Supplementary to:

Insights into the chemical and physical drivers of surface ozone in the Trans-Himalaya

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Text S1: Formulae of O3 exposure indices

MDA8 (μgm[-3]) = $max(\frac{1}{8}\sum_{j=i}^{i+7} [O_3]_j)$ where, *j*=0, 1, …, 23 h

M7 (ppbv) = $\frac{1}{n}\sum_{i}^{n} [O_3]_i$, for 09:00–15:59 h

AOT40 (ppm h) = $\sum_{i}^{n} ([O_3]_i - 40) \times \Delta t, if\ [O_3]_i \geq 0.04\ ppmv$ for 07:00–17:59 h (Δt=1 h as hourly averaged O_3 is used)

SUM06 (ppm h) = $\sum_{i}^{n} [O_3]_i \times \Delta t, if\ [O_3]_i \geq 0.06\ ppmv$ for 07:00–17:59 h (Δt=1 h as hourly averaged O_3 is used)

W126 (ppm h) = $\sum_{i}^{n} (\frac{[O_3]_i}{1+4403 expexp\ (-0.126\times[O_3]_i)}) \times \Delta t, if\ [O_3]_i > 0\ ppmv$ for 07:00–17:59 h (Δt=1 h as hourly averaged O_3 is used)

OSDMA8 = Annual maximum of 6-month running mean of MDA8

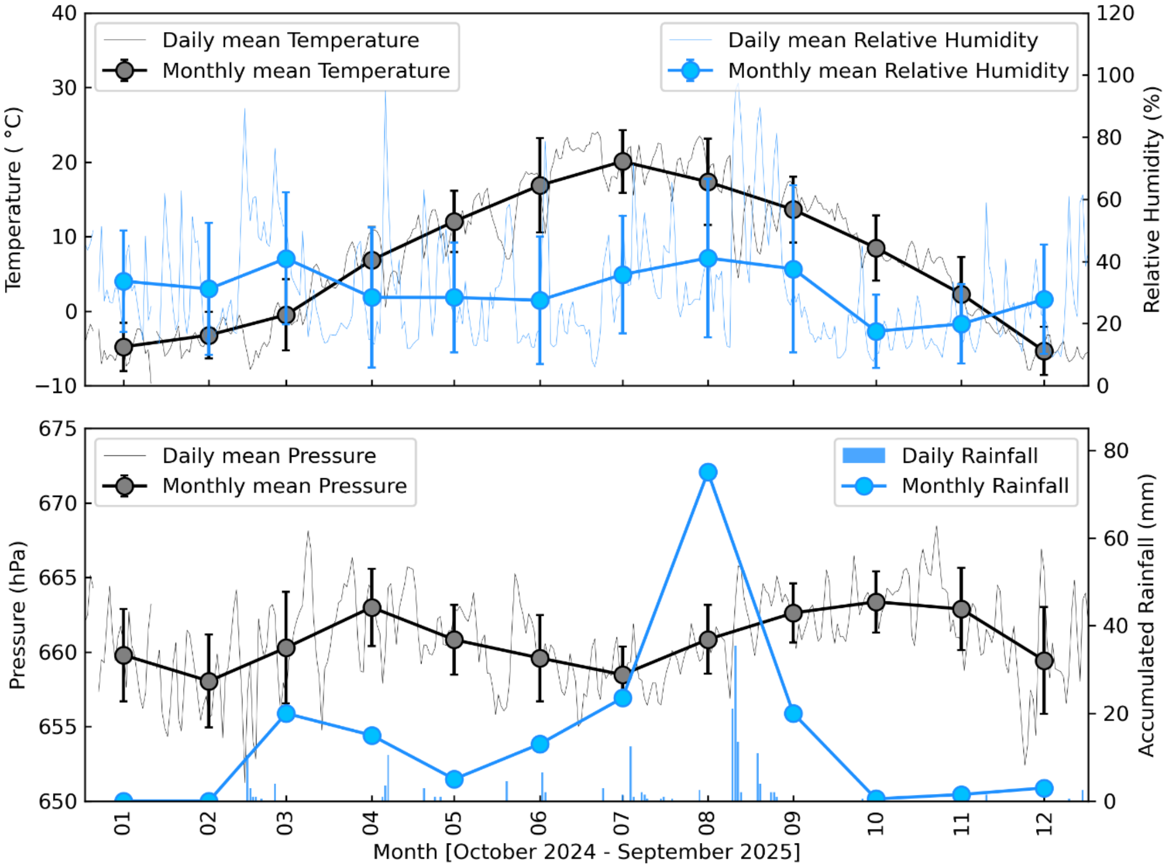

Figure S1: Temporal variation of meteorological parameters (daily and monthly) at Leh town over the study period.

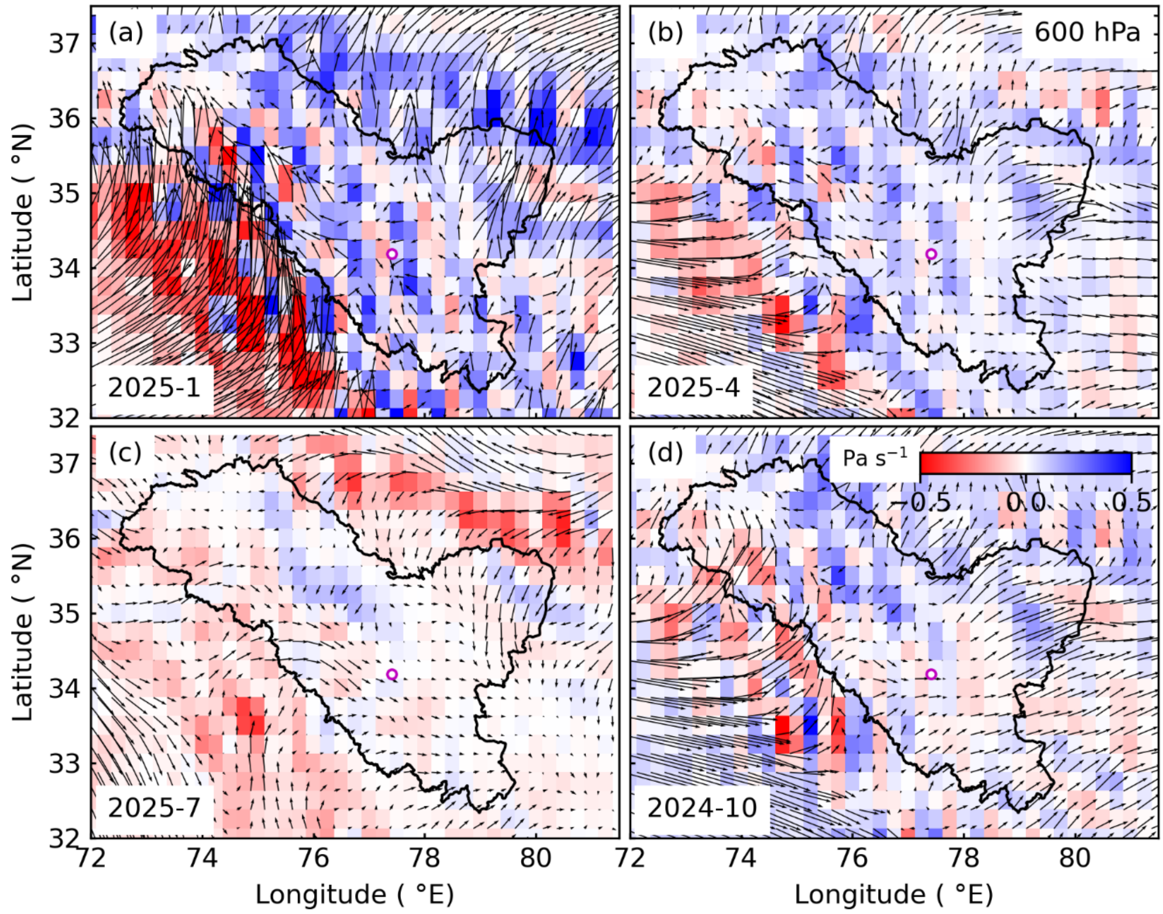

Figure S2: Synoptic winds at 600 hPa for different months representing different seasons. Magenta circle depicts the study site. Background colour map shows vertical wind (Pa s^{-1}).

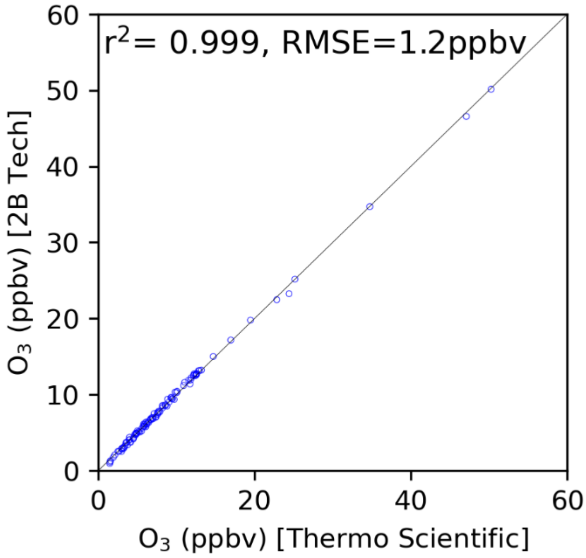

Figure S3: Comparison of O_3 measured from 2B Tech and Thermo Scientific analyser operated through single inlet in ambient conditions.

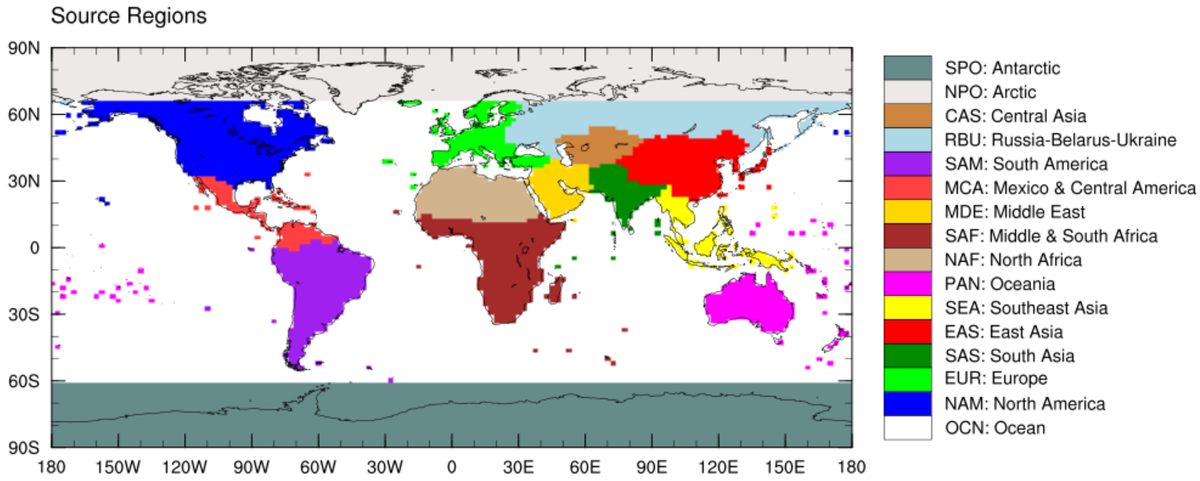

Figure S4: Different source regions as defined for the CAM4-Chem simulations.

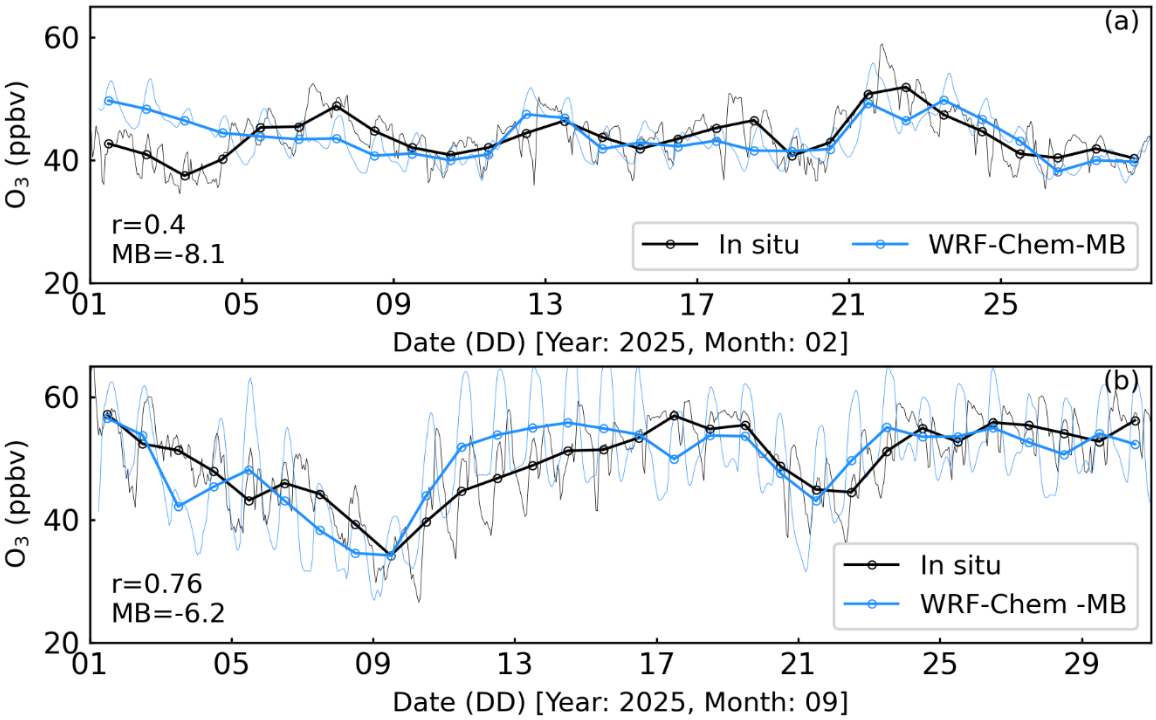

Figure S5: Comparison of WRF-Chem simulated O_3 with the measurements over the study region. While thin lines represent hourly values, thick lines with scatter represent daily mean. Correlation coefficient, r and mean bias (MB) are corresponding to daily mean.

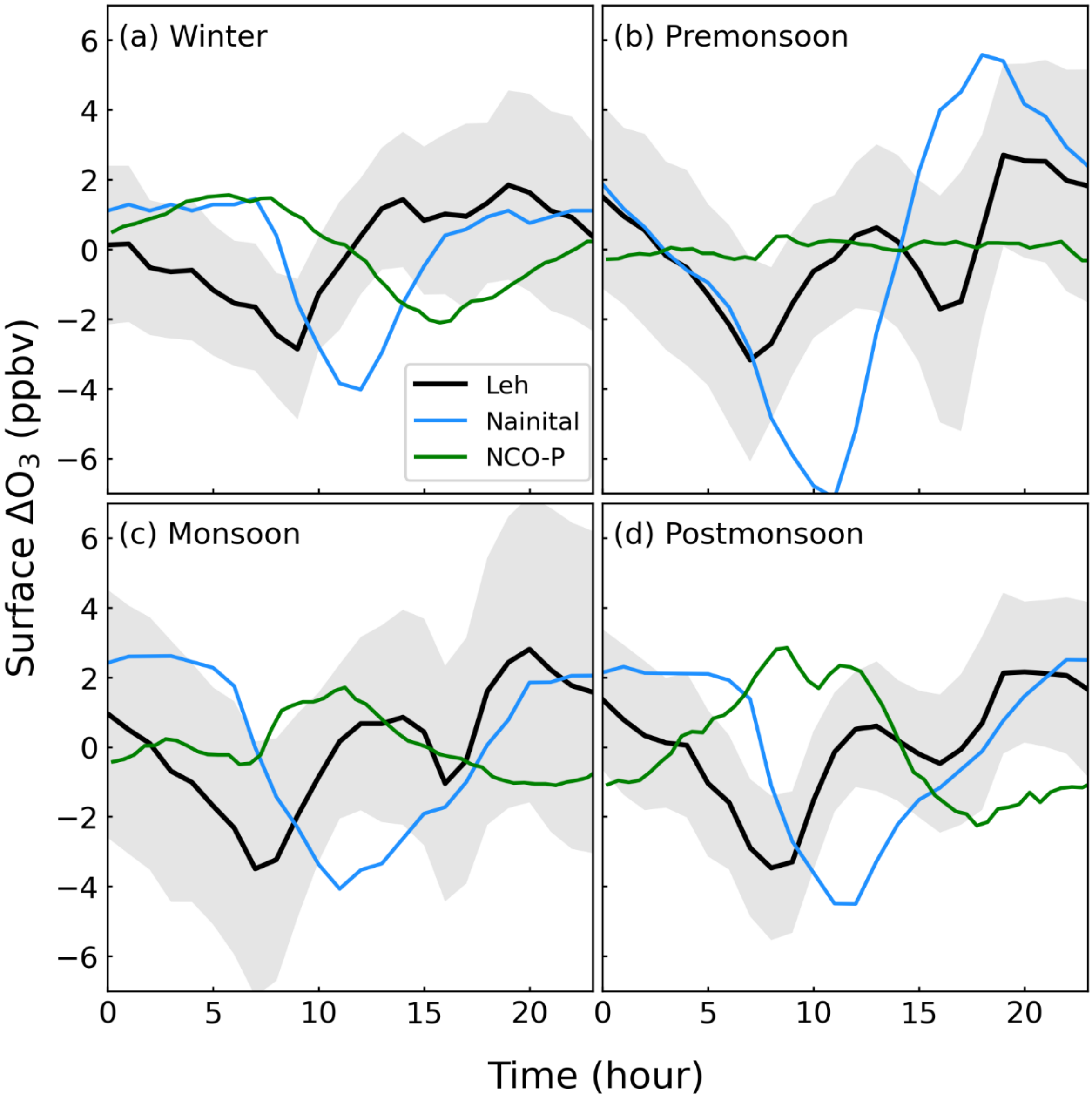

Figure S6: Mean diurnal pattern of ΔO_3 at the study site (black) for different seasons: Winter (DJF—December-January-February), premonsoon (MAM—March-April-May), monsoon (JJAS—June-July-August-September), postmonsoon (ON—October-November). The shaded region represents standard deviation. Diurnal variations observed at cleaner high-altitude sites, Nainital (1.9 km amsl) and NCO-P (5 km amsl), are also shown (Sarangi et al., 2014; Cristofanelli et al., 2010). Post-noon enhancement seen at Nainital during premonsoon season could be due to the influence of transport from an elevated regional boundary layer over nearby IGP (Indo Gangetic Plain) region.

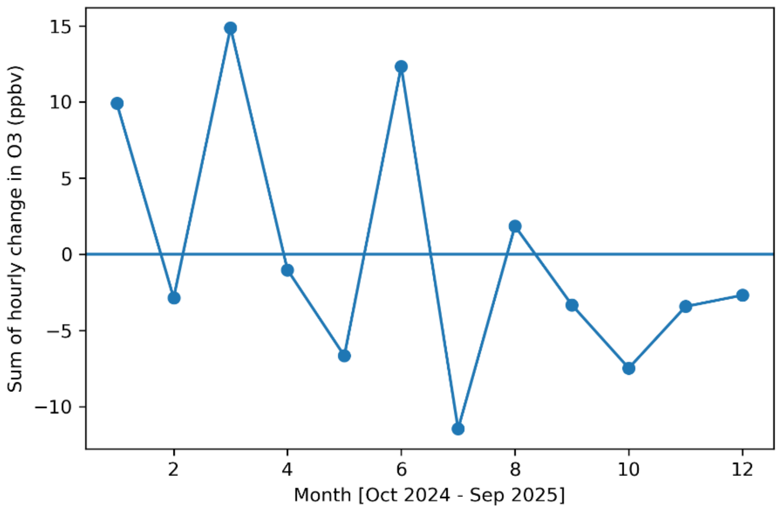

Figure S7: Sum of hourly change in observed O_3 over the study region.

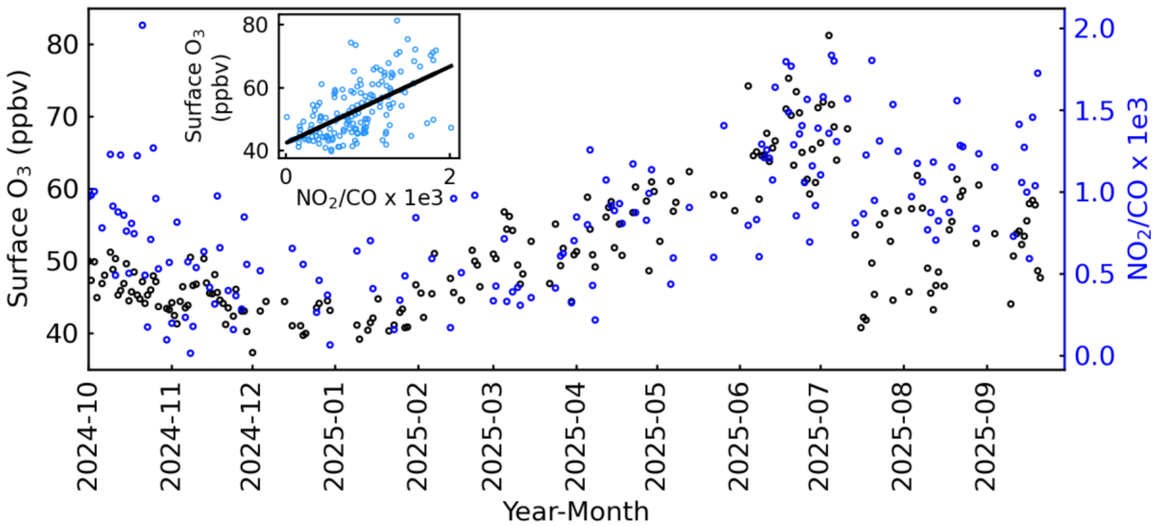

Figure S8: Variations of surface O_3 and ratio of NO_2/CO from TROPOMI over the study region. Inset shows the linear association of O3 with NO_2/CO.

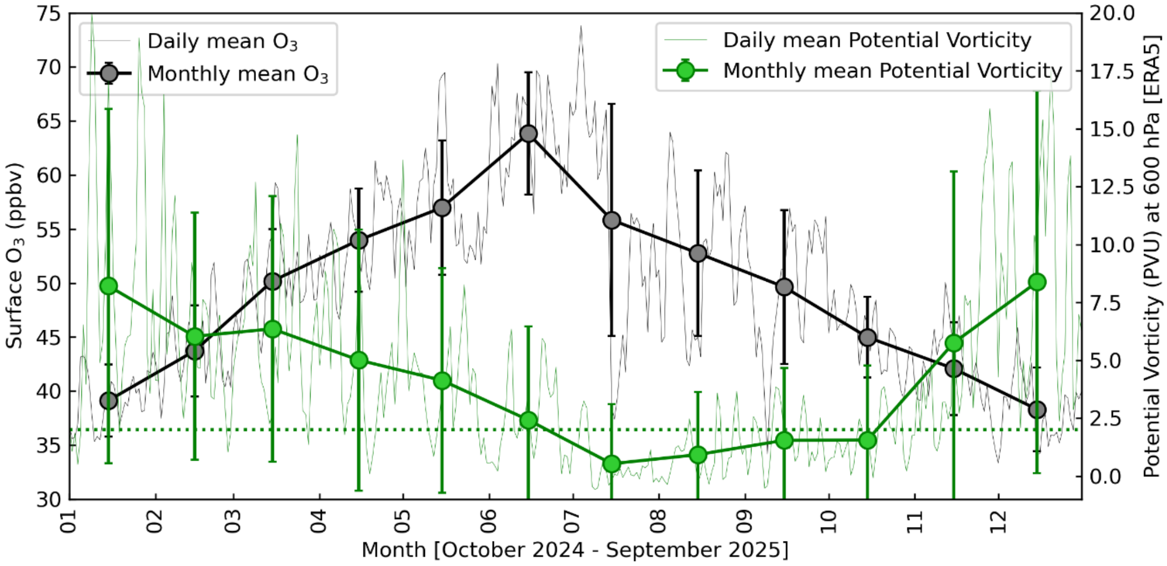

Figure S9: Variations of surface O_3 and potential vorticity (PVU $=10^{-6}$ K kg^{-1} m^2 s^{-1}) at 600 hPa at study site. The dotted green line suggest 2 PVU, above which air is considered to be stratospheric.

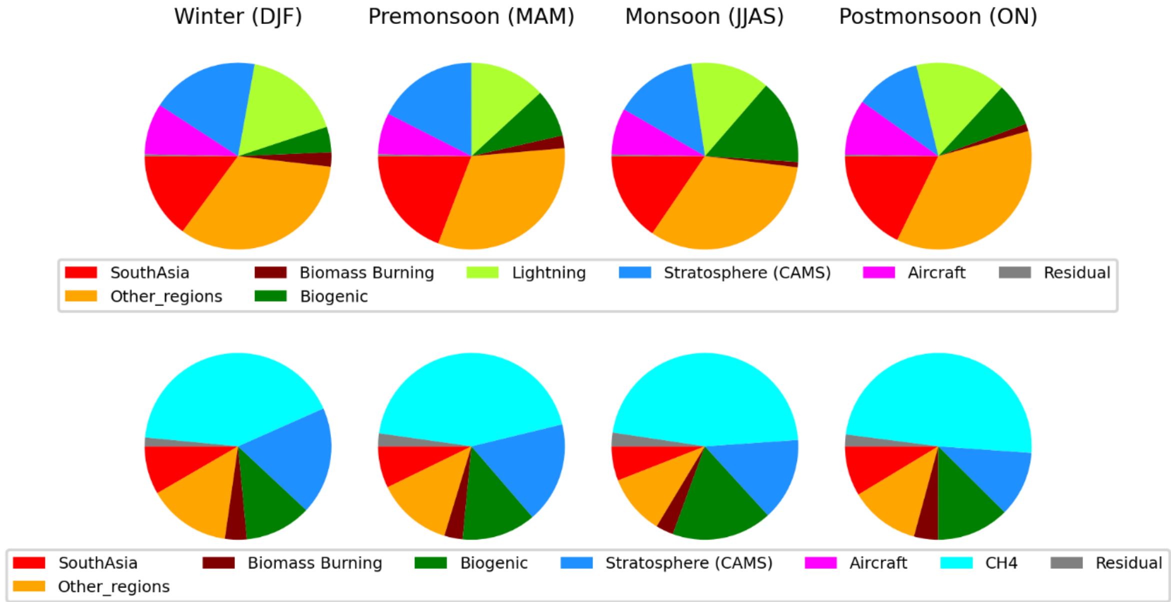

Figure S10: Contribution of various sources to surface O_3 over the study region based on NO_x (top panel) and VOC (bottom panel) tagging in the CAM4-Chem model simulations.

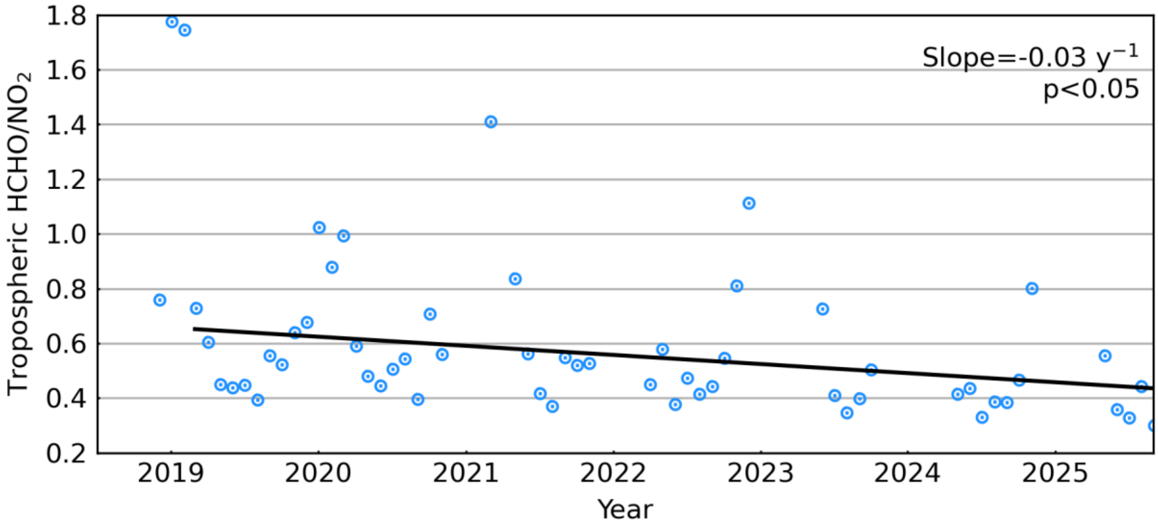

Figure S11: Monthly mean ratio of tropospheric HCHO/NO_2 over Leh region (77.41°–77.70° E; 34.08°–34.23° N) during 2018–2025. Note that the initial three points are excluded in the linear fit (black line) as two of them appear to be outliers with very high values of 1.7–1.8.

Table S1: Monthly mean O_3 along with standard deviation observed at Leh.

Month	Mean O_3	Standard deviation
Oct-2024	45	3.7
Nov-2024	42.1	4.3
Dec-2024	38.3	3.9
Jan-2025	39.1	3.3
Feb-2025	43.7	4.2
Mar-2025	50.2	4.8
Apr-2025	54	4.8
May-2025	57	6.2
Jun-2025	63.8	5.7
Jul-2025	55.8	10.7
Aug-2025	52.8	7.6
Sep-2025	49.6	7.1