

Comparative Assessment of PM_{2.5} Concentration over India: Spatio-Temporal Analysis of MERRA-2, CAMS Reanalysis, Satellite and Surface Observations

Vaishnavi S

National Atmospheric Research Laboratory, India. Indian Institute Of Space Science and Technology, India

Author list (excluding presenting author)

Vikas Singh, Vikas

Abstract

Particulate matter (PM) is a complex mixture of chemicals such as metals, organics, inorganics, dust, soot, sea-salt etc. Primary PM can originate from natural or anthropogenic sources and can go through complex chemical reactions to form secondary particles such as sulphate, nitrates etc. Reanalysis datasets have a pivotal role in assessing spatio-temporal variation of pollution concentration, influencing air quality and climate related government policies and health assessments. While these datasets are state-of-the-art, they still may have biases and uncertainties. Hence, an evaluation of these datasets against surface measurements is necessary, mainly for India that has been experiencing poor air quality predominantly due to the high levels of fine particulate matter (PM_{2.5}). In this study we compare and evaluate PM_{2.5} in 2022 over India obtained from MERRA-2 (Modern-Era Retrospective Analysis for Research and Applications), CAMS (Copernicus Atmospheric Monitoring Services) Reanalysis and SDPM25 (Satellite derived PM_{2.5} - a dataset provided by Washington University's Atmospheric Composition Analysis group) against the surface PM_{2.5} measurements by CPCB (Central Pollution Control Board) at 280 locations across India. MERRA-2 does not include nitrates, so this work uses the nitrate to sulphate ratio from various studies in India to estimate the nitrates. The Datasets were inter-compared and evaluated against ground-based observations over different regions of India by calculating different statistical parameters. The results show that PM_{2.5} concentrations from CAMS and SDPM25 are better correlated with surface observation than the MERRA-2. CAMS have higher biases and significantly overestimate surface PM_{2.5} over the polluted regions such as IGP and dusty regions whereas the MERRA-2 and SDPM25 have lower biases. The SDPM25 provides better monthly PM_{2.5} estimates, however, it does not provide daily and hourly estimates. This study underscores the regional model biases for improvements and selecting appropriate datasets for PM_{2.5} assessments in India.

Early Career Scientist

YES, I am an early career scientist.

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