

Characterization and source apportionment of size-segregated atmospheric particulate matter collected at ground level and from the urban canopy in Tianjin, a coastal city

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Introduction

An observation of size-segregated atmospheric particulate matter on urban scales (200–300 m) is necessary for understanding the sources, transport, transformation, and removal mechanisms of particles. However, studies that have focused on investigating the size distribution of chemical compositions and sources of particulate matter (PM) in different mode at ground level and from the urban canopy have not yet been conducted.

Experimental techniques and methods

A novel campaign was carried out on a 255 m meteorological tower in Tianjin from December 2013 to January 2014. Thirteen sets of size-segregated atmospheric particles were collected at 10 m and 220 m. Twelve components of particulates, including water-soluble inorganic ions (Na^+ , NH_4^+ , K^+ , Mg^{2+} , Ca^{2+} , F^- , Cl^- , NO_2^- , NO_3^- and SO_4^{2-}) and carbonaceous species (elemental carbon (EC) and organic carbon (OC)), were analyzed. Positive matrix factorization (PMF) was used to apportion the sources of PM in different mode.

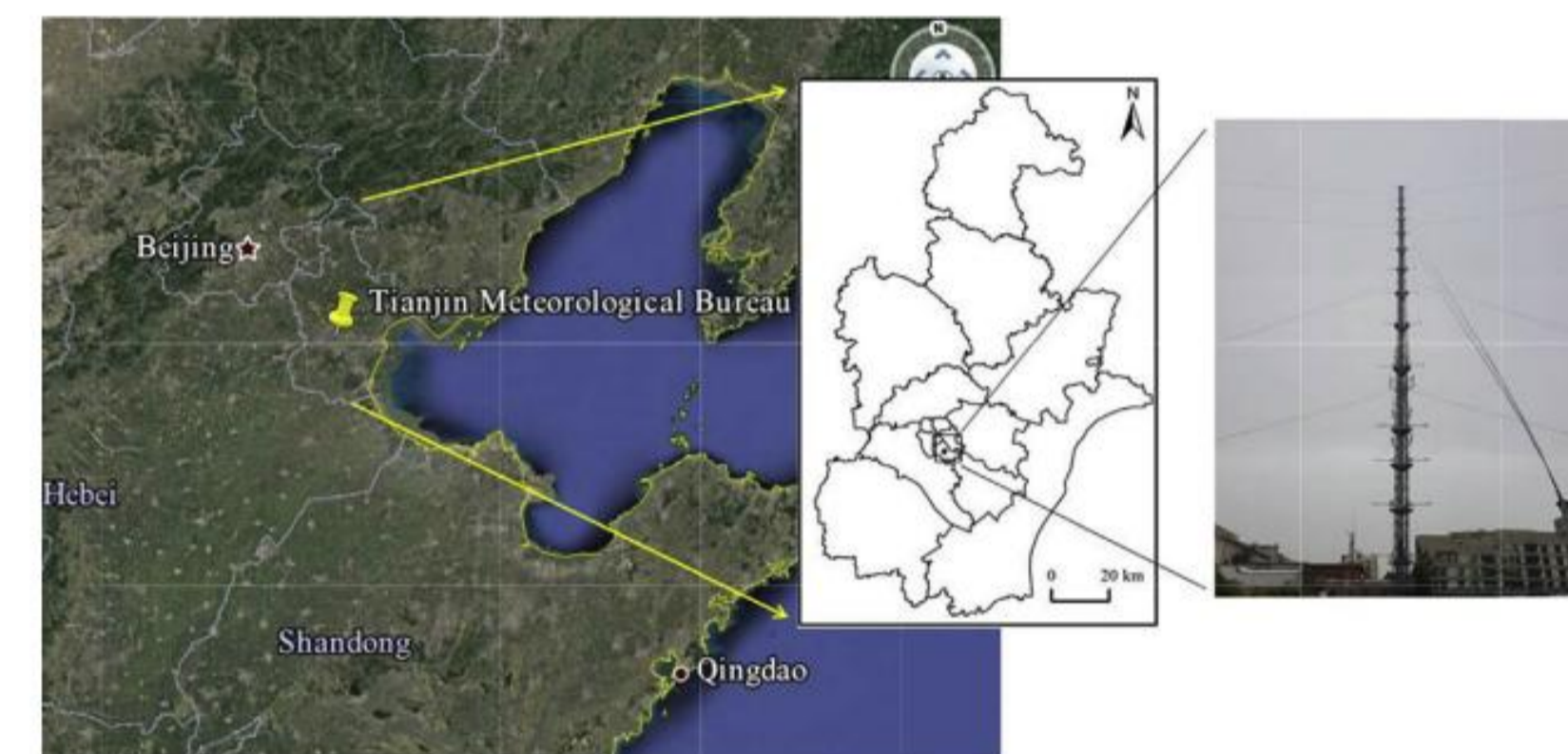
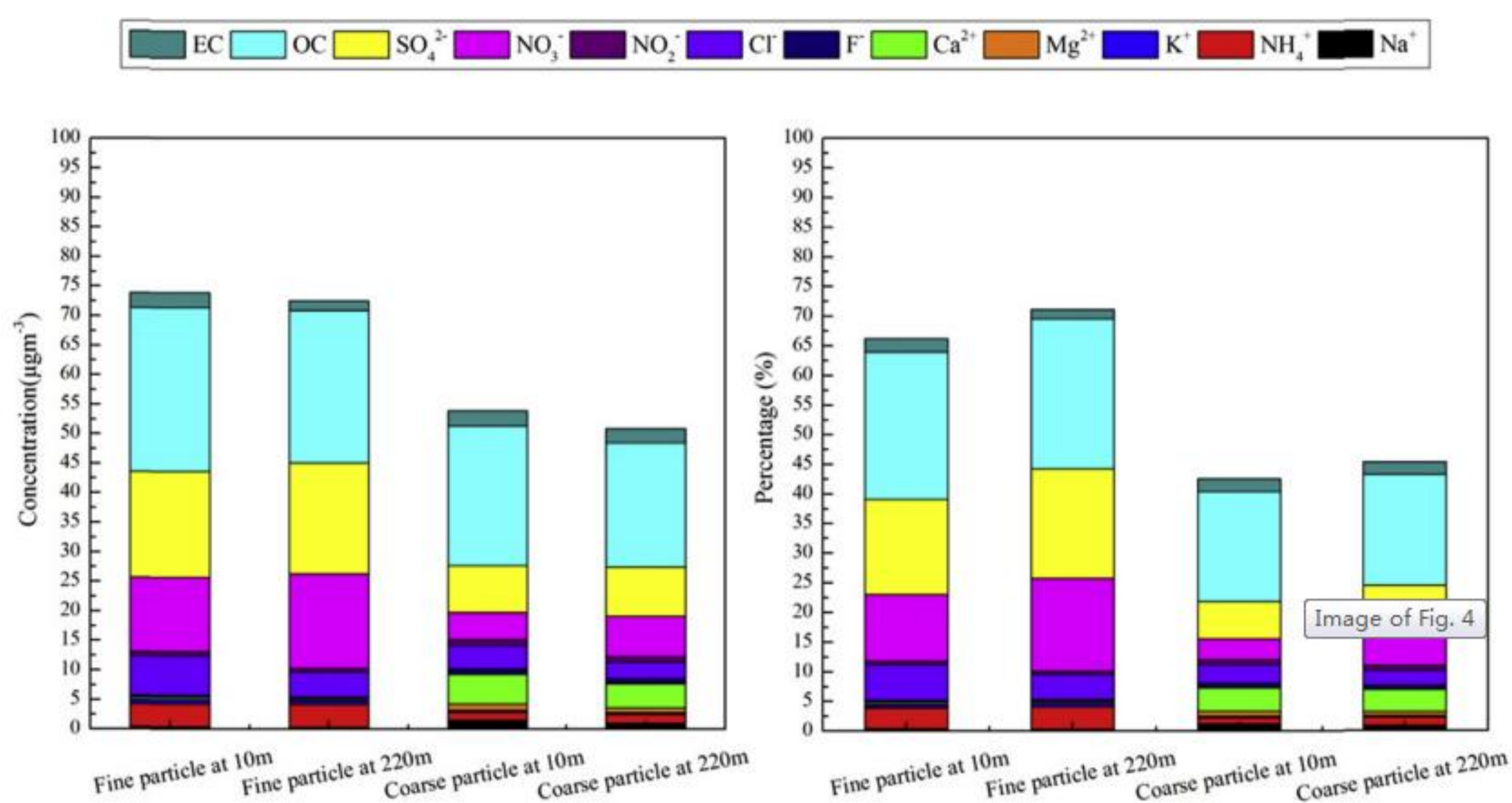
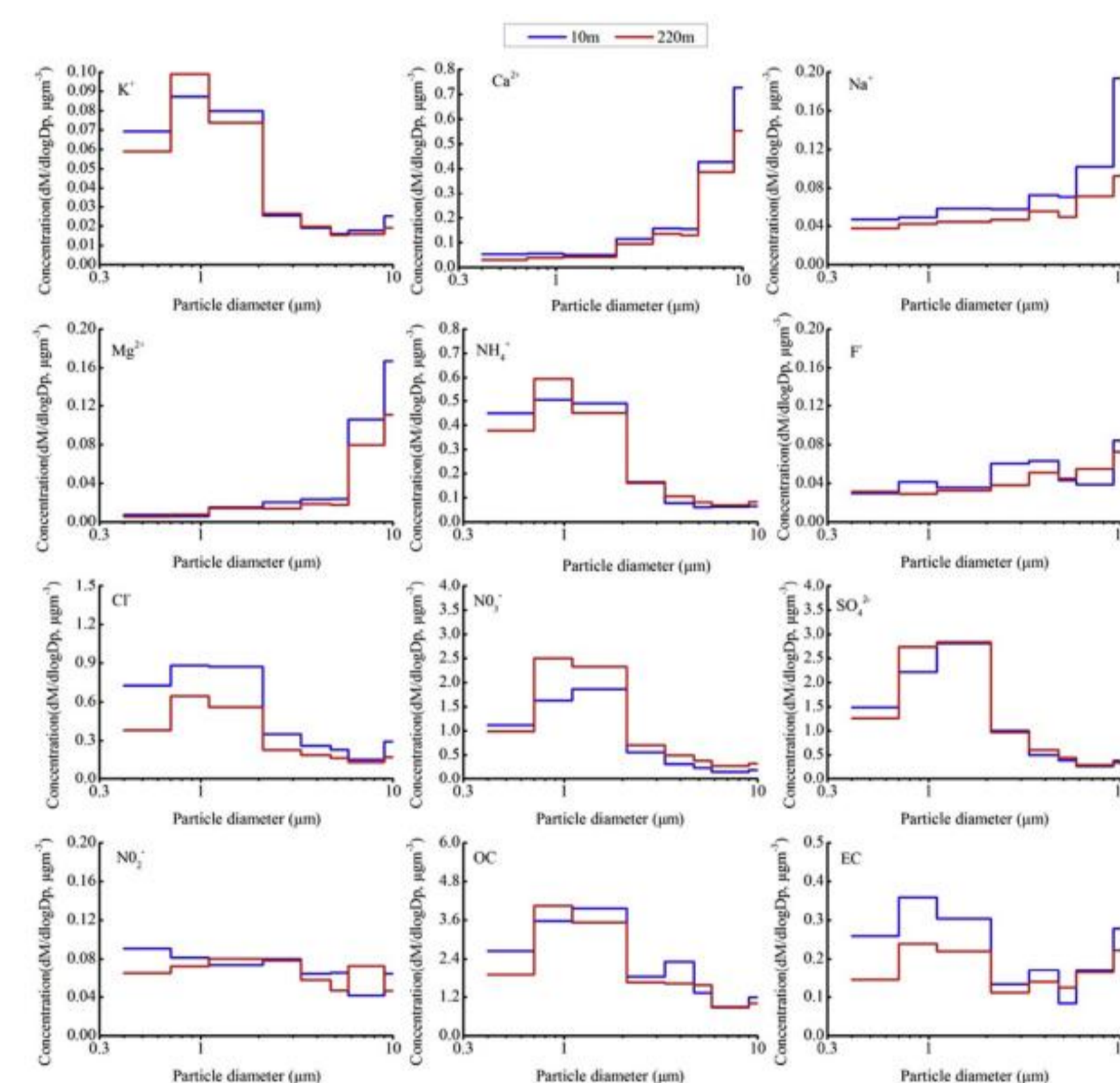


Fig. 1. Location of the sampling site in Tianjin.

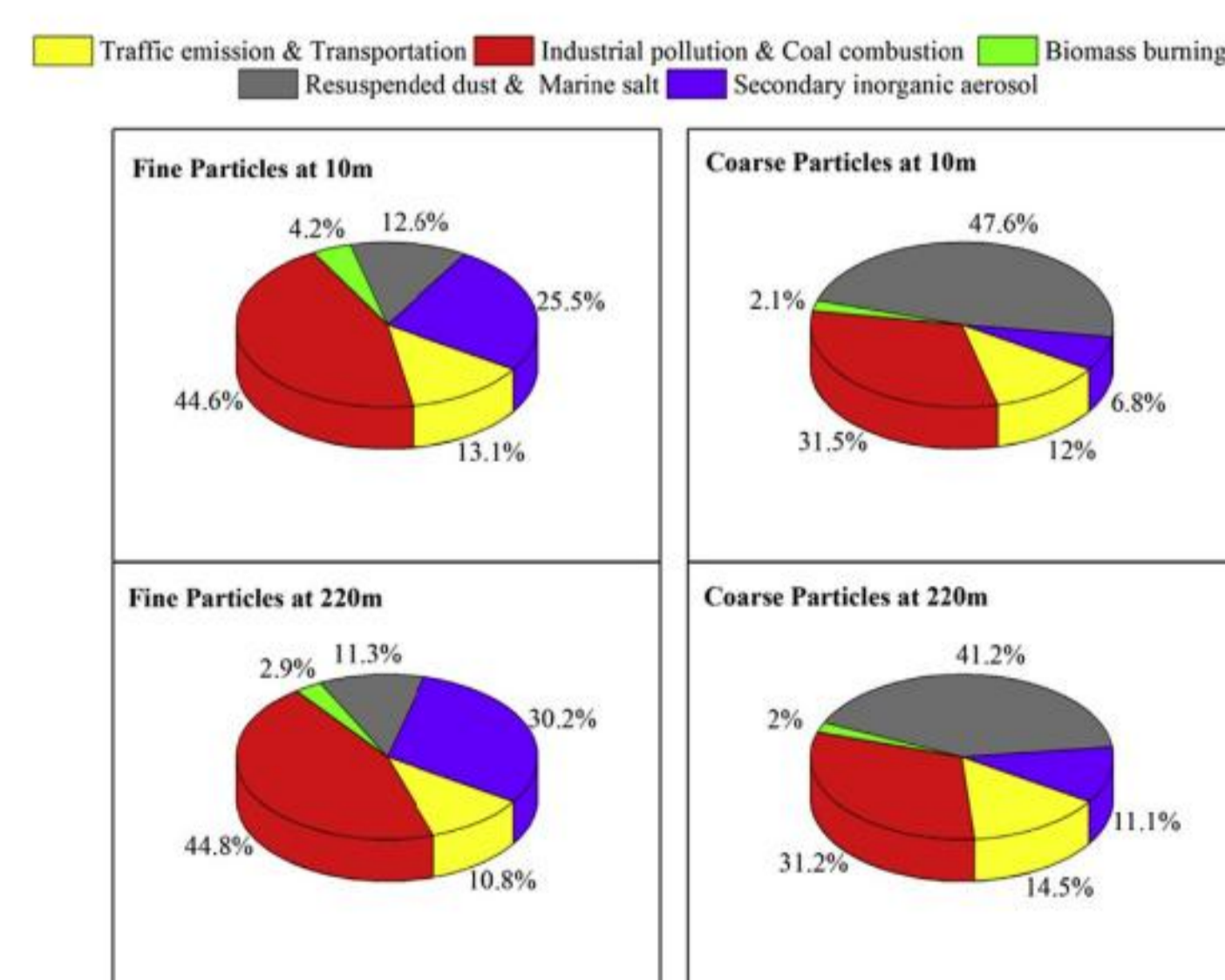
Results and discussion



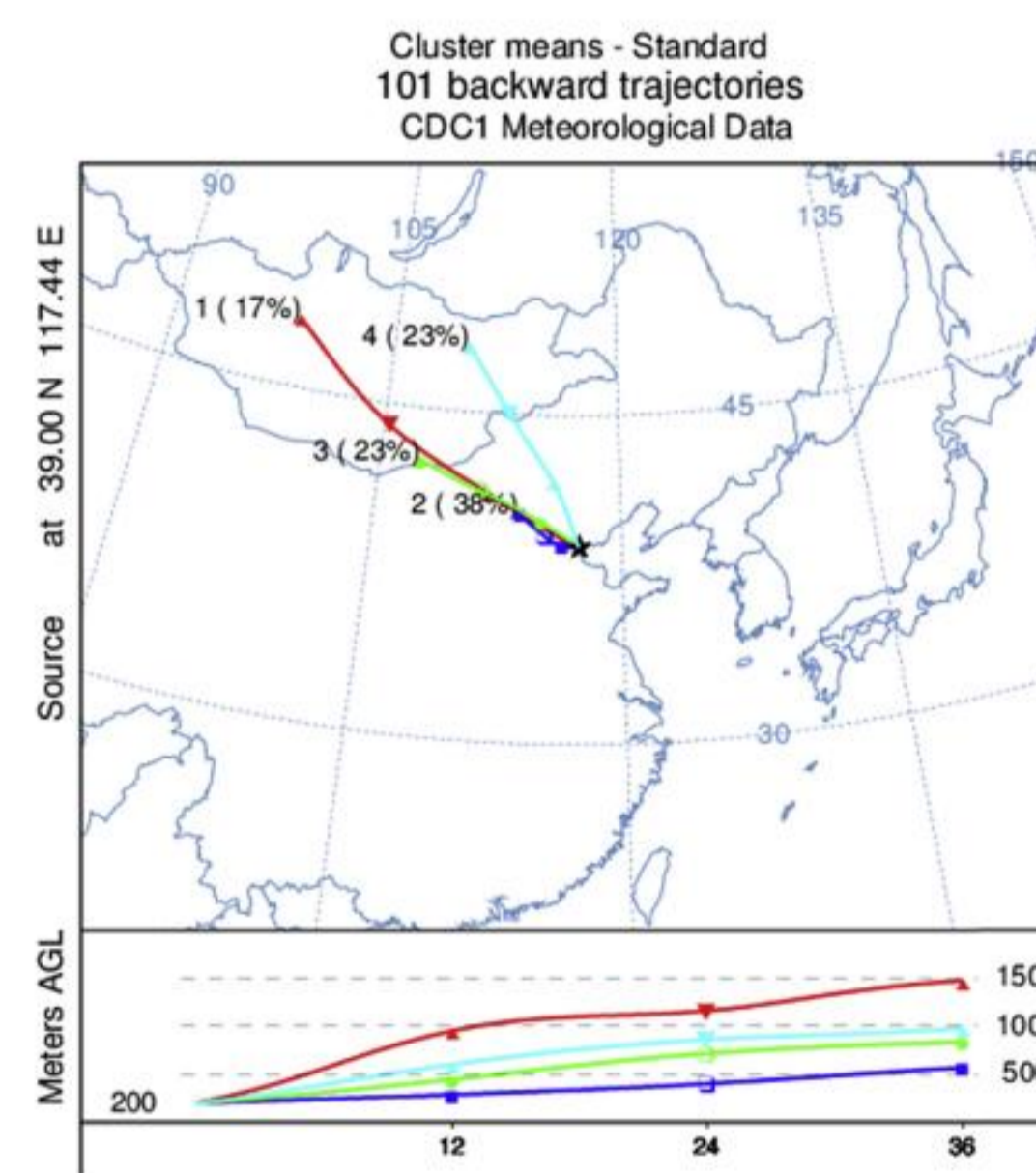
Concentrations and percentages of the twelve components in fine-mode and coarse-mode particles at different heights.



Average size distributions of chemical species measured at 10 m and 220 m



Concentrations and percentages of the twelve components in fine-mode and coarse-mode particles at different heights



Air mass backward trajectories at receptor heights of 200 m above the ground level at the sampling site.

Conclusion

- ◆ A similar bimodal distribution of PM mass concentrations could be found at two different heights, which peaked at 0.7–1.1 μm and 9.0–10.0 μm , respectively.
- ◆ The size distributions of major primary species, such as Cl^- , Na^+ , Mg^{2+} and EC, were similar at the two different heights, indicating that they were common and dominant sources at ground level and in the urban canopy.
- ◆ Industrial pollution and coal combustion (44.6% vs. 44.8%), secondary inorganic aerosols (25.5% vs. 30.2%), traffic emissions and transport (13.1% at 10 m vs. 10.8% at 220 m) and re-suspended dust and marine salt (12.6% vs. 11.3%) were the major sources of fine particles at 10 m and 220 m.
- ◆ The 220 m height was influenced by local emissions, which may be not high enough to reflect the background levels of pollutants in the atmospheric boundary layer.