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Accounting of SO_2 emissions from combustion in industrial boilers

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Abstract

Combustion in industrial boilers has become a major source of acid rain pollution due to the huge emissions of SO_2. This study builds the accounting framework of SO_2 emissions from combustion in industrial boilers and set up a high resolution SO_2 emissions inventory of Beijing-Tianjin-Hebei region. We integrate the emission allocation methods in chemical species and space to calculate the total amount of SO_2 emissions. Based on the GAINS model, this study further allocated the total SO_2 emissions to each district of Beijing-Tianjin-Hebei region according to the quota of coal consumption of industrial boilers. Thus, a high resolution SO_2 emission inventory was set up to provide solid foundation for effective air quality management and mitigation strategies of Beijing-Tianjin-Hebei region.

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Keywords: Combustion in industrial boilers, SO2 emission inventory, Beijing-Tianjin-Hebei

1. INTRODUCTION

Industrial SO_2 pollution has a large effect on air quality in Beijing-Tianjin-Hebei region, accounting for 91.2% of total SO_2 emissions in 2013 [1,2]. Industrial boilers are the main source of industrial SO_2 emissions. There have been 624,000 units of industrial boilers in China since 2013, more than 80% of which are coal-fired boilers that consumed 490 million tons of standard coal per year [3].

SO_2 emission allocation in chemical species, time and space have been extensively studied [3, 4, 5, 6], Wang et al. [7] developed fine-resolution temporal (seasonal, day-of-week, diurnal) and vertical allocations specific to source categories and chemical species, and then evaluated their individual and combined effects on the East Asian air quality prediction. Also, air quality model GAINS based on industrial boilers emissions has been developed by IIASA, which divide the industry sectors according to

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industrial boiler characteristics [8]. Meanwhile, some researchers studied SO_2 emissions from combustion in industrial boilers [9, 10, 11, 12, 13]. Wilson et al. examined the historic SO_2 emissions from non-utility point sources in the western region. Their analysis focused on the sources with an SO_2 emissions change of 250 tons per year or more, between 1990 and 1998, which were investigated to determine the primary reasons for this emissions change [9]. Vallack et al. had set up top-down inventories of SO_2 emissions which compiled for 1995 for developing countries. They predicted Asian emissions would be particularly high with SO_2 emissions projected to increase a lot especially in China [10]. Garg et al. built Sub-regional and sector level distribution of SO_2 emissions inventories for India for all the 466 Indian districts using base data for years 1990 and 1995. The sectoral decomposition at district level includes emissions from fossil fuel combustion, non-energy emissions from industrial activities and agriculture [11]. Zhang et al. assessed regional differences in SO_2 emission control efficiencies in China through the modelling analysis of four scenarios of SO_2 emissions, of which four impact metrics were used to evaluate the efficiency of different scenarios of SO_2 emissions reduction to analyse how to realize its SO_2 emissions reduction target to maximize the resulting air quality benefits for China and downwind regions [3].

Accounting research for air pollution emissions from combustion of industrial boilers in China is still very few, and the comprehensive emissions inventory has not been established so far [14]. This paper aims to set up a SO_2 emission inventory for industrial boilers of Beijing-Tianjin-Hebei region. The time, spatial, and chemical allocation of industrial boilers emissions are integrated based on the emission allocation method. The emission accounting framework of combustion in industrial boilers is thereby built, based on which a high resolution SO_2 emission inventory of Beijing-Tianjin-Hebei region is presented according to the coal consumption data of industrial boilers.

2. METHODOLOGY

The standard method for chemical allocation of SO_2 is to measure the ratio of each matter in sulfur oxides released from industrial boilers by doing experiments [15]. In this paper, we integrate parameters of emission curve for Asian boilers and make chemical allocation for Beijing-Tianjin-Hebei region.

Spatial allocation can dispatch the total emissions to the district to build high accuracy and high resolution emission inventory [16]. This study allocated the total emissions to each district based on the coal consumption of industrial boilers. The quota of SO_2 emissions for districts is then determined by amount of coal consumption in industrial boilers.

Based on the chemical allocation and total amount of boilers, we calculate the city's total amount SO_2 emissions. Then, the total SO_2 emissions of 214 districts are dispatched to build SO_2 emission inventory based on the date of coal consumption of 6435 units of industrial boilers in Beijing-Tianjin-Hebei region. The high resolution emission distribution of five sectors is shown in Fig. 1.

Industrial boiler data are collected from Ministry of Environmental Protection of China. Some calculation coefficients are obtained from GAINS model [8].