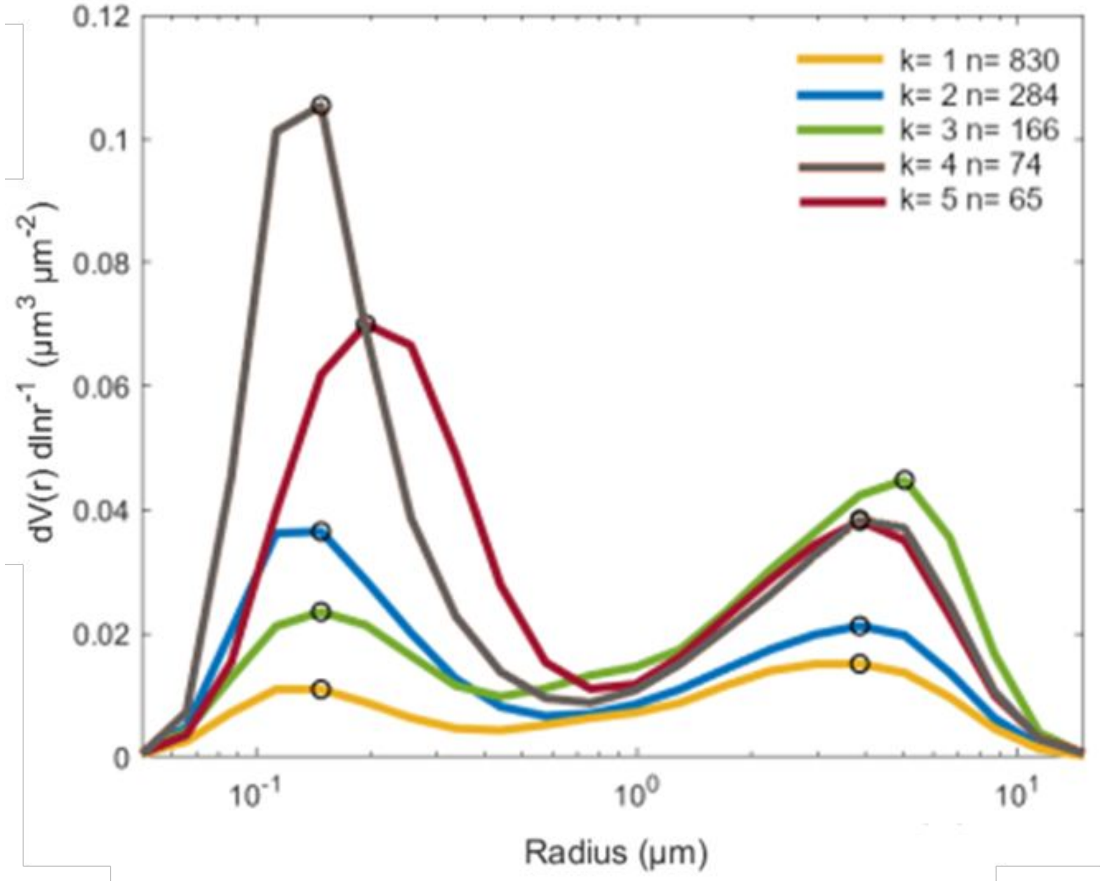
- July to October (southwest monsoon season)
  - high AOD, high EAE (smaller particles), high FMF
  - fine urban aerosol particles and biomass burning activities SW of the Philippines

- November (transition to northeast monsoon season)
  - low AOD, low EAE (larger particles), low FMF
  - marine particles from Philippine SEA & western Pacific Ocean

CLUSTERING OF VOLUME SIZE DISTRIBUTION



VSD derived from AERONET measurements between Jan 2009 and Oct 2018.



Cluster analysis of VSD data yielding five characteristic and averaged VSDs. The black circles show the peak locations in submicrometer (<1 μm) and coarse (≥ 1 μm) modes.

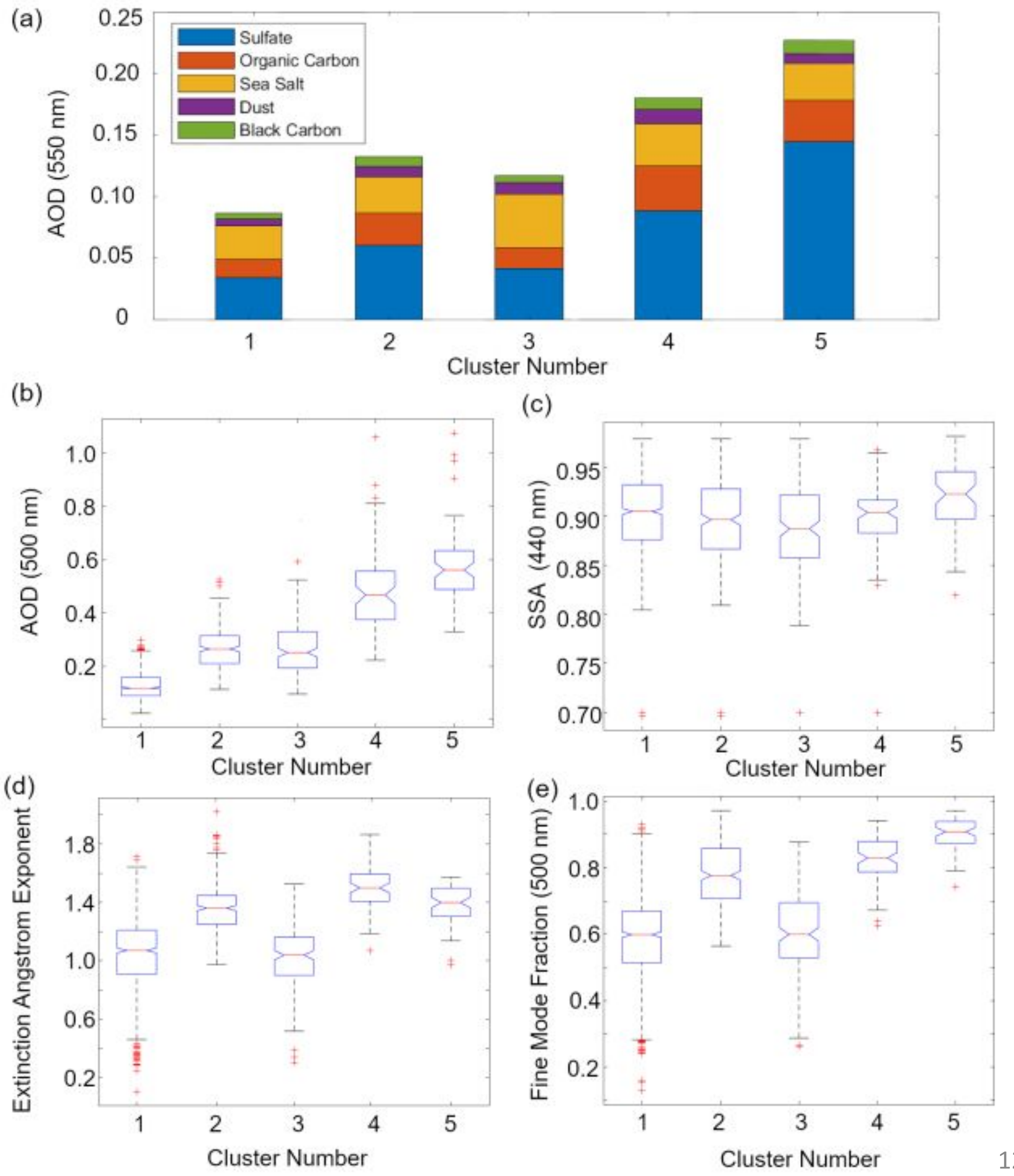
Lorenzo et al. (Atmos. Chem. Phys., 2023)

AIR MASS TYPES

Air mass type	AOD	AE	FMF	SSA
Clean fine	< 0.1[a]	> 1[a]	> 0.7[a]	–
Polluted fine	> 0.1[a]	> 1[a]	> 0.7[a]	–
Clean coarse	< 0.1[a]	< 1[a]	< 0.3[a]	–
Polluted coarse	> 0.1[a]	< 1[a]	< 0.3[a]	–
Clean marine	< 0.2[b]	< 0.9[d]	–	0.98[e]
Urban and industrial	> 0.2[b]	> 1[d]	–	0.9–0.98[e]
Biomass burning	–	> 1.4[a]	–	0.89-0.95[e]
Desert dust	> 0.3[c]	< 1[d]	–	0.92–0.93[e]

[a] From MODIS. [b] AOD at 500 nm. [c] AOD at 400 nm.
[d] AE at 380 to 870 nm. [e] SSA at 440 nm.

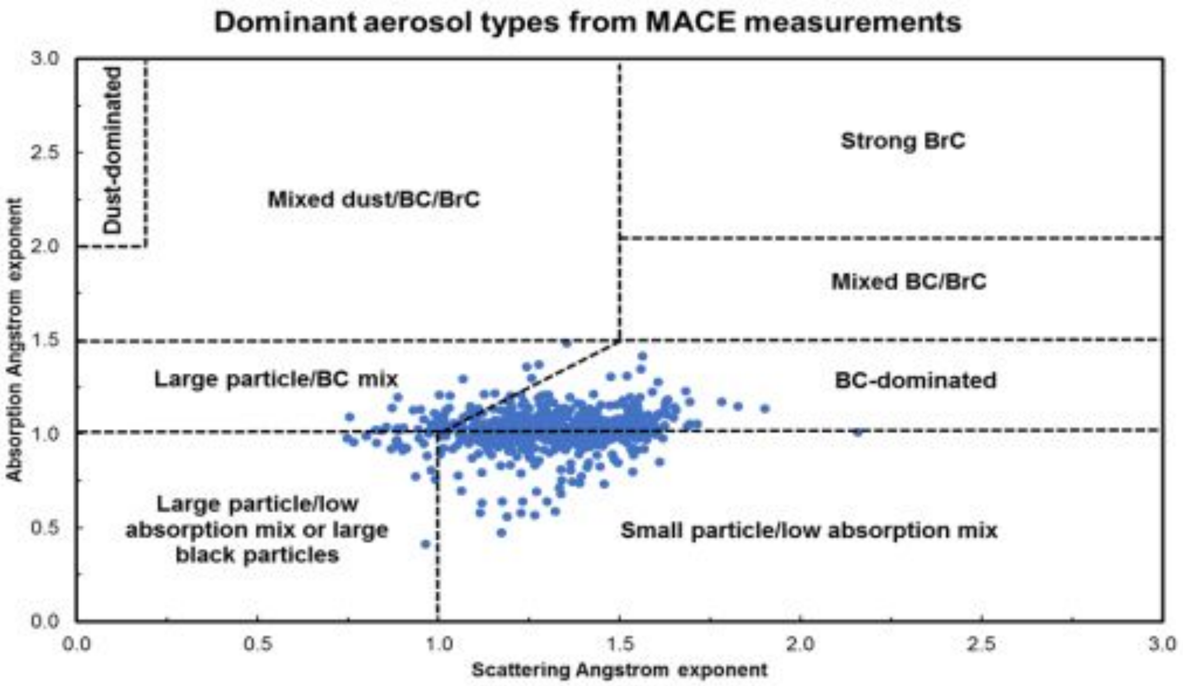
- Cluster 1 – clean marine (58%)
- Cluster 2 – fine polluted source (20%)
- Cluster 3 – dust source (12%)
- Cluster 4 – urban and industrial source (5%)
- Cluster 5 – cloud-processing air mass (cloud processing due to the conversion of SO_2 to sulfate) (5%)

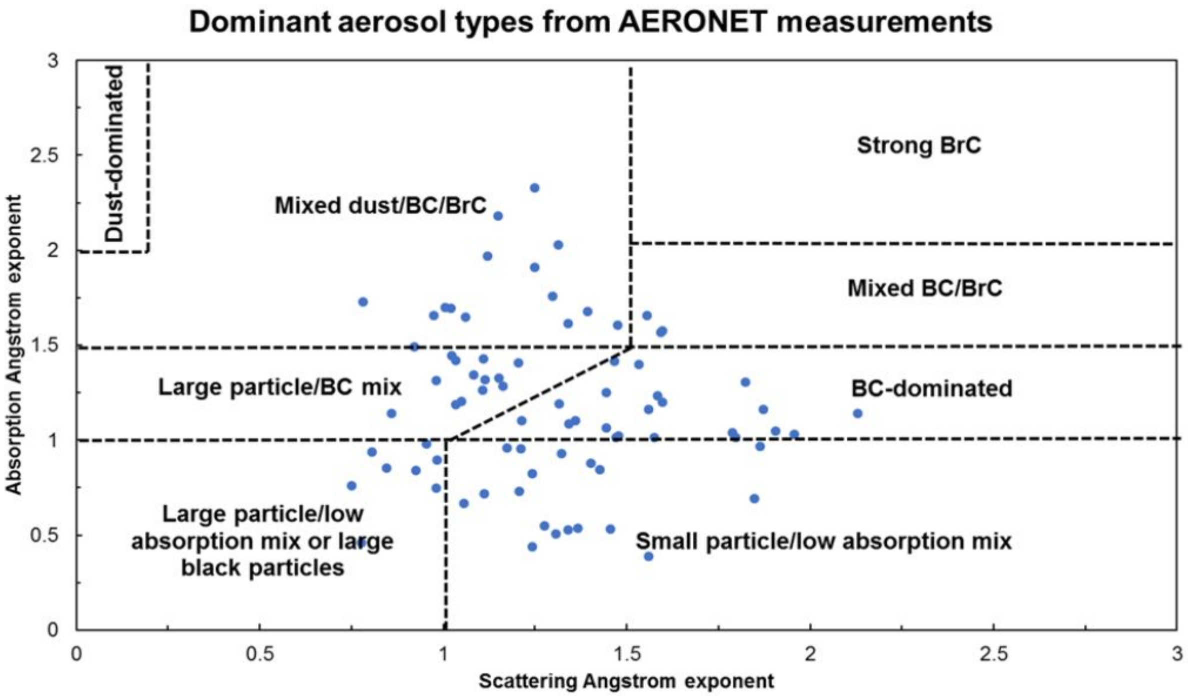


Lorenzo et al. (Atmos. Chem. Phys., 2023)

AEROSOL TYPE CLASSIFICATION

Algo et al. (unpublished)





Absorption versus scattering Ångström exponent plot from ground-based in-situ measurements (left) and AERONET (right) using the chemical speciation matrix developed by Cappa et al. (2016).

- Surface measurements – 55% BC-dominated, 34% small particle/low absorption mix
- AERONET measurements
  - 27% BC-dominated, 23% small particle/low absorption mix, 19% mixed dust/BC/BrC
  - no single dominant classification that explains the aerosol chemical mixture

WAYS FORWARD

- $PM_{2.5}$ measurements in NDMU.
- Analyze factors that affect the AOD-$PM_{2.5}$ relationship.
- Estimate $PM_{2.5}$ based on satellite AOD, surface (e.g., HSRL) and airborne (e.g., ASIA-AQ) measurements, and numerical models.
- Use satellite-derived $PM_{2.5}$ in epidemiological studies.
- Assess aerosol climate effects through long-term retrievals of aerosol optical properties.
- Utilize AOD measurements to analyze pollution episodes.

Thank you!