

Based on the extensive tables and analysis derived from the dataset in the attached file (which appears to cover **hourly air quality data for Delhi in January 2023**), here's a structured overview of **key insights and findings**:

◆ 1. Overall Statistical Insights (Descriptive Statistics)

Derived from `df.describe()` and `stats_table`:

- **PM2.5** → **Mean: 358.26 $\mu\text{g}/\text{m}^3$** , Max: 1310.20; significantly higher than safe limits (WHO guideline: 15 $\mu\text{g}/\text{m}^3$ daily).
- **PM10** → **Mean: 420.99 $\mu\text{g}/\text{m}^3$** , Max: 1499.27; also greatly exceeds the threshold.
- **CO** → **Mean: 3814.94 ppb**, Max: 16876.22; spikes highly, possibly from traffic or industrial events.
- **O₃ (ozone)** has the lowest values among pollutants with **mean of 30.14**, though its inverse relationship with others (e.g. CO, PM2.5) is notable.

◆ 2. Time-of-Day Pollution Patterns

From the **Time-Wise Statistics Table**:

- **Noon and Evening** exhibit the highest levels across almost all pollutants, particularly:
 - **PM2.5** peaking at 475.1 in the Evening.
 - **CO** highest at Noon (~6204).
 - **NO₂ and SO₂** also heavier around Noon.
- **Morning** shows relatively moderate pollution; **Night** has slightly lower values, but not negligible.

Insight: Daytime human activities (traffic, industrial output) likely drive pollution peaks.

◆ 3. Daily Trends (Daily Average Table)

- Some **high-pollution days** in Jan:
 - **Jan 2, Jan 13 & Jan 19** amongst the worst days across PM2.5, CO, NO₂.
 - **Lowest pollution days** seem to be around **Jan 14–16**, indicating short atmospheric relief, possibly due to rain or wind.

◆ 4. Correlation Analysis

From the **Correlation Matrix Table**:

- **Very high positive correlation between PM2.5 and PM10 (0.994)** ⇒ same sources (e.g., dust, combustion).
- **Strong correlation of CO with PM2.5 (0.95)** and SO₂/NO₂/NH₃ ⇒ likely from traffic or combustion sources.
- **Ozone shows negative correlation with most pollutants**, particularly PM2.5 and PM10 ⇒ photochemical reactions leading to ozone formation often reduce NO₂/CO levels.



Quick Visual Correlation Summary:

Pair	Correlation
PM2.5 & PM10	0.994
PM2.5 & CO	0.953
SO ₂ & NH ₃	0.844
PM2.5 & O ₃	-0.45

◆ 5. Top Pollution Hours

From the "Top 5 pollutant hours":

- **Jan 13 and Jan 19** repeatedly occur in top 5 hours for PM2.5, PM10, CO, NO₂, and SO₂ ⇒ extreme events.
- **CO peak at 16876 ppb at Jan 13, 5 PM** ⇒ likely related to vehicular emissions during peak hour.

◆ 6. Health Threshold Exceedances

From the Exceedance Table:

Pollutant	Threshold	Exceedance Count (out of 561 hrs)
PM2.5	60	561 (100%)
PM10	100	555
CO	2000	373
NO2	40	454
SO2	20	519
O3	100	55
NH3	20	200

Key Concerns:

- **PM2.5 always exceeds safe levels** — most hazardous category.
- **SO₂, NO₂, CO** frequently cross danger thresholds.
- **O₃ is not a major concern**, but may pose secondary risks during peaks.

◆ 7. Monthly Aggregated AQI Proxy (PM2.5)

- Monthly average for Jan is **~358.26 µg/m³**, indicating **very poor to severe air quality** by Indian AQI standards (250+ is “severe”).

◆ 8. Seasonal Variation (from the plot)

From the plot of PM2.5 across seasons:

- Highest levels in **Winter**, consistent with Delhi’s seasonal inversion, stubble burning, and meteorological trapping.
- Lowest levels likely in **Monsoon/Summer**, pending seasonal label clarification.

Summary of Key Insights:

1. **High Pollution** across all pollutants, particularly **PM2.5 and CO**.
2. **Peak pollution during Afternoon to Evening**, driven by human activity.
3. **Jan 13 & 19 identified as worst air days**—likely warranting public health intervention.
4. **PM2.5 above threshold 100% of the time**—making Delhi's air highly toxic.
5. **O₃ has inverse correlation**, confirming photochemical dynamics.
6. **Combustion-based emissions (traffic, industry)** are primary contributors.

Would you like visualizations (graphs/plots) or an HTML/report summary from this data for presentation or further analysis?