

Spatiotemporal pattern analyses of AOD and NO₂ VCD in Southeast Asian countries using low-Earth and geostationary orbit satellite data

Donghee Lee¹, Seonggyun Na¹, Jeong-Ah Yoo², Ja-Ho Koo^{1*}

1. Department of Atmospheric Sciences, Yonsei University, Seoul, South Korea

2. National Institute of Environmental Research, Incheon, South Korea

Introduction

1. Insufficient Ground Observation Stations

- To investigate AOD, there are only six AERONET observation stations in Southeast Asia with more than 10 years of data
- There are only two observation stations (PANDORA) in Southeast Asia available for analyzing NO₂

2. Using Retrieval Products from Satellite measurements

- This study investigates the general air quality pattern based on retrieval products from polar-orbit satellite measurements, particularly using the aerosol optical depth (AOD) and the vertical column density of nitrogen dioxide (NO₂)

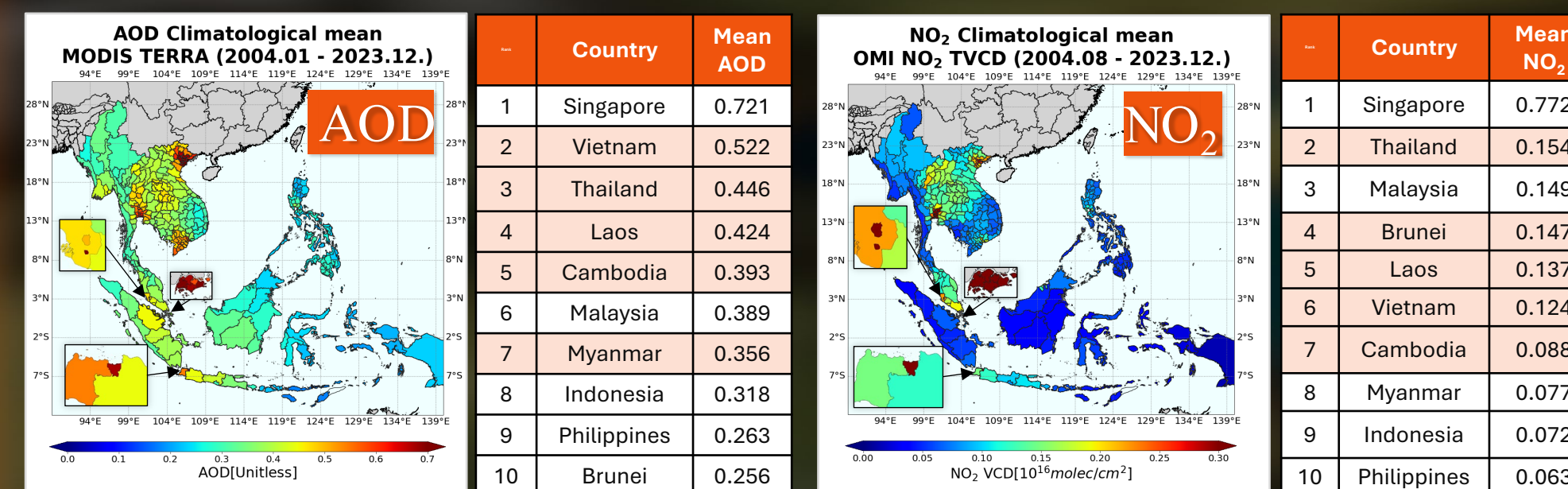
3. Useful For Installation and Management of AQMS

- This information will be useful for the installation and management of local air quality monitoring station (AQMS) in ASEAN countries

Result 1. Climatological AOD and NO₂

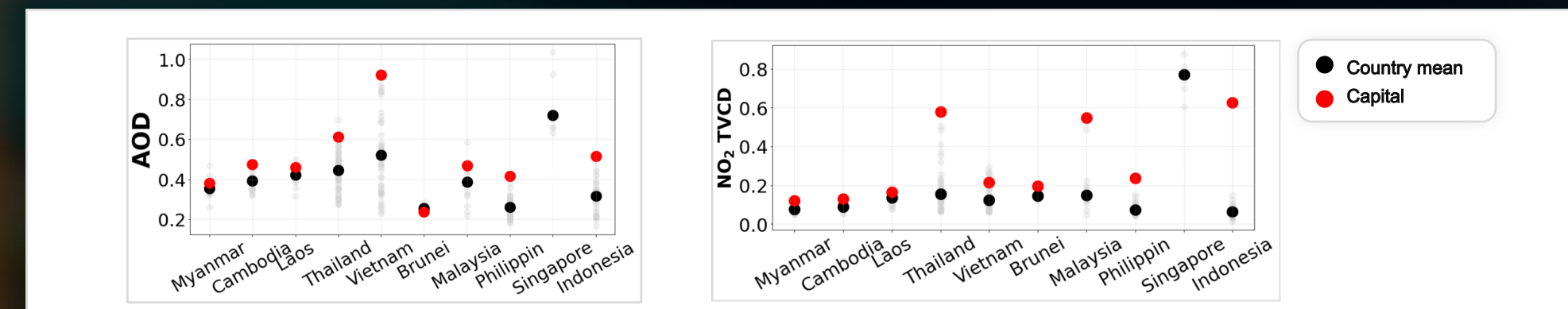
1. Regions with Elevated Tropospheric NO₂ Column Density and AOD

- The average tropospheric NO₂ column density and AOD are observed to be higher in regions such as Singapore, Northern Vietnam (Red River Delta), Southern Vietnam (Mekong River Delta), Kuala Lumpur, Thailand (Bangkok Metropolitan Area), and Jakarta.



2. Comparison of AOD and NO₂ Between National Averages and Capital Cities

- The AOD and NO₂ levels in the capitals were higher than the national averages in all countries, except for Brunei's AOD.

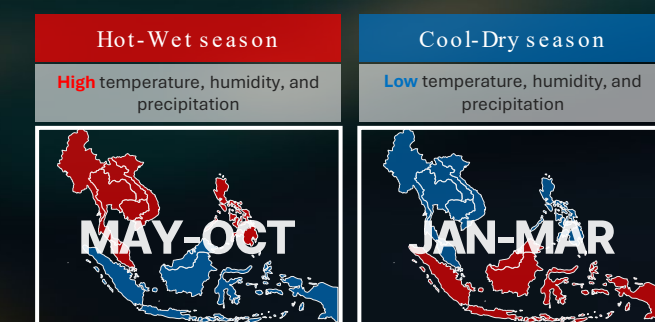


AOD and NO₂ levels are **higher** in capital cities and major metropolitan areas

Result 2. Divided Southeast Asia into 2 Regions

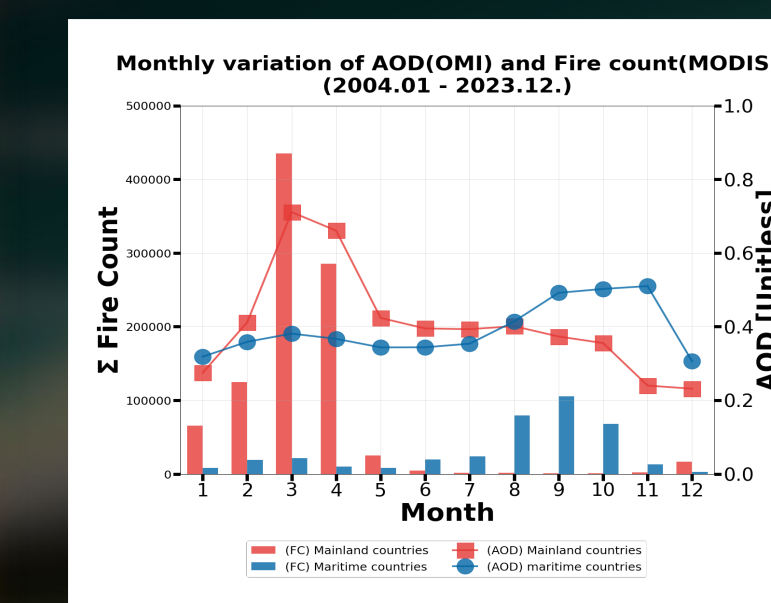
1. Monsoon Seasons in Mainland countries and Maritime countries

- Mainland Regions have experienced the wet season (May-October) and the dry season (November–April)
- Maritime Regions have its wet season from November to April and the dry season from May to October
- During the dry season, the risk of wildfires increases



2. AOD Monthly Variation in Mainland and Maritime regions (Affected by biomass burning)

- In Mainland regions, wildfires are frequent during the dry season from January to May, leading to elevated AOD levels
- In Maritime regions, wildfires occur frequently during the dry season from May to October, resulting in increased AOD
- Monthly correlation analysis shows a relatively high correlation between fire counts (FC) and AOD in Laos, Myanmar, and Indonesia
- Since AOD from wildfires can be transported across borders, further analysis is necessary to understand its broader impact



Country	FC-AOD Correlation (r)
Laos	0.69
Myanmar	0.43
Indonesia	0.43
Brunei	0.28
Thailand	0.19
...	

Data and Method

Region : Southeast Asia(10 countries)

Southeast Asia is divided into **Mainland countries** in the Northern Hemisphere, including Myanmar, Thailand, Laos, Cambodia, and Vietnam, and **Maritime countries** in the Southern Hemisphere, encompassing Indonesia, the Philippines, Malaysia, Singapore, and Brunei. These regions have unique cultural, and AOD characteristics due to their geographical differences.

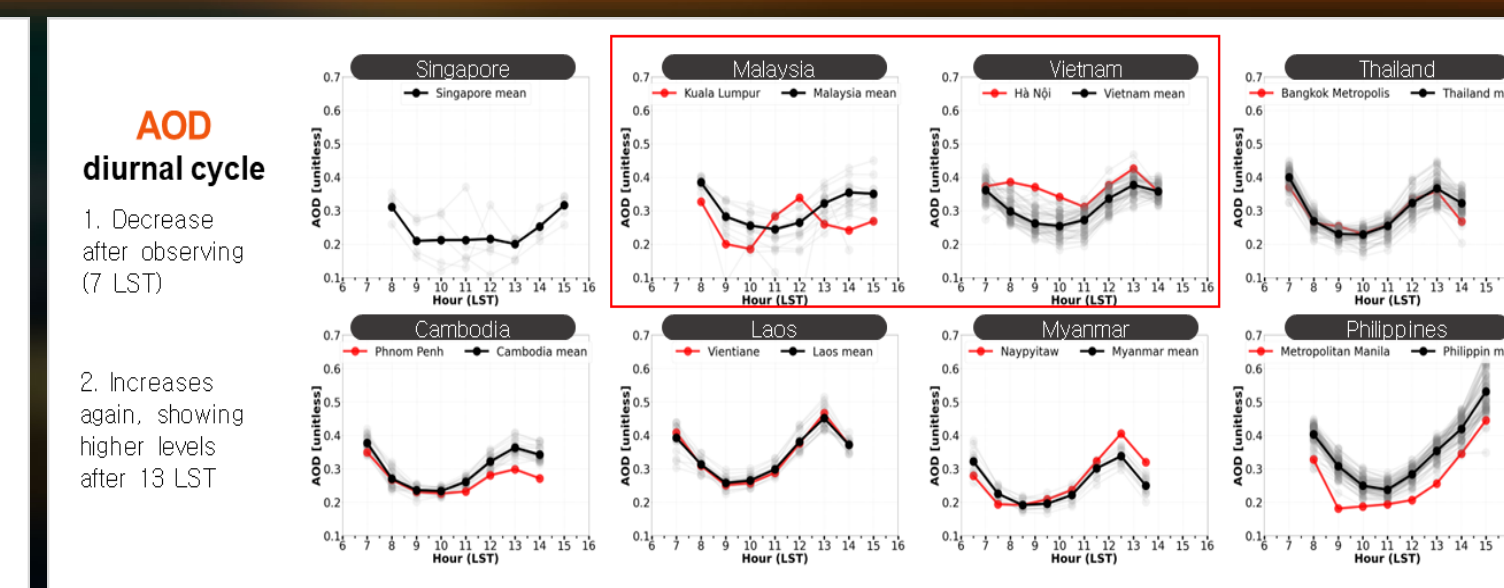
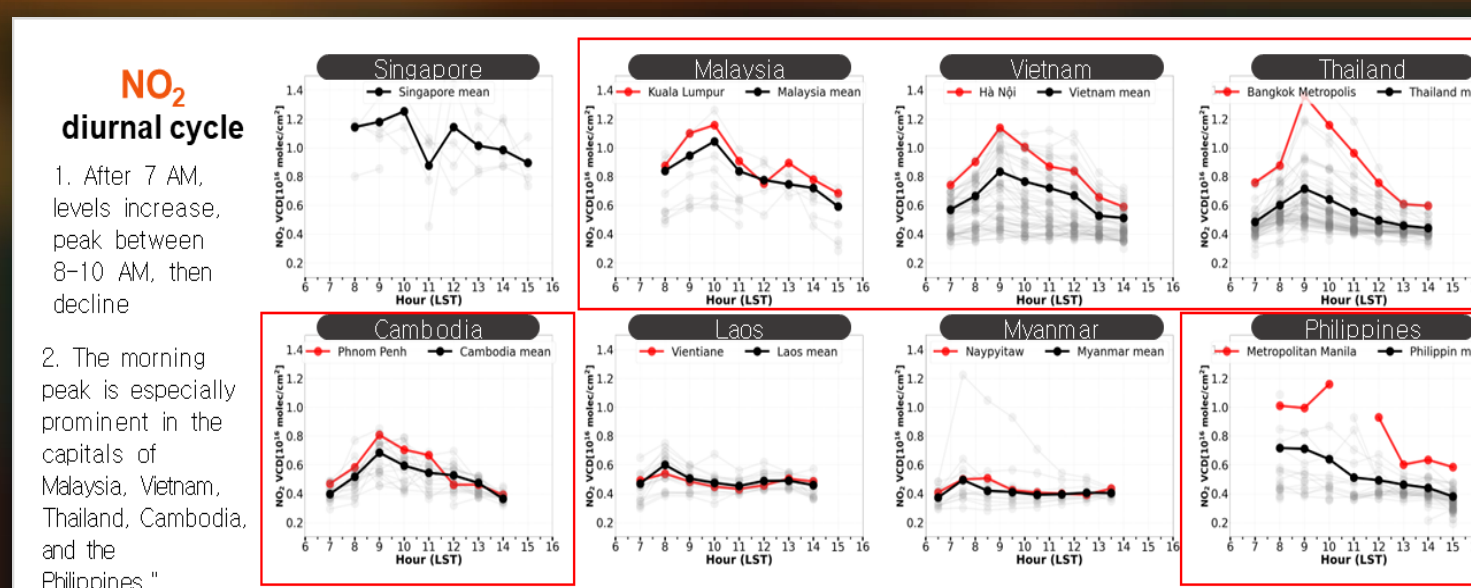


Period : 2004.01.01. - 2023.12.31.

Satellite	Product	Level
MODIS MOD 04	AOD	L2
GEMS	AOD, NO ₂	L2
OMI	Tropospheric NO ₂	L2
MODIS MCD14ML	Fire Count	-

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Result 3. GEMS Diurnal Variation over the Southeast countries



Summary and Discussion

1. AOD and NO₂ levels are higher in capital and major metropolitan areas
2. Southeast Asia is divided into two regions, related to the seasonal variation, which affects wildfires
 - Wildfires occur frequently during the dry season, resulting in increased AOD.
 - Dry season is different between Mainland countries and Maritime countries
3. AOD and NO₂ Diurnal Variation
 - Since 2020, the GEMS satellite (GEO) has been conducting multiple observations per day over Southeast Asia, which is different from LEO satellites.
 - This has enabled the observation of diurnal variation in AOD and NO₂