Comparison of column-integrated aerosol optical and physical properties in Beijing and Xianghe

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Bremen Dec.,19, 2013

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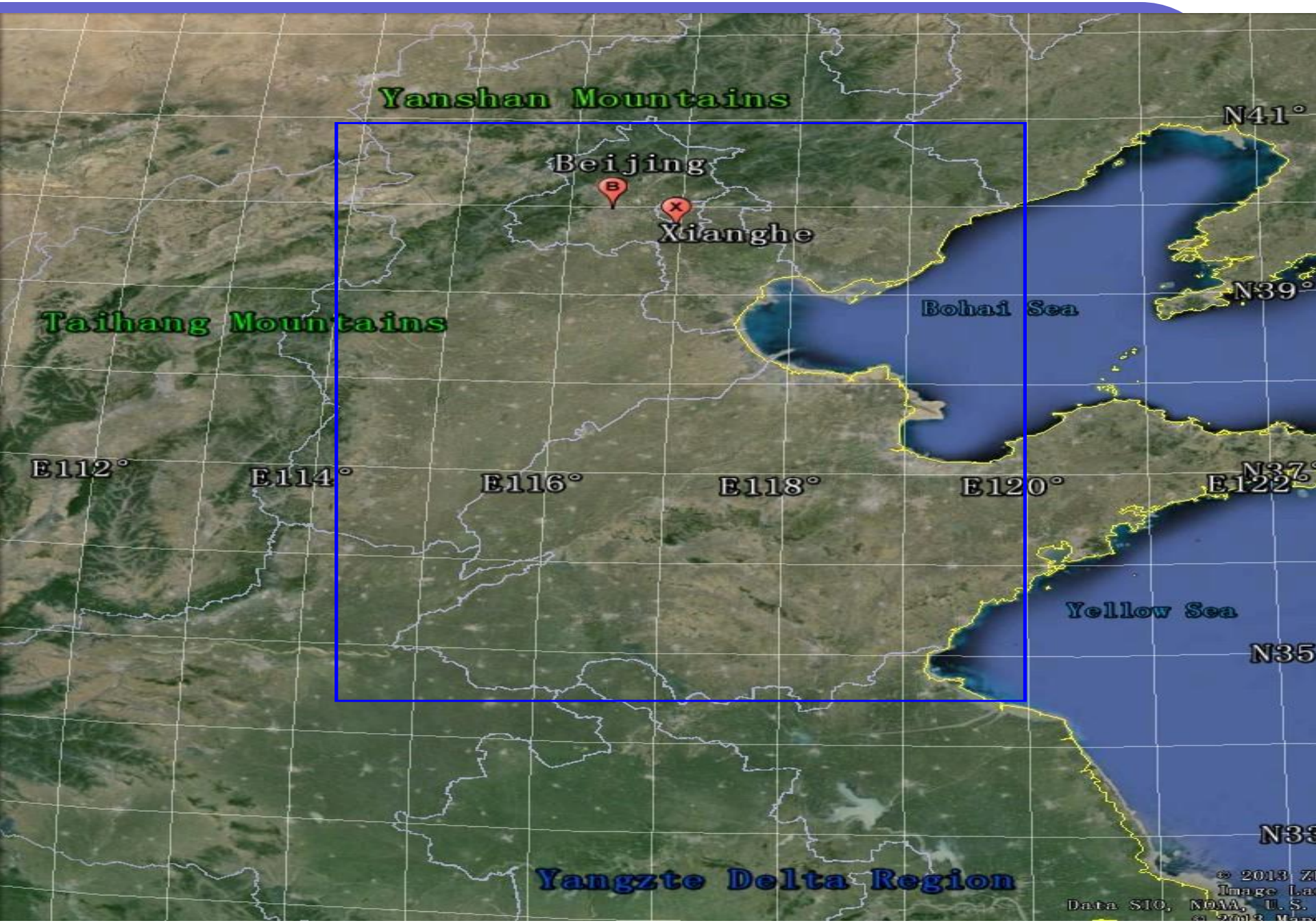
Motivation

- Large spatiotemporal variation of aerosol properties
- Increase of aerosol loading in North China Plain (NCP,114-120° E, 34.5-41° N) caused by rapid economic development and population growth
- Long-term accurate observation of aerosol key properties


Yanshan Mountains
Beijing
Xianghe
Taihang Mountains
Bohai Sea
Yellow Sea
Yangzte Delta Region
N41°
N39°
N35
N33
E112°
E114°
E116°
E118°
E120°
E122°

Sites, data and methodology

✓Sites

Beijing(39.98° N, 116.38° E): Yanshan Mountains, heavily industrialized areas

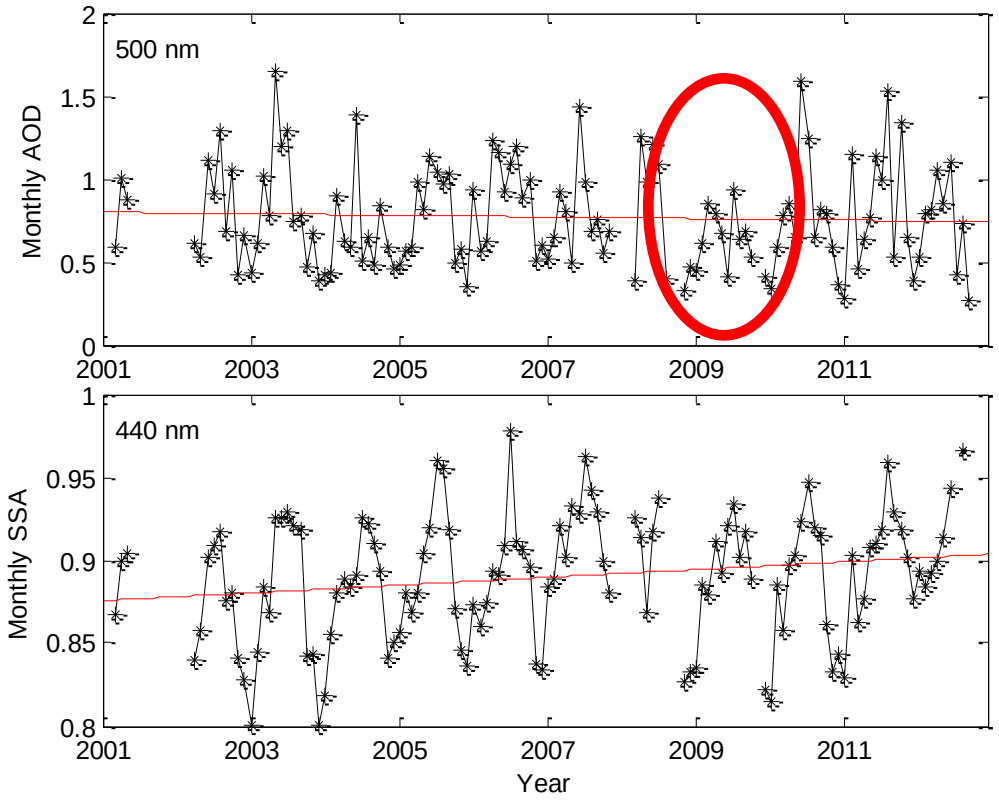
Xianghe(39.75° N, 116.96° E): a county of Hebei Province. The land cover is a mixture of construction and farmland.

✓ Version 2 and level 2 daily mean AERONET data (Oct. 2004 to Jun. 2012) AOD, AE, δ_α ($AE_{440\text{-}675nm} - AE_{675\text{-}870nm}$), AAE, SSA, FMF, Refractive index, Fine mode effective radius (r_f)…

✓Wilcoxon rank sum test

The two-sided rank sum test of the null hypothesis was performed on the two independent samples (Beijing and Xianghe) come from distributions with equal medians, against the alternative that they do not have equal medians.

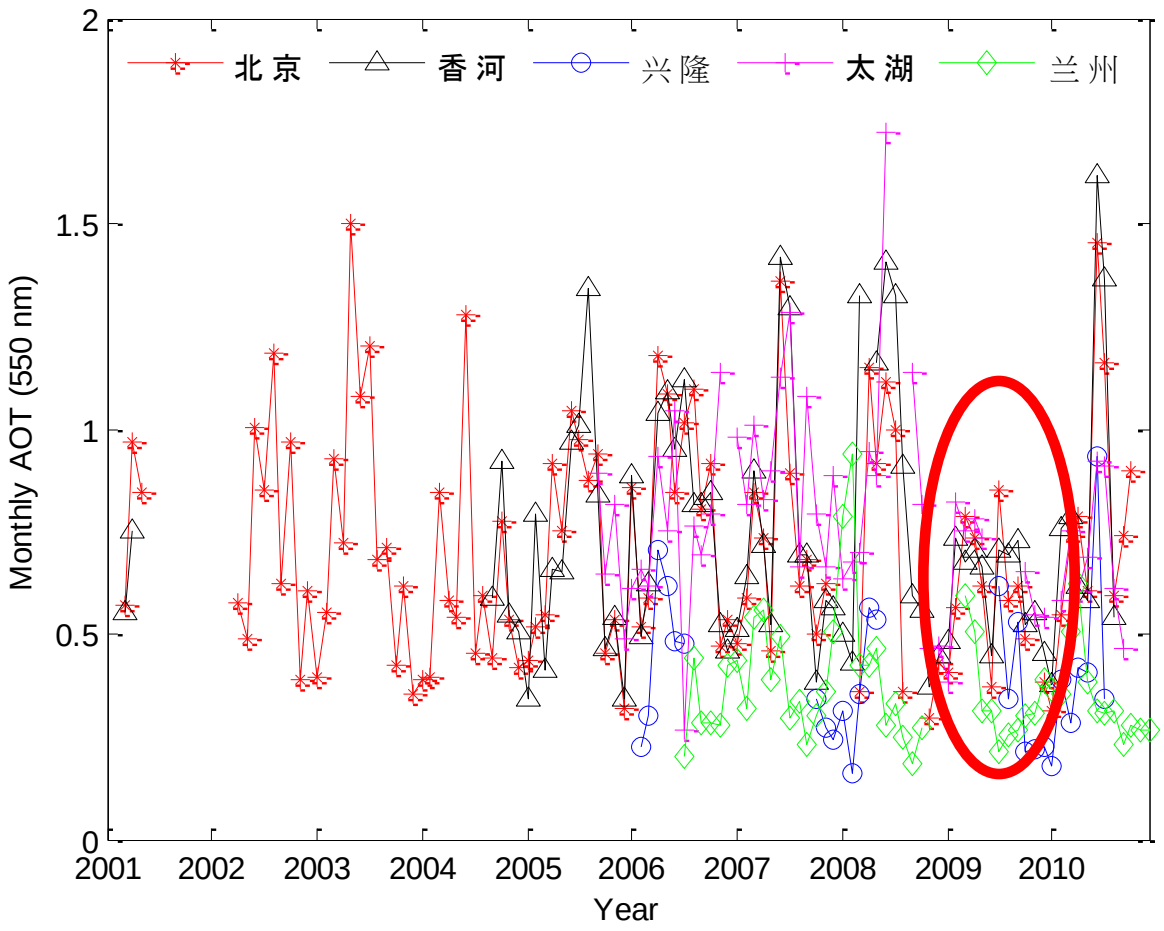
Time series of AOD and SSA at Beijing



Lower AOD during 2009

SSA increase by~0.028 resembled previous results (Lyapustin et al., 2011)
The regulation of BC emissions over BJ.
PM chemical composition measurements reported an observed 33% BC reduction in 2008 as compared to 2005-2007(Okuda et al., 2011).

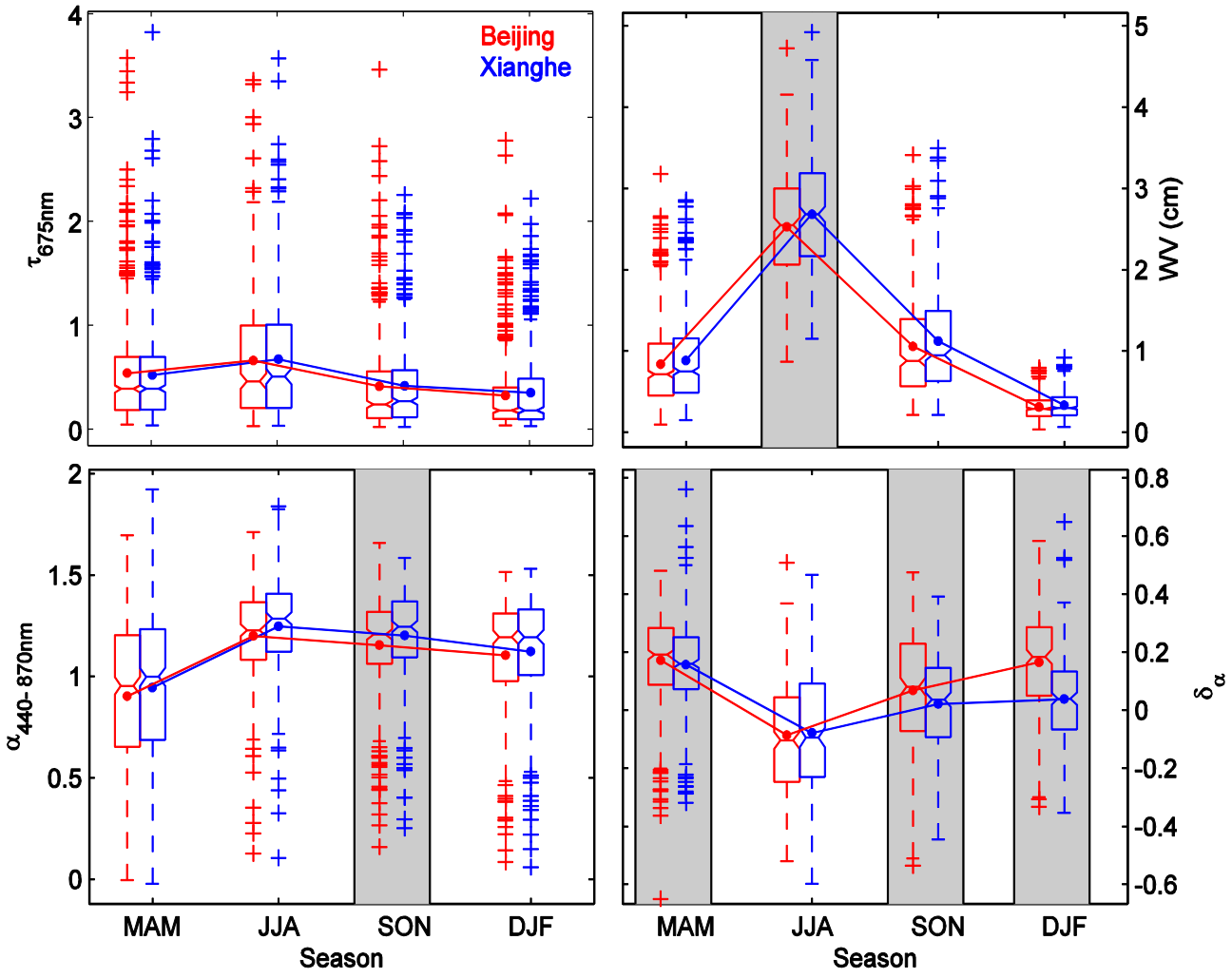
Time series of AOD in China



The decreasing of AOD during 2009 was also derived from MODIS AOD time series around BJ site (Xia et al., 2013)

Air pollution control taken for the Beijing Olympic Games in 2008 and economic crises in 2009

Comparison of aerosol optical and physical properties at BJ and XH

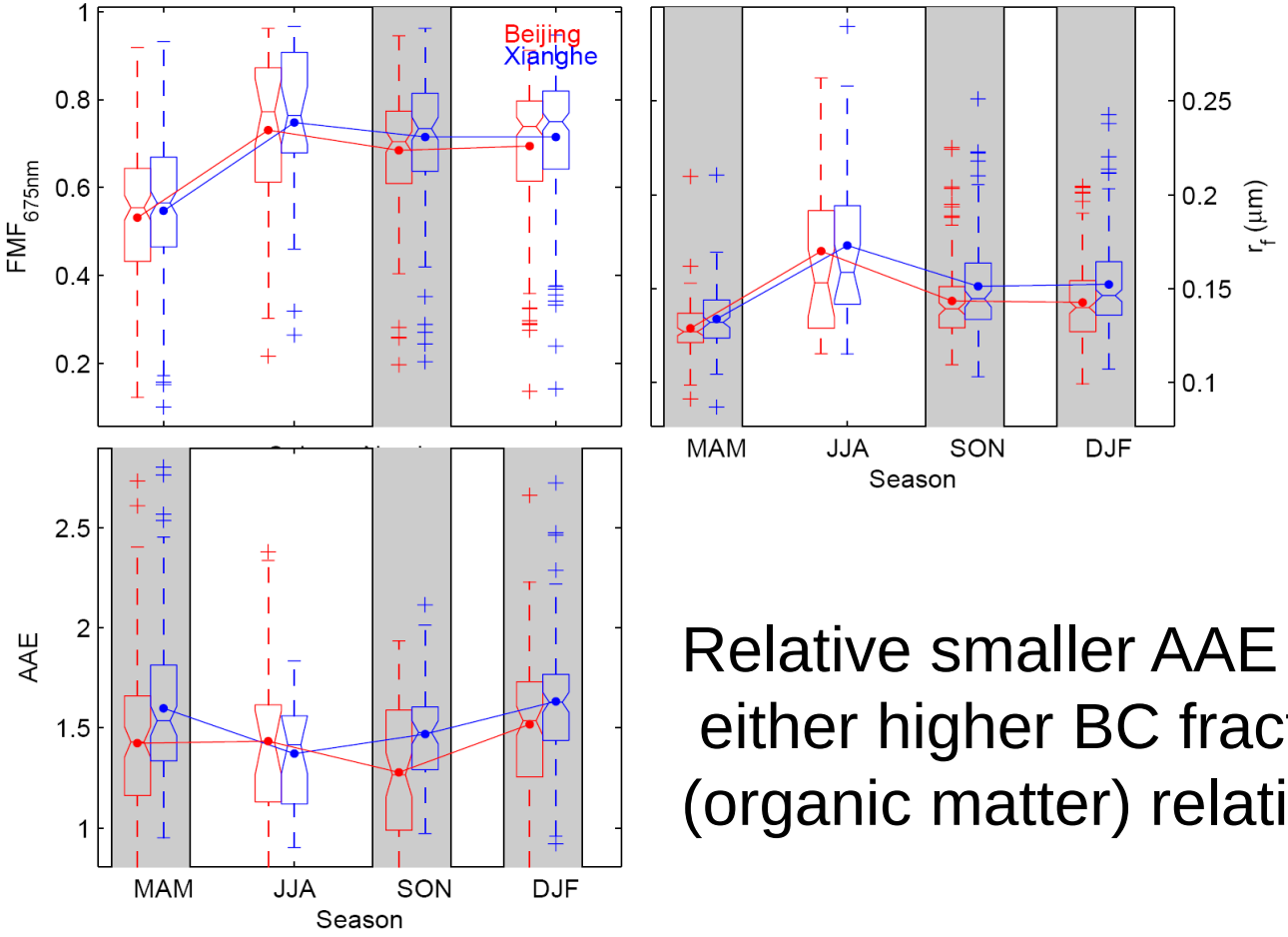


Distinct seasonal variation

R>0.84 and Dif<0.05. A good agreement in AOD at these two sites indicated that aerosol pollution in the Greater Beijing area was regional.

Significant difference in δ_α indicated that r_f was quite different.

Comparison of aerosol optical and physical properties at BJ and XH

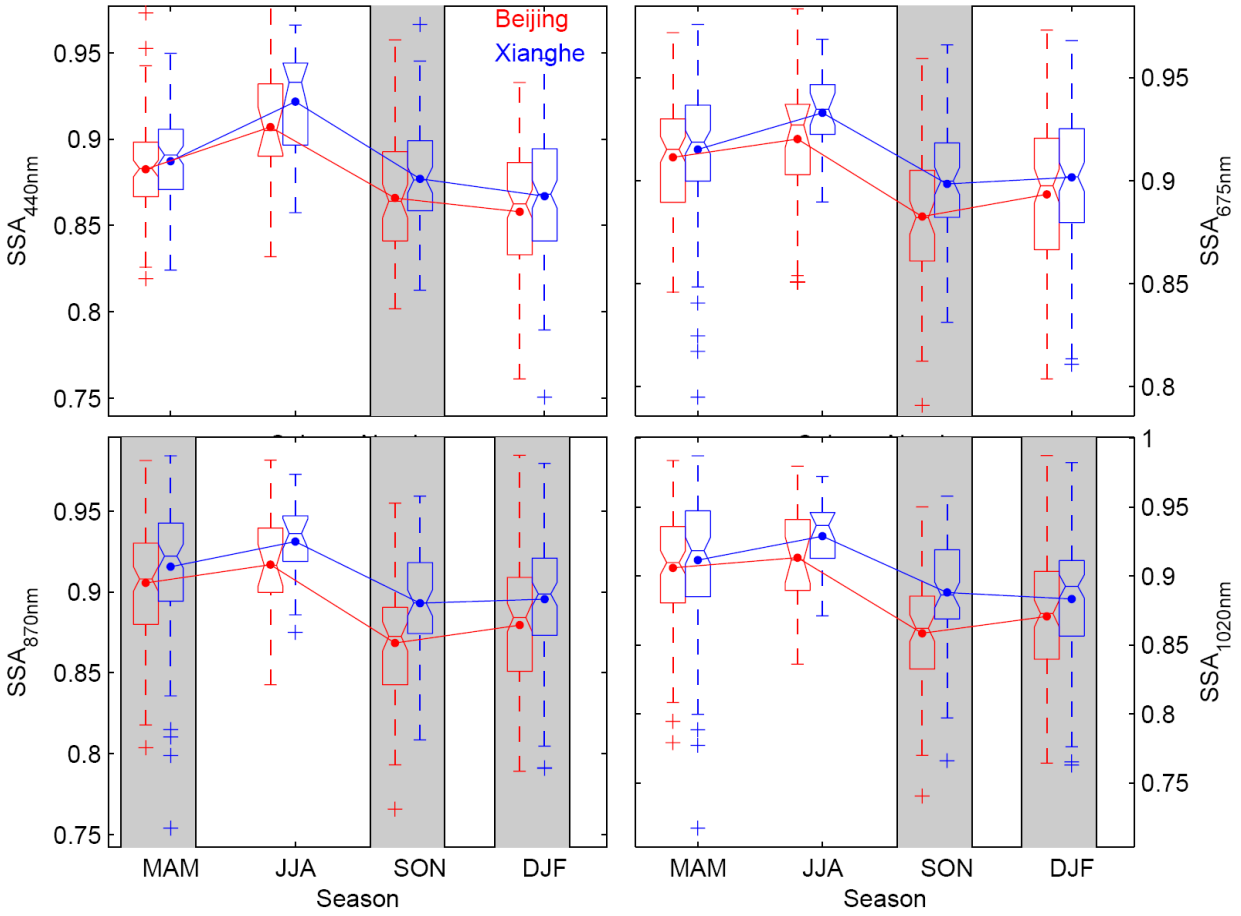


AAE=1.43 and 1.52 in BJ and XH, ~1.47 in XH during March 2005 (Yang et al., 2009).

Median AAEs at XH were significantly larger than those at BJ (MAM, SON, DJF)

Relative smaller AAE at BJ indicated either higher BC fraction or lower OM (organic matter) relative to XH.

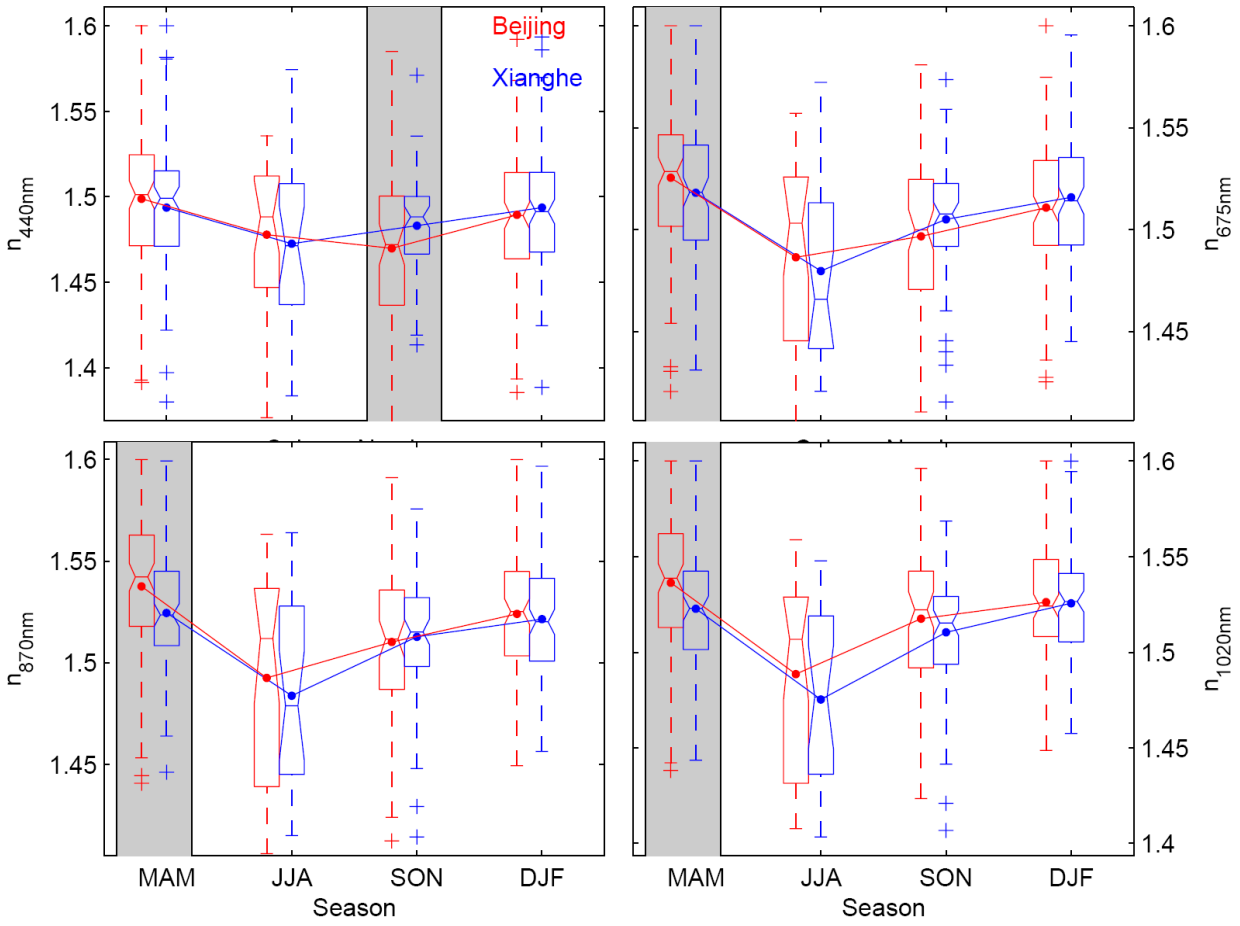
Comparison of SSA at BJ and XH



SSAs at XH were always larger than those at BJ.

The difference was significant in fall at 4 wavelengths.

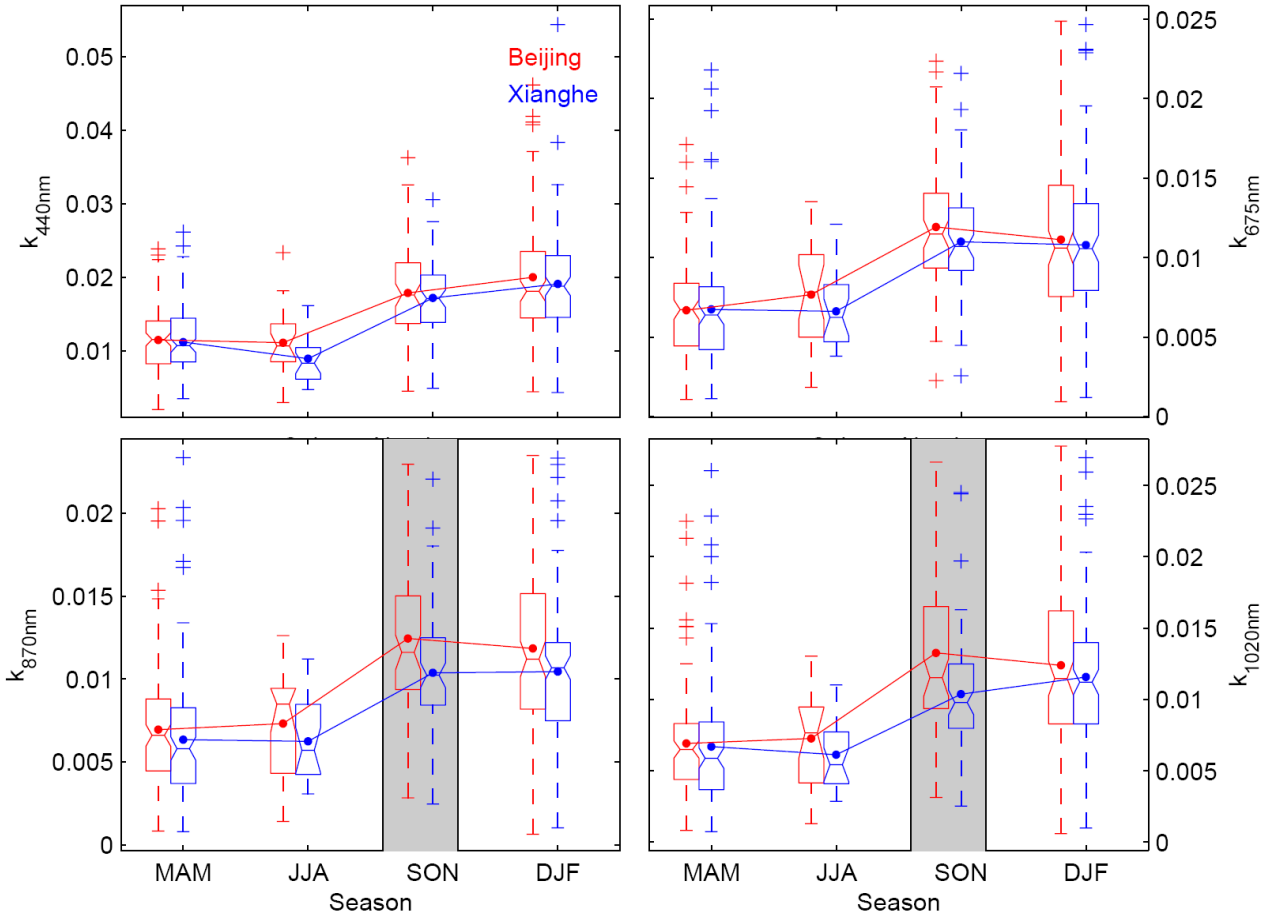
Comparison of real part of refractive index at BJ and XH



Real part (λ> 440 nm) at XH was significantly smaller than that at BJ in spring.

Relatively smaller scattering ability of aerosols at XH

Comparison of imaginary part of refractive index at BJ and XH



No significant difference in imaginary part at 440 and 675 nm.

At longer wavelengths, difference in imaginary part was generally larger than that at shorter wavelengths and the difference was significant in fall.

Conclusions

- The AOD (500 nm) at Beijing showed a weak decrease from 2001 to 2012.
- The SSA from 440 through 1020 nm wavelength was found to increase at Beijing from 2001 to 2012.
- The seasonal medians of AOD at Beijing and Xianghe stations were very close to each other.
- There are significant differences between the two sites in absorption Angstrom exponent (AAE), real and imaginary part of refractive index and thereby SSA and the difference was seasonal dependence.
- The difference of aerosol absorption properties indicated that there should be difference in aerosol physical and chemical properties in urban and rural regions of North China Plain.

Discussion

- Fall is the harvest season in NCP. Straw burning as an easy way to dispose of agricultural waste. Significant difference of aerosol optical and physical properties in fall was likely due to significant emission of smoke aerosols in rural areas and relatively stable weather in this season.
- Absorption difference were significant at longer wavelength. Some component of the coarse mode aerosol was more absorbing at BJ.
- Chemical composition measurements are need.
- Difference in local emissions at BJ & XH
- BJ and XH are not only impacted by local pollution but also by pollution from surrounding areas. It was reported that about 34% of particles in summer can be traced to sources outside Beijing.

Thanks for your attention

OMI UVAI

Smoke or BB aerosol absorption properties
Aerosol absorption at UV wavelength could not reflect the absorption at VIS