Characterising black carbon along Yangtze River in China

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Refractory black carbon (rBC) sources in the Yangtze River valley region include coal combustion, biomass burning and diesel engine emissions. Shanghai, Nanjing and Wuhan each have a population in excess of 8 million people and many other cities along the Yangtze River are home to over 1 million people making the region one of the most polluted in China (Fu et al., 2013). This paper presents results from a research cruise along the Yangtze River and provides a unique study to continuously capture the regional pollution in eastern China.

The comprehensive measurements on the ship took place along the Yangtze River between 21st November and 4th December 2015, and covered the length of the river from Shanghai to Wuhan and back to Shanghai. Physical and optical properties of individual rBC particles were characterised using a single particle soot photometer (SP2). PM_1, $PM_{2.5}$ and trace gases including nitrogen oxides (NO-NO_2-NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and ozone (O_3) were also simultaneously measured.

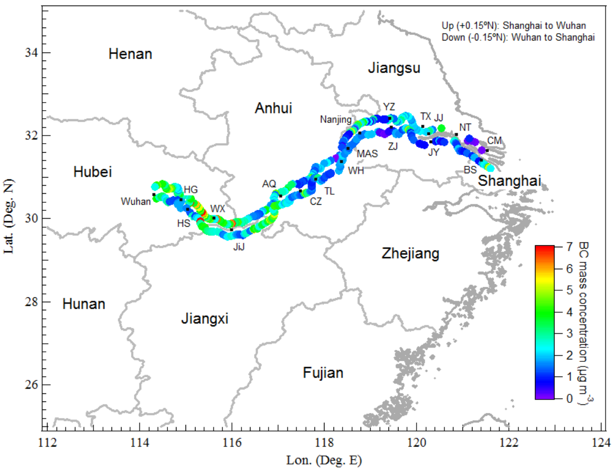

Figure 1. BC mass concentrations along the Yangtze River during the experiment.

The rBC average concentration along the Yangtze River (Figure 1) during the campaign was 2.41 ± 1.11 $\mu g.m^{-3}$. SO_2 showed a good correlation with NO (r = 0.71), NO_x (r = 0.73) and CO (r = 0.84), indicating these species were likely to be emitted from the same sources. A previous study found similar correlations with these pollutants and identifying ship emissions to be their source (Lu et al., 2006). The ratios of SO_2/NO_x and CO/NO_x showed a good correlation (r = 0.70) and were used to determine that regions are highly affected by coal combustion emissions when both ratios are high, whereas regions are strongly affected by diesel engine emissions when both ratios are low (Wang et al., 2002).

The single particle BC optical properties obtained from the SP2 during the campaign can be used to separate ambient mass loading of BC from traffic-related and solid fuel sources based on the variation of the scattering enhancement (E_s) as a function of BC core mass diameter (D_c).

Particles with small BC core size dominated in the Shanghai area, implying that BC emissions arise from the same sources; while particles with large BC core sizes dominated in cities outside Shanghai during the period 25th November to 3rd December, which indicates that the source distribution is different from that of Shanghai. Mass size distributions of BC were classified by SO_2/NO_x and CO/NO_x ratios. BC particles with larger BC core diameters were coincident with high ratios of the gas phase tracers previously attributed to coal combustion emissions and lower BC core diameters to diesel emissions.

These results, and others, will be used to assess regional variations in BC emissions and properties.

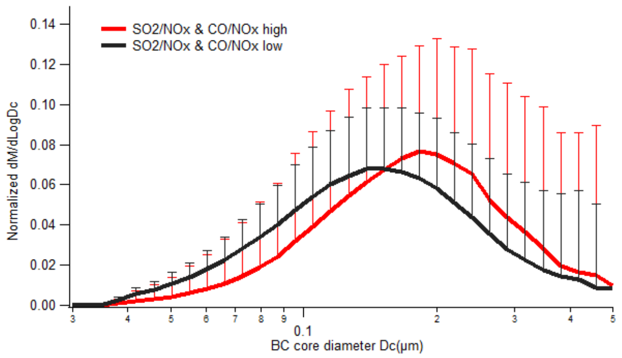

Figure 2. The normalized mass size distributions of BC. The normalised error bar are the + σ (standard deviation).

Fu et al. (2013) *Atmospheric Environment*, **70**, 39-50.

Lu et al. (2006) *Atmospheric Environment*, **40**, 2767-2782.

Wang et al. (2002) *Journal of Geophysical Research: Atmospheres*, **107**, 2156-2202.