**Supplemental material**

Multi-model inter-comparisons of air quality simulations for the KORUS-AQ campaign

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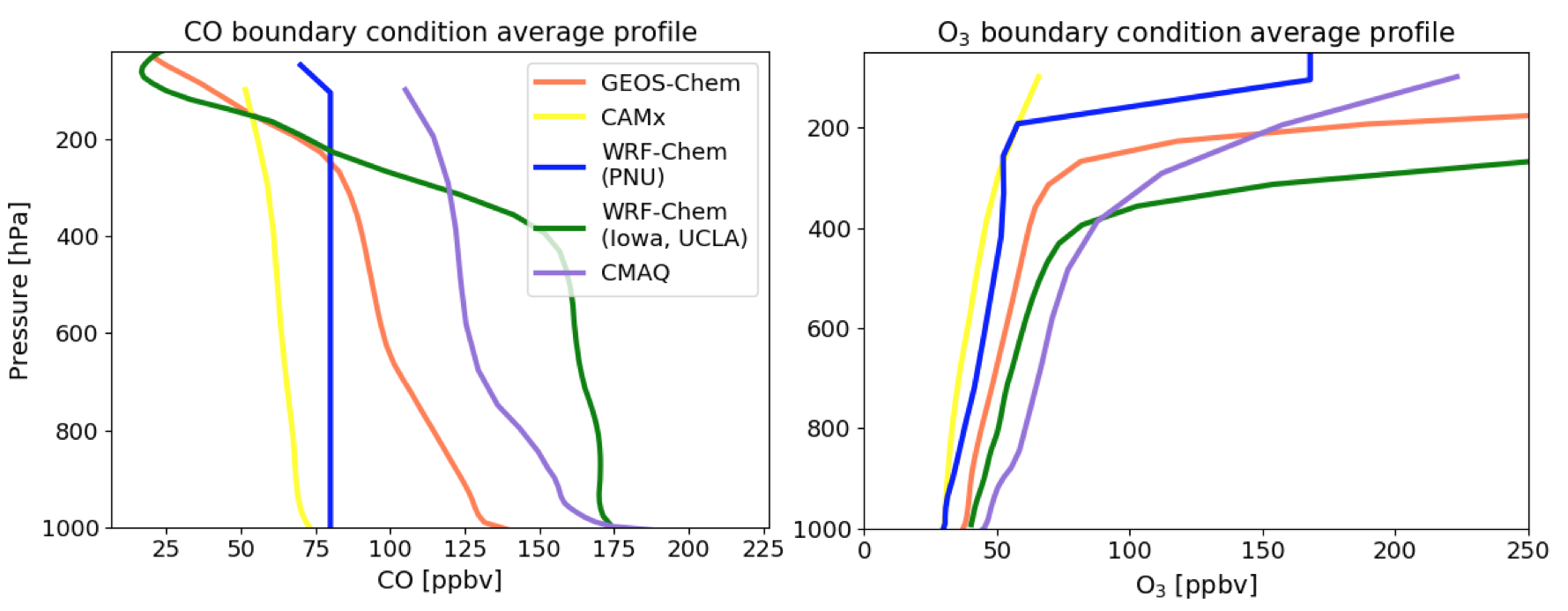
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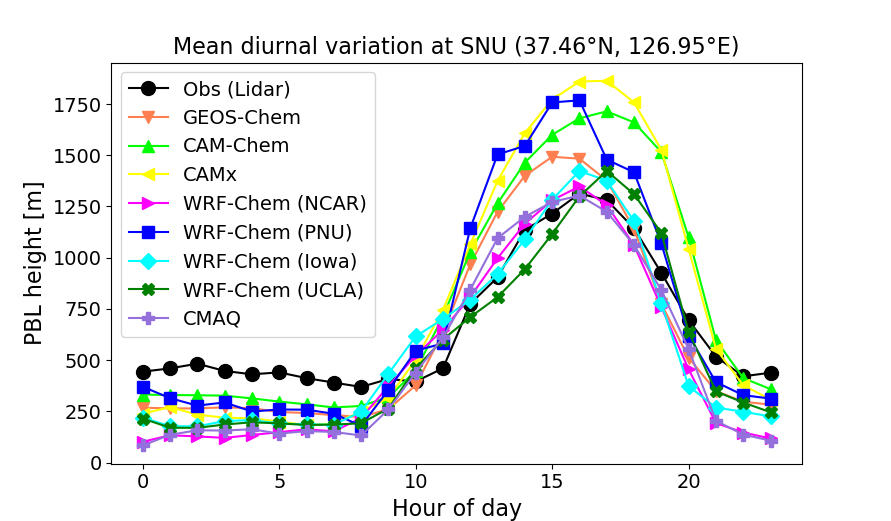
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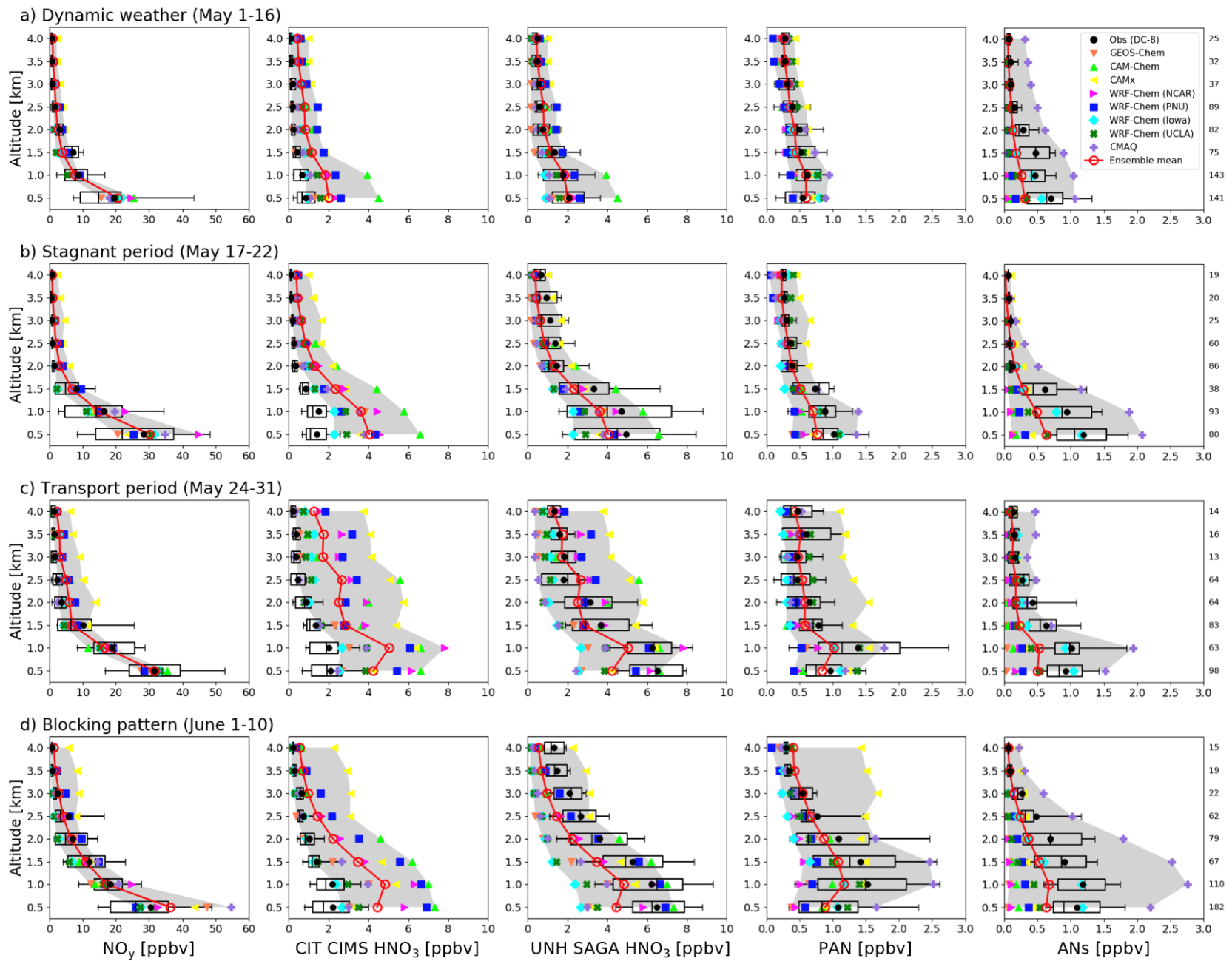
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**Figure S1. Comparison of average vertical profiles of CO and O3 mixing ratios from the lateral boundary conditions used in each model.**

Sources of the lateral boundary conditions used in each model are presented in Table 1.

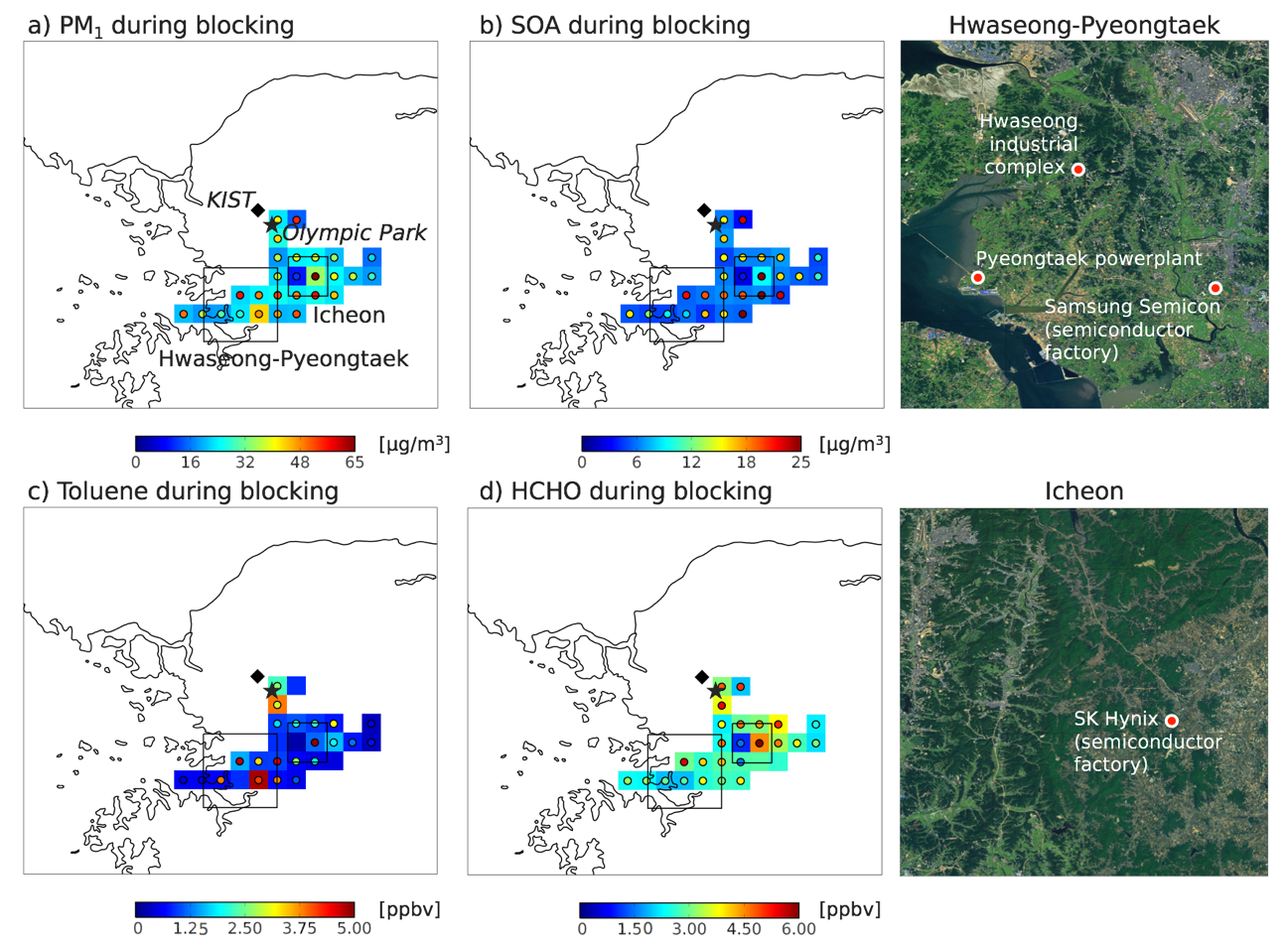
**Figure S2. Comparison of mean diurnal profiles of observed (lidar) and simulated PBL height at Seoul National University (SNU; 37.46°N, 126.95°E) during the whole campaign period.**

Lidar backscatter profiles were observed and retrieved by Sang-Woo Kim (SNU) using the retrieval algorithm by Brooks (2003).



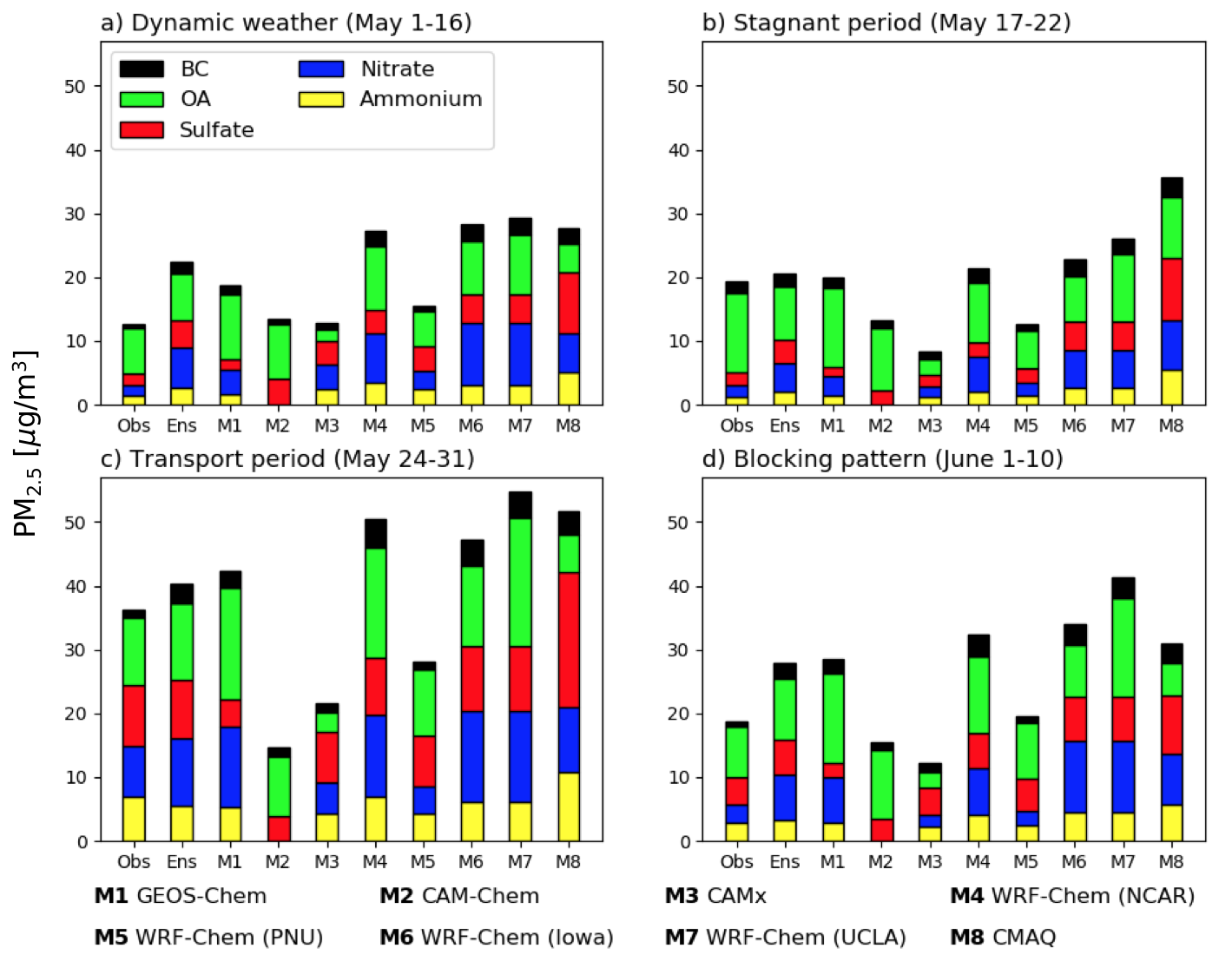
**Figure S3. Comparison of simulated and observed mean vertical profiles of NOy and its components (HNO3, PAN, ANs) in the SMA (37-37.6°N, 126.6-127.7°E) during different synoptic conditions.**

Boxplots and whiskers indicate the interquartile and 10-90 percentile ranges of observations. Vertical lines and closed black circles each indicate the median and mean values. Different colors represent the mean vertical profile of each model with solid lines in red indicating the model ensemble and model ranges in gray shades. HNO3 mixing ratios measured by two different instruments (CIMS, SAGA) are shown for comparison. Data sampling and averaging methods are identical to Figure 7.



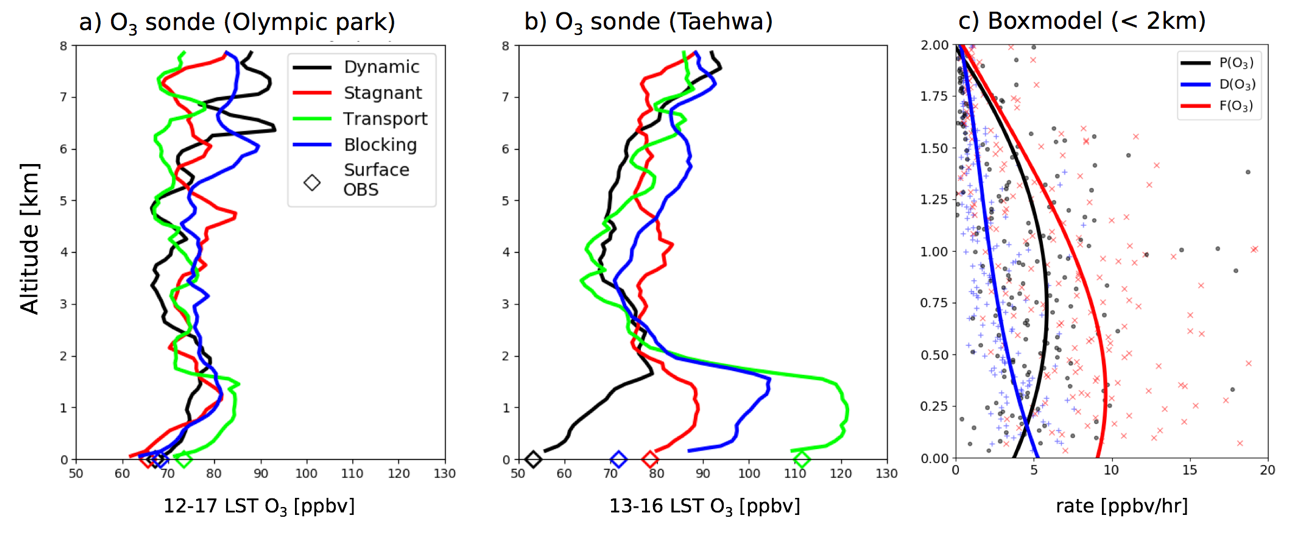
**Figure S4. Model ensemble (background) and observed (overlaid circles) a) PM1, b) secondary organic aerosol (SOA) concentrations, c) toluene, and d) HCHO mixing ratios along the DC-8 flight track averaged below 1.5 km in the SMA during the blocking period (June 1-10).**

Squared areas indicate major industrial complexes (Hwaseong-Pyeongtaek and Icheon) in the Gyeonggi province. DC-8 observations and the ensemble model were gridded to 0.1o horizontal resolution.

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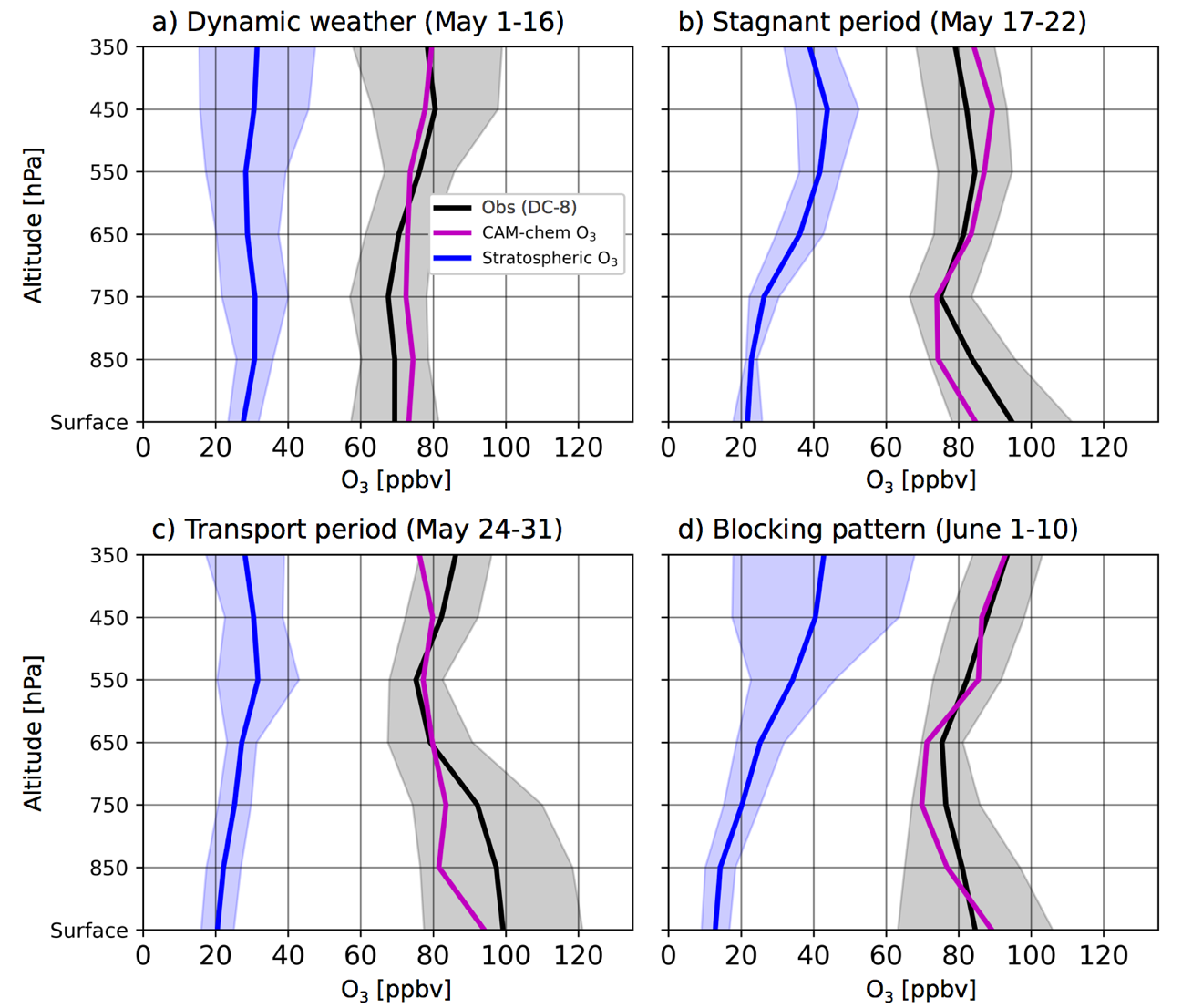
**Figure S5. Comparison of simulated and observed mean PM2.5 chemical compositions in surface air at the Olympic park ground site (37.519°N, 127.122°E) for different synoptic regimes during the campaign.**

Each chemical component is indicated in different colors and the observations are from the MARGA ADI2080 (DOGA Limited, Turkey) instrument for inorganic aerosols, and the OCEC Analyzer (Sunset Laboratory Inc., USA) for carbonaceous aerosols. We used OC/OM = 1.82 for calculating OA according to Kim et al. (2018). Model results from the lowest model layer were sampled coherently with the observations.



**Figure S6. Comparison of O3 sonde observations at a) Olympic park, b) Taehwa research forest (37.280°N, 127.227°E), and c) 0-D photochemical boxmodel simulations along the DC-8 flight track in the SMA below 2 km.**

In a) and b) colors indicate different synoptic conditions and open diamonds indicate corresponding surface observations at each site. The NASA Langley Research Center (LaRC) 0-D observation-constrained photochemical boxmodel was used in c) to calculate the campaign average vertical distributions of simulated O3 net production (black), destruction (blue), and formation (red) rates. Net O3 production, P(O3), is the difference between the formation rate, F(O3), and destruction rate, D(O3) (Schroeder et al., 2020). Simulated profiles were binned and averaged with 10 m intervals to retain the lowest aircraft altitudes and are displayed with different markers and colors for each variable. Solid lines indicate the 3rd degree least squares polynomial fit of each binned profile.



**Figure S7. Simulated CAM-Chem (magenta) O3 mixing ratios during KORUS-AQ with stratospheric O3 (blue) contributions.**

Stratospheric O3 contributions are estimated using a tracer of stratospheric O3 with tropospheric chemical loss and without dry deposition.