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Short communication

Seasonal chemical composition variations of wet deposition in Urumchi, Northwestern China

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Abstract

Urumchi suffered serious air quality problem in recent years. Although the main air pollutants and wet deposition monitoring have been undertaken by Urumchi Environmental Monitoring Center for many years, researches on chemical composition and variations of wet deposition were not there till now. In this paper, wet deposition monitoring data in Urumchi from 2000 and 2005 were selected to perform this evaluation based on data quality and data integrity. The volume-weighted mean (VWM) concentrations of parameters of wet deposition, namely pH, conductivity, SO_4^{2-}, NO_3^-, F^-, Cl^-, NH_4^+,Ca^{2+}, Mg^{2+}, Na^+ and K^+ concentrations, were 6.86 and 91.04 $\mu s\,cm^{-1}$, 14.3, 1.63, 0.37, 3.78, 1.22, 4.79, 0.59, 1.05, 0.74 $mg\,L^{-1}$, respectively. Acid precipitation appeared only in wintertime in few cases, and its extreme value was 4.96; the maximum emerged during sand storm event in the non-winter season with the value of 9.35. Wet deposition and air pollution characteristics varied with seasons. In order to make a certainty of possible sources of ions in different seasons, principal component analysis was applied, and conclusions were drawn that in wintertime, the predominant contributor to the wet deposition was coal combustion for residential heating; however, in the non-winter season, the situation was more complicated, dust and soil from outside the urban, dust re-suspension, local industries process, motor vehicle emissions all played their roles.

Keywords: Arid area; Sand-dust; Emission; Variation; Contribution; Principal component analysis

1. Introduction

Atmospheric deposition can occur in two forms, dry and wet deposition, which together is referred to as bulk deposition. Measurements of the chemical composition of atmospheric deposition are needed to establish depositional fluxes through the atmosphere in specific regions. These data are also very useful for validating global or regional-scale model simulations of air pollutants. In recent years, the need for such information has led to increasing interest in the number of atmospheric deposition chemistry in many countries and regions (Arndt et al., 1998; Walker et al., 2000; Irwin et al., 2002; Sakata et al., 2006).

Since the beginning of the 1990s, chemical surveys of snow had been carried out in the Tienshan Mountains and adjacent areas of Xinjiang Uigur

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autonomous district, China. Large amounts of data on snow chemistry were obtained (Wake et al., 1992; Williams et al., 1992; Wang et al., 1998; Jiang et al., 2002), and research results have indicated that sodium and potassium were found in the forms of sulfate-coupled compounds and that the sources of the sulfate were deserts and dry lakes in Central Asia.

Xinjiang is an important source of sandstorm in Asia; it mainly occurs in the arid and semiarid regions of deserts or land that has been affected by desertification. Thus, the southern Junggar Basin of Xinjiang is one of the main sources of sandstorm in China. The ground-surface vegetation and physical conditions of the soil of the source area have been investigated and analyzed (Qian et al., 2004; Wang et al., 2004; Ta et al., 2006), while the chemical properties of wet deposition in this area are still unexplored.

Urumchi, capital of the Xinjiang, is located in Northwestern China, which is an important town on the famous ancient trade route, the Silk Road. It has experienced severe air pollution in recent years because of the large amount of coal use for industrial purposes and residential heating, as well as an unfavorable topography coupled with sandstorm events. This paper has a three-fold purpose, the first is to record and explain variations in the chemical composition of wet deposition in Urumchi for the period between 2001 and 2005, the second is to make a comparison of the contributions from different sources, and the third is to verify the contributions of each factor.

2. Materials and methods

2.1. Study area

Urumchi is situated north of the Tienshan Mountains (Figs. 1 and 2), on the south edge of the Junggar Basin (42°45′–44°08′N and 86°37′–88°58′E), where Gurbantunggut desert is located. It is surrounded by mountains in three directions except in the north, with an altitude ranging between 680 and 920 m above sea level. The municipal area is 139.5 km^2 with a population of 2.2 million.

Urumchi lies in an arid region with moderately hot climate in summer and severely cold winters; spring and autumn tend to last for only a short period of time. In the past 6 years, the monthly mean temperature varies between −11.7 and 23.4 °C, with precipitation occurring mainly during wintertime. Owing to the influence of the mountainous topography surrounding the city in three directions, the monthly average surface wind speed is approximately 3.2 $m\,s^{-1}$. Generally, low wind speed and temperature inversion (756.9 m, average) caused by an unfavorable topography leads to an accumulation of airborne pollutants over the city, particularly in winter months. However, in the non-winter seasons, especially in spring, the situation is exacerbated by sandstorms. Dust from the Earth's surface is assumed to be a very important constituent of the atmosphere and of precipitation/snowfall (Wake et al., 1992; Williams et al., 1992).

Urumchi is often categorized as an industrialized city in the Northwest of China. Coal consumption

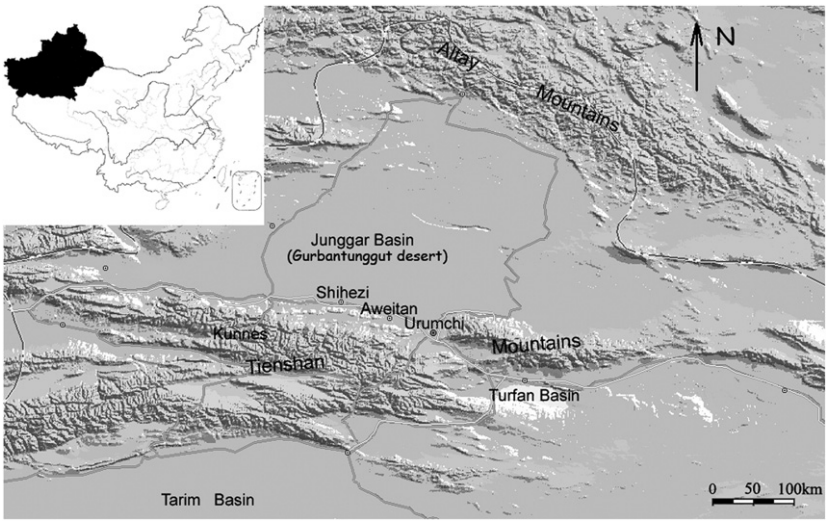

Fig. 1. Location of Urumchi and other study areas in Xinjiang.