Cohort Study of Day-Night Aerosol Characteristics over Different Environments in India: A Recent Start-up and Initial Results

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Abstract

The importance of aerosol in climatic perturbations stems from its heterogeneous nature due largely to the multitude of sources, its volatility and mobility (Holben et al., 1998; Devara et al., 2002; Eck et al., 2020). Multi-site characterization of atmospheric aerosols can help to understand the behavior of aerosols across multiple locations, and how they interact with the environment, local meteorology, and long-range transport. Many studies regarding spatial and temporal variations of atmospheric aerosols have been carried out, but considerable uncertainties still exist due to the large variabilities and ensuing poor understanding of aerosol properties (IPCC, 2007). Plus, both daytime (sun and sky) and nighttime (moon) ground-based passive remote sensing of aerosol properties is sparse over the globe (Berkof, 2011). Measurements available from satellites need accurate calibration and validation with ground truth for different types of aerosols prevailing over characteristic environments. The NASA-AERONET mission made such measurements possible with the model CE318-T since 2016 onwards. This study reports some initial results of the round-the-clock observations of aerosol products carried out over three different environments from the NASA-AERONET CE318-T photometers, installed at Amity University Haryana (AUH), Panchgaon (pristine) in August 2017; Indian Institute of Tropical Meteorology (IITM), Pune (mixed with more industrial) in December 2023; and IITM-ART-CI (Atmospheric Research Testbed in Central India), Bhopal (urban) in January 2024. The results show (i) higher AODs (Aerosol Optical Depth) during daytime as compared to those during nighttime, (ii) inverse relationship between AOD and wavelength, (iii) larger Angstrom Exponent (AE) values, indicating dominance of fine-mode particles over urban and industrial sites while smaller AE (coarse-mode) over rural environment, (iv) seasonal variations are associated with local meteorology. Precipitable water vapor exhibits larger values during nighttime and smaller during daytime. The results obtained from the analysis of synchronous MODIS and CALIPSO satellite data, and HYSPLIT trajectory model for transport are also presented.

Material and Methodology

The regular synchronous data at the three sites in this study have been recorded and the data analyses algorithms have been followed as per the standard protocol of the NASA-AERONET. The level 1.5 data for daytime and level 1.0 data for nighttime measurements of aerosol products are used in this multi-site study. Although several aerosol products have been deduced over three sites associated with different environments, only a few selected parameters have been sown explained here. Moreover, the site at Bhopal commenced only in this year, the data sample size is very small for meaningful comparison of the aerosol features between the sites considered in this study.

Results and Discussion

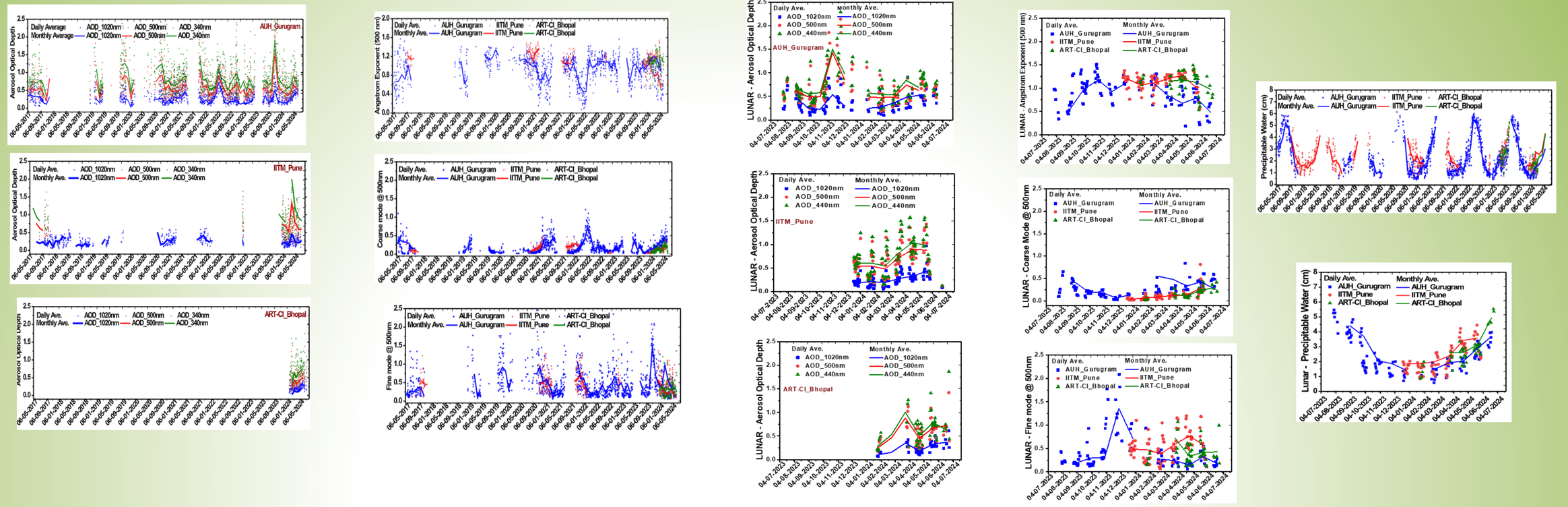

Figure: Space-time cross-sections of different characteristic aerosol parameters over three different environments in India

Conclusions

The results of the preliminary analysis of the data show, in the quiescent conditions (i) higher AODs during day and nighttime over urban environment, (ii) dominance of fine-mode particles during both day and nighttime over urban environment, (iii) higher water vapor during day and nighttime over rural environment. As the data flow at the study sites are continuing, more data with highly reliable results with cloud-screening method for the lunar aerosol data are expected. The day-night asymmetry in aerosol forcing at BOA, ATM and TOA would be more interesting for the study of climate change studies.

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