



Concentration and Chemical Composition of PM_{2.5} in Tianjin, China

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Introduction

Tianjin is located about 120 km southeast of Beijing and has a total population of over 10 million and an area of 11919.7 km². As 2008 Olympic Games will be held in Beijing and Tianjin, air quality in this region of China attracts much more attention.

Tianjin is faced with the serious problem of high particulate matter and poor visibility. Since the national air quality standard for PM is based on PM₁₀, information on fine particle pollution is scarce. In this study, concentration and chemical composition of PM_{2.5} as well as its impacts on atmospheric light extinction were investigated.

Experimental

1. Sample collection

PM_{2.5} mass concentration: continuous sampling and measurement at the urban center using TEOM series 1400a ambient particulate monitor (R&P Co., Inc.)

Chemical speciation: 24h sampling using quartz fiber filter under a flow rate of 100L/min.

Integrated PM_{2.5} samples were collected at an urban, an industrial and a coastal site of the city.



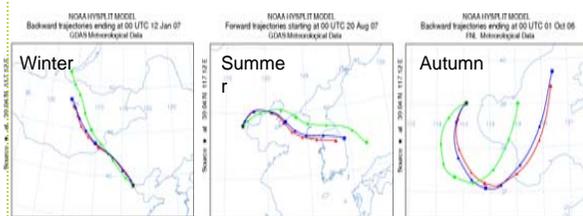
2. Chemical analysis

Eight water-soluble ions (Cl⁻, NO₃⁻, SO₄²⁻, Na⁺, NH₄⁺, K⁺, Mg²⁺, Ca²⁺): ion chromatography (Dionex120)

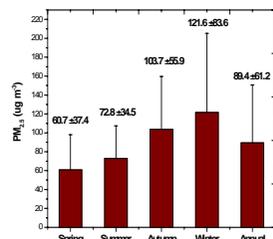
Organic and elemental carbon: DRI Model 2001 (Thermal/Optical Carbon Analyzer) implementing the IMPROVE TOR protocol.

3. Air mass trajectories

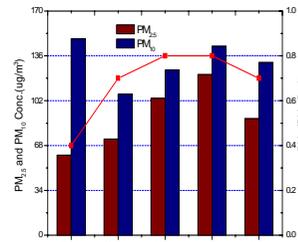
HYSPLIT-4 Model of the Air Resources Laboratory of NOAA



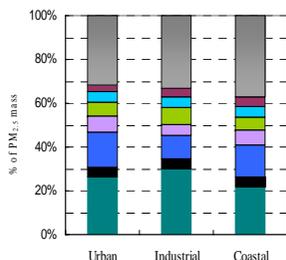
1. Ambient concentration



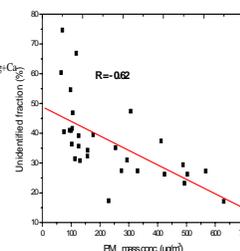
Results



2. Chemical composition

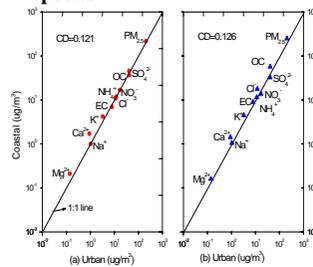


(1.4*OC+EC): 31%, 34%, 25%
Ionic species: 38%, 33%, 36%



Relationship between PM_{2.5} concentration and the fraction of unidentified material

3. Spatial distribution of major PM_{2.5} species



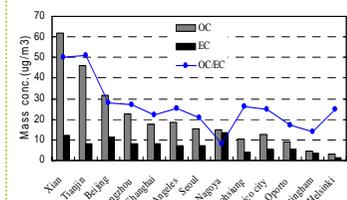
Concentration scattering diagrams
(The chemical data for the urban site was selected as a reference)

Coefficient of divergence (CD)

$$CD = \sqrt{\frac{1}{p} \sum_{i=1}^p \left(\frac{x_{ij} - x_{ik}}{x_{ij} + x_{ik}} \right)^2}$$

x_{ij} : average concentration for a chemical component i at site j ; j and k represent two sampling site; p is the number of chemical components.

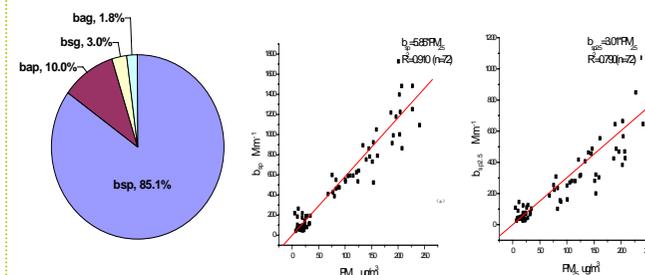
4. Elemental carbon (EC) and organic carbon (OC) during winter



Secondary organic carbon: $OC_{sec} = EC \times (OC/EC)_{min}$
minimum ratio of OC/EC:
urban site 1.8, coastal site 2.1, industrial site 2.6

	Tianjin ^a	Beijing	Birmingham	Oporto	Mira Loma	Fresno
SOC (µg/m ³)	27.1	17.2	0.63	5.7	5.2	3.5
SOC/OC (%)	50	45	17	39	49	20

5. Particulate light extinction in Tianjin



Constitutes of atmospheric light extinction

Relationship between PM_{2.5} and particulate light scattering (bsp)

Fine particle scattering efficiency ($b_{sp}^{3.0}$)

Summary

1. The annual average concentrations of PM_{2.5} were 89.4 µg m⁻³ with the highest value in winter and lower values in summer and spring.
2. Levels of major PM_{2.5} chemical species were similar at different sites. Organics and sulfates were the two largest contributors to fine particle mass.
3. Severe organic aerosol pollution was observed in Tianjin, and the SOC contribution to OC was significant even in winter.
4. Particle light scattering accounted for more than 80% of the atmospheric light extinction, and the scattering efficiency of PM_{2.5} was about 3.0 m²/g.