Characteristics and formation mechanism of severe autumn hazes in Beijing

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In recent years, severe hazes with high $PM_{2.5}$ concentrations in China due to rapid economic growth and urbanization have been a serious problem, especially in the North China Plain since they may cause adverse impacts on environment and health. Although ample of previous studies about winter and summer hazes have been conducted, little work has been done for the autumn hazes. Previous studies suggested that specific meteorological conditions and heavy emissions from biomass burning are major factors. To better understand the autumn extreme hazes in Beijing, a suite of strengthened observations was conducted in Tsinghua University from September 27 to October 18, 2015 with hourly-based continuous gas and particle measurements including a single particle mass spectrometer (ATOFMS).

As shown in Figure 1, there were two extreme haze episodes during October 4-7 and 14-17. During the first episode, $PM_{2.5}$ concentration increased sharply at the beginning of the episode and remained high (~ 300 μg/m^3) until being cleaned up by the blow of strong north wind. While during the second episode, $PM_{2.5}$ concentration increased gradually at the beginning and then increased sharply to higher concentration (~ 300 μg /m^3) on October 16. The high $PM_{2.5}$ episodes appeared under the condition of low wind speed mainly from south and high humidity. The increased $PM_{2.5}$ concentration corresponded to the increased concentrations of sulfate, nitrate, ammonium, organics, black carbon, water and gaseous precursors. These observation results suggest that stable synoptic conditions, formation of secondary species and hygroscopic growth contributed to the formation of the severe hazes. Moreover, satellite map of fire points and the backward trajectories of the air masses indicated that biomass burning and regional transport were also important for the formation of this autumn hazes.

Temporal variation information of different particle type counts obtained by ATOFMS (Figure 2) showed that the number of potassium-containing particles increased a lot during haze episodes, especially the K_OC type, indicating the enhanced contribution of biomass burning to the autumn hazes.

In conclusion, stable synoptic conditions, formation of secondary species, hygroscopic growth, biomass burning and regional transportation contributed to the formation of haze in autumn.

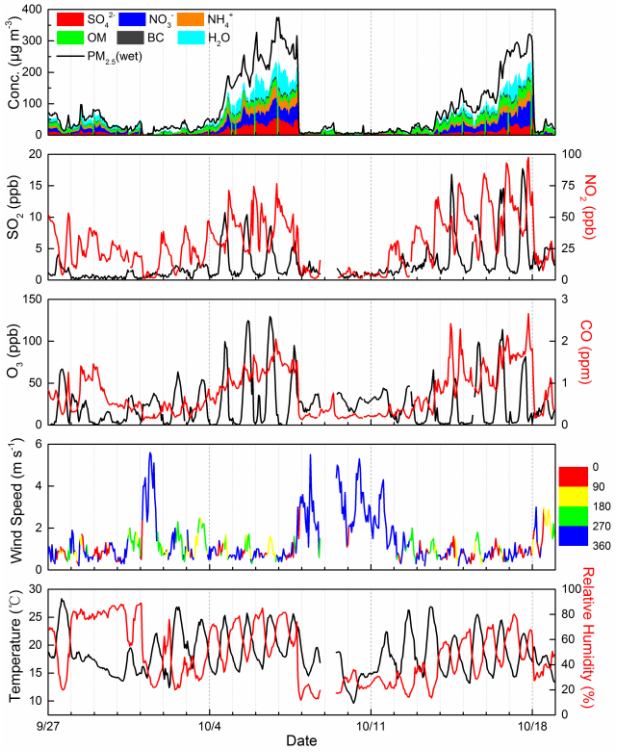

Figure 1. Time series of $PM_{2.5}$, and its major components, and gaseous precursors, and meteorological data.

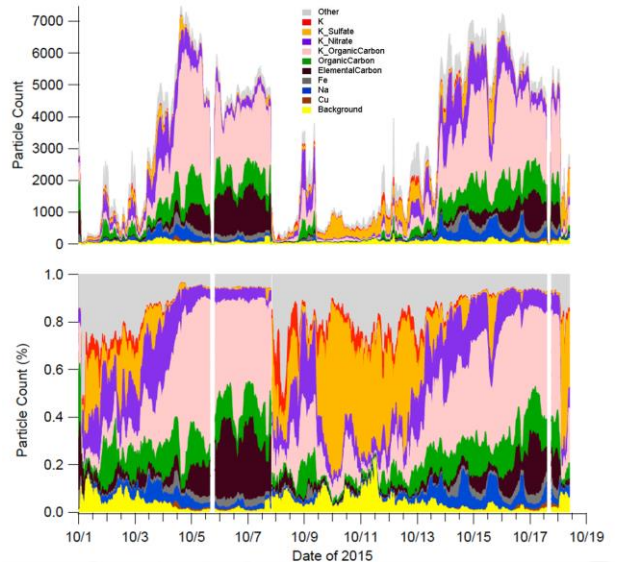

Figure 2. Temporal variation of different particle type counts with 30 min time resolution by ATOFMS.