RC2: 'Comment on essd-2024-601', Anonymous Referee #2, 24 Jun 2025
General comments:

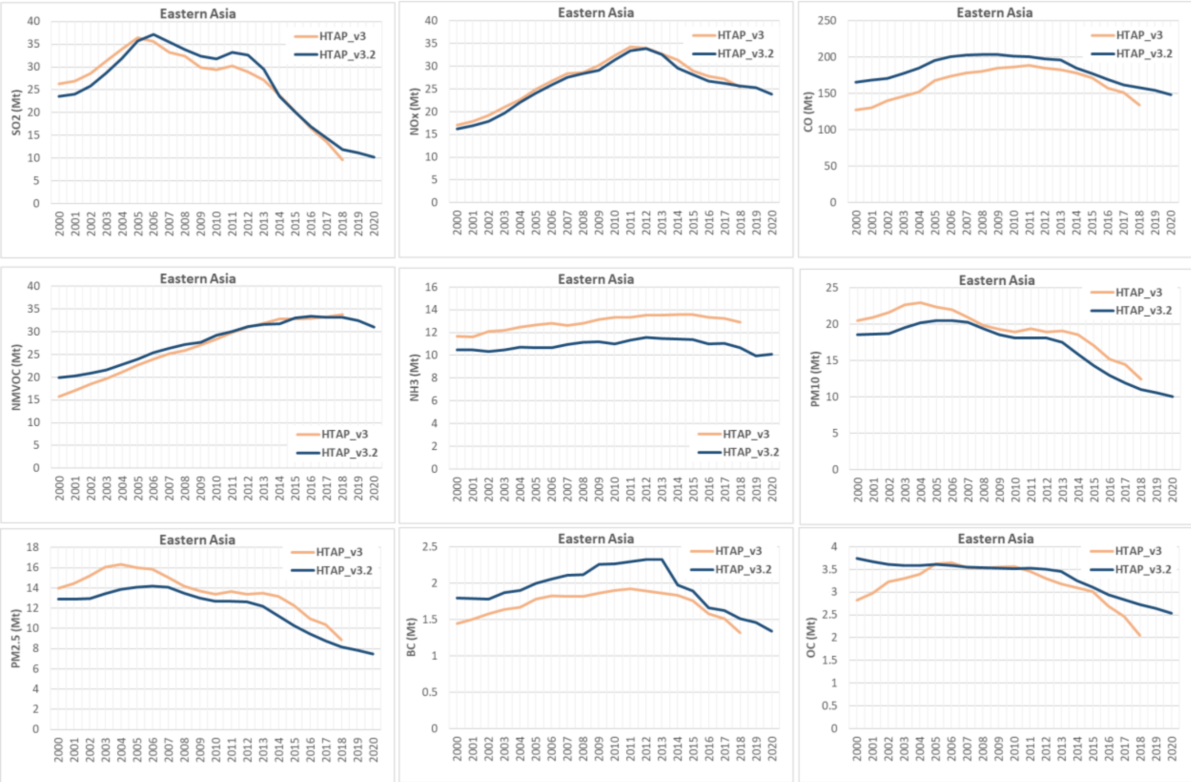
The Global Air Pollution Mosaic Inventory HTAP_v3.1 proposed in this paper is an up-to-date database of seven regional inventories coordinated and blended, with gaps filled in using the latest version of EDGARv8. The results provide an information support to analyze the status and trends of air pollutants emission. There are still some issues need to be addressed before it can be accepted.

The authors are grateful to the Reviewer's suggestions which helped improving the clarity of the manuscript. In the following, answers to each comment are provided in red. Moreover, data quality checks have been performed and implemented, as well as regional aggregations have slightly changed to fully align with IPCC AR6 final regions. For all these reason, this revised version has been renamed as HTAP_v3.2 for transparency also in the manuscript, to avoid any misunderstanding with the previous release. This final product is made publicly available at 10.5281/zenodo.17086684.

Firstly, it is recommended to highlight the differences in the results of HTAP_v3.2 and HTAP_v3 (The HTAP_v3 emission mosaic: merging regional and global monthly emissions (2000–2018) to support air quality modelling and policies) to further reflecting the advantages of HTAP_v3.1. For example, HTAP_v3.1 has added China's MEIC emission inventory, what is the difference in the results between HTAP_v3.1 and HTAP_v3?

Secondly, has the HTAP-v3.2 result been validated and what about the accuracy of it?

In order to address this comment, we have added in the Supplement the comparison of HTAPv3 vs. HTAPv3.2 emission time series for Eastern Asia, reflecting the different estimates in particular for China between REAS (used in HTAPv3) and MEIC (used in HTAPv3.2). For completeness we also added the comparison figures for all other aggregated world regions in the supplement, showing either the improvement of the EDGAR data between version 6 (used in HTAP_v3) and 8 (used in HTAP_v3.2) (as in the case of international shipping and aviation, Africa, Latin America and the Caribbean, Middle East) or the improvements of the input data by regional inventory providers (i.e. for all other world regions). As an example, we report here below the comparison for Eastern Asia, while all comparison figures are made available in the supplement.



Thirdly, the time scale for HTAP_v3.2 has been extended from 2018(HTAP_v3) to 2020, but the results section has less analysis for 2020, does the results for those two years reflect the impact of the epidemic? It is necessary to analyze the emission inventory results in 2020 to understand the impact of the COVID-19 pandemic on the emission.

Yes, a paragraph on the impact of the COVID-19 pandemic on global emissions has been introduced.

Finally, why the results figures for different pollutants are presented in different time scales? For example, Figure 4 shows 2018 emissions for SO2; Figure 5 shows 2000 and 2018 emissions for NOx; Figures 6-8 show 2018 January emissions for different pollutants in different sectors.

Being a 'Living data Process' ESSD paper (https://www.earth-system-science-data.net/living_data_process.html), the purpose of this work was to update the previous HTAPv3 mosaic publication (https://essd.copernicus.org/articles/15/2667/2023/) making use of the latest available emission information. We were instructed to maintain the same type of content and figures as in the previous HTAPv3 paper (https://essd.copernicus.org/articles/15/2667/2023/) and provide updates only for the methodological part, numbers and figures updates using the latest data. For comparability reasons, we maintained the former figures format as in the original HTAPv3 paper. This paper should not include new analysis or a different structure compared to the previous work, but it should present the same type of information including updated data (and eventually methodology).

The year 2018 is kept for key figures both because it is the last available year of the previous HTAP paper and to avoid the impact of the COVID-19 pandemic on the general sectoral and regional shares discussion.

However, in order to assess the Reviewer's comment we added a new figure (Fig.3) to present the entire time series of emissions by sector and pollutant which show the effect of the COVID-19 pandemic. Moreover, we added a paragraph on the 2020 emission levels, as reported in the following:

"The extension of the HTAP mosaic up to the year 2020 allows investigating the impact of COVID-19 pandemic on global, regional and sectoral pollutant emissions, as shown in Figs. 2 and 3. All pollutants sensibly decreased from 2019 to 2020 due to the restrictions and reduced activities induced by the COVID-19 pandemic. According with our study, the following emission reductions are found: -8.5% for NOx (mostly due to a significant decrease in power generation, industrial and transportation emissions), -3.2% for CO, -2.8% for NMVOC, -1.9% and -2.1% for PM_{10} and $PM_{2.5}$, -4.6% for BC and -1.1% for OC. Only NH_3 shows an increasing trend by 1.9% due to the reduced impact of COVID-19 restriction on the agricultural sector. SO_2 emissions experienced a much larger decrease (-16.3%) not only due to the COVID-19 pandemic but mostly to the implementation of the International Maritime Organisation (IMO) regulations (IMO, 2014; IMO, 2020; Diamond et al., 2023; Osipova et al., 2021), which lowered the sulfur content in fuel and reduced SO_2 shipping emissions by 72%. From a sectoral perspective, international aviation emissions are those associated with the highest reduction (-52.3%) for all pollutants due to the flights restrictions, followed by the power generation sector with emission reductions between 4% and 10% depending on the pollutant and road transport sector (around -10%). These emission reductions are consistent with the sectoral emission decreases found in global studies for fossil CO_2 (Crippa et al., 2021) which are directly linked to a reduction in anthropogenic combustion activities. From a regional perspective, a decrease from around 5% to 12% is found for all regions and combustion related pollutants."

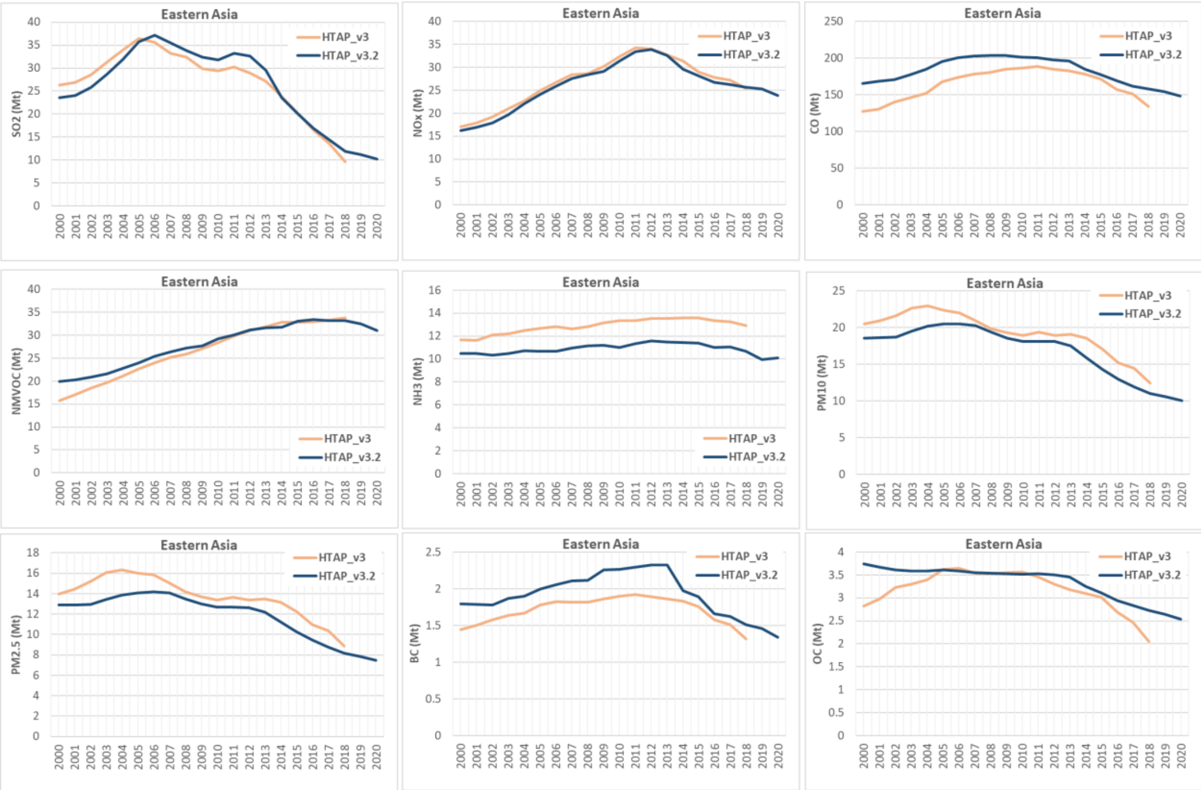
In addition, there are some details need to be checked, such as the mismatch of the figure caption and the description in the text (e.g., Figure 6), the inconsistent use of "Fig. X" and "Figure. X", and the missing units of the results. It is recommended that the authors check and verify the details.

In the following we have addressed the specific comments and performed all consistency checks across the manuscript.

Specific comments:

Abstract: It is important to highlight not only the improved features of HTAP_v3.1, but also the differences in the results between HTAP_v3.1 and HTAP_v3, such as the differences and changes in the results of the old and new databases. What are the emission result differences and changes of these two databases in the same year (e.g., 2018)? Has the HTAP-v3.1 result been validated?

As summarised in Table 5 and presented in the section 2.3, several updates in the input data to the mosaic have been incorporated compared to the previous release, spanning from methodological updates, improvements of certain emission estimates, extension of the time series, new spatial proxies, etc. However, one of the major updates is certainly the inclusion of MEIC data for China due to its high share to the total emissions. Following the Reviewer's suggestion, we have included in the Supplement the comparison of HTAPv3 vs. HTAPv3.2 emission time series for Eastern Asia, reflecting the different estimates in particular for China between REAS (used in HTAPv3) and MEIC (used in HTAPv3.2). For completeness we also added the comparison figures for all other aggregated world regions in the supplement, showing either the improvement of the EDGAR data between version 6 (used in HTAP_v3) and 8 (used in HTAP_v3.2) (as in the case of international shipping and aviation, Africa, Latin America and the Caribbean, Middle East) or the improvements of the input data by regional inventory providers (i.e. for all other world regions).



The following text has been added to the supplement, together with the corresponding figures:

“Figures S6-S17 show the comparison between HTAPv3 and HTAPv3.2 emissions by aggregated world regions, highlighting changes and improvements between the 2 versions of the mosaic. For example, for Eastern Asia, the comparison figure reflects the different emission estimates in particular for China between REAS (used in HTAPv3) and MEIC (used in HTAPv3.2). The improvement of the EDGAR data between version 6.1 (used in HTAP_v3) and 8.1 (used in HTAP_v3.2) appears in the figures of international shipping and aviation, Africa, Latin America and the Caribbean, Middle East (Figs S7-S11), while the improvements of the input data by regional inventory providers is shown for all other world regions (Figs S12-S17).”

P16 line38-42: “……while they declined to 103Mt as effect of the COID-19 pandemic.” Which year the 103Mt emission is for? What is the base year for comparison?

The entire NOx results description has been re-written to best describe the emission trends.

“Global NOx emissions increased from 108.2 Mt in 2000 to 122.1 Mt on 2011 as a result of the increase in energy- and industry-related activities in particular over the Asian domain, and then started declining down to 113.6 Mt in 2018 due to the stabilisation and reduction of Chinese emissions. A further decline of global emissions down to 103 Mt in 2020 is found as consequence of the COID-19 pandemic. On the opposite, historically industrialised countries show the strongest decreases in the emissions: -65.8% for North America (in 2018 compared to 2000), -43.6% for Europe -34.8% for Australia, Japan, and New Zealand. Lower emission reductions are found for Eastern Europe and West-Central Asia (-8.9%).”

P17 line5: “……552.3 Mt in 2000 to 533.9 Mt in 2018 (and 515.5 in 2020).” What is the unit of 515.5 here?

The unit of measure Mt has been added in the text.

P17 line8-11: “Road transport CO emissions halved over the past two decades (54.5%), while the emissions from all other sectors increased.” Why?

The following explanation has been added to the text:

This trend can be explained by the effective implementation of regulatory standards on vehicles and in particular the increasing use of oxidation catalysts to oxidise CO to CO_2.

P17 line19-23: Global NH3 emissions in 2020 are higher than in 2018, why? Can this result reflect the impact of the epidemic? It can also demonstrate the necessity of analyzing the 2020 emission results.

Thanks for the reviewer’s comment, we were able to identify an issue in the 2019 and 2020 data for the United States NH3 emissions for the waste sector which were impacting the trend between 2018 and 2020 NH3 emissions at global level. We corrected the data in this updated version of the mosaic.

P17 line24-43: The analysis of particulate emissions is mainly for PM10. I would suggest that PM2.5, BC, and OC emissions could be provided.

Detailed numbers for PM2.5, BC and OC were not presented in the text since very similar to the PM10 figures. The following sentence has been added to the manuscript for completeness:

“The same regional emission trends and order of magnitude of emission changes as for PM_{10} is also found for $PM_{2.5}$, BC and OC.”

P17 line26: “……+56.8.0% for Africa.” Should this be 56.8 % here?

The number has been corrected to “+56.8%”.

P18 line33 and 43: The expressions “Figs. 5-8” and “Figures 7 and 8” are inconsistent, and it is recommended that abbreviations or full names be used consistently.

According with ESSD author guidelines (https://www.earth-system-science-data.net/submission.html), “*The abbreviation "Fig." should be used when it appears in running text and should be followed by a number unless it comes at the beginning of a sentence, e.g.: "The results are depicted in Fig. 5. Figure 9 reveals that..."*.”

This is why we differentiated the two nomenclatures. We remind the appropriateness of our choice also to the Editorial Board of ESSD.

P22 line24-26: “The largest variability is found domestic shipping emissions (CO and NMVOC), energy (OC, BC), agricultural crops (PM), road transport (PM, NMVOC) and industry (NH3, NMVOC)”. Here, it is mentioned that OC, BC emissions from energy have the largest variability. But there is no analysis of the OC and BC emission results in the results section.

The Reviewer is correct regarding the lack of analysis of BC and OC emissions from energy in the results section since the energy sector does not represent a major source of BC and OC emissions, as shown in Fig.2. On the other hand, when dealing with very small emission numbers, the uncertainty of such estimates may be larger than other better characterised and quantified sources. We added the following disclaimer to the text to clarify the relative importance of the variability in the emissions for certain sector-pollutant combinations.

‘Moreover, high variability values may be associated to very low emission levels, as in the case of BC and OC emissions from the energy sector as shown in Fig. 2, which will finally not significantly affect the accuracy of total emission estimates.’

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