Assessment of Changes in Air Quality since the National Clean Air Programme

Launch Webinar
January 13, 2026 | 3:00 – 4:30 PM IST

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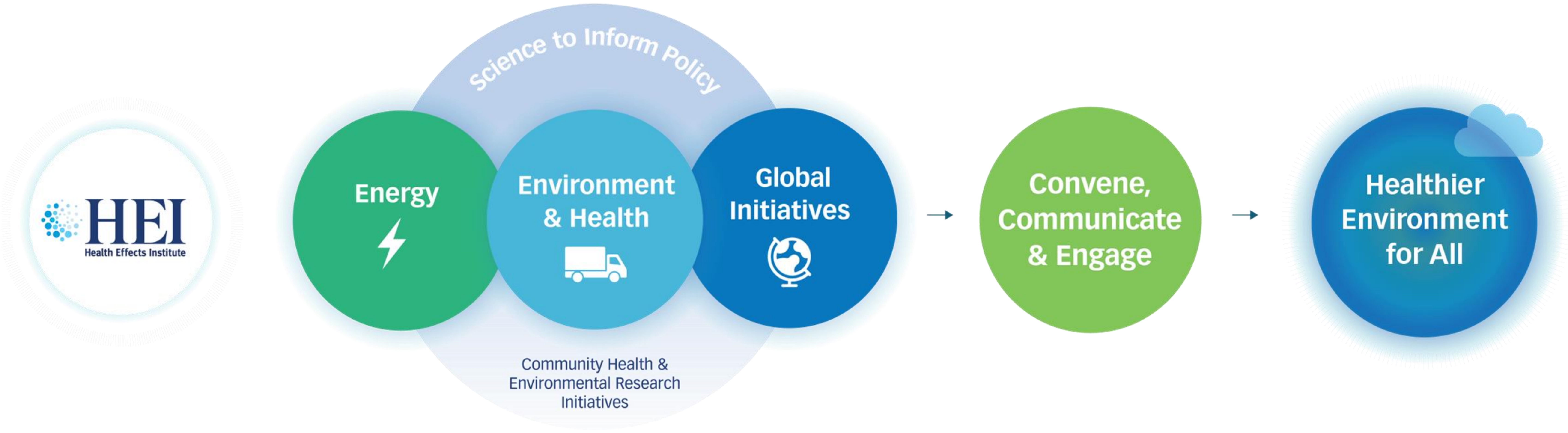
ABOUT HEI



HEI provides impartial science to inform decisions that foster a healthier environment for all.

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Assessment of Changes in Air Quality since the National Clean Air Programme

Approach & Key findings

Abinaya Sekar, PhD
January 13, 2026

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National Clean Air Programme (NCAP)

Launched in 2019

Aim: To reduce PM_{10} and $PM_{2.5}$ levels and focuses on monitoring, emission reduction across multiple sectors, and to enhance public awareness.

Pollution reduction target:

Initially, the target was a 20–30% reduction in PM_{10} and $PM_{2.5}$ by 2024, using 2017 as the baseline.

In September 2022, this was revised to a PM_{10} reduction of up to 40% or meeting national standards by 2025–26.

Target for monitoring stations: 1500 for manual stations and 150 for Continuous Ambient Air Quality Monitoring Stations.

Funding: Of the 130 cities, million-plus cities receive grants under the 15th Finance Commission, while others are funded through MoEFCC's Control of Pollution Scheme.

Over ₹13,000 crore has been spent on air quality improvement.

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Overview

Data	Pollutants	Assessment Period	Locations
Continuous ambient air quality monitoring stations	PM_{10} and $PM_{2.5}$	2017-2024	NCAP cities (n = 102)

- Annual NAAQS compliance & Number of days of 24 hr-NAAQS exceedance
- Use of data from a single station average vs. city average
- Use of annual average vs. three-year rolling average
- Rate of change from the baseline year (2017, or the earliest available year after 2017),
- Trend assessment using non-parametric approaches, and testing the effect of season and meteorology.

- Seasonal trend decomposition using Locally Estimated Scatterplot Smoothing (LOESS) [openair package in R]
- Weather normalization [rmweather package in R] - Weather Normalization (ERA5 data)
  - Temperature, boundary layer height, precipitation, relative humidity, wind direction, wind speed, and atmospheric pressure
- Non-parametric tests: Mann-Kendall and Theil-Sen estimation

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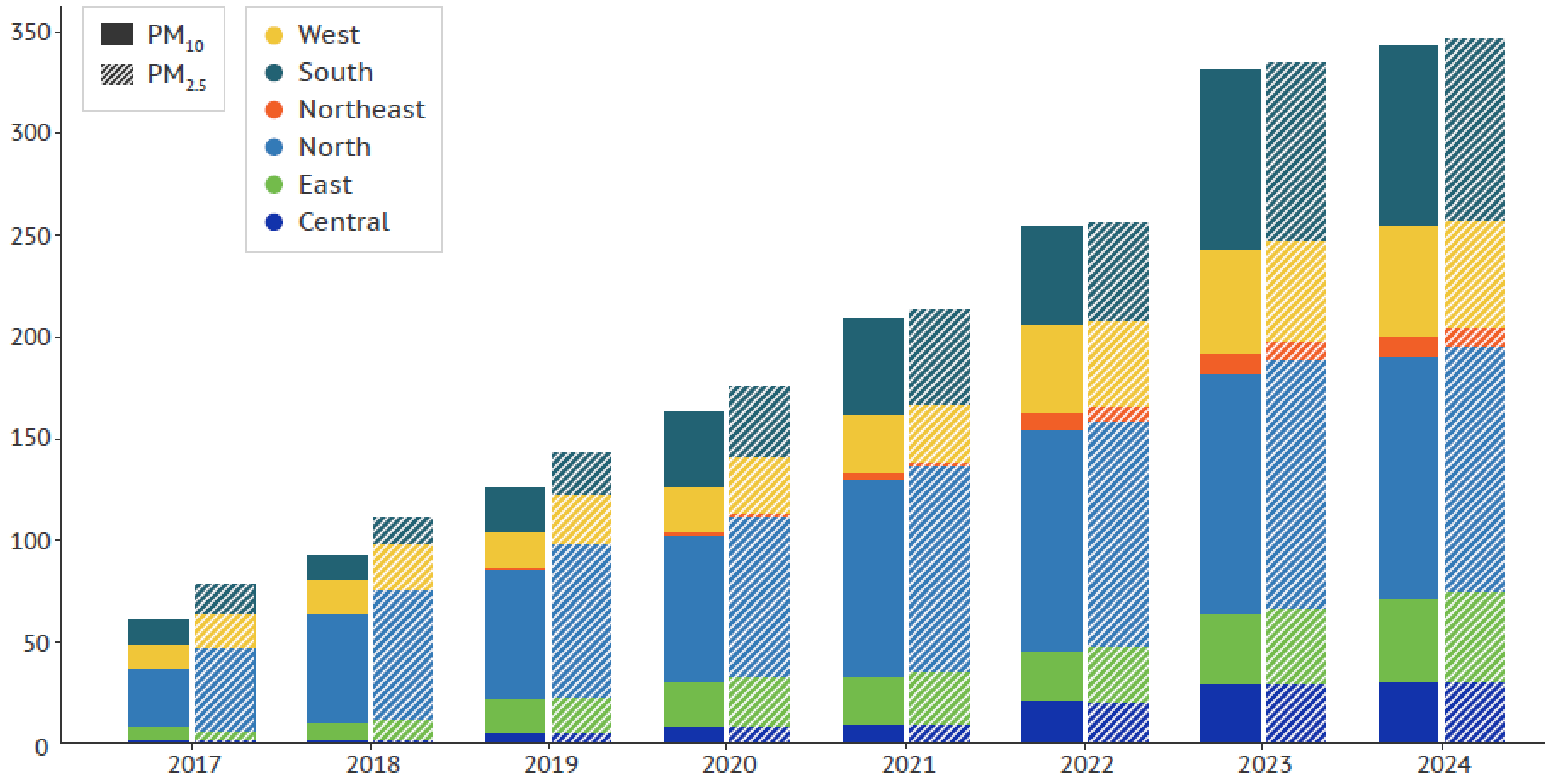
The number of stations and data availability increased since 2017

Number of real-time monitoring stations between 2017 and 2024



$PM_{2.5}$ - increased by 344%, rising from 78 stations in 38 cities (2017) to 346 stations in 101 cities (2024).

PM_{10} - increased by 462%, rising from 61 stations in 33 cities (2017) to 343 stations in 102 cities (2024).

The highest increase was observed in the northern region, while the smallest increase was seen in the Northeast.

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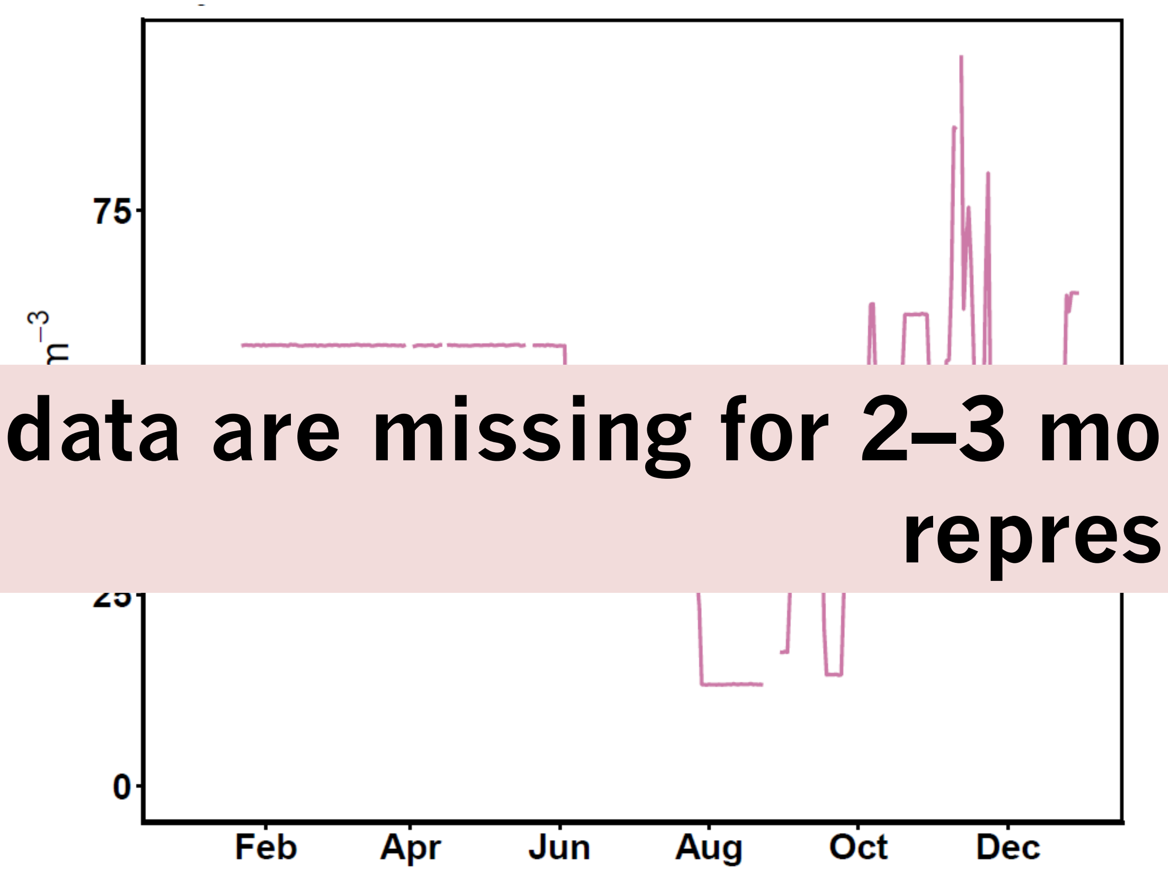
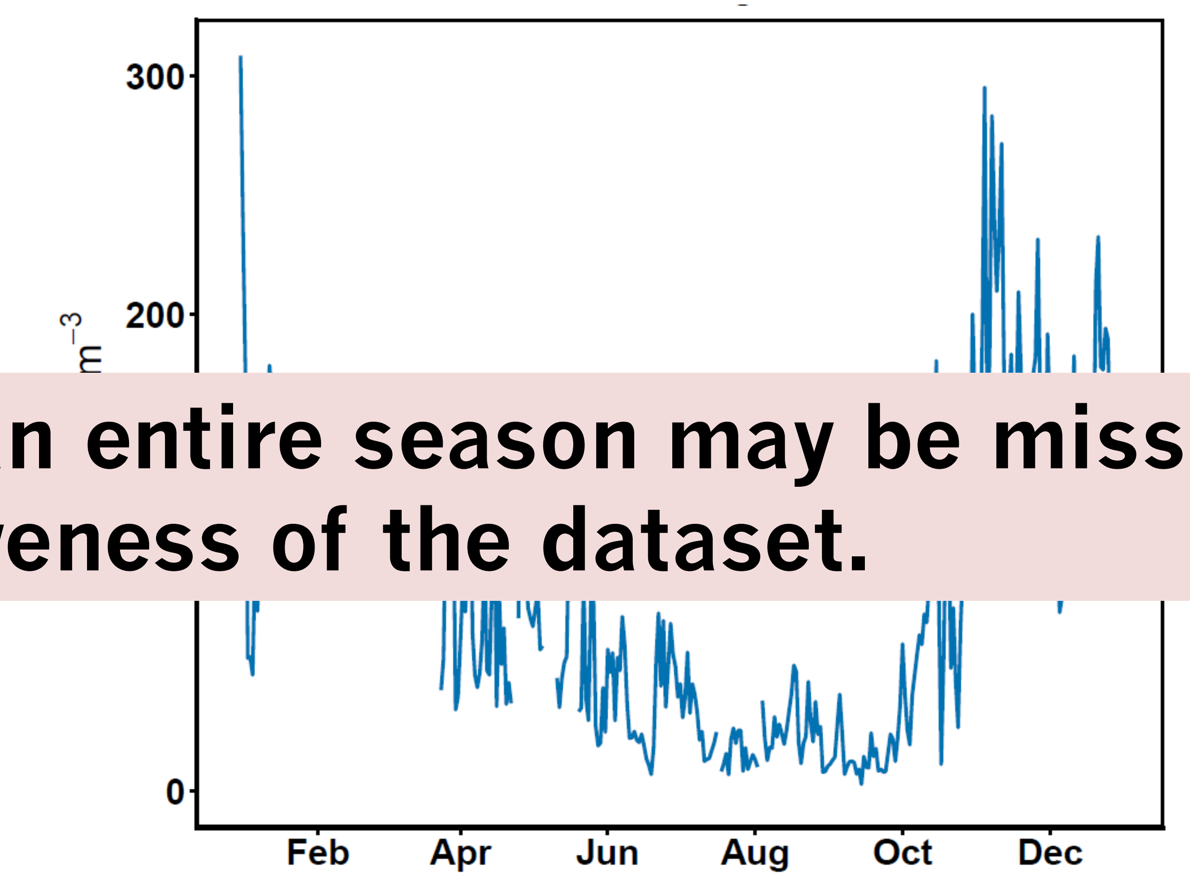
Annual data availability thresholds alone are insufficient

(a) SAC ISRO Satellite, Ahmedabad; data availability: 90.1%



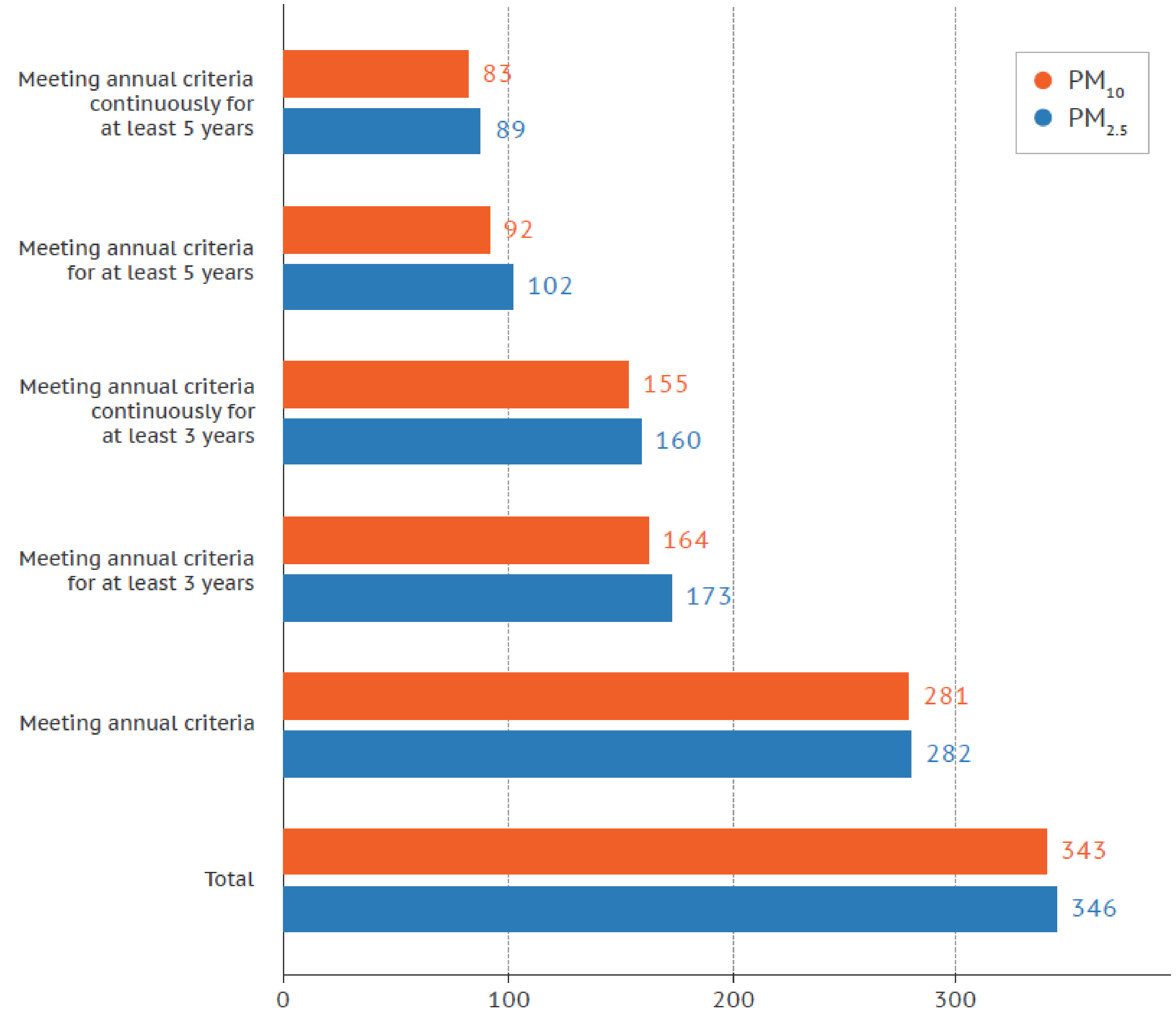
(b) Jai Bhim Nagar, Meerut; data availability: 78.4%



If data are missing for 2–3 months, an entire season may be missed, reducing the representativeness of the dataset.

Data completeness criteria for the analysis - at least 18 hours daily, 23 days or more each month and data for 11 months.

Number of monitoring stations under various data criteria between 2017-2024



Data completeness criteria - at least 18 hours daily, 23 days or more each month and data for 11 months.

After applying data completeness criteria, station numbers reduced drastically, reducing the number of stations available for assessment of trends.

~82% of PM_{10} and $PM_{2.5}$ stations meet annual data completeness criteria for any year between 2017-2024

~50% of stations have ≥3 years of complete data

~45% have continuous complete data for ≥3 years *(minimum used for trend assessment)*

~25% have continuous complete data for ≥5 years

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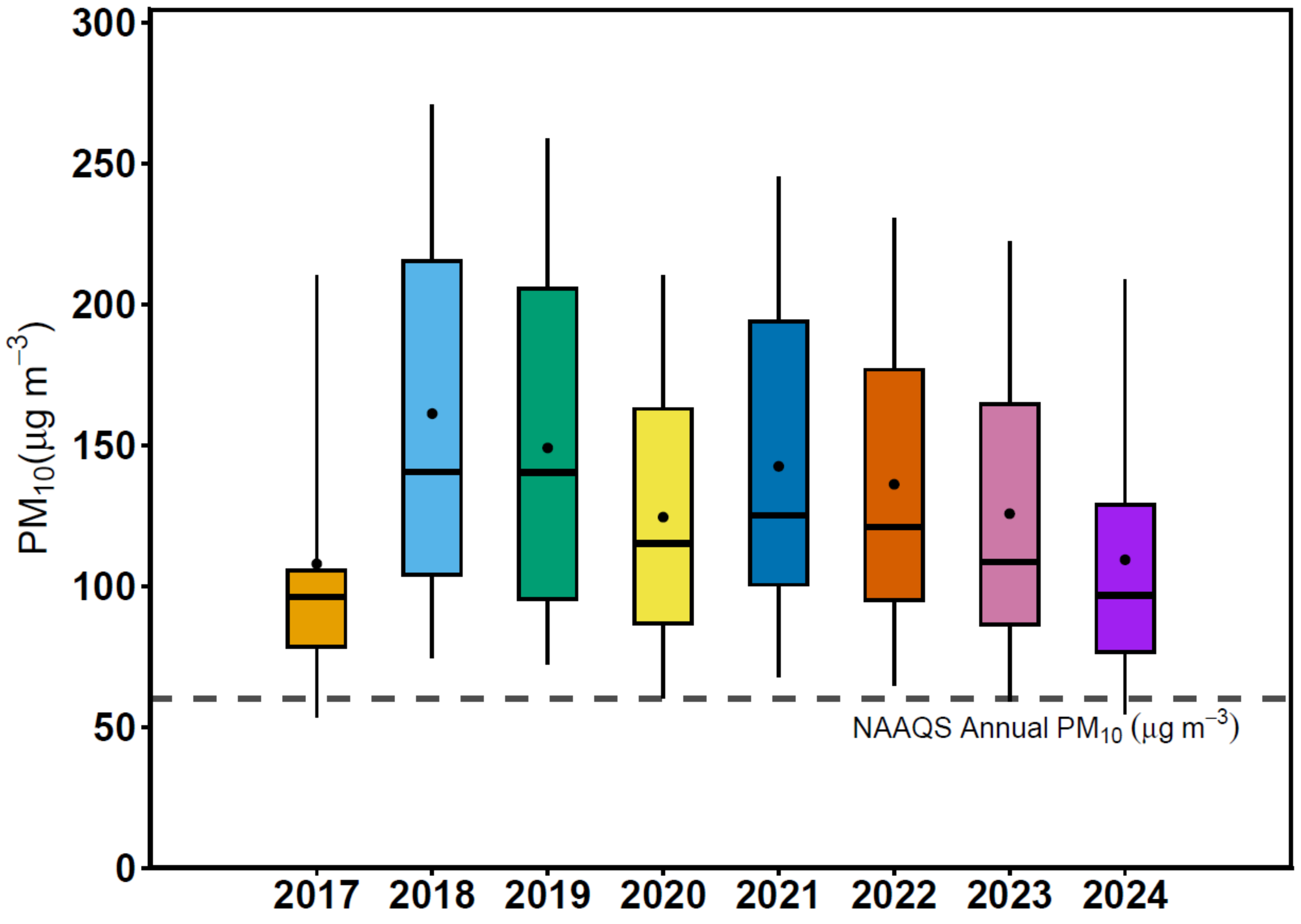
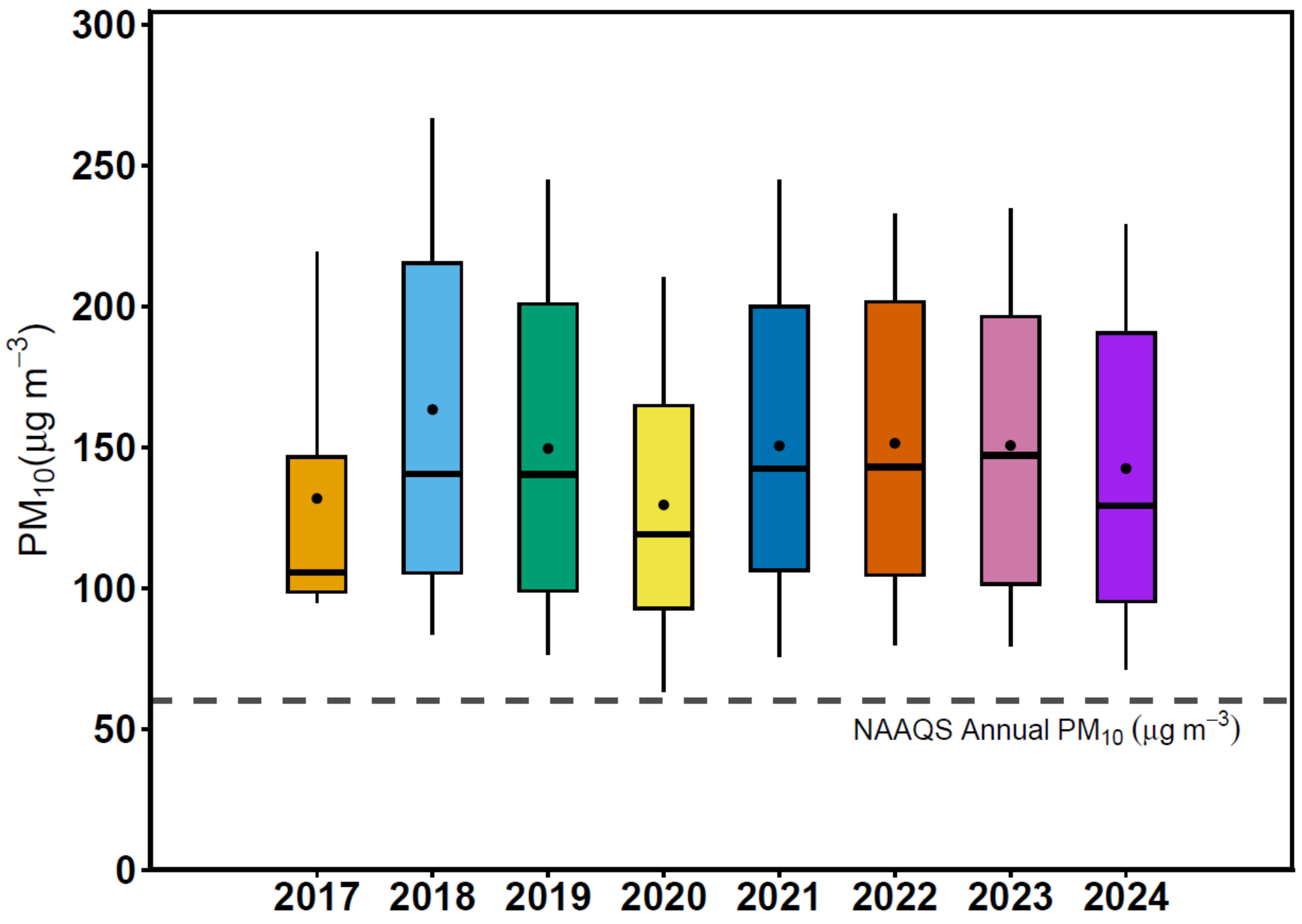
Selection of stations and data availability can influence the observed trends



(a) Annual average PM_{10} from stations meeting completeness criteria for any year between 2017-2024



(b) Annual average PM_{10} from stations with at least five years of complete data between 2017-2024

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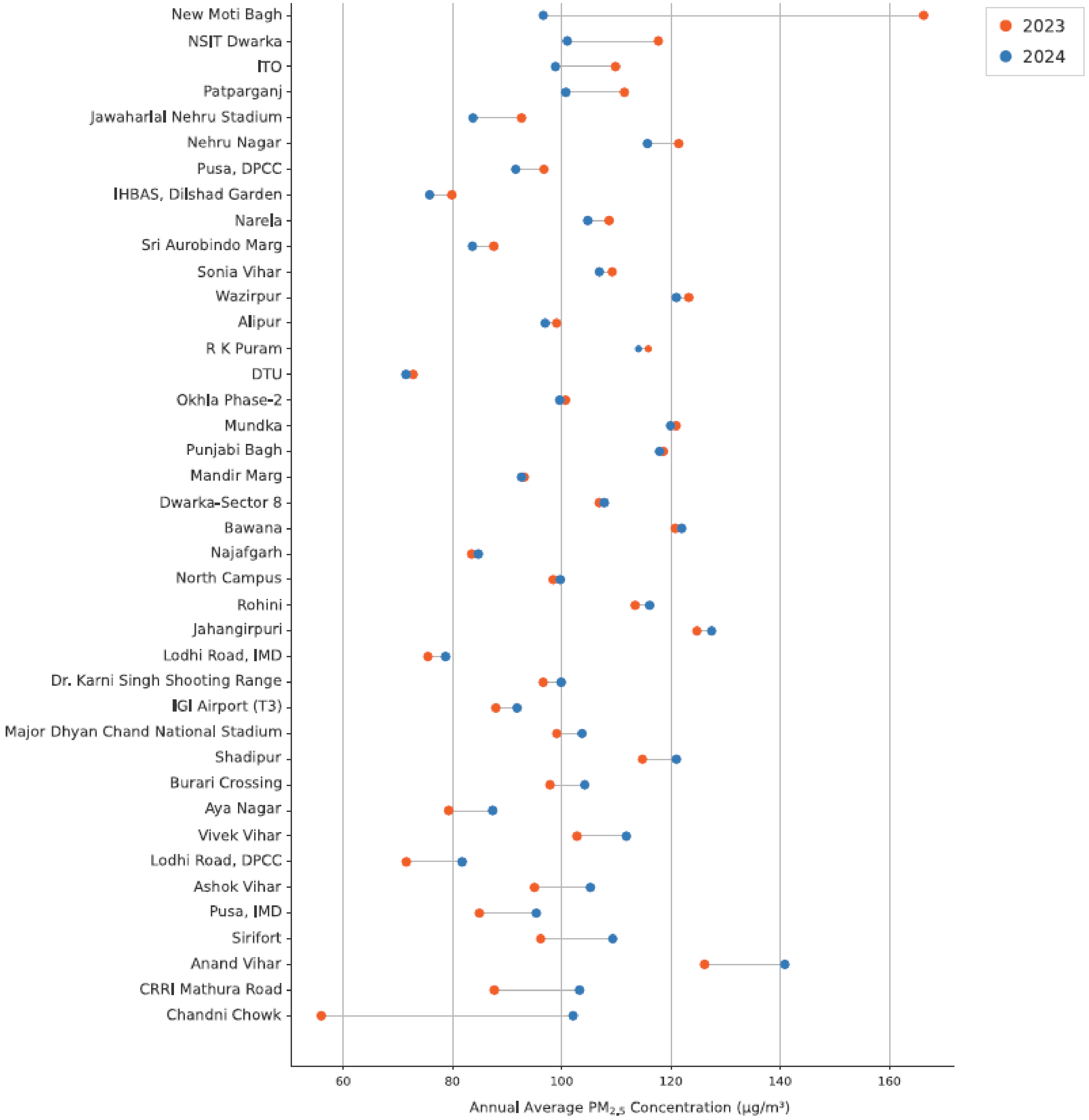
Station-level averages offer better representation of local variation than city-wide averages

We analysed 553 station–year pairs to assess consistency between station-level and city-level annual PM_{10} concentrations.

443 records (~80%) were within ±20% of the corresponding city average, indicating strong overall alignment; however, 110 records (20%) exceeded this threshold.

For example, in Delhi (2019), 27 stations met annual completeness criteria; however, only 16 (~59%) fell within the ±20% range.



Change in $PM_{2.5}$ level between 2023 and 2024 in Delhi

In terms of annual NAAQS compliance, progress has been observed for $PM_{2.5}$, whereas limited improvement is seen for PM_{10}

Year	PM_{10}		$PM_{2.5}$	
	Total number of stations	Number of stations above annual NAAQS (%)	Total number of stations	Number of stations above annual NAAQS (%)
2017	11	**10 (91%)**	17	**16 (94%)**
2018	59	57 (96%)	70	63 (90%)
2019	77	76 (99%)	91	75 (82%)
2020	101	97 (96%)	117	90 (77%)
2021	115	113 (98%)	131	104 (79%)
2022	160	156 (98%)	159	130 (82%)
2023	184	174 (95%)	178	132 (76%)
2024	281	**258 (92%)**	282	**173 (61%)**

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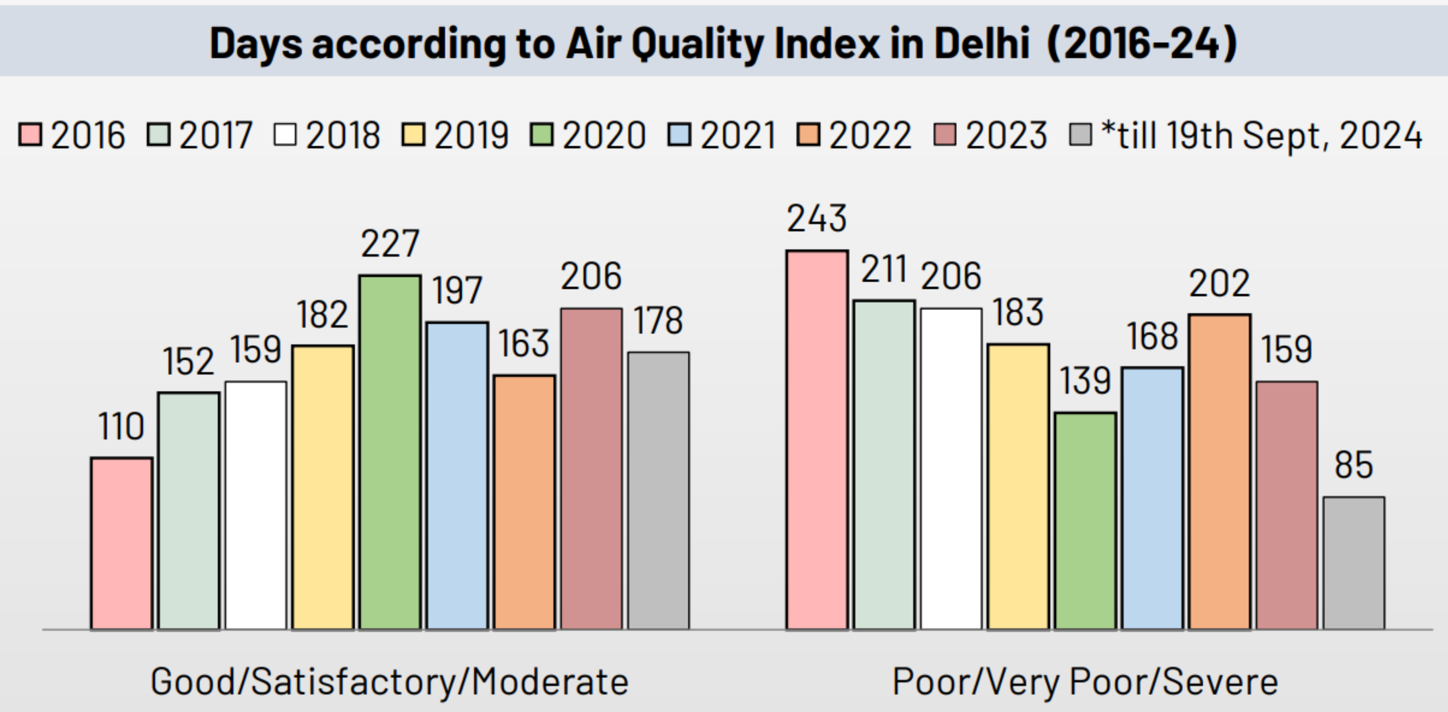
The number of NAAQS exceedance days is not a reliable metric for tracking long-term trends

Some states assess progress by tracking changes in the number of good air days or days exceeding the 24-hour NAAQS threshold



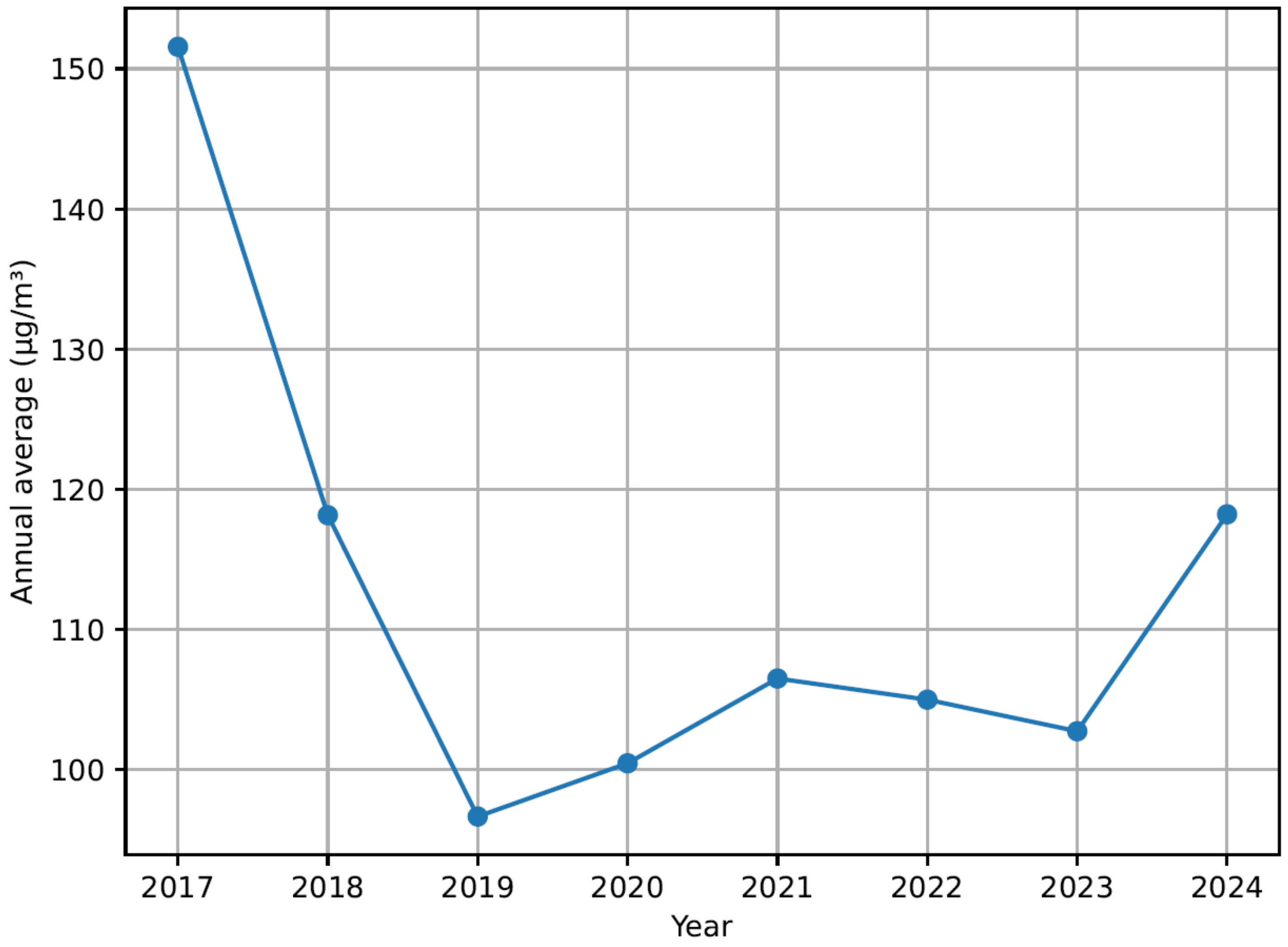
Source: DPCC, 2024

For example, at stations with at least five years of data, we found that in states such as Delhi, Punjab, Maharashtra, Rajasthan, Telangana, and West Bengal, the data showed high variability with no clear trend.

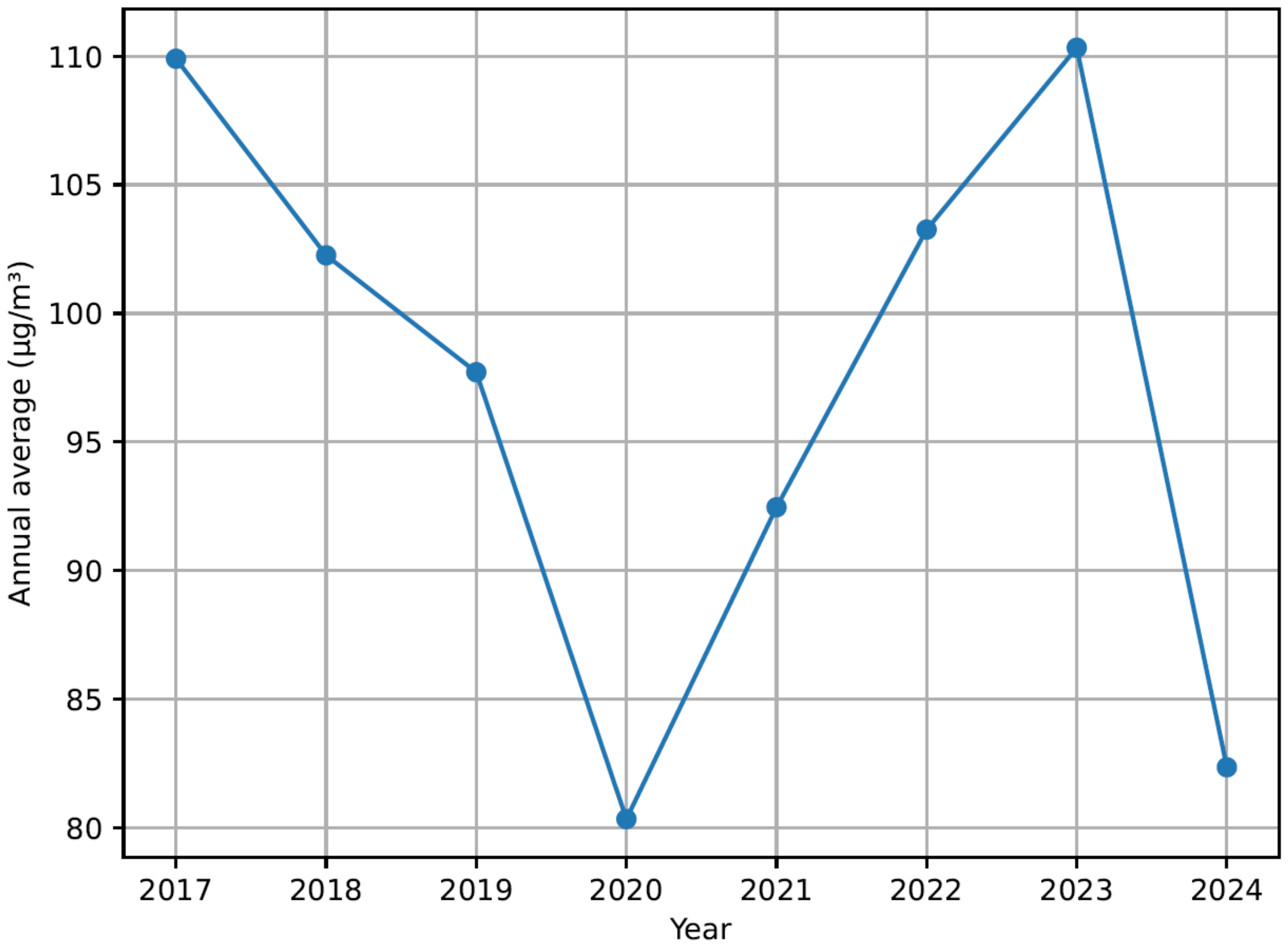
Exceedance counts or good AQI days are binary and insensitive to magnitude, and at both the station and city levels they fail to provide a consistent trend.

Absolute change between 2 years can be misleading

Of the total $PM_{2.5}$ monitoring stations analyzed (n = 211), approximately 68 % showed a decreasing trend, while about 32 % showed an increasing trend.



(a) PM_{10}, Golden Temple, Amritsar - Baseline levels are very high



(b) PM_{10}, Bollaram Industrial Area, Hyderabad - Baseline levels are very low

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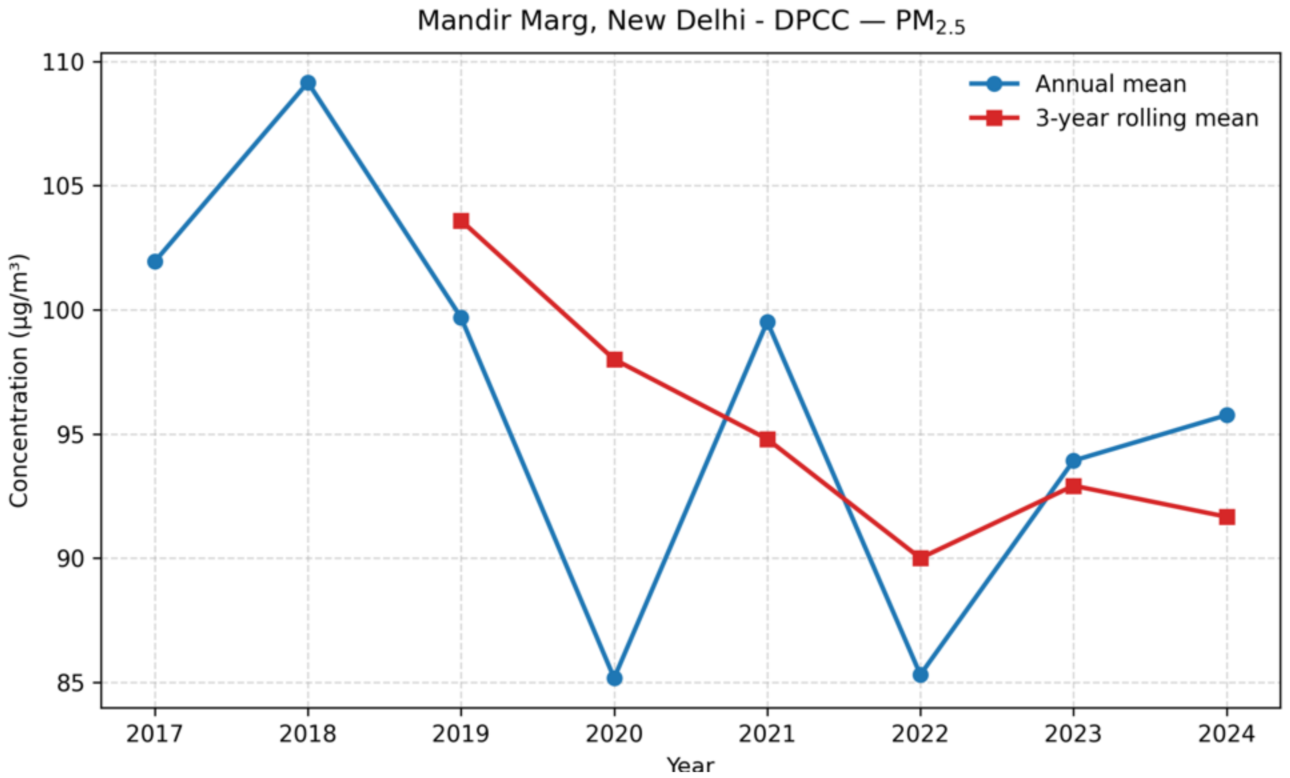
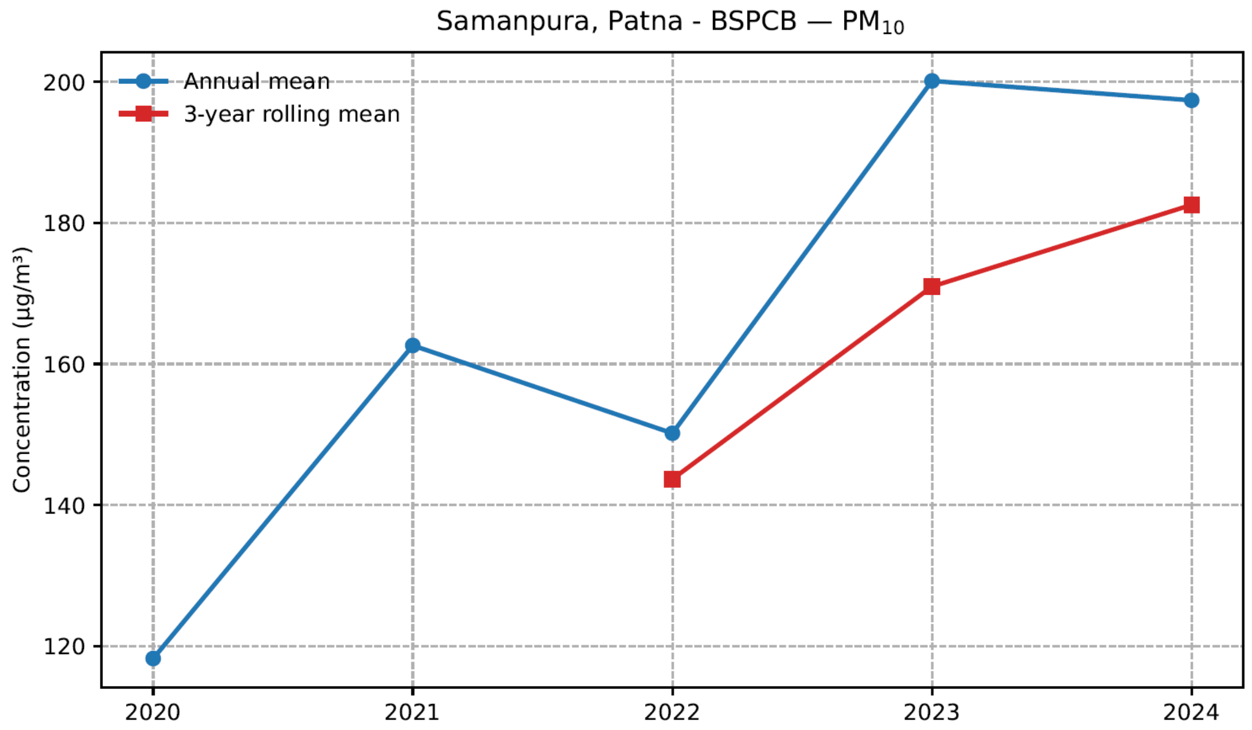
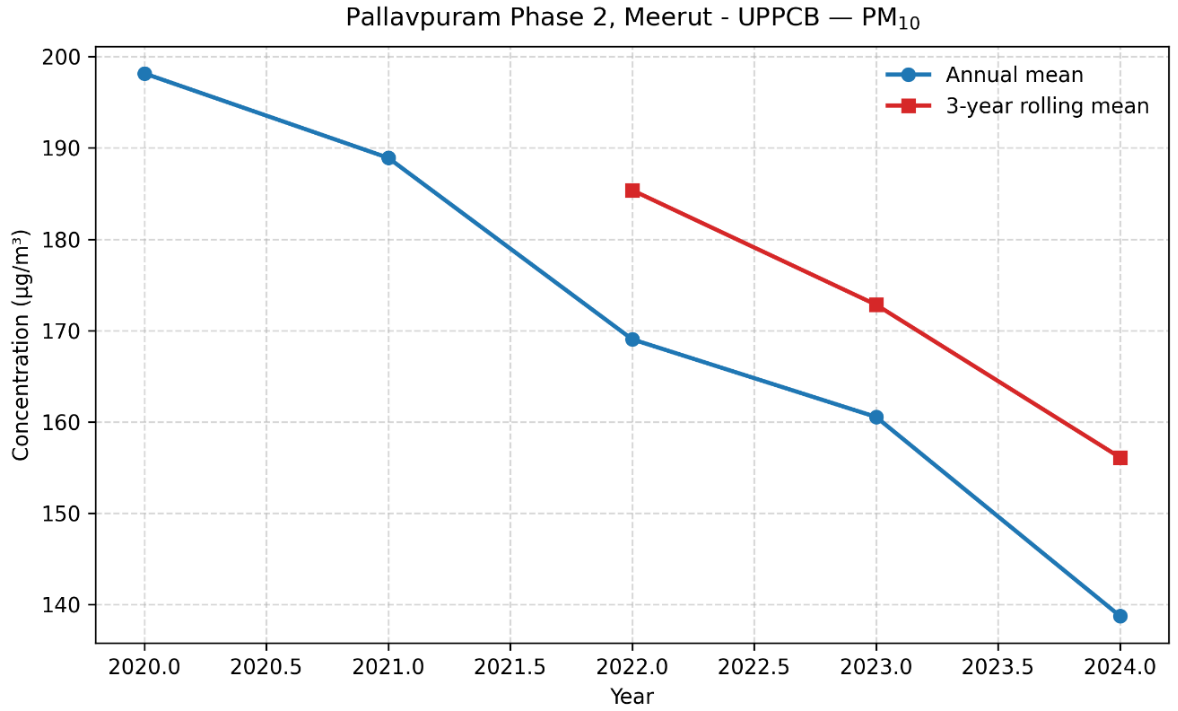
Three-year rolling averages provide more reliable signals of sustained change over time.





Higher annual averages indicate recent increases in pollution



Three-year rolling average is higher, indicating higher past levels and a recent decline.

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More than half of the stations show a declining trend

Trend assessments show a decrease in more than half of the stations across all datasets (raw, deseasoned, weather-normalized) for both PM_{10} and $PM_{2.5}$.

Deseasoned and weather-normalized data reveal a more pronounced trend, indicating that seasonal and meteorological factors can introduce noise and obscuring the underlying long-term signal.

PM_{10} (n=155) - Decreasing trends observed at 67% (raw), 65% (deseasoned), and 64% (weather-normalized) of stations.

$PM_{2.5}$ (n=160) - Decreasing trends observed at 74% (raw), 69% (deseasoned), and 74% (weather-normalized) of stations.

PM_{10} (n=155) - Statistically significant decreasing trends increase from 25 stations (raw) to 63 (deseasoned) and 84 (weather-normalized).

$PM_{2.5}$ (n=160) - Statistically significant decreasing trends increase from 36 stations (raw) to 87 (deseasoned) and 103 (weather-normalized).

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KEY TAKEAWAYS

The number of air quality monitoring stations has increased substantially, and more data are now available as additional stations come online. However, rigorous evaluation of data completeness remains essential for credible trend detection.

Using a rolling average can be more reliable for assessing air quality trends, especially for regulatory reporting. Accounting for meteorological variability tools is critical, especially when evaluating changes over time.

Trend analysis shows that PM_{10} and $PM_{2.5}$ levels are declining at many monitoring stations. The magnitude of improvement is vastly different across locations. In addition to PM_{10}, $PM_{2.5}$ should also be considered when assessing air quality progress, as even small changes in $PM_{2.5}$ levels can have a significant impact on public health and quality of life.

Thank you!

If you are interested in trends for a specific station, city, or state, please email Abinaya Sekar at **asekar@healtheffects.org**.

www.healtheffects.org | www.stateofglobalair.org | www.heienergy.org

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UPCOMING WEBINAR

Use of Low-Cost Sensors for Air Quality Monitoring in South Asia

JANUARY 20, 2026–FEBRUARY 17, 2026
3:00PM TO 4:30PM IST

HEI is pleased to announce a five-part virtual webinar series focused on the use of low-cost sensors for air quality monitoring.

Global Initiatives