# Assessing health implications due to aerosol dynamics and climate trends using ground-based and Satellite observations

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## AERONET Science Application Exchange
## September 17 – 19, 2024

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# Background

- Limited access to aerosol measurements, which are crucial for understanding public health impacts (Dzando et al., 2022).
- The reliance on satellite technology for aerosol observations, such as MODIS, OMI etc presents certain limitations, including potential discrepancies in data accuracy and coverage (Vohra et al., 2020; , Li et al., 2014)
- The seasonal climate variations in Ghana significantly influence public health
- Air pollution, has been linked to various health issues, including respiratory diseases and increased mortality rates (Gyasi et al., 2022)
- The unique climatic conditions in Ghana exacerbate these health risks by elevating the concentrations of harmful aerosols in the atmosphere (Gyasi et al., 2022).

# Objectives

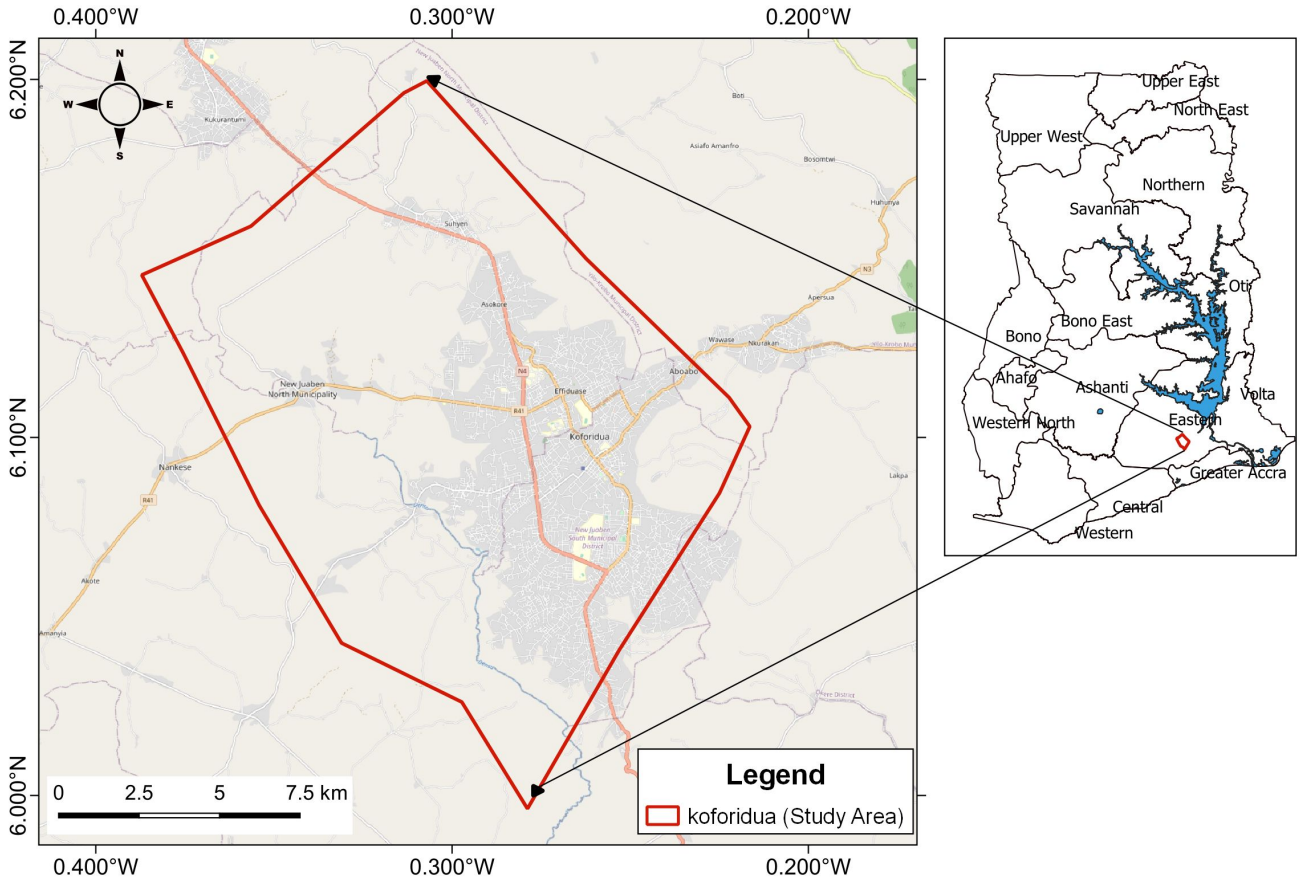
- To Analyze Aerosol Dynamics
- Validate existing ground-based with satellite measurement
- To Examine Climate Trends
- To Evaluate Health Implications

# Data and Methods

- **Data Collection**: - Ground-based AOD from the AERONET station at ANU (2017 - 2022)
- **Satellite data**
  - Modis and OMI – 2017 – 2022 (500nm)
- **Climate data from Ghana Meteorological Agency**
  - Rainfall and temperature - 1980 - 2022
- **Health data from health facility**
  - Respiratory diseases – 2017 - 2022
- **Statistical analyses**:
  - Compared AOD values from ground-based and satellite sources and assessed the correlation (Anderson et al., 2013; , Li et al., 2013).

# Overview of Koforidua's Climate and Air Quality

- **Location:** Koforidua is located in the Eastern Region of Ghana, characterized by **tropical climate** with distinct **wet and dry seasons.**




- **Air Quality Profile:**
  - **Natural Sources:** Dust storms (especially during Harmattan)
  - **Anthropogenic Sources:** Vehicular emissions, open burning, industrial activities, and urbanization.

# Climate Trends

- **Climate Trends:**
  - Variable rainfall

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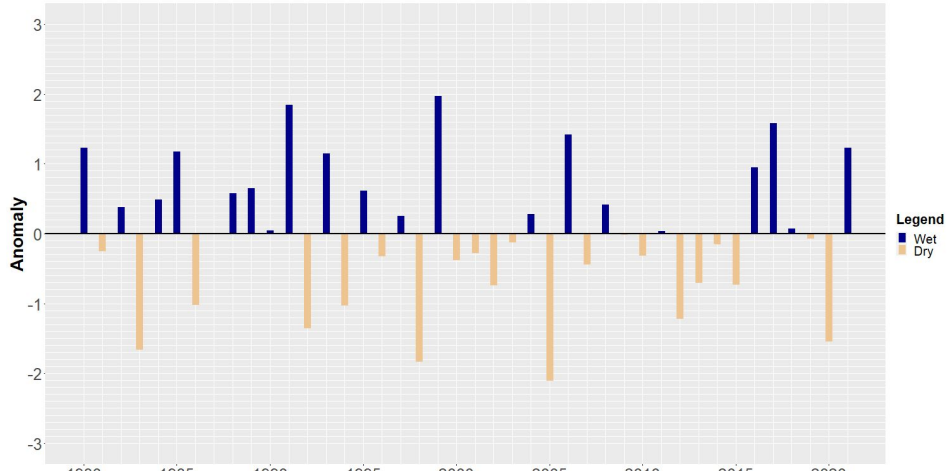
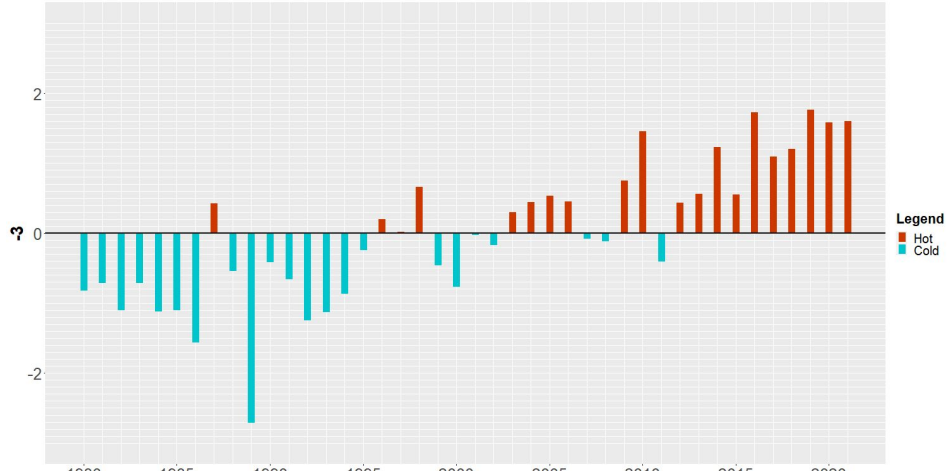
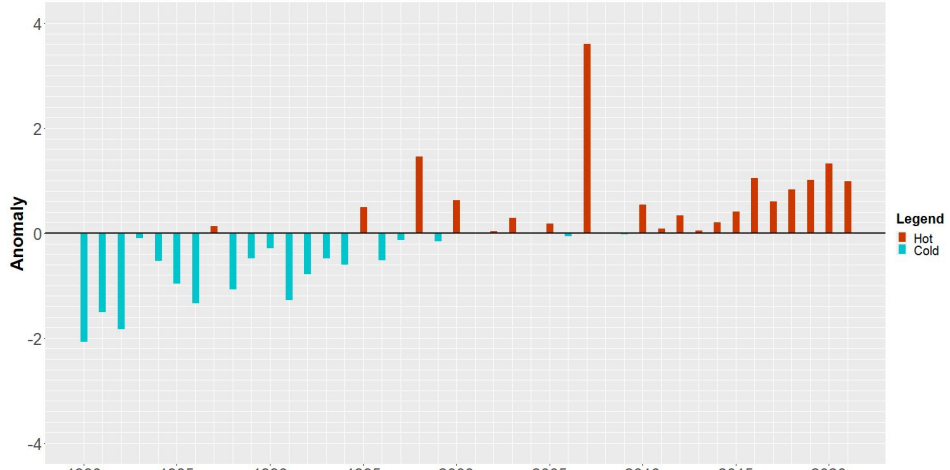
  - Day and night temperature increasing

  - Extreme events
    - Floods
    - Drought



# Seasonal cycle of climate at Koforidua

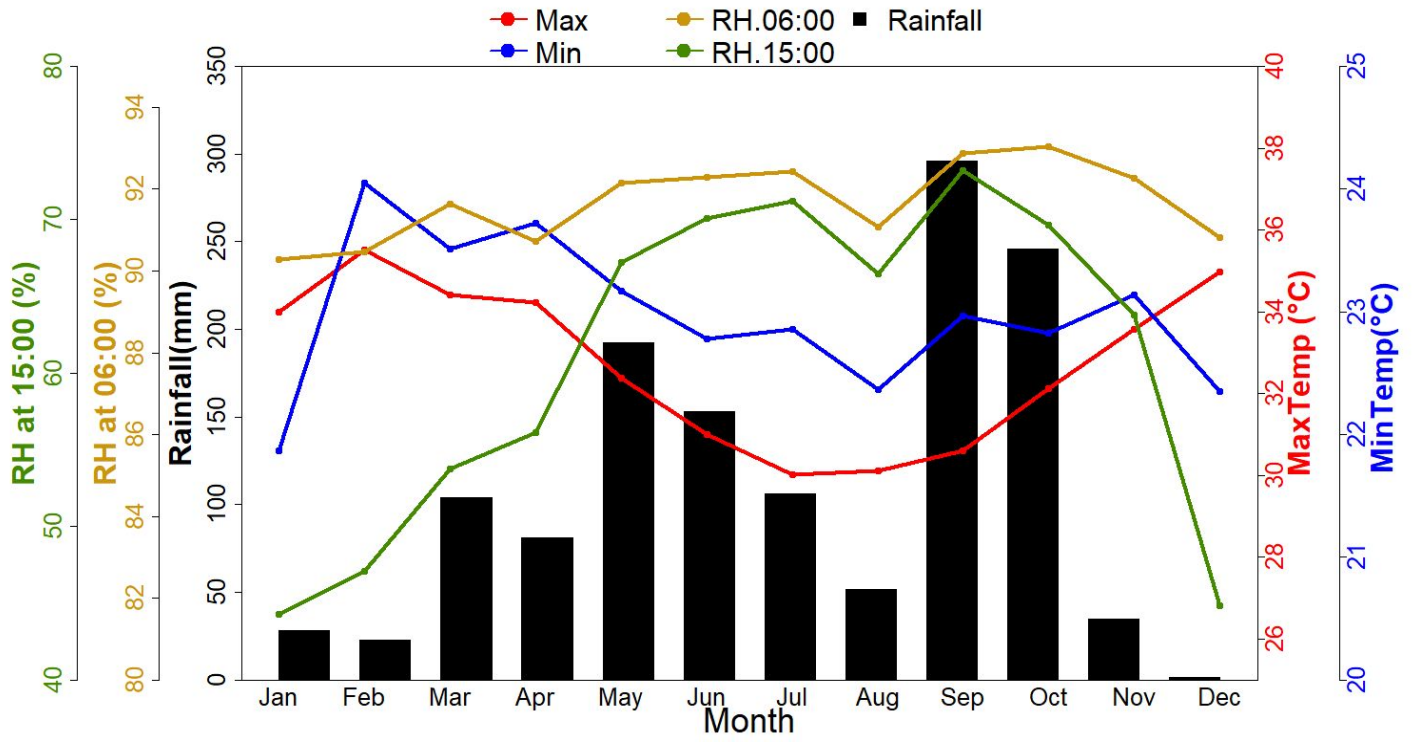
Koforidua experiences bi-modal rainfall regime

First peak – June
Second peak – September

Day temperature peaks in February – 35$^{o}$C
Night temperature peaks in April – 21.5

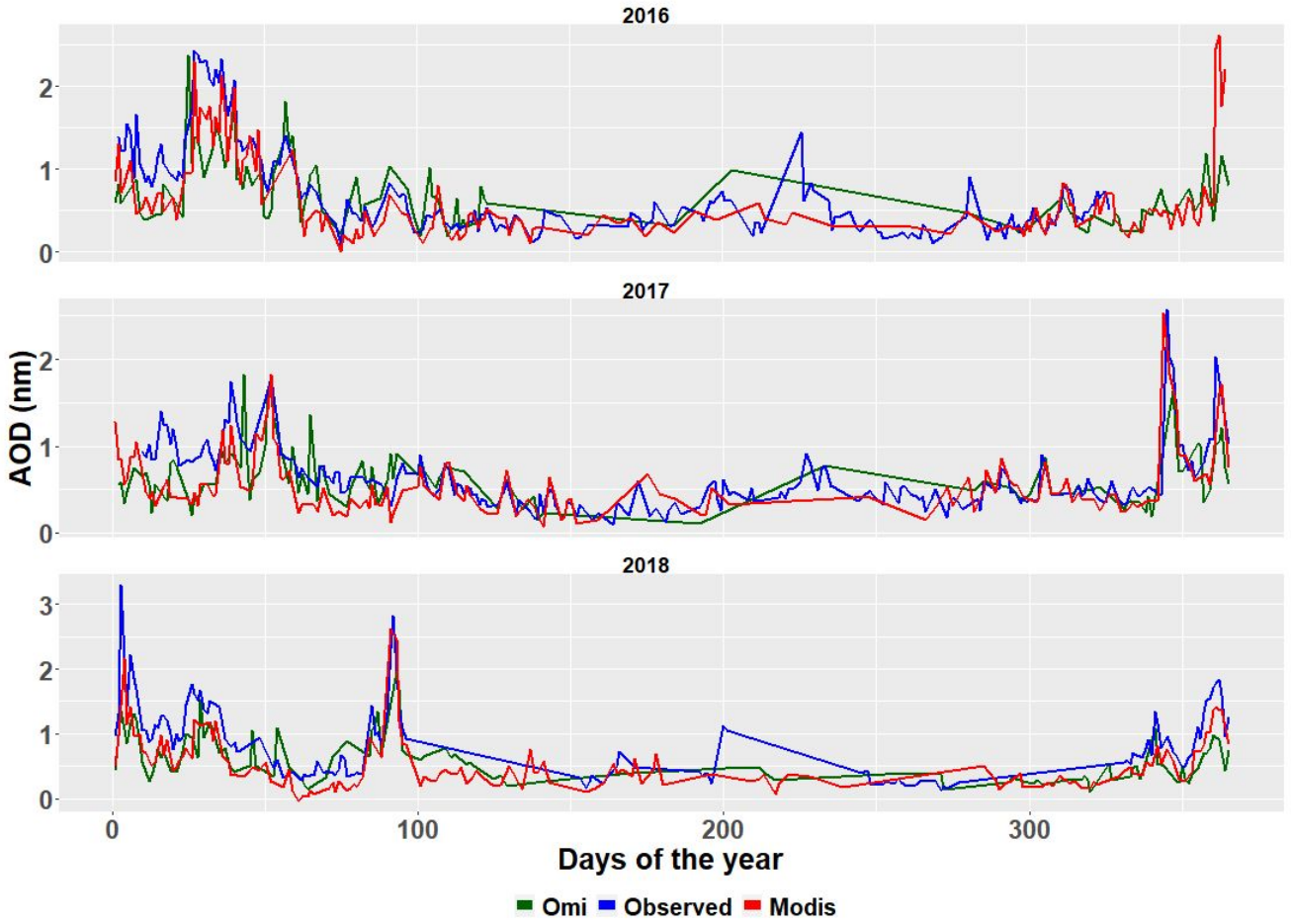
The peaks of temperature coincides with the peak of aerosols

The climate variables reaches their minimum in August which also aligns with aerosols



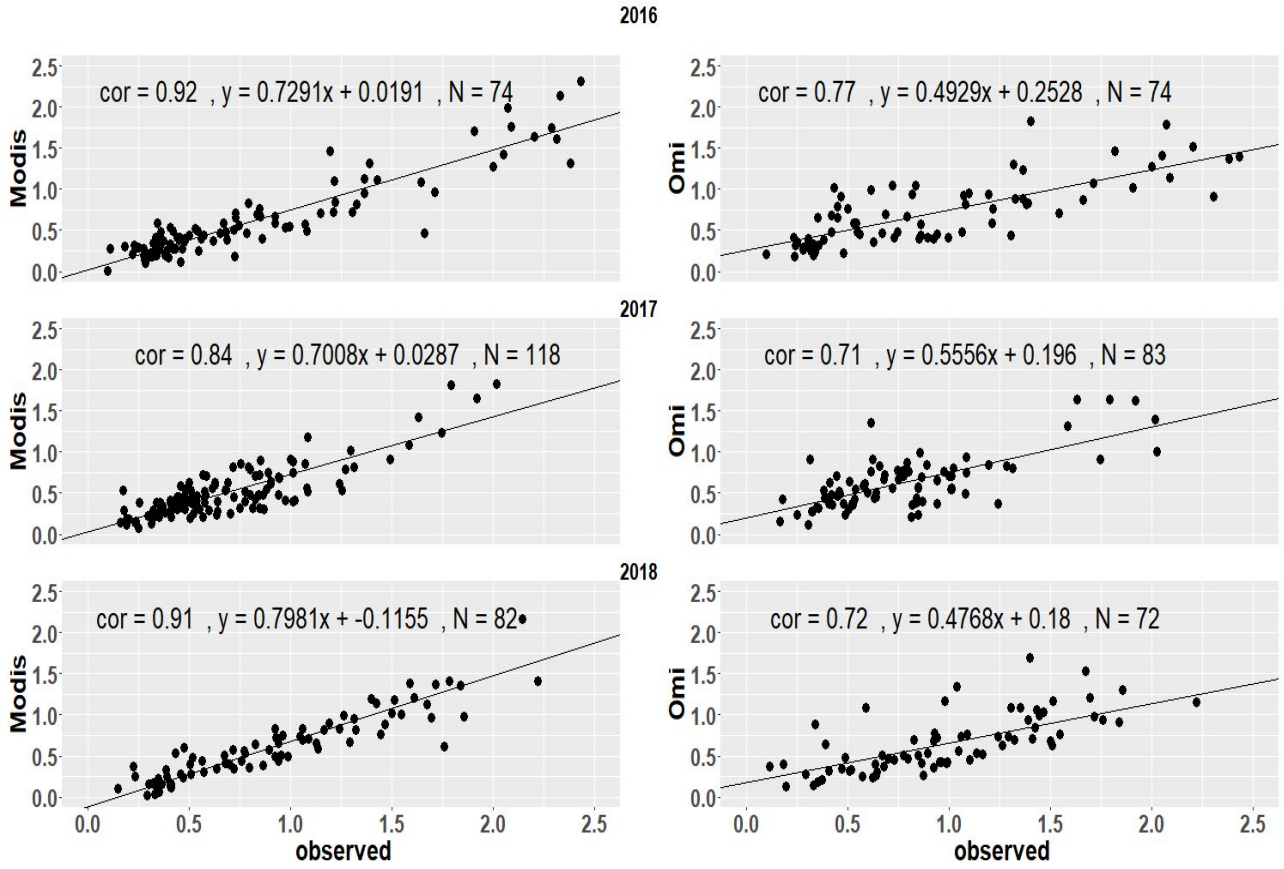
# Comparism of satellite and ground measurement

- **Seasonal Variations in Aerosols:**
- Both **OMI** and **MODIS** satellite data effectively capture the **seasonal cycle** of aerosol concentrations in Koforidua.
- **Harmattan Season (Dry Season):** Higher aerosol concentrations during the dry season due to dust transport from the Sahara, visible in both satellite and ground measurements.
- **Wet Season:** Aerosol concentrations are lower in the wet season, as rainfall tends to cleanse the atmosphere of particulate matter.
- Although both **OMI** and **MODIS** detect the **same seasonal trends**, they differ in their estimates of aerosol amounts



# Strong Correlation Between Ground-Based and Satellite Data

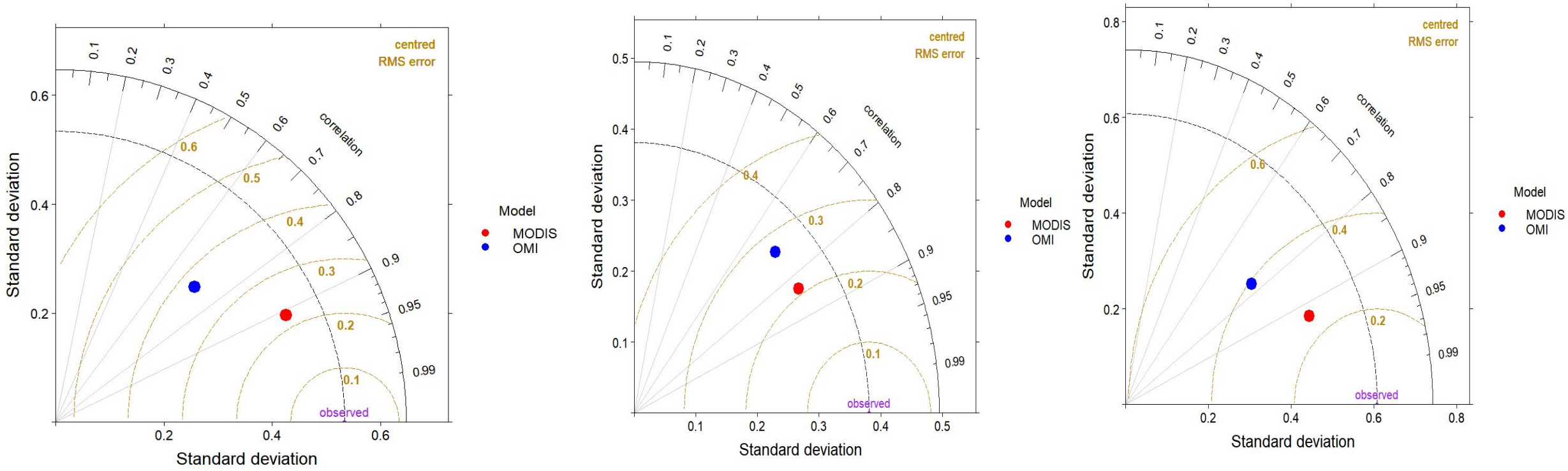
- A **strong positive correlation** (e.g., **r = 0.84** to **0.92**) was observed between **MODIS AOD**
- **MODIS** captures the **temporal variability** of aerosol concentrations well, showing consistency with **daily and seasonal patterns** observed on the ground.




**OMI AOD** values also demonstrate a **strong correlation** with observed (**r = 0.71** to **0.77**), validating the satellite's ability to detect aerosol trends.

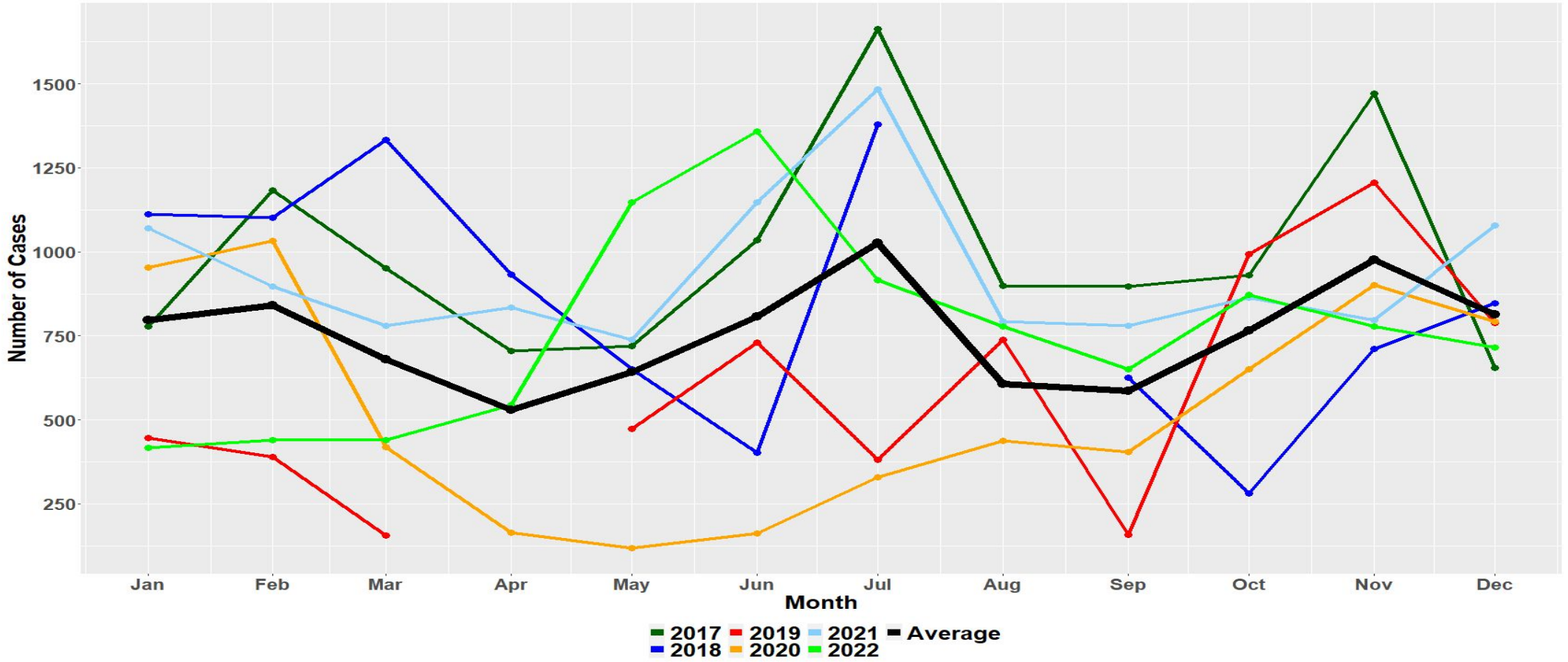
Although OMI tends to **underestimate AOD** during certain periods, the overall trend matches ground observations, particularly during high aerosol periods like the **Harmattan**.

# Strong Correlation Between Ground-Based and Satellite Data




Both **MODIS** and **OMI** show a high degree of correlation with ground measurements, confirming their utility in tracking aerosol dynamics, though with some differences in magnitude.

# Reported cases of Respiratory diseases




Reported cases of Respiratory diseases:

- Peak in July
- High in the dry season
- When Aerosol is high

# Correlation between Aerosol and Respiratory Diseases

**2018**
Moderate correlation between aerosols and respiratory diseases. –
Low correlation for MODIS data. - Strong correlation for OMI data.

**2020**
Increased correlation for aerosols and MODIS. - Decreased correlation for OMI.
- Suggests changing dynamics in air quality and health impacts.

| Source/Year | 2018 | 2020 |
|---|---|---|
| Aerosol | 0.48 | 0.63 |
| Modis | 0.14 | 0.73 |
| OMI | 0.62 | 0.37 |

# Conclusion

- **Complementary Nature:**
  - Ground-based measurements and satellite observations are **complementary**. Satellite data provides a broader perspective, while ground-based sensors offer **higher accuracy** and **localized insights**.
- **Key Validation Insights:**
  - Both **OMI** and **MODIS** satellite data effectively capture the **seasonal cycle** of aerosols in Koforidua, confirming the **temporal trends** observed on the ground.
  - However, satellite data may differ slightly in **estimating the amount** of aerosols, highlighting the need for **continuous ground validation**.
- **Moving Forward:**
  - Ongoing efforts should focus on further improving the integration of **ground-based** and **satellite** measurements for more accurate aerosol monitoring and health impact assessments in Koforidua.

# Conclusion

- Correlation analysis highlights the complex relationship between air pollution and respiratory health. - Strengthened correlations for aerosol and MODIS data suggest increasing relevance.

- Ongoing research is essential for understanding health implications of air quality also looking demography and gender.

- The increasing correlation of aerosol measurements and MODIS with respiratory diseases emphasizes the need for continued monitoring and research