HaChi - Size - and time -resolved measurements of winter and summer haze particles from the Beijing area

LEIBNIZ-INSTITUT FÜR TROPOSPHÄRENFORSCHUNG

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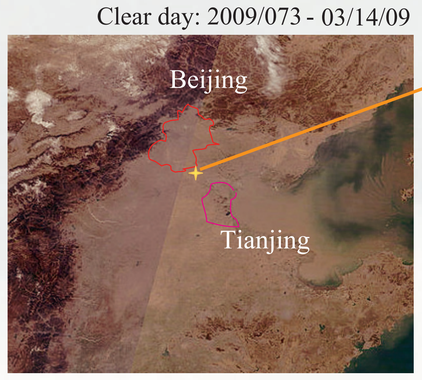
INTRODUCTION

Satellite observations of Beijing clearly show that this area is frequently plagued with heavy air pollution caused by significantly increased particle emissions. The aerosol affects the regional air quality and impairs the visibility by the formation of haze. This process strongly depends on the chemical, optical, and microphysical properties of particles governing the ability to take up water. Furthermore, these particles play an important role for cloud formation processes, precipitation and the radiative balance of the atmosphere by subsequently acting as Cloud Condensation Nuclei. The HaChi project (Haze in China) targets to study chemical parameters of submicron aerosol in order to associate the chemical composition with the ability to act as condensation nuclei during the formation of haze.

Hazy day: 2009/077 - 03/18/09

Clear day: 2009/073 - 03/14/09



MODIS Terra, True color, Pixel size: 2km

The measurement site is situated between the megacities Beijing (northwest) and Tianjin (southeast).

Winter campaign: 02/03/ - 04/04/2009

Summer campaign: 13/07/ - 13/08/2009

BULK MEASUREMENTS

Sample collection

DIGITEL High Volume sampler (HVS)

PM_1-inlet + 24 hours system

Cutoff: 1 µm (Dp_{aer})

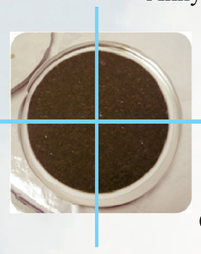
Quartz fibre filters

Transport in deep-frozen state.

Chemical analysis

Mass

Anhydromonosaccharide (levoglucosan), dicarboxylic acid (oxalate)



Inorganic ions

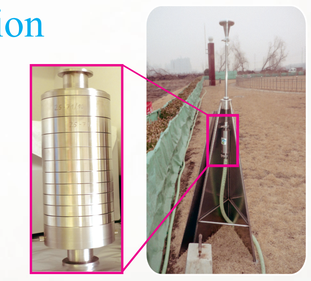
Carbonaceous material: OC, EC, WSOC

SIZE - AND TIME-RESOLVED MEASUREMENTS

Sample collection

11-stage low pressure Berner impactor (BLPI)

6 hours day and night samples, respectively

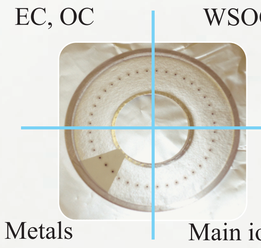


Cutoffs	
Stage	$D_{(aer)}$ in µm
1	0.015 - 0.03
2	0.03 - 0.06
3	0.06 - 0.125
4	0.125 - 0.25
5	0.25 - 0.5
6	0.5 - 1.0
	Σ PM_1

Chemical analysis

EC, OC

WSOC



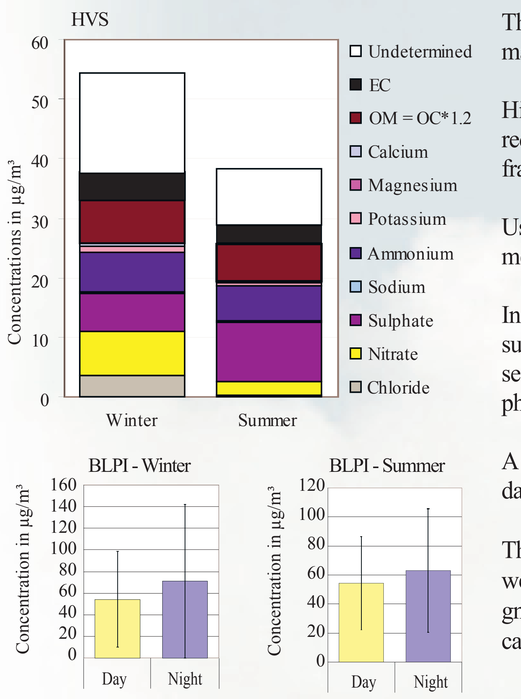
Metals

Main ions

+ Meteorological data set:

Relative humidity, temperature, wind speed, wind direction, precipitation

AVERAGE CHEMICAL COMPOSITIONS



The average PM_1 concentrations for the winter and summer campaign differ in total mass concentration as well as chemical composition of main constituents.

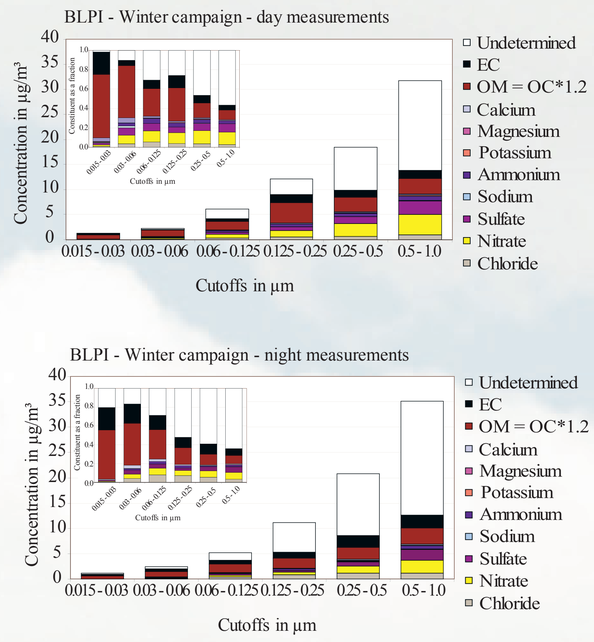
Higher mass concentrations were found from the winter campaign samples compared to samples collected during the summer campaign due to a higher undetermined fraction (probably crust material or water).

Usually higher mass concentrations were detected during during the night measurements compared to day samples.

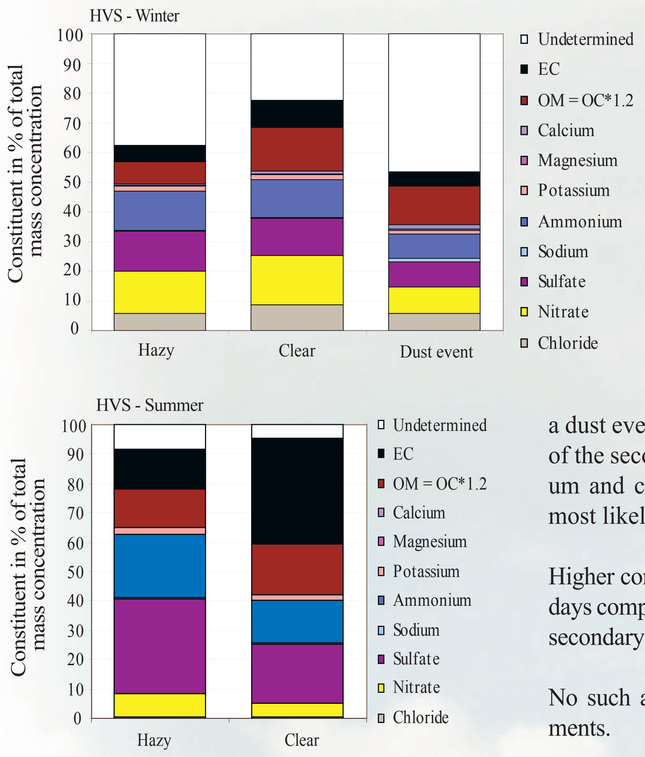
In general a higher ion content was observed in the aerosol sampled during the summer campaign than from the winter campaign filters due to a higher amount of secondary formed ammonium, nitrate and sulfate likely as a consequence of higher photochemical activity during the summer time.

A higher chloride content was observed exclusively for night samples compared to day samples during both campaigns.

The larger the particles size the higher the relative amount of secondary formed ions were found for day and night samples collected during the summer time. Such a significant increase of ion content with the particle size was not observed for winter campaign samples.



HAZY AND CLEAR DAY PARTICLE COMPOSITIONS



Usually, highest PM_1 concentrations are observed during haze periods, while the particle load was lower on clear days.

Averaged mass concentration in µg/m³ (HVS)

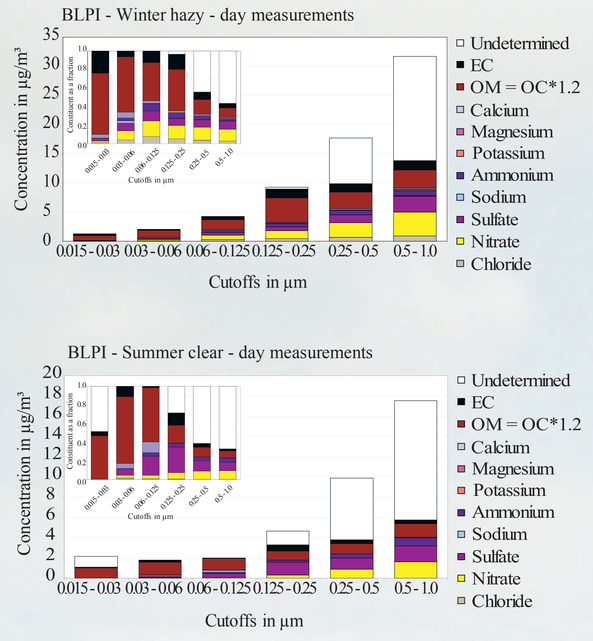
	Hazy	Clear	Remains
Winter	60 ± 20	31 ± 9	55 ± 28
Summer	45 ± 20	18 ± 7	37 ± 13

The main components of the varied submicron particles are inorganic ions and carbonaceous material.

The chemical composition of particles collected during a dust event was characterized by a significantly decreased contribution of the secondary formed ions, an increased content of sodium, magnesium and calcium, and of a remaining unidentified fraction containing most likely crust material such as silicates as well as water.

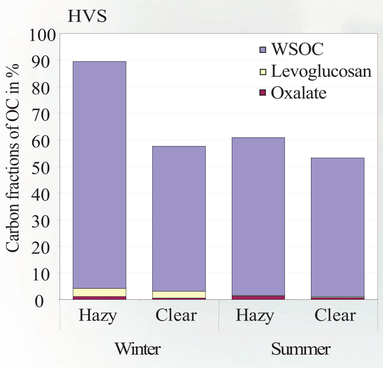
Higher concentrations of ions were found from samples collected on hazy days compared to clear day aerosol during the summer campaign due to the secondary formed sulfate, ammonium, and nitrate.

No such a distinction was determined during the winter time measurements.



A significant higher content of carbonaceous material (EC and OM) was observed in the aerosol collected on clear days compared to hazy days caused by higher OC and EC concentrations during the winter and the summer period, respectively.

WSOC COMPOSITION

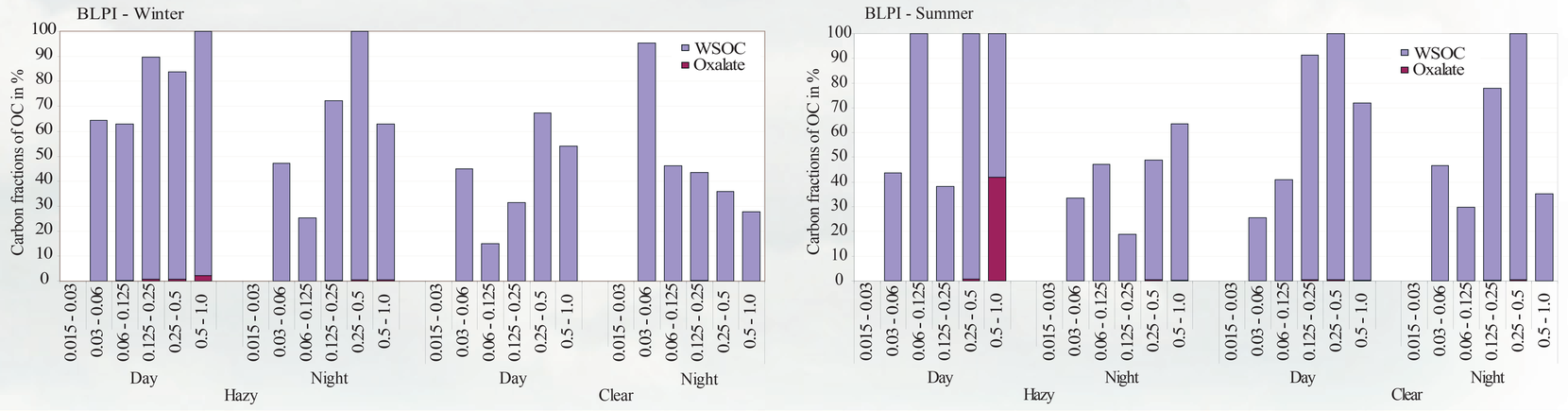


The OC fractions are mostly dominated by WSOC.

A higher WSOC and higher therein-enclosed oxalate concentrations are determined on hazy conditions than during clear sky measurements.

Averaged oxalate concentrations in ng/m³

	Hazy	Clear	Remains
Winter	157 ± 62	86 ± 88	108 ± 65
Summer	228 ± 51	73 ± 32	167 ± 56



ACKNOWLEDGEMENT

This work is supported by:

- the German Science Foundation under grant number DFG WI 1449/14-1
- the National Natural Science Foundation of China (NSFC) under grant No. 40875001
- the Namias travel grant award of AGU

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