PROTECTING THE ATMOSPHERE: CHINA

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Summary

China has many environmental problems, most of which have previously occurred in developed and developing countries. Air pollution is among the most serious. China's air pollution is caused mainly by combustion of excessive quantities of fossil fuels, especially coal. Coal alone accounts for more than 70% of the energy consumed in China. This fact is an obstacle to the protection of the Chinese atmosphere.

The Chinese government is paying great attention to atmospheric changes and climate by providing financial support for scientific research and providing a legal framework to minimize pollution.

In this paper, we give an introduction to some control measurements for protecting the atmosphere in China. Firstly, we introduce air-pollution issues in China. These mainly deal with the deteriorating atmospheric environment, trans-boundary transport and deposition of sulfur dioxide, aerosols and their environmental effects, and emission of greenhouse gases. We use the grid data from the Total Ozone Mapping Spectrograph (TOMS) on the Nimbus-7 satellite to analyze the spatial and temporal distributions of total ozone over China from 1978 to 1994, with data from 1997. Geographical distribution and temporal changes of total ozone over China are illustrated. We also give a brief introduction about protection and mitigation measures for the atmosphere in

China, and introduce relevant environmental laws.

1. Introduction

Life would be impossible on the Earth, without its surrounding atmosphere. Among other things, it protects living things from the atrocious environment of outer space. It provides carbon dioxide for plants to photosynthesize into oxygen for animals to breathe. It provides a suitable climate for life, and a protective shield against the strong ultraviolet radiation from the sun. Its nitrogen can be fixed into plant nutrients. It is the transport medium for the water cycle. The flowery natural world would not have appeared without the atmosphere.

Unfortunately human living standards and industry release large amounts of pollutants to the atmosphere and this has significantly changed its composition, both regionally and globally. These changes have affected global climate as well as the living conditions of humanity itself. Some of these changes are deadly and may be irreversible. They have awakened the attention of governments and scientists everywhere.

China has many environmental problems, most of which have previously occurred in the developed and are becoming evident in many developing countries. Air pollution is among the most serious. China's air pollution is caused mainly by combustion of unconscionably large amounts of fossil fuels, especially coal. Coal alone accounts for more than 70% of the energy supply in China. This fact is an obstacle to the protection of the Chinese atmosphere.

The Chinese government is currently paying great attention to atmospheric changes and climate by providing financial support for scientific research and providing a legal framework to minimize pollution.

Protecting the atmosphere is truly a global task; one country or one region cannot do it alone. For the common benefit of the world, governments and scientists from every country must work together to restore our glorious planet.

Air pollution in China comes mainly from burning coal, with soot and sulfur dioxide as the major pollutants. Because China is an important member of the world community, it has an important role in protecting the global environment.

1.1. China's deteriorating atmospheric environment

Human activities in China have seriously deteriorated its atmosphere. Air quality in cities (especially the largest ones) has degenerated markedly, with emissions of pollutants continually increasing and polluted areas continually expanding. The major pollutants are sulfur dioxide, NO_x, and aerosols. People see, smell, and taste the polluted air and their health has been affected as well. To avoid the occurrence of London-type smog, the tenth meeting of the third Environment Committee of the State Council decided to implement daily and weekly reports on air quality and to forecast air pollution in the major cities. In this way, the trend of air pollution can be monitored in real time. In addition, the work of prevention and control of the air pollution could pay more attention to threats to human health. This was an important measure for strengthening pollution protection and achieving environmental protection targets in China. At the end of 1998, Beijing's municipal administration began to take strict measures to address its serious air pollution.

Urban air quality is affected by many factors, including the natural environment, the structure of industry, construction, emissions, and environmental management. Variations in these factors can create large differences in pollution between cities. In 1997, the State Environmental Protection Administration (SEPA) began to organize weekly reports of air quality in some key cities. In May 1997, Nanjing first released its air pollution index (API) on television and in newspapers, and in February 1998, Beijing began to release its API to the China Environment Newspaper, the Beijing Youth Paper and the Beijing Evening Paper. By April 1998, weekly reports had been developed by 39 cities, 35 of which released them to national and local newspapers and periodicals. Six media now carry these weekly reports: newspapers, radio, television (including CATV), 168 information broadcasting stations, the Internet, and large screens in streets.

Statistical analysis of the weekly APIs for 26 cities shows that the average values in seven cities (27% of the total) are below 100, meaning that the air quality is good. The average values in another 9 cities (35%) are 100–200, meaning that the air quality is poor, and the average values for the remaining 10 cities (38%) exceed 200, which indicates significant pollution. The APIs also show that TSP (total suspended particulates) and sulfur dioxide, a sign of coal combustion, are excessive in many cities. TSP is the major pollutant in more than half of the 26 cities.

Concentrations of sulfur dioxide are seriously high in cities of the North-east because of heavy industry, and in the South-east because of high-sulfur coal. sulfur dioxide is the major pollutant in Guiyang, Chongqin, and Qingdao.

NO_x in cities comes mainly from vehicle exhausts. NO_X has become the major pollutant in cities such as Shanghai, Guangzhou, and Beijing. Throughout the period of statistical analysis, the major pollutant in Shanghai and Guangzhou was NO_x. In Beijing, soot and vehicle exhaust emission comprise more than half the pollution. Vehicle exhaust emission has become an important component of pollution in some developed coastal cities even though the total pollution is not great there.

The rate of increase of urban air pollution had begun to moderate by 1997. Annual-average sulfur dioxide ranged from 3 to 248 $\mu g/m^3$, with a national average of 66$\mu g/m^3$. Annual-average sulfur dioxide exceeded the Grade II national air-quality standard of 60 $\mu g/m^3$ in 52% of the northern cities and in 38% of the southern cities, whose average concentrations were 72 $\mu g/m^3$ and 60 $\mu g/m^3$, respectively. Annual-average NO_x ranged from 4 to 140 $\mu g/m^3$ and averaged 45 $\mu g/m^3$. Northern cities averaged 49 $\mu g/m^3$, southern cities 41 $\mu g/m^3$. More than 34 of the cities (36%) did not meet the Grade II standard of 50 $\mu g/m^3$. Annual TSP ranged from 32 to 741 $\mu g/m^3$ and averaged 291 $\mu g/m^3$. Sixty-seven cities (72.0%) did not meet the Grade II national standard of 200 $\mu g/m^3$. The average deposition of dust in the cities was 15.3 ton/km^2 per month, with averages of 21.5 and 9.3 ton/km^2 per month in northern and southern cities, respectively.

1.2 Trans-boundary transport and deposition of sulfur oxide

Pollutants released to the atmosphere will travel with the air and will ultimately be deposited to the surface by precipitation and various dry processes. During transport and deposition, chemical reactions may create secondary pollutants.

The major energy resource in China is coal. Burning fossil fuel releases much sulfur dioxide into the air, where it can react with other constituents to create secondary pollutants such as gaseous SO_3 and particulate H_2SO_4. With social-economic development, increasing population and demands for energy will inevitably increase the emission of acidic pollutants. This links acid rain closely to fossil fuels. China now has one of the largest areas affected by acid rain, and this has already harmed the economy in parts of China. Research over the past several years has indicated that the main cause of acid rain in China is coal burning. Controlling acid rain means controlling sulfur dioxide emission. Since the early 1980s, scholars have learned the spatiotemporal distribution of acid pollutants, and this is an important part of the program for controlling acid rain.

The area with precipitation of pH below 5.6 covers about 40% of China. The sulfate/nitrate ratio of 6.41 in Chinese acid rain indicates that it is caused mainly by sulfur dioxide emission, which must be reduced by reducing regional and industrial emissions. Because about 90% of China’s sulfur dioxide comes from burning coal, China needs to burn more clean coal, conserve energy, and adjust its municipal infrastructure if it is to reduce its sulfur dioxide. Currently, sulfur dioxide from the thermal power industry accounts for 35% of the total emission. This value will increase to 60% by the year 2010. Development of economic and technical policies will be an important incentive for controlling sulfur dioxide. The Chinese government has adopted some strict measures to greatly reduce the emission of sulfur dioxide.

In 1997, the average pH of precipitation ranged from 3.7 to 7.8 over China. Average pH values in 44 cities (48% of the cases) were below 5.6. In southern China, average pH values in 75% of the cities were below 5.6, and averages below 4.5 were found in Changsha, Zunyi, Hangzhou and Yibin. Overall, acid rain was found in 72% of the cities. In Changsha, Jingdezhen and Zunyi, more than 90% of the rain events were acidic. The pH value in the northern cities Tumen, Qingdao, and Taiyuan averaged below 5.6.

The acid rain problem was the most severe in Central China, where the average pH was below 5.0 and more than 70% of the rain events were acidic. Acid rain in the southwestern areas was also very serious. Average pH in the central districts of Chongqing was below 5.0, and 70% of the rain events were acidic. Most of southern China’s acid rain was found in the Pearl River Delta and central and eastern areas of Guangxi. In 1997, the average pH of precipitation was higher than that of the previous year, but the rain was acidic more often.

To study acid rain, Chinese scholars have developed Eulerian transport and deposition

models for acid pollutants. For example, Lei Xiaoen (1996) developed the Diagnosis and Projection Model for air pollutants in Chongqin. Gao Huiwang (1995) developed the time-changing model NUIAP. Li Zongkai (1995) developed a regional transport and deposition model for acid pollutants. Mao Jietai (1990) developed a statistical model for acid deposition in Guangdong and Guangxi provinces. Huang Meiyuan (1995) developed the practical acid deposition model IAP. An acid-deposition model with a stream field classification (1995) was developed in the Chinese Research Academy of Environmental Sciences.
In order to mitigate acid rain, the Chinese government adopted a series of control measures, such as clean-coal techniques, energy conservation, and desulfurizing techniques. The government also initiated economic policies, such as taxing emissions of sulfur dioxide, controlling the total amounts of emissions, and promoting energy conservation.

In order to limit the increase of acid rain, the State Council established "The Two Controlled Zones" (for acid rain and sulfur dioxide) as a national priority. By the year 2000, all industrial sources of sulfur dioxide in the two controlled zones had to meet state standards. Also, a program of Total Amount Control for sulfur dioxide emissions has been implemented. The State Council can also require that the concentration of sulfur dioxide in certain cities meet the national standards. By the year 2010, emissions of sulfur dioxide will be limited to levels of the year 2000. By that time, urban sulfur dioxide must also meet national standards, and the ranges of acid rain in the control zones would be reduced significantly from those of the year 2000.

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Biographical Sketches

Mingxing Wang is a professor at the Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS). His research interests include Sources and sinks of greenhouse gases, carbon cycle modeling and climate change due to the increase of greenhouse gases. Professor Wang has achieved many scientific research results in the fields of atmospheric aerosols, acid rain, and climate changes due to the increase of atmospheric trace gases, published more than 140 papers in Chinese and international journals, and given lots of presentations at international conferences. He is of great attainments in atmospheric sciences and is one of the well-known atmospheric chemists in China today. He has been teaching a degree course "Atmospheric Chemistry" at the Graduate School of the University of Science and Technology of China since 1985. Some of his publications are as fellows: