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*Supplement of*

## **Comparison and evaluation of anthropogenic emissions of SO<sub>2</sub> and NO<sub>x</sub> over China**

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**Table S1. Spatial proxies used in the ECLIPSE and MIX emission inventories.**

| Sub-sectors                          | Spatial proxies   | Data source   |
|--------------------------------------|---|---|
| <b>ECLIPSE</b>                       |   |   |
| Power plants                         | Plant locations   | Google Earth (Liu et al., 2015)   |
| Industrial combustion <sup>a</sup>   | Total population, urban population, rural population            | Lamarque et al., 2010; Riahi et al., 2012                                   |
| Industrial processes <sup>a</sup>    | Urban population, industrial plants                             | Lamarque et al., 2010; Riahi et al., 2012                                   |
| Residential <sup>a</sup>             | Total population, urban population, rural population            | Lamarque et al., 2010; Riahi et al., 2012                                   |
| On-road transportation <sup>a</sup>  | Population, Road networks                                       | Lamarque et al., 2010; Riahi et al., 2012                                   |
| Off-road transportation <sup>a</sup> | Inland waterways, roads, railways, population, urban population | Lamarque et al., 2010; Riahi et al., 2012                                   |
| Waste <sup>a</sup>                   | Population, urban and rural population                          | Lamarque et al., 2010; Riahi et al., 2012                                   |
| Agriculture (fertilizer)             | Cropland area   | Potter et al., 2010   |
| Agriculture (livestock)              | Livestock map   | FAO, 2007   |
| <b>MIX<sup>b</sup></b>               |   |   |
| Power                                | Plant locations   | Google Earth (Liu et al., 2015)   |
| Industrial heating                   | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS <sup>e</sup> , LandScan <sup>f</sup> , urban/rural extents <sup>g</sup> |
| Residential heating                  | Urban population  | NBS, LandScan, urban/rural extents  |
| industrial boiler                    | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| Residential combustion (fossil fuel) | Urban population  | NBS, LandScan, urban/rural extents  |
| Residential combustion (biofuel)     | Rural population  | NBS, LandScan, urban/rural extents  |
| Iron and steel                       | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| Cement                               | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| Other industrial process             | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| On-road vehicles                     | Vehicle population <sup>c</sup> , road network <sup>d</sup>     | China Digital Road-network Map (Zheng et al., 2014)                         |
| motorcycles                          | Vehicle population <sup>c</sup> , road network <sup>d</sup>     | China Digital Road-network Map (Zheng et al., 2014)                         |
| Off-road (agriculture machinery)     | Machine power <sup>c</sup> , rural population <sup>d</sup>      | NBS, LandScan, urban/rural extents  |
| Off-road (construction)              | Total GDP <sup>c</sup> , urban population <sup>d</sup>          | NBS, LandScan, urban/rural extents  |
| off-road (others)                    | Total population  | NBS, LandScan   |
| Solvent use - industry               | Industrial GDP <sup>c</sup> , urban population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| Solvent use - residential            | Urban population  | NBS, LandScan, urban/rural extents  |
| Agriculture (fertilizer)             | Fertilizer use <sup>c</sup> , rural population <sup>d</sup>     | NBS, LandScan, urban/rural extents  |
| Agriculture (livestock)              | Meat consumption <sup>c</sup> , rural population <sup>d</sup>   | NBS, LandScan, urban/rural extents  |
| Waste                                | Total population  | NBS, LandScan   |

<sup>a</sup> Spatial proxies included were derived from the EDGAR emissions gridding manual,

[http://publications.jrc.ec.europa.eu/repository/bitstream/JRC78261/edgarv4\\_manual\\_i\\_gridding\\_pubsy\\_final.pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC78261/edgarv4_manual_i_gridding_pubsy_final.pdf)

<sup>b</sup> Derived from Li et al. (2017)

<sup>c</sup> Proxies used to distribute provincial emissions to county

<sup>d</sup> Proxies used to distribute county-level emissions to grids

<sup>e</sup> National Bureau of Statistics, <http://www.stats.gov.cn/tjsj/>

<sup>f</sup> LandScan Global Population database

<sup>g</sup> Urban / rural extents developed by Schneider et al. (2009)

**Table S2. Fuel distribution among sectors in ECLIPSE and MIX emission inventories, 2010**

| Inventories                 | ECLIPSE          | MIX  |
|-----------------------------|------------------|------|
| Coal <sup>a</sup> , Mt coal |                  |      |
| Power                       | 1743             | 1576 |
| Industry                    | 747              | 968  |
| Heating                     | n/a <sup>b</sup> | 259  |
| Residential                 | 301              | 222  |
| Coal sum                    | 2792             | 3025 |
| Gasoline, Mt gasoline       |                  |      |
| On-road                     | 71               | 69   |
| Diesel, Mt diesel           |                  |      |
| On-road                     | 72               | 92   |
| Off-road                    | 26               | 42   |
| Diesel sum                  | 98               | 134  |

<sup>a</sup> Including coal and derived coal (coke, briquettes)

<sup>b</sup> Coal consumptions for heating are distributed into “Power” and “Industry” sectors in ECLIPSE

**Table S3. Abbreviations of provinces of mainland, China**

| Abbreviation | Province       | Abbreviation | Province |
|--------------|----------------|--------------|----------|
| ANHU         | Anhui          | JIAX         | Jiangxi  |
| BEIJ         | Beijing        | JILN         | Jilin    |
| CHOQ         | Chongqing      | LIAO         | Liaoning |
| FUJN         | Fujian         | NINX         | Ningxia  |
| GANS         | Gansu          | QINH         | Qinghai  |
| GUAD         | Guangdong      | SHAA         | Shaanxi  |
| GUAX         | Guangxi        | SHDG         | Shandong |
| GUIZ         | Guizhou        | SHAH         | Shanghai |
| HAIN         | Hainan         | SHXI         | Shanxi   |
| HEBE         | Hebei          | SICH         | Sichuan  |
| HELJ         | Heilongjiang   | TIAJ         | Tianjin  |
| HENA         | Henan          | TIBT         | Tibet    |
| HUBE         | Hubei          | XINJ         | Xinjiang |
| HUNA         | Hunan          | YUNA         | Yunnan   |
| INMO         | Inner Mongolia | ZHEJ         | Zhejiang |
| JIAS         | Jiangsu        |              |          |

**Table S4. Description of model simulation cases and statistics of model performance of SO<sub>2</sub>, summer average in 2010.**

| Simulation cases | Emission estimates  | Spatial proxies     | R     | Slope | NMB (%) | RMSE (DU) |
|------------------|---------------------|---------------------|-------|-------|---------|-----------|
| ECL-case0        | EM-ECL <sup>a</sup> | SP-ECL <sup>b</sup> | 0.650 | 0.861 | -71.1   | 0.372     |
| ECL-case1        | EM-MIX <sup>c</sup> | SP-ECL              | 0.633 | 0.850 | -71.0   | 0.373     |
| ECL-case2        | EM-ECL              | SP-MIX <sup>d</sup> | 0.667 | 0.842 | -69.9   | 0.363     |
| MIX              | EM-MIX              | SP-MIX              | 0.643 | 0.863 | -69.8   | 0.367     |

<sup>a</sup> ECLIPSE emission estimates by sectors in China

<sup>b</sup> Spatial proxies by sectors based on ECLIPSE

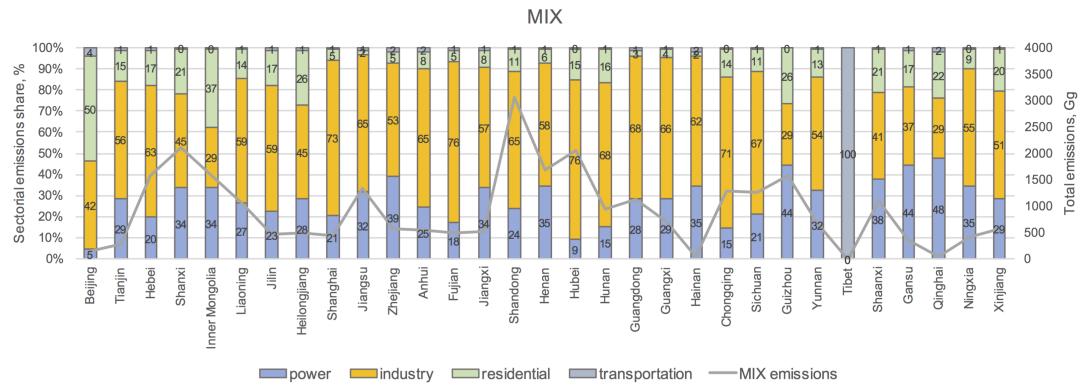
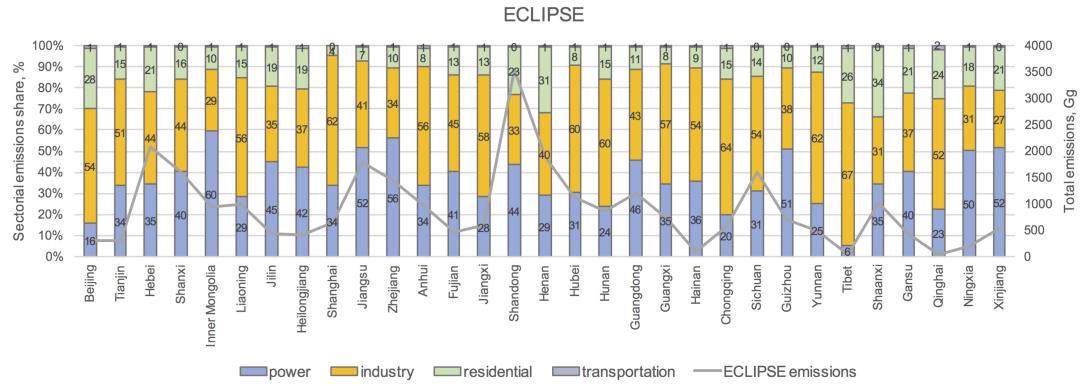
<sup>c</sup> MIX emission estimates by sectors in China

<sup>d</sup> Spatial proxies by sectors based on MIX

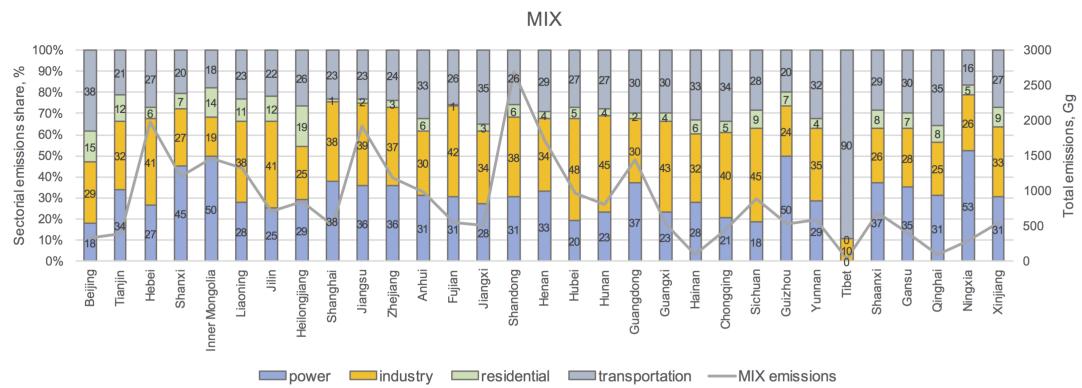
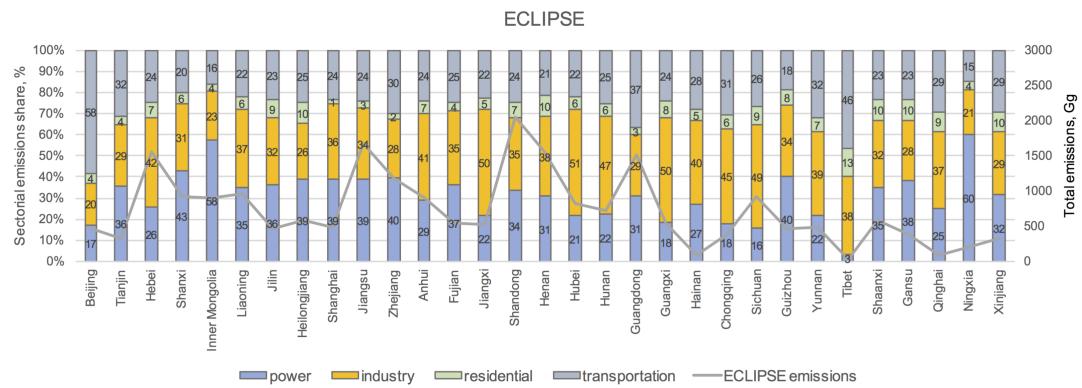
**Table S5. Top-down SO<sub>2</sub> emission evaluations over China <sup>a</sup>.**

| Inventories                   | ECLIPSE | MIX   |       |
|-------------------------------|---------|-------|-------|
| Year                          | 2005    | 2010  | 2005  |
| Bottom-up emissions (kmole/s) | 14.6    | 12.2  | 14.9  |
| Top-down emissions (kmole/s)  | 25.6    | 24.9  | 21.2  |
| R                             | 0.773   | 0.722 | 0.896 |
| Slope                         | 0.615   | 0.539 | 0.923 |
| NMB (%)                       | -42.9   | -51.0 | -29.1 |
| RMSE (mole/s)                 | 11.8    | 10.5  | 8.29  |
|                               |         |       | 8.80  |

<sup>a</sup> Only contain grids that covered by OMI pixels filtered by criterion described in the text

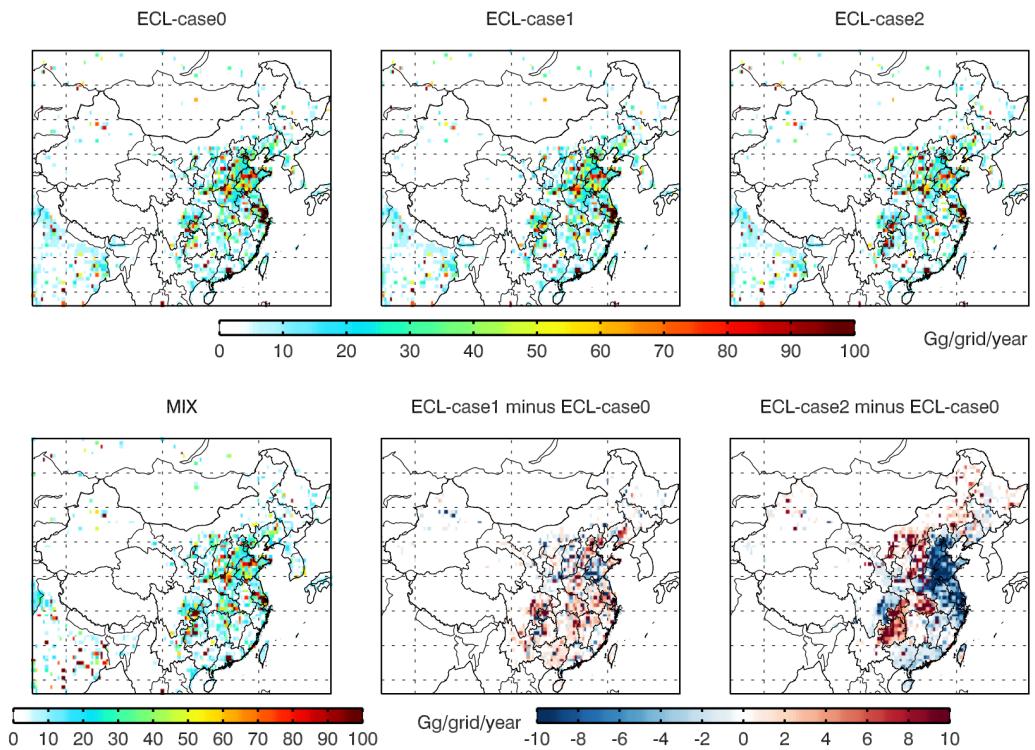


(a)  $\text{SO}_2$

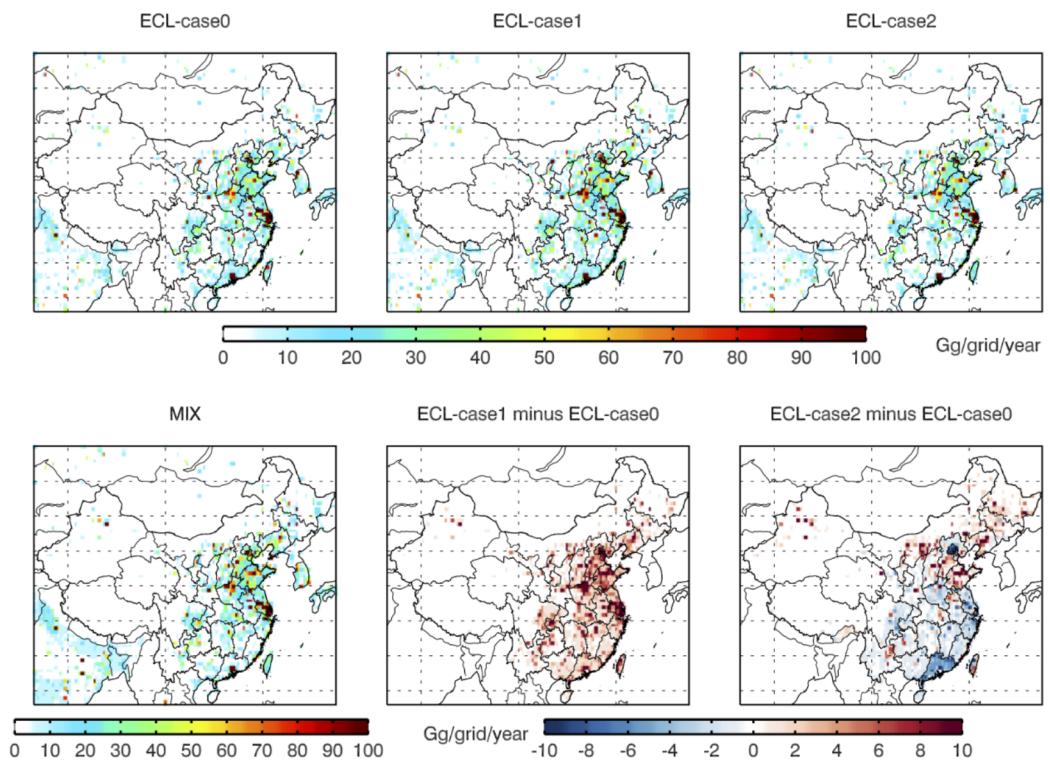


(b)  $\text{NO}_x$

Figure S1. Sectorial distribution by provinces in ECLIPSE and MIX, 2010.



(a)  $\text{SO}_2$



(b)  $\text{NO}_x$

**Figure S2. Emissions by sensitivity cases in 2010.**

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