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Vertical profiles of trace gas and aerosol properties over the eastern North Atlantic: variations with season and synoptic condition

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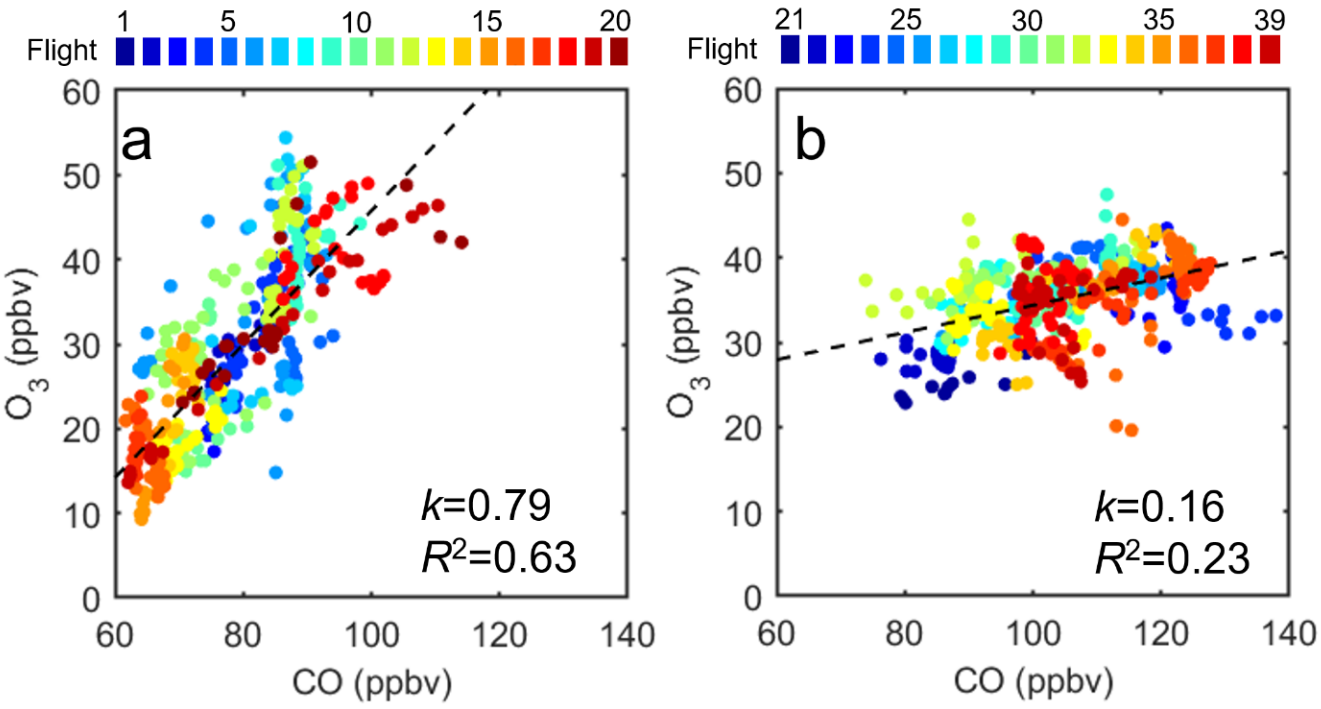

Fig. S1. Correlation between O_3 and CO during the (a) summer IOP and (b) winter IOP in the FT colored by flight number. The dashed lines show the linear fits of the data points.

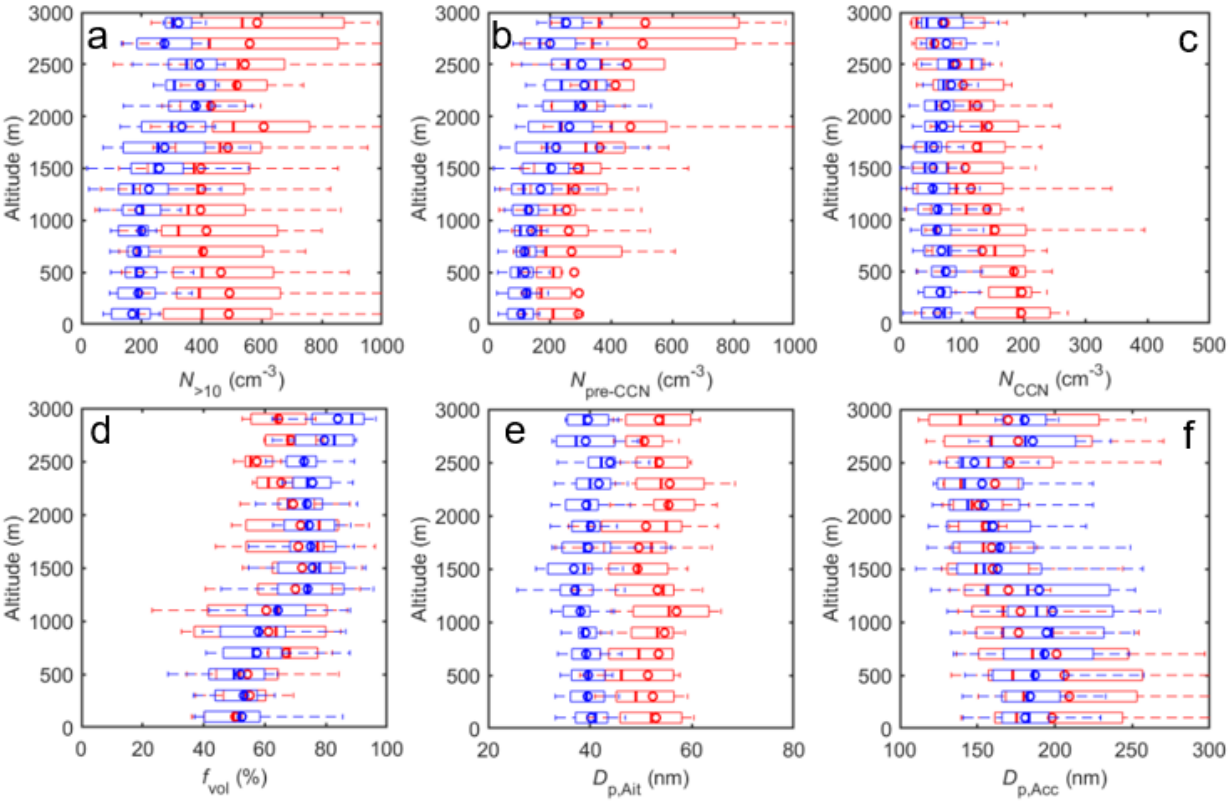

Fig. S2. Vertical profiles showing the (a) concentration of particles larger than 10 nm ($N_{>10}$), (b) concentration of Aitken-mode aerosols or aerosols too small to form cloud droplets ($N_{pre-CCN}$), (c) concentration of accumulation-mode aerosols or CCN (N_{CCN}), (d) aerosol volatile fraction (f_{vol}), (e) average size of Aitken-mode aerosol ($D_{p,Ait}$), and (f) average size of accumulation-mode aerosol ($D_{p,Acc}$) over the ENA site during the summer IOP (red) and winter IOP (blue). The data correspond to the periods when BC mass concentrations are below 5 ng m^{-3}. The line and circle markers represent the median and mean of the data, and the edges of the box indicate the 25th and 75th percentiles, respectively.

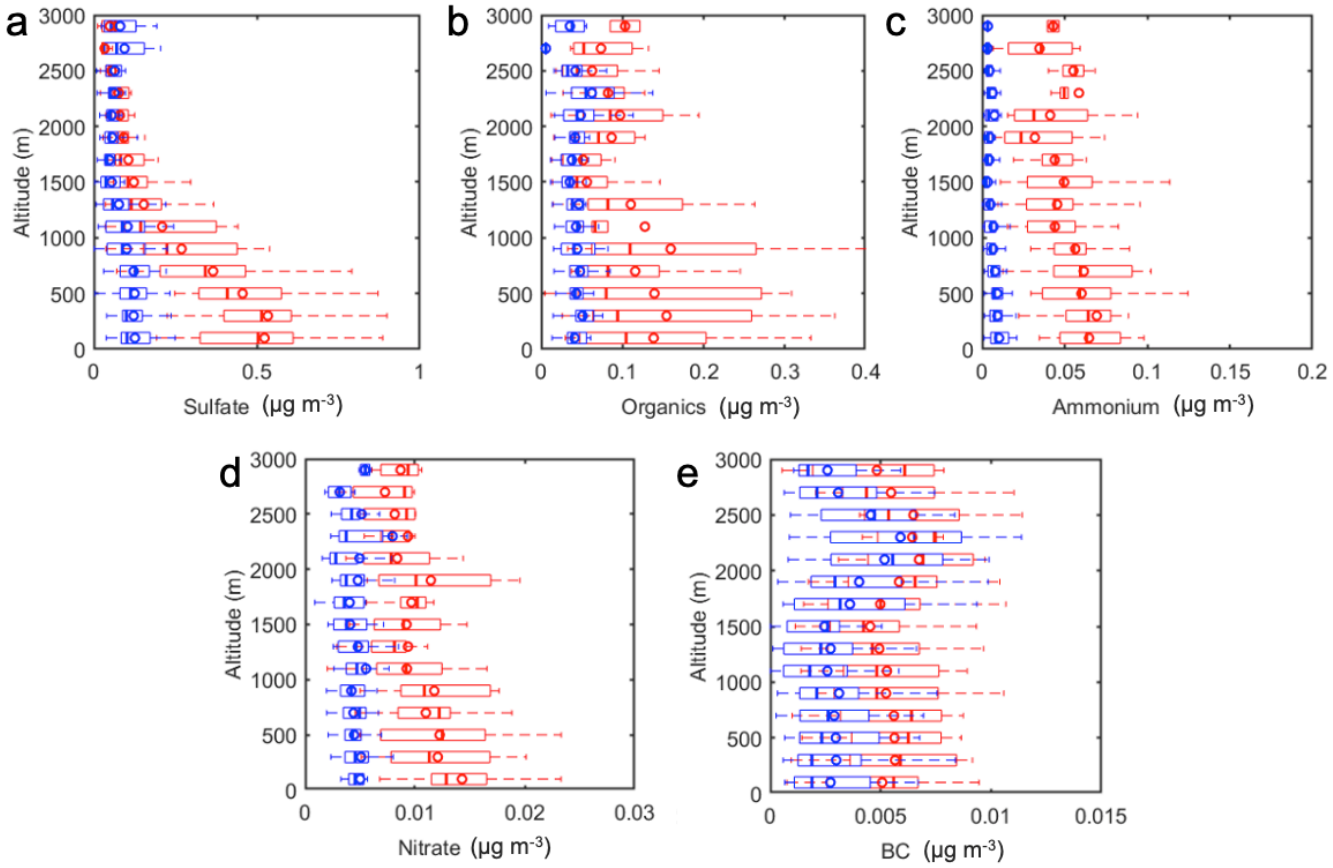

Fig. S3. Vertical profiles showing the mass concentrations of (a) sulfate, (b) organics, (c) ammonium, (d) nitrate, and (e) black carbon (BC) over the ENA site during the summer IOP (red) and winter IOP (blue). BC is measured by the SP2, and the rest of the compositions are measured by the HR-ToF-AMS.The data correspond to the periods when BC mass concentrations are below 5 ng m^{-3}. The line and circle markers represent the median and mean of the data, and the edges of the box indicate the 25th and 75th percentiles, respectively.

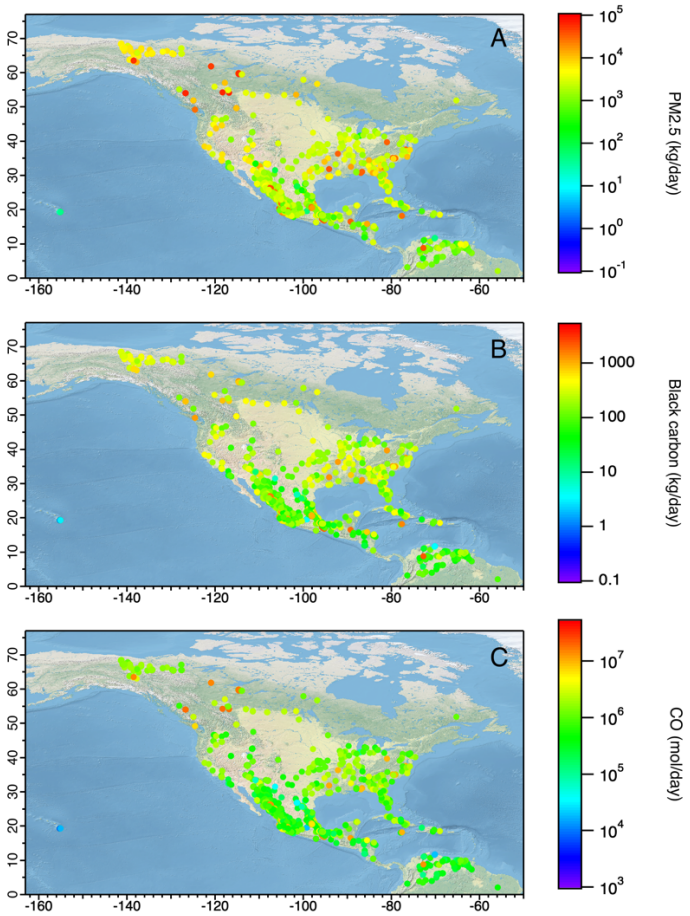

Fig. S4 Fire emissions during June 23-26, 2017 estimated using the Fire Inventory from NCAR (FINN) (Wiedinmyer et al., 2011). (A) Biomass burning emissions. (B) Black carbon emissions. (C) CO emissions. The map was created using public domain map data on Natural Earth (naturalearthdata.com) and the GSHHG Database (ngdc.noaa.gov/mgg/shorelines/).

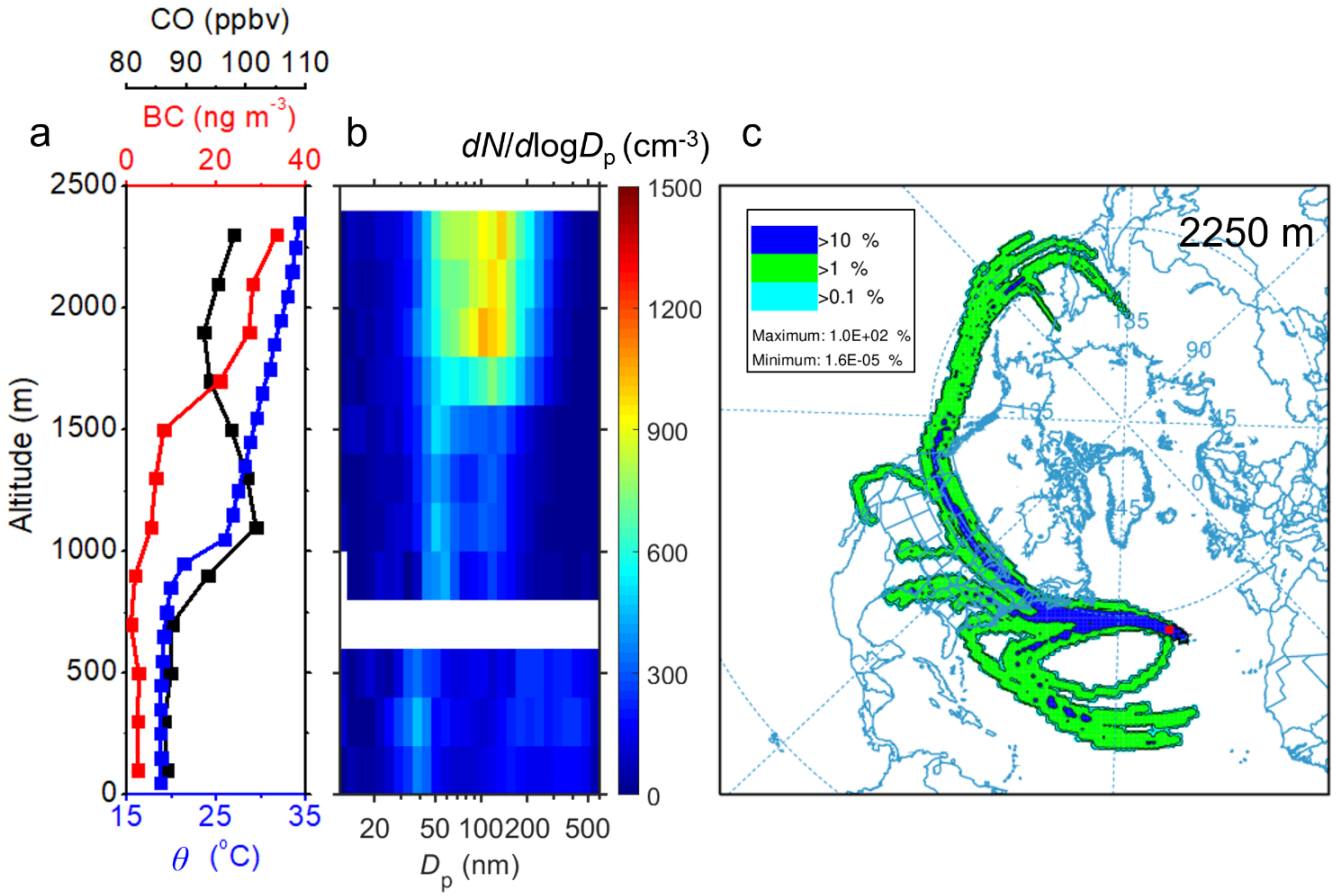

Fig. S5. A long-range transport event observed during the research flight on July 18, 2017. (a) Vertical profiles of potential temperature (θ), black carbon mass concentration (BC), and carbon monoxide mixing ratio (CO). (b) Vertical contour of aerosol size distributions as a function of altitude measured by the FIMS. The size distributions between 600 and 800 m are not shown due to the interference of cloud droplet shattering. (c) Frequency analysis of hourly back trajectories arriving at the ENA site on June 29, 2017 generated by HYSPLIT. The frequency is the sum of the number of trajectories that passed through each grid cell divided by the total number of trajectories analyzed. The CO mixing ratio, BC concentration, and size distributions are normalized to standard temperature and pressure (273.15 K and 101.325 kPa; STP).

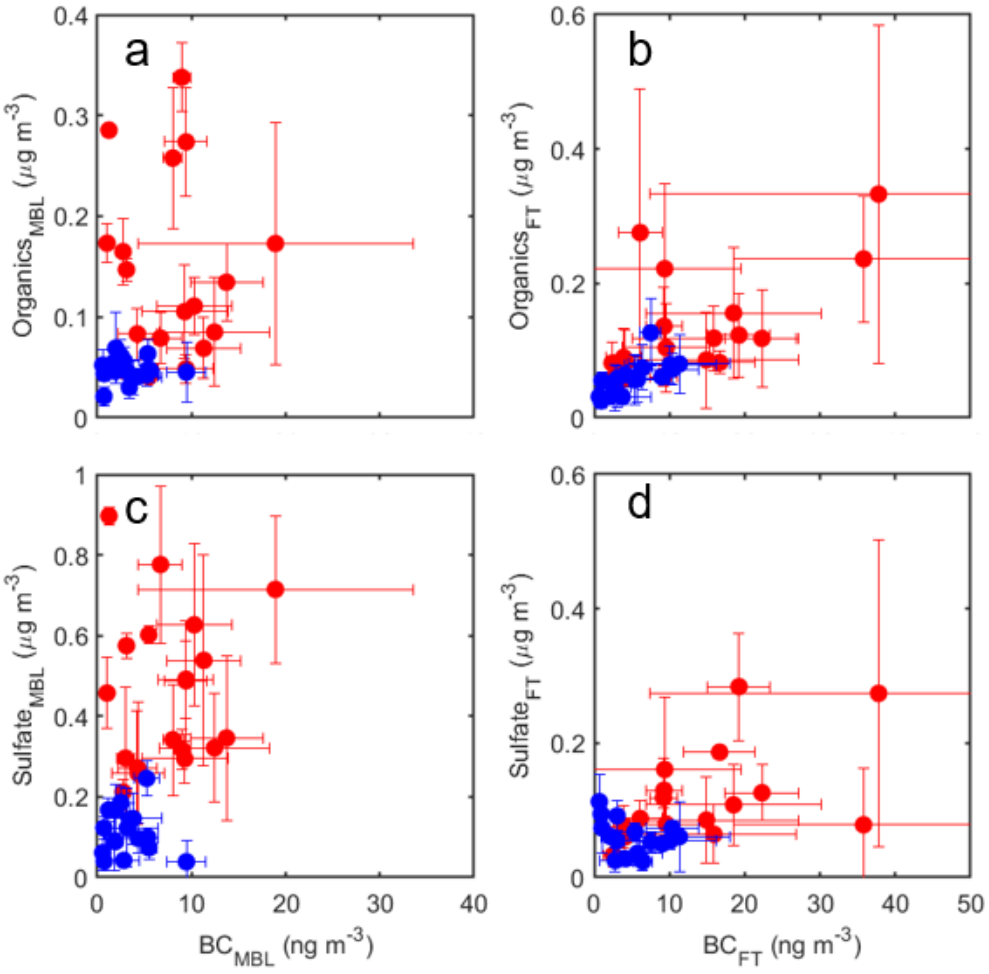

Fig. S6. Correlation between the mass concentrations of organics and black carbon in the (a) MBL and (b) FT, and correlation between the mass concentrations of sulfate and black carbon in the (c) MBL and (d) FT. Data from the summer IOP and winter IOP are shown in red and blue, respectively.

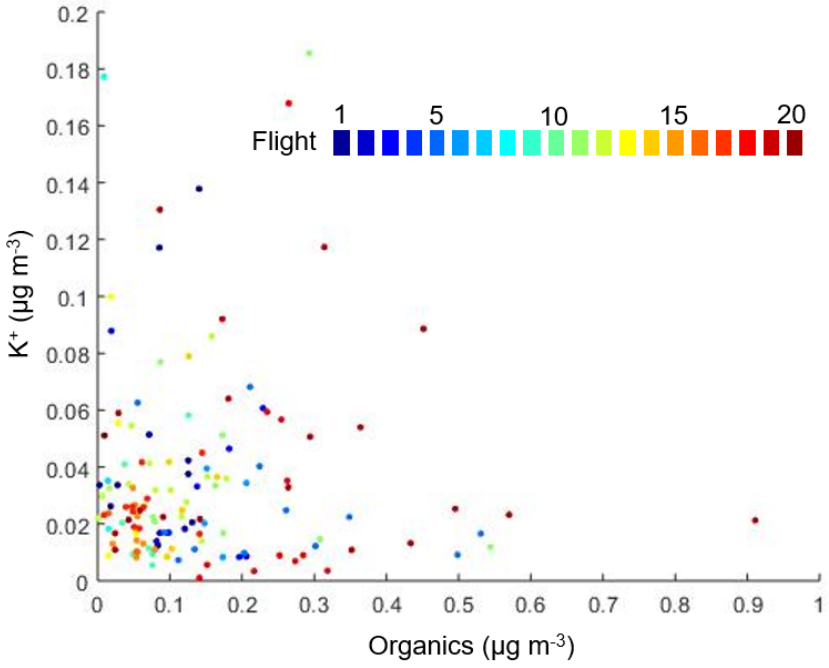

Fig. S7 Correlation between potassium (K^+) and organics for aerosol observed in the lower free troposphere from 1600 m to 2500 m during the summer IOP flights. The mass concentrations of potassium and organics are measured by the PILS and HR-ToF-AMS, respectively. Data points are colored by flight number.

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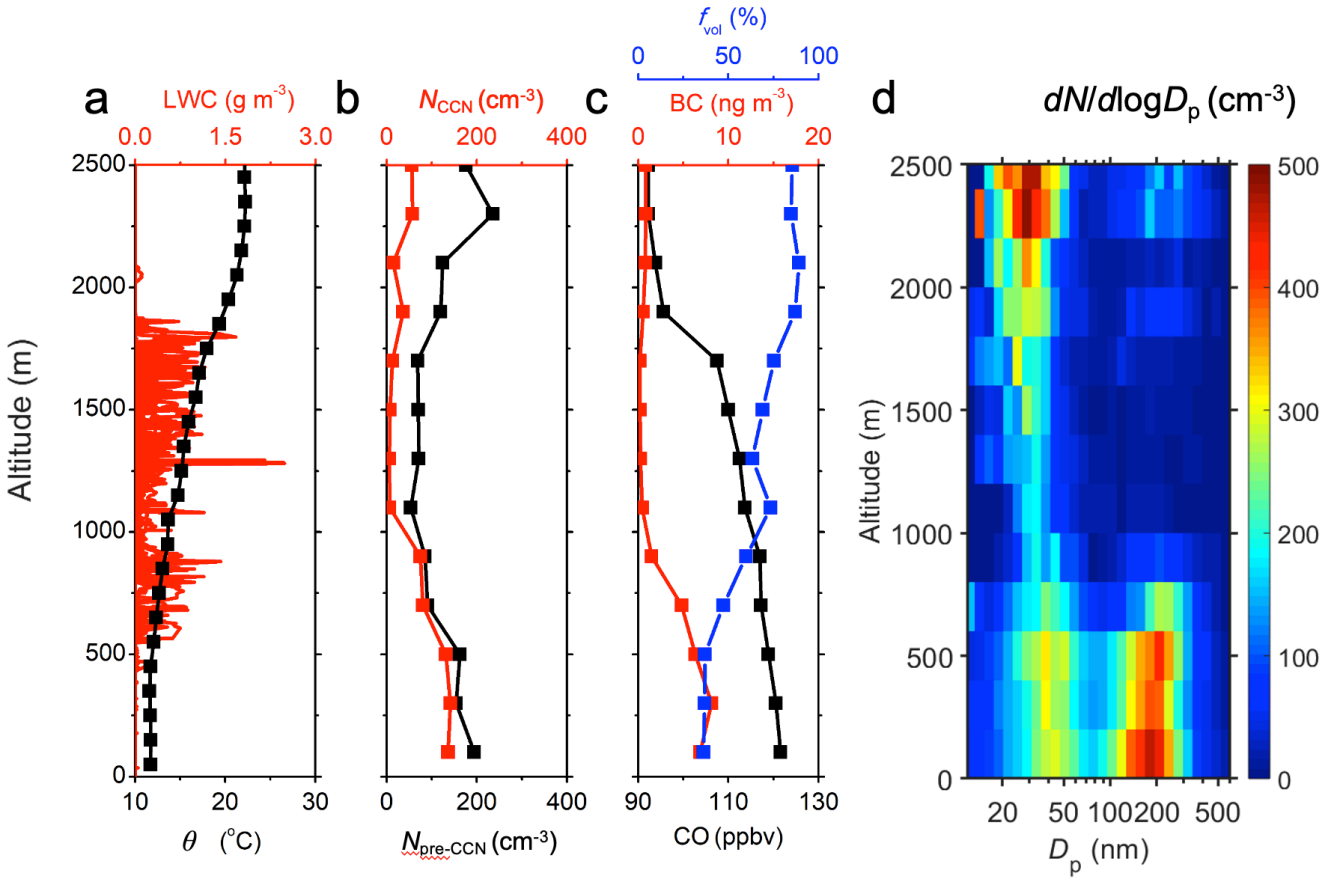

Fig. S8. Vertical profiles of parameters under the synoptic condition of post-front on February 11, 2018. (a) Potential temperature (θ) and liquid water content (LWC). (b) $N_{pre\text{-}CCN}$ and N_{CCN}. (c) Concentrations of carbon monoxide (CO) and black carbon (BC), and aerosol volatile fraction (f_v). (d) Vertical contour of aerosol size distributions as a function of altitude. Size distributions between 1800 and 2000 m are not shown due to the interference of cloud droplet shattering. The CO mixing ratio, BC concentration, particle concentrations, and size distributions are normalized to standard temperature and pressure (273.15 K and 101.325 kPa; STP).

References:

Wiedinmyer, C., Akagi, S. K., Yokelson, R. J., Emmons, L. K., Al-Saadi, J. A., Orlando, J. J., and Soja, A. J.: The Fire INventory from NCAR (FINN): a high resolution global model to estimate the emissions from open burning, Geoscientific Model Development, 4, 625-641, 10.5194/gmd-4-625-2011, 2011.