# AN EMISSION INVENTORY IN JAPAN
# -COMPARISON WITH THE STANDARD EMISSIONS-

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## 1. Introduction

An emissions inventory in Japan region was submitted from Japanese research group(Team-J) for "Emissions Inventory Intercomparison Study" in MICS-Asia project. In this report, the outline of the inventory is introduced and the advanced comparison with the standard emission data provided to MICS-Asia is reported.

## 2. Outline of the emissions inventory

The emissions inventory in Japan region is a part of an East Asia gridded emissions inventory(EAGRID2000), which is revised from the previous EAGRID1995. Major differences from the previous version are as follows.

/Improvement of estimation method for road vehicle emissions: start emission and effects of climatic condition
/Addition of off-road vehicle emissions and emissions from field burning of agricultural residues
/Improvement of spatial resolution from 10km to 1km for whole Japan
/Improvement of temporal resolution to monthly and hourly emissions
/Consideration of the difference between weekday and weekend(road vehicle emission)

The other framworks of the inventory are same as the previous inventory. We chose the estimation method of a bottom-up approach as much as possible as follows.

a) Perfect Bottom up Approach :
Registered Stationary Sources (Comprehensive Survey on Air Pollutants Emissions by Ministry of Environment)
b) Bottom up Approach by Statistical Activity Data:
Road Transport, Navigation, Aviation
Biogenic VOC
c) Top down Approach:
Relatively small Commercial/Institutional facilities and domestic sources
Other combustion/non-combustion sources

(Note that the emissions from coastal shipping are not included in the new inventory except the emissions on inland sea.)

## 3.Results of comparison

### 3.1 National emissions

National annual emissions in Japan from EAGRID are compared with the standard emissions data in Table 1 and Fig. 1. The 95% confidence intervals of the standard emissions, except $PM_{10}$, are also shown cited from Streets et al.(2003). Good agreement is observed in case of $CO_2$ because the similar fundamental energy statistics in Japan were used. For other pollutants, good agreements are shown in NOx, $SO_2$ and NMVOC with less than 10% differences. Relatively large differences more than 10% are observed in case of CO, $PM_{10}$ and $NH_3$. EAGRID emissions are roughly in the 95% confidence intervals of the standard emissions; inversely, uncertainties of the standard emissions are well stated by the 95% confidence intervals if EAGRID estimates are correct.

Comparisons of sectoral emissions of $SO_2$, NOx, CO and $CO_2$ are presented in Fig.2. Differences in some sectors for some pollutants are large, e.g. $SO_2$ and CO in transport sector. These differences may come from the difference of the definition of category, therefore we do not discuss further.

**Table 1 Comparison of national emissions between "Standard emissions" and EAGRID-Japan**

Unit: Gg (Tg in CO2)

| | NOx | $SO_2$ | NMVOC | CO | $PM_{10}$ | $NH_3$ | $CO_2$ |
|---|---|---|---|---|---|---|---|
| A. EAGRID2000-Japan | 2,371 | 872 | 2,008 | 5,048 | 192 | 443 | 1,221 |
| B. Standard emissions, 2000 | 2,198 | 801 | 1,847 | 6,806 | 271 | 339 | 1,209 |
| with 95% confidence interval | ±0.19 | ±0.09 | ±0.35 | ±0.34 | - | ±0.29 | ±0.07 |
| A/B-1 | 0.08 | 0.09 | 0.09 | -0.26 | -0.29 | 0.31 | 0.01 |

*Standard emissions are sums of the grid data downloaded from the web site.The 95% confidence intervals are cited from Streets et al.(2003)

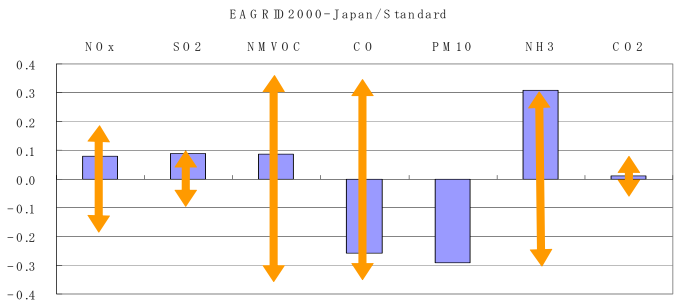


**Fig.1 Ratio of EAGRID-Japan to the standard emissions data(bar) and the 95% confidence intervals of the standard emissions(arrow)**

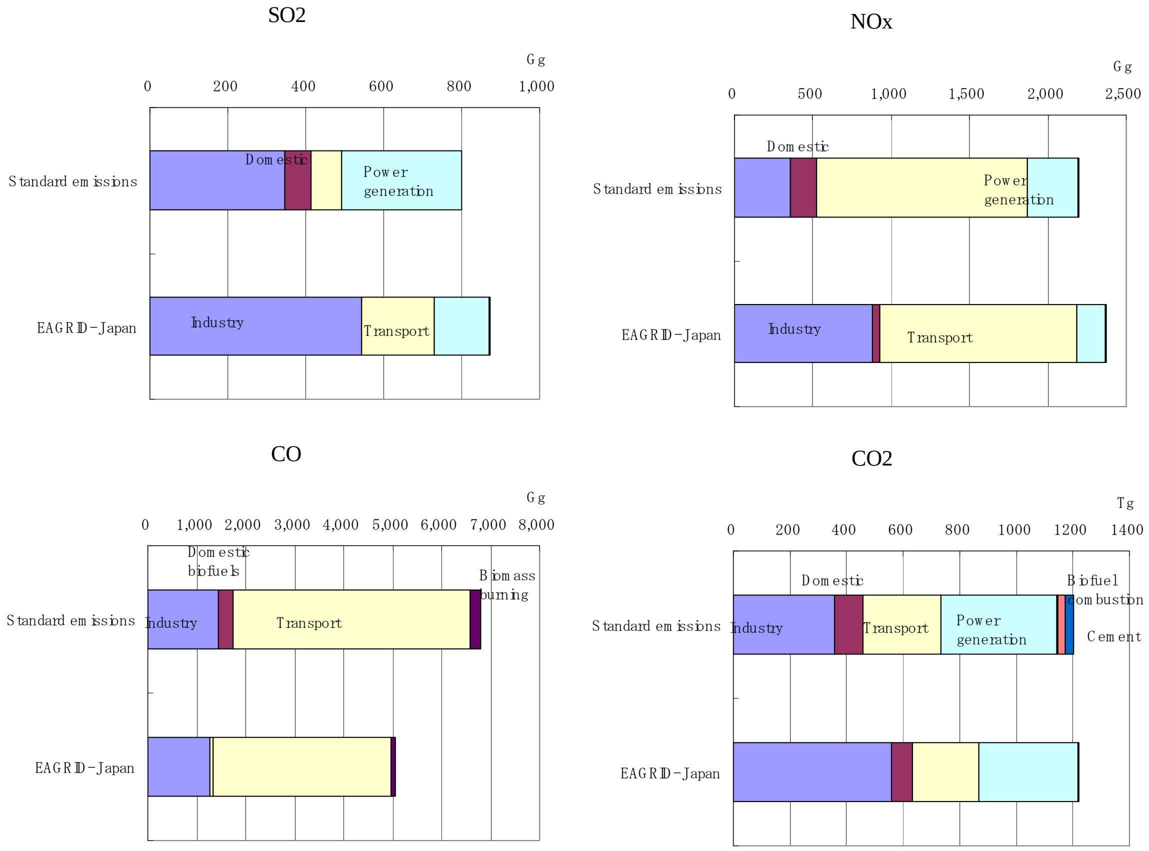


**Fig. 2 Comparisons of sectoral emissions of SO2, NOx, CO and CO2**

### 3.2 Spatial distribution

Grid cell emissions of EAGRID in Japan were estimated mainly from the reported point source emission records(70,000LPS), activity data with high spatial resolution(e.g. road traffic line sources by car type with an information of traveling speed) and surrogate indices(e.g. numbers of employee in specifical industries for allocation of specifical paint use) in 1 km grid of working scale. Therefore, we think that generally the distributions of EAGRID reflect more real conditions than the standard data. The comparisons of 0.5 degree x 0.5 degree grid emissions between the Standard and EAGRID for four pollutants are shown in Fig.3. In $SO_2$, there are some grid cells with large differences. The standard emissions may be overestimated in these grid cells, located in the megacities. LPS of $SO_2$, many of them are power plants or heavy industrial sites, are located at the fringe of megacities, so if the grid data are summarised to 1 x 1 degree grid cell, the standard emissions well correlate with EAGRID-Japan(from $r^2_{0.5}$=0.29 to $r^2_1$=0.64). On the other hand, for NMVOC and NOx, much of them are emitted from various small area sources, both estimates correlate well each other; the gridding scheme of the standard emissions seems to yield good results for these area sources. In case of $NH_3$, the numbers of domestic animals by village or town, cultivated land by grid and other closely related activity data used in EAGRID-Japan may be difficult to apply to all asian region; the correlation is improved also by up to 1 x 1 scale(from $r^2_{0.5}$=0.48 to $r^2_1$=0.64).

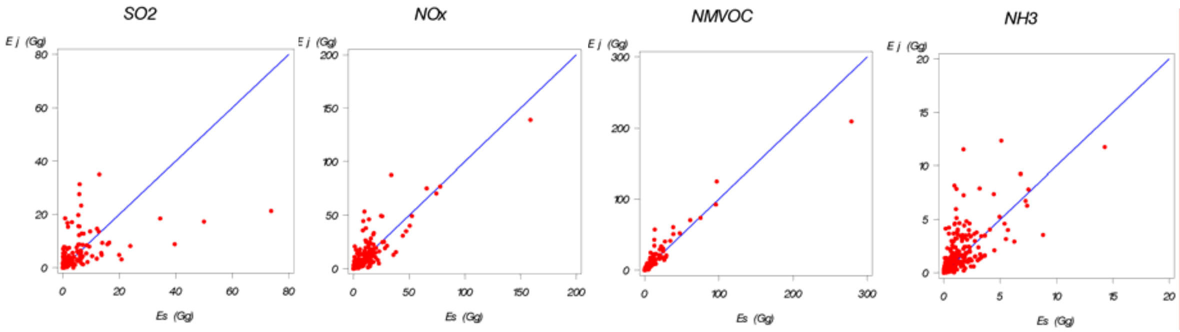


**Fig.3 Comparison of 0.5 degree x 0.5 degree annual grid emissions between the Standard emissions(Es) and EAGRID-Japan(Ej)**

### 3.3 Variation on time axis

Though the standard emissions include seasonal variation of domestic sources in China, uniform emission rate is assumed in other regions. EAGRID-Japan consists of the mean hourly emissions by month. The main causes of seasonal variations are activity variation(e.g. heat load, incineration of agricultural waste) and emission factor's variation(e.g. temperature dependence on internal combustion engines and evaporative emissions). Fig.4 shows the diurnal variations by month for four pollutants. Coefficients of variation(CV) on seasonal and diurnal variation are follows; $SO_2$ (seasonal 2%, diurnal 17%), NOx(6%, 32%), NMVOC(3%, 48%), $NH_3$(61%,56%). Consequently, mean emission rates in the model simulation period, Mar, Jul and Dec, are not so much different from the annual mean emission rates except $NH_3$ and CO as shown in Table 2.

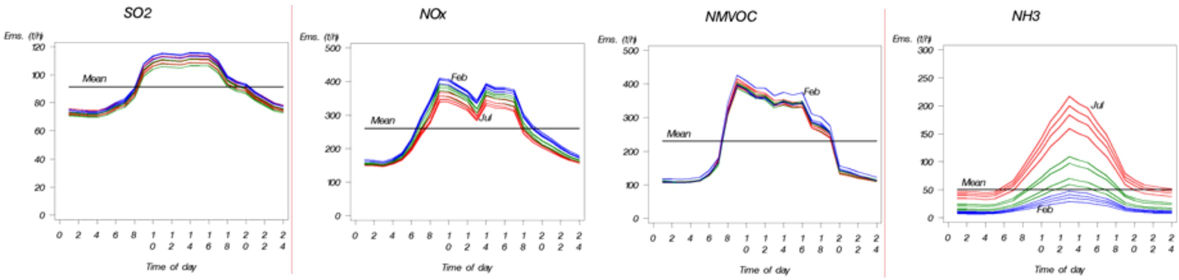


**Fig.4 Diurnal variation of emission rates by month(hourly emissions from whole Japan region)**

**Table 2. Ratio of monthly mean emission rate to annual mean emission rate in EAGRID**

| | Mar | Jul | Dec |
|---|---|---|---|
| SO2 | 1.01 | 1.00 | 1.03 |
| NOx | 1.07 | 0.92 | 1.06 |
| NMVOC | 0.99 | 0.97 | 1.00 |
| NH3 | 0.41 | 2.05 | 0.47 |
| CO | 1.12 | 0.82 | 1.14 |
| PM10 | 0.97 | 0.97 | 0.97 |

### 4. Summary

One of the emissions data in Japan, EAGRID2000 was compared to the standard emission dataset, and the following conclusions were obtained.

(1) National total amounts and those estimated uncertainty levels of the standard emissions are suggested to be appropriate from the intercomparison.
(2) Gridding methods applied to the standard emissions are also suggested appropriate in the case of composition from various small area sources.
(3) Unless non-linearity dominates in the atmospheric modes, the standard emission rates are appropriate to simulate monthly mean concentrations, however, diurnal variations are desirable to include the models for reproducing the atmospheric diurnal cycle.

### Reference

Streets D. G. et al.(2003), JGR, 108(D21),8809