Inorganic markers, carbonaceous components and stable carbon isotope from biomass burning aerosols in Northeast China

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Introduction

Carbonaceous, such as organic carbon (OC) and elemental carbon (EC) aerosols contribute from 10% up to 90% of total fine aerosol mass (particulate matter with a diameter <2.5μm or PM2.5particulate matter PM < 2.5 μm), affecting local/regional air quality, human health, the Earth's climate(Pöschl, 2005). Biomass burning such as wildfires, agricultural waste burning and bio-fuel combustion can contribute to large amounts of OC and EC in the atmosphere (Zhang et al., 2014) .

The Sanjiang Plain is one of the most productive agricultural regions in China (Wang et al., 2011). During the harvest seasons, burning of agricultural residues is a normal very commen practice in this region, which has been evident by the Moderate Resolution Imaging Spectroradiometer (MODIS) fire count data (Qin et al., 2014).

Stable carbon isotope ratio measurements in combination with measurements of biomass burning markers (e.g. water-soluble potassium) is expected to gain provide new insights into characteristics and composition of atmospheric aerosols from different sources (Mkoma et al., 2014).

In this paper, we present the measurement results on inoraanic markers, carbonaceous components and the stable carbon
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Experimental

Study sites

The study was conducted in the Sanjiang Plain in northeast China, which is an alluvial plain formed by three major rivers including the Songhua River, the Heilong River, and the Wusuli River (Figure1). Agricultural residues burning after harvesting is a common practice in this region and may produce large amounts of air pollutants.

$PM_{2.5}$ aerosol samples were collected on prebaked quartz filters for a day/night basis (07:00-18:00 LT for daytime and 18:00-06:00 LT for nighttime) by a high volume air sampler (Tianhong Co., Wuhan, China) at a flow rate of 1.05 m³/min.

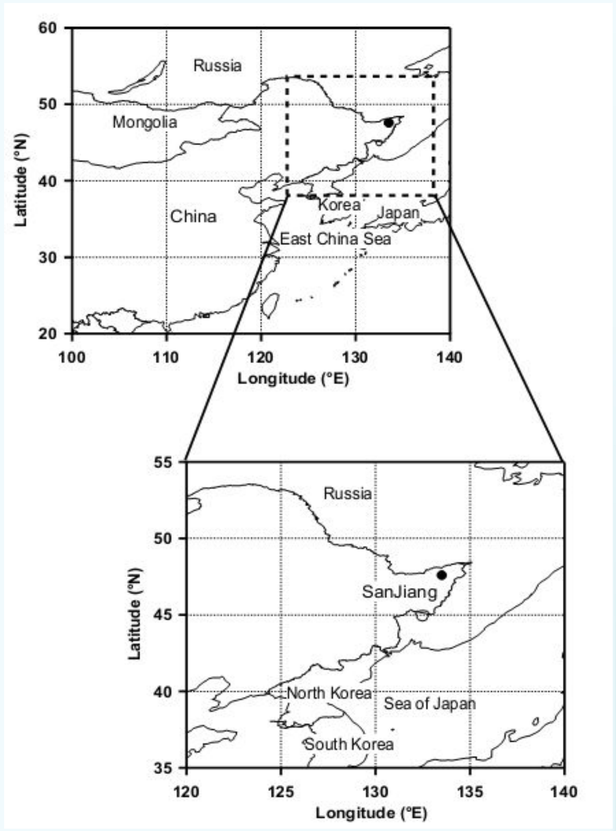

Figure 1. A sampling location in the Sanjiang Plain, Northeast China

Chemical analysis

- SO_4^{2-}, NO_3^-, Cl^-, MSA^-, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, and Na^+ were measured using an ion chromatograph (761 Compact IC, Metrohm).
- Separation of OC & EC with Sunset EC/OC Analyzer
- Water-soluble organic carbon (WSOC) was measured using a TOC analyzer (Shimadzu, TOC-V_{CSH}).
- TC and their stable carbon isotopic ratio were determined using an elemental analyzer (EA) (Carlo Erba, NA 1500) coupled with an isotope ratio mass spectrometer (IRMS, Finnigan MAT Delta Plus) (Jung and Kawamura, 2011).

Results

- A remarkable high $PM_{2.5}$ concentration was identified during the early October, which was known as a typical biomass burning season in this region.
- During this pollution episode, The fire counts map shows the biomass burning activities in Northeast Asia (mainly in the Heilong Jiang province) was very extensive.

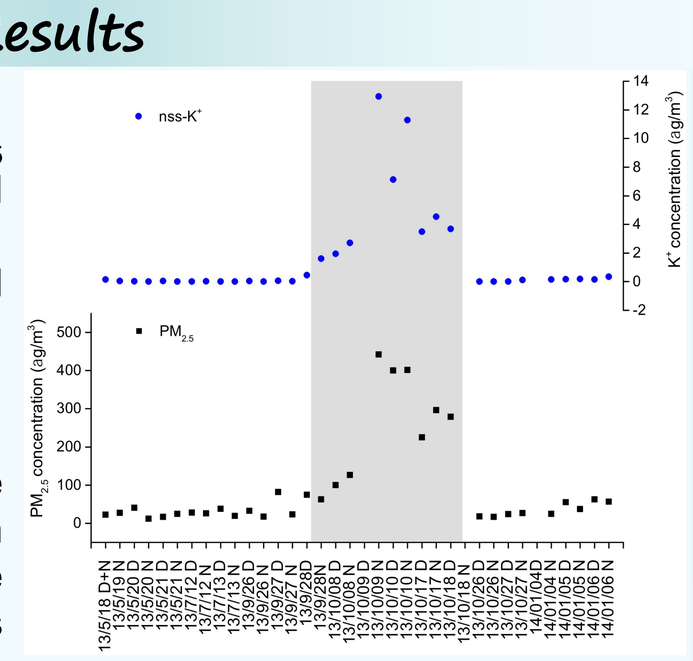

Figure 2. non-sea-salt potassium (nss-K^{+}) (top) and $PM_{2.5}$ mass concentrations (bottom), D and N denote daytime and nighttime

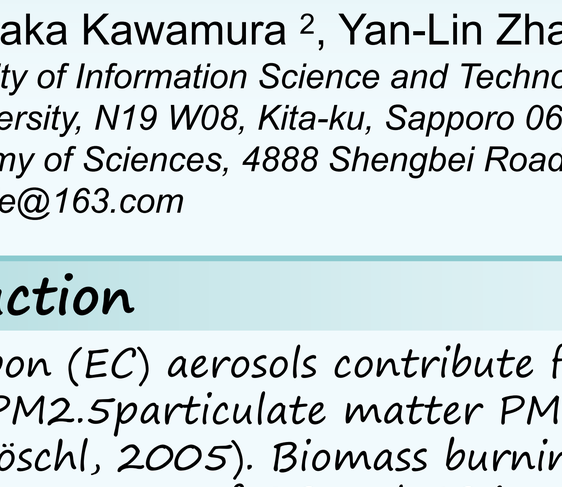

Figure 3. MODIS fire counts on October 9-10, 2013 (a) and MODIS Terra aerosol optical depth at 550 nm on October 9-10, 2013 (b)

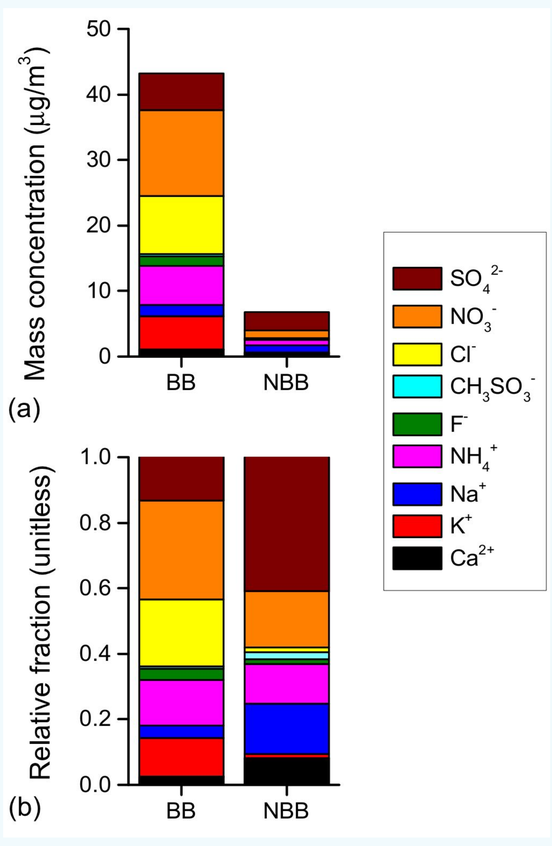

Figure 4. Average mass concentrations (μg/m³) (a) and relative abundances (b) of major water-soluble ions in ambient $PM_{2.5}$ samples

- K^+ in biomass burning aerosols is most enriched in KCl particle followed by KNO_3 and/or NH_4NO_3.
- Enhancement of NO_3^- due to the oxidation of increased NO_x emissions from biomass burning.
- A lower $\delta^{13}C$ values (mean: -26.2‰) is observed from late September to early October.

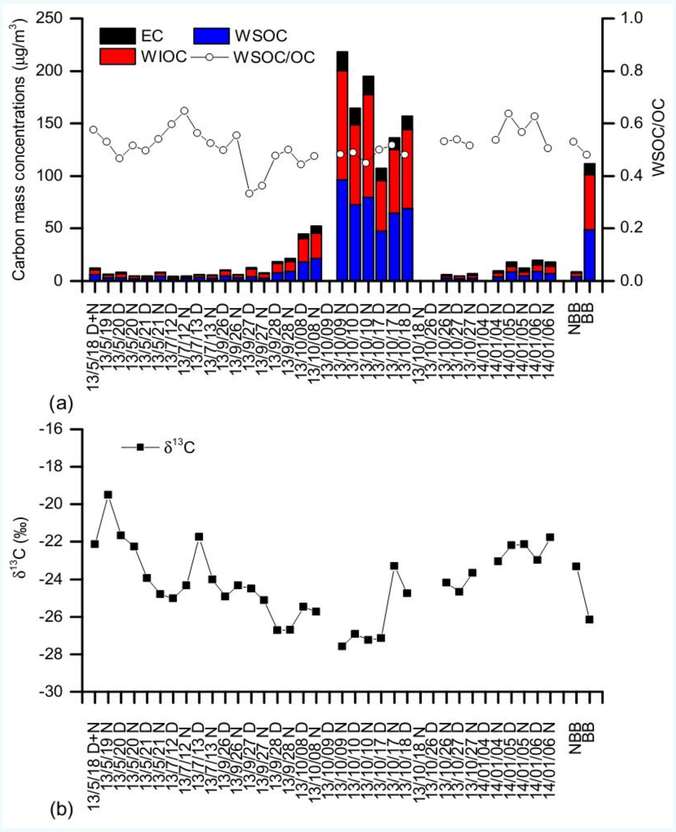

Figure 5. EC, WIOC,WSOC,and WSOC/OC ratio (a) and stable carbon isotopic composition ($\delta^{13}C$) of total carbon (b) in ambient $PM_{2.5}$ samples

Conclusions

- The enrichment in both the non-sea-salt potassium and chlorine is significantly larger than other inorganic species, suggesting that biomass-burning aerosols in Sanjiang Plain are mostly fresh and less aged.
- *The* WSOC-to-OC ratio is lower than that reported in biomass-burning aerosols in tropical regions, further supporting that biomass-burning aerosols in Sanjiang Plain are mostly primary and secondary organic aerosols may be not significant.
- A lower average $\delta^{13}C$ value (-26.2‰) is observed during the biomass-burning period, indicating a dominant contribution from combustion of C3 plants in the studied region.

References

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