Air Quality Index (AQI) Report

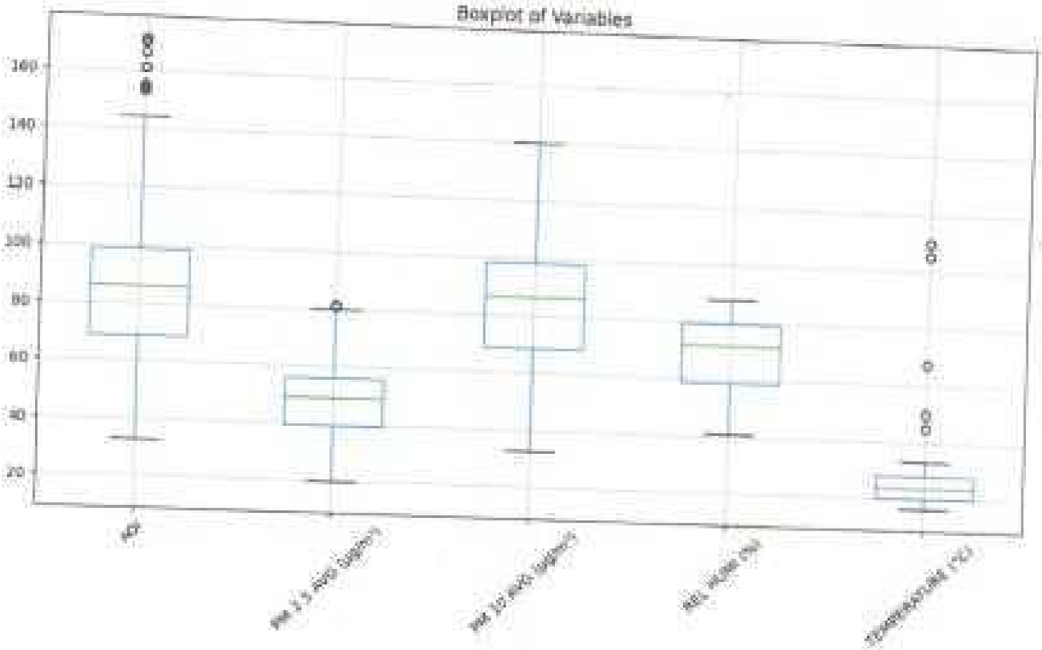
Data Source: West Bengal Pollution Control Board
Station: Bhasa,2nd Campus of Asutosh College
(Nov_2025)

Introduction

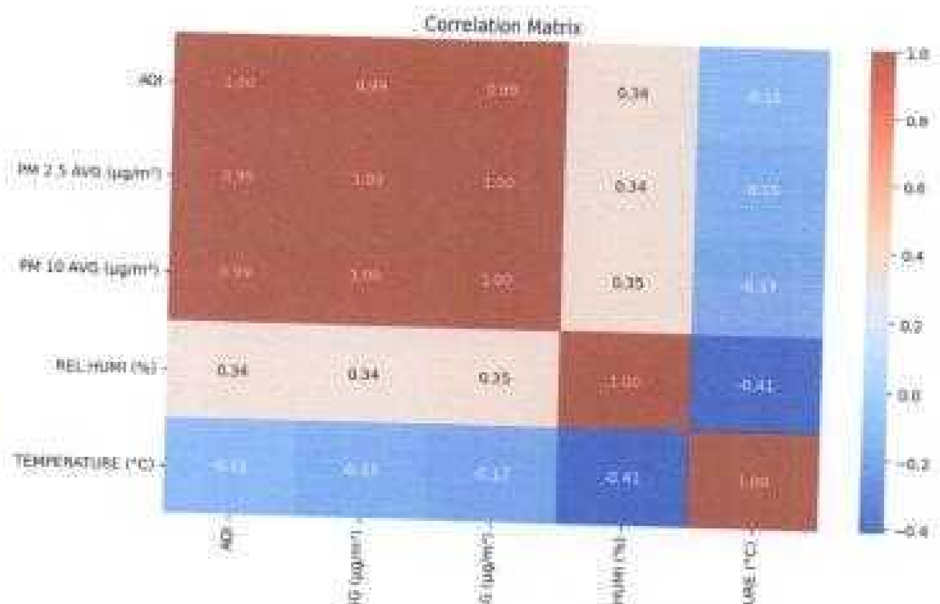
The month of **November** usually shows a noticeable rise in air pollution levels in many parts of India, reflected in higher values of the Air Quality Index (AQI). As winter begins to set in, the atmosphere becomes cooler and more stable, which slows down the dispersion of pollutants. This leads to the accumulation of particulate matter such as **$PM_{2.5}$ and PM_{10}**, along with emissions from vehicles, industries, construction, and seasonal biomass burning. As a result, AQI levels during November often range from **moderate to very poor**, especially in urban and semi-urban regions. Understanding AQI trends in this month is important for assessing environmental quality, identifying pollution sources, and taking necessary health precautions for vulnerable populations.

The Air Quality Index (AQI) around the Bhasa campus during the month of **November** typically shows a noticeable decline due to seasonal and regional environmental factors. November marks the transition from the post-monsoon season to early winter, when atmospheric conditions such as lower temperature, calm winds, and increased moisture lead to **reduced dispersion of pollutants**. As a result, particulate matter—especially **$PM_{2.5}$ and PM_{10}**—tends to accumulate in the air. Local sources such as nearby construction activities, vehicular emissions along connecting roads, biomass burning in surrounding rural pockets, and occasional industrial influence contribute to rising pollution levels. Together, these factors often push the AQI into the **moderate to poor category**, making air quality a concern for sensitive groups. Monitoring AQI trends during this month becomes essential for understanding pollution dynamics and taking precautionary measures in the Bhasa campus region.

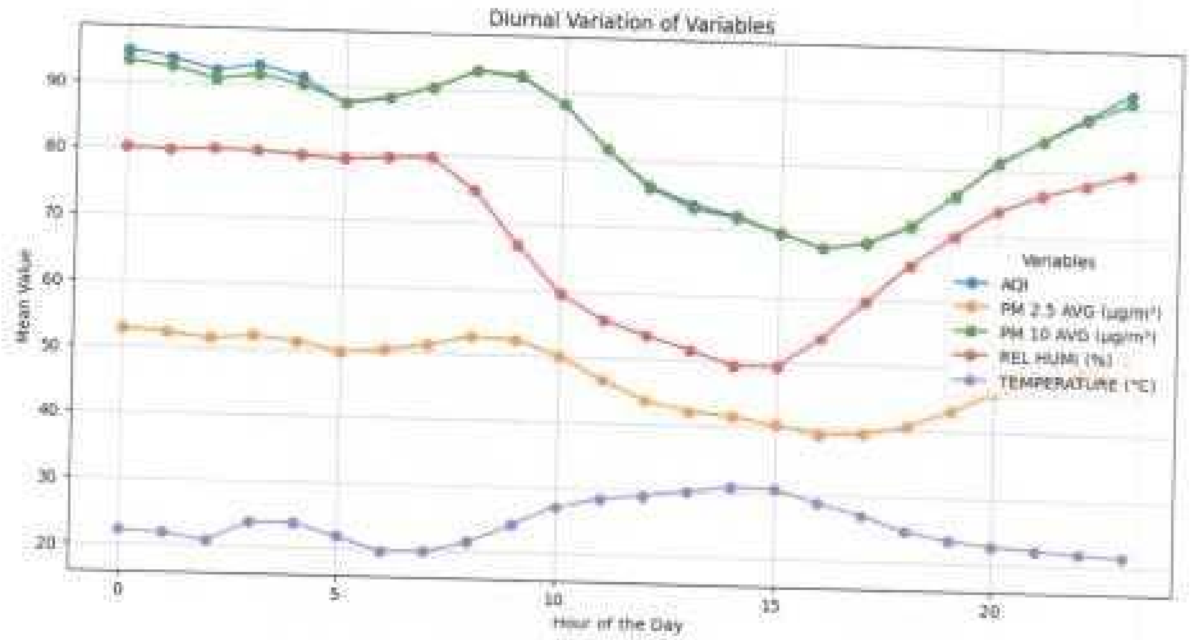
The boxplot provides a comparative view of the distribution of AQI, PM2.5, PM10, relative humidity, and temperature for the study period. The **AQI values** show a wide spread with several high outliers, indicating occasional spikes in pollution levels; the median lies in the moderate-to-poor range. **PM2.5 concentrations** display moderate variability, with most values clustered near the median but with a few high outliers, reflecting intermittent deterioration in fine particulate matter.



PM10 levels show an even wider range than PM2.5, with a high upper whisker, suggesting that coarse particles fluctuate significantly and often reach elevated levels. **Relative humidity** exhibits a moderately narrow distribution, indicating fairly stable atmospheric moisture with occasional higher values. In contrast, **temperature** shows the least variation among all variables, with values tightly grouped around the median, although a few higher temperature outliers are present. Overall, the plot highlights that pollutant parameters—especially AQI and PM10—experience the greatest variability and are more prone to peak episodes, while temperature remains comparatively stable.



The correlation matrix reveals strong and meaningful relationships among the air quality and meteorological variables. The most prominent pattern is the **extremely high positive correlation between AQI, PM2.5, and PM10**, with coefficients close to 0.99–1.00, indicating that particulate matter is the dominant driver of AQI in the study area. This suggests that even small increases in PM2.5 or PM10 concentrations directly and substantially elevate overall air pollution levels. Relative humidity (RH) shows a **moderate positive correlation** with particulate pollutants (around 0.34–0.35), implying that humid conditions may aid the suspension or formation of fine particles, thereby slightly enhancing pollution levels. In contrast, temperature exhibits a **weak negative correlation** with AQI and particulate matter (ranging from –0.11 to –0.17), meaning that lower temperatures are associated with slightly higher pollution levels—likely due to reduced atmospheric mixing and the tendency of pollutants to accumulate during cooler periods. The strongest meteorological relationship is the **negative correlation between temperature and relative humidity (–0.41)**, reflecting a typical atmospheric pattern where cooler air holds more moisture. Overall, the matrix highlights that particulate matter overwhelmingly controls AQI variability, while meteorological factors—especially humidity and temperature—play secondary but still influential roles in shaping air quality dynamics.



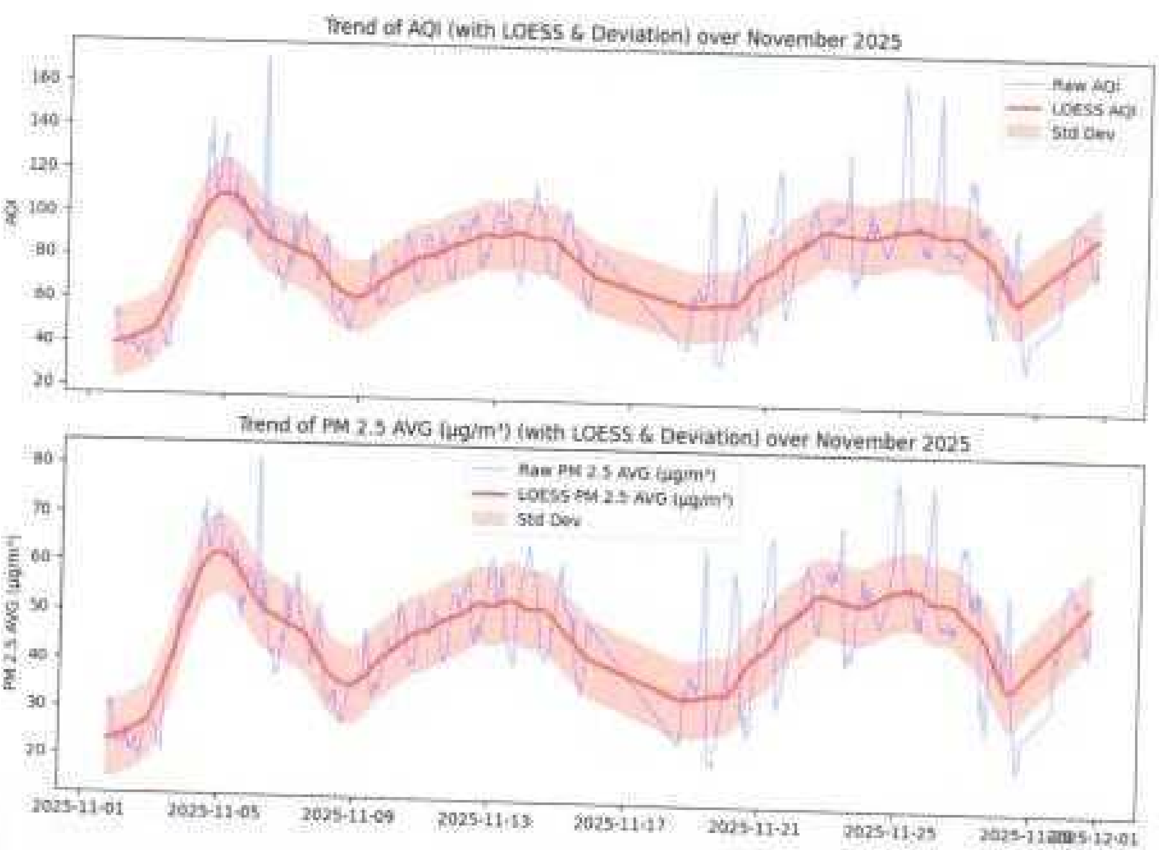
The diurnal variation plot shows how air quality parameters and meteorological conditions fluctuate throughout the 24-hour day. **AQI** remains high during the late-night and early-morning hours (around 0:00–6:00), indicating poor dispersion conditions caused by low temperatures and atmospheric stability. As the day progresses, AQI values gradually decline, reaching their lowest point during the afternoon (around 13:00–16:00). This drop is consistent with stronger sunlight, increased thermal mixing, and better ventilation of pollutants. Toward the evening and night (after 18:00), AQI begins rising again as temperatures fall and atmospheric stability returns.

A similar pattern is seen in **PM2.5 and PM10**, which follow the same trend as AQI—staying high at night and early morning, then decreasing steadily during the daytime. PM10 shows slightly larger fluctuations than PM2.5, indicating variable contributions from coarse particles, possibly due to human activities or wind disturbances. Both pollutants reach their minimum during the afternoon, highlighting the role of enhanced mixing height and dilution at that time of day.

Relative humidity (RH) behaves inversely compared to temperature. RH is highest during the night and early-morning hours (around 0:00–8:00) when the air is cooler and can hold less moisture. After sunrise, humidity drops sharply, reaching its lowest values in the afternoon, when temperatures peak. In the evening, RH begins to rise again as temperatures decrease.

Temperature, in contrast, shows a classic diurnal cycle: cool during the night, gradually increasing after sunrise, and peaking in the early afternoon (around 13:00–15:00). After sunset, the temperature decreases steadily. This temperature pattern directly influences the fluctuations seen in AQI and particulate matter.

Overall, the plot highlights a typical winter diurnal cycle where **nighttime accumulation of pollutants** leads to high AQI and PM levels, while **daytime atmospheric mixing** improves air quality temporarily. Meteorological factors—especially temperature and humidity—play a significant role in shaping these daily pollution dynamics.

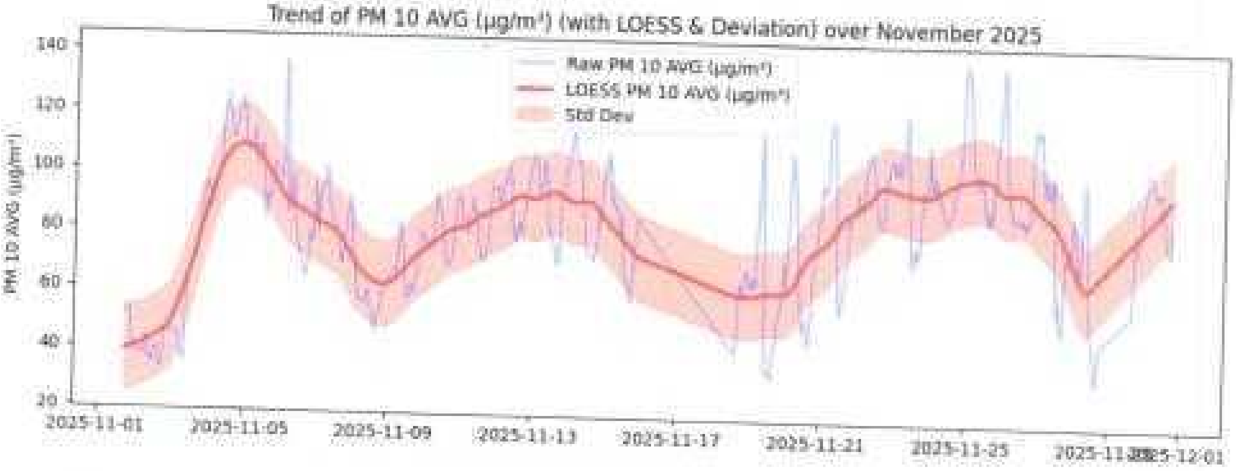


The LOESS-smoothed trend lines for AQI and PM2.5 across November 2025 reveal distinct pollution patterns influenced by meteorological conditions and periodic emission sources. Both variables exhibit **a sharp rise during the first week of November**, indicating a rapid deterioration in air quality. This initial spike suggests the combined influence of seasonal transitions, lower morning temperatures, and possibly intensified anthropogenic activities such as biomass burning or festival-related emissions.

Following this early peak, both AQI and PM2.5 show a **steady decline around mid-November**, reaching a temporary minimum. The smaller shaded bands during this period imply reduced variability, suggesting relatively stable atmospheric conditions. However, from mid-November onward, the trend reverses, and a **gradual rise in pollution levels** occurs. This upward pattern persists until the last week of the month, reflecting typical winter phenomena—cooler temperatures, stronger inversion layers, and slower pollutant dispersion.

Throughout the month, the blue raw data lines show significant short-term fluctuations, while the red LOESS curves smooth out these variations to highlight the overall pattern. The shaded red regions (standard deviation) indicate periods of high variability, especially during peaks, showing that pollution episodes were intermittent but intense. Toward the end of the month, both AQI and PM2.5 values rise again, suggesting a transition into December with worsening air quality conditions typical of the winter season.

Overall, the trends consistently show that **PM2.5 is a major driver of AQI**, with both following almost identical temporal patterns. The month demonstrates cyclical pollution behavior, with early-month and late-month peaks, mid-month improvement, and strong meteorological influence on daily air quality.

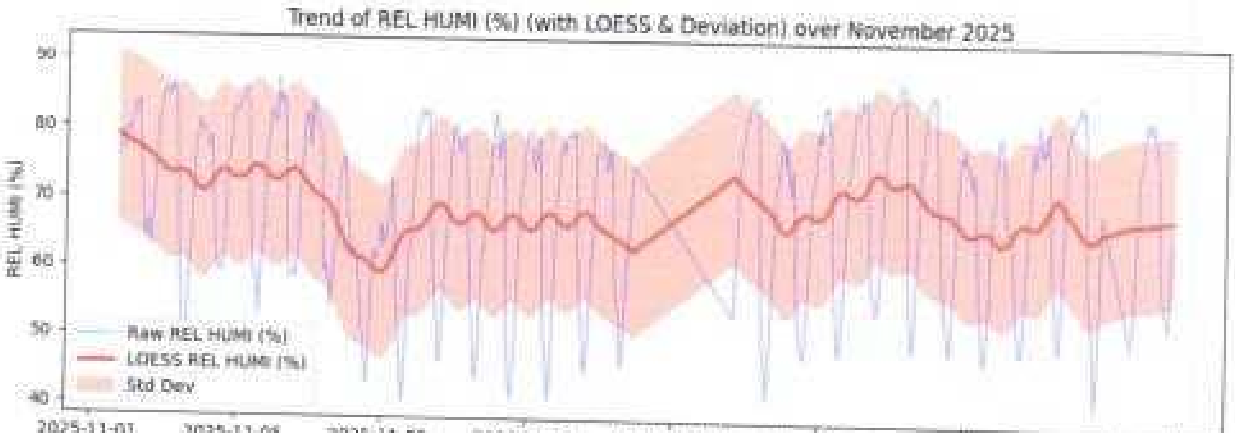


The LOESS-smoothed trend of PM_{10} over November 2025 shows a dynamic pattern of particulate pollution with distinct peaks and troughs. At the beginning of the month, PM_{10} levels start moderately but **rise sharply during the first week**, reaching a pronounced peak around November 4–6. This early spike indicates a significant pollution episode, likely driven by seasonal atmospheric stability, increased emissions, or local activities producing coarse particulate matter.

Following this peak, PM_{10} concentrations **gradually decline**, reaching a lower phase around November 9–12. This reduction suggests temporary improvement in atmospheric dispersion, possibly due to slight warming or increased wind movement. However, from mid-November onward, PM_{10} values show a **consistent upward trend**, reflecting a gradual buildup of pollutants as winter conditions become more stable and mixing heights decrease.

During the latter half of the month, PM_{10} levels remain relatively high and exhibit frequent short-term spikes in the raw data. The shaded standard deviation band widens in this period, indicating **greater variability** and more fluctuating emission sources or meteorological shifts. Another notable dip appears around November 27–28, followed by a renewed rise heading into early December—signaling the onset of more intense winter pollution episodes.

Overall, the PM_{10} trend mirrors typical winter-season behavior: initial rapid deterioration, a mid-month relief period, and a late-month rebound tied to atmospheric cooling and pollutant accumulation. The close alignment between raw and smoothed values confirms PM_{10} as a significant contributor to deteriorating air quality during November.

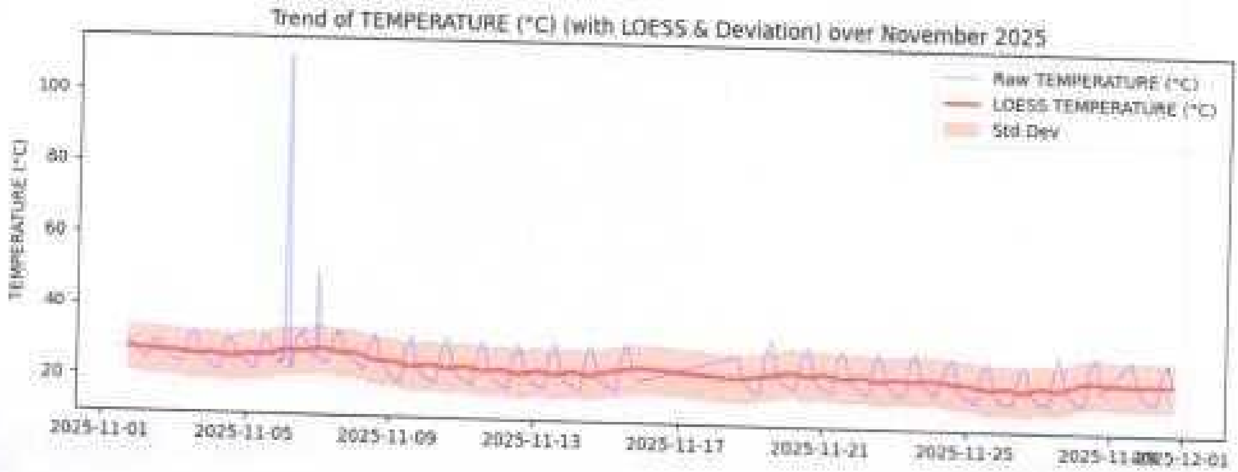


The LOESS-smoothed trend of relative humidity (RH) over November 2025 shows a distinct cyclical pattern driven by daily temperature variations and broader meteorological conditions. At the beginning of the month, RH values are relatively **high**, generally ranging between 70% and 80%, reflecting cooler nighttime conditions and moisture retention in the air. As the first week progresses, the smoothed trend shows a **gradual decline**, reaching a noticeable low around November 8–10, where RH dips into the lower 60% range. This decline may be associated with slightly warmer or drier air masses entering the region during this period.

After this low point, RH begins to **increase once again**, showing an upward trend from mid-November onward. This rise corresponds to the gradual onset of winter-like conditions, where cooler temperatures support higher humidity. The red LOESS line displays fluctuations but maintains a generally elevated profile through the second half of the month, frequently staying in the 65%–75% range.

The raw data (blue line) shows strong **diurnal oscillations**—characterized by high peaks at night and sharp drops during the daytime. These daily patterns reflect the inverse relationship between temperature and humidity: as daytime temperatures increase, the air holds more moisture and RH decreases; at night, cooling causes RH to rise sharply. The wide shaded standard deviation band in several periods, especially mid-month and late in the month, indicates greater variability in humidity due to changing weather systems or shifting atmospheric conditions.

Overall, the graph suggests that November 2025 experienced **a transition from moderately humid to more consistently humid conditions,** with clear daily cycles and a mid-month trough followed by recovery. This behavior aligns with seasonal cooling and is consistent with humidity's known influence on air quality, particularly its moderate positive correlation with particulate matter.



The temperature trend over November 2025 shows a **gradual cooling pattern**, which is typical for the transition from late autumn into early winter. At the beginning of the month, the LOESS-smoothed temperature line shows relatively **higher values**, around 28–30°C. As the month progresses, the smoothed trend declines steadily, reaching around **18–20°C** in the latter half. This downward trend reflects the seasonal shift toward cooler conditions.

The raw temperature data (blue line) displays consistent **diurnal fluctuations**—higher temperatures during the day and lower temperatures at night—creating a regular wave-like pattern throughout the month. This is a natural pattern influenced by solar heating during the day and cooling after sunset.

Two noticeable **spikes in the raw temperature** appear early in the month (around November 4–6), where temperatures momentarily jump above 40°C and even exceed 100°C. These values are unrealistic and likely represent **sensor errors or data anomalies** rather than actual atmospheric conditions. The LOESS-smoothed trend helps reduce the impact of these errors and highlights the true temperature pattern.

Throughout the month, the **standard deviation band (shaded region)** remains relatively narrow, indicating that temperature variability is moderate and mostly driven by the daily heating–cooling cycle rather than abrupt weather changes. Toward the end of the month, the smoothed line stabilizes around 20°C, suggesting that cooler temperatures have become consistent.

Overall, the trend demonstrates a **clear seasonal cooling**, regular diurnal cycles, and limited meteorological volatility—except for the anomalous spikes, which are likely instrumental errors. This cooling trend also helps explain rising AQI levels, as lower temperatures reduce atmospheric mixing and lead to pollutant accumulation.

Conclusion

The overall analysis of the temperature pattern for November 2025 indicates a clear and consistent **seasonal cooling trend**, moving from warmer early-month conditions toward noticeably lower temperatures by the end of the month. Daily temperature fluctuations follow a regular diurnal cycle, and the absence of major weather disturbances—apart from a few clear sensor-related anomalies—highlights a generally stable atmospheric environment. As temperatures drop, the atmosphere becomes less efficient at vertical mixing, which can contribute to the **accumulation of air pollutants** near the surface. Therefore, the November temperature trend not only reflects the natural transition toward winter but also provides an important context for understanding **worsening air quality and increasing AQI levels** during the same period.

Note:

Report produced by Air Quality Monitoring System Committee

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