A NEW ATHROPOGENIC EMISSION INVENTORY SYSTEM FOR ASIA IN SUPPORT OF ATMOSPHERIC MODELING

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1. INTRODUCTION

A regional inventory for Asia for the year 2000 was developed by *Streets et al*. [2003] and widely examined during and following the TRACE-P experiment. However, because of the dramatic economic growth in East Asia since 2000, that inventory no longer represents the level of present-day emissions in East Asia, especially for China. China's gross domestic product (GDP) increased ~10% annually and coal consumption increased ~15% annually during the past 5 years. Atmospheric emissions are also thought to have increased markedly from space-based observations [*Richter et al*., 2005]. In addition, some shortcomings in previous inventories were found, as a result of reanalysis of the inventories themselves and validation tests against forward and inverse modeling results and satellite retrievals. A true representation of trans-Pacific transport and the import of pollution into North America requires a revision of these emission estimates. A technology based, bottom-up methodology is developed to build a new anthropogenic emission inventory for Asia for the year 2006 in support of NASA's INTEX-B experiment.

2. METHODOLOGY

We are adopting a new strategy for this work, as follows: (a) use the TRACE-P inventory both as the foundation of the new dataset and as a default for work still in progress; (b) update China's emissions to the most recent year for which activity data are available, using an improved methodology documented in *Streets et al*. [2006] and *Zhang et al*. [2007a]; (c) incorporate the best available datasets for selected regions where national inventories exist and are thought to be more reliable than the TRACE-P inventory; (d) for other regions in Asia, extrapolate the TRACE-P estimates to the most recent year based on updated activity statistics; (e) extrapolate the emission estimates to the year 2006 based on growth factors; and (f) check for consistency among the different datasets, choose an appropriate level of precision for the final product, fill gaps with the TRACE-P inventory, and finally export the dataset for the whole of Asia in a uniform data format. So far, under item (c), we have built in the following datasets: the India inventory from Dr. Reddy, the Japan inventory from Dr. Kannari, the Republic of Korea inventory from Dr. Park, a Taiwan inventory from the Taiwan EPB, and a Far East Russia inventory from IIASA.

China is still the focus of our new Asia inventory. The general approach used to build China's new regional emission inventory is described in *Streets et al*. [2006] and *Zhang et al*. [2006, 2007a]. We have implemented a new technology-based methodology in order to be able to reflect the types of technology presently operating in China. We have also implemented an anthropogenic PM emission model to calculate primary PM emissions, including PM_{10} and $PM_{2.5}$, which the TRACE-P inventory did not address [*Zhang et al*., 2006, 2007b]. We are also in the process of adding mercury to the list of species covered [*Streets et al*., 2005]. Activity data are obtained from statistics published by a variety of government agencies. Fuel consumption by sector and by province is

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derived from the China Energy Statistical Yearbook. Technology distributions within each sector are obtained from a variety of Chinese technology reports, as well as an energy demand approach. Emission factors are mainly based on measurements in China or estimations based on the actual technology level and practice. In some cases, where local information is lacking, we use adjusted emission factors for similar activities from international databases.

3. RESULTS

We are currently releasing the first version of the modeling system through INTEX-B website. The components of this version are shown in Table 1. We finally extrapolate the inventory to the year 2006 and consolidate the different datasets to a uniform spatial resolution of 30 min × 30 min. As a sample, Figure 1 shows the updated gridded NO_x and $PM_{2.5}$ emissions over Asia for the year 2006.

We estimate total Asian anthropogenic emissions in the year 2006 as follows: 47.1 Tg SO_2, 36.7 Tg NO_x, 298.2 Tg CO, 54.6 Tg NMVOC, 29.2 Tg PM_{10}, 22.2 Tg $PM_{2.5}$, 2.97 Tg BC, and 6.57 Tg OC. Compared with TRACE-P inventory for the year 2000, the SO2, NOx. CO, NMVOC and BC emissions in Asia were increased by 43.4%, 61.8%, 41.1%, 35.7%, and 46.9% separately, while OC emissions were decreased by 6.6%. The emission changes between the two inventories reflect a combination of: (a) actual growth in emissions due to increasing economic development, (b) the effects of replacing the TRACE-P inventory by local inventories in several countries, and (c) improvements and corrections made to the original TRACE-P inventory. The changes should not be viewed solely as real emissions growth. The 2006 inventory values are considered to be a reasonable reflection of the absolute magnitude of emissions in that year, pending re-calculation with actual activity statistics when they become available.

China shows significant emission increases in the past several years. Based on the methodology described above, we have generated three years of estimates for China, 2001, 2003 and 2004, and projected the 2004 emissions to the year 2006. We calculate that anthropogenic emissions in China in 2004 were 28.3 Tg SO_2, 18.6 Tg NO_x, 158 Tg CO, 21.5 Tg VOC, 18.2 Tg PM_{10}, 13.3 Tg $PM_{2.5}$, 1.7 Tg BC, 3.2 Tg OC, and 696 Mg Hg. we also finished a new analysis of China's NOx emissions, including an emission trend analysis for 1995-2004 and a comparison with GOME and SCIAMACHY satellite retrieval trends [*Zhang et al.*, 2007a]. We found both the emission inventory data and the satellite observations indicate a continuous and accelerating growth rate between 1996 and 2004 over East Central China. However, the growth rate from the emission inventory is lower than that from the satellite observations.

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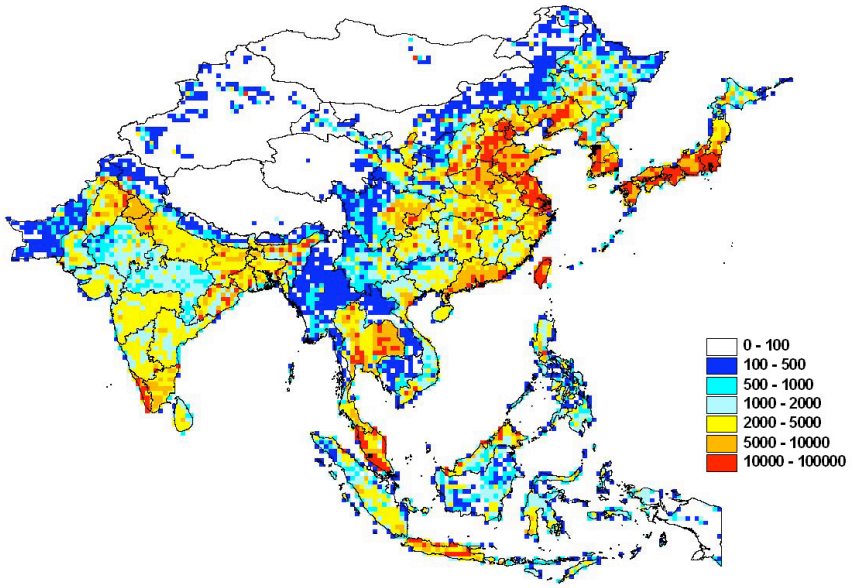
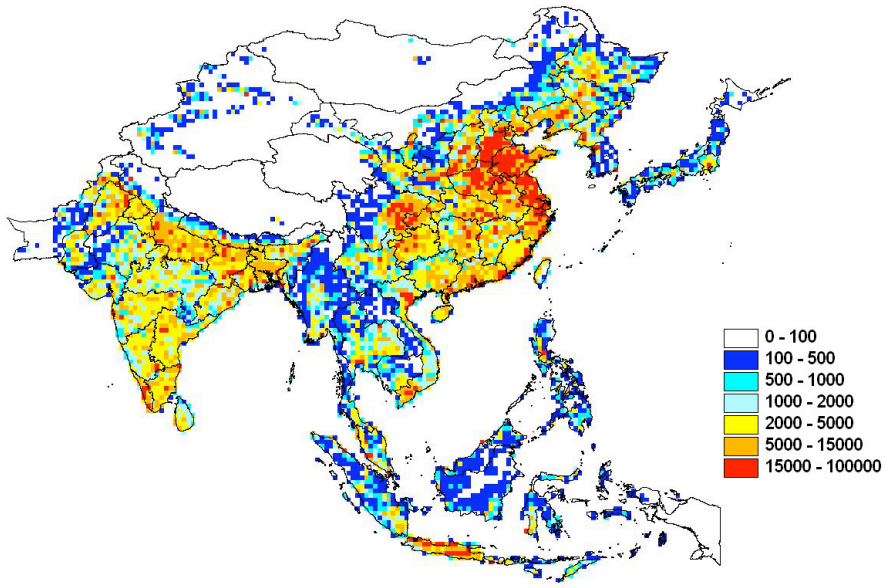


NOx



PM2.5

Fig. 1. Gridded emissions of NOx and PM2.5 at 0.5 degree resolution. Upper: NOx, lower: PM2.5. Unit: tons/yr per grid cell.

Table 1. Components of new Asian emission inventory

Region		China	Japan	South Korea	Taiwan	Far East Russia	Other Regions
Reference Year		2004	2000	2003	2003	2000	2004
Species	**SO_2**	1	2	2	2	2	3
	NO_x	1	2	2	2	2	3
	CO	1	2	2	2	2	3
	VOC	1	2	2	2	N/A	3
	PM_{10}	1	2	2	2	2	5
	$PM_{2.5}$	1	2	5	2	2	5
	BC	1	4	4	4	N/A	3
	OC	1	4	4	4	N/A	3
	NH_3	4	2	2	4	N/A	4
	Hg	1	N/A	N/A	N/A	N/A	N/A

1 = estimates made with the new methodology
2 = estimates incorporated from other datasets
3 = estimates extrapolated to the reference year from the TRACE-P inventory
4 = estimates use TRACE-P inventory values as a default for now
5 = rough estimates
N/A = estimates not presently available, but will be added later

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