Anonymous Referee #1

This manuscript presents a description of the HTAPv3 global mosaic of anthropogenic inventories. The dataset provides a consistent times series for almost two decades of air pollutant emissions at high spatial (0.1x0.1 degree) and temporal (monthly) resolution by incorporating the best available local information. As stated by the authors, HTAPv3 is a unique and state-of-the-art tool that will substantially contribute to support policy-relevant modelling studies at both regional and global levels. Therefore, the dataset presented in the manuscript if of interest. The paper is well written and structured, and its quality is very good, which makes it a good contribution to ESSD. I recommend the manuscript to be published once the following comments have been addressed:

General comments:
Despite the recent advances made in terms of emission inventory developments in Latin America and Africa - e.g., GEAA-AEIv3.0M for Argentina by Puliafito et al. (2021), INEMA for Chile by Álamos et al., (2022); DACCIWA for Africa by Keita et al., (2021) – the HTAP_v3 mosaic does not integrate regional inventories from any of these two regions. Could you clarify why you decided to cover these regions with EDGAR emissions instead of using more local information?

As correctly pointed out by the Reviewer, the HTAP_v3 mosaic aims to represent historic and current emission levels distributed over the globe, integrating to the extent possible officially reported emission maps and state-of-the-art inventories. When the third phase of the HTAP_v3 emission mosaic was launched (Spring 2020) a consultation involving all emission inventory developers and the broader scientific community was conducted with the aim of identifying data providers for each region and defining technical details (e.g., sector disaggregation, time frame, data formats, etc.) as well as the willingness to commit to extensive cooperation with the mosaic development team in order to ensure that each regional inventory was appropriately integrated into the mosaic. The opening of the HTAP_v3 mosaic data collection task was also announced at the TF-HTAP meeting in April 2020, and every year since a follow-up presentation at the Spring TF-HTAP meeting has been performed in order to communicate to a larger community the ongoing work, to ask for feedback, and to expand participation by the broader community.

The HTAP_v3 mosaic does not represent only a collection of publicly available data, but also the community effort made by researchers and experts in the field of emissions working together to enhance our understanding of global air pollutant emission sources. In all cases, extensive cooperation between the mosaic development team and each regional team was required to ensure compatibility, identify sectoral gaps, and avoid double-counting of emissions.

After assessing the interest shown by different inventory compilers, the corresponding data availability, and the time schedule foreseen for this project (publication of the HTAP_v3 mosaic by early 2022), the current data providers of HTAP_v3 (CAMS-REG, REAS, USA EPA, ECCC, CAPSS-KU, JAPAN (PM2.5EI and J-STREAM), EDGAR) were selected. Furthermore, looking at the hemispheric transport of air pollution a major role is played by

regions situated in the Northern Hemisphere which also reinforced our decision to start working with people already available for collaboration and then gap-filling missing information with the EDGAR database.

While the design and development of the HTAP_v3 mosaic required focussed time and effort over a short time period, looking now at newly available datasets such as the GEAA-AEIv3.0M for Argentina by Puliafito et al. (2021), the INEMA for Chile by Álamos et al., (2022), and the DACCIWA for Africa by Keita et al., (2021) we believe that including some of these inventories in an updated version of HTAP_v3 would be relevant. However, the modelling community needs the HTAP_v3 data now and their modelling experiments cannot be delayed.

More specifically, the inventory for Argentina documented by Puliafito et al. (2021) seems to fulfil all of the requirements of HTAP_v3 (e.g. temporal, spatial, and sectoral coverage), and the authors believe it would represent an important improvement to characterize South American emissions, although covering only Argentina.

The inventory for Chile (Alamos et al., 2022), on the other hand, covers only the 2015-2017 period, while the purpose of HTAP_v3 was to support time series analysis of air pollutant emissions and the corresponding air quality modelling. So, the work by Alamos et al. (2022), although possibly representing the best available knowledge of recent emission levels in Chile, does not satisfy the selection criteria defined for the development of HTAP_v3.

Concerning the work by Huneeus et al. (2020), it provides an overview of available global inventories (including EDGAR) and local/city scale datasets. This work aims at evaluating differences among inventories and approaches, but it does not provide a reference official inventory to be used over the South American domain. For this reason, only the Puliafito et al. (2021) work covering Argentina may be considered in future updates of HTAP_v3. Another possibility would be to rely on the ongoing work under the 'Latin America and Caribbean GEIA Working Group' (http://www.geiacenter.org/analysis/working-groups/latin-america-and-caribbean-wg) and integrate state-of-the-art inventories for South American countries as soon as they become available. This process will require time and coordination with local experts, therefore being an ongoing work it cannot be integrated in the current HTAP_v3 mosaic.

The DACCIWA inventory for Africa (Keita et al., 2021) was not yet published at the time when we gathered the contributions from the different data providers. Feeding the HTAP_v3 mosaic with the DACCIWA data would require the support of the DACCIWA developers since higher sector resolution data should be shared, consistent with HTAP_v3 features. Furthermore, the DACCIWA data require authorization for download.

To summarize, we agree with the suggestion of the Reviewer regarding the possibility to include inventories covering the South American and African domains in future updates of HTAP_v3 in collaboration with the corresponding inventory developers.

In the conclusions we added the following paragraph to possibly include in future updates of HTAP_v3 additional regional inventories following the scientific literature development:

'Thanks to the continuous improvement of local and regional emission inventories, recent literature shows emerging new datasets reporting regional information over areas of the world not covered by local inventories in the current HTAP_v3 mosaic (e.g. Argentina (Puliafito et

Following with the previous point, it is not clear to me why for China the authors decided to use REAS instead of MEIC, giving the fact that the later report emissions until a more recent year (2015 versus 2017) and that the information considered to spatially distribute emissions from industrial plants is more precise in MEIC.

Similarly to the arguments reported above in the selection of the inventories contributing to HTAP_v3, in the case of MEIC the authors were not able to obtain detailed data (e.g., sector disaggregation, temporal coverage, and high spatial resolution maps) and all of the support from the MEIC experts needed to appropriately integrate the MEIC data for China into the HTAP_v3 mosaic. MEIC publicly available data (http://meicmodel.org.cn/?page_id=1772&lang=en) unfortunately do not follow the requirements of the HTAP_v3 mosaic, so enhancing cooperation with the MEIC developers is of the utmost importance in future when representing Chinese emissions. We hope to be able to include Chinese emissions from MEIC in a future HTAP mosaic inventory through the necessary cooperation with the MEIC experts.

According to the authors, "One key goal of the HTAP_v3 mosaic is to collate in one inventory the most accurate spatially-distributed emissions for all air pollutants at the global level, based on the best available local information". Recent studies have shown that the EDGAR inventory tends to significantly over allocate PM emissions from residential combustion processes in certain urban areas of Latin America (Huneeus et al., 2020). Coming back to my first point, should not HTAPv3 consider local available emissions for this region?

In line with the comments of the Reviewer regarding specific local inventories which could have been incorporated in HTAP_v3, the following paragraph has been included in section 2.1 to clarify the choice of the selected local/regional inventories and possible future updates of HTAP_v3:

'Recent literature studies (Puliafito et al., 2021; Huneeus et al., 2020; Alamos et al., 2022; Keita et al., 2021; MEIC for China (http://meicmodel.org.cn/?page_id=1772&lang=en)) document additional regional/local inventories which may contribute to future updates of HTAP_v3, in particular extending the mosaic compilation to regions in the Southern Hemisphere. Considering relative hemispheric emission levels as well as the atmospheric dynamics happening in the Northern Hemisphere and regulating the transboundary transport of air pollution, the current HTAP_v3 mosaic should still satisfy the needs of the atmospheric modelling community, although improvements using latest available inventories for Africa and South America may also be considered for future updates.'

The HTAPv3 inventory includes NOx and NMVOC emissions from agricultural crops. These emissions could potentially be double counted if HTAPv3 is combined with a natural emission model such as MEGAN, which includes the estimation of NMVOC from crops and soil NOx emissions (including agricultural soils). It would be good if the authors can add a sentence mentioning that these emissions should be treated with careful.

The authors agree with the Reviewer's comment and the following paragraph is now included in the paper:

'The high sector disaggregation available within the HTAP_v3 mosaic gives needed flexibility to modellers to include or exclude emission sub-sectors in their simulations, in particular when integrating the anthropogenic emissions provided by HTAP_v3 with other components (e.g. natural emissions, forest fires, etc.). However, we recommend particular caution when using a natural emissions model such as MEGAN (Model of Emissions of Gases and Aerosols from Nature, https://www2.acom.ucar.edu/modeling/model-emissions-gases-and-aerosols-nature-megan), which includes the estimation of NMVOC emissions from crops and soil NOx emissions (including agricultural soils) that are also provided by the HTAP_v3 mosaic.'

The HTAPv3 inventory provides information and guidance for the speciation of NMVOC and PM emissions (PM2.5 is reported together with BC and OC). However, no information is provided concerning the speciation of NOx emissions (NO and NO2, and HONO for the specific case of road transport). Could you comment on this point?

In HTAP_v3, NOx emissions include the sum of NO+NO2 and they are expressed as NO2 mass unit. In HTAP_v3, NOx emissions include the sum of NO+NO2 and they are expressed as NO2 mass unit. For road transport, we expect the partitioning of NOx emissions between NO, NO2, and HONO to be highly region-dependent based on the fleet composition (e.g., number of diesel vehicles relative to gasoline vehicles) and technology level (e.g., the level of exhaust after treatment). The regional inventories, however, report total NOx with no speciation. Standard practice in global models is to emit all anthropogenic NOx as NO, while we expect that regional modelling groups will have access to appropriate best practices for their particular regions. This was our experience with previous HTAP mosaic inventories. We therefore consider a speciation for NOx emissions in the HTAPv3 global mosaic to be beyond the scope of the current manuscript. If the community expresses a strong interest in speciated NOx emissions, we may revisit this for future versions of the HTAP mosaic inventories. This is now clarified in the revised manuscript (conclusions section) as following:

'The speciation of NOx emissions into its components (NO, NO2, HONO) is not provided by the global HTAP_v3 mosaic and it is beyond the scope of the current work since the regional inventories report total NOx with no speciation. Standard practice in global models is to emit all anthropogenic NOx as NO, while we expect that regional modelling groups will have access to appropriate best practices for their particular regions. In particular for road transport, the partitioning of NOx emissions between NO, NO2, and HONO is highly region-dependent and it is based on the fleet composition (e.g., number of diesel vehicles relative to gasoline vehicles) and technology level (e.g., the level of exhaust after treatment).'

Following with what happened with their predecessors, HTAP_v3 will quickly become a widely used emission dataset among the air quality modelling community. Having this in mind, I think it is important that in the conclusions sections the authors include a subsection listing the main limitations of the dataset and summarizing the considerations that users should take into account when using it (e.g., agricultural waste burning emissions should be treated with caution to avoid double counting when combined with existing biomass burning emission inventories). I would also recommend to further develop the part on future works (e.g., are there any knowing emission information needs from the modelling community that could not be covered with the present version of HTAP and may be tackled in future versions?)

We agreed with the Reviewer's comment and therefore we have added a section to the conclusions discussing the main limitations and future updates of HTAP_v3:

'When using the HTAP_v3 emission mosaic, users should consider the following limitations, for example when combining the HTAP_v3 data with other emission input needed to run atmospheric models:

- agricultural waste burning emissions should be treated with caution to avoid double-counting when combined with existing biomass burning emission inventories;

- NMVOC and NOx emissions from agricultural soils should be treated with caution to avoid double-counting when combining the HTAP_v3 data with a natural emissions model such as MEGAN (Model of Emissions of Gases and Aerosols from Nature);

- the speciation of NOx emissions into its components (NO, NO2, HONO) is not provided by the global HTAP_v3 mosaic and it is beyond the scope of the current work since the regional inventories report total NOx with no speciation. Standard practice in global models is to emit all anthropogenic NOx as NO, while we expect that regional modelling groups will have access to appropriate best practices for their particular regions. In particular for road transport, the partitioning of NOx emissions between NO, NO2, and HONO is highly region-dependent and it is based on the fleet composition (e.g., number of diesel vehicles relative to gasoline vehicles) and technology level (e.g., the level of exhaust after treatment).

Thanks to the continuous improvement of local and regional emission inventories, recent literature shows new datasets that report regional information over areas of the world not covered by local inventories in the current HTAP_v3 mosaic (e.g. Argentina (Puliafito et al. 2021), Africa (Keita et al., 2021) and the MEIC inventory (http://meicmodel.org.cn/?page_id=1772&lang=en)). Future updates to this mosaic may also integrate reliable and up to data information over South America or Africa as time and resources permit.'

Specific comments:

Adding a summary table that compares the main features of the different versions of HTAP (e.g., pollutants, number of sectors, temporal coverage, resolution), would help the reader to quickly spot the main improvements and added value of this new version Change CAMS-REF-v5.1 to CAMS-REG-v5.1 (line 54)

The correction of CAMS-REG-v5.1 has been included.

A summary table including the comparison of the main features of the three HTAP mosaics has been includes as Table 4, as shown below:

	HTAP_v1	HTAP_v2.2	HTAP_v3
Time coverage	2000-2005	2008 and 2010	2000-2018
Time resolution	yearly	yearly and monthly	yearly and monhtly
Substances	CH_4, NMVOC, CO, SO_2, NOx, NH_3, PM_{10}, $PM_{2.5}$, BC, OC	SO_2, NOx, CO, NMVOC, NH_3 (only for agriculture), PM_{10}, $PM_{2.5}$, BC, OC	SO_2, NOx, CO, NMVOC, NH_3,

			PM$_{10}$, PM$_{2.5}$, BC, OC
Sectors	Aircraft, Ships, Energy, Industry Processes, Ground Transport, Residential, Solvents, Agriculture, Agriculture Waste Burning, and Waste	Air, Ships, Energy, Industry, Transport, Residential (including waste), and Agriculture (only for NH3)	International Shipping, Domestic Shipping, Domestic Aviation, International Aviation, Energy, Industry, Fugitives, Solvent Use, Road Transport, Brake and Tyre Wear, Other Ground Transport, Residential, Waste, Agricultural Waste Burning, Livestock, and Agricultural Crops
Geographical coverage	Globe	Globe	Globe
Spatial resolution	0.1°x0.1°	0.1°x0.1°	0.1°x0.1°
Input datasets	UNFCCC, REAS, GAINS, EMEP, EPA, EDGARv4.1	US EPA, Environment Canada, MICS, TNO/EMEP Europe (MACC II), MICS Asia III+ REAS2.1, EDGARv4.3	CAMS-REG-v5.1, REASv3.2.1, US EPA, ECCC, CAPSS-KU, JAPAN (PM2.5EI and J-STREAM), EDGARv6.1
Reference	Janssens-Maenhout et al., 2012	Janssens-Maenhout et al., 2015	This work

References:

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