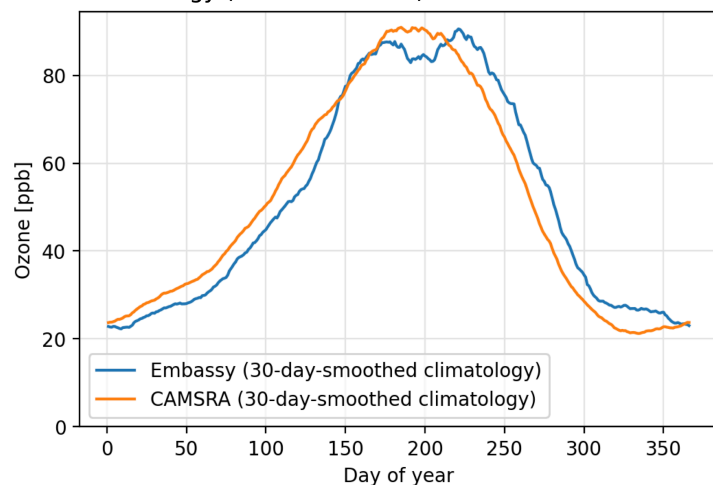


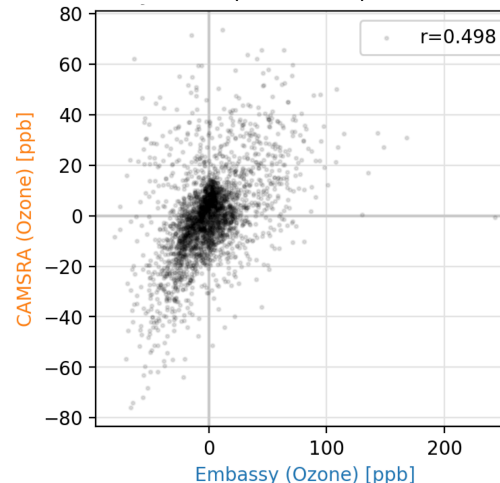
CAMSRA vs. U.S. Embassy in-situ measurements of **ozone** in **Beijing** (2010–2021)

All days in common:

Climatology (absolute values)

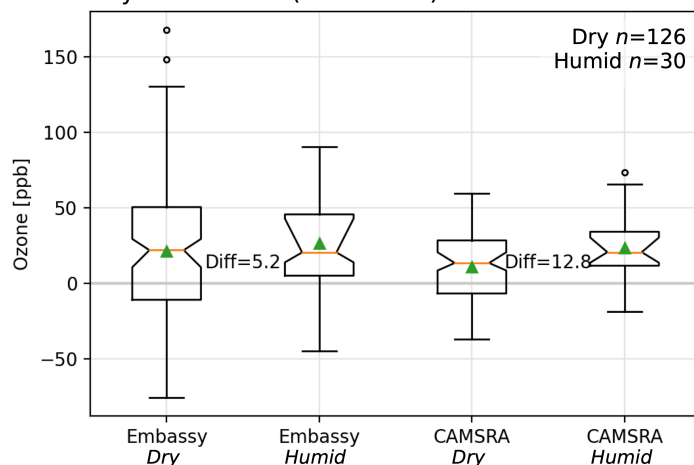


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2010–2021)



All CAMSRA data (2003–2021)

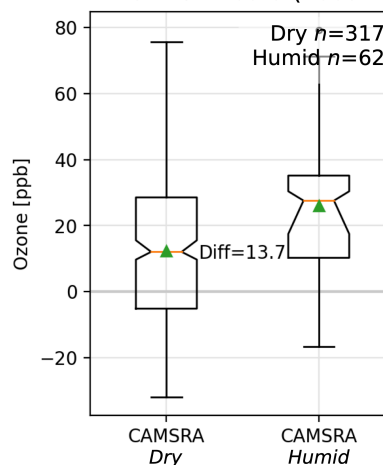


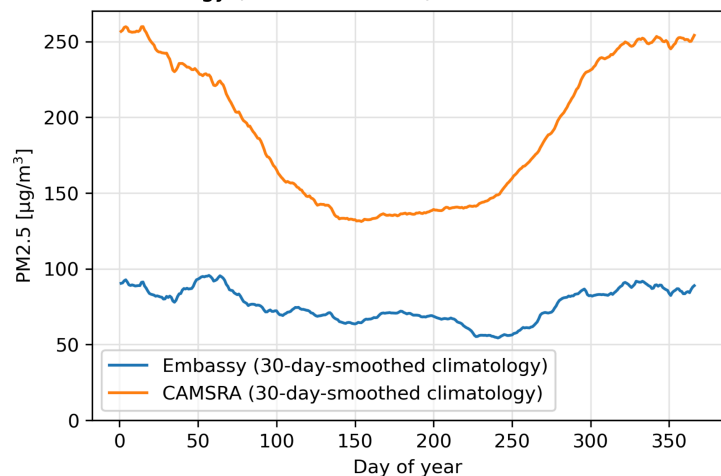
Figure S1. Comparison of CAMSRA and in-situ ozone data (2010–2021) in Beijing. Hourly in-situ data from the Beijing U.S. Embassy was downloaded from AirNow.gov for the maximum available overlap with our CAMSRA analysis period, sub-sampled to 3-hourly (and timezone-adjusted) to match CAMSRA's timesteps, and thereafter handled the same as CAMSRA data.

Top left: Climatology of daily-maximum in-situ data and CAMSRA data (calculated only for days in common) at the gridcell containing the embassy location. **Top right:** Scatterplot of in-situ versus CAMSRA data (anomalies from their respective climatologies), with their Pearson's correlation coefficient displayed. **Bottom left:** Boxplots compare anomalies during dry versus humid heat days for in-situ and CAMSRA data, only for days in common. Medians and their bootstrapped 95% confidence intervals are shown with orange lines and notches, means are shown as green triangles, and differences between means of dry versus humid heat days are displayed. **Bottom right:** Boxplots compare anomalies during dry versus humid heat days for CAMSRA data over its entire period, as analyzed in the main text.

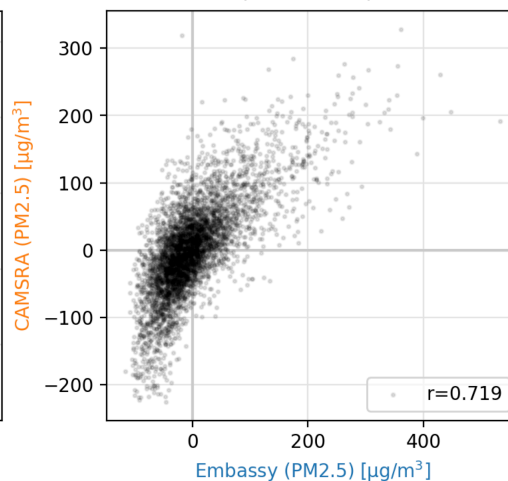
CAMSRA vs. U.S. Embassy in-situ measurements of **PM_{2.5}** in **Beijing** (2008–2021)

All days in common:

Climatology (absolute values)

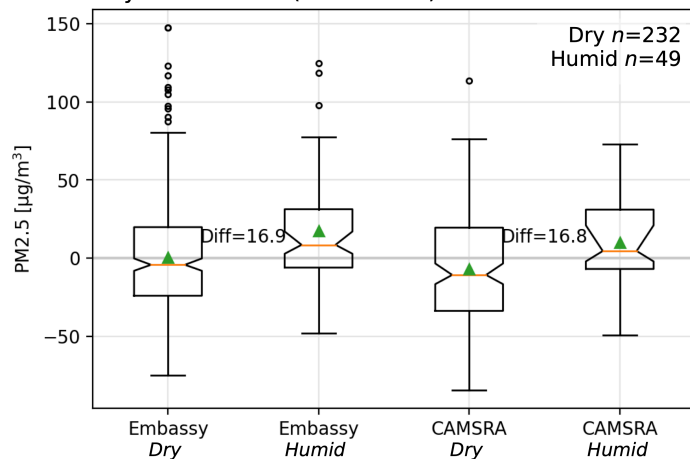


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2008–2021)



All CAMSRA data (2003–2021)

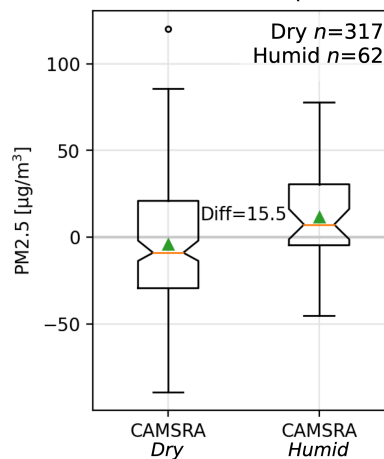
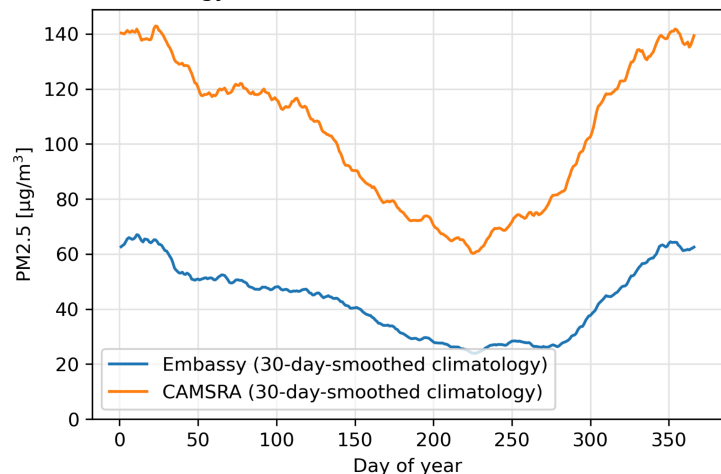


Figure S2. Comparison of CAMSRA and in-situ PM_{2.5} data (2008–2021) in Beijing. Same as Figure S1 but for PM_{2.5} in Beijing.

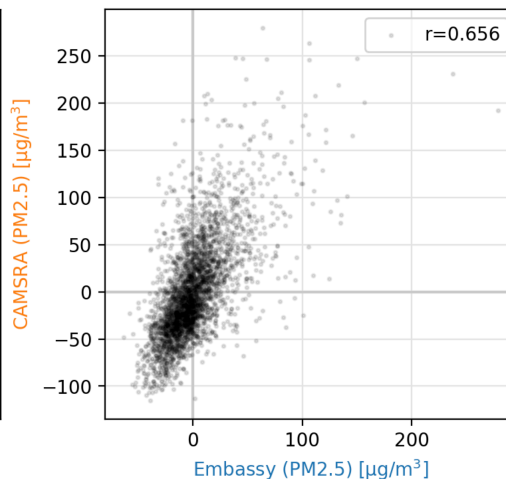
CAMSRA vs. U.S. Embassy in-situ measurements of **PM_{2.5}** in **Shanghai** (2011–2021)

All days in common:

Climatology (absolute values)

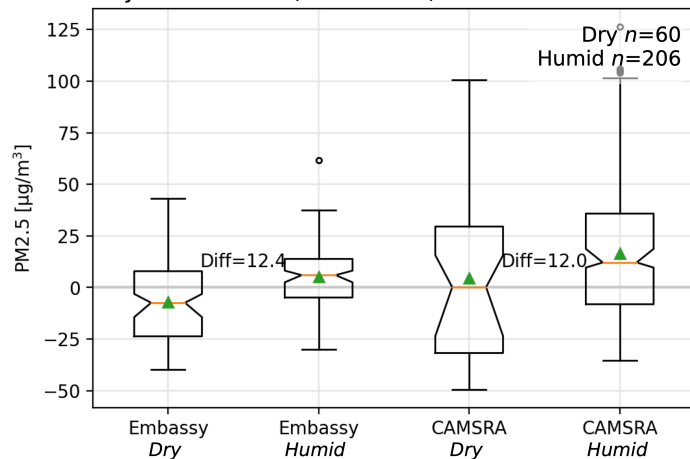


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2011–2021)



All CAMSRA data (2003–2021)

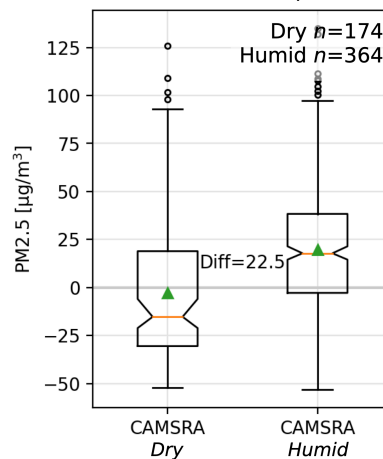
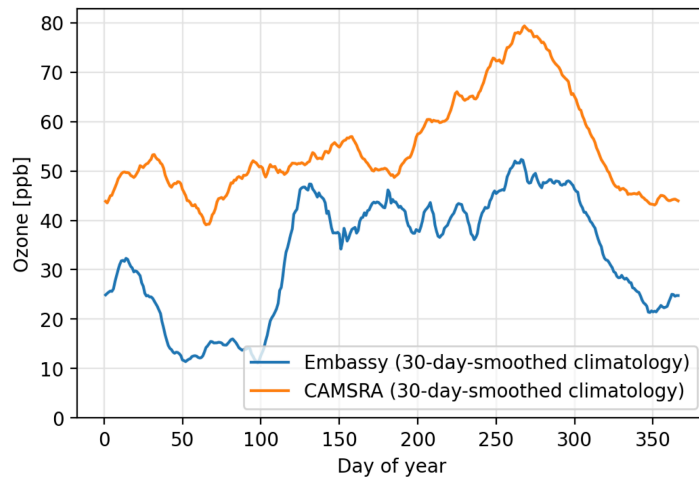


Figure S3. Comparison of CAMSRA and in-situ PM_{2.5} data (2011–2021) in Shanghai. Same as Figure S1 but for PM_{2.5} in Shanghai.

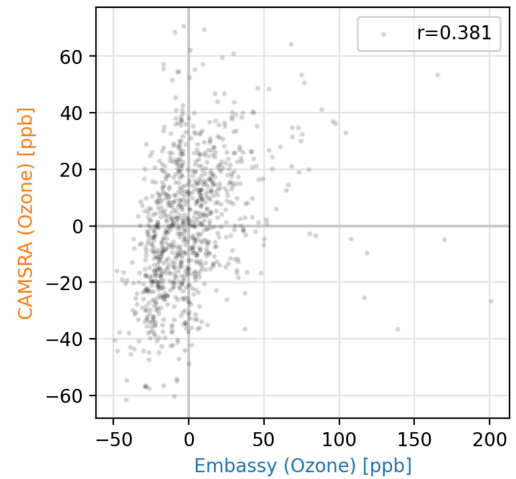
CAMSRA vs. U.S. Embassy in-situ measurements of **ozone** in **Guangzhou** (2014–2019)

All days in common:

Climatology (absolute values)

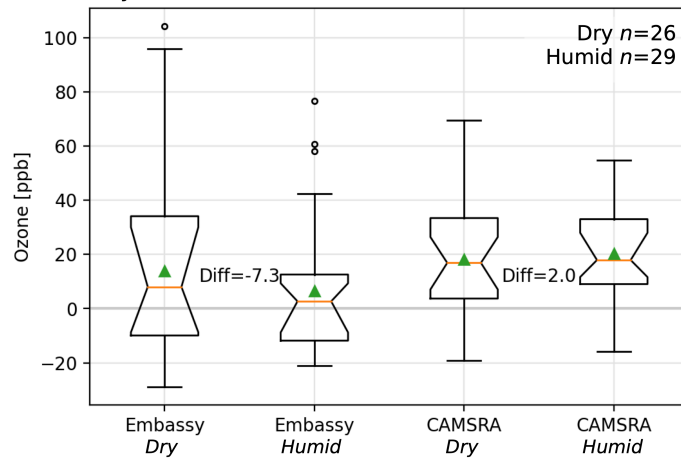


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2014–2019)



All CAMSRA data (2003–2021)

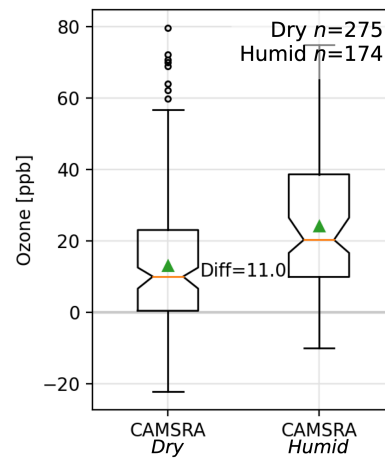
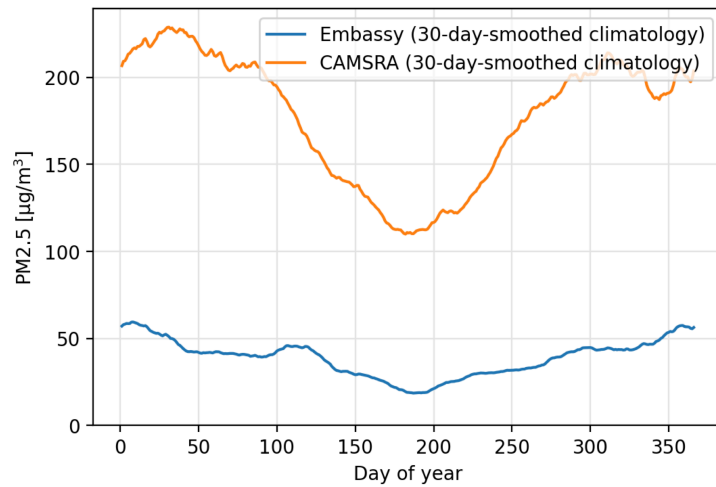


Figure S4. Comparison of CAMSRA and in-situ ozone data (2014–2019) in Guangzhou. Same as Figure S1 but for ozone in Guangzhou.

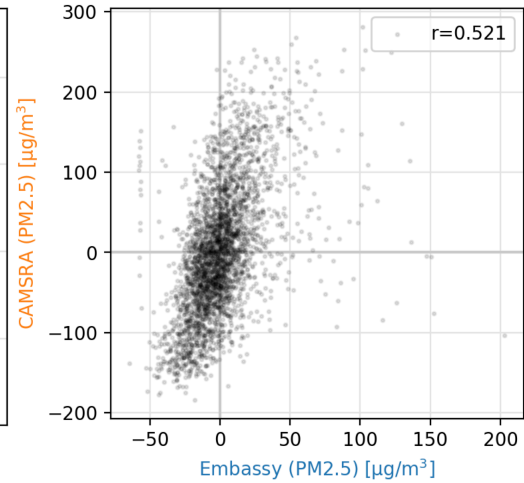
CAMSRA vs. U.S. Embassy in-situ measurements of **PM_{2.5}** in **Guangzhou** (2011–2021)

All days in common:

Climatology (absolute values)

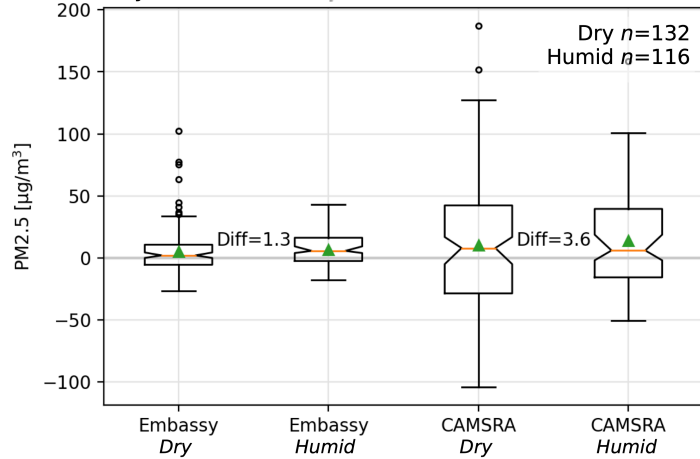


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2011–2021)



All CAMSRA data (2003–2021)

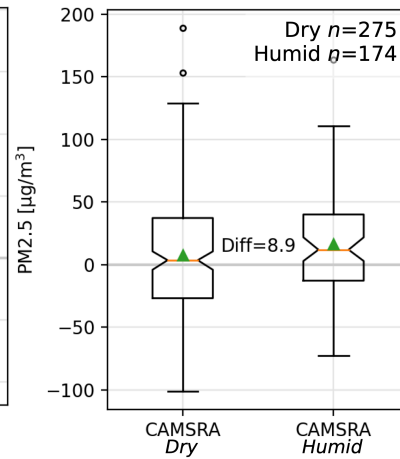
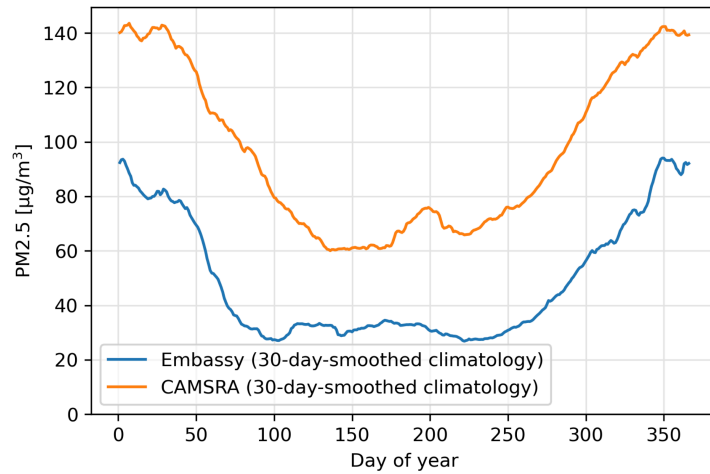


Figure S5. Comparison of CAMSRA and in-situ PM_{2.5} data (2011–2021) in Guangzhou.
Same as Figure S1 but for PM_{2.5} in Guangzhou.

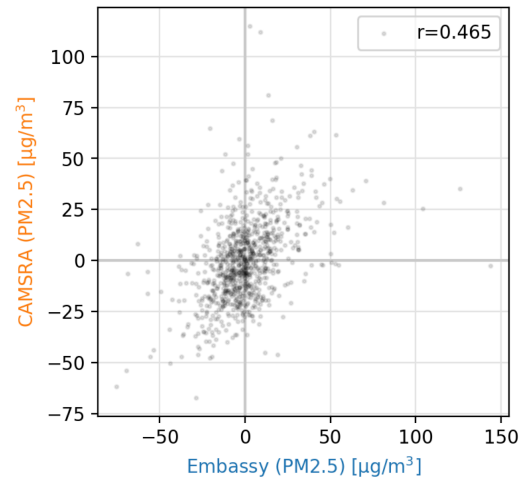
CAMSRA vs. U.S. Embassy in-situ measurements of **PM_{2.5}** in **Islamabad** (2019–2021)

All days in common:

Climatology (absolute values)

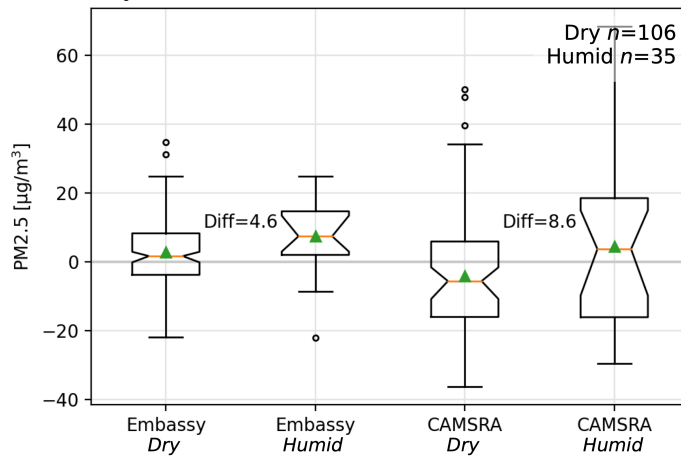


Correlation (anomalies)



Dry vs. humid heat days (anomalies):

Days in common (2019–2021)



All CAMSRA data (2003–2021)

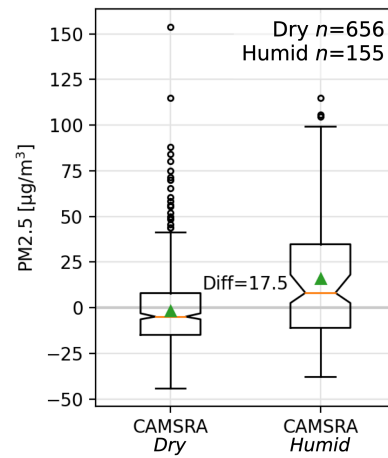


Figure S6. Comparison of CAMSRA and in-situ PM_{2.5} data (2019–2021) in Islamabad.

Same as Figure S1 but for PM_{2.5} in Islamabad. Note that for the Islamabad hotspot, as explained in Data and Methods in the main text, dry and humid heat days are defined as when one occurs in any of the nine ERA5 grid cells contained within the target CAMSRA grid cell.

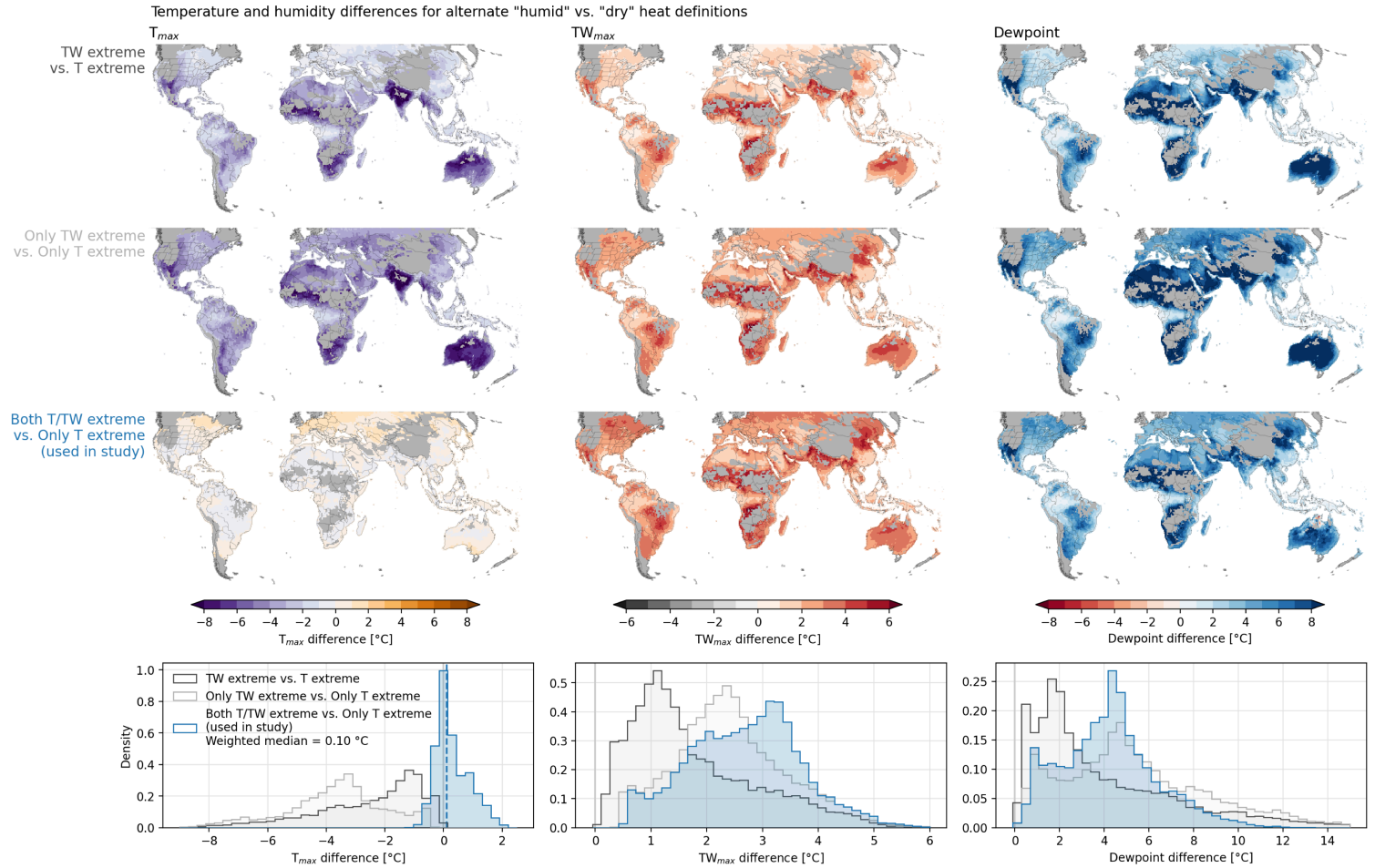


Figure S7. Comparison of temperature and humidity differences for alternate "humid" and "dry" heat definitions. This study's definition of "dry" and "humid" heat days compares conditions that are primarily different in terms of TW_{max} and Dewpoint rather than T_{max} . **Left column: Top map:** Plotted for each gridcell is the average T_{max} of days with extreme TW_{max} (i.e., wherein TW_{max} exceeds its historical 95th percentile value, calculated across all days in 1981–2010) minus that of days with extreme T_{max} (by same definition). "Dry" and "humid" heat are therefore determined by T_{max} and TW_{max} alone, respectively, regardless of the behavior of each other. These groups of days correspond with the orange and red circles in the schematic in Figure 1. **Middle map:** Same as top map, but with "dry" heat days defined as days wherein *only* T_{max} is extreme (i.e., T_{max} exceeds its 95th percentile but TW_{max} does *not* exceed its 95th percentile), and "humid" heat days as days wherein *only* TW_{max} is extreme. These groups of days correspond with the non-overlapping portions of the orange and red circles in the schematic in Figure 1. **Bottom map:** Same as middle map, but with "humid" heat days defined as days wherein *both* T_{max} and TW_{max} are extreme. These groups of days correspond with the non-overlapping part of the orange circle and the union of the orange and red circles in the schematic in Figure 1, as labeled, and as used in the study to define "dry" and "humid" heat days. **Histogram:** Area-weighted histograms are shown for each of the three mapped comparisons (for T_{max} during "humid" minus "dry" heat days), and the area-weighted median of 0.10 °C difference between "humid" and "dry" heat days as defined in the study is shown as a dashed line, displaying that temperature differences are much smaller using these definitions. **Middle and right columns:** As in left column but for TW_{max} and Dewpoint differences between "dry" and "humid" heat days.

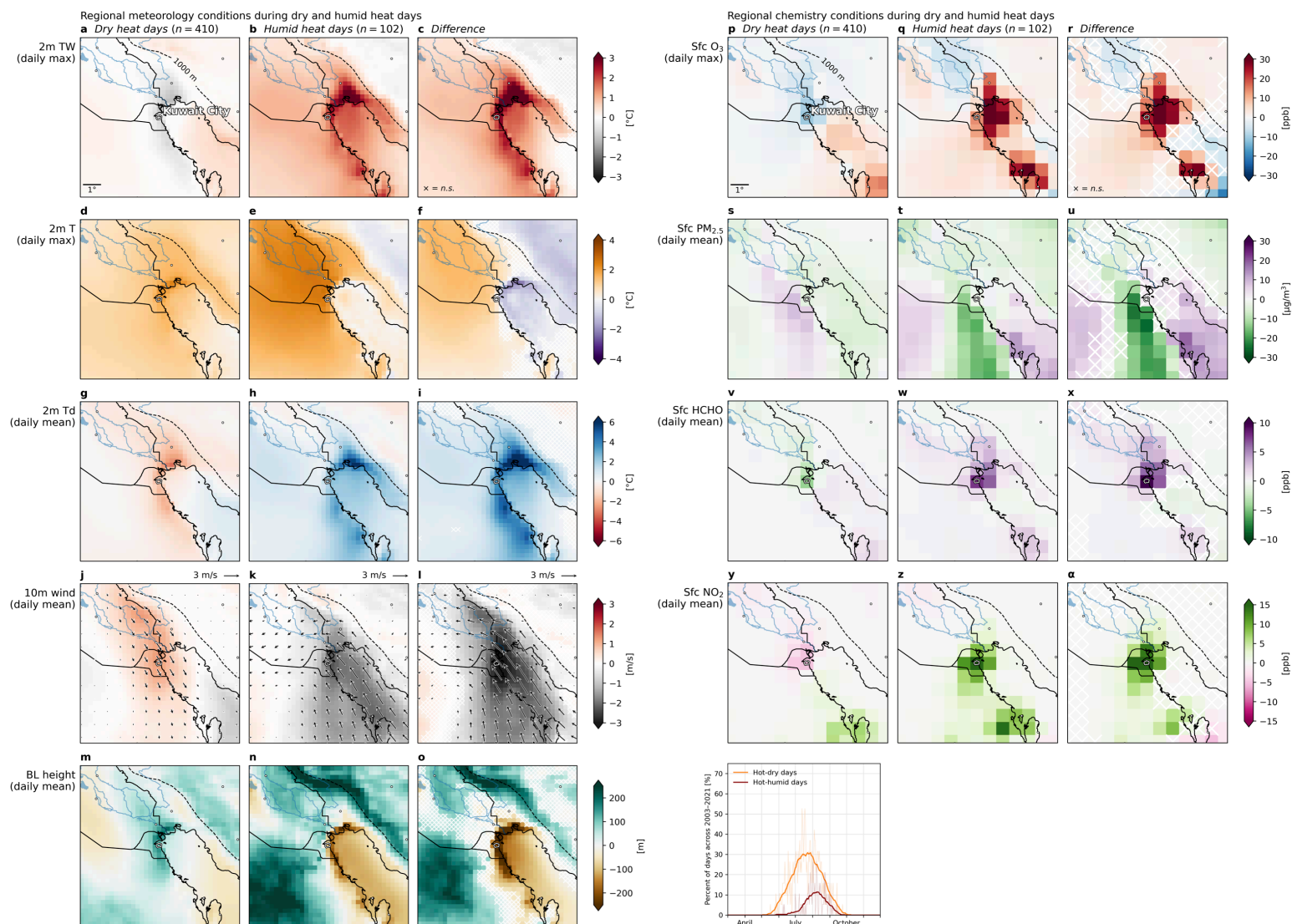


Figure S8. Regional meteorological and chemical conditions during dry and humid heat days in Kuwait City. As in Figure 4 in the main text, but including composites of 2-meter daily-maximum temperature (**d-f**), 2-meter dewpoint temperature (**g-i**), surface PM_{2.5} (**s-u**), and surface NO₂ (**y-α**), and including the time of year of all occurrences of dry and humid heat days over 2003–2021 and their smoothed frequencies throughout the season (bottom right).

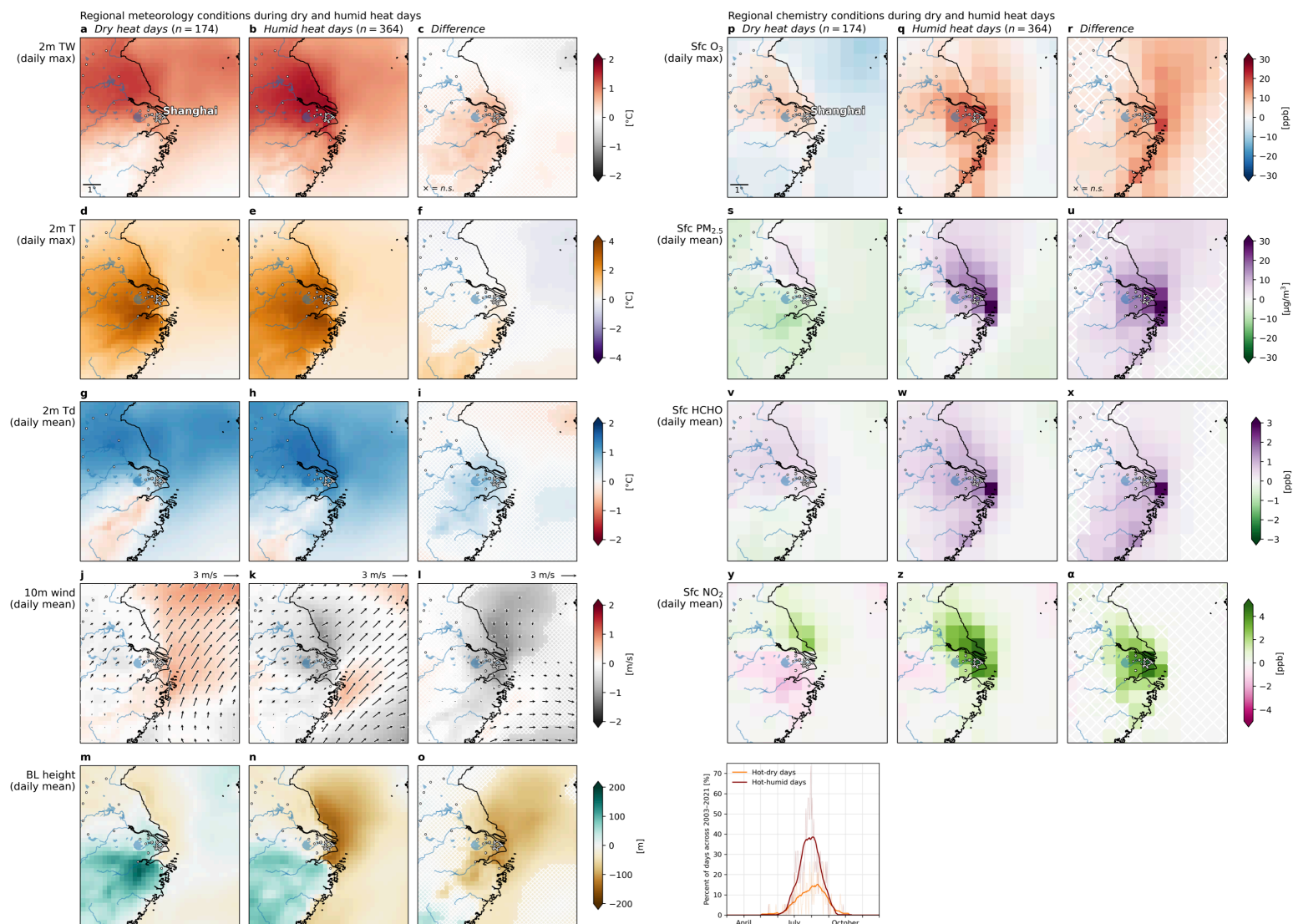


Figure S9. Regional meteorological and chemical conditions during dry and humid heat days in Shanghai. As in Figure S8 but for Shanghai.

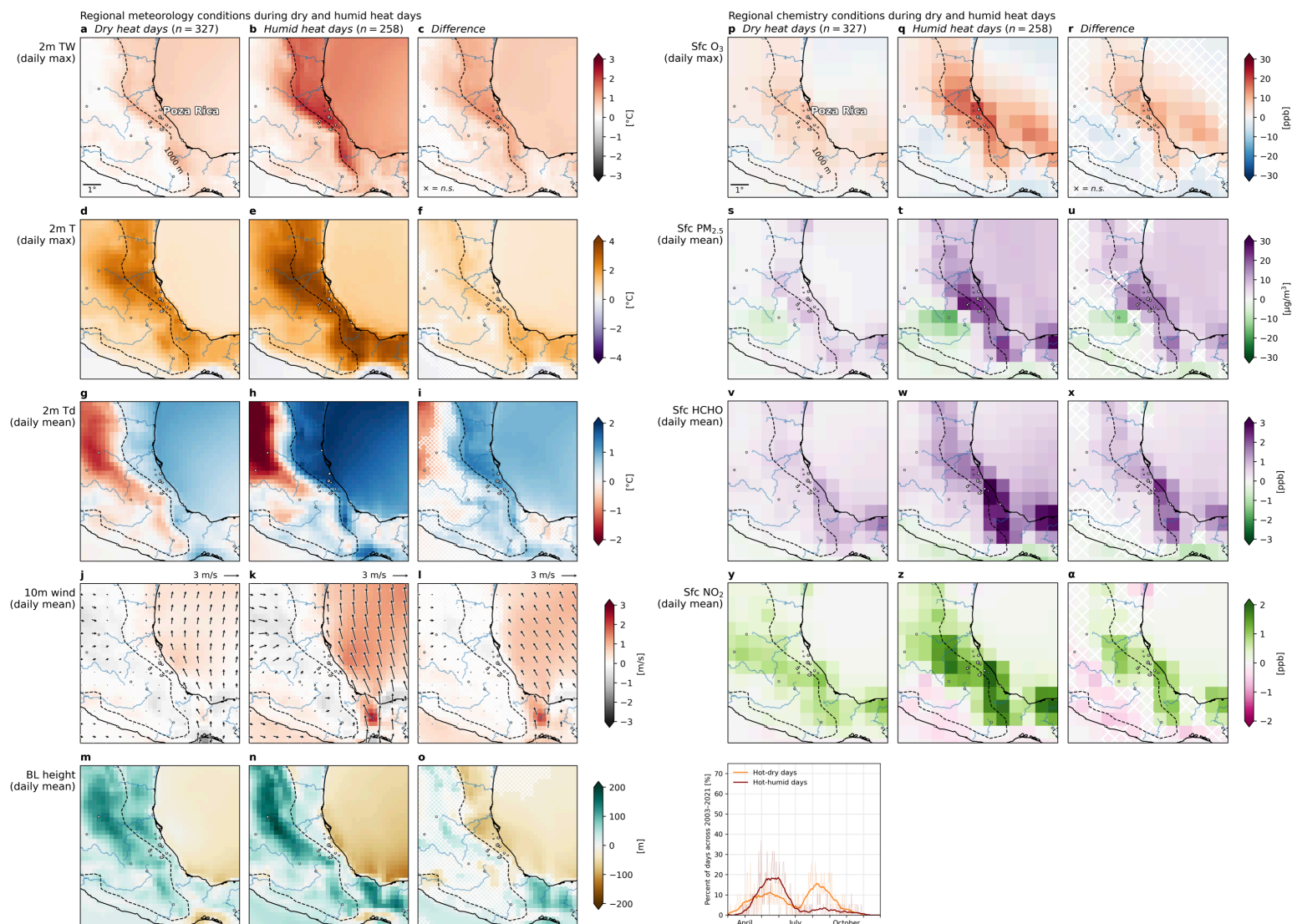


Figure S10. Regional meteorological and chemical conditions during dry and humid heat days in Veracruz. As in Figure S8 but for the Veracruz hotspot (centered on the city of Poza Rica within Veracruz).

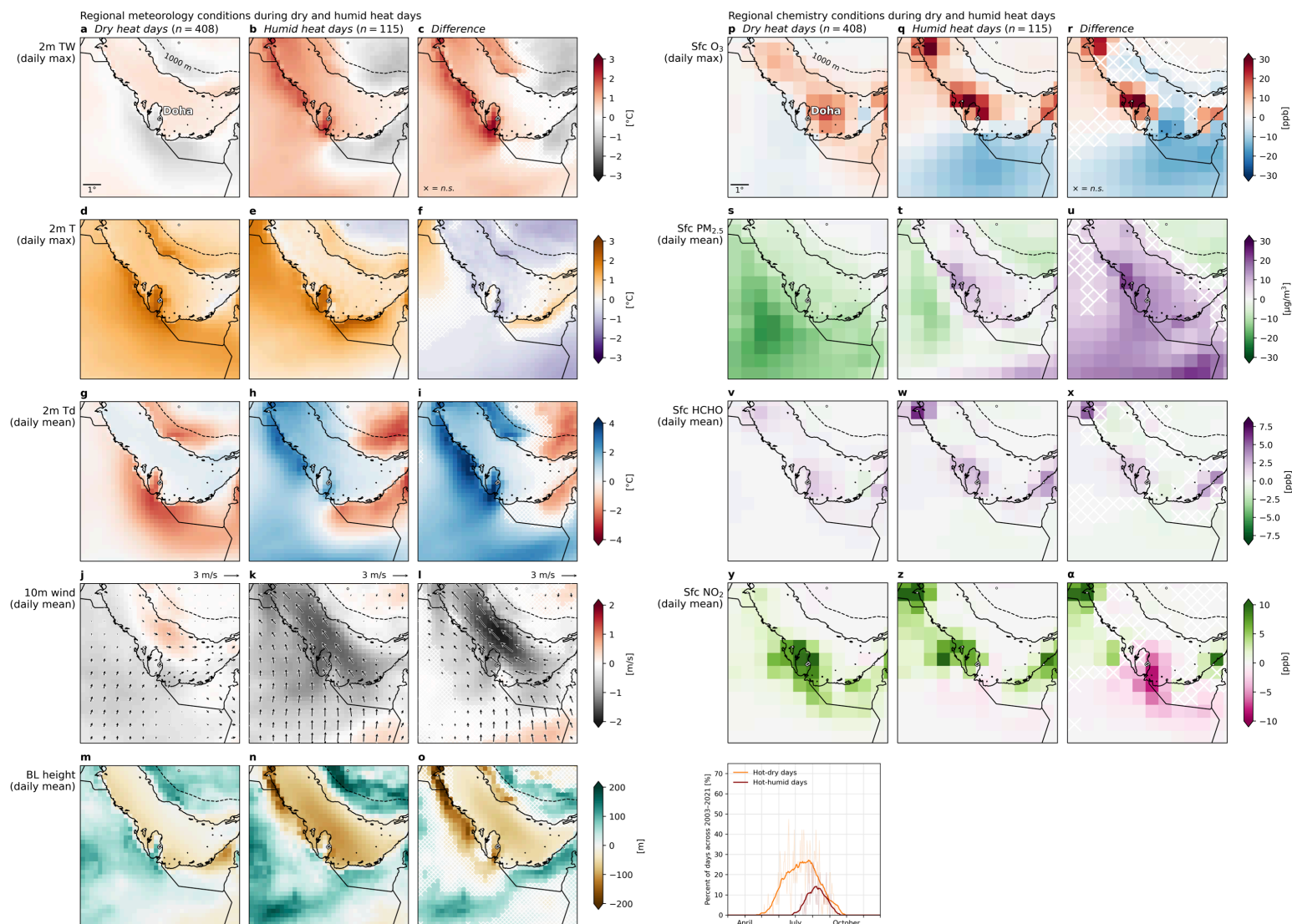


Figure S11. Regional meteorological and chemical conditions during dry and humid heat days in Doha. As in Figure S8 but for Doha.

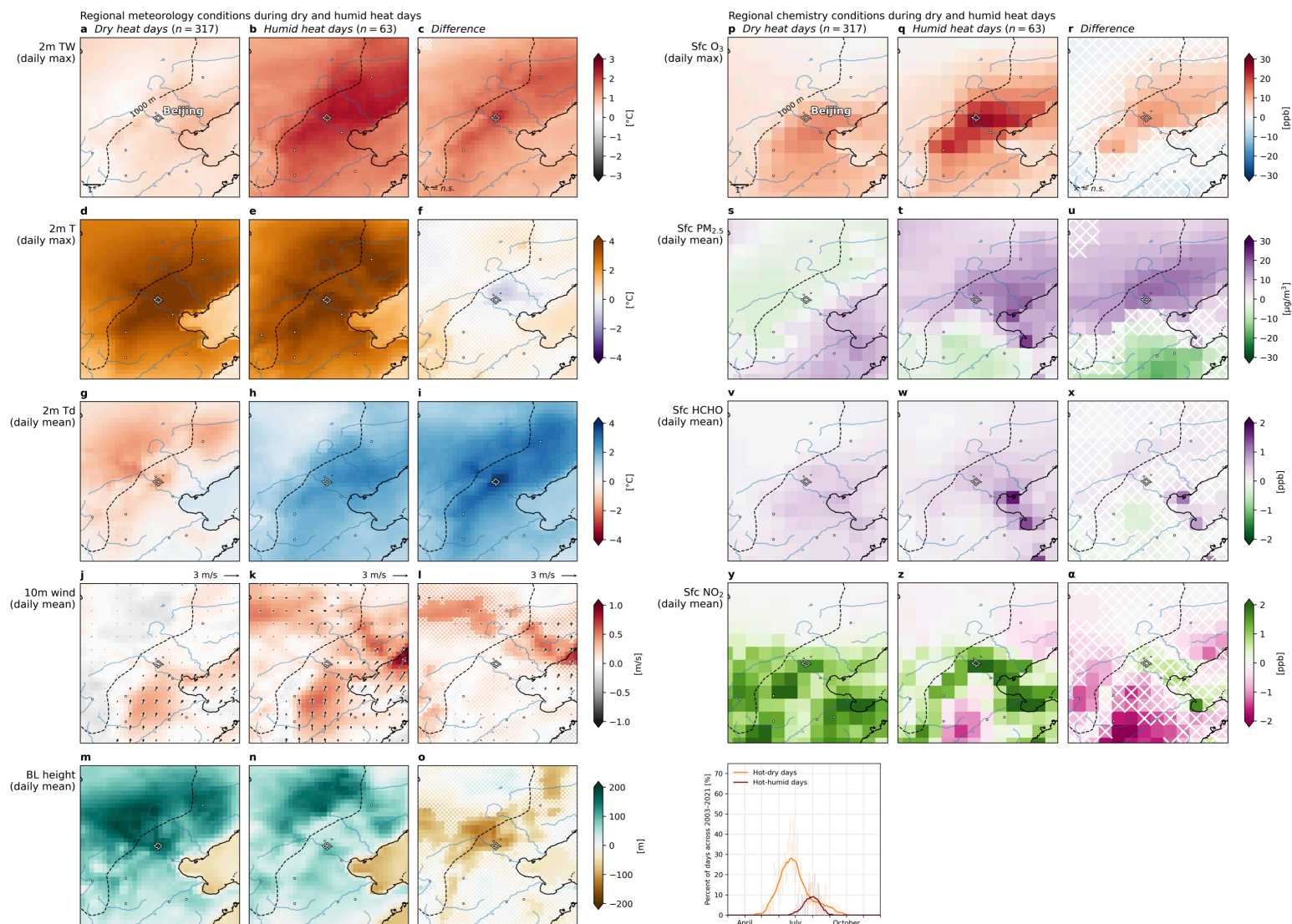


Figure S12. Regional meteorological and chemical conditions during dry and humid heat days in Beijing. As in Figure S8 but for Beijing.

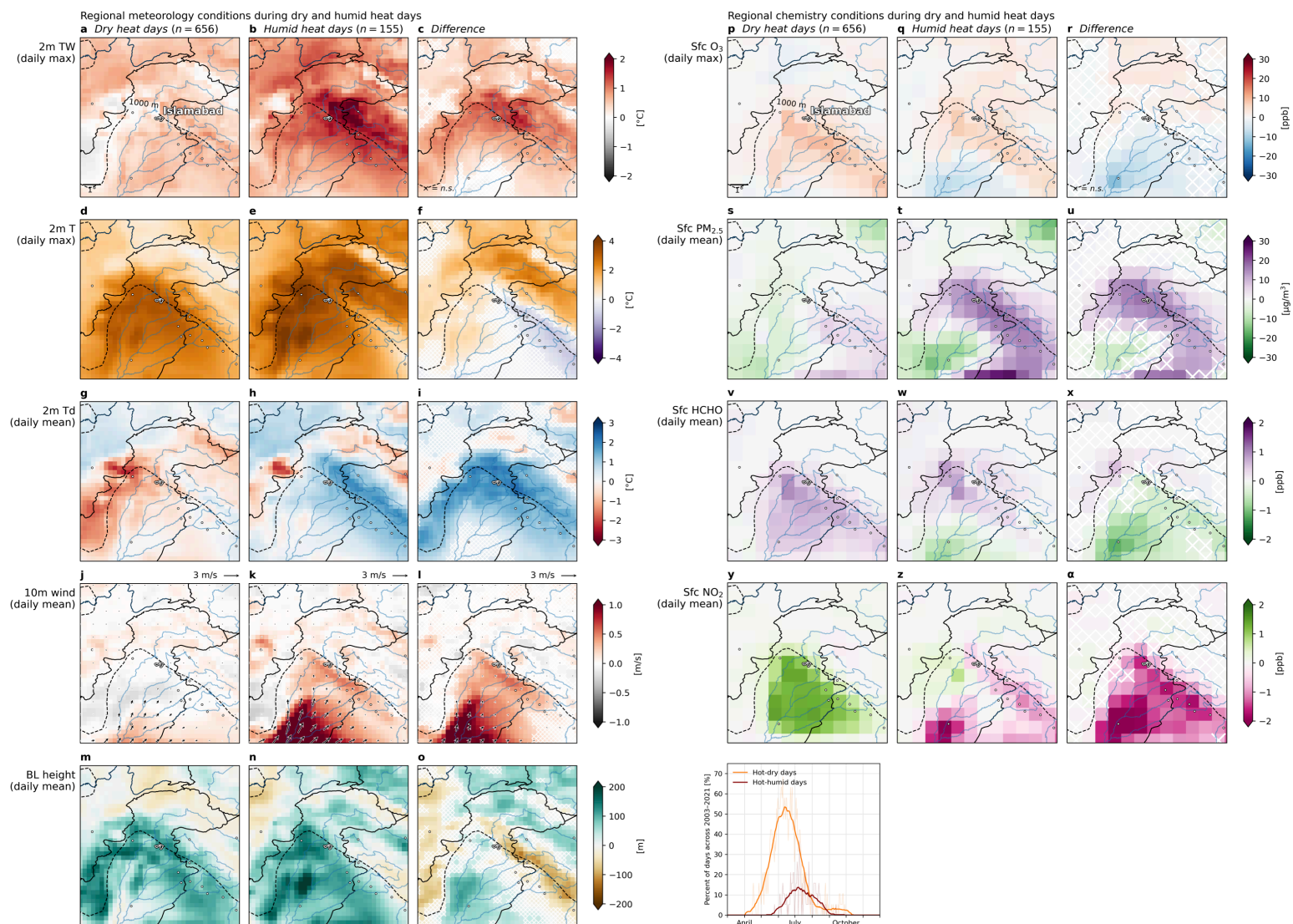


Figure S13. Regional meteorological and chemical conditions during dry and humid heat days in Islamabad. As in Figure S8 but for Islamabad.

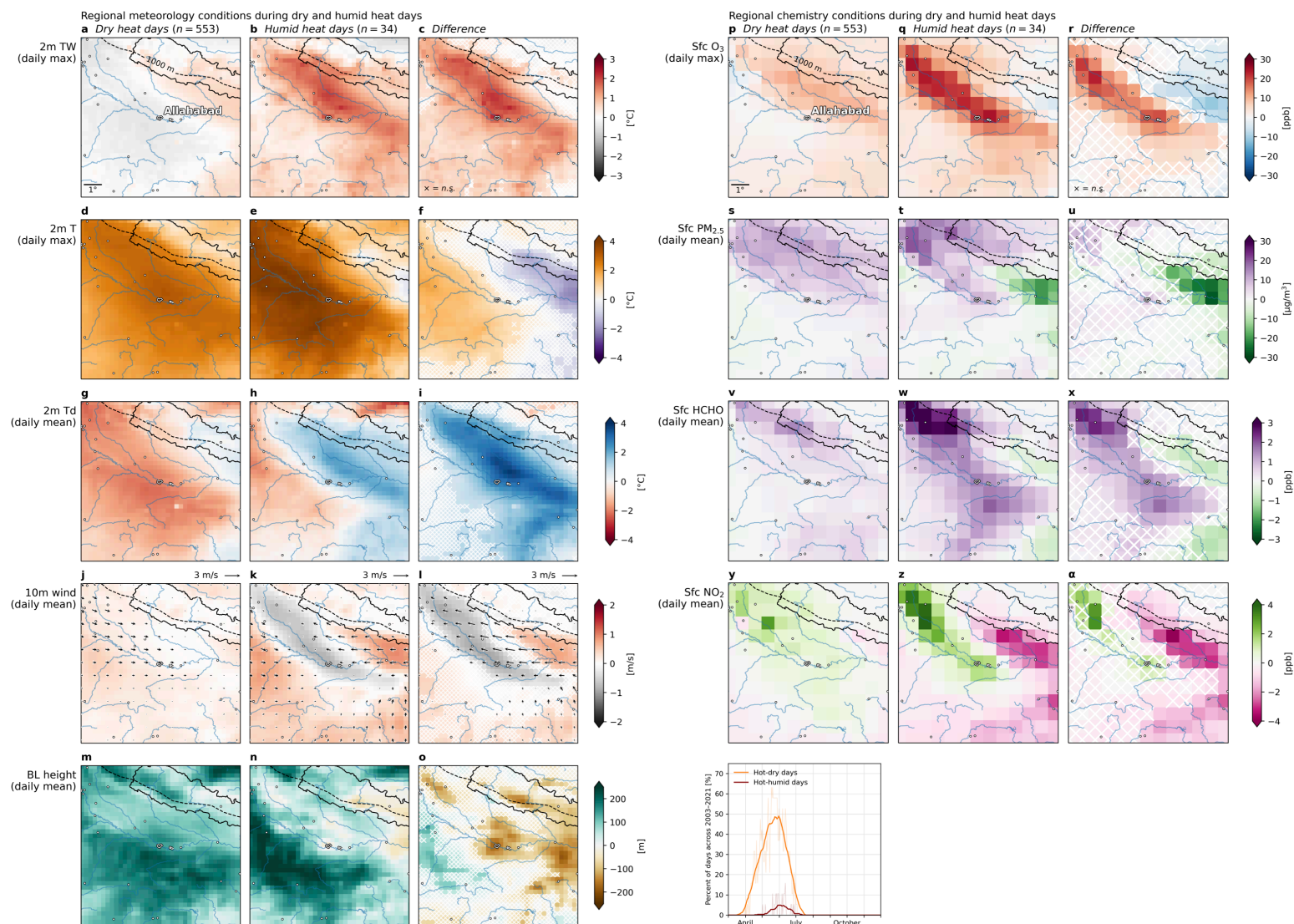


Figure S14. Regional meteorological and chemical conditions during dry and humid heat days in Allahabad. As in Figure S8 but for Allahabad.

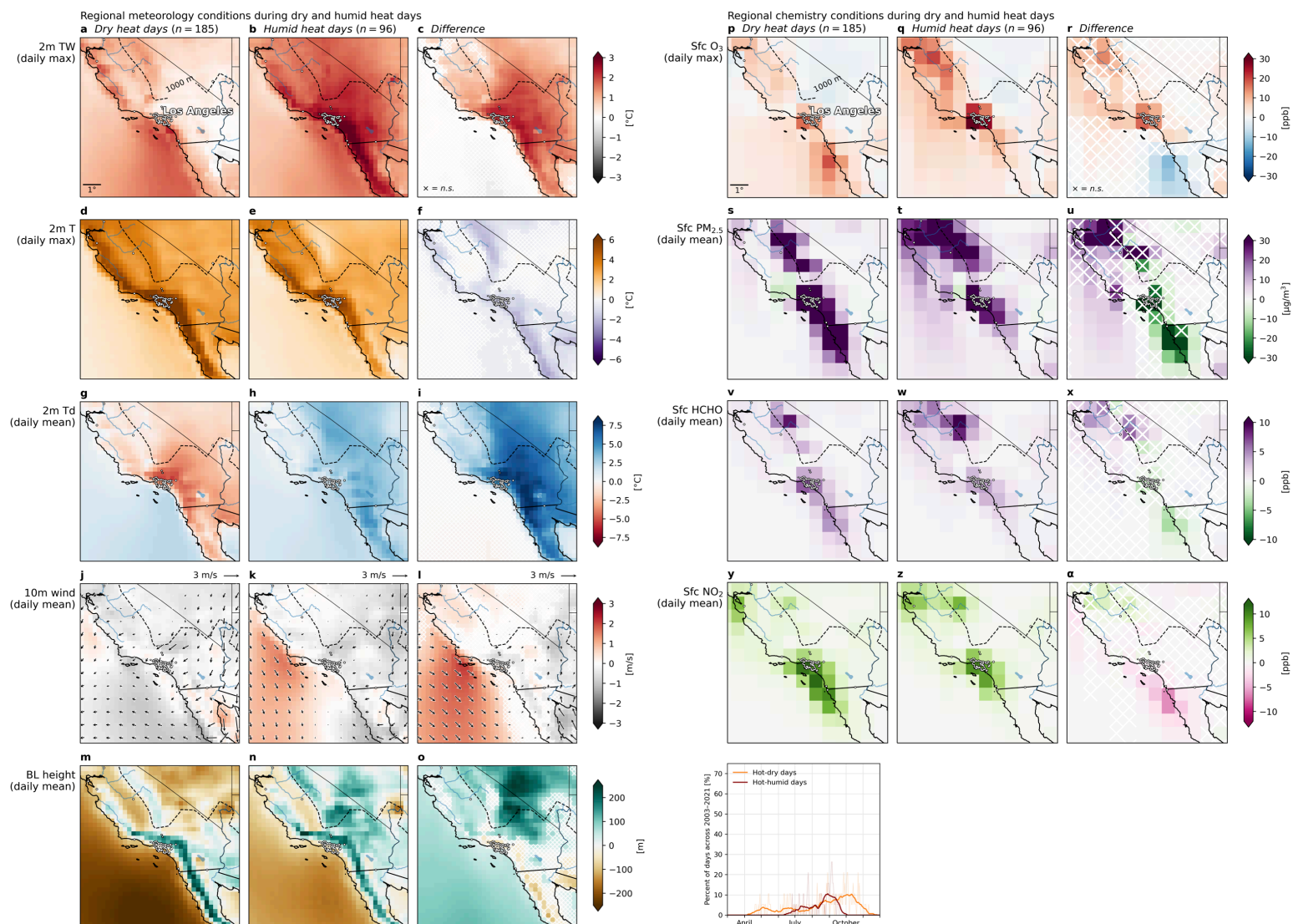


Figure S15. Regional meteorological and chemical conditions during dry and humid heat days in Los Angeles. As in Figure S8 but for Los Angeles.

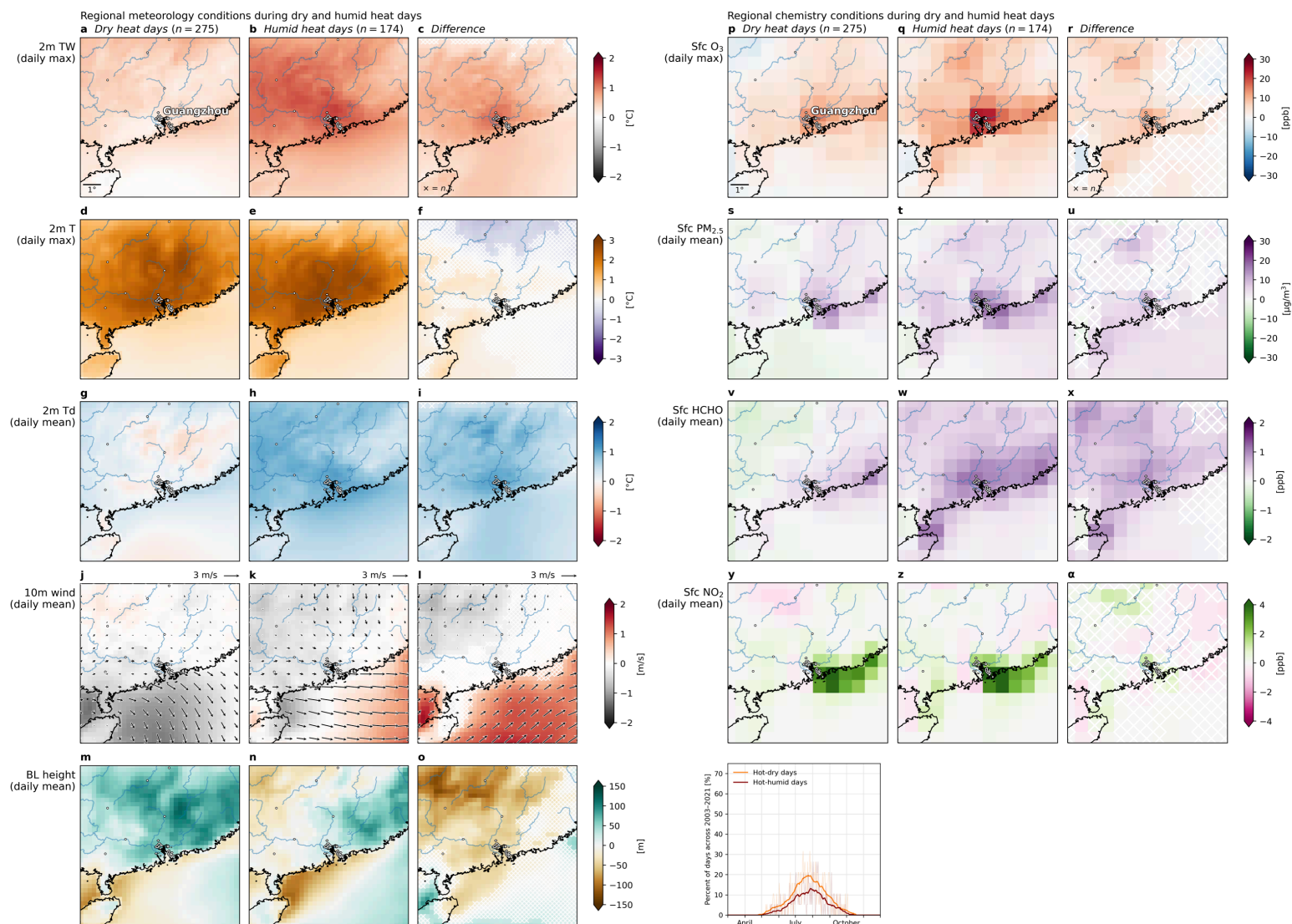


Figure S16. Regional meteorological and chemical conditions during dry and humid heat days in Guangzhou. As in Figure S8 but for Guangzhou.

a Modeled O₃ anomaly difference (humid minus dry heat)

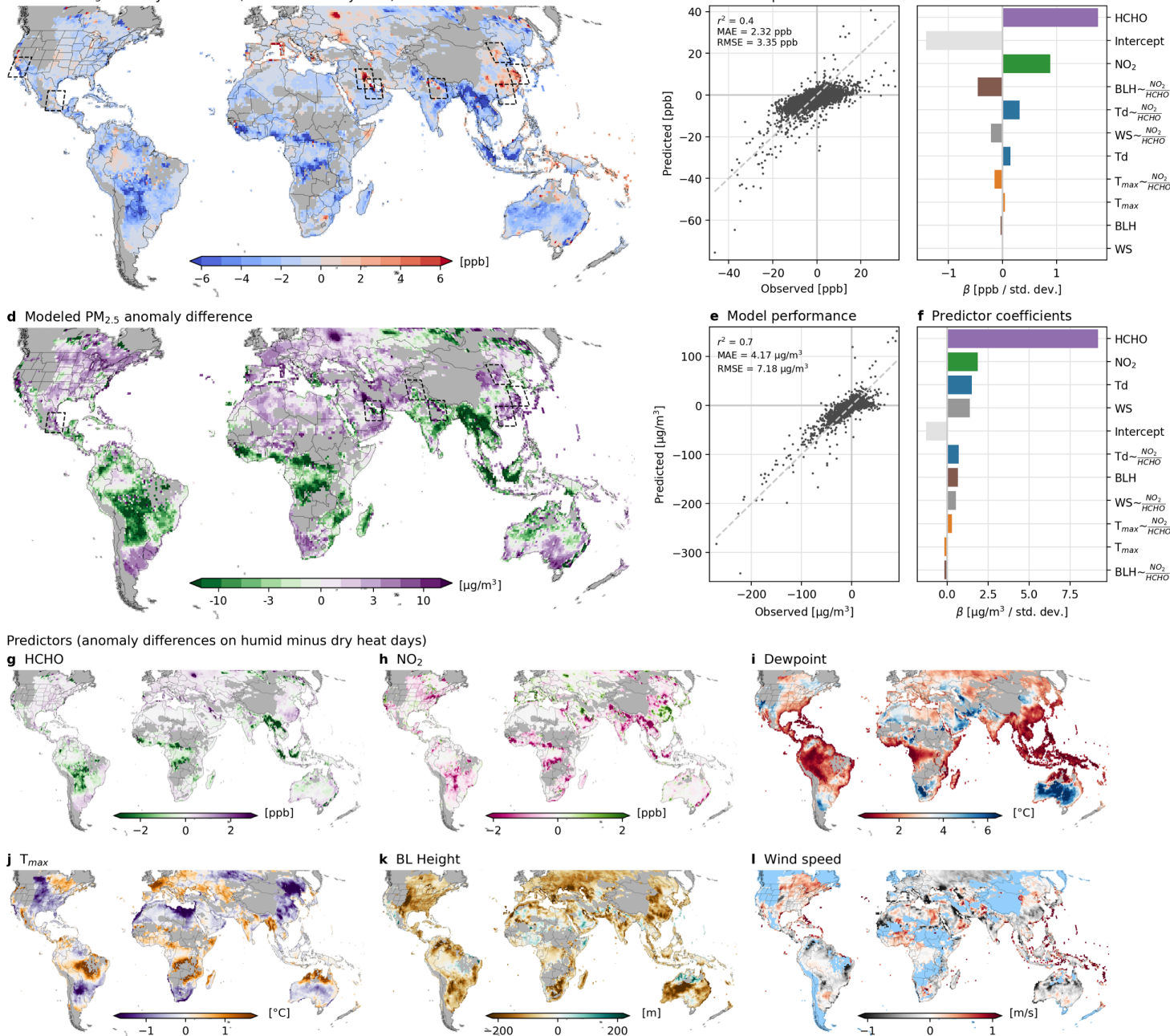


Figure S17. Multiple linear regression model of humid heat and pollution co-occurrence from meteorological and chemical conditions. Same as Figure 7 in the main text but instead of simple background characteristics, the actual differences in variable anomalies between humid and non-humid heat days are used as predictors. Interaction terms between the four meteorological variables (Tmax, Td, BLH, and WS) and background chemical regime (warm-season mean NO2/HCHO ratio) are also included.