Insights into the seasonal variations, meteorological effects, and source characteristics of aerosol particle composition in Yangtze River Delta (YRD) region, China

L. L. Tang[1,2], H. X. Yu[3], Y. J. Zhang[1,2] and A. J. Ding[4]

1Jiangsu Collaborative Innovation Center of Atmospheric Environment and Equipment Technology(CICAEET),Nanjing University of Information Science and Technology,Nanjing 210044,China
2 Jiangsu Environmental Monitoring Centre, Nanjing 210036, China
3Nanjing University, Nanjing 210093, China
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Presenting author email: lily3258@163.com

With the fast development both in economic and industrial activities in the last ten (10) years, many large cities in mid-eastern areas of China are experiencing increased haze events and atmospheric pollution, which have caused significant impacts on the regional environment, human health and even climate. Extreme haze episodes have repeatedly shrouded the Yangtze River Delta (YRD) region particularly during the year 2013. Atmospheric submicron particulate matter (PM1) is one of the most significant pollution components known to be responsible for this dramatic events. Despite its current popularity in the studies of aerosol chemistry, the characteristics, sources and evolution of atmospheric PM1 species are still poorly understood in YRD, China, particularly for the harvest, winter and summer seasons.

To better understand these extreme events, we conducted real-time measurements of PM1 species (sulfate, nitrate, ammonium, chloride and organics) in Nanjing using an Aerodyne Aerosol Chemical Speciation Monitor for one (1) continuous year, from January to December 2013.The study after a careful synthetic analysis found the following; a remarkable seasonal variability of PM1 and its composition with the highest occurrence during the winter season and the lowest at summer. However, with enhanced contributions from open biomass burning, abundantly high PM1 species were also recorded in the late-spring and autumn, respectively; secondary species, including organics, sulfate, nitrate and ammonium were the major constituents of PM1, with special dominance by organic fraction and nitrate; the severe winter haze was driven by stable synoptic meteorological conditions over YRD, and not just only by the increase in anthropogenic emissions. In addition, we found that the lowest and highest PM1 often occurs in the afternoon and evening hours, respectively, which is attributed to the daily variations in the boundary layer depth and anthropogenic emissions. Also the positive matrix factorization (PMF) analysis of the ACSM OA mass spectra revealed four key OA factors: hydrocarbon-like mixed with cooking related OA (HOA + COA); fresh biomass burning OA (BBOA); oxidized biomass burning-influenced OA (OOA-BB); and highly oxidized OA (OOA). The diurnal distribution of the OA consistently displayed pronounced peaks during the afternoon periods, reflecting a significant contribution of secondary PM formation. Both emissions and meteorological variations dominated the long-term PM concentration trend, while in the short term concentrations meteorological factors played a more dominant role. Analysis from air mass back-trajectory indicated that the high pollutant concentrations were linked to the air masses from the western or southern (summer and autumn harvest) and northwestearn (winter season) areas.

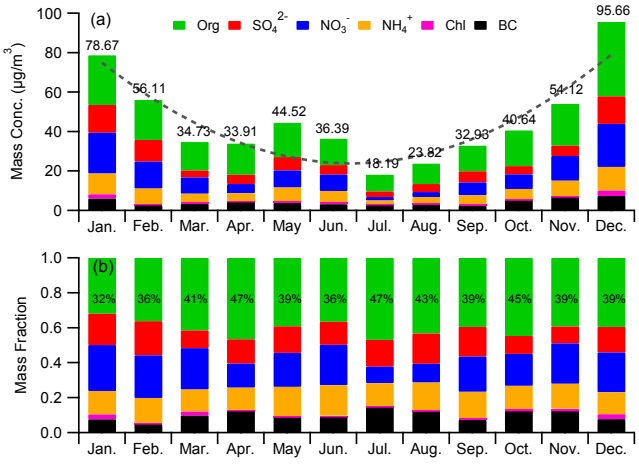

Figure 1. Characteristics of the monthly average (a) mass concentration and (b) mass fraction of atmospheric PM1 in Yangtze River Delta (YRD) region.

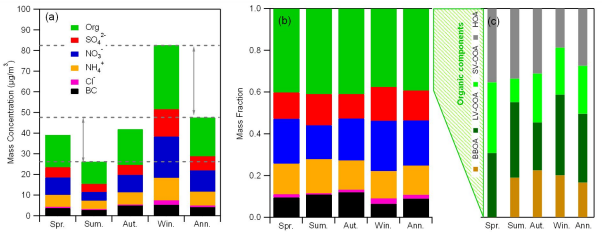

Figure 2. Seasonal variations of the PM1 chemical components and organic sources in Yangtze River Delta (YRD) region.

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