Evaluation of Satellite-Based Models in Estimating Surface PM2.5 in Bangladesh

Eleni Konstantelos

Department of Earth & Atmospheric Sciences, State University of New York at Oneonta

Introduction

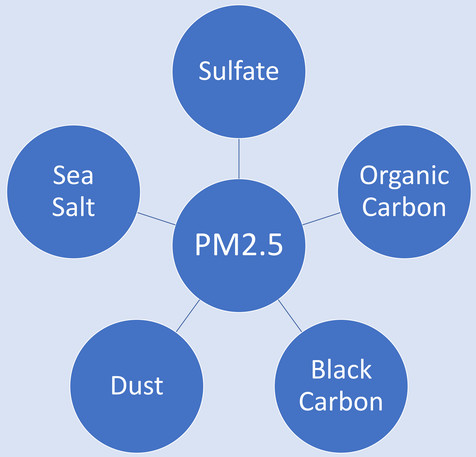
Air quality has always been an important topic to discuss meteorologically, but there has been an emerging focus on the health impacts as time has shown the effects of long-term exposure to poor air quality. The National Science Foundation International Research Experience for Students program collaborated with the State University of New York at Albany, the Bangladesh University of Engineering and Technology, and the University of Dhaka. The goal of this partnership is to analyze the usefulness of low-cost sensors and remote sensing technologies to further the understanding of the air quality issues in Bangladesh. Factors that cause poor air quality in the country include densely populated cities, brick kiln pollution, and waste burning that affects indoors and outdoors. The use of these low-cost sensors and satellite data is crucial to the advancement of developing countries like Bangladesh by providing the public with accurate and reliable data.

Objectives

1. To investigate the inter-city variation of $PM_{2.5}$ across the seven of Bangladesh
2. To learn about the annual cycles from 2000-2022
3. To gather information about inter-season variability
4. To learn about which aerosol contributes the most to poor air quality in each season and each division
5. To spread awareness to the public through accurate and accessible data.

Methods

Aerosol Composition of PM2.5



MERRA-2 $PM_{2.5}$ Calculations:

$$PM_{2.5} = 1.375 \times SO_4 + 1.6 \times OC + Dust_{2.5} + SS_{2.5}$$

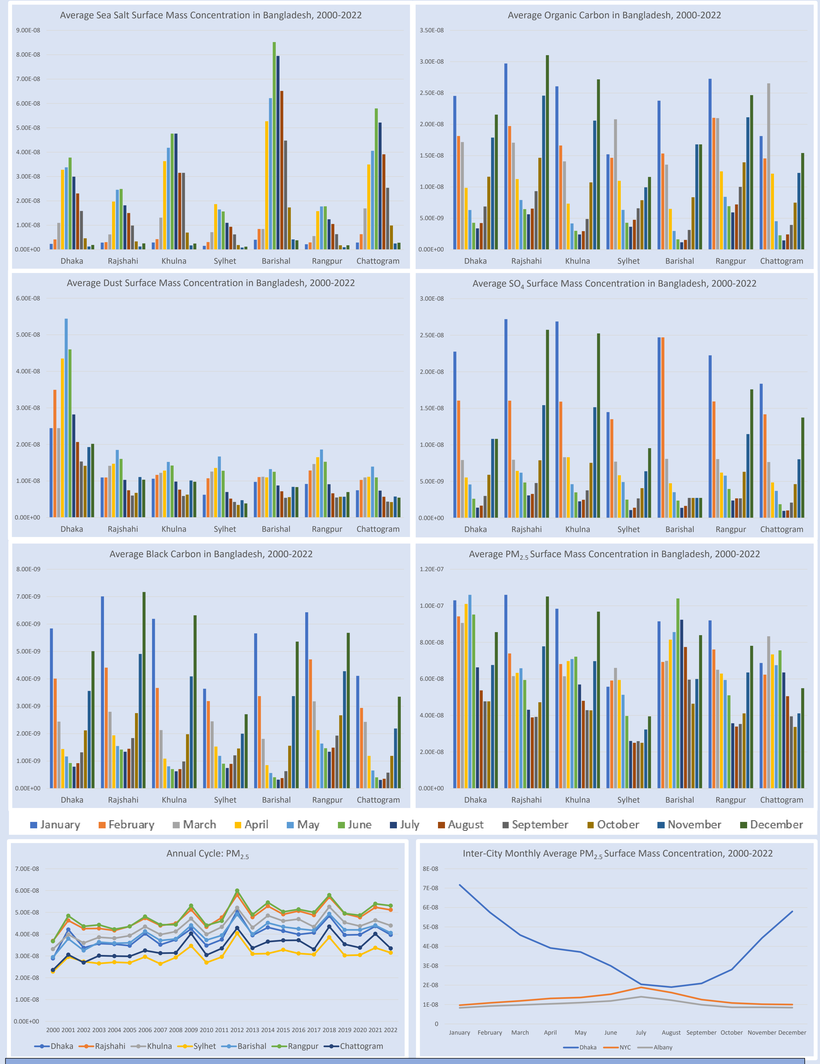
MERRA-2 Parameters

- Variable: Surface mass concentration $PM_{2.5}$
  - Units: kg/m^3
  - Temporal Resolution: Monthly
  - Spatial Resolution: 0.5 x 0.625
- Date Range: 1/1/2000-12/31/2022

Plots Used

- Inter-City Variation: Time Series, Area Averaged
- Inter-Season Variation: Time Series, Recurring Averages
- Annual Cycles: Time Series, Recurring Averages

Results



Study Area

Division	Population	Industries
Dhaka	44,215,107	Textiles and pharma- chemicals
Chattogram	33,202,326	Textile and garment
Rajshahi	20,353,119	Silk, jute, glass
Rangpur	17,610,956	Tobacco
Khulna	17,416,645	Mills and shipyard
Sylhet	11,034,863	Cane and tea
Barishal	9,100,102	Rice, jute, fish

Conclusion

- It was found that black carbon, organic carbon, and sulfate concentrations were highest during the winters for each city and Rajshahi had the highest concentrations throughout most of the year.
- Dust in all cities was the highest during the pre-monsoon season and has the highest concentrations in Dhaka mostly caused by the dense population and unfinished construction.
- Looking at the annual cycles of PM2.5, organic carbon, and black carbon from 2000-2022 in all cities, there has been an overall gradual increase in all three pollutants with notable spikes in 2009, 2012, and 2018.
- The seasonal variations reveal that the overall PM2.5 has the greatest concentrations during the winter months although the summer months have seen the greatest variability.
- When Dhaka experiences its best air quality, is when NYC experiences its worst air quality.

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