"HTAP_v2: a mosaic of regional and global emission gridmaps for 2008 and 2010 to study hemispheric transport of air pollution" by G. Janssens-Maenhout et al., ACPD 15, C2857–C2864, 2015

The authors are grateful to Referee #1 for the interest and comments on the paper. We tried to improve the paper as requested with more details and data.

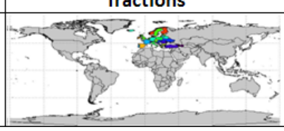
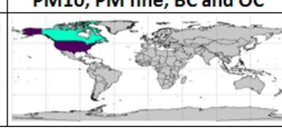
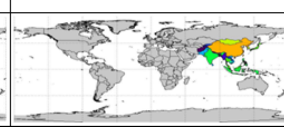
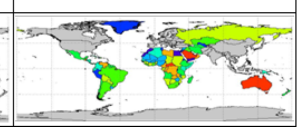
The modifications in reply to the comments of referee # 1 are highlighted "yellow" and "blue" in the paper.

Specific Comments

Page 12871, Line 17: We added to the paper – as suggested - that "The Lamarque et al. (2010) data used a similar methodology of combining country level inventories for most OECD countries with research inventories for Asia and EDGAR for other regions."

Section 2, general
We added the following overview table specifying the general source and characteristics for the data in each world region.

Table 1a: Overview of the data sources and their generic characteristics, as used for the different regions in HTAP_v2.2

Data source	**EMEP - TNO (MACCII)**	**US EPA + Environ Can**	**MIX-ASIA (incl REAS2.1)**	**EDGARv4.3 (prelim.)**
type of data source	country inventories + point sources	state inventories + point sources	county inventory for China + country inventories	country inventories
coverage of human activities	all except international shipping/aviation	all except international shipping/aviation	all, except international shipping/aviation and except agricultural waste burning	all inclusive international shipping/aviation
temporal resolution	yearly gridmaps (monthly profiles of EMEP model added)	monthly profiles	monthly gridmaps	monthly profiles (for 3 different lattitude bands
spatial resolution	0.125deg x 0.0625deg, after raster resampling 1/5 x 1/5 and aggregation of 4 x 8 converted into 0.1deg x 0.1deg	0.1deg x 0.1deg and height profiles	0.25deg x 0.25deg, after raster resampling 1/5 x 1/5 and aggregation of 2 x 2 converted into 0.1 deg x 0.1 deg	0.1deg x 0.1deg
substances	CO, NMVOC, NOx, SO2, NH3, PM coarse and fine and BC/OC fractions	CO, NMVOC with speciation profiles, NOx, SO2, NH3, PM10, PM fine, BC and OC	CO, NMVOC, NOx, SO2, NH3, PMcoarse, PM2.5, BC and OC	CO, NMVOC, NOx, SO2, NH3, PM10, PM2.5, BC and OC
in HTAPv2.2 used geo-coverage				

We added the explanation on the re-gridding procedure with special attention to the cells that cover borders between countries at the end of paragraph 2.2.5.
"This replacement took place after the gridmaps were converted into 0.1° x 0.1° using a raster resampling procedure. For EMEP-TNO the resampling implied a 25-fold division to 0.0025°x0.0125° followed by an aggregation of 4x8 gridcells. For the MICS-Asia the resampling needed also a 25th fold division to 0.05°x0.05° followed by an aggregation of

2x2 gridcells. The cells including country borders are split up and allocated to the different countries using the corresponding areal percentage."

We added – as requested – an additional section 2.3 on the temporal profiles supplementary, in which a comparison has become apparent with Fig. 1c.

Page 12876, section 2.2.1: The authors agree that it is important to detail where lack of data caused not actual but extrapolated data. Even though the 2008 and 2010 are mostly actual data for all data source, unavailability of data lead to few exceptions, which we more explicitly mentioned in the paper:

- "The 2010 data for Canada were missing and as such extrapolated by US EPA based on the 2008 National Emission Inventory of Environment Canada and assuming no trend but using updated point sources (Pouliot et al., 2014)."
- "The EMEP-TNO data were only available for 2006 and 2009. The 2008 data for Europe is based on the EMEP-TNO data for 2009 data and the 2010 data for Europe are based on the same 2009 data but using the trend in EMEP-TNO data between 2006 and 2009."

The trends between 2008 and 2010 in emissions and in the driving activity data are so small that no significant impact on the implied emission factors is observed.

Page 12877, Line 10: The authors edited the line as suggested. "EMEP-TNO data for country with only partial coverage …"

Page 12878, Line 6: The EMEP modeling group provided "the monthly profiles, which are with a monthly factor (varying around 1/12) specified for each country and for each sector, with a further compound-specific modulation for the agricultural sector". This has been added in the text.

Page 12880, Line 6: The paper Balsama et al. (2014) is indeed not describing the EDGARv4.3 gapfilling for HTAP_v2.2 but analysed the EDGARv4.3 preliminary dataset of EDGAR and its trends. This analysis was useful to identify similarities in the behavior of certain substances and supported the underlying methodology for deriving implied emission factors. The authors agree that it is not here at its correct place (shifted to section 3.6.)

Page 12880, Line 19: We added "EDGAR provides also sector-specific monthly profiles, defined with first-order estimated factors for each of the three different zones: Northern Hemisphere, Equatorial region and Southern Hemisphere (Table S1.2)."

A comparison of the monthly profiles is added in a new section 2.3:

2.3 Overview of the temporal profiles used in HTAP_v2.2

The modulation of annual emissions over time is necessary in order to provide the modelers emission data consistent with the seasonal pattern and activities. Monthly data were generated for all sectors except for the international shipping and international aviation, which are considered constant over the year. US-EPA, EMEP and EDGAR

provided monthly profiles, but MICS-Asia provided directly and solely monthly emission gridmaps.
Figure 1c summarizes the sector-specific monthly profiles for each of the regional datasets. The temporal profiles are additive and specified with monthly factors modulating around 1/12 for each of the sectors. For the agricultural sector, EMEP provided compound-specific monthly factors, which are characterized by high NMVOC emission in spring and high CO emission in autumn. Agriculture (largely contributing to NH3 emissions) shows most seasonal variation, which differs also most between the different regions because of region-specific management practices (for e.g. crop cultivation), climate and geographical location and soil composition. The residential sector is characterized by a monthly distribution which is inversely related with the temperature and therefore with the use of heating systems, and in some developed countries with air conditioning (which is boosting emissions in some developed countries during hot summers). The seasonality remains relatively modest in all regions for the transport, industry and energy sectors.
The strongest variation over the year and between regions is observed for the agricultural sector (+215% in the EMEP-TNO profiles but only +45% in the MICS-Asia profiles), followed by the residential sector ([+70%, -75%] in the EMEP-TNO profiles, [+20%, -25%] in the US EPA profiles and [+115%, -40%] in the MICS-Asia profiles).

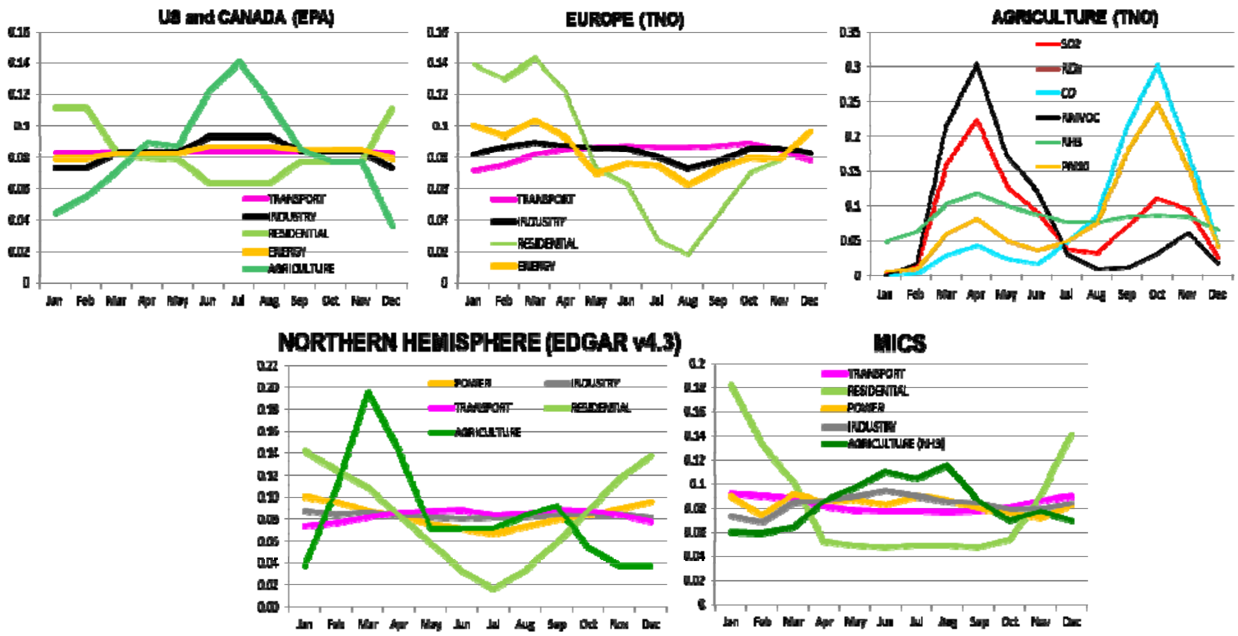


Figure 1c – Temporal profiles with relative factors varying around 1/12 and applied on the yearly emissions of the different data sources (US EPA for US and Canada, EMEP-TNO for Europe with compound-specific variation of the agricultural temporal profiles, EDGAR temporal profiles for the Northern hemisphere and MICS profiles for Asia).

Section 3.1:

Page 12882, Line 20: We reformulated as follows: “The Asian region is still characterized by a relative large contribution of SO2 from (coal fired) power plants and manufacturing industry.”

Page 12883, Line 3: The authors compared the International shipping emissions with the bottom-up and top-down estimated emissions reported in the "Third IMO GHG Study 2014" in Table 2a. We note that an agreement between the data of HTAP (EDGAR based), and IMO (both top down and bottom up estimates) is obtained for all compounds within 30% except for CO. The CO emission factor showed also in other inventories high uncertainty: the IMO (2009) used a more than twice as high emission factor than the new IMO study (2014). EDGAR shows a 55% and 70% higher estimate for the 2008 and 2010 than the bottom-up values of the IMO (2014) study, which on his turn is 55% respectively 33% higher than the 2008 and 2010 top down estimates of the IMO(2014) study. These observations and the IMO (2014) and IMO (2009) references are taken up in the main text of the paper.

Table 2a: Comparison of the international shipping emissions: IMO Bottom up (BU) and IMO Top Down (TD) emissions of the IMO(2014) study and the EDGAR emissions of the HTAP_v2.2 (2015) study.

kton /yr	BC	CO	NMVOC	NOx	OC	PM10	PM2.5	SO2
EDGAR 2008	34	1340	730	13762	458	1376	1376	8348
IMO BU 2008		864	727	20759		1545	1545	11041
IMO TD 2008		553	615	18442		1221	1221	8280
EDGAR 2010	33	1300	720	14000	430	1400	1400	8300
IMO BU 2010		763	593	16708		1332	1332	9895
IMO TD 2010		574	638	19098		1304	1304	9232

Section 3.2:
Pages 12886 – 12887: The authors consulted several trade databases to provide a quantitative indication of the consumption versus production-based emission inventories for sector 4_industry. With the World Input-Output Database, Boitier (2012) compared the production-based CO2 inventory with the consumption-based one and concluded a 14% higher emissions for OECD countries in 2008 (and even 23% for EU27) under the consumption-based approach and a 22% lower emissions for the BRIC countries (20% for China). This range (20% for Germany and 10% for USA whereas -10% for Brasil) matches also with the Global Trade Analysis data of Davis et al (2011). This affects the production-based inventory of air pollutants from the industry sector in a similar way, but probably more than linearly. For the air pollutants there is in addition a considerably lower emission factor of the industry in OECD countries than in developing countries because of an unequal implementation of end-of-pipe measures. Therefore the authors propose the following addition in the paper: “The importance of this consumption- versus production-based approach can be expected in 2008 (and also 2010) to be at least but probably even larger than what Boitier (2012) and Davis et al. (2011) amongst others reported for CO2. A consumption-based approach would yield at least 10% higher emissions for industrialised countries whereas 10% lower emissions for developing countries with emerging economy.”

Page 12887: Lines 3-4: Referee #1 points to a substantial difference between the per capita emissions of SO_2 of about 20%. This is indeed worth investigating. We downloaded the EUROSTAT data again and recalculated the per capita emissions. The 11.5 kg SO_2/cap of Eurostat is valid for 2008 and not for 2010. The 2010 value of EuroSTAT is 8.9 kg SO_2/cap, which is very close to our estimate of 9.1 kg SO_2/capita – the 0.2 difference can be due to different years of download (as different reporting years cause small fluctuations) as well as gapfilling by TNO for countries with incomplete time series, but is less than the range we get from using different reporting years. The large decrease of more than 2kg SO_2/cap between 2008 and 2010 is due to the large emission reduction in the (for some countries coal based) power industry (-26%) and a bit in industrial process industry (-16%).
The authors modified the sentence in the paper accordingly as: "For SO_2 the per capita emission in 2010 for EU-28 of 9.1 kg SO_2/cap is very close to the reported value of 8.9 kg SO_2/cap from EuroSTAT (2014) - the 0.2 difference is much less than the 20% higher per capita SO_2 emission in 2008 (11.5 kg SO_2/cap). EU's 9.1 kg SO_2/cap is about half the SO_2 per capita for China in 2010 and about one third of the SO_2 per capita for USA."

Section 3.3:
Page 12888, Line 15 and following: We reformulated the two sentences as follows: "The GDP is subject to heterogeneity (by the different economic activities), to heteroskedasticity (by the time-dependent inflation and currency exchange rates) and to incompleteness (by the not officially reported activities). It is not recommended to use this per unit of GDP emissions indicator for relative small countries with a substantial service sector (e.g. Luxembourg).

Section 3.4
The authors agreed to provide more details on the calculation of the implied emission factors. In fact, the lack of activity data for all data sources, except for EDGAR induced the following approximation of calculating the denominator of the formula with solely EDGAR activity data for that country and sector while accounting in the numerator the country- and sector-specific emissions as given by the original data source. Moreover the common HTAP sectors aggregated subsectors which are based on activity data with different units. This is mainly the case for the sector 4_Industry which accounts the combustion emissions (/TJ) and the process emissions (/ton product). With a commonly dominating energy-intensive industry (and a ratio of combustion over process emissions larger than 1), we opted to weigh the industry emissions with the energy needs (and as such partially skewed up the implied emission factor). But also the agricultural sector is skewed up, since we opted to weigh the total emissions of crop cultivation and of livestock with the number of animals elevated (mainly because 85% of the crops is used as animal food). We propose to clarify this in the text by clearly working out the formula for each of the sectors (indicating the use of EDGAR activity for all implied emission factors) and warning for a skewed up implied emission factor. We therefore replaced the single formula with the following:

$$EF_{C,3\_energy}(t,x) = \frac{\left.\sum_{subsector\ j} EM_{C,3\_energy,j}(t,x)\right|_{datasource\ of\ C}}{\left.\sum_{subsector\ j} AD_{C,3\_energy,j}(t)\right|_{EDGARv\ 4.3}} \quad [kton/TJ] \quad (1)$$

$$EF_{C,4\_ind.}(t,x) = \frac{\left.\left[\sum_{comb.\ subsector\ j} EM_{C,4\_ind.,j}(t,x) + \sum_{proc.subsector\ k} EM_{C,4\_ind.,k}(t,x)\right]\right|_{datasource\ of\ C}}{\left.\sum_{comb.\ subsector\ j} AD_{C,4\_ind.,j}(t)\right|_{EDGARv4.3}} \quad [kton/TJ] \quad (2)$$

$$EF_{C,5\_ransport}(t,x) = \frac{\left.\sum_{subsector\ j} EM_{C,5\_transport,j}(t,x)\right|_{datasource\ of\ C}}{\left.\sum_{subsector\ j} AD_{C,5\_transport,j}(t)\right|_{EDGARv\ 4.3}} \quad [kton/TJ] \quad (3)$$

$$EF_{C,6\_res.}(t,x) = \frac{\left.\left[\sum_{comb.\ subsector\ j} EM_{C,6\_res.,j}(t,x) + \sum_{waste\ prod.\ subsector\ k} EM_{C,6\_res.,k}(t,x)\right]\right|_{datasource\ of\ C}}{\left.\sum_{comb.\ subsector\ j} AD_{C,6\_res.,j}(t)\right|_{EDGARv4.3}} \quad [kton/TJ] \quad (4)$$

$$EF_{C,8\_agr.}(t,x) = \frac{\left.\left[\sum_{animal\ subsector\ j} EM_{C,8\_agr.,j}(t,x) + \sum_{crop\ subsector\ k} EM_{C,8\_agr.,k}(t,x)\right]\right|_{datasource\ of\ C}}{\left.\sum_{animal\ subsector\ j} AD_{C,8\_agr.,j}(t)\right|_{EDGARv4.3}} \quad [ton/head] \quad (5)$$

And we added in the main text (and in a footnote in the implied emission factors table): "It should be noted that the implied emission factors of sectors 4_industry, 6_residential and 8_agriculture are slightly skewed up because of an incomplete accounting of activity data which are for these sectors a combination of activities of different nature and as such expressed with different units. The emissions of sector 4_industry mainly originate from the energy-intensive subsectors and therefore are weighed with the energy needs (in TJ). We omitted the accounting of industrial process emissions, which are calculated per kton product manufactured. In sector 6_residential the waste is included, although calculated per kton dry or wet waste, which we could not combine with the residential energy consumption in TJ. The emissions of the 8_agricultural sector are weighed with the number of animals and not with the kton crops cultivated, because the crops serve for 85% as animal food and are therefore considered a justified measure of agricultural activity."

Results of implied emission factors in figure 4:

The authors recognized that statistics with small numbers are unreliable. Therefore the calculation of robust implied emission factor calculations was only carried out for larger countries with activities in all sectors. As such we left out the following countries:

For CO:

- for the htap_4_INDUSTRY sector: Togo, Eritrea, Congo, Côte d'Ivoire, Kenya, Benin.
- for the htap_6_RESIDENTIAL sector: Maldives.
- for the htap_5_TRANSPORT sector: North-Korea, Afghanistan, Laos, Tajikistan, Mongolia.

For SO2:

- for the htap_4_INDUSTRY sector: Namibia, Laos, Jamaica.

For NOx:

- for the htap_6_RESIDENTIAL sector: Maldives.
- for the htap_5_TRANSPORT sector: Afghanistan, Laos, North-Korea, Tajikistan.

For NMVOC:

- for the htap_3_ENERGY sector: Bhutan.
- for the htap_4_INDUSTRY sector: Togo, Eritrea, Côte d'Ivoire, Congo, Cameroon, Kenya, Benin, Aruba, Antigua, Bahamas, Ethiopia, Sudan, Senegal, Equatorial Guinea, Central African Rep., Sri Lanka, Angola, Mozambique, Zambia, Jamaica.
- for the htap_6_RESIDENTIAL sector: Am. Samoa, Gum, Maldives, Tonga.
- for the htap_5_TRANSPORT sector: Afghanistan, Laos, North-Korea.

For PM10:

- for the htap_4_INDUSTRY sector: Togo, Eritrea, Côte d'Ivoir, Congo, Kenya, Benin.
- for the htap_5_TRANSPORT sector: Afghanistan.

For PM2.5:

- for the htap_3_ENERGY sector: Tajikistan, Luxembourg.
- for the htap_4_INDUSTRY sector: Togo and Eritrea.
- for the htap_5_TRANSPORT sector: Afghanistan.

For BC:

- for the htap_3_ENERGY sector: Nigeria, Malaysia, Belgium, Oman, Finland, Georgia, Vietnam, Canada, Armenia, Tunisia, Jordan, The Netherlands, Trinidad and Tobago, Algeria, Latvia, United Arab Emirates, Brunei, Turkmenistan, Japan, Mozambique, Congo, Qatar, Bahrain, Moldova, Kyrgyzstan, South-Korea, Taiwan, Luxembourg, Bhutan, Tajikistan.
- for the htap_4_INDUSTRY sector: Trinidad and Tobago, Malta.
- for the htap_5_TRANSPORT sector: Afghanistan.

For OC:

- for the htap_3_ENERGY sector: Tunisia, Jordan, Trinidad and Tobago, Algeria, United Arab Emirates, Brunei, Turkmenistan, Tajikistan, Mozambique, Congo, Qatar, Bahrain, Kyrgyzstan, Taiwan, Myanmar, South-Korea, Vietnam.
- for the htap_4_INDUSTRY sector: Bahrain, Eritrea.
- for the htap_6_RESIDENTIAL sector: Greenland, Gibraltar, Faroe Islands, Saint Pierre et Miquelon

- for the htap_5_TRANSPORT sector: Afghanistan

For NH3:

- for the htap_8_AGRICULTURE sector: Faroe Islands, Tajikistan, Greenland, Falkland Islands, Kyrgyzstan, South-Korea, Brunei, Am. Samoa, Malaysia, Trinidad and Tobago, Bahamas, Saint Pierre et Miquelon, Sri Lanka, Suriname, Réunion, Thailand, Indonesia, Japan, Barbados, Bhutan, Guyana, Costa Rica

The authors propose to mention this list of countries in a footnote on Figure 4.

Page 12889, Line 13-15: We reformulated the text as follows: "It should be noted that emissions, in particularly those reported under country-specific point sources, are allocated to the reporting country solely, also for cells covering country borders. The areal fraction of these cells would incorrectly spread the emissions also to the neighboring country, which yield in the case of e.g. the power emissions for Canada up to 30% increase with the USA emissions along its borders."

Page 12890, Line 13-14: We reformulated the sentence as: "The high SO_2 implied emission factor (from EDGARv4.3) represents the use of lower quality fuels in sea transportation, especially in international waters: 85% of the sea bunker fuel in 2010 consists of residual fuel oil with an emission factor of 1.29 ton SO2 /TJ."

Section 3.5

The authors agree that the section should start mentioning where extrapolation in time has been undertaken. This was only done for Canada (US-EPA/Environ Canada) and for Europe (TNO-EMEP). Both regions were affected by the economic crisis of 2008, yielding stagnation and even downwards trends in the following years, mainly in the energy and industry sectors. The latter sectors are constructed for a large share by point source data, which were updated with the real estimates for 2010. As such, the emission gridmaps of 2010 are considered to represent also for Canada and Europe the actual 2010 estimates reasonably well. However every change for each country is not only caused by the change in activity but also and even more by the change in emission factor or implementation of end-of-pipe measures, which were occurring in some developing countries and caused relative large differences.

We propose to add in the beginning of section 3.5 (after the first sentence) the following paragraph: "It should be noted that the data provided for Canada by US-EPA/Environment Canada and for Europe by TNO were actually not representing 2010, but 2008 and 2009, respectively. However updates were undertaken: point source data of 2010 were used and implemented in the gridmaps. Both regions were affected by the economic crisis of 2008, yielding stagnation and even downwards trends in the following years, mainly in the energy and industry sectors. The latter sectors are primarily composed of point sources and as such the gridmaps of 2010 can be considered to represent also for Canada and Europe the actual 2010 situation."

We also reformulated the second last sentence after having (re) verified the increasing coal use: "For the developing countries (calculated with the EDGARv4.3 data and based on the IEA (2013) fuel statistics), the SO2 emissions of the energy sector slightly increase from 2008 to 2010 because of the increased coal use mainly in South-East Asia (as also observed by Weng et al., 2012) and the increased use of heavy fuel oil in the Middle East."

Section 3.6

By compiling the dataset with different data sources, it became apparent that at the borders of different datasets, large inconsistencies occur. As an example: the TNO-EMEP and MIX-Asia datasets cover respectively the European and the Asian part of Russia, but were showing ground transport emission differences of one order of magnitude. Even though both emission datasets are compiling a bottom-up inventory with similar methodology, different assumptions on emission factors and end-of-pipe measures can explain this. Therefore we opted to have single countries represented by the same dataset. However, each of the datasets used, calculates the emissions at country or county/province level and makes assumptions at this subregional level, which on its turn can lead to inconsistencies at the borders of each country/county/province.
This is clarified in the paper by modifying the introduction of section 3.6 as follows: "Even though the HTAP_v2.2 data sources are all bottom-up constructed inventories, they differ considerably in e.g. the assumptions taken on the modelling of technology and end-or-pipe measures and use different emission factors and quite different, and lead to inconsistencies at the borders between two adjacent inventories. On their turn the different bottom-up inventories are constructed with sub-regional (country, state, county or province level) activity data and emission factors. As such, inconsistencies can be expected at each country border and the variation of the emissions at cross-border cells gives already a first indication on the region- and sector-specific emission uncertainty.

Table 3

Even though the HTAP_v2.2 mosaic of final emission gridmap products does not allow for a full quantification of the error propagation, the authors agree that more information on the uncertainties can be provided in the main text of the paper. All data sources follow a similar methodology and face similar sources of uncertainty, which resemble the situation of the UNFCCC's CRF dataset of national inventories. Evaluation of their uncertainties by deterministic error propagation calculations or probabilistic Monte Carlo simulations has been addressed by e.g. Jonas et al (2010) (and references in there) and provides input on an uncertainty analysis of a bottom-up inventory per sector and per region. The GHG inventories are tackling with CO2 the combustion sectors, with CH4 also the agricultural (livestock and crops) and waste sectors and with N2O the industrial processes and agricultural sectors. The analysis for greenhouse gases is only a starting point, because for the air pollutants the emission factors strongly depend on the technology and end-of-pipe measures. Balsama et al. (2014) evaluated common behaviours between several species in the EDGARv4.2 data and observed that SO2 and NOx belong to the same cluster as CO2 (all strongly combustion related) and NH3 belongs to the same cluster as N2O.
The approach for assessing the CO2 uncertainty by Andres et al (2012), grouping countries on the basis of their statistical infrastructure was considered appropriate for the HTAP_v2.2 global dataset as well. Countries with well maintained statistical

infrastructure are the 24 OECD-1990 countries[1] as well as India - using the British statistical accounting system according to Marland et al. (1999). For the other countries, a larger range in uncertainty is present, for which we refer to Gregg et al. (2008) or Tu (2011) and Olivier (2002). For the annual CO2 inventory, the biofuel is carbon-neutral and not taken up, which leaves out a relative large source of uncertainty. For the N-related emissions, the division in countries could be based on the common agricultural practices of countries for which we refer to Leip et al (2011) and Rufino et al (2014). This explains the setup of Table 3 with qualitative indication of uncertainty ranges (using the terminology low (L), low medium (LM), upper medium (UM) or high (H)) for the different sectors and species.

In addition to the uncertainty of the activities, the quality and representativeness of the controlled emission factors play a crucial role. The standard range of uncertainty already varies according to the EMEP/EEA (2013) Guidebook's Uncertainties Chapter 5 for the absolute annual total of different pollutants between at least 10% for SO2, at least 20% for NOx and CO, at least 50% for NMVOC, an order of magnitude for NH3, and PM10, PM2.5, BC and OC. These considerations have been taken into account to indicate qualitatively a range for the different uncertainties (L, LM, UM, H).

For the combustion-related sectors is the uncertainty of the partially abated emission factor for air pollutants and in particular for aerosols larger than the uncertainty on the reported activity data, yielding a relative uncertainty that is larger than for CO2. In addition non-reported activities, in particular using non-reported biofuel or even rubbish, fall beyond this assessment and would need for an assessment the use of top-down derived emission estimates.

The Authors propose a shortening of the caption of Table 3 and the following addition in the main text of the paper: "Guidance on evaluation of emission uncertainties can be obtained from the evaluations of the national inventories reported to UNFCCC, addressed by e.g. Jonas et al (2010) (and references in there). With the evaluation of common behaviours between species in EDGARv4.2 of Balsama et al (2014) we propose the same approach of CO2 uncertainty assessment for SO2 and NOx (all driven by combustion-related activities), and the approach of N2O for NH3. As such Table 3 follows the grouping of countries by Andres et al (2012) and Marland et al (1999), based on their statistical infrastructure. Countries with well maintained statistical infrastructure are the 24 OECD-1990 countries plus India with a British statistical accounting system. For the other countries, a larger range in uncertainty is present, for which we refer to Gregg et al. (2008) or Tu (2011) and Olivier (2002). For the annual CO2 inventory, the biofuel is carbon-neutral and not taken up in the national inventories. However, for the air pollutants it is an additional large source of uncertainty, which is often not officially reported and as such missing. For the N-related emissions, the division in countries could be based on common agricultural practices (Leip et al, 2011 and Rufino et al, 2014).

In addition to the uncertainty of the activities, the quality and representativeness of the controlled emission factors play a crucial role. The standard range of uncertainty already varies according to the EMEP/EEA (2013) Guidebook's Uncertainties Chapter 5 for the absolute annual total of different pollutants between at least 10% for SO2, at least 20%

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[1] Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Japan, Luxembourg, The Netherlands, Norway, New Zealand, Portugal, Sweden, Turkey, and the United States

for NOx and CO, at least 50% for NMVOC, an order of magnitude for NH3, and PM10, PM2.5, BC and OC. These considerations have been taken into account to indicate qualitatively a range for the different uncertainties (using the terminology low (L), low medium (LM), upper medium (UM) or high (H)) for the different sectors and species."

Page 12891, Line 14: The HTAP modeling community is not only using the HTAP_v2.2 emission inventory but will also run the emission scenarios of ECLIPSEv5, which starts in 2010. The starting emission inventory (or base year inventory) of the ECLIPSEv5 scenarios is the important point of reference for all projections. Here we compare the ECLIPSEv5 emission inventory for 2010 with the HTAP_v2.2 2010 data, in order to evaluate how close the reference point is to the "officially accepted" regional inventories. We agree that the GAINS dataset can not be considered an external independent source of verification. The huge amount of information in GAINS on emission factors and reductions for certain technologies has also been flowing in the TNO-EMEP, MIX-Asia and EDGARv4.3 datasets. We added this to the paper.

Page 12892, Line 15: If for the same region two different data sources provide emission gridmaps for PM2.5 and PM10, it is not guaranteed that for each cell the flux of PM2.5 emissions is smaller than the flux of PM10 emissions and with non-compliance of the equation mass_PM2.5≤ massPM10. Another spatial proxy data set with and without point source can create a huge difference. The same applies for different data sources of BC and OC compared to PM2.5, for which BC+OC≤PM2.5 should hold. We reformulated this in the paper as follows: Another type of inconsistency in mass balance at grid cell level occurs when for the same region the data sources of the gridmaps for PM10 and PM2.5 or for PM2.5 and BC/OC are different. Already the application of different spatial proxy datasets (e.g. with and without point sources) results in an inconsistent allocation of multi-pollutant sources to different grid cells.

Page 12892, Line 24 – Page 12893, Line 3 has been rewritten as follows:
"Even though this mosaic inventory can not present the same consistency as one global bottom-up inventory, its extensive evaluation and use helped improving its quality. The evaluation was undertaken in particular in discussion with TNO and with US EPA to identify missing sources or misallocation of point sources. In addition the use of the dataset by global and regional climate and air quality modelers and the modelers' feedback (personal communications with L. Emmons of 5 November 2013 and D. Henze of 19 November 2013) were most useful and are further encouraged."

Page 12893, Line 6: The authors refer with the annotation "regionally accepted as reference" to the buy-in of each region for accepting this dataset as reference. The emission inventory for their region has been provided by their own regional inventory compilers. Therefore the dataset has a more official status than any global emission inventory that is not composed of regional inventories.
We propose to modify the sentence as follows: "This paper describes the HTAP global air pollutant reference emission inventory for 2010, which is composed of latest available data from regional inventory compilers."

Page 12893, Line 15: Indeed the sector-specific emissions are calculated according to the international standards such as IPCC/EMEP guidelines but for the activity data we needed to refer to consistent international statistics. The sentence is modified as follows: “Even though the HTAP_v2.2 dataset is not a self-consistent bottom-up database with activity data of consistent international statistics, with harmonized emission factors, and with global sets of spatial proxy data, it provides a unique set of emission gridmaps with global coverage and high spatial resolution, including important point sources.”

Figure 2
The captions for figure 2 are shortened with one single caption with: “Sector-specific breakdown of regional emission totals (Tg) for 2010: SO_2, NO_x, CO, NMVOC, PM_{10}, $PM_{2.5}$, BC, OC and NH_3”. The species name is placed within each sub-figure as suggested on top of the center of the Antartica region.

The sectors in Table 1b and used further in the main text of the paper (incl. the figures) are the same. The authors opted to use abbreviations which contain the names of the sectors as they are used in the figures: 1_AIR , 2_SHIPS, 3_ENERGY, 4_INDUSTRY, 5_TRANSPORT, 6_RESIDENTIAL and 8_AGRICULTURE. Table 1b and the main text of the paper has been modified accordingly.