



# Chemical composition of fog water in Nanjing area of China and its related fog microphysics

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## ABSTRACT

Fog samples were collected at Pancheng in the Nanjing area of China during December 2006 and December 2007. Fog droplet spectra, surface meteorological elements and visibility were also measured during the same period. The data from PM<sub>10</sub>, SO<sub>2</sub> and NO<sub>2</sub> measurements were obtained from the air quality monitoring networks of Nanjing. The total ionic concentration (TIC) and electrical conductivity (EC) in fog samples, and the local pollutant emissions were one or two orders of magnitude higher than those found in Europe or South America for instance. Pollutants were expected to be mainly from local sources, including factories, plants, freeways, soil sources, house construction, and biomass burning. Advection also contributed to pollution levels in radiation–advection fogs. The scavenging of NH<sub>3</sub> and coarse particles by fog droplets was the main cause for the high mean pH value of 5.9. In-phase temporal evolution of TIC, [SO<sub>4</sub><sup>2-</sup>], [NO<sub>3</sub><sup>-</sup>], SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub> and S/LWC (S: the surface area of fog droplets per unit volume of air; LWC: liquid water content) was found to be due to the interaction of air pollutants and fog droplets, change of air mass due to advection, and so on. S/LWC seemed to be a better indicator for describing the relationship between TIC and microphysics with respect to LWC. A formula between TIC and S/LWC was derived and the related parameters were discussed. Depositions of chemical species in fog cases were estimated and the result showed that deposition was efficient.

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## 1. Introduction

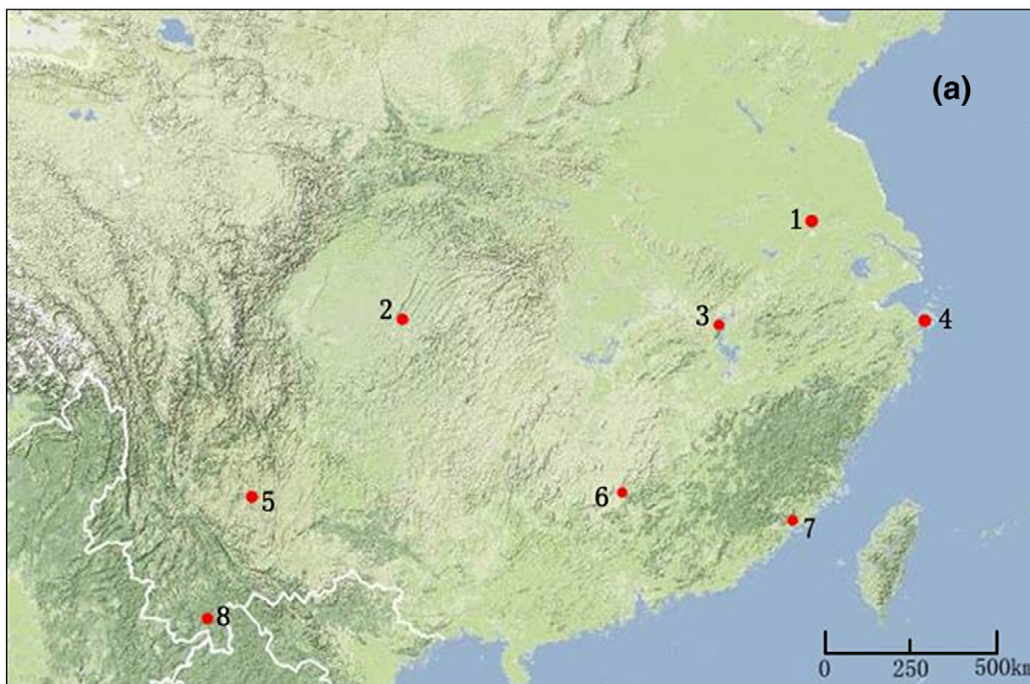
The chemistry of fog and cloud water has become an important topic of investigation over the last few decades (Fisak et al., 2002; Aikawa et al., 2007a,b). Acidic fogs have been frequently reported (Mrose, 1966; Waldman et al., 1982, 1985; Munger et al., 1983, 1990; Jacob et al., 1984, 1985; Aikawa et al., 2001; Igawa et al., 2001; Bridges et al., 2002). Acidic clouds or fogs were found to be a potential reason for the forest decline in West Germany, the Appalachian Mountains of eastern North America, and other parts of Europe and North America (Anderson et al., 1999). In addition, the highly concentrated chemical composition of fog water is a potential hazard for

human health. The physico-chemical interactions among gases, particles and fog droplets can all influence the composition of fog droplets (Jacob and Hoffmann, 1983; Munger et al., 1983; Pandis and Seinfeld, 1989; Pandis et al., 1990).

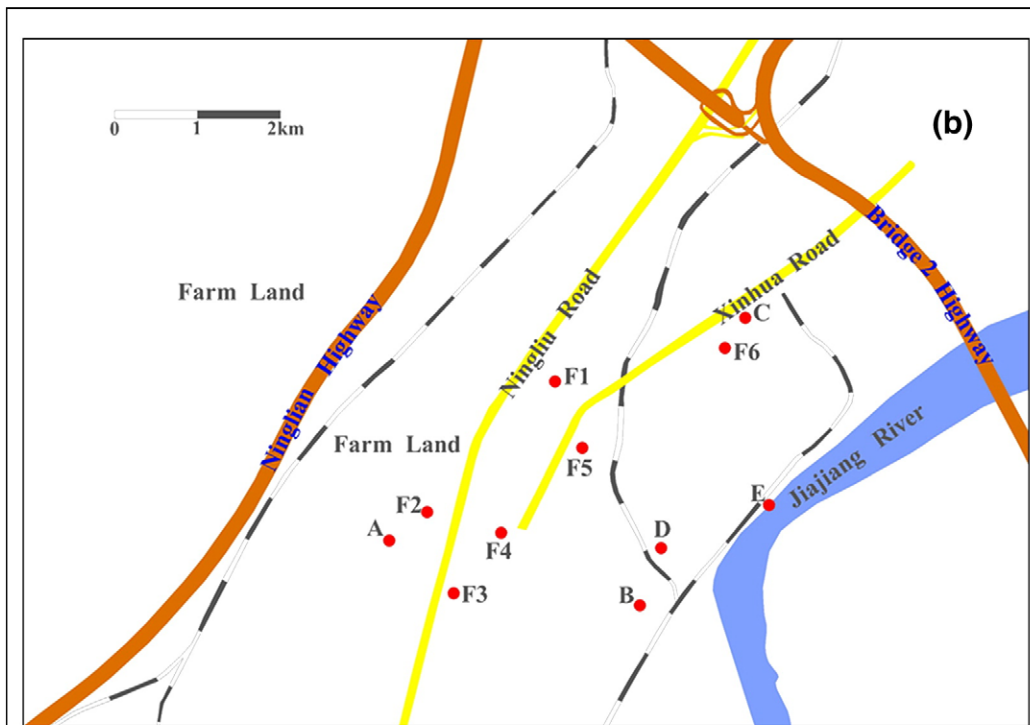
In China, fog is a common phenomenon in many regions (Wang et al., 2005), and systematic studies on fog chemistry started in the 1980s. As shown in Fig. 1a, acidic fogs have been found in Chongqing (Li et al., 1996), at Lushan Mountain in the Jiangxi Province (Ding et al., 1991), at Nanling Mountain in the Guangdong Province (Wu et al., 2004), and in the southern Fujian Province (Liu et al., 1996). Alkaline fog samples have been collected in Anning in the Yunnan Province (Huang et al., 1992), in Zhoushan in the Zhejiang Province (Mo and Xu, 1989) and in Jinghong in the Yunnan Province (Zhu et al., 2000). The primary ions in fog water are NH<sub>4</sub><sup>+</sup> or Ca<sup>2+</sup> as cations and SO<sub>4</sub><sup>2-</sup> as an anion in most regions of China (Li, 2001). However, the most important ions in Zhoushan are Na<sup>+</sup> and Cl<sup>-</sup> (Mo and Xu,

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| 1. Pancheng—Alkaline fog                | 2. Chongqing—Acidic fog                            |
| 3. Lushan, Jiangxi Province—Acidic fog  | 4. Zhoushan, Zhejiang Province—Alkaline fog        |
| 5. Anning, Yunnan Province—Alkaline fog | 6. Nanling Mountain, Guangdong Province—Acidic fog |
| 7. Southern Fujian Province—Acidic fog  | 8. Jinghong, Yunnan Province—Alkaline fog          |



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| <b>A:</b> Observation Site                             | <b>B:</b> Steel Plant                                  |
| <b>C:</b> Petrochemical Factories                      | <b>D:</b> Thermal Power Station                        |
| <b>E:</b> Nitrogenous Fertilizer Plant                 | <b>F1, F2, F3:</b> House Construction during 2006-2007 |
| <b>F4, F5, F6:</b> House Construction only during 2007 |  |

Fig. 1. (a) Map of the main sites in China at which fog chemistry have been carried out; (b) Map of observation site Pancheng and vicinity.

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