Vol. 4 Issue No. 4, October-December 2022 e-ISSN 2456-7701

Journal of Science and Technological Researches

A Peer Reviewed Journal

Origin of Innovation

Domain: www.jstr.org.in, Email: editor@jstr.org.in

COMPARARTIVE STUDY OF THE $PM_{2.5}$ DURING 2017-2021 OVER JAIPUR, RAJASTHAN

Vikram Sıngh Bhati, Abhishek Saxena*

School of Basic and Applied Sciences, Sangam University, Bhilwara, Rajasthan, India.

Email:saxenaabhishek85@gmail.com

Date of Received	**28 October, 2022**
Date of Revised	**21 November, 2022**
Date of Acceptance	**17 December, 2022**
Date of Publication	**31 December, 2022**

DOI : https://doi.org/10.51514/JSTR.4.4.2022.13-17

COMPARARTIVE STUDY OF THE $PM_{2.5}$ DURING 2017-2021 OVER JAIPUR, RAJASTHAN

Vikram Sıngh Bhati, Abhishek Saxena*

School of Basic and Applied Sciences, Sangam University, Bhilwara, Rajasthan, India.

Email:saxenaabhishek85@gmail.com

ABSTRACT

The present study aims to compare data acquired at Jaipur, an urban site in Rajasthan (26.9124° N, 75.7873° E, 431 MSL) using the ground station and $PM_{2.5}$ aerosol values for the period 2017-2021 were derived from the Modern-Era Retrospective Analysis for Research and Application, version 2. To study aerosol variability, datasets from two different sources were analyzed and compared. The global COVID-19 pandemic forced the consequences of a nationwide lockdown; the $PM_{2.5}$ level dropped by 40% in the first phase of the lockdown (March to May 2020). The seasonal levels were also compared in both datasets. In comparison, higher $PM_{2.5}$ values were observed in post-Monsoon due to aerosol transport and a rise in local emissions after the lockdown was relaxed. However, minima in Monsoon exhibits due to the atmosphere's precipitation/washout of aerosols. A linear fit between the datasets shows similarity within 95% confidence. In 2017-2021 mean value of $PM_{2.5}$ concentrations from Merra-2 and the local station were 46.92 ± 15.99 µg/m3 and 51.24 ± 21.50 µg/m3, respectively. Detailed results will be presented during the presentation.

Keywords: *Aerosol, $PM_{2.5}$, Urban site, Rajasthan*

INTRODUCTION

Extreme pollution of $PM_{2.5}$ is harm for public health in India. This suggests that local traffic may be a significant source of $PM_{2.5}$ and the control of which would be essential to improve air quality. Health effects from exposure to PM or aerosols are widespread and range from mild respiratory diseases to severe chronic effects. The health effects attributed to aerosols are mostly assessed through epidemiological studies on a small group of populations or hospital data on symptoms combined with the occupational information of the patients. Vehicle emissions continue to be the most prevalent source of severe danger to humans [13]. Some examples of studies show direct physiological evidence (whether in humans or experimental animals) for an association between aerosol exposure and disease [1]. Increased fossil fuel consumption is leading to increased emissions of pollutants in Asian countries [2]. Due to the rapidly growing population, increasing development and vehicle density, traffic congestion, degrading road conditions and inadequate regulation of industrial emissions, the air quality in Jaipur has reached dangerous levels [3]. Therefore, effective and efficient measures to curb air pollution become mandatory for the sustainable development of Jaipur and public health. In combination with the studies on health effects, these exposure studies are also valuable in the development of better tools for combustion or better housing design or a change in public policy. Satellite data on fire events showed that crop residue burning across the Punjab area significantly contributed to high $PM_{2.5}$ levels in Delhi during the crop burning season [14]. In the present work, $PM_{2.5}$ aerosols are compared from the Jaipur Ground station (Monitoring in real time - Central Pollution Control Board) (CPCB) and "Modern-Era Retrospective Analysis for Research and Applications", version 2 (MERRA-2) model. In comparison, higher $PM_{2.5}$ values were observed in MERRA-2 datasets than in CPCB during 2017-2021. Seasonal levels reveal that post-monsoon levels are highest. However, long-term (2017-2021) mean $PM_{2.5}$ concentrations from MERRA-2 and CPCB were 46.92 ± 15.99 µg/m^3 and 51.24 ± 21.50 µg/m^3, respectively.

SITE DESCRIPTION

Jaipur is an urban site and the capital city of Rajasthan. Jaipur has a cold and dry winter and hot summer and receives moderate rainfall during the monsoon [4]. Jaipur has witnessed fast expansion as the state capital of Rajasthan during the previous two decades, and its closeness to India's national capital area has a direct influence on its surrounds. From mid-March 2020, Jaipur has seen a considerable

*Author for correspondence

e-ISSN 2456-7701
Vol. 4 Issue No. 4, October-December 2022

improvement in air quality index (AQI) and noise levels due to restricted human activity during the COVID-19 crisis [4]. Hence, it is an important site to investigate.

METHODOLOGY

3.1 Data collection

Data on particulate matter ($PM_{2.5}$) were collected during (2017-2021) in Jaipur, India, using the observations from the real-time monitoring database of the Central Pollution Control Board (CPCB). The hourly averaged data of $PM_{2.5}$ was acquired from CAAQM across India (https://app.cpcbccr.com/ccr/#/caaqm-dashboard/caaqm-landing), which CPCB, Delhi, manage. CPCB evaluation technique and technical information may be found in CPCB Report [5]. Dust storms from the surrounding area and frequently from the Middle East affected in the northwest region [6] [7].

Data quality was ensured by filtering the string records, missing data, incorrect data,unique observations in the data and consider their invalid data. Additionally, we use the MERRA-2 reanalysis $PM_{2.5}$ products during the same period to compare with CPCB. NASA's Global Modeling and Assimilation Office (GMAO) provided the MERRA-2 data with a horizontal resolution of 0.5° x 0.625° (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/). There have been reports on the MERRA-2 items and evaluation details [8], [9], [10]. Data collected from CPCB and MERRA2 models were averaged seasonally and annually. The statistics are shown in the table. The mean of the MERRA-2 Model and CPCB were 46.92±15.99 μg/m^3 and 51.24±21.50 μg/m^3, respectively.

$PM_{2.5}$	MERRA-2 Model (μg/m^3)	CPCB (μg/m^3)
Mean	46.92	51.24
Max	111.00	110.90
Min	20.70	14.61
std	15.99	21.50
Skewness	1.38	0.68
Kurtosis	3.31	-0.02

Table: Mean statistics of $PM_{2.5}$ data at Jaipur during 2017-2021

3.2. Limitations

Duration of analyzing the result, it should be noted that the CPCB observe location in Jaipur is situated in an urban region. Therefore, the current study focuses on urban changes rather than regional or rural ones. The current study reports on increases in air pollution from 2017 to 2021, including the COVID-19 lockdown and successive unlock periods. Variations in emissions, urban meteorology, atmospheric, dynamics and chemistry all affect the amount of pollutants in the air. The possible factors causing the reduction in pollution levels could be the impact of western disturbances, lockdown(s), global level dynamics, and non-linear chemistry.

RESULT AND DISCUSSIONS

This paper presents five years of continuous measurement of $PM_{2.5}$ from 2017-2021. The missing CPBC data are due to instrument re-calibration and maintenance intervals. Daily CPCB coverage for the entire study period was very high. Such data coverage helps perform time-series statistical analysis. The table represents the $PM_{2.5}$ mean statistic computed. Figure 1 shows the comparison of long-term trends between the two datasets [11]. The sources such as regional transport have a more substantial influence on $PM_{2.5}$ concentrations. Hence reduction in anthropogenic activities, a minimum, was observed during the covid19 lockdown, then it quickly rose to normal levels and spiked during Dec-2021 [12]. The results are consistent with the winter peaks observed in previous years. Figure 2 shows the seasonal mean from both datasets, consistent with the previous graph. Please note that the MERRA2 model shows lesser values than the CPCB dataset. This difference in magnitude could be attributed to the grid resolution of the model, a-priori values, and equations solved in the model; the $PM_{2.5}$ concentrations peak in the post-monsoon period and minima in the monsoon season. In figure 3, a linear fit is established between both datasets. The R-value is 0.7, showing good linearity. However, the spread is inconsistent, which is attributed to the different distribution of the datasets. We will incorporate meteorological parameters from both datasets in future work to get more insight and correlation. This is carried out for an urban site. An inter-comparative study between urban, rural, and industrial sites is underway.

e-ISSN 2456-7701
Vol. 4 Issue No. 4, October-December 2022

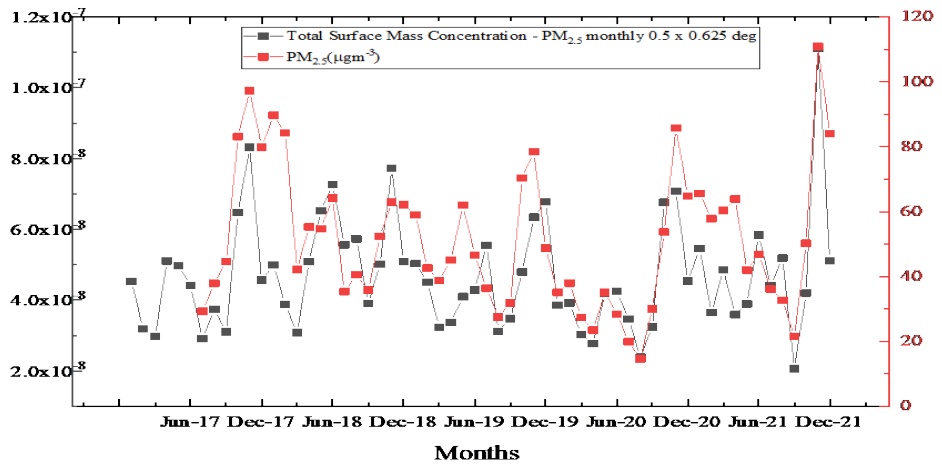

Fig. 1 : Comparison of $PM_{2.5}$ concentration from MERRA and CPCB data from 2017-2021.

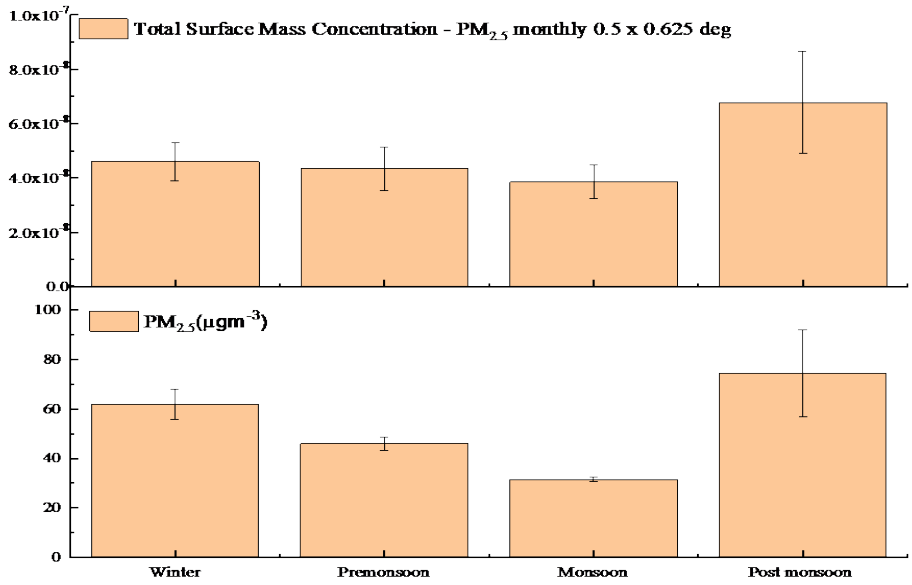

Fig. 2: Comparison of $PM_{2.5}$ Seasonal average from MERRA and CPCB data.

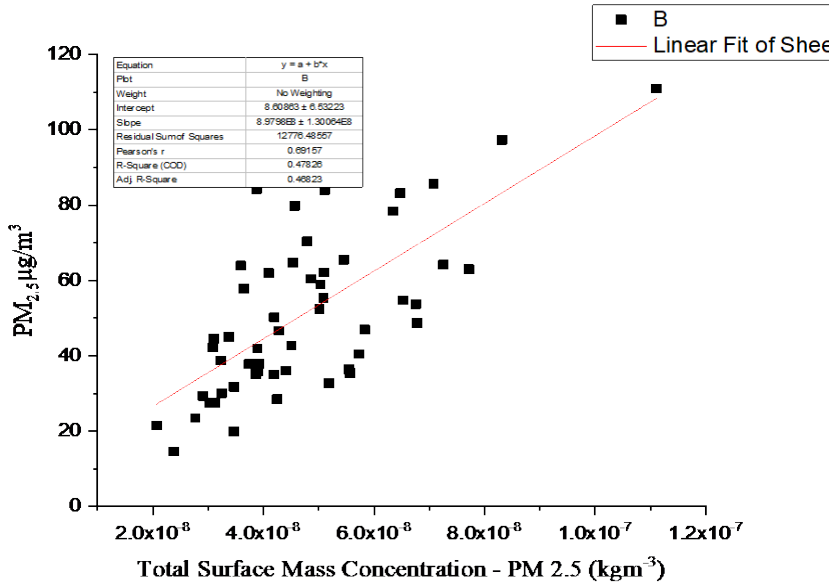

Fig. 3: Linear Fit between MERRA and CPCB data.

CONCLUSIONS

We have examined $PM_{2.5}$ concentrations from two different datasets observations over Jaipur, Rajasthan. The study of the ground-based $PM_{2.5}$ provides the fine details of the characteristics, and based on our analysis, we are able to conclude the finding as:

- Daily contributions breakdown suggests that regional transportation is more influential for higher $PM_{2.5}$ concentrations.
- Before the lockdown, Jaipur's $PM_{2.5}$ concentrations was higher than the national norm; interestingly, a significant reduction in $PM_{2.5}$ concentration occurred as the lockdown was initiated. However, after the lockdown, air pollution is continuously growing daily.
- The supplementary pollution source in Rajasthan is industrial activities and crop residue burning in addition to the local sources.
- Overall, the regional disparity consequences from the comparative study infer that more urban locations such as Jaipur should be studied in particular for model improvements.

ACKNOWLEDGMENT

All of the authors are grateful to and acknowledge the Central Pollution Control Board (CPCB, India) and the Rajasthan State Pollution Control Board (RSPCB) for making the air quality data and GMAO MERRA-2 meteorological data information publicly available. The authors are grateful for the conference committee's approval to let them present their work.

Credit statement

Vikram Singh: Conceptualization, Formal analysis, Investigation,

Abhishek Saxena: Visualization, Review, Editing,

Writing original draft, and Discussion

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

[1]. Balakrishnan, K., Sambandam, S., Ramaswamy, P., Mehta, S., & Smith, K. R. (2004). Exposure assessment for respirable particulates associated with household fuel use in rural districts of Andhra Pradesh, India. Journal of Exposure Science & Environmental Epidemiology, 14(1), S14-S25.

[2]. Baldasano, J. M., Valera, E., & Jiménez, P. (2003). Air quality data from large cities. Science of the Total Environment, 307(1-3), 141-165.

[3]. Kumar, A., Garg, A., &Pandel, U. (2011). A study of ambient air quality status in Jaipur city (Rajasthan, India), using air quality index. Nature and Science, 9(6), 38-43.

[4]. Bhardwaj, A. (2020). Effect on the Air Quality and Noise Levels of Jaipur City in the Event of COVID-19: A Short Review. Environmental Sciences Proceedings, 4(1), 2.

[5]. CPCB (2019), Annual report, Available at: https://cpcb.nic.in/annual-report/(accessed 20October 2022).

[6]. Yadav, R., Sahu, L. K., Beig, G., Tripathi, N., &Jaaffrey, S. N. A. (2017). Ambient particulate matter and carbon monoxide at an urban site of India: influence of anthropogenic emissions and dust storms. Environmental Pollution, 225, 291-303.

[7]. Verma, S., Payra, S., Gautam, R., Prakash, D., Soni, M., Holben, B., & Bell, S. (2013). Dust events and their influence on aerosol optical properties over Jaipur in Northwestern India. Environmental monitoring and assessment, 185(9), 7327-7342.

[8]. Gelaro, R., McCarty, W., Suárez, M. J., Todling, R., Molod, A., Takacs, L., ... & Zhao, B. (2017). The modern-era retrospective analysis for research and applications, version 2 (MERRA-2). Journal of climate, 30(14), 5419-5454.

[9]. Randles, C. A., Da Silva, A. M., Buchard, V., Colarco, P. R., Darmenov, A., Govindaraju, R., ... & Flynn, C. J. (2017). The MERRA-2 aerosol reanalysis, 1980 onward. Part I: System description and data assimilation evaluation. Journal of climate, 30(17), 6823-6850.

[10]. Buchard, V., Randles, C. A., Da Silva, A. M., Darmenov, A., Colarco, P. R., Govindaraju, R., ... & Yu, H. (2017). The MERRA-2 aerosol reanalysis, 1980 onward. Part II: Evaluation and

case studies. Journal of Climate, 30(17), 6851-6872.

[11]. Panchabikesan, K., Vellaisamy, K., & Ramalingam, V. (2017). Passive cooling potential in buildings under various climatic conditions in India. Renewable and Sustainable Energy Reviews, 78, 1236-1252.

[12]. Saxena, A., & Raj, S. (2021). Impact of lockdown during COVID-19 pandemic on the air quality of North Indian cities. Urban Climate, 35, 100754.

[13]. Pavel, M. R. S., Zaman, S. U., Jeba, F., Islam, M. S., & Salam, A. (2021). Long-Term (2003–2019) Air Quality, Climate Variables, and Human Health Consequences in Dhaka, Bangladesh. Frontiers in Sustainable Cities, 52.

[14]. Dhaka, S. K., Longiany, G., Panwar, V., Kumar, V., Malik, S., Singh, N., ... &Hayashida, S. (2022). Trends and Variability of $PM_{2.5}$ at Different Time Scales over Delhi: Long-term Analysis 2007-2021. Aerosol and Air Quality Research, *22*, 220191.

[15]. Biswas, J., & Pathak, B. (2022). Effects of COVID-19 pandemic lockdown: A satellite data-based appraisal of air quality in Guwahati, Assam. Materials Today: Proceedings, 65, 2794-2800.

[16]. Liu, S., Yang, X., Duan, F., & Zhao, W. (2022). Changes in Air Quality and Drivers for the Heavy $PM_{2.5}$ Pollution on the North China Plain Pre-to Post-COVID-19. International Journal of Environmental Research and Public Health, 19(19), 12904.