Supplement of "Formation of Highly Absorptive Secondary Brown Carbon Through Nighttime Multiphase Chemistry of Biomass Burning Emissions"

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1. Methods

1.1 Aerosol liquid water content calculations

The size resolved aerosol liquid water content (ALWC) was formulated as the following in which the ALWC was the summation of aerosol water contributed by inorganic aerosols and organic aerosols:

$$ALWC(D_a)=ALWC_{Inorg}(D_a) + ALWC_{org}(D_a)$$

Where the $ALWC_{Inorg}(D_a)$ was calculated using the ISORROPIA (Kuang et al., 2018) model using reverse mode and metastable with size resolved inorganic aerosol chemical compositions measured by the SP-AMS as inputs. The $ALWC_{org}(D_a)$ was calculated as:

$$ALWC_{org}(D_a)=\frac{m_{org}(Da)}{\rho_{org}} \times \rho_w \times \frac{\kappa_{org}}{(\frac{100\%}{RH}-1)}$$

The $m_{org}(Da)$ is the size resolved organic aerosol mass concentrations measured by the SP-AMS, the κ_{org} derived in Kuang et al. (2021) was used.

2. Supplementary Figures

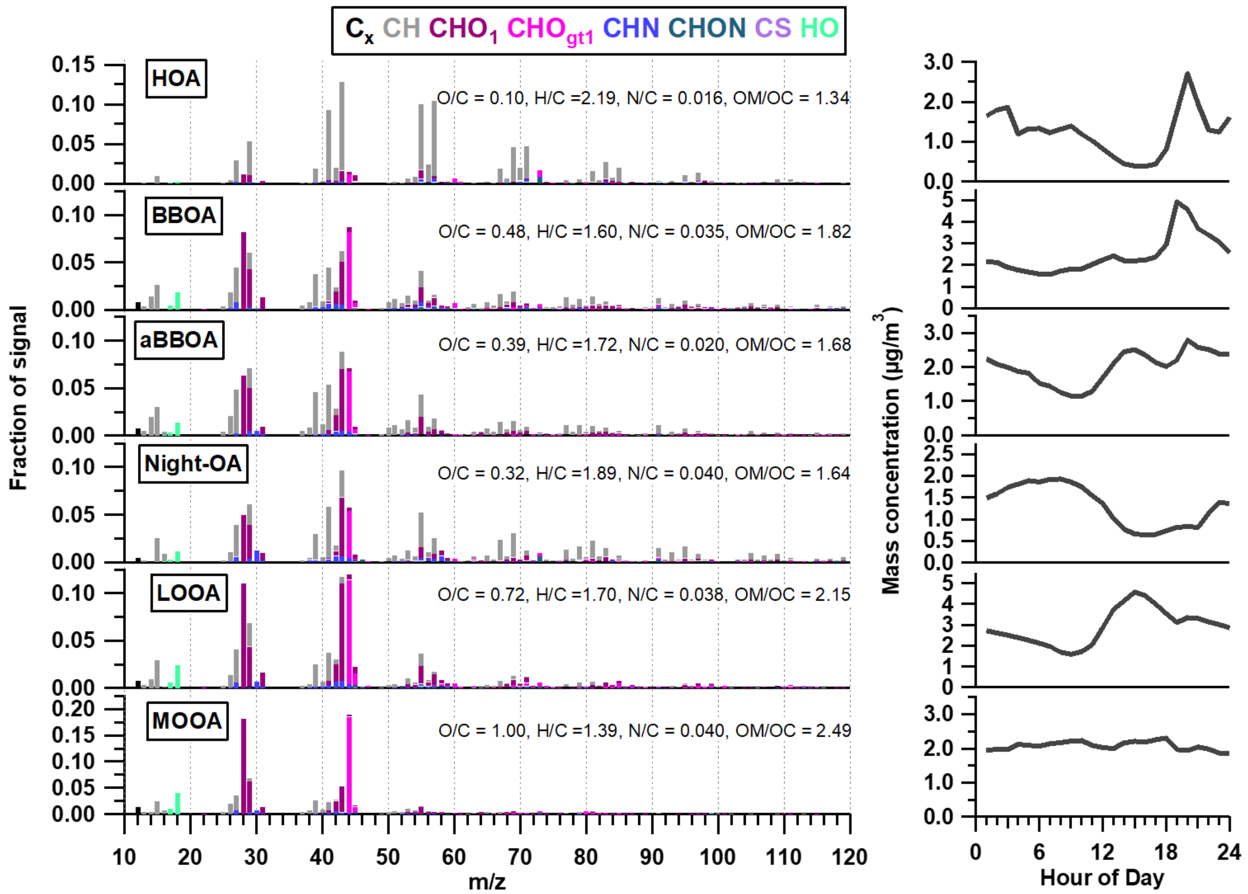

Figure S1. Mass spectral profile and diurnal variation of PMF factors based on SP-AMS measurements, note than the O/C of HOA here is different with that in Luo et al. (2022) because of the mislabeling and corrected here.

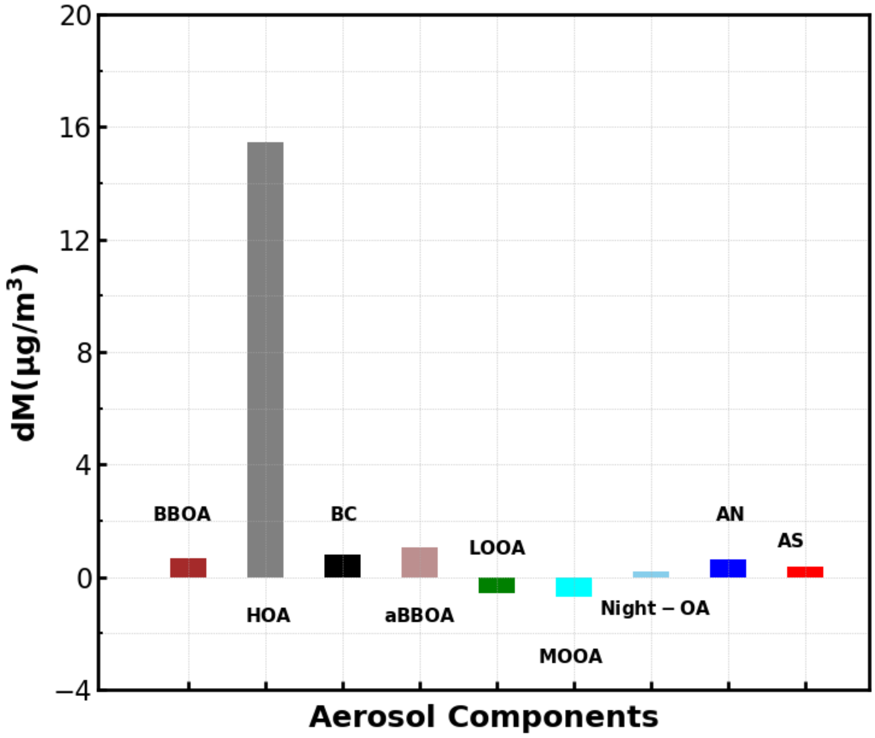

Figure S2. Average mass concentration changes of aerosol components for identified HOA increase cases, AN represents ammonium nitrate and AS represents ammonium sulfate.

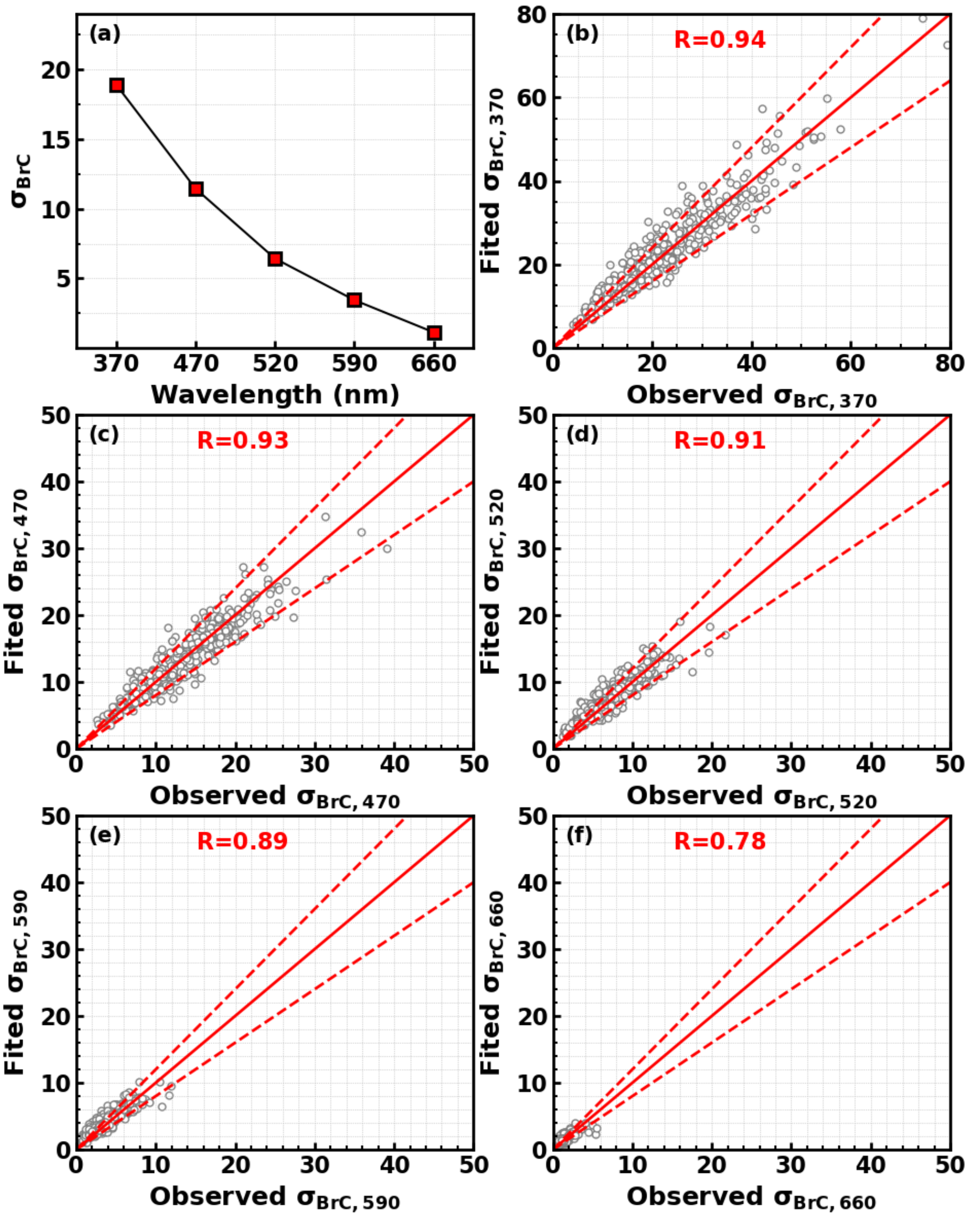

Figure S3. (a) Average BrC absorptions at different wavelengths, (b-f) Comparisons between predicted and observed BrC absorption values at wavelengths of 370 nm, 470 nm, 520 nm, 590 nm, and 660 nm using the multivariate linear regression method.

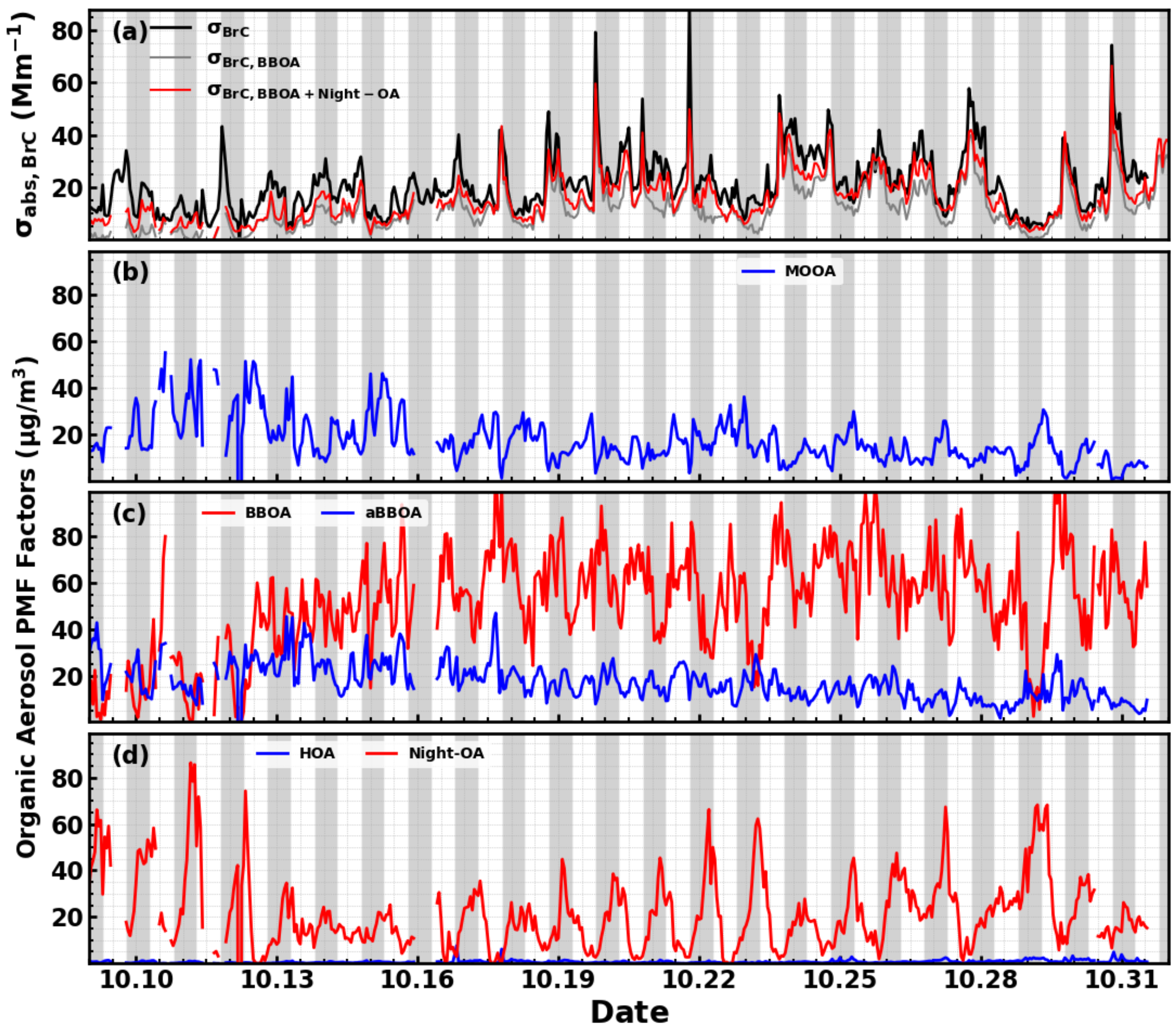

Figure S4. Timeseries of contributions of different OA factors to BrC absorption at 370 nm.

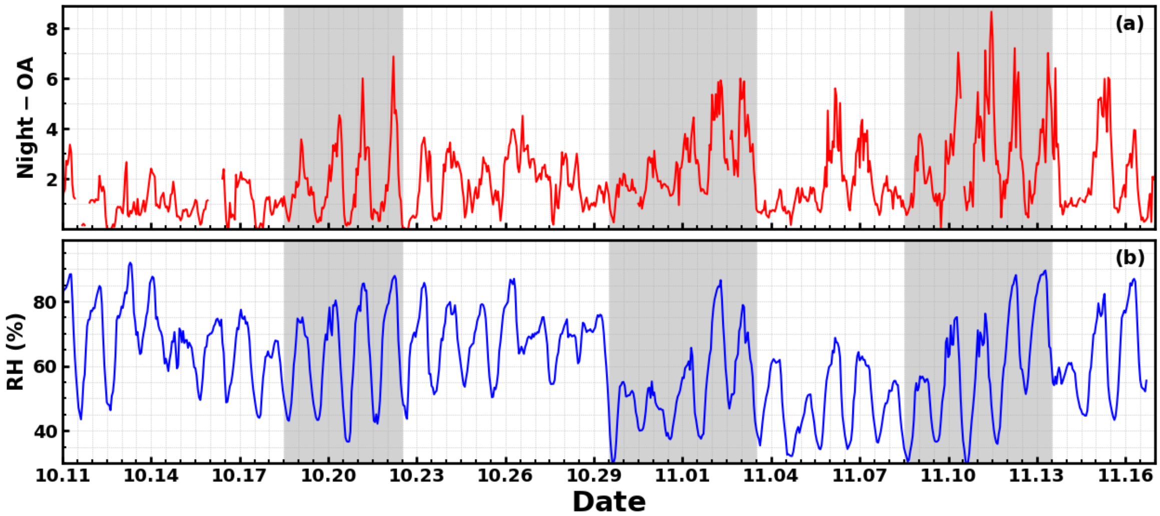

Figure S5. Timeseries of **(a)** Night-OA mass concentrations and **(b)** relative humidity (RH). Gray shading areas represent periods with remarkable Night-OA formations.

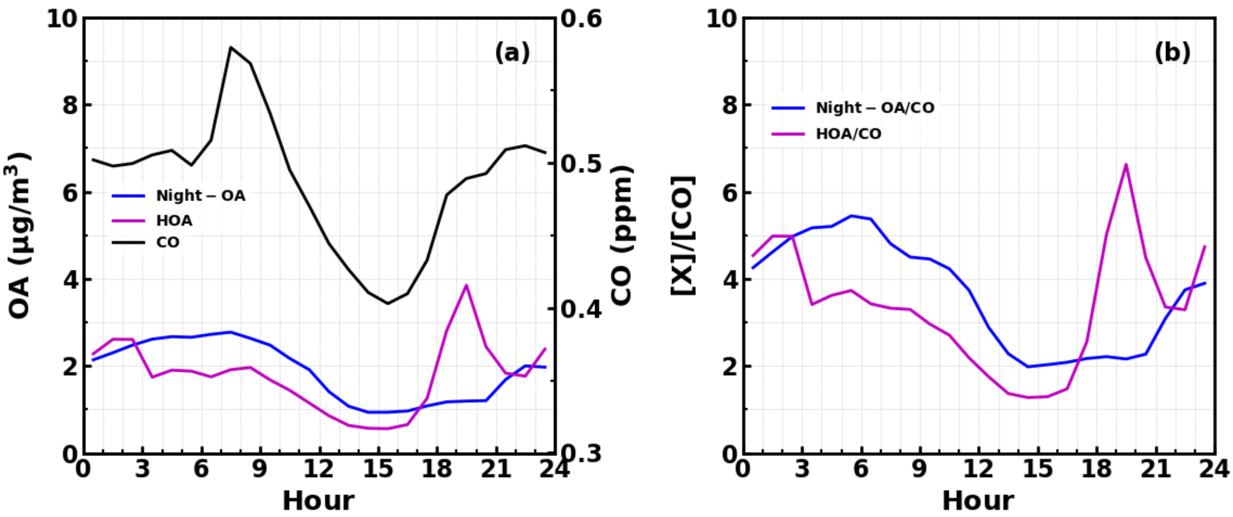

Figure S6. (a) Average diurnal variations of Night-OA, HOA and CO; (b) Average diurnal variations of [Night-OA]/[CO] and [HOA]/[CO]

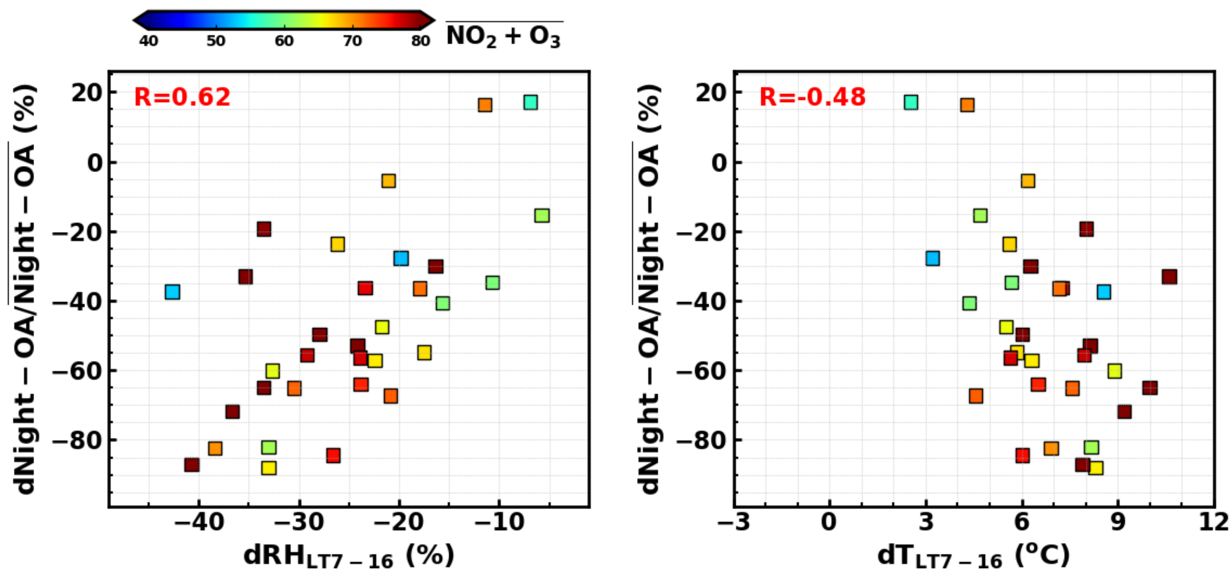

Figure S7. (a) Correlations between Night-OA decrease and RH changes from local time 07:00 in the morning to 16:00 in the afternoon; (b) Correlations between Night-OA decrease and air temperature (T) changes from local time 07:00 in the morning to 16:00 in the afternoon. Colors of square markers represent Ox (NO_2+O_3) levels.

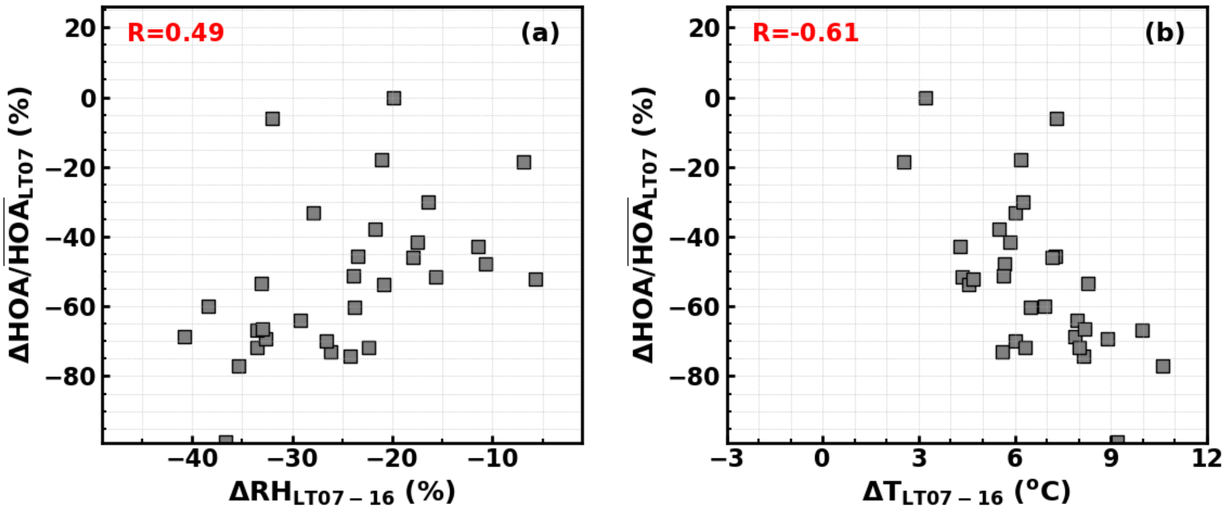

Figure S8. **(a)** Correlations between HOA decrease and RH changes from local time 07:00 in the morning to 16:00 in the afternoon; **(b)** Correlations between HOA decrease and air temperature (T) changes from local time 07:00 in the morning to 16:00 in the afternoon.

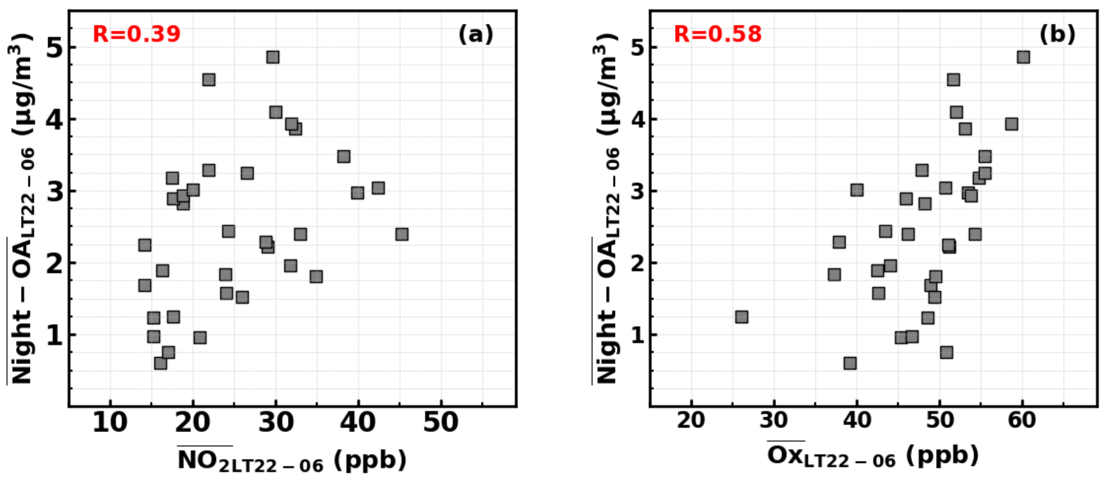

Figure S9. **(a)**Correlations between average Night-OA mass concentration (local time 22:00 to 06:00 of next morning) and corresponding average NO_2 concentration; **(b)** Correlations between average Night-OA mass concentration (local time 22:00 to 06:00 of next morning) and corresponding average Ox (NO_2+O_3) concentration.

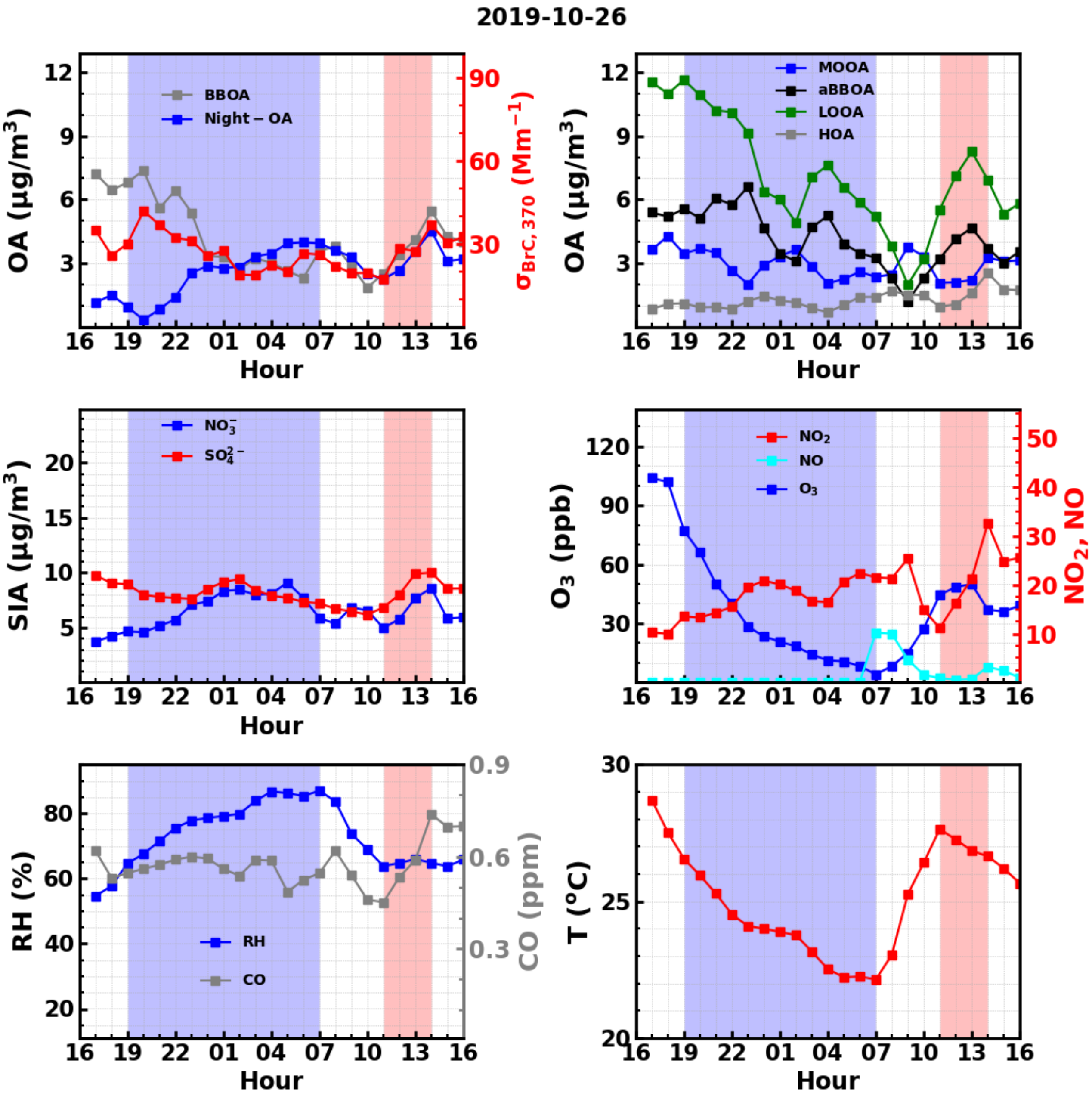

Figure S10. Evolution of aerosol chemical compositions, NO$_2$, O$_3$, NO CO, and metrological parameters such as RH and T from local time 16:00 of 25th 10, 2019 to 16:00 of 26th 10, 2019, blue shading areas represent nighttime and pink shading areas corresponding to periods with obvious daytime Night-OA increase.

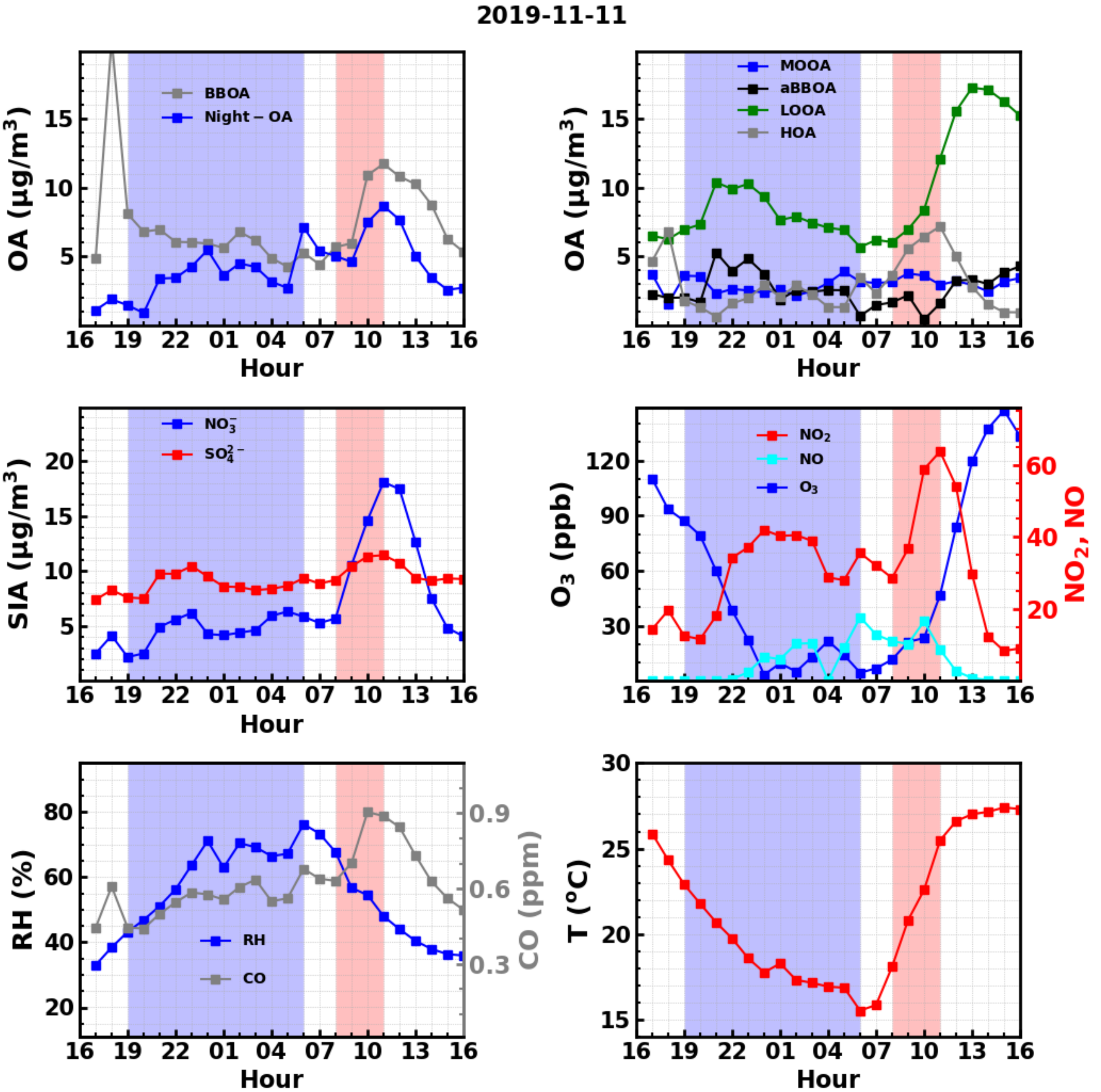

Figure S11. Evolution of aerosol chemical compositions, NO_2, O_3, NO CO, and metrological parameters such as RH and T from local time 16:00 of 10[th] 11, 2019 to 16:00 of 11[th] 11, 2019, blue shading areas represent nighttime and pink shading areas corresponding to periods with obvious daytime Night-OA increase.

References:

Kuang, Y., Zhao, C. S., Zhao, G., Tao, J. C., Xu, W., Ma, N., and Bian, Y. X.: A novel method for calculating ambient aerosol liquid water content based on measurements of a humidified nephelometer system, Atmospheric Measurement Techniques, 11, 2967-2982, 10.5194/amt-11-2967-2018, 2018.

Kuang, Y., Huang, S., Xue, B., Luo, B., Song, Q., Chen, W., Hu, W., Li, W., Zhao, P., Cai, M., Peng, Y., Qi, J., Li, T., Chen, D., Yue, D., Yuan, B., and Shao, M.: Contrasting effects of secondary organic aerosol formations on organic aerosol hygroscopicity, Atmos. Chem. Phys. Discuss., 2021, 1-27, 10.5194/acp-2021-3, 2021.

Luo, B., Kuang, Y., Huang, S., Song, Q., Hu, W., Li, W., Peng, Y., Chen, D., Yue, D., Yuan, B., and Shao, M.: Parameterizations of size distribution and refractive index of biomass burning organic aerosol with black carbon content, Atmos. Chem. Phys., 22, 12401-12415, 10.5194/acp-22-12401-2022, 2022.