The Chemical Composition Characteristics of Aerosol and its Impact on the Visibility in North China Plain
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Highlights
- Visibility and mass concentrations of PM2.5 present non-linearity correlations in different RH.
- Organic matter, NH4NO3, (NH4)2SO4 were the three main light extinction coefficients in Beijing.
- The increase concentration of NH4NO3, (NH4)2SO4 and organic matter result in the occurrence of low visibility events in autumn or winter in NCP.
- As PMF model, 37.1% and 26.5% of the LEC came from secondary aerosol on PD in Beijing and Tianjin.

Abstract
To better understand the chemical composition (water soluble ions (WSIs) and carbonaceous aerosol (CA)) characteristics of aerosol and its impact on the visibility in North China Plain (NCP), four experimental sampling campaigns were carried out during Jun, 2013 to May, 2014. The sampling sites were located in Beijing, Xiangshan, Tianjin, Shijiazhuang, Qinhuangdao. The air pollution episodes mainly happened in autumn and winter in NCP. In the sight of different particle size distribution, the ratio of anions to cations in the fine size (0.64) was greater than that in the coarse size (0.54) in NCP. The coefficient of diversences indicates that the aerosol pollution had a similar characteristic in the five cities of NCP and pollutants had a characteristic of mutual influence and regional transfer process. There were different non-linearity correlations between visibility and mass concentrations in different relative humidity. When RH was greater than 70%, the visibility was less than 5km, showing that due to its hygroscopic growth in a higher RH, the increasing of PM2.5 resulted in the decreasing of visibility. The Interagency Monitoring of Protected Visual Environments (IMPROVE) method was used to estimate the light extinction coefficients (LEC) from the measured concentrations of chemical species. Organic matter(OM), ammonium nitrate(NH4NO3), ammonium sulfate((NH4)2SO4) were the three dominant species contributing to LEC in Beijing and had the highest proportion of total contributions to LEC in summer, accounting for 32.2%, 25.9%, 24.4%, respectively. The LEC of sea salts had not changed much in the full year, accounting for 4.1~5.3% in Beijing and 4.8~7.4% in Tianjin. According to the Ambient Air Quality Standard, the days were divided into Pollutational Days (PD) and Attained Days (AD). The increasing concentrations of NH4NO3, (NH4)2SO4 and OM resulted in an increase of LEC in NCP, which led to the occurrences of low visibility events in autumn and winter. NH4+, NO3- and SO42- mainly existed in the fine size (diameter<2.1μm) in Beijing (73.5, 80.7, 78.0% on PD and 63.3, 79.4, 72.5% on AD) and Tianjin (81.0, 80.6, 82.1% on PD and 71.5, 44.3, 69.7% on AD). However, the CA, mainly coming from fuel combustion, also played an important part in the visibility impairment in the coarse size (2.1<diameter<9.0μm). According to positive matrix factorization (PMF) model, 37.1% of the LEC came from secondary aerosol on PD in Beijing and 26.5% in Tianjin. In addition, biomass burning, fuel combustion and fugitive dust were also important contribution sources of LEC in NCP.

Methodology
The sampling sites were located in Beijing(BJ), Xiangshan(XS), Tianjin(TJ), Shijiazhuang(SJZ), Qinhuangdao(QHD) in the North China Plain during Jun, 2013 to May, 2014. A nine-stage sampler (Andersen Series 20-800, USA) was used to collect particles. Water soluble ions and carbonaceous aerosols were measured by ion chromatograph (DIONEX, ICS-90, USA) and thermal/optical carbon aerosol analyzer (DRI Model 2001A, Desert Research Institute, USA).

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