Supplementary Information for Individual particle compositions and aerosol mixing states at different altitudes over the ocean in East Asia

Kouji Adachi[1*], Atsushi Yoshida[2], Tatsuhiro Mori[3] Nobuhiro Moteki[4], Sho Ohata[5], Kazuyuki Kita[6], Yoshimi Kawai[7], Makoto Koike[8]

[1] Department of Atmosphere, Ocean, and Earth System Modeling Research, Meteorological Research Institute, Tsukuba, Japan
[2] National Institute of Polar Research, Tachikawa, Japan
[3] Department of Applied Chemistry, Faculty of Science and Technology, Keio University, Yokohama, Japan
[4] Department of Chemistry, Graduate School of Science, Tokyo Metropolitan University, Hachioji, Japan
[5] Institute for Space–Earth Environmental Research, Nagoya University, Nagoya, Japan
[6] Department of Earth Science, Graduate School of Science and Engineering, Ibaraki University, Mito, Japan
[7] Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan
[8] Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Tokyo, Japan

Correspondence to: Kouji Adachi (adachik@mri-jma.go.jp)

Supporting figures 1-8.
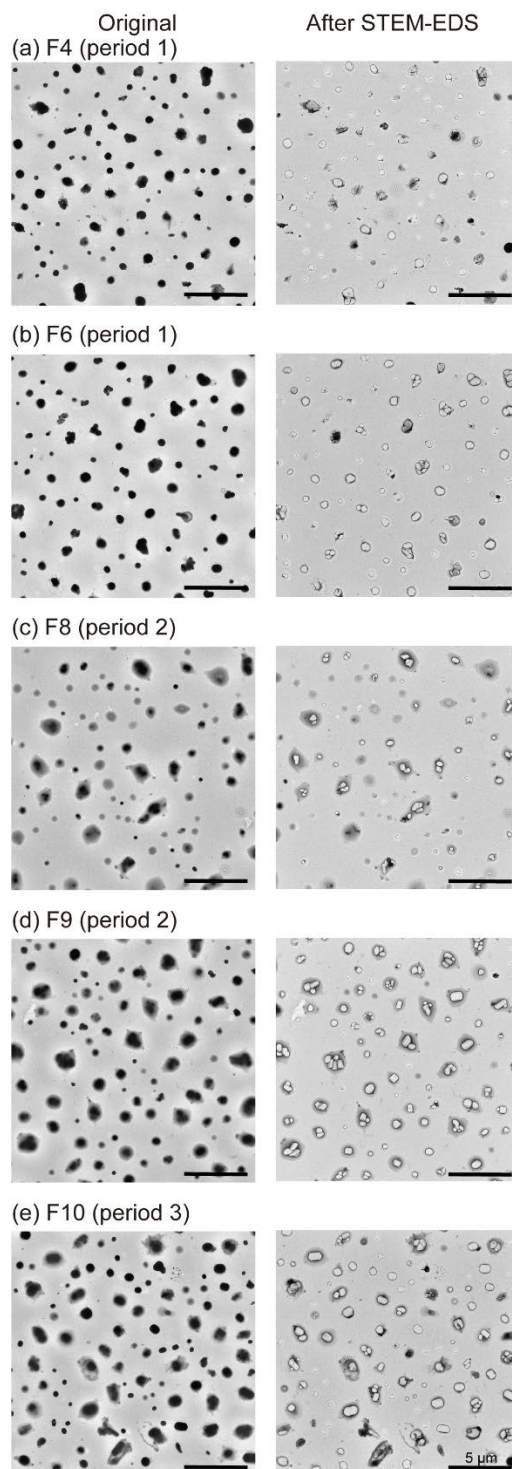
Figure S1. Examples of TEM images before (left) and after (right) the STEM-EDS particle measurements of the airborne samples. All scale bars are 5 μm.
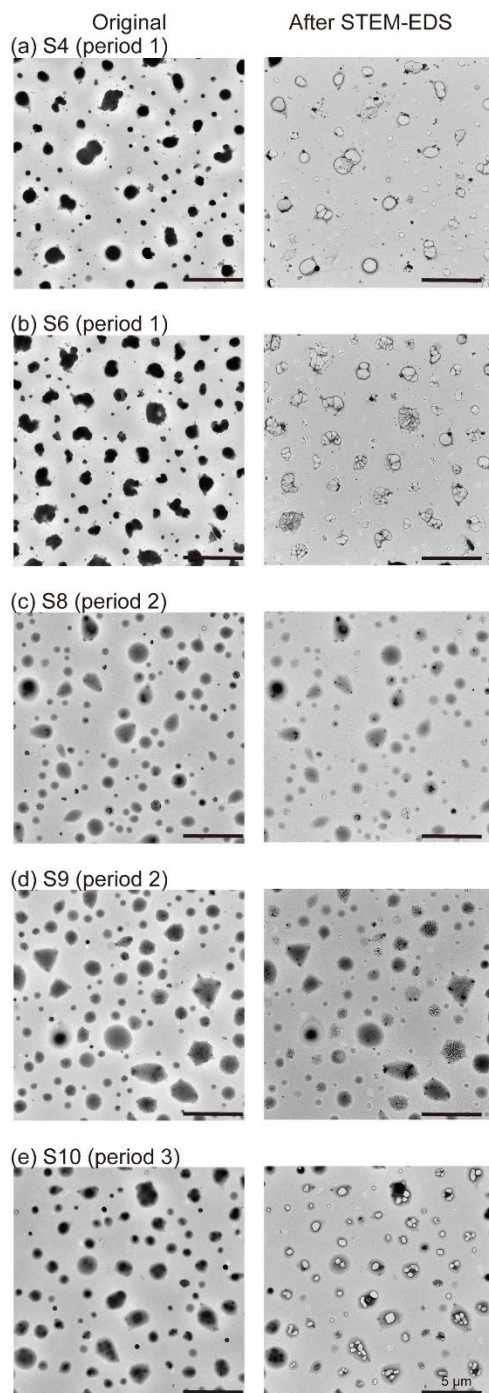
Figure S2. Examples of TEM images before (left) and after (right) STEM-EDS particle measurements of the shipboard samples. All scale bars are 5 μm. (a)-(e): Shipboard samples corresponding to airborne samples with the same flight number. These samples were collected at 5:00 UTC (a-d) and 3:00 UTC (e) when the aircraft was over or near the ship.
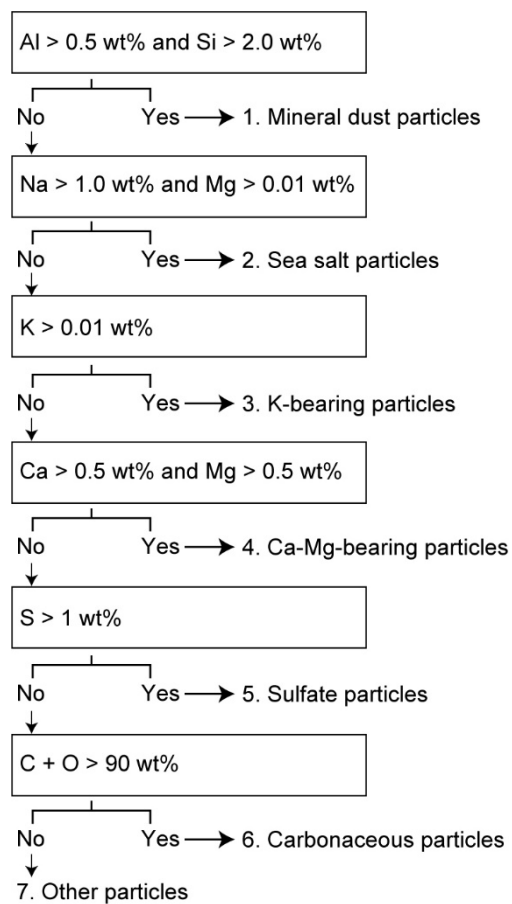
Figure S3. A flow chart for classifying individual particles into seven categories based on the STEM-EDS measurements.
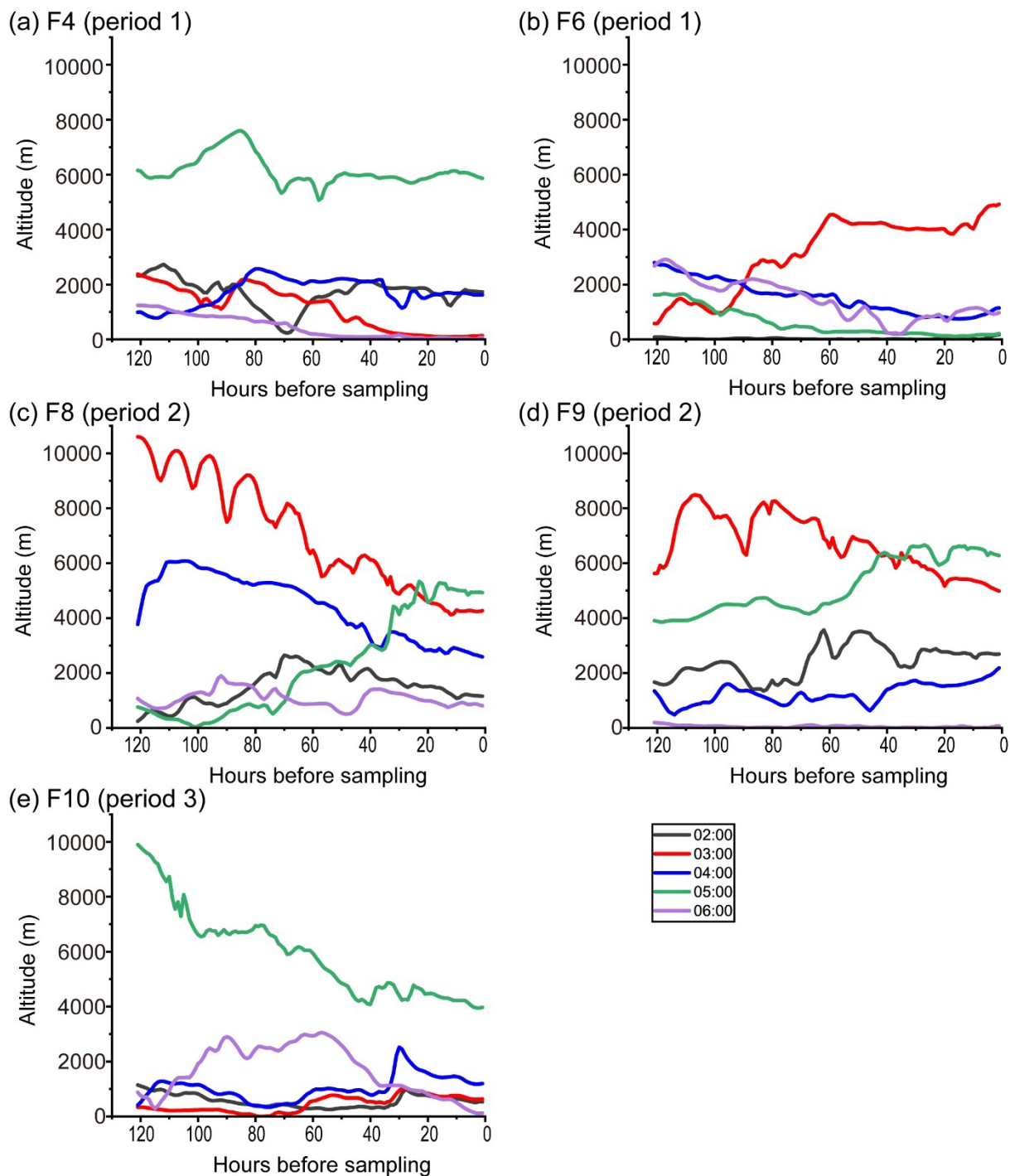
Figure S4. Back trajectories (altitudes) of sampled air parcels during each flight. The trajectories (120 h) start every hour (UTC). The trajectories with latitude and longitude are shown in Figure 2.
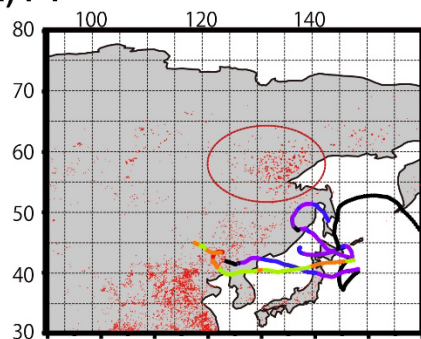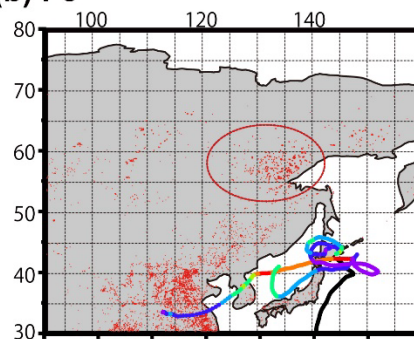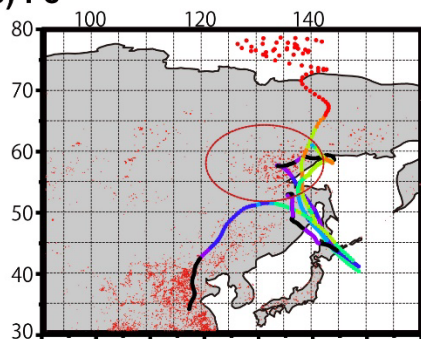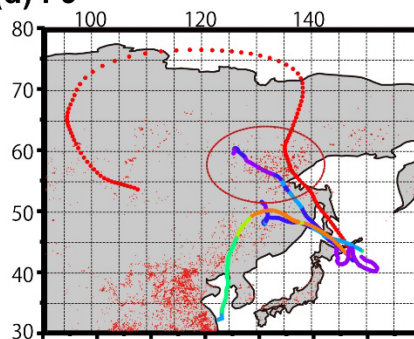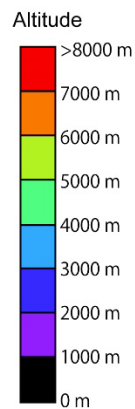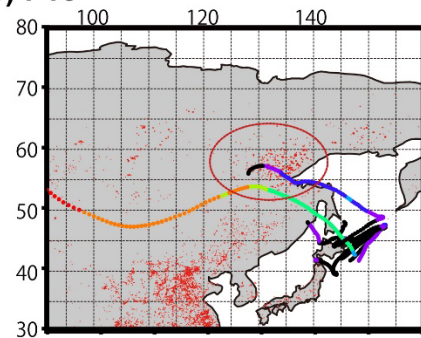
Figure S5. Back trajectories of sampled air parcels during each flight with larger area than that in Figure 2. The trajectories (120 h) start every hour (UTC). Colors along the trajectories indicate altitudes. Red dots indicate active fires during the sampling period (from July 22 to August 1, 2022) from NASA's Fire Information for Resource Management System (NASA FIRMS, 2025). The area of biomass burning in the Siberian Forest is shown as a red circle.
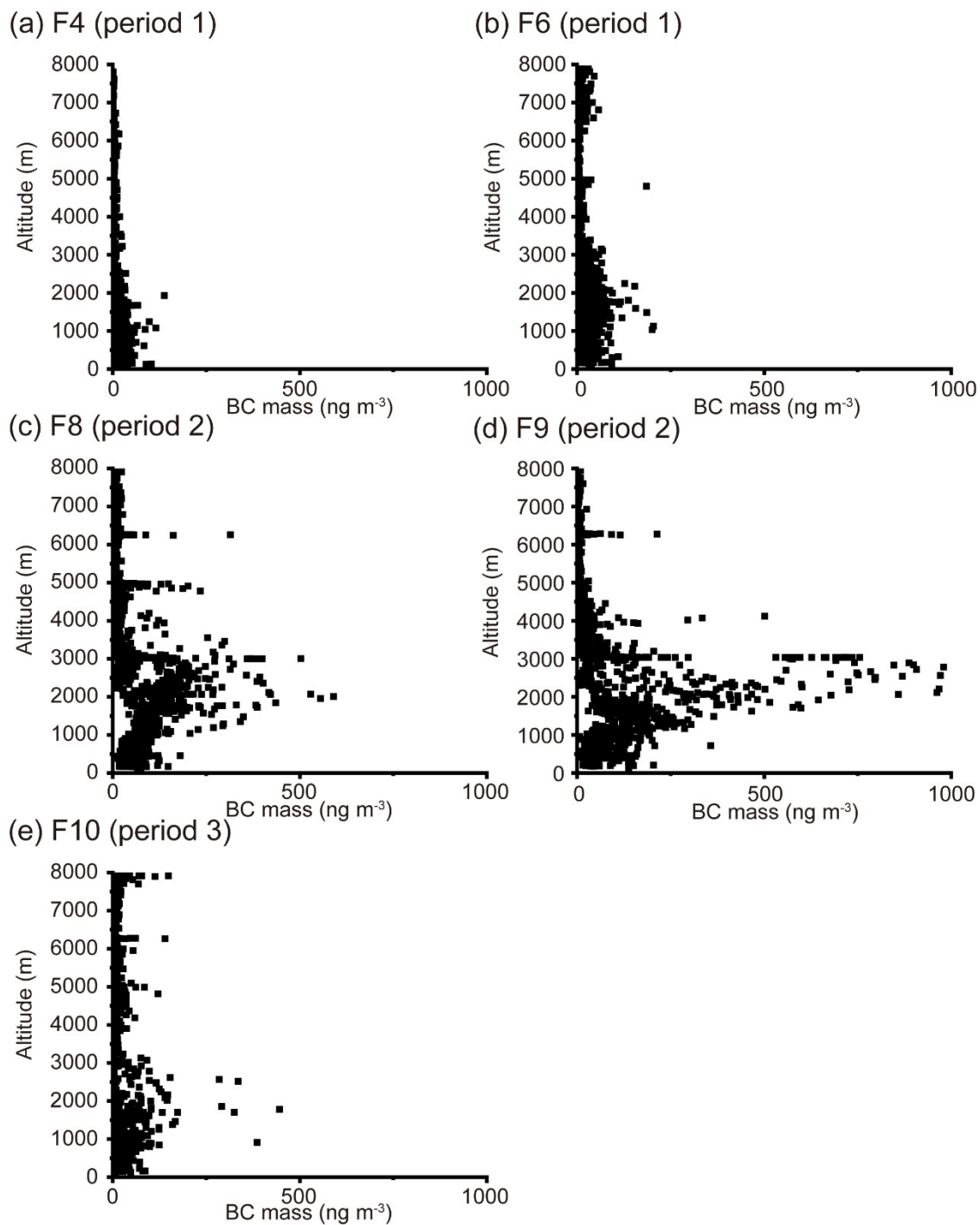
Figure S6. Black carbon (BC) mass concentrations over flight altitudes measured with a single particle soot photometer (SP2). Each plot represents a 10-second average.
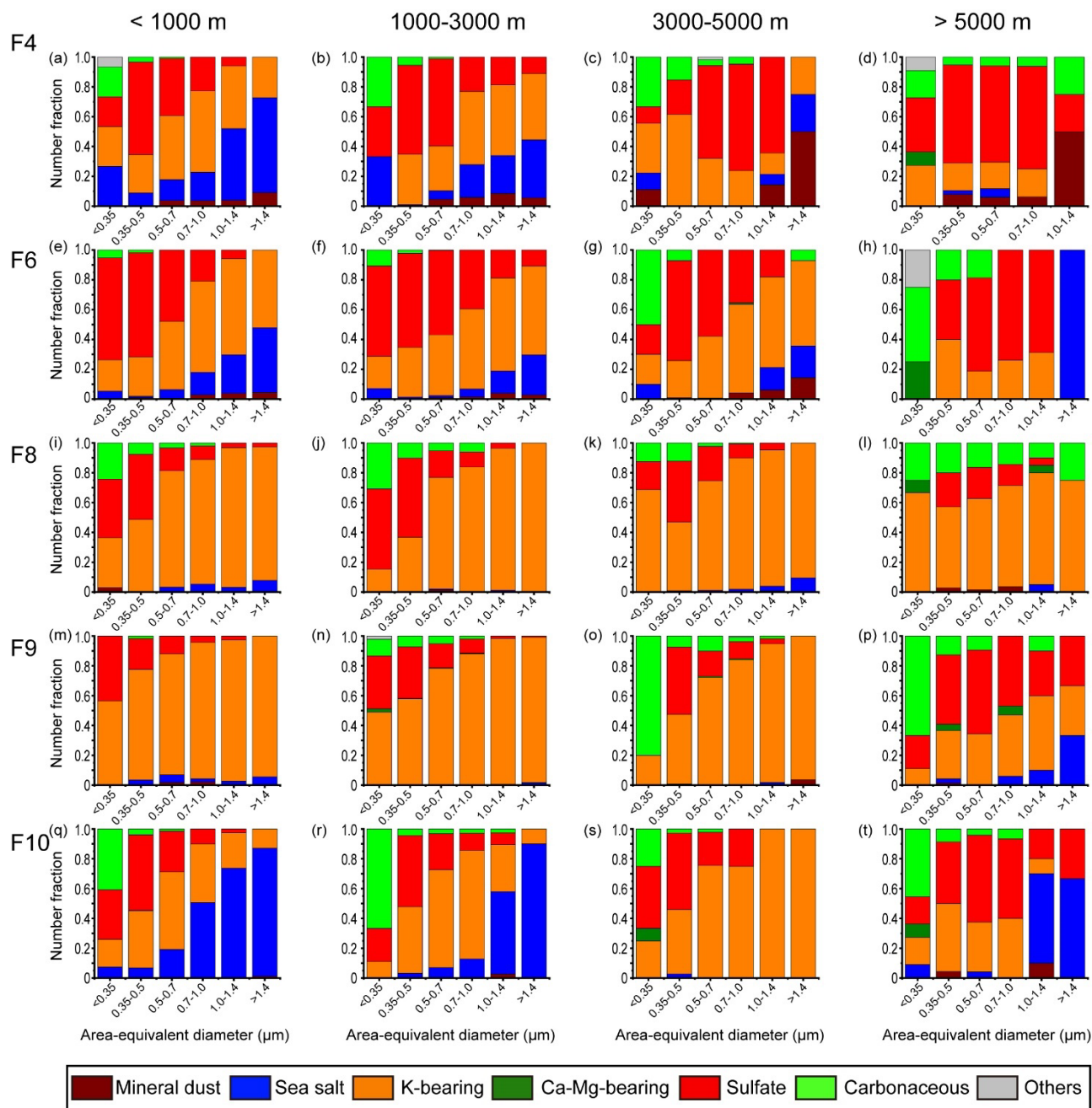
Figure S7. Size-dependent number fractions of airborne samples with different altitudes from each flight. Samples were classified based on the sampling altitudes of < 1000 m, 1000-3000 m, 3000-5000 m, and > 5000 m. The ranges of lognormal size bins are < 0.35, 0.35-0.50, 0.50-0.71, 0.71-1.0, 1.0-1.4, and >1.4 μm.
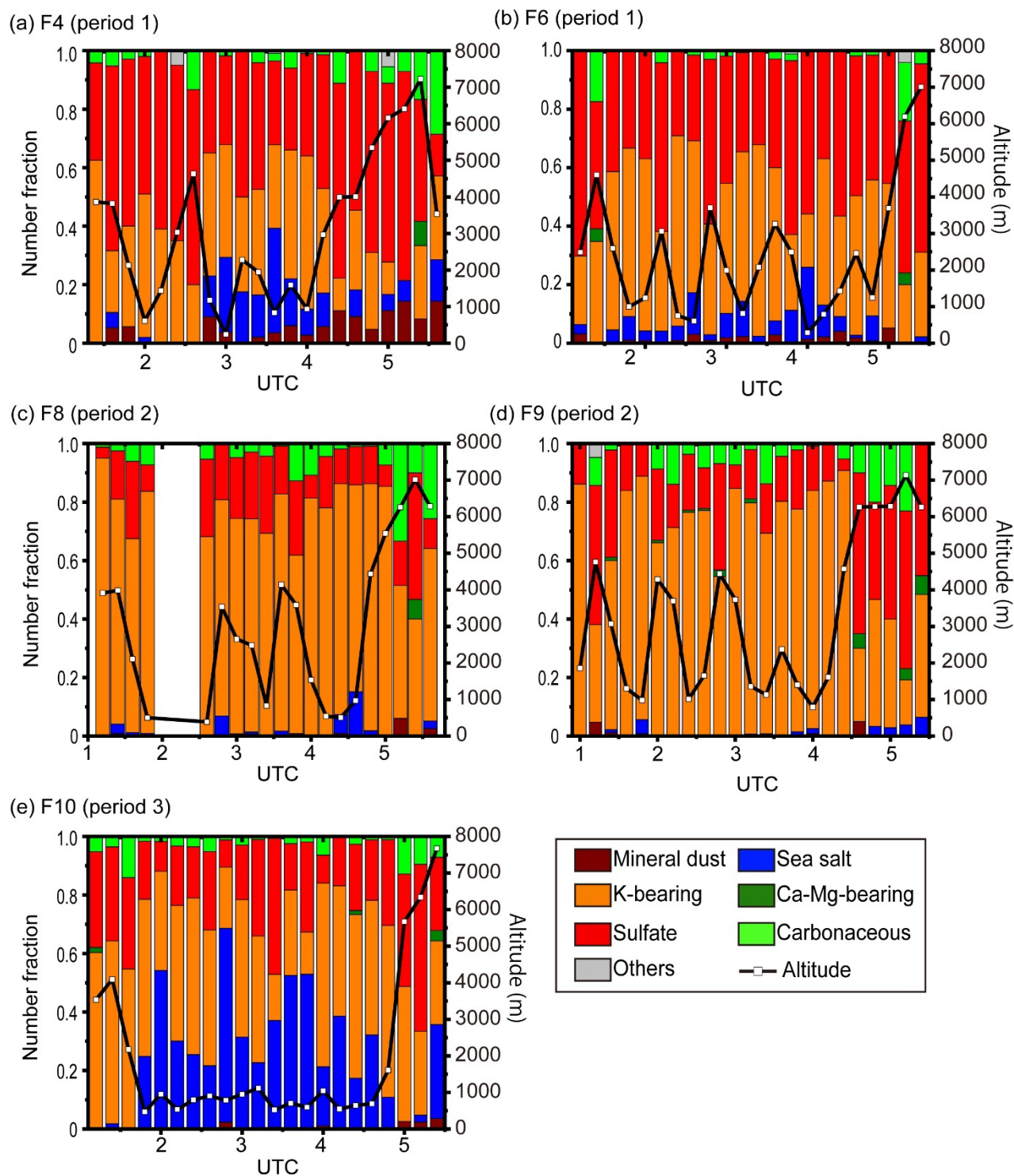
Figure S8. Number fractions of all airborne samples with averaged altitudes during each sampling period.