Coupling NASA Satellite Aerosol Data with Surface Low-cost Air Sensor Observations for Mapping Brick Kiln Particle Emissions in and Around the Megacity of Dhaka, Bangladesh

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Abstract

With a mean annual $PM_{2.5}$ concentration of 77.1 ($\mu g/m^3$) Dhaka, the capital of Bangladesh, and the country of Bangladesh have emerged as the 1st and 2nd most polluted capital and country in the world. The annual mean $PM_{2.5}$ concentration in Dhaka is currently ranked 15.4 times above the World Health Organization's (WHO) annual air quality guideline value. A significant portion of this pollution is contributed by the brick kiln industry throughout the country, specifically surrounding Dhaka. The pollution arising from the traditional energy-inefficient methods used in brick manufacturing is estimated to result in approximately 6,000 deaths per year. Accurate mapping of the pollution distribution is the first step for developing science-based solutions for addressing the pollution resulting from brick kiln pollution in Bangladesh. This study investigates the geographical distribution and seasonal variability of brick kiln pollution and meteorology effects using satellite and ground data. Satellite aerosol optical depth (AOD) data from NASA's MODIS instrument aboard the Aqua and Terra satellites and observations from the deployment of ground sensors around brick kiln industries in Dhaka, were considered and a relationship between these data was investigated. Results show that AOD values extracted from Aqua and Terra satellites show a correlation to elevated ground-based $PM_{2.5}$ measurements in subdistricts of Dhaka which contain high amounts of brick kiln clusters. There are clear differences in surface concentrations of $PM_{2.5}$ between seasons in which producing months have more than a 500% increase than non-producing months. Although decreased AOD values correlate with non-producing versus producing months, the differences are minute compared to those of $PM_{2.5}$ surface measurement variability. The observed seasonal variations in satellite AOD and ground-measured $PM_{2.5}$ concentration are greatly impacted by meteorological factors such as precipitation, boundary layer mixing height, and temperature. Further research is necessary to disentangle the impact of each factor.

Early Career Scientist

YES, I am an early career scientist.

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