Author's response

Dear Editor,

Thank you for the revision of our manuscript number ESSD-2021-81. We have reviewed and adjusted the manuscript considering all referee's commentaries. Below, you will find our detailed responses. Within this response letter the following style is used: the original general comments made by the referee are kept in normal text (initiated with R), our responses are *in blue italics initiating with A* (Authors). We will use *italics black* for other authors texts (citations, initiated with C). The corresponding edit in the manuscript will be included in red. In addition, we attach the appendix section below with the new suggested changes highlighted in yellow.

Referee comments 1 (RC1)

Comment on essd-2021-81 Anonymous Referee #1 Referee comment on "High resolution seasonal and decadal inventory of anthropic gas phase and particle emissions for Argentina" by S. Enrique Puliafito et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-81-RC1, 2021

Review of "High resolution seasonal and decadal inventory of anthropic gas phase and particle emissions for Argentina" ESSD-2021-81.

R1: This is an excellent study and deserves to be published. In fact, it has been difficult to find fault with it beyond errors in language that will be caught by Copernicus' copy-editing stage. It is clear this paper builds on work that has been undertaken over several years, resulting in several other papers since at least 2015. The paper under review brings together these works into a comprehensive study covering all sectors and a range of emission species. The comparison with EDGAR is particularly useful, as EDGAR is widely used but uses a relatively standard method across all countries.

A. Thank you very much for your comments and recommendations, which helped to improve our study.

R1. I have a few very minor comments.

R1. Line 148: National Communications are submitted to the UNFCCC, not the IPCC.

A. Yes, you are wright. Corrected.

R1. Line 633: The authors state that this is 'clearly' a result of EDGAR using a low resolution population map. Can they support this statement with reference to EDGAR publications? I think the more information that the EDGAR team has about how to make improvements, the better.

A. Analyzing the spatial distribution of the EDGAR emissions one can distinguish the inner border of less populated provinces as well as districts borders in more populated areas. The use of country and subnational borders to distribute population data is confirmed in Janssens-Maenhout, G. et al, (2019) by means of the Gridded Population of the World map (GPWv3). According to Crippa et al, (2020), and more specifically Janssens-Maenhout, G. et al, (2019):

> *C:"…gridded world population (are) provided by the Center for International Earth Science Information Network (CIESIN, 2005 and updated in 2011) for the years 1990, 1995, 2000, 2005, 2010 and 5 projected to 2015. In-house proxy datasets are developed by dividing the total population into rural and urban. These data are applied in order to cover the country area and population and take into account the fraction of country data in cells with an intersection of the country's borders…." (Suppl. Mat., Page 14). EDGAR uses Gridded Population of the World, Version Three (GPWv3) from CIESIN, which "…is constructed from national or subnational input units (usually administrative units) of varying resolutions…" (CIESIN, 2005, GPWv3).*

C:"…Gridded Population of the World, Version Three (GPWv3): This is a gridded, or raster, data product that renders global population data at the scale and extent required to demonstrate the spatial relationship of human populations and the environment across the globe. The purpose of GPW is to provide a spatially disaggregated population layer that is compatible with data sets from social, economic, and Earth science fields. ***The gridded data set is constructed from national or subnational input units (usually administrative units) of varying resolutions****. The native grid cell resolution is 2.5 arc-minutes, or ~5km at the equator, although aggregates at coarser resolutions are also provided. Separate grids are available for population count and density per grid cell…" (https://sedac.ciesin.columbia.edu/data/collection/grump-v1/about-us)*

C:…"Global Rural-Urban Mapping Project, Version One (GRUMPv1) *This project builds on GPW to construct a common geo-referenced framework of urban and rural areas by combining census data with satellite data. GRUMPv1 actually comprises three data products. First, GRUMPv1 provides a higher resolution gridded population data product at 30 arc-seconds, or ~1km at the equator, for 1990, 1995, and 2000. Second, GRUMPv1's urban extents data set delineates urban areas based on NOAA's night-time lights data set and buffered settlement centroids (where night lights are not sufficiently bright). Third, GRUMPv1 provides a points data set of all urban areas with populations of greater than 1,000 persons, which may be downloaded in Excel, CSV, and shapefile formats. As with GPW, there is an extensive map collection depicting the data sets at country, continental, and global levels". (https://sedac.ciesin.columbia.edu/data/collection/grump-v1/about-us).*

References

Crippa, M., Solazzo, E., Huang, G. *et al.* High resolution temporal profiles in the Emissions Database for Global Atmospheric Research. *Sci Data* **7,** 121 (2020). https://doi.org/10.1038/s41597-020-0462-2

Janssens-Maenhout, G. *et al*. EDGAR v4.3.2 Global Atlas of the three major greenhouse gas emissions for the period 1970–2012. *Earth Syst. Sci. Data* **11**, 959–1002, https://doi.org/10.5194/essd-11-959-2019 (2019); and Supplement of Earth Syst. Sci. Data, 11, 959–1002, 2019 https://doi.org/10.5194/essd-11-959-2019-supplement

CIESIN: Gridded population of the world, version 3 (GPWv3), Center for International Earth Science INformation Network (CIESIN), USA, downloaded from http://sedac.ciesin.columbia.edu/data/collection/gpwv3, 2005 and updated in 2011.

Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Dentener, F., van Aardenne, J. A., Monni, S., Doering, U., Olivier, J. G. J., Pagliari, V., and Janssens-Maenhout, G.: Gridded emissions of air pollutants for the period 1970–2012 within EDGAR v4.3.2, Earth Syst. Sci. Data, 10, 1987–2013, https://doi.org/10.5194/essd-10-1987-2018, 2018.

Lines 633-635 former manuscript says:

"The larger EDGAR emissions (negative values) for the whole district are clearly an overestimation due to not considering a high-resolution population density map, as there are no direct sources on most of this region, and most of the emissions are located on a unique location on the east-edge of the district (see red dot)".

Line 633-635 will now be:

According to Janssens-Maenhout et al, (2019), EDGAR uses national and subnational administrative units as proxy population data using Gridded Population of the World, Version Three (GPWv3) provided by the Center for International Earth Science Information Network (CIESIN, 2005). This approach produces an emission overestimation over many low populated regions compared to the high-resolution population density map used in GEAA.

R1: Line 637: Regarding the possible overestimation of residential emissions in EDGAR, I believe EDGAR estimates these using bioenergy data from IEA. The authors might consider checking this and adding detail here, since potentially the IEA's bioenergy estimates for Argentina are incorrect, and this has wider consequences.

A. *According to Janssens-Maenhout, et al., (2019) EDGAR v4.3.2 basic emissions calculations (Eq. 1 and Eq. 2, pages 962-963) use a country specific latitude, longitude mask as proxy data "... [$fi,j(lat,lon,t)$]... ", to spatially distribute the energy consumption of year t, for a given sector i, with technology j. For Southern Hemisphere and "RCO - Energy for Buildings sector", EDGAR uses the same GWPv3 population map as spatial proxy. As total energy consumption EDGAR uses IEA World Energy Balances 2016. As we understand, IEA uses annual National Energy Balances.*

Analyzing the residential (+ commercial + public services) sectors energy consumption, main fuel is electricity and natural gas (see Figures A1 and A2 below, extracted from IEA https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Energy%20consumption&indicator=ElecConsBySector; and Figure A3a is calculated in GEAA using Argentina national energy balance. Other secondary fuels are also used as kerosene, liquified gas (LGP), charcoal, together with wood and other primaries. (Figure A3b)

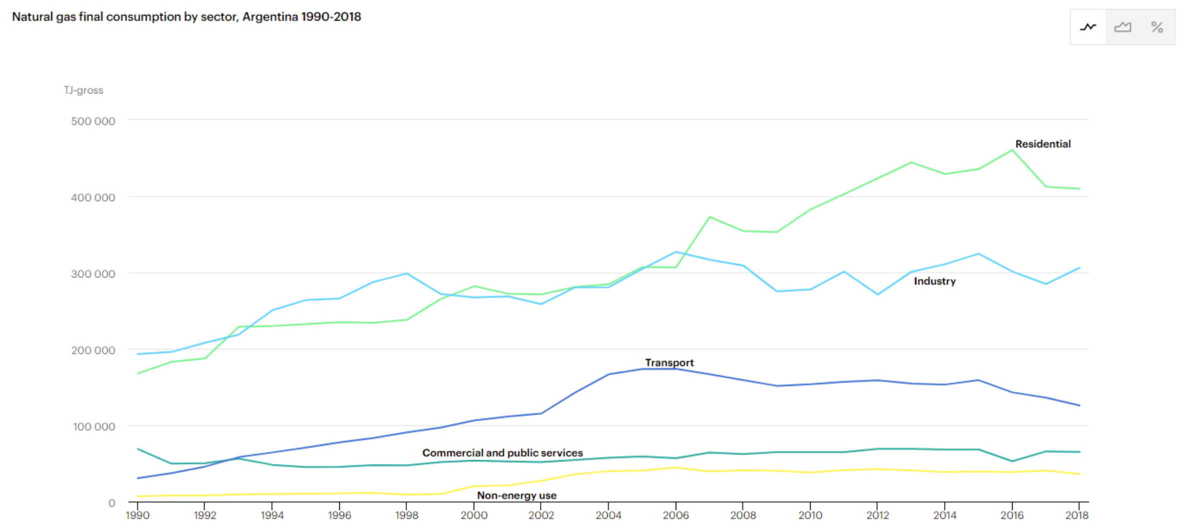


Figure A1: Natural gas consumption by sector according to IEA. Source: https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Energy%20consumption&indicator=ElecConsBySector

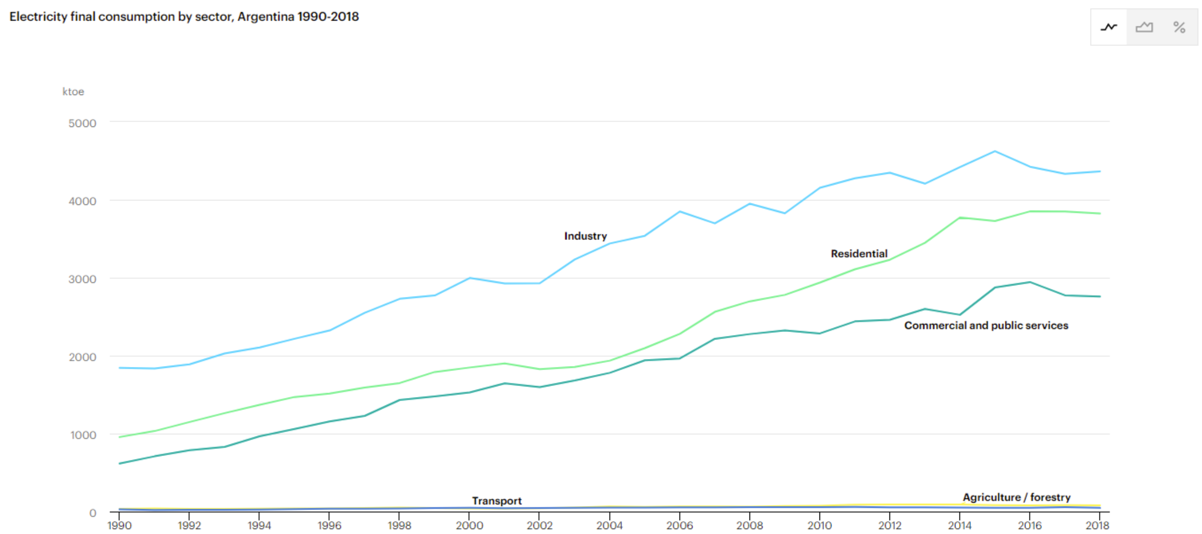


Figure A2: Electricity consumption by sector according to IEA. Source: https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Energy%20consumption&indicator=ElecConsBySector

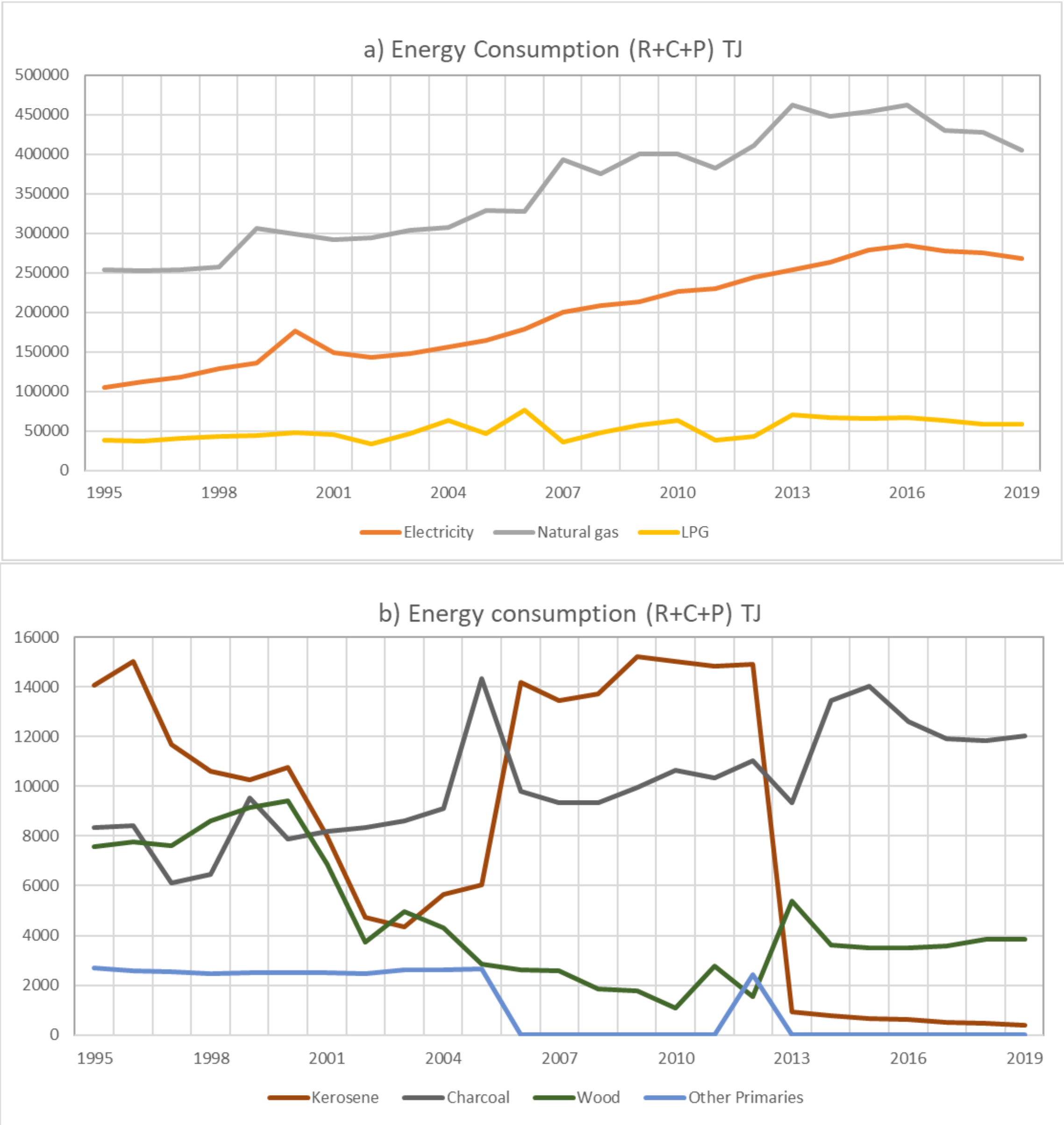


Figure A3: Energy consumption (TJ) for residential+ commercial + public services (R+C+P) (see also Figure 3c in manuscript).

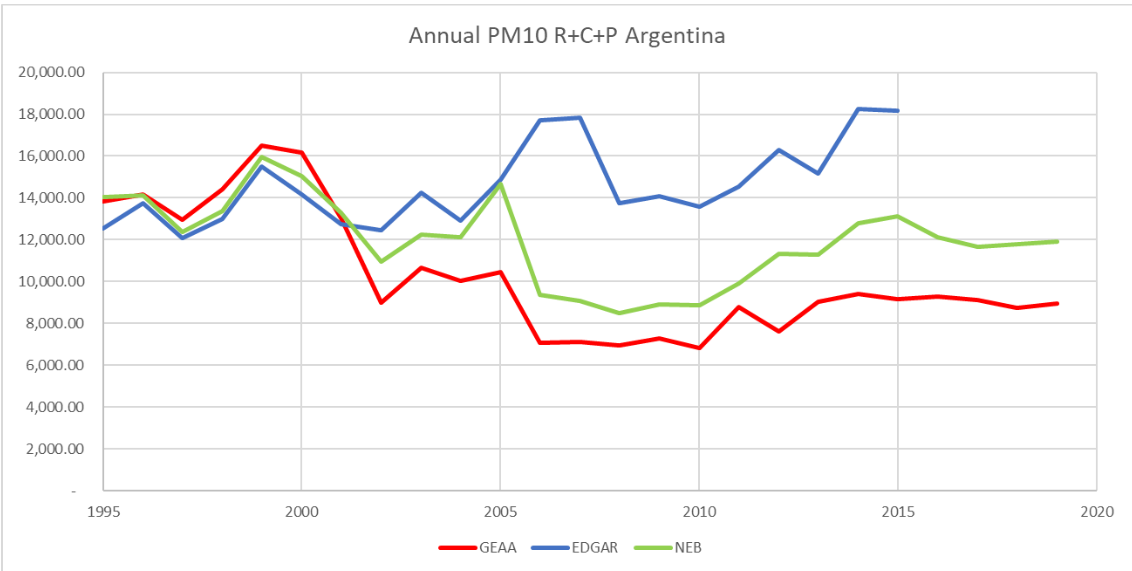
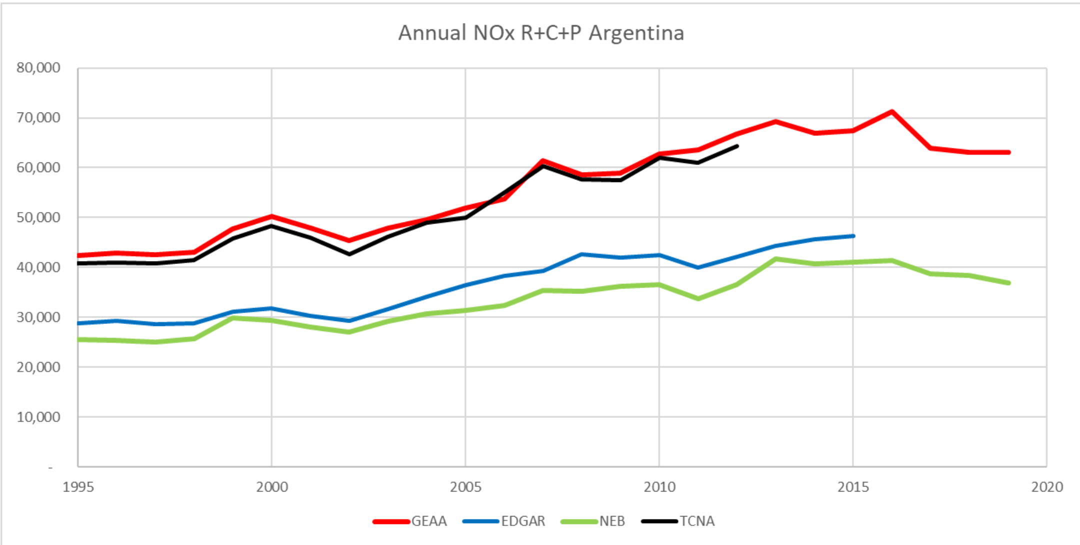


Figure A4: PM10 emissions from residential+ commercial + public services (R+C+P)

Comparing PM10 emissions using EDGAR and GEAA (Figure A4) based on the used fuels, we observed that GEAA and EDGAR are similar from 1995-2000 but diverge afterwards. The main difference is in the amount of primary energy (wood and other primaries) considered in each inventory. As alternative calculation (see NEB -National Energy Balance- green line, Figure A4) we used the same energy consumption from Figure A3 but increasing the emission factor for wood, from 404 g/GJ (EMEP2019 Tables 3.3-3.5 section 1.A.4.b.i) to 700 g/GJ obtaining a better fit with EDGAR up to year 2005. From there on, both curves still diverge, although with a smaller discrepancy than GEAA. The main reason is the variability in kerosene and wood, being wood the highest PM10 emitter (Figure A3b) (since PM10 emissions factors are much higher than the rest). While natural gas (NG) represents (on average) 56% of residential energy, kerosene + charcoal + wood + others represent only 4% of energy. On contrast, the ratio of PM10 emission factors between wood and NG (wood/NG) is 700, while for NOx emission factors wood/NG is only 2. Then an overestimation of wood (and other primaries) in NOx emission is less visible than for PM10. We then believe that EDGAR most likely overestimates wood and charcoal consumption.

Figure A5 compares NOx emissions between GEAA and EDGAR as shown in the manuscript. TCNA is the third national communication of Argentina to UNFCC, which is also based on the national energy balance. The green line (NEB) considers the same residential energy consumption as GEAA and TCNA, but uses a lower NG emission factors of 71 g/GJ, and 200 g/GJ for wood (EMEP2019 Tables 3.3-3.5 section 1.A.4.b.i) instead of 150 g/GJ for NG and 110 g/GJ for wood used in TCNA. We adopted in GEAA same emission factors as TCNA. There is no estimation of PM10 in TCNA.

In conclusion if we would have adopted (EMEP2019 Table 3.3 section 1.A.4.b.i) emissions factors as we expect EDGAR does, we would have seen an overestimation also in NOX emissions.



<u>Figure A5:</u> NOx emissions from residential + commercial + public services (R+C+P)

Line 635-644 former manuscript says:

"When appreciating the annual values, the differences of PM_{10} (and other pollutants), show similar values between the years 1995-2000, but thereafter diverges. This difference arises from a possible overestimation on the EDGAR inventory on the amount of firewood and charcoal used for heating and cooking in homes. In effect, this amount has been decreasing significantly since 2002, being replaced by an increase in the use of natural gas and LPG (Figure 3c); therefore, EDGAR trends should be corrected (Figure 8d). For estimating the residential emissions, as mention in Section 2.3.4 GEAA uses the census fractions map (INDEC, 2020) which gives fine detail of the location and amount of homes, specifying the main fuel used for cooking and heating (natural gas, wood, etc.). For NOx (Figure 9d) EDGAR overestimates GEAA values, which is seen as mostly blue areas (negative values) in Figure 9b. Since both annual series show equivalent variations, it is most probably that the discrepancies arise from the use of different emissions factors in each inventory. "

Line 635-644 will be rephrased as:

When appreciating the annual values, the differences of PM_{10} (and other pollutants), show similar values between the years 1995-2000, but thereafter diverge. Firewood, charcoal and other primary energy sources used for heating and cooking in homes have been very variable but with decreasing trend since 2003, being replaced by increasing use of natural gas and LPG (Figure 3c). While natural gas (NG) represents (on average) 56% of residential energy, kerosene + charcoal + wood + other primaries represent only 4% of energy consumption at households. However, the ratio of PM_{10} emission factors between wood and NG (wood/NG) is 600 to 700, while for NOx emission factors the wood/NG ratio is only 1.2 to 2. Then, any overestimation of wood (and other primaries) will be more visible in PM_{10} emissions (Figure 8d) than for NOx (Figure 9d). As energy consumption inputs, EDGAR uses the International Energy Agency (IEA) World Energy Balances 2016 (Janssens-Maenhout, et al., 2019), however wood and other primary energy inputs may have been overestimated, given the high variability, or they might have used a constant per capita consumption. The 40% higher values of annual residential NOx emissions in GEAA and TCNA (Figure 9d) with respect to EDGAR is produced by a higher emissions factor adopted in Argentina (TCNA) for NG emissions (150 g/GJ) compared to 51 g/GJ proposed by EMEP (EMEP2019 Table 3.3 section 1.A.4.b.i). Have we adopted 51 g/GJ as from EMEP, then we would have obtained a lower total annual NOx emissions, consistent with less primary energy use (firewood, others).

R1: Line 654: Here emissions in sector 1B1 (fugitive from solid fuel production) are mentioned, but I cannot find any description in the Methods section on how these are estimated. I believe EDGAR uses a constant emission factor per produced tons of coal. Do the authors use a different method? Do they have further comments on this? I think EDGAR's fugitive emissions in general are very approximate, and any pointers on how this could be improved would surely be welcomed.

A: Thanks for the suggesting. We will add the following discussion in the Methods section of the revised manuscript. We have checked the coal production from national bases and the information in the Argentine National Energy Balance-NEB- (Figure A6), and the IEA data bases (Figures A7-A9). Comparing the national records and the IEA, both records are consistent. In GEAA, we have calculated the 1B1 sector (solid fuel production) using only the national production, estimated from the Argentine NEB, which is also used in TCNA. We applied two emission factors for mining and post-mining operations: 18 m^3 CH_4/t and 2.5 m^3 CH_4/t gross production of coal, respectively (IPCC Chap 4). Retro-calculating the coal amount used in EDGAR (computing the amount of coal from CH_4 emissions) assuming the same IPCC emissions factors, we obtain the black line in Figure A6. Therefore, we can assume that EDGAR has used a percentage of total coal uses (net production + import) or used another emission factor. This overestimation produces an annual average emission difference of 22.3 kt of CH_4 between EDGAR and GEAA.

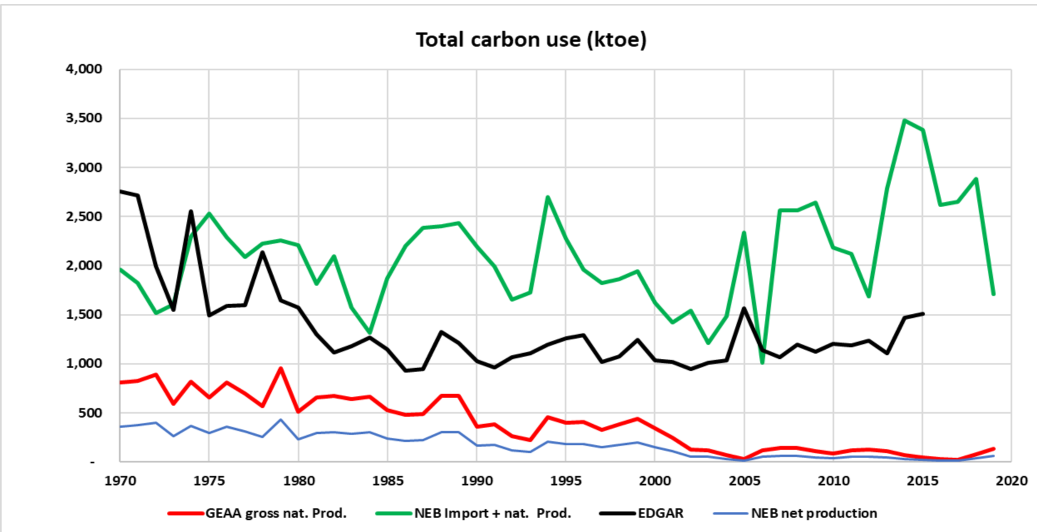


Figure A6: *Coal production and coal import in Argentina (ktoe). Red line data used in GEAA (only national coal gross production), green line: NEB data of import + national net production, black: estimation of EDGAR data, blue line net coal production.*

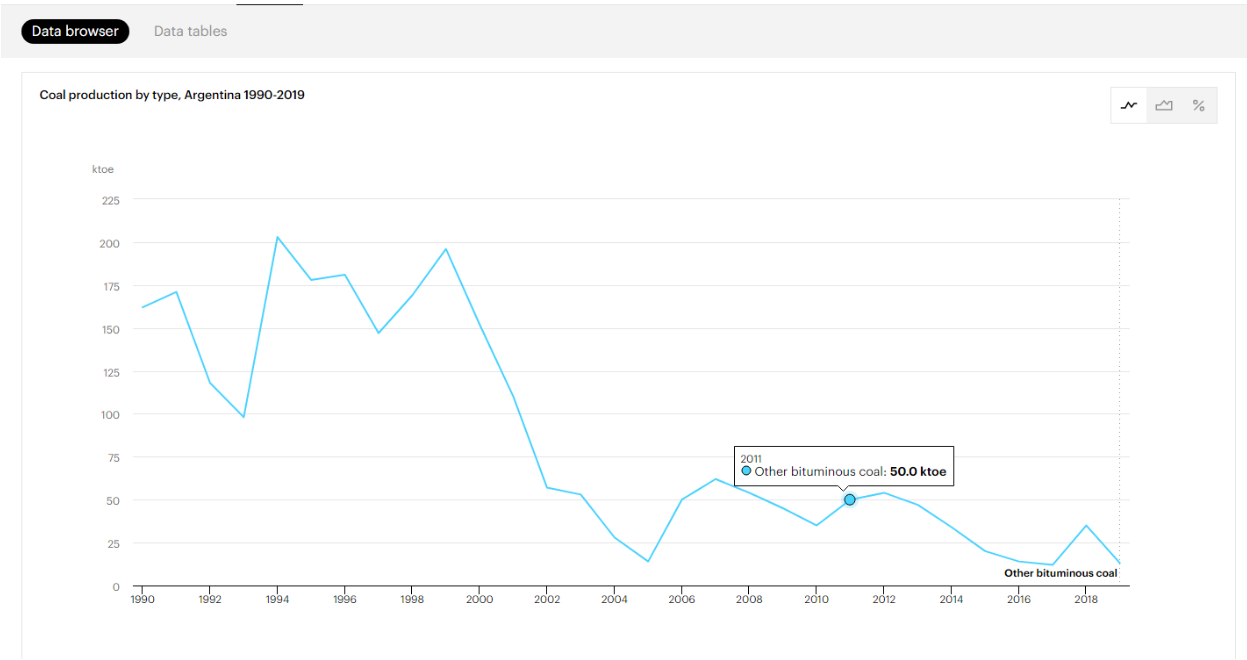


Figure A7: *Coal production in Argentina (ktoe) IAE. Source: https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Coal&indicator=CoalConsByType*

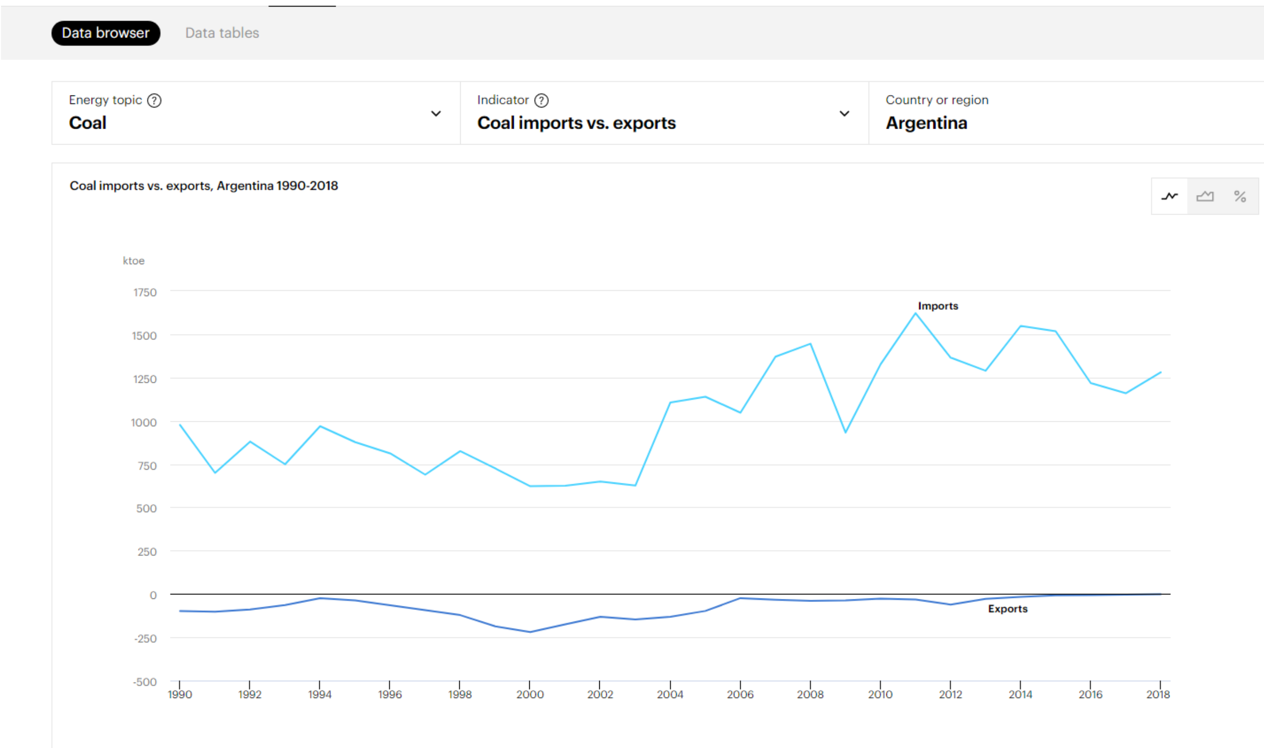


Figure A8: *Coal imports vs export in Argentina (ktoe) IAE. Source: https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Coal&indicator=CoalConsByType*

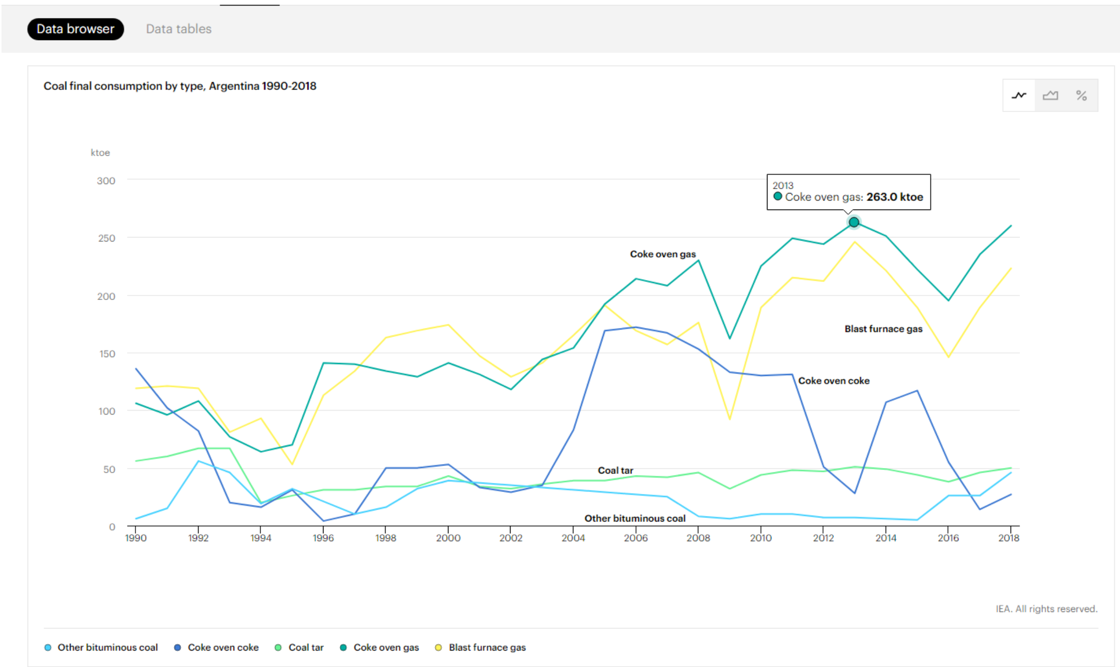


Figure A9: *final consumption by type in Argentina (ktoe) IAE. Source: https://www.iea.org/data-and-statistics/data-browser?country=ARGENTINA&fuel=Coal&indicator=CoalConsByType*

A: In the methodological section "2.3.2 Fuel production sector" (lines 200-205) former manuscript says: *"Emissions from the production and transformation of fuels were calculated from own consumption, venting, and flaring in refineries, and the production from oil and gas in wells. The Ministry of Energy (Minem, 2020) maintains a monthly record of up-stream (production and extraction of gas and oil) in the wells and down-stream (fuel production, own consumption, and sales) in the refineries. Emissions were calculated from own consumption (in wells and refineries) according to the type of fuel consumed, using Eq. (1). In a GIS format, each well or refinery are represented as point sources, so the emissions are in their respective coordinate."*

we will change by:

"Emissions from the production and transformation of fuels were calculated from own consumption, venting, and flaring in refineries, and the production from oil and gas in wells. Within the solid fuel production sector (1B1) we estimated the gross production of coal using the Argentine National Energy Balance-NEB. We applied two emission factors for mining and post-mining operation (18 m^3 CH_4/t and 2.5 m^3 CH_4/t gross production of coal, respectively, IPCC Chap 4) based on mining activity in Río Turbio, Santa Cruz (-51.57, -72.31). The Ministry of Energy (Minem, 2020) maintains a monthly record of up-stream (production and extraction of gas and oil) and down-stream (fuel production, own consumption, and sales) activities in wells and refineries. Emissions were calculated from own consumption (in wells and refineries) according to the type of fuel consumed, using Eq. (1). In a GIS format, each well or refinery are represented as point sources, so total emissions are located at their respective coordinate."

Lines 654-658 former manuscript says:

"On the other hand, for the fuel production and fugitive emissions subsectors (1A1cb, 1B1 and 1B2), GEAA-AEIv3.0M has an important difference with respect to EDGAR, especially in methane emissions being EDGAR more than 90 % larger than GEAA (for the sum of subsectors). These differences totalize 598 Gg of CH_4 (or 14,970 Gg CO_{2eq}) per year (Figure 7 and Table 8 App.). Note that for the particular case of the 1B1 sector (fugitive emissions from coal mining), the activity data for the GEAA inventory has been estimated from the national primary energy balance, which possess large uncertainties (TCNA, 2015)"

Lines 654-658 will be changed by:

On the other hand, for the fuel production and fugitive emissions subsectors (1A1cb, 1B1 and 1B2), GEAA-AEIv3.0M has an important difference with respect to EDGAR, especially in methane emissions: EDGAR annual CH_4 emissions are more than 90 % larger than GEAA (for the sum of subsectors). These differences totalize 598 Gg of CH_4 (or 14,970 Gg CO_{2eq}) per year (Figure 7 and Table 8 App.). Note that for the particular case of the 1B1 sector (fugitive emissions from coal mining), the activity data for the GEAA inventory has been estimated from the national primary energy balance, which possess large uncertainties (TCNA, 2015). As mentioned above, although EDGAR uses the Energy Balances from IEA, which in turn is based on national energy balances, the amount of coal computed from CH_4 emissions in EDGAR, using the same IPCC emissions factor, seems to be proportional to the total coal uses (net production + import of coal; see Figure S18, Suppl mat).

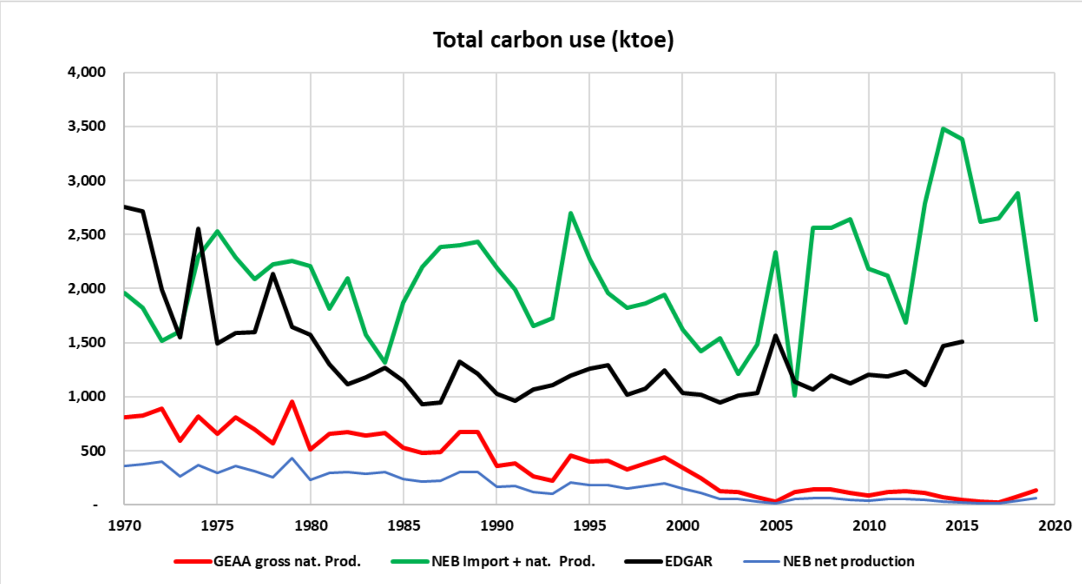


Figure S18: *Coal production and coal import in Argentina (ktoe). Red line data used in GEAA (only national coal gross production), green line: National Energy Balance (NEB) data of import + national net production; blue line NEB net coal production; black line: estimation of EDGAR data.*

R1: Lines 659ff: With respect to differences in N2O emissions, the point is made that this could be inclusion/exclusion of LULUCF N2O emissions. Do the authors know whether the EDGAR grids include LULUCF N2O emissions? Could a comparison additionally be made to EDGAR non-gridded data, which I believe do allow exclusion of LULUCF emissions?

A. *EDGAR N_2O temporal series 1970-2015 for Argentina in the Manure management and Agriculture sectors (3A-3C) presents the following subsectors: 3.A.2: Manure Management, 3.C.1: Emissions from biomass burning, 3.C.4: Direct N_2O Emissions from managed soils, 3.C.5: Indirect N_2O Emissions from managed soils, 3.C.6: Indirect N_2O Emissions from manure management. The recent new gridded maps EDGAR 6.0 (v. 2018) includes subsectors 3C1b Agricultural waste burning; (3C2+3C3+3C4+3C7) Agricultural soils 3C5+3C6; 4D3 Indirect N_2O emissions from agriculture.*
The focus of the current paper is producing a pollutant map for the air quality modelling, which besides the important climate impacts of N_2O source strength does not directly influence on local air quality. Thus, a comparison with respect to the new version of EDGAR (6.0) is out of the scope of for the present work, and will probably be an activity for a future research. We have presented gridded comparison of PM_{10} and NOx in Figures 8 and 9 and similar figures can be produced for other pollutants

R1: Finally, some comment on how readily the dataset might be updated in future would be of interest.

A: We are now updating the inventory to April 2021 with the latest available information.

Referee comments 3 (RC3)

Comment on essd-2021-81 Anonymous Referee #3. Referee comment on "High resolution seasonal and decadal inventory of anthropic gas phase and particle emissions for Argentina" by S. Enrique Puliafito et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-81-RC3, 2021

R3. Emission inventories are a critical input to air quality and climate models, while we lack comprehensive regional emission inventories over Argentina for a long time. The authors have developed an anthropogenic emission inventory for Argentina from 1995 to 2020, which is of great importance for the scientific community. The local activity database and emission factors used in this work improve the estimates of anthropogenic emissions in Argentina compared to global emission inventories. Overall, I think that this study provides important and useful emission datasets and is publishable in the journal of ESSD.

A. Thank you very much for your positive an encouraging comment.

R3. My only concern is that the uncertainty of the estimated emissions is not quantitatively assessed with the uncertainty range, and the comparison with global emission inventories lacks the CEDS inventory, which should be included in the analysis.

A. Thank you very much for the interesting and constructive suggestion. Besides the already presented comparison with EDGAR data base and TCNA 2015 (Argentine inventory) we will included in the revised manuscript, as suggested, a comparison with CEDS international database for several individual sectors and pollutants in the form of total annual time series from 1995 to 2015. In doing so, we will maintain the comparison with respect to EDGAR, as already done in the original manuscript. It must be noted that, according to Hoesly et al, (2018) and McDuffie et al, (2020), compilers of CEDS database, for Argentina they have used the TCNA 2015 Argentine inventory, so, in some senses the suggested comparison was already presented in the initial manuscript. Nevertheless, we will explicitly include CEDS in each respective section and add a supplementary material with the full annual comparison among the inventories.
We must also add an additional comment concerning the Argentine inventory. Argentina has presented the third biennial update to UNFCC in 2019. The official data posted in the governmental page (https://inventariogei.ambiente.gob.ar/resultados last access July 27, 2021) has some differences with the previous TCNA, 2015, so, we will include both inventories for Argentina which we will be calling TCNA2015 (1990-2012) and TCNA2019 (1990-2016).

References

McDuffie, E. E., Smith, S. J., O'Rourke, P., Tibrewal, K., Venkataraman, C., Marais, E. A., Zheng, B., Crippa, M., Brauer, M., and Martin, R. V.: A global anthropogenic emission inventory of atmospheric pollutants from sector- and fuel-specific sources (1970–2017): an application of the Community Emissions Data System (CEDS), Earth Syst. Sci. Data, 12, 3413–3442, https://doi.org/10.5194/essd-12-3413-2020 , 2020.

Hoesly, R. M., Smith, S. J., Feng, L., Klimont, Z., Janssens-Maenhout, G., Pitkanen, T., Seibert, J. J., Vu, L., Andres, R. J., Bolt, R. M., Bond, T. C., Dawidowski, L., Kholod, N., Kurokawa, J.-I., Li, M., Liu, L., Lu, Z., Moura, M. C. P., O'Rourke, P. R., and Zhang, Q.: Historical (1750–2014) anthropogenic emissions of reactive gases and aerosols from the Community Emissions Data System (CEDS), Geosci. Model Dev., 11, 369–408, https://doi.org/10.5194/gmd-11-369-2018 , 2018.

TCNA (2015) : Third National Communication of Argentina to the UNFCC, City of Buenos Aires. [online] Available from: https://unfccc.int/documents/67499, 2015.

TCNA(2019): Third Bienal Upadate of National Communication of Argentina to the IPCC, City of Buenos Aires, (https://inventariogei.ambiente.gob.ar/resultados last access July 27, 2021)

Based on Table 1b of the original text, the comparisons include the following sectors and pollutants:

Sector and Activities	CO2	CH4	N2O	CO	NOx	SO2	NMVCOC	TSP	PM10	PM2.5	BC
Fuel Combustion:											
Power and heat production	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Fuel Production (incl. fugitive emissions, venting, and flaring)	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Road transportation	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Domestic aviation	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Railroad and navigation	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Residential Commercial and Public offices combustion	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Fuel use in agriculture / others	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**abcde**	**ae**	**ae**	**ae**	**ae**
Industrial Processes (non-combustion):											
Production of minerals, chemicals, and metals, pulp/paper/food/drink	**abcde**	**abcde**	**abcde**	**ade**	**ade**	**ade**	**ade**	**ae**	**ae**	**ae**	**ae**

a. GEAA (1995-2015); b. TCNA2015 (1995-2012); c: TCNA2019 (1995-2014); d: CEDS (1995-2014); e: EDGAR (1995-2015)

The explicit comparison in form of figures and tables is organized as a supplementary file "comp_geaa_ceds_edgar_tcna.xlsx", which contains detailed annual temporal profile information for each inventory. It includes tables and figures according to the following index:

Table A6: Index of supplementary file: "comp_geaa_ceds_edgar_tcna.xlsx"

Page 1 Summary table for all species and sectors
Page 2 Summary tables for CO_2 all sectors and inventories
Page 3 Tables and Figures for CO_2 all sectors and inventories
Page 4 Summary tables for CH_4 all sectors and inventories
Page 5 Tables and Figures for CH_4 all sectors and inventories
Page 6 Summary tables for N_2O all sectors and inventories
Page 7 Tables and Figures for N_2O all sectors and inventories
Page 8 Summary tables for CO all sectors and inventories
Page 9 Tables and Figures for CO all sectors and inventories
Page 10 Summary tables for NO_X all sectors and inventories
Page 11 Tables and Figures for NO_X all sectors and inventories
Page 12 Summary tables for NMVOC all sectors and inventories
Page 13 Tables and Figures for NMVOC all sectors and inventories
Page 14 Summary tables for SO_2 all sectors and inventories
Page 15 Tables and Figures for SO_2 all sectors and inventories
Page 16 Summary tables for NH_3 all sectors and inventories
Page 17 Tables and Figures for NH_3 all sectors and inventories

This index will be explicitly included in the Appendix of the manuscript. Also Tables A7 through A10 (from the Appendix) summarizes the main results of the inter-comparison study. The main results are presented in table A7, which we copy here:

Table A7: Comparison of total annual values for 5 inventories: GEAA, TCNA2015, TCNA2019, CEDS and EDGAR, years 1995-2015

SECTOR	POLLUTANT	CO2		CH4		N2O		NOX		CO		NMVOC		SO2	
		mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd
1A1a	GEAA-TCNA2019	1.0%	1.2%	10.8%	16.0%	166.8%	132.3%	18.8%	11.4%	5.3%	4.5%	8.2%	9.1%	29.5%	9.0%
1A1a	GEAA-TCNA2015	1.5%	1.9%	7.3%	13.2%	178.9%	108.8%	12.1%	12.4%	5.9%	4.7%	7.9%	11.5%	31.8%	36.5%
1A1a	GEAA-CEDS	16.8%	6.9%	62.3%	35.1%	230.4%	77.3%	9.5%	13.7%	35.6%	8.2%	23.8%	11.3%	21.4%	27.4%
1A1a	GEAA-EDGAR	23.9%	5.4%	75.7%	33.2%	197.2%	74.0%	15.5%	7.3%	128.0%	8.3%	22.5%	20.3%	162.7%	35.9%
1A1a	GEAA-AVERAGE	8.6%	2.5%	28.5%	13.2%	136.9%	78.8%	10.2%	7.8%	32.3%	4.2%	10.1%	8.7%	23.1%	11.7%
1A1bc	GEAA-TCNA2019	17.2%	16.9%	10.3%	12.4%	9.8%	11.7%	15.9%	14.4%	15.7%	10.6%	9.3%	12.9%	28.7%	36.7%
1A1bc	GEAA-TCNA2015	9.7%	11.4%	5.8%	8.2%	14.5%	19.5%	11.9%	13.6%	11.5%	8.5%	6.8%	11.2%	24.6%	35.3%
1A1bc	GEAA-CEDS	22.1%	16.6%	95.4%	22.9%	90.6%	8.0%	12.8%	12.6%	12.8%	8.0%	6.9%	10.5%	29.0%	35.7%
1A1bc	GEAA-EDGAR	28.8%	10.6%	113.9%	15.6%	14.3%	12.1%	71.0%	12.5%	168.4%	10.8%	95.3%	35.3%	186.8%	34.6%
1A1bc	GEAA-AVERAGE	15.0%	10.0%	44.1%	10.7%	7.0%	7.9%	10.5%	9.1%	43.4%	6.7%	19.9%	11.2%	29.4%	20.6%
1A4abc	GEAA-TCNA2019	12.3%	12.2%	96.3%	17.6%	15.8%	18.4%	4.7%	9.4%	11.5%	10.7%	7.7%	11.5%	5.8%	8.5%
1A4abc	GEAA-TCNA2015	6.5%	3.5%	6.4%	3.0%	12.0%	16.6%	2.4%	6.2%	10.1%	8.3%	4.3%	7.4%	9.5%	12.3%
1A4abc	GEAA-CEDS	13.9%	5.4%	51.4%	28.3%	88.3%	9.4%	15.7%	8.1%	21.3%	9.0%	7.5%	9.8%	34.1%	12.6%
1A4abc	GEAA-EDGAR	13.4%	5.0%	83.8%	13.4%	14.4%	13.2%	97.4%	8.5%	58.6%	8.2%	44.9%	10.8%	138.4%	20.9%
1A4abc	GEAA-AVERAGE	9.5%	4.5%	49.3%	5.8%	9.6%	9.9%	17.6%	9.6%	6.4%	8.6%	10.9%	8.0%	36.0%	8.5%
1A2	GEAA-TCNA2019	18.9%	19.2%	85.4%	12.5%	83.9%	15.9%	3.9%	5.2%	10.3%	13.7%	5.0%	5.9%	4.2%	4.5%
1A2	GEAA-TCNA2015	26.4%	5.6%	7.2%	10.3%	6.9%	10.2%	2.5%	3.5%	5.7%	8.2%	3.5%	3.2%	4.5%	5.9%
1A2	GEAA-CEDS	12.8%	10.8%	15.2%	15.4%	113.8%	4.4%	4.2%	5.6%	6.0%	7.9%	4.0%	4.1%	3.8%	4.6%
1A2	GEAA-EDGAR	8.9%	12.2%	22.5%	23.3%	20.2%	22.4%	91.0%	13.9%	62.0%	19.9%	268.1%	43.1%	363.2%	34.3%
1A2	GEAA-AVERAGE	10.0%	11.0%	23.1%	6.4%	19.4%	4.4%	20.2%	4.7%	11.2%	6.1%	54.4%	6.4%	77.1%	5.1%
1A3bc	GEAA-TCNA2019	15.4%	6.8%	13.8%	5.0%	37.6%	13.1%	13.1%	7.6%	14.3%	16.3%	17.0%	16.2%	37.7%	15.7%
1A3bc	GEAA-TCNA2015	10.4%	8.7%	5.4%	5.7%	12.7%	13.6%	12.0%	8.7%	18.5%	20.0%	12.0%	16.8%	29.8%	16.6%
1A3bc	GEAA-CEDS	11.4%	4.2%	29.4%	27.1%	122.7%	9.9%	10.5%	7.9%	15.6%	15.7%	13.4%	15.5%	18.4%	21.4%
1A3bc	GEAA-EDGAR	14.2%	5.2%	3.4%	3.8%	84.0%	10.9%	9.9%	11.4%	15.5%	13.9%	10.1%	11.3%	44.6%	59.0%
1A3bc	GEAA-AVERAGE	10.7%	3.7%	5.8%	6.5%	29.8%	10.6%	7.6%	6.6%	7.1%	10.4%	9.9%	10.0%	19.3%	18.9%

Table A7: Comparison of total annual values for 5 inventories: GEAA, TCNA2015, TCNA2019, CEDS and EDGAR, years 1995-2015, cont.

SECTOR	POLLUTANT	CO2		CH4		N2O		NOX		CO		NMVOC		SO2	
		mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd
1B1-2	GEAA-TCNA2019	19.2%	18.8%	6.6%	6.3%	16.9%	18.5%	26.9%	19.2%	2.2%	1.9%	56.6%	25.7%	12.7%	12.7%
1B1-2	GEAA-TCNA2015	16.9%	13.8%	2.2%	2.9%	14.1%	16.0%	19.5%	16.9%	2.0%	2.1%	46.9%	27.4%	11.7%	13.0%
1B1-2	GEAA-CEDS	87.1%	36.6%	134.5%	16.8%	76.9%	13.1%	23.2%	23.3%	222.4%	16.2%	22.9%	35.8%	12.5%	12.4%
1B1-2	GEAA-EDGAR	67.3%	53.2%	93.5%	22.9%	61.4%	25.3%	81.5%	65.2%	232.3%	22.2%	23.6%	25.6%	119.0%	16.0%
1B1-2	GEAA-AVERAGE	28.0%	22.3%	45.8%	7.2%	19.1%	12.8%	28.4%	22.2%	94.0%	2.1%	27.6%	21.6%	19.3%	16.0%
2A-H	GEAA-TCNA2019	3.9%	5.8%	202.3%	68.9%										
2A-H	GEAA-TCNA2015	74.3%	7.7%												
2A-H	GEAA-CEDS	45.7%	11.0%	30.9%	24.0%	147.3%	42.1%	73.9%	31.8%	41.4%	22.9%	17.8%	24.9%	196.5%	84.0%
2A-H	GEAA-EDGAR	154.9%	17.9%	34.5%	20.2%	54.6%	24.5%	83.4%	26.7%	6.9%	8.7%	154.9%	22.8%	16.1%	23.6%
2A-H	GEAA-AVERAGE	85.6%	1.7%	81.9%	2.2%	56.2%	42.1%	44.7%	36.6%	36.5%	17.1%	51.3%	15.7%	53.0%	36.6%

Ref.: mad: Mean absolute differences between GEAA-AEIv3.0M and the other captioned inventory for years 1995-2015. sd.: Standard deviation of the two inventories for years 1995-2015. AVERAGE includes the mean values of TCNA2015 (1995-2014) and CEDS (1995-2014).

To include the new explicit comparison in the main text, we will modify several sections in the manuscript to introduce the comparison with CEDS:

In the Abstract section says:
"Spatial and temporal comparisons were also performed against EDGAR HTAPv5.0 inventory for several pollutants. The agreement was acceptable within less than 30% for most of the pollutants and activities, although a >90% discrepancy was obtained for methane from fuel production and fugitive emissions and >120% for biomass burning".

It changes:

"Temporal comparisons for several pollutants were also performed against two international databases: Community Emissions Data System (CEDS) and EDGAR HTAPv5.0 inventories; for EDGAR it also includes a spatial comparison. The agreement was acceptable within less than 30% for most of the pollutants and activities, although >90% discrepancy was obtained for methane from fuel production and fugitive emissions and >120% for biomass burning"

In the Introduction section, Lines 117… says:

"We compare our results with the Argentine GHG inventory for the Third National Communication of Argentina to the IPCC (TCNA, 2015), which includes annual GHG emissions from 1990 through 2014. Annual and monthly emissions of air quality pollutant such as PM and NOx are also compared to the estimations presented in the EDGAR HTAPv5.0 inventory (Crippa et al., 2016, 2020; EDGAR, 2019)"

Which changes to:

"We compare our results with the Argentine GHG inventory for the Third National Communication of Argentina to the IPCC (TCNA, 2015), which includes annual GHG emissions from 1990 through 2014, and was further updated in 2019 (TCNA, 2019), spanning from years 1990 to 2016. Annual total emissions of GHG and air quality pollutants are also compared to the estimations presented in the EDGAR HTAPv5.0 inventory (Crippa et al., 2016, 2020; EDGAR, 2019) and Community Emissions Data System (CEDS) (Hoesly, et al. 2018; McDuffie et al, et al, 2020)"

In Section 4. Inter-comparison of GEAA-AEIv3.0M with other Emissions Inventories for Argentina (Lines 582…). It says:

"Since the present GEAA-AEIv3.0M inventory includes spatial and temporal variation, its calibration requires a double control and validation. For the temporal comparison we use the Argentina national greenhouse gas inventory (TCNA, 2015) that compiled the total annual values for Argentina between 1990 and 2014"

Which changes as:

"Since the present GEAA-AEIv3.0M inventory includes spatial and temporal variation, its calibration requires a double control and validation. For the temporal comparison we use the Argentina national greenhouse gas inventory (TCNA, 2015) that compiled the total annual values for Argentina between 1990 and 2014 and an updated version in 2019 (TCNA, 2019) spanning from years 1990 to 2016. In addition the most commonly used international inventories EDGAR HTAPv5.0 and CEDS are also considered. It should be noted that CEDS uses TCNA 2015 as a basis for the Argentine information (Hoesly et al, 2018), but for some species and sectors they differ. There are also some differences between TCNA 2015 and TCNA 2019 prior to year 2014. Therefore, we will compare GEAA with 4 temporal series: TCNA2019, TCNA2015, CEDS and EDGAR"

In the following lines (585…) says:

"Although the activity data for both studies were taken basically from the same national sources, the focus and methodology of each inventory varies. In TCNA activities and emissions are accumulated using a top-down approach to obtain a nation-wide annual total by sector. While in our case (GEAA-AEIv3.0M) the activities and emissions are first located in each point, line, or area with a bottom-up approach, and then the totals are calculated as the sum of all cells in the spatial grid. Therefore, the sum of the activities by sector and year may vary slightly.
Likewise, we compare the annual values with the international EDGAR inventory, which differs especially in the use of proxy variables used for its spatial disaggregation, which has already been discussed elsewhere (Puliafito et al., 2015, 2017). A spatial comparison can also be made with the EDGAR inventory, although it has a resolution of 0.1° × 0.1°, which requires an adaptation of our higher resolution inventory (0.025° × 0.025°)."

Now changes as:

"Although the activity data for GEAA and TCNA (and therefore CEDS) were taken basically from the same national sources (mostly from the National Energy Balance), the focus and methodology of each inventory varies. In TCNA activities and emissions are accumulated using a top-down approach to obtain a nation-wide annual total by sector. While in our case (GEAA-AEIv3.0M) the activities and emissions are first located in each point, line, or area with a bottom-up approach, and then the totals are calculated as the sum of all cells in the spatial grid. Therefore, the sum of the activities by sector and year may vary slightly. With respect to EDGAR, it differs in the use of proxy variables for its spatial disaggregation, which has already been discussed elsewhere (Puliafito et al., 2015, 2017). A spatial comparison with the EDGAR inventory is presented in section 4.2"

In Section 4.1 (lines 604…) says
" 4.1 Comparison with total annual values from TCNA"

And Lines 607…
"Figure 7a shows the annual values for both inventories, and Figure 7b shows the average annual differences by activity Table A7 (App.). Most of the activities (1A1, 1A2, 1A1b, 1A1c, 1A3a, 1A3b, 1A4a-b, 2B, 2C, 3A, 3C, see Table 1a) agree within ± 6.0 % with total differences for the sum of all sectors of 0.4 ± 3.9 %. Higher discrepancies are found in sector 1A1c (FPR 7%), 1A3c-d (R+N: 13.3%), 3C (AG: -12.5%) and (AWB -6.5%). For fuel production, the discrepancy arises from the way the activity is computed".

Will change as:

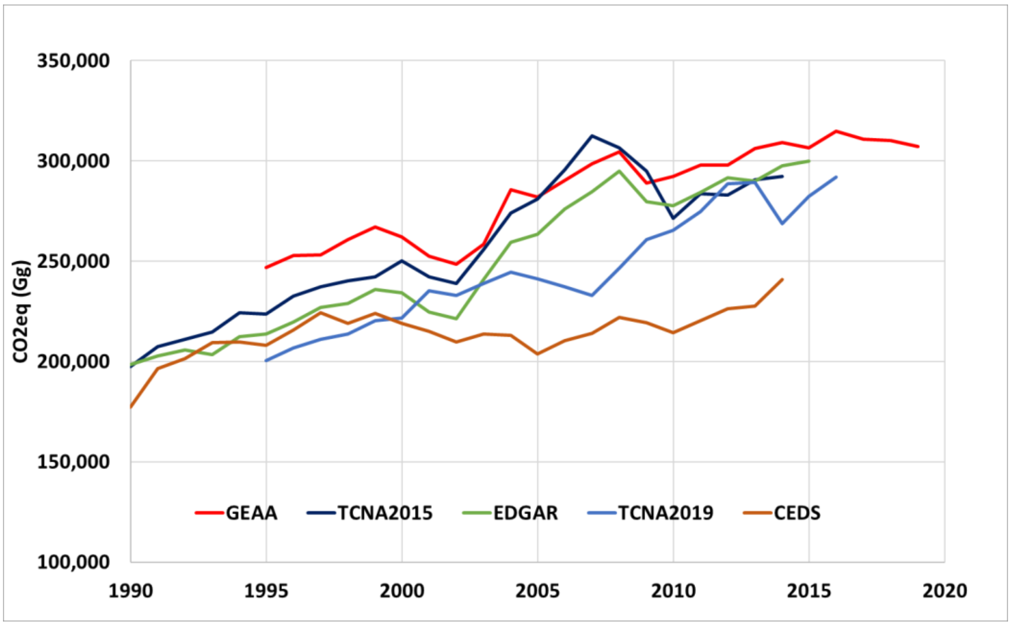
" 4.1 Comparison with total annual values from TCNA, EDGAR and CEDS"

"Figure 7a shows the annual values for TCNA2019, TCNA2015, CEDS and EDGAR inventories, and Figure 7b shows the average annual differences by activity Table A7 (App.). Most of the activities (1A1, 1A2, 1A1bc, 1B1, 1B2, 1A3a, 1A3b, 1A4abc, 2B, 2C, 3A, 3B, see Table 1a) agree within ± 16.0 %. Higher discrepancies are found for N_2O and CH_4, and in sectors 1B1 (FPR >100%), 1B2 (FUG>50%), 1A3c-d (R+N: 13.3%), 3C (AG: -12.5%) and (AWB -6.5%). For fuel production, the discrepancy arises from the way the activity is computed.

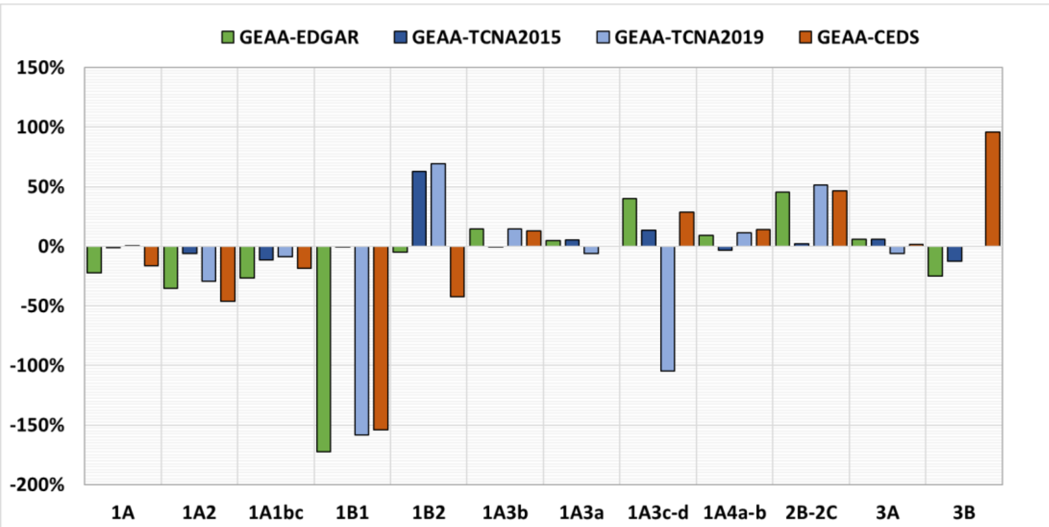
(see also discussion below in manuscript and response to Reviewer 1 on solid fuel emissions discrepancies with EDGAR)

Figure 7 changes to:

a)



b)



<u>Figure 7:</u> a) Evolution of total annual CO_2eq-Gg emissions for GEAA (red), TCNA2015 (blue); TCNA2019 (light-blue); EDGAR (green) and CEDS (brown), inventories for Argentina years 1990-2019. (Table 5 and Tables A5 App.); b) Percentage difference in GHG emissions [(GEAA – inventory)/GEAA] for years 1995 through 2016, for the considered activities (see also Tables A6 and A7 App.). Note that CEDS does not provides N2O profiles. **GHG are calculated as (CO2eq = CO2 + CH4*25 + N2O*298).**

Lines 615-619

"Figure A6 (App.) show annual GHG emissions comparison for the energy sector excluding refining and fugitive emissions from fuel production, resulting in a very good agreement between GEAA, TCNA and EDGAR for the main energy sector when the same aggregation scheme is applied. EDGAR however has 2.5 times more CH_4 emissions for the fuel production sectors (1A1bc,1B1,1B2) than GEAA and TCNA (see discussion below)"

Will be replaced with the following discussion

In the supplementary material (file comp_geaa_ceds_edgar_tcna.xlsx see Appendix for description) we present a sectorial comparison for CO_2, CH_4, N_2O, CO, NOx, SO_2, and NMVOC among TCNA2019, TCNA2015, CEDS and EDGAR inventories. Table A7 (App.) summarizes the main results for the inventories intercomparisons. Figure A7 (App) compares all inventories for the energy sector. For the Public Energy 1A1a sector, GEAA and TCNA agree within 1%, while EDGAR and CEDS have 16% larger CO_2 emissions and 95% higher values for CH_4. For NOx, CO, SO_2 and NMVOC, all profiles agree within 10%, 9%, 14% and 23% respectively. For refinery own consumption (1A1bc) and manufacturing own fuel consumption (1A2), all pollutants profiles agree within 15%. However, CH_4 for 1A1bc has larger dispersion (45%). EDGAR also show high discrepancies for CO for these sectors (> 60%). Transport (1A3: ROT, DOA, R+N) and residential, commercial, other (1A4) sectors have also good agreement within 10% for all inventories and most pollutants. CO profiles from EDGAR shows the highest differences (59%) for 1A4 sector while CEDS presents 21% disagreement with respect to the mean of all five profiles. Fugitive emissions (sector 1B1 and 1B2) presents the highest disagreement, in the solid fuel transformation (coal), and oil/gas production and transformation. GEAA, TCNA2015 and TCNA209 agree within 20%; CEDS and EDGAR are more than 100% higher for CH_4 and CO than GEAA. EDGAR has 2.5 times more CH_4 emissions for the fuel production sectors (1A1bc,1B1,1B2) than GEAA and TCNA (see additional discussion below)"

Figure A7 will be replaced by (which includes CEDS profiles)

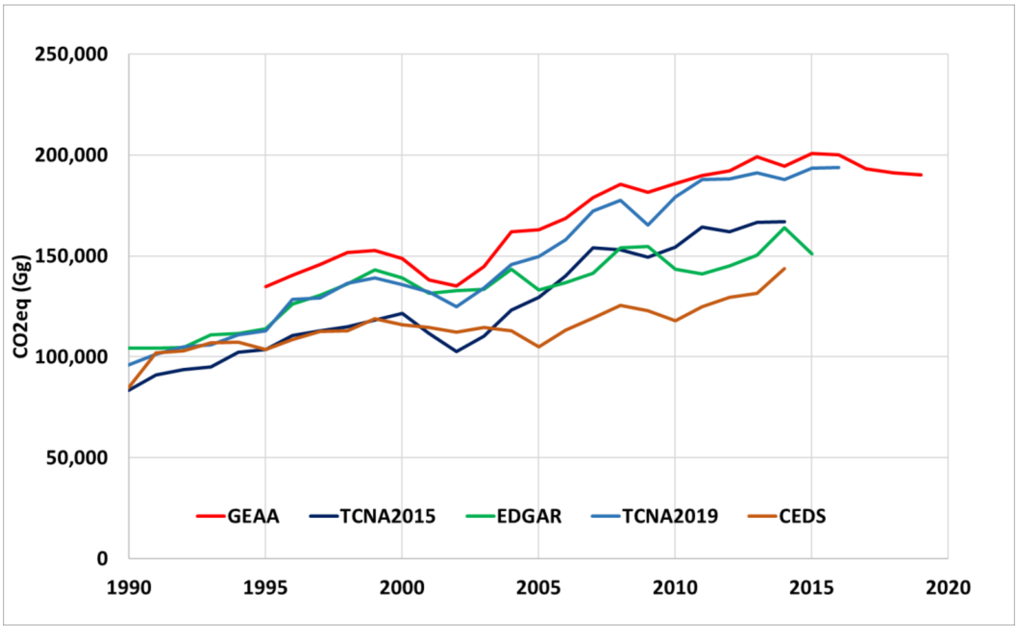


Figure A7. Comparison of annual GHG emissions for the energy sector between the different inventories considered in this work (see Suppl. Mat).

Conclusions section. Lines 691…

"Finally, we compared the GEAA-AEIv3.0M results against the Argentine GHG inventory of the Third National Communication of Argentina to the IPCC (TCNA, 2015), which compiles total country wide annual GHG emissions from 1990 through 2014, agreeing within ± 4%. Spatially and temporal comparison was also done with EDGAR HTAPv5.0 inventory for several pollutants. The agreement was acceptable within less than 30%

for most of the pollutants and activities, although a discrepancy bigger than 90% was obtained for CH_4 arising from fuel production and > 120% for biomass burning."

Will change to

"Finally, we compared the GEAA-AEIv3.0M results against the Argentine GHG inventory of the Third National Communication of Argentina to the UNFCCC TCNA2015 and its update TCNA2019, which compiles total country wide annual GHG emissions from 1990 through 2016, agreeing within ± 4.5%. Total annual emissions were also compared to international databases as CEDS and EDGAR for several sectoral and pollutants; spatially comparison was also done with EDGAR HTAPv5.0 inventory. The agreement with CEDS and EDGAR was acceptable within less than 30% for most of the pollutants and activities, although a discrepancy bigger than 90% was obtained for CH_4 arising from fuel production and > 120% for biomass burning."

R2. Besides, I would like to see the evaluation of emission trends with top-down observational constraints, such as comparing NOx and SO2 emissions estimated in this study with NO2 and SO2 retrievals from the OMI satellite. There are also some top-down inversion products of global CO, NOx, and SO2 emissions available at present, which can be used to extract and summarize the emissions over Argentina and evaluate the bottom-up emission inventory developed in this study

A. Thank you for the interesting suggestion. It would be very interesting indeed to include these satellite comparisons, but we feel that this is out of the scope of this compiled description and inter-comparison of the GEAA inventory. Including the satellite comparison would require adding a new methodological section presenting the satellite instruments and measurements, the retrieval algorithm, its uncertainties, and so on. We estimate that such comparisons study could be a paper by its own, and Reviewer R1 already highlighted the importance of bringing together the work undertaken over several years into a single comprehensive study covering many sectors and a range of emission species. Moreover, comparing with tropospheric column (i.e., using OMI or TROPOMI) requires a full atmospheric model like WRF-Chem, which we have only recently implemented in our group. On the other hand, the time given of 4 weeks is scarce to prepare this new research. Reviewing other inventories papers for example those presented by the EDGAR team (i.e., Crippa et al, 2020; in Janssens-Maenhout, G.et al, 2019; or by the CEDS team, the above-mentioned McDuffie et al, 2020 or Hoesly et al, 2018; and many others) do not include a satellite retrieval validation in the presentation of their inventory paper. For example, Fioletov et al, 2011, use several years of OMI measurements to calibrate the retrievals for SO_2 in the US, but does not describe in detail the emission inventory used. In summary, as much as we would like to present such study in this paper, we do not have time to do it now, and most importantly, we will rather focus on a future manuscript specifically centered at performing a spatio-temporal comparison with respect to satellite retrievals.

References

Boersma, K. F., Eskes, H. J., Dirksen, R. J., van der A, R. J., Veefkind, J. P., Stammes, P., Huijnen, V., Kleipool, Q. L., Sneep, M., Claas, J., Leitão, J., Richter, A., Zhou, Y., and Brunner, D.: An improved tropospheric NO2 column retrieval algorithm for the Ozone Monitoring Instrument, Atmos. Meas. Tech., 4, 1905–1928, https://doi.org/10.5194/amt-4-1905-2011, 2011.

V. E. Fioletov, C. A. McLinden, N. Krotkov, M. D. Moran, and K. Yang. Estimation of SO2 emissions using OMI retrievals; Geophysical Research Letters, VOL. 38, L21811, doi:10.1029/2011GL049402, 2011

High resolution seasonal and decadal inventory of anthropic gas-phase and particle emissions for Argentina

S. Enrique Puliafito[1,2], Tomás R. Bolaño-Ortiz[1,2], Rafael P. Fernandez[2,3,4], Lucas L. Berná[1,5], Romina M. Pascual-Flores[1,2], Josefina Urquiza[1,2], Ana I. López-Noreña[1,2,3], María F. Tames[1,2]

[1] Research Group for Atmospheric and Environmental Studies (GEAA), Mendoza Regional Faculty, National Technological University (FRM-UTN), Mendoza, M5500, Argentina
[2] National Scientific and Technical Research Council (CONICET), Mendoza, M5500, Argentina
[3] School of Natural Sciences, National University of Cuyo (FCEN-UNCuyo), Mendoza, M5501, Argentina
[4] Institute for Interdisciplinary Science (ICB-CONICET), Mendoza, M5501, Argentina
[5] National Agency of Scientific and Technological Promotion (ANPCyT), Buenos Aires, B1675, Argentina

Correspondence to: S. Enrique Puliafito (epuliafito@frm.utn.edu.ar)

APPENDIX

TABLES

Table A1. Argentine inventories developed at the Group for Atmospheric and Environmental Studies (GEAA)

Name	Sectors	Species	Extension/ Temporal /Resolution	Reference
GEAA-AEIv1.0A	Road transport sector	CO_2, CH_4, CO, NOx, NMVOC, TSP, PM_{10}, $PM_{2.5}$	Argentina, annual 2014, 9 × 9 km	Puliafito et al., (2015)
GEAA-AEIv2.0A	Public electricity and heat production, oil refining, fugitive emissions from oil and gas production, domestic aviation, road transport, rail and inland navigation, residential sector, cement production	CO_2, CH_4, N_2O, CO, NOx, NMVOC, TSP, PM_{10}, $PM_{2.5}$	Argentina, annual 2016, 0.025° × 0.025°	Puliafito et al., (2017)
GEAA-AEIv3.0A	Public electricity and heat production, oil refining, fugitive emissions from oil and gas production, domestic aviation, road transport, rail and inland navigation, residential sector, cement production, agriculture, livestock production, biomass burning.	CO_2, CH_4, N_2O, CO, NOx, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC	Argentina, annual, 2016, 0.025° × 0.025°	Puliafito et al., (2020a, 2020b)

Table A2. Other acronyms used in this text

Acronym	Definition	Web page / observation
	Fuels and technology considered in power plants	
CC	Combined cycle	Power plant technology
TV	Turbo steam	Power plant technology
TG	Turbo gas	Power plant technology
DI	Diesel Engine	Power plant technology
NG	Natural Gas	Fuel
FO	Heavy fuel oil	Fuel
GO	Gasoil	Fuel
CM	Mineral coal, carbon, charcoal	Fuel
BD	Biodiesel	Fuel
	Transport variables	
RGS	Refueling Gas Stations	Loading fuel stations for vehicles
VKT	Vehicle kilometer transported (v-km)	Passenger transport index
TKT	Ton kilometer transported (t-km)	Freight transport index
PKT	Passenger kilometer transported (p-km)	Public transport index
LTO	Landing and take-off	Aviation index
FO	Heavy fuel oil	Fuel for navigation
CNG	Compressed natural Gas	Fuel
NA	Gasoline	Fuel
GO	Gasoil	Fuel
AK	Kerosene for aviation	Jet fuel for aviation
AG	Gasoline for aviation	Fuel for aviation

Table A3. List of industrial activities

Number	Code	Activity	Number	Code	Activity
1	2.C.1	steel-iron	24	2.B.10	pet
2	2.C.3	aluminium	25	2.B.10	polyethylene high density
3	2.B.4	benzoic acid	26	2.B.10	polyethylene
4	2.B.4	acetaldehiyde	27	2.B.10	polypropylene
5	2.B.4	acetic acid	28	2.B.10	ammonium sulphate
6	2.B.4	ethyl acetate	29	2.B.7	carbon sulfide
7	2.B.4	acetone	30	2.B.4	toluene
8	2.B.4	n-butyl acetate	31	2.B.10	urea
9	2.B.2	nitric acid	32	2.H.1	paper-bisulfite
10	2.B.4	salicylic acid	33	2.H.1	paper-kraft
11	2.B.4	alcohol	34	2.H.1	paper-pulp
12	2.B.1	ammonia	35	2.H.2	vegetable oil
13	2.B.4	aromatics-btx	36	2.H.2	food-poultry
14	2.D.3	asphalt	37	2.H.2	sugar
15	2.D.3	asphalt roof	38	2.H.2	Beverage
16	2.D.3	asphalt roads	39	2.A.2	calcium lime
17	2.B.10	sulfuric acid	40	2.A.1	cement
18	2.B.2	benzene	41	2.D.3	car painting
19	2.B.7	sodium carbonate	42	2.B.5	calcium carbide
20	2.B.10	chlorine	43	2.A.3	glass
21	2.B.10	ethylene	44	2.A.2	calcium lime
22	2.B.10	nylon	45	2.A.1	cement
23	2.B.10	other-chemical			

Table A4 Summary of annual pollutants emissions for Argentina during December 2019 and December 1995

Ref: TPP: Power Plants, MFC: Manufacturing own fuel consumption, ROC: Refinery own consumption, FPR: Fuel production, FUG: Fugitive, venting and flare, ROT:

ACTIVITY	CO2 Gg	CH4 Mg	N2O Mg	NOx Mg	CO Mg	NMVOC Mg	SO2 Mg	NH3 Mg	TSP Mg	PM10 Mg	PM2.5 Mg	BC Mg
TPP 2019	3,100.97	138.86	114.83	10,028.99	2,878.71	2,112.44	2,450.64	13.12	130.64	114.73	90.53	15.01
TPP 1995	1,684.40	36.11	61.53	5,676.15	1,467.62	1,078.55	1,562.11	7.66	83.20	69.02	52.88	10.57
MFC 2019	2,493.85	225.83	30.09	5,574.6	32,520.0	547.6	258.12	-	1,031.55	977.86	928.21	251.43
MFC 1995	2,199.21	236.32	33.13	4,658.9	25,957.4	532.2	448.4	-	1,201.29	1,122.91	1,026.84	280.55
ROC 2019	1,050.41	21.00	2.36	2,805.05	316.00	102.75	420.74	-	2696.47	2061.42	1525.32	240.92
ROC 1995	754.94	17.60	2.10	1971.17	227.93	61.25	507.46	-	2224.75	1712.92	1065.96	150.58
FPR 2019	28.30	1.44	1.73	143.64	31.5	17.03	358.22	-	41.24	41.24	41.24	9.52
FPR 1995	11.66	0.58	0.87	61.08	13.08	8.33	515.75	-	17.28	17.28	17.28	3.99
FUG 2019	409.96	30,722.51	2.57	37.86	196.04	15,981.51	1494.81	18.79	17.85	17.83	17.82	8.92
FUG 1995	271.84	23,125.54	2.02	57.78	288.93	19,950.89	1172.47	14.74	14.73	14.72	14.71	7.17
ROT 2019	4,271.50	1,369.27	322.68	37,707.75	177,927.01	39542.90	1,138.12	1,239.09	1,248.63	998.90	899.01	229.11
ROT 1995	3,781.77	889.39	280.08	31,279.36	147,935.03	32950.38	1,142.29	1,003.80	1,268.36	1,014.69	913.22	456.35
DOA 2019	147.70	1.03	4.13	516.43	206.57	103.29	93.68	1.84	1.65	1.03	0.05	0.15
DOA 1995	174.47	1.22	4.88	610.04	244.02	122.01	110.66	2.17	1.95	1.22	0.05	0.18
R+N 2019	77.66	7.11	1.98	203.61	1,793.42	0.18	78.94	419.77	124.14	123.64	112.11	72.87
R+N 1995	34.96	3.29	0.89	101.44	727.53	0.08	41.32	153.37	42.00	41.54	37.92	24.65
R+C 2019	895.82	47.87	1.60	2,393.55	797.85	79.78	4.79	-	35.11	35.11	35.11	1.90
R+C 1995	459.05	24.53	0.82	1,226.53	408.84	40.88	2.45	-	17.99	17.99	17.99	0.97
FAG 2019	887.291	35.43	7.06	14,098.61	11,727.19	2,356.99	482.93	-	22.80	18.93	16.09	5.31
FAG 1995	647.78	26.23	5.25	10,490.45	8,742.04	1,748.41	317.15	-	16.61	13.79	11.72	3.87
MOP 2019	1,084.50	10.47	44.65	201.84	4,871.35	825.26	512.38	352.43	1,621.51	648.70	371.99	7.29
MOP 1995	779.38	22.11	36.55	164.31	2,534.76	711.51	647.88	81.17	814.25	310.90	184.44	6.53
LF 2019	-	231,758.26	7,255.71	556.16	-	17,636.18	-	17,006.29	7,482.47	2,317.20	943.95	-
LF 1995	-	257,013.01	6,821.64	460.90	-	12,909.43	-	17,478.22	4,184.50	1,663.68	961.79	-
AG 2019	53.83	3,303.86	1,813.39	5,652.13	-	1,264.14	-	44,120.22	316.04	252.83	189.62	-
AG 1995	6.94	2,190.94	267.14	832.64	-	660.90	-	7,216.91	165.22	132.18	99.13	-
AWB 2019	129.27	277.29	5.71	432.24	5,496.83	326.22	69.28	36.64	801.98	39.93	513.46	643.87
AWB 1995	144.27	309.48	6.37	482.42	6,134.92	364.09	76.11	40.90	879.87	43.72	563.32	706.52
OBB 2019	366.66	1,237.97	20.40	574.33	22,179.19	274.71	71.02	332.25	6,429.18	4,094.06	2,003.57	144.56
OBB 1995	367.17	1,305.20	20.35	548.91	22,840.33	274.90	72.19	335.85	6,779.71	4,264.83	2,074.71	139.04
TOT. 2019	**14,997.721**	**269,158.2**	**9,628.89**	**80,926.79**	**260,941.66**	**81,170.98**	**7,433.67**	**63,540.44**	**22,001.26**	**11,743.41**	**7,688.08**	**1,630.86**
TOT. 1995	**11,317.84**	**285,201.55**	**7,543.62**	**58,622.08**	**217,522.43**	**71,413.81**	**6,616.24**	**26,334.79**	**17,711.71**	**10,441.39**	**7,041.96.**	**1,790.97**

Road transport, DOA. Domestic Aviation, R+N: Railroad and navigation, R+C: Residential and commercial, FAG: Fuel use in agriculture, MOP: Manufacturing own process, LF: Livestock feeding, AG: Agriculture, AWB: Agriculture waste burning, OBB. Open biomass burning.

Table A5: Impact of COVID-19 lockdown on Argentine emissions: Summary of monthly emissions for April 2020 and April 2019

ACTIVITY	CO2 Gg	CH4 Mg	N2O Mg	NOx Mg	CO Mg	NMVOC Mg	SO2 Mg	NH3 Mg	TSP Mg	PM10 Mg	PM2.5 Mg	BC Mg
TPP 2019	2,530.77	116.50	95.10	7,771.41	2,433.55	1,793.39	30.22	10.20	84.93	80.61	70.39	5.64
TPP 2020	2,283.65	105.10	85.86	6,945.81	2,204.38	1622.988	20.37	-	76.43	72.55	63.35	4.72
MFC 2019	2,093.32	181.19	24.26	4,744.0	27,105.6	444.2	231.7	-	831.10	785.91	739.35	199.83
MFC 2020	1,798.00	148.91	19.89	4,097.1	23,207.1	369.4	192.49	-	675.23	638.86	601.50	162.11
ROC 2019	978.8	20.61	2.74	2,613.18	288.87	94.15	500.51	-	2,657.90	2,041.85	1,400.41	226.99
ROC 2020	377.30	7.39	0.97	1,004.66	2,368.31	35.90	20.31	-	935.38	711.2	557.05	81.96
FPR 2019	25.97	1.31	1.73	133.52	29.05	16.79	655.63	-	38.11	38.11	38.11	8.79
FPR 2020	25.32	1.27	1.69	130.19	28.32	16.40	649.15	-	37.15	37.15	37.15	8.57
FUG 2019	366.10	27,433.58	2.25	66.03	337.74	22,672.10	1,306.81	16.43	16.46	16.45	16.44	8.00
FUG 2020	282.16	18,951.76	1.51	64.42	330.79	20,533.41	877.53	11.03	11.58	11.57	11.56	5.49
ROT 2019	4,041.20	1,247.94	296.17	34,981.68	160,653.89	35,763.14	1,119.41	1,070.96	1,253.78	1,003.03	902.72	240.59
ROT 2020	2,258.54	496.35	131.63	16,620.72	60,076.25	13,588.2	796.19	467.55	957.93	766.35	689.71	184.77
DOA 2019	150.08	1.05	4.20	524.77	209.91	104.95	95.19	1.87	1.68	1.05	0.05	0.15
DOA 2020	-	-	-	-	-	-	-	-	-	-	-	-
R+N 2019	115.04	10.49	2.93	296.29	2,700.24	0.27	113.80	641.24	191.46	190.85	172.91	112.39
R+N 2020	-	-	-	-	-	-	-	-	-	-	-	-
R+C 2019	1,195.09	63.86	2.13	3,193.16	1,064.39	106.44	6.39	-	46.83	46.83	46.83	2.53
R+C 2020	1,250.06	66.80	2.23	3,340.03	1,113.34	111.33	6.68	-	48.99	48.99	48.99	2.65
FAG 2019	887.29	35.42	7.05	14,098.6	11,727.18	2,356.98	482.93	-	22.80	18.92	16.08	5.30
FAG 2020	-	-	-	-	-	-	-	-	-	-	-	-
MOP 2019	1,193.51	12.54	45.19	200.79	4,579.51	575.14	494.57	350.62	1,984.99	677.00	380.50	70.78
MOP 2020	-	-	-	-	-	-	-	-	-	-	-	-
TOT. 2019	**1,1052.01**	**29,124.49**	**483.77**	**68,623.42**	**211,129.9**	**63,927.53**	**5,038.18**	**2,091.31**	**7,130.05**	**4,900.61**	**3,783.7**	**818.01**
TOT. 2020	**5,991.37**	**1,9672.47**	**157.92**	**25,257.15**	**87,124.05**	**34,654.61**	**2,542.36**	**478.58**	**2,666.26**	**2,214.11**	**1,945.96**	**445.55**
(20-19)/19	**-45.8%**	**-32.45%**	**-67.3%**	**-63.19%**	**-58.7%**	**-45.7%**	**-49.5%**	**-77.11%**	**-62.6%**	**-54.81%**	**-48.5%**	**-45.5%**

Ref: TPP: Power Plants, MFC: Manufacturing own fuel consumption, ROC: Refinery own consumption, FPR: Fuel production, FUG: Fugitive, venting and flare, ROT: Road transport, DOA. Domestic Aviation, R+N: Railroad and navigation, R+C: Residential and commercial, FAG: Fuel use in agriculture, MOP: Manufacturing own process, LF: Livestock feeding, AG: Agriculture, AWB: Agriculture waste burning, OBB. Open biomass burning.

Comparison of total annual values for 5 inventories: GEAA, TCNA2015, TCNA2019, CEDS AND EDGAR

In this Section we compare the total annual values for Argentina for the period 1995 through 2015 for several national and international databases. We include the present work GEAA-AEIv3.0M with the Third National Communication of Argentina to the IPCC (TCNA, 2015), which includes annual GHG emissions from 1990 through 2014 and the recent update TCNA 2019 (which spans from year 1990 to 2016). Annual total emissions of GHG and air quality pollutants are also compared to the estimations presented in the EDGAR HTAPv5.0 inventory (Crippa et al., 2016, 2020; EDGAR, 2019) and the Community Emissions Data System **(**CEDS) (Hoesly, et al. 2018; McDuffie et al, et al, 2020). We selected those sectors and pollutants that are present in at least 3 inventories. PM10, PM25 are only present in EDGAR (Table A10). These contaminants were discussed in the main text.

The supplementary file "comp_geaa_ceds_edgar_tcna.xlxs", contains detailed information for each inventory and their comparison. It includes tables and figures, according to Table A6. Tables A7 through Table A10 retrieves some of the main results of the comparisons.

Table A6: Index of supplementary file comp_geaa_ceds_edgar_tcna.xlxs

Page 1	Summary table for all species and sectors
Page 2	Summary tables for CO2 all sectors and inventories
Page 3	Tables and Figures for CO2 all sectors and inventories
Page 4	Summary tables for CH4 all sectors and inventories
Page 5	Tables and Figures for CH4C all sectors and inventories
Page 6	Summary tables for N2O all sectors and inventories
Page 7	Tables and Figures for N2O all sectors and inventories
Page 8	Summary tables for CO all sectors and inventories
Page 9	Tables and Figures for CO all sectors and inventories
Page 10	Summary tables for NOX all sectors and inventories
Page 11	Tables and Figures for NOX all sectors and inventories
Page 12	Summary tables for NMVOC all sectors and inventories
Page 13	Tables and Figures for NMVOC all sectors and inventories
Page 14	Summary tables for SO2 all sectors and inventories
Page 15	Tables and Figures for SO2 all sectors and inventories
Page 16	Summary tables for NH3 all sectors and inventories
Page 17	Tables and Figures for NH3 all sectors and inventories

Table A7: Comparison of total annual values for 5 inventories: GEAA, TCNA2015, TCNA2019, CEDS and EDGAR, years 1995-2015

SECTOR	POLLUTANT	CO2		CH4		N2O		NOX		CO		NMVOC		SO2	
		mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd
1A1a	GEAA-TCNA2019	1.0%	1.2%	10.8%	16.0%	166.8%	132.3%	18.8%	11.4%	5.3%	4.5%	8.2%	9.1%	29.5%	9.0%
1A1a	GEAA-TCNA2015	1.5%	1.9%	7.3%	13.2%	178.9%	108.8%	12.1%	12.4%	5.9%	4.7%	7.9%	11.5%	31.8%	36.5%
1A1a	GEAA-CEDS	16.8%	6.9%	62.3%	35.1%	230.4%	77.3%	9.5%	13.7%	35.6%	8.2%	23.8%	11.3%	21.4%	27.4%
1A1a	GEAA-EDGAR	23.9%	5.4%	75.7%	33.2%	197.2%	74.0%	15.5%	7.3%	128.0%	8.3%	22.5%	20.3%	162.7%	35.9%
1A1a	GEAA-AVERAGE	8.6%	2.5%	28.5%	13.2%	136.9%	78.8%	10.2%	7.8%	32.3%	4.2%	10.1%	8.7%	23.1%	11.7%
1A1bc	GEAA-TCNA2019	17.2%	16.9%	10.3%	12.4%	9.8%	11.7%	15.9%	14.4%	15.7%	10.6%	9.3%	12.9%	28.7%	36.7%
1A1bc	GEAA-TCNA2015	9.7%	11.4%	5.8%	8.2%	14.5%	19.5%	11.9%	13.6%	11.5%	8.5%	6.8%	11.2%	24.6%	35.3%
1A1bc	GEAA-CEDS	22.1%	16.6%	95.4%	22.9%	90.6%	8.0%	12.8%	12.6%	12.8%	8.0%	6.9%	10.5%	29.0%	35.7%
1A1bc	GEAA-EDGAR	28.8%	10.6%	113.9%	15.6%	14.3%	12.1%	71.0%	12.5%	168.4%	10.8%	95.3%	35.3%	186.8%	34.6%
1A1bc	GEAA-AVERAGE	15.0%	10.0%	44.1%	10.7%	7.0%	7.9%	10.5%	9.1%	43.4%	6.7%	19.9%	11.2%	29.4%	20.6%
1A4abc	GEAA-TCNA2019	12.3%	12.2%	96.3%	17.6%	15.8%	18.4%	4.7%	9.4%	11.5%	10.7%	7.7%	11.5%	5.8%	8.5%
1A4abc	GEAA-TCNA2015	6.5%	3.5%	6.4%	3.0%	12.0%	16.6%	2.4%	6.2%	10.1%	8.3%	4.3%	7.4%	9.5%	12.3%
1A4abc	GEAA-CEDS	13.9%	5.4%	51.4%	28.3%	88.3%	9.4%	15.7%	8.1%	21.3%	9.0%	7.5%	9.8%	34.1%	12.6%
1A4abc	GEAA-EDGAR	13.4%	5.0%	83.8%	13.4%	14.4%	13.2%	97.4%	8.5%	58.6%	8.2%	44.9%	10.8%	138.4%	20.9%
1A4abc	GEAA-AVERAGE	9.5%	4.5%	49.3%	5.8%	9.6%	9.9%	17.6%	9.6%	6.4%	8.6%	10.9%	8.0%	36.0%	8.5%
1A2	GEAA-TCNA2019	18.9%	19.2%	85.4%	12.5%	83.9%	15.9%	3.9%	5.2%	10.3%	13.7%	5.0%	5.9%	4.2%	4.5%
1A2	GEAA-TCNA2015	26.4%	5.6%	7.2%	10.3%	6.9%	10.2%	2.5%	3.5%	5.7%	8.2%	3.5%	3.2%	4.5%	5.9%
1A2	GEAA-CEDS	12.8%	10.8%	15.2%	15.4%	113.8%	4.4%	4.2%	5.6%	6.0%	7.9%	4.0%	4.1%	3.8%	4.6%
1A2	GEAA-EDGAR	8.9%	12.2%	22.5%	23.3%	20.2%	22.4%	91.0%	13.9%	62.0%	19.9%	268.1%	43.1%	363.2%	34.3%
1A2	GEAA-AVERAGE	10.0%	11.0%	23.1%	6.4%	19.4%	4.4%	20.2%	4.7%	11.2%	6.1%	54.4%	6.4%	77.1%	5.1%
1A3bc	GEAA-TCNA2019	15.4%	6.8%	13.8%	5.0%	37.6%	13.1%	13.1%	7.6%	14.3%	16.3%	17.0%	16.2%	37.7%	15.7%
1A3bc	GEAA-TCNA2015	10.4%	8.7%	5.4%	5.7%	12.7%	13.6%	12.0%	8.7%	18.5%	20.0%	12.0%	16.8%	29.8%	16.6%
1A3bc	GEAA-CEDS	11.4%	4.2%	29.4%	27.1%	122.7%	9.9%	10.5%	7.9%	15.6%	15.7%	13.4%	15.5%	18.4%	21.4%
1A3bc	GEAA-EDGAR	14.2%	5.2%	3.4%	3.8%	84.0%	10.9%	9.9%	11.4%	15.5%	13.9%	10.1%	11.3%	44.6%	59.0%
1A3bc	GEAA-AVERAGE	10.7%	3.7%	5.8%	6.5%	29.8%	10.6%	7.6%	6.6%	7.1%	10.4%	9.9%	10.0%	19.3%	18.9%

Ref.: mad: Mean absolute differences from two inventories for years 1995-2015. sd.: Standard deviation of two inventories for years 1995-2015. GEAA-AVERAGE: Differences between GEAA profile and the average of all inventories profile. TCNA2015 (1995-2014); CEDS (1995-2014).

Table A7: Comparison of total annual values for 5 inventories: GEAA, TCNA2015, TCNA2019, CEDS and EDGAR, years 1995-2015,cont.

SECTOR	POLLUTANT	CO2		CH4		N2O		NOX		CO		NMVOC		SO2	
		mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd	mad	sd
1B1-2	GEAA-TCNA2019	19.2%	18.8%	6.6%	6.3%	16.9%	18.5%	26.9%	19.2%	2.2%	1.9%	56.6%	25.7%	12.7%	12.7%
1B1-2	GEAA-TCNA2015	16.9%	13.8%	2.2%	2.9%	14.1%	16.0%	19.5%	16.9%	2.0%	2.1%	46.9%	27.4%	11.7%	13.0%
1B1-2	GEAA-CEDS	87.1%	36.6%	134.5%	16.8%	76.9%	13.1%	23.2%	23.3%	222.4%	16.2%	22.9%	35.8%	12.5%	12.4%
1B1-2	GEAA-EDGAR	67.3%	53.2%	93.5%	22.9%	61.4%	25.3%	81.5%	65.2%	232.3%	22.2%	23.6%	25.6%	119.0%	16.0%
1B1-2	GEAA-AVERAGE	28.0%	22.3%	45.8%	7.2%	19.1%	12.8%	28.4%	22.2%	94.0%	2.1%	27.6%	21.6%	19.3%	16.0%
2A-H	GEAA-TCNA2019	3.9%	5.8%	202.3%	68.9%										
2A-H	GEAA-TCNA2015	74.3%	7.7%												
2A-H	GEAA-CEDS	45.7%	11.0%	30.9%	24.0%	147.3%	42.1%	73.9%	31.8%	41.4%	22.9%	17.8%	24.9%	196.5%	84.0%
2A-H	GEAA-EDGAR	154.9%	17.9%	34.5%	20.2%	54.6%	24.5%	83.4%	26.7%	6.9%	8.7%	154.9%	22.8%	16.1%	23.6%
2A-H	GEAA-AVERAGE	85.6%	1.7%	81.9%	2.2%	56.2%	42.1%	44.7%	36.6%	36.5%	17.1%	51.3%	15.7%	53.0%	36.6%

Ref.: mad: Mean absolute differences from two inventories for years 1995-2015. sd.: Standard deviation of two inventories for years 1995-2015. GEAA-AVERAGE: Differences between GEAA profile and the average of all inventories profile. TCNA2015 (1995-2014); CEDS (1995-2014).

Table A8: TCNA 2015 inventory: annual GHG emissions (CO2eq) for Argentina

Year	Thermal	Industry	Refineries	Oil and gas wells		Transport		
	power plants	Own generation	Own consumption	Fuel production	Fugitive	road	aviation	RR+Nav
	1A	1A2	1A1b	1A1c	1B2	1A3b	1A3a	1A3c-d
1990	15,706.88	16,501.02	9,269.17	3,447.89	6,950.76	25,507.58	815.39	288.37
1991	19,136.44	16,768.11	10,901.54	4,892.44	7,408.33	29,461.89	733.85	330.67
1992	18,017.77	17,352.62	10,659.80	3,694.22	7,750.94	32,019.02	884.85	328.63
1993	18,015.32	16,740.70	10,289.13	3,474.92	8,309.04	32,737.29	948.27	344.06
1994	17,628.19	20,018.24	9,023.33	3,740.68	8,866.12	35,737.92	1,951.31	363.93
1995	18,166.10	19,449.54	9,102.76	4,080.22	9,564.93	36,945.09	1,514.86	338.02
1996	21,285.91	19,873.51	9,524.50	5,085.91	10,516.06	39,232.40	1,314.52	661.29
1997	19,134.48	21,989.22	11,828.70	6,910.75	11,067.24	41,133.64	1,250.39	610.85
1998	21,058.34	21,275.85	13,295.01	8,668.25	11,319.03	41,052.62	1,454.38	660.72
1999	25,361.58	19,713.04	11,113.80	6,853.12	11,751.22	40,063.34	1,625.74	525.97
2000	24,930.20	19,833.80	11,372.46	7,270.08	12,002.19	42,946.45	1,456.41	554.78
2001	18,588.23	19,715.11	11,363.35	7,466.04	12,324.69	39,290.91	1,221.01	537.51
2002	15,629.79	19,228.19	12,045.22	7,869.93	11,878.26	36,005.43	1,051.15	367.43
2003	19,294.77	21,491.67	12,629.12	8,040.06	12,695.49	36,180.78	993.08	413.59
2004	24,327.20	23,400.78	12,906.03	8,478.70	12,913.57	39,735.19	1,129.51	488.02
2005	26,647.44	22,467.38	12,080.06	8,123.95	12,774.80	41,411.57	1,154.19	528.46
2006	29,569.33	25,295.68	12,529.30	8,182.17	12,910.18	44,517.82	1,051.50	609.38
2007	34,148.97	27,087.89	13,781.99	8,977.27	12,887.55	47,496.82	1,113.14	418.64
2008	37,551.54	24,402.58	14,938.58	9,757.38	12,828.71	48,113.19	1,227.32	403.06
2009	34,574.48	23,556.89	15,451.87	10,271.38	12,134.80	48,806.22	1,265.50	403.63
2010	37,231.26	23,094.29	15,944.78	10,060.11	11,871.86	49,949.26	1,072.06	1,267.85
2011	42,719.05	24,455.59	15,401.95	9,978.06	11,785.01	51,675.56	1,029.39	1,672.33
2012	45,839.43	21,296.52	15,557.41	10,015.44	11,492.12	49,547.25	1,123.33	1,619.72
2013	45,387.65	21,873.91	15,876.59	10,002.27	11,146.36	52,200.96	1,425.95	1,264.30
2014	42,862.29	20,911.32	15,477.85	10,093.15	11,178.27	54,278.65	1,424.71	1,225.31

- All values are expressed in Gigagram (Gg)

Table A8: TCNA 2015 inventory: annual GHG emissions (CO2eq) for Argentina (cont)

Year	Residential R+C+G	Industry process	Livestock	Agriculture	AWB	Open Fire	TOTAL CO2eq
	1A4a-b	2B-2C	3A	3C	3C	4D	
1990	24,517.72	9,540.84	87,636.74	349.19	212.30	11,169.89	197,453.73
1991	24,720.74	8,378.34	88,594.13	463.43	186.93	11,271.16	207,248.02
1992	25,140.64	8,303.30	89,722.18	529.82	146.92	11,342.06	210,977.93
1993	26,223.75	8,912.40	90,799.21	1,282.76	134.26	11,443.96	214,834.65
1994	26,742.26	9,721.20	91,952.85	1,883.75	133.34	7,415.99	224,217.00
1995	27,148.36	9,328.91	89,756.38	2,105.59	137.81	7,669.22	223,710.37
1996	28,071.42	9,836.97	88,821.63	3,248.31	132.77	7,163.02	232,683.63
1997	28,671.85	10,826.80	87,426.72	3,150.95	133.77	5,200.40	237,382.10
1998	29,365.26	10,418.14	86,637.43	3,276.85	127.27	6,473.43	240,118.89
1999	30,813.07	10,039.09	87,100.90	3,902.55	123.16	5,087.66	242,294.36
2000	31,740.68	10,885.59	90,383.24	3,801.71	115.26	11,855.40	250,161.47
2001	32,065.79	10,576.84	92,194.44	4,001.92	107.31	16,481.77	242,123.13
2002	30,385.11	11,208.32	97,328.20	3,775.15	105.59	10,447.44	239,063.64
2003	31,773.64	12,198.88	103,077.81	4,886.99	106.57	11,451.45	255,793.80
2004	34,189.58	13,146.01	105,890.70	5,634.71	105.42	4,966.31	273,923.78
2005	37,339.45	14,491.42	106,500.77	5,336.95	110.22	5,947.75	280,932.86
2006	38,947.71	15,127.06	108,307.50	6,397.94	105.65	5,548.83	295,454.24
2007	43,609.29	15,764.48	108,912.19	7,209.60	98.65	4,828.97	312,602.88
2008	41,330.10	15,117.25	105,199.48	5,242.94	97.31	5,579.43	306,559.03
2009	40,661.47	12,766.63	100,433.97	4,887.72	98.70	6,485.02	295,095.93
2010	41,853.22	15,038.69	67,294.02	6,567.54	95.44	5,202.85	271,323.15
2011	42,581.64	16,209.16	68,960.22	7,136.69	91.84	4,398.59	283,778.11
2012	42,563.09	15,384.33	72,408.78	6,109.88	89.43	3,525.62	283,094.35
2013	44,474.53	16,378.75	74,069.66	6,540.19	86.17	3,609.97	290,780.21
2014	46,118.80	16,578.47	75,076.70	7,141.45	212.30	3,987.29	292,425.83

Table A9: Comparison total annual values GEAA and TCNA 2015 from 1995 through 2014

SECTOR	TPP	MFC	ROC	FPR	FUG	ROT	DOA	R+N	R+C
1995	-2.3%	-7.6%	4.5%	16.8%	61.1%	11.3%	2.9%	20.6%	2.4%
1996	-2.2%	-7.2%	3.1%	2.7%	55.5%	6.4%	4.0%	-40.0%	1.7%
1997	0.7%	-6.6%	8.0%	-19.1%	60.6%	3.4%	3.8%	-29.1%	-3.3%
1998	-1.6%	-0.1%	3.8%	-27.4%	65.0%	6.7%	3.2%	-30.0%	-6.5%
1999	-1.0%	-1.1%	-0.9%	-7.1%	62.0%	4.9%	2.6%	-11.7%	-3.4%
2000	-0.4%	-3.9%	-15.3%	-8.3%	55.1%	-4.9%	2.7%	-18.3%	-3.7%
2001	0.4%	-7.5%	-12.2%	-7.2%	61.3%	-7.7%	1.0%	13.2%	-8.9%
2002	0.8%	3.7%	-2.5%	-9.4%	61.9%	-2.5%	1.0%	14.7%	-6.5%
2003	-7.3%	-2.7%	4.4%	-7.2%	62.4%	-2.3%	1.0%	28.5%	-1.8%
2004	-1.3%	-7.4%	-14.0%	-13.7%	60.3%	1.4%	1.0%	42.7%	11.6%
2005	0.7%	-3.1%	-14.6%	-7.3%	58.5%	-6.2%	1.0%	39.9%	4.9%
2006	-3.2%	-8.6%	-13.6%	-4.5%	59.8%	-5.9%	1.0%	38.0%	-3.8%
2007	-3.1%	-14.0%	-18.6%	-4.2%	63.5%	-1.6%	1.0%	26.2%	-15.2%
2008	-0.4%	-3.7%	-28.2%	-5.3%	61.2%	3.5%	1.0%	29.1%	-9.3%
2009	0.0%	-9.3%	-17.2%	-5.1%	62.4%	-5.4%	1.0%	24.0%	2.1%
2010	-0.9%	-1.2%	-24.4%	-7.7%	66.0%	-6.1%	27.5%	27.4%	-2.4%
2011	-2.9%	-3.6%	-26.7%	-7.4%	64.6%	-4.8%	30.6%	22.4%	-11.2%
2012	-3.3%	-8.1%	-21.5%	-6.9%	68.6%	0.0%	21.9%	19.5%	-6.9%
2013	-2.0%	-8.5%	-24.0%	-7.0%	71.2%	-0.1%	0.1%	22.9%	0.8%
2014	-3.9%	-19.0%	-22.3%	-4.3%	69.9%	-5.7%	3.8%	26.0%	-6.3%
Average	-1.27%	-5.98%	-0.79%	-6.97%	62.55%	-0.79%	5.59%	13.30%	-3.30%

Ref: TPP (1A1): Power Plants, MFC (1A2): Manufacturing own fuel consumption, ROC (1A1b): Refinery own consumption, FPR (1A1c): Fuel production, FUG (1B2): Fugitive, venting and flare, ROT (1A3b): Road transport, DOA(1A3a). Domestic Aviation, R+N (1A3c-d): Railroad and navigation, R+C (NG) (1A4a-b): Residential and commercial, MOP (2B-2C): Manufacturing own process, LF (3A): Livestock feeding, AG (3C): Agriculture, AWB: Agriculture waste burning, OBB (4D). Open biomass burning.

Table A9: Comparison total annual values GEAA and TCNA 2015 from 1995 through 2014

SECTOR	MOP	LF	AG	AWB	OBB	Total	Std. Dev
1995	-7.5%	12.3%	-21.6%	-17.5%	-25.2%	12.1%	23.4%
1996	3.7%	11.3%	-23.2%	-16.5%	-18.8%	10.5%	23.4%
1997	-10.2%	8.2%	-19.0%	-7.3%	19.1%	8.8%	21.0%
1998	2.5%	9.9%	-28.4%	7.9%	-17.3%	10.2%	22.8%
1999	6.9%	14.1%	-12.4%	6.2%	6.4%	11.6%	20.3%
2000	8.3%	7.9%	-8.2%	5.1%	-74.5%	6.6%	28.3%
2001	10.0%	7.3%	-13.1%	13.3%	-26.5%	9.0%	20.4%
2002	11.3%	-0.2%	-6.0%	11.1%	-17.1%	7.4%	18.9%
2003	-0.4%	-5.7%	-12.6%	22.4%	-6.9%	5.1%	20.3%
2004	4.5%	-0.8%	-11.7%	19.7%	42.1%	6.8%	26.5%
2005	0.2%	-6.3%	-13.7%	20.2%	8.0%	2.6%	42.2%
2006	4.6%	-7.6%	-15.6%	32.5%	24.7%	0.6%	28.4%
2007	1.0%	-11.3%	-9.1%	37.0%	17.9%	-2.6%	23.2%
2008	2.3%	-6.6%	-7.1%	37.7%	52.3%	2.5%	27.4%
2009	1.9%	-11.6%	-2.3%	29.9%	7.7%	0.3%	20.5%
2010	-0.2%	22.9%	0.7%	20.3%	-2.3%	9.5%	21.8%
2011	-0.1%	21.8%	-15.4%	24.6%	9.6%	6.8%	23.2%
2012	2.6%	14.4%	3.9%	22.8%	35.9%	7.0%	22.3%
2013	0.2%	13.7%	-16.2%	10.1%	55.9%	7.7%	25.9%
2014	1.0%	20.4%	-19.2%	3.3%	-9.7%	7.0%	25%
Average	2.13%	5.71%	-12.51%		14.13%	6.47%	24.26%

- The percentage difference has been computed as (GEAA – TCNA) / GEAA * 100.%

Ref: TPP (1A1): Power Plants, MFC (1A2): Manufacturing own fuel consumption, ROC (1A1b): Refinery own consumption, FPR (1A1c): Fuel production, FUG (1B2): Fugitive, venting and flare, ROT (1A3b): Road transport, DOA(1A3a). Domestic Aviation, R+N (1A3c-d): Railroad and navigation, R+C (NG) (1A4a-b): Residential and commercial, MOP (2B-2C): Manufacturing own process, LF (3A): Livestock feeding, AG (3C): Agriculture, AWB: Agriculture waste burning, OBB (4D). Open biomass burning.

Table A10: Comparison total annual values GEAA and EDGAR from 1995 through 2015 for PM

1995-2015	GEAA-EDGAR	PM10		PM2.5	
Stat./ sector		Mean	Std. Dev.	Mean	Std. Dev.
TPP	1A1a	-108.67%	26.68%	-80.6%	28.8%
MFC	1A2	-87.5%	18.7%	-61.9%	19.9%
ROC/FPR	1A1bc	194.2%	1.5%	192.8%	2.52%
FUG	1B2	170.6%	26.9%	172.4%	25.58%
ROT	1A3b	-5.8%	9.3%	-16.3%	9.2%
DOA	1A3a	-157.6%	3.8%	-197.9%	0.2%
R+N	1A3c-d	-77.6%	31.1%	-46.4%	107.1%
R+C	1A4a-b	-26.4%	24.6%	18.17%	24.25%
MOP	2B-2C	-68.9%	16.9%	-48.7%	17.7%
LF	3A	102.4%	5.4%	161.0%	4.2%
AG	3C	126.0%	9.5%	-193.9%	0.9%
OBB	4D	-95.3%	40.4%	-134.5%	27.5%
Total		**-49.6%**	**17.3%**	**-95.5%**	**15.9%**

- The percentage difference has been computed as (GEAA – EDGAR) / GEAA * 100.%

Ref: PP: Power Plants, MFC: Manufacturing own fuel consumption, ROC: Refinery own consumption, FPR: Fuel production, FUG: Fugitive, venting and flare, ROT: Road transport, DOA. Domestic Aviation, R+N: Railroad and navigation, R+C (NG): Residential and commercial (natural gas), R+C (OF) Residential and commercial (other fuels), FAG: Fuel use in agriculture, MOP: Manufacturing own process, LF: Livestock feeding, AG: Agriculture, AWB: Agriculture waste burning, OBB. Open biomass burning.

FIGURES

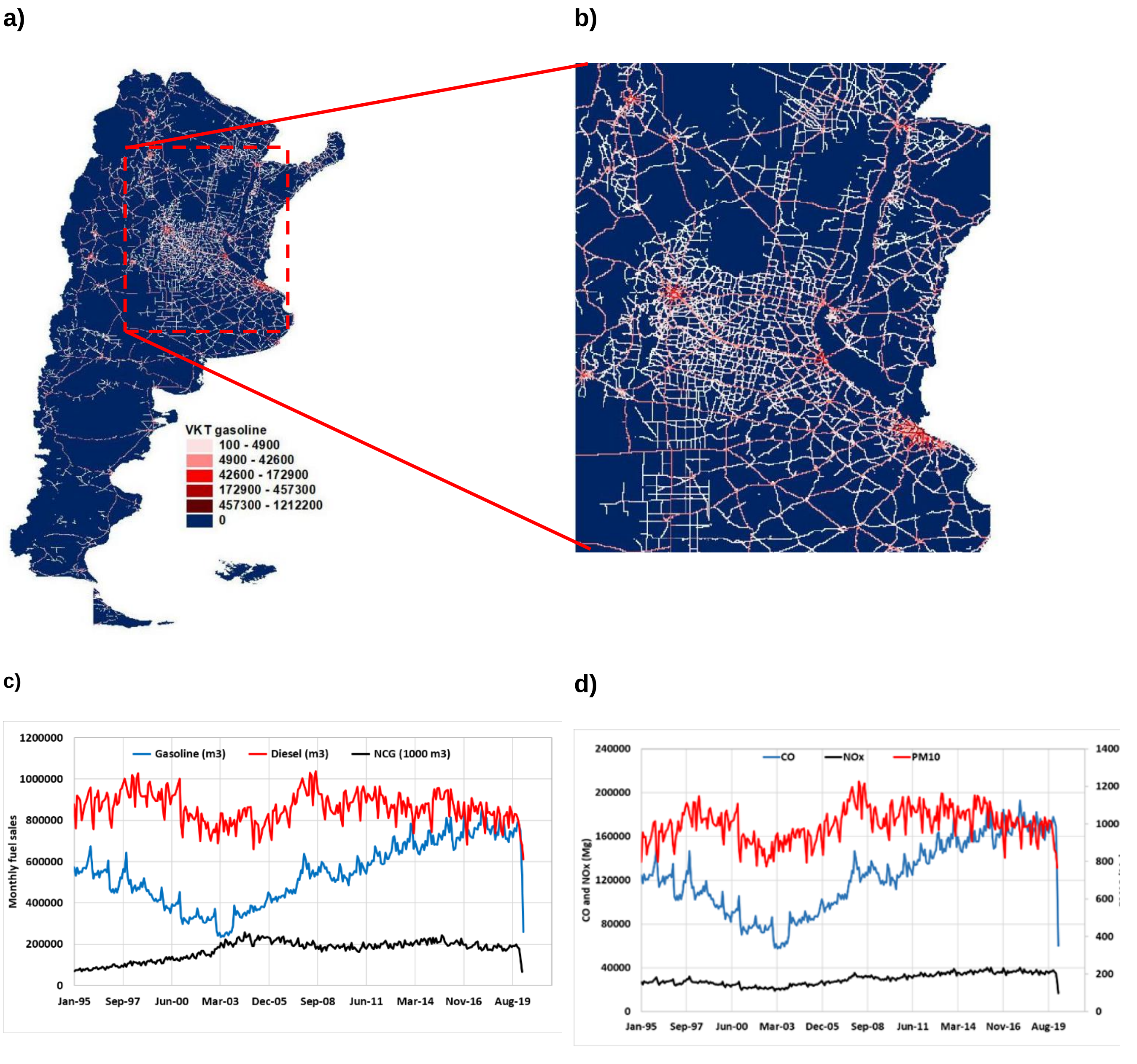
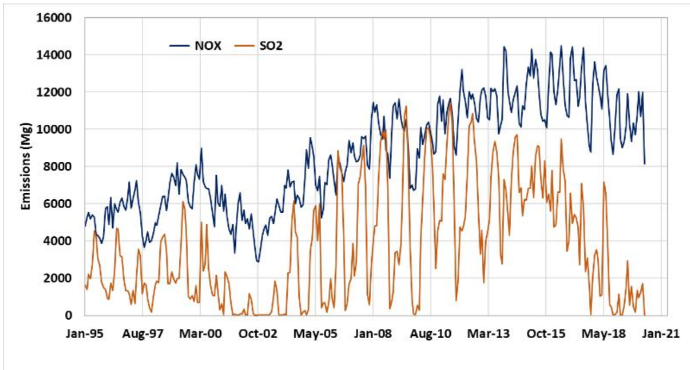
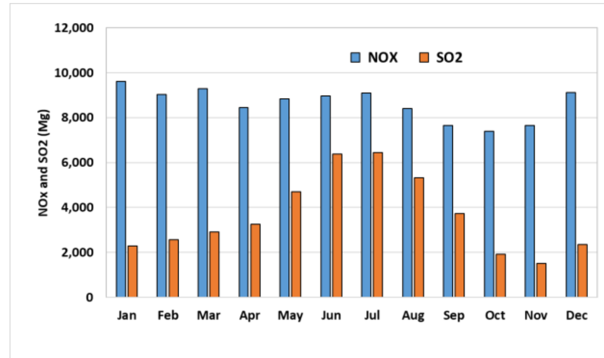


Figure A1: Calculated VKT for gasoline vehicles; b) Calculated VKT for gasoline vehicles at central area of Argentina. c) Monthly fuel sales: Gasoline blue line); Gas oil (red line); Compressed natural gas (CNG) (black line); d) Monthly emissions (in Mg) from road transport between January-1995 through April 2020; CO (blue line) and NOx (black line) left axis, PM10 (red line) right axis.

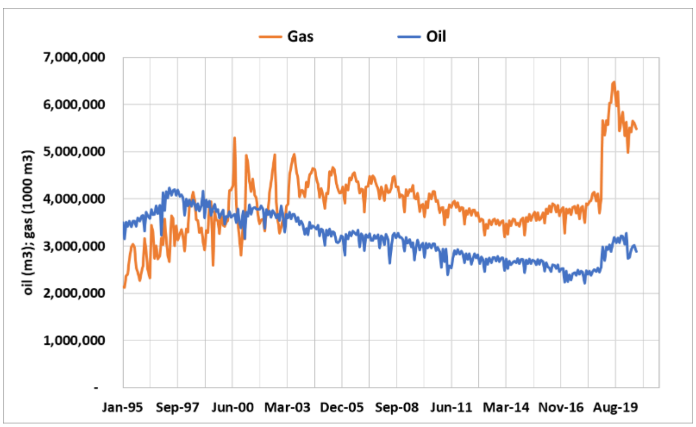
a)


NOX SO2
Emissions (Mg)
16000
14000
12000
10000
8000
6000
4000
2000
0
Jan-95 Aug-97 Mar-00 Oct-02 May-05 Jan-08 Aug-10 Mar-13 Oct-15 May-18 Jan-21

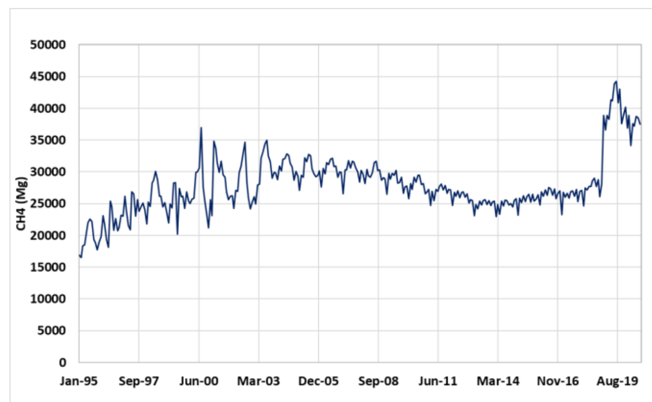
b)


NOX SO2
NOx and SO2 (Mg)
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

c)

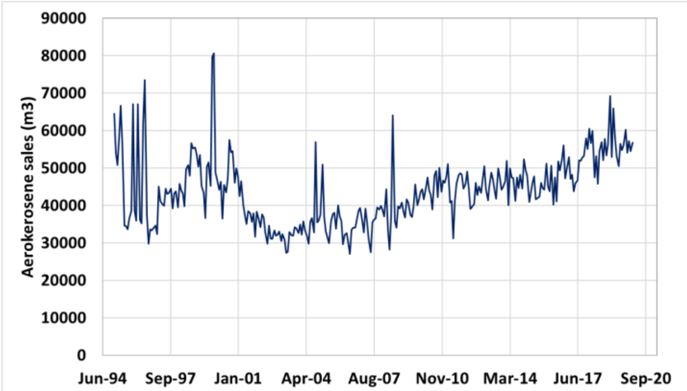

Gas Oil
oil (m3); gas (1000 m3)
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
Jan-95 Sep-97 Jun-00 Mar-03 Dec-05 Sep-08 Jun-11 Mar-14 Nov-16 Aug-19

d)


CH4 (Mg)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-95 Sep-97 Jun-00 Mar-03 Dec-05 Sep-08 Jun-11 Mar-14 Nov-16 Aug-19

e)

f)



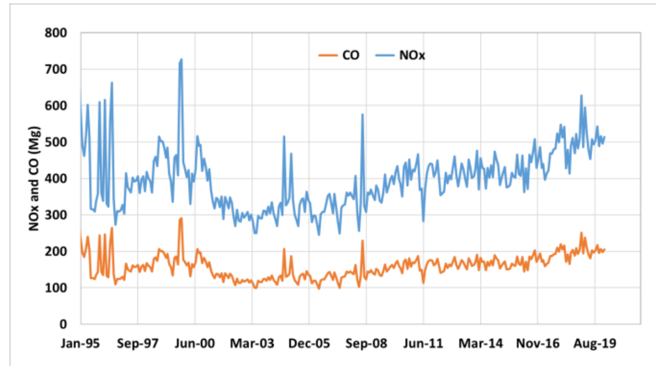
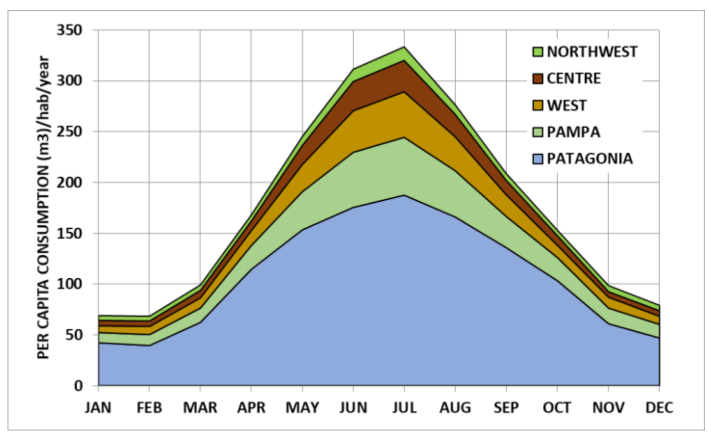


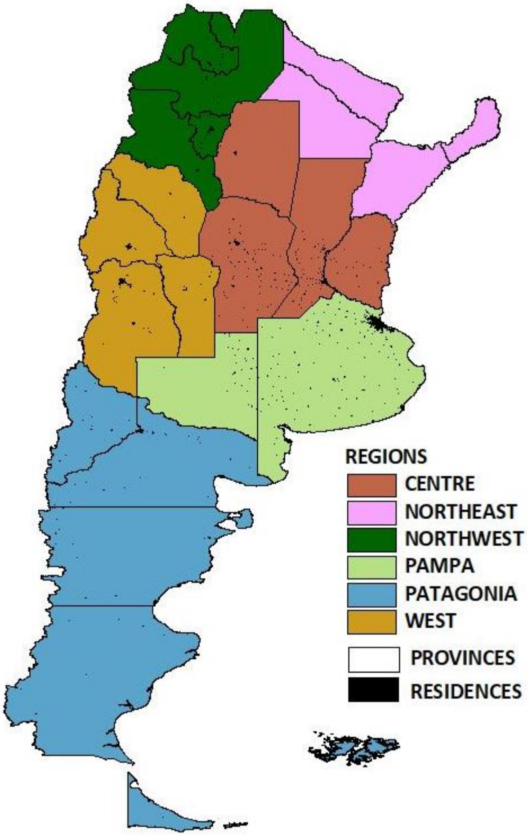
Figure A2. a) Monthly NOx and SO_2 emissions (Mg) from thermal power plants; b) average seasonal NOx and SO_2 emissions 1995-2019 (Mg) from thermal power plants; c) Monthly oil (m^3) and gas production (1000 m^3); d) Monthly methane emissions (Mg) from fuel production. e) Monthly aerokerosene sales at airports (m^3) for domestic and international flights; f) Monthly CO and NOx emissions from aviation.

a)

b)



c)



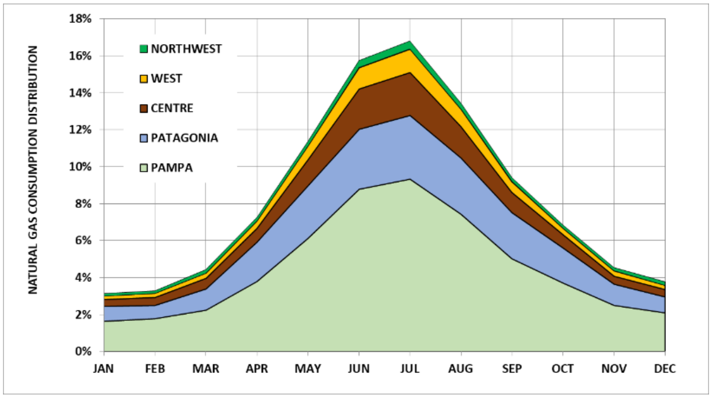


Figure A3. a) Regions and provinces with natural gas consumption at homes, b) Per capita annual natural gas consumptions, c) regional and seasonal distribution of natural gas consumptions per region (% of total annual consumption).

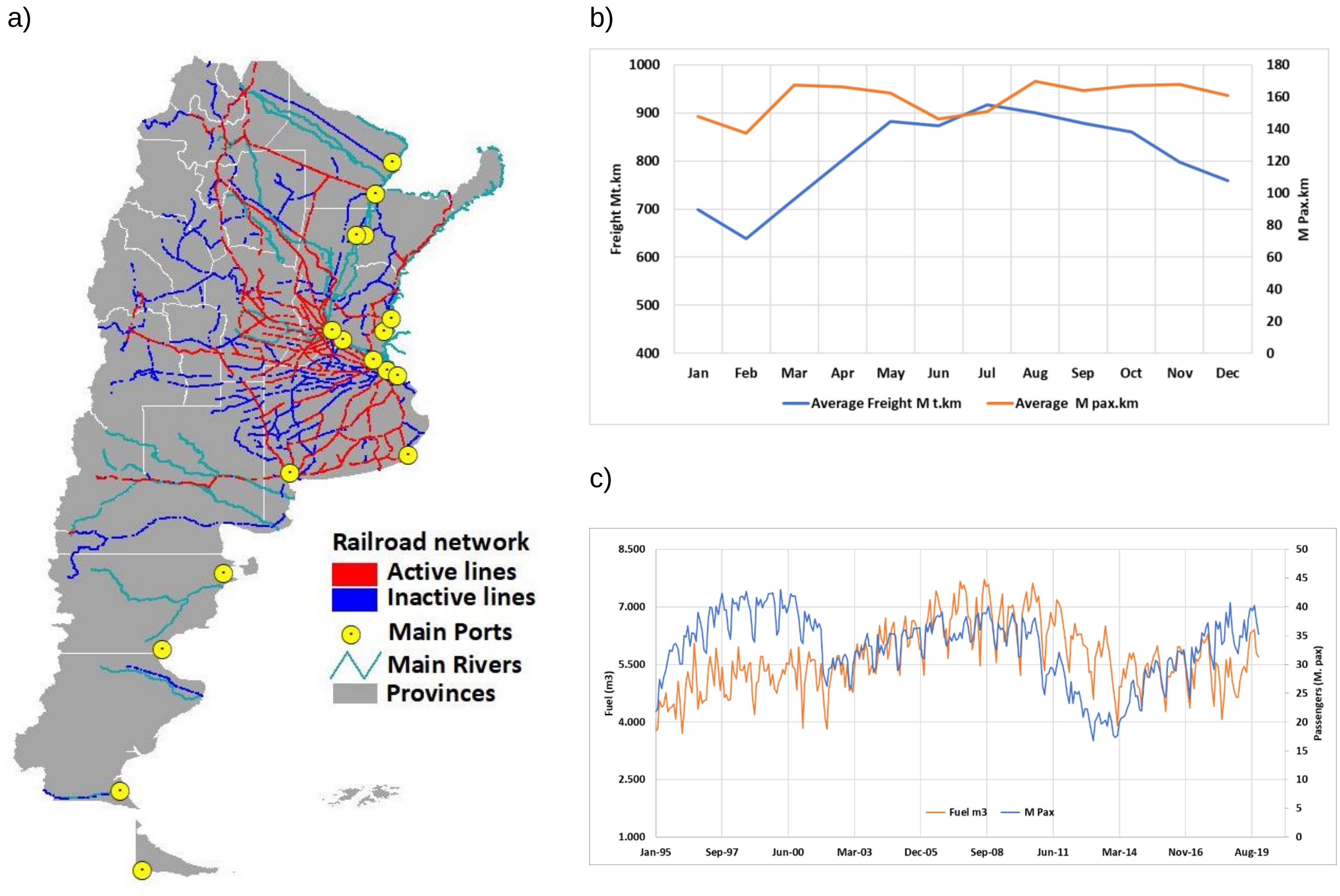


Figure A4. a) Railroad network and navigation ports, b) seasonal railroad freight (Million t. per km) and passenger activity (Million passengers per km), c) Monthly railroad activity and fuel consumption (m^3) and passenger activity (Million passengers per km).

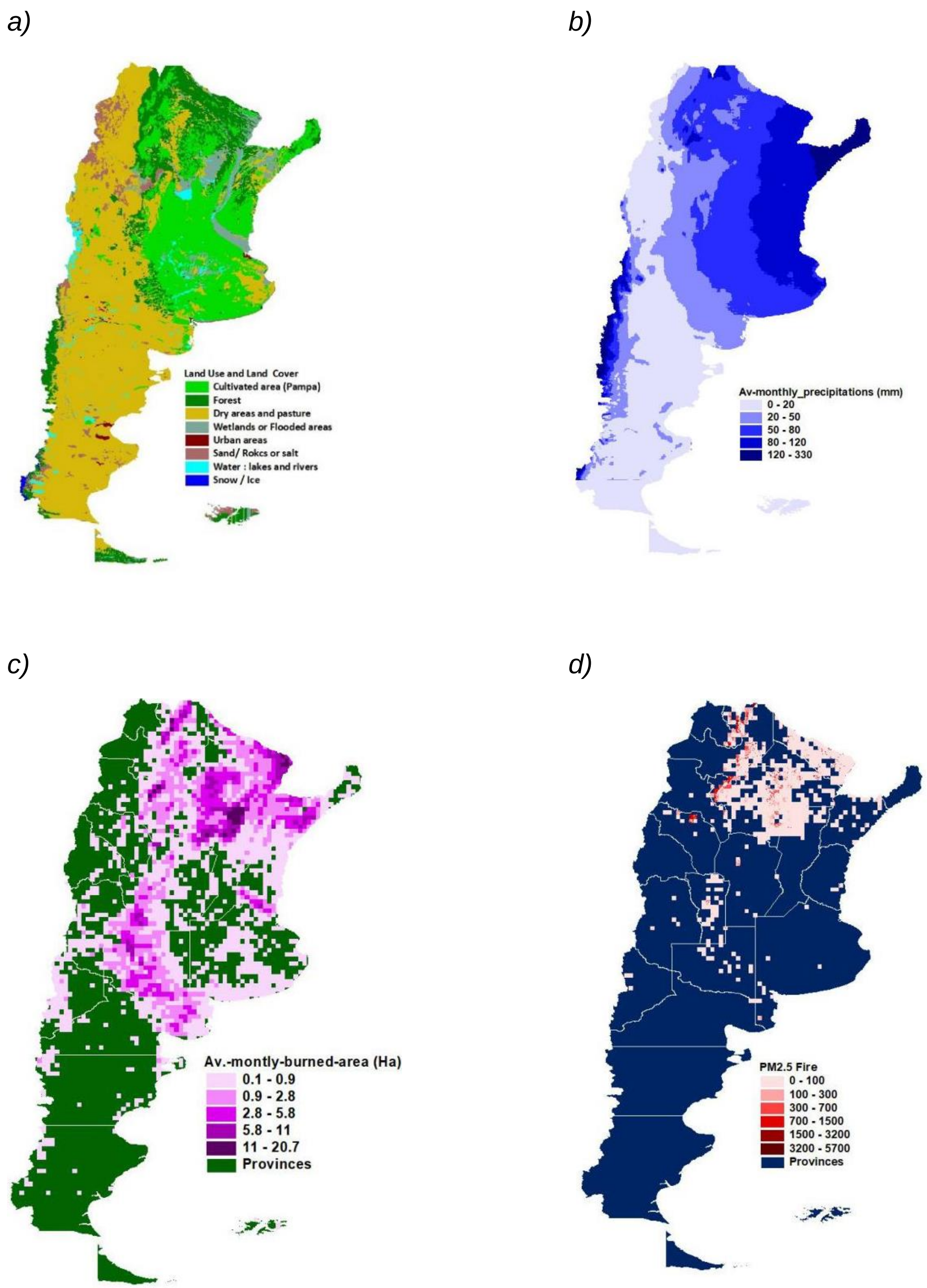


Figure A5. a) Land types for Argentina; b) monthly average precipitation (mm/cell); c) monthly average burned area (ha/cell); d) PM2.5 emissions in (kg/cell) for Sept. 2017.

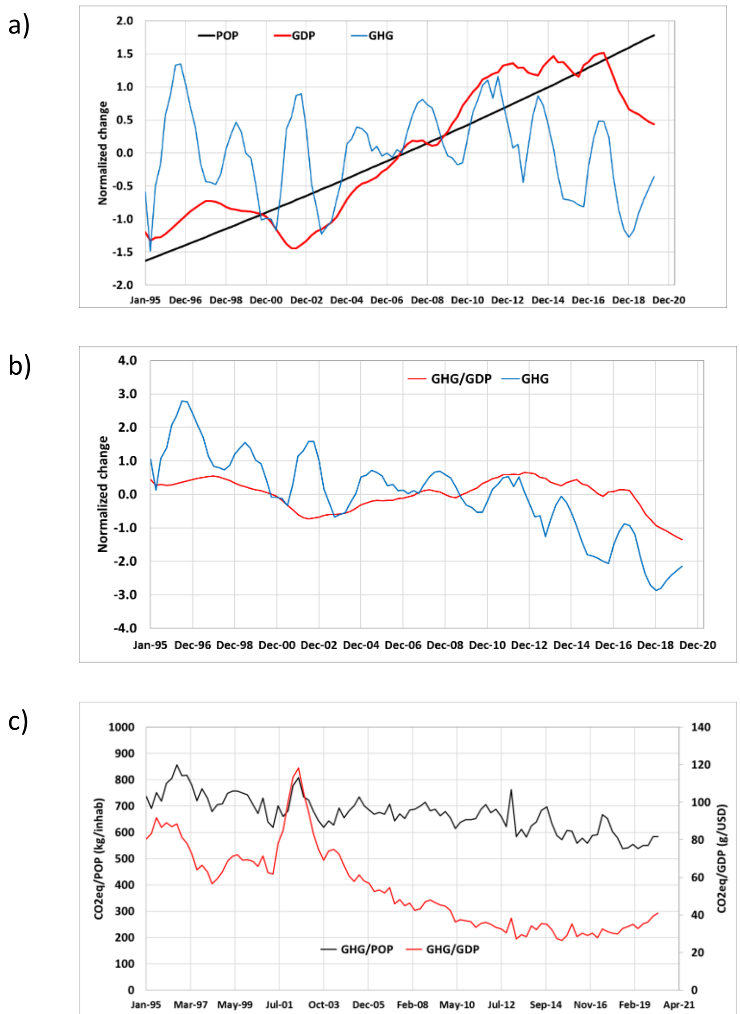


Figure A6: Normalized Change in a) Population, Gross Domestic Product and GHG in terms of CO2eq between 1995 and 2020; b) Population de-trended GDP and GHG. c) De-trended GHG/cap and GHG/GDP. The normalized function is obtained by subtracting the function mean value and divided by its standard deviation.

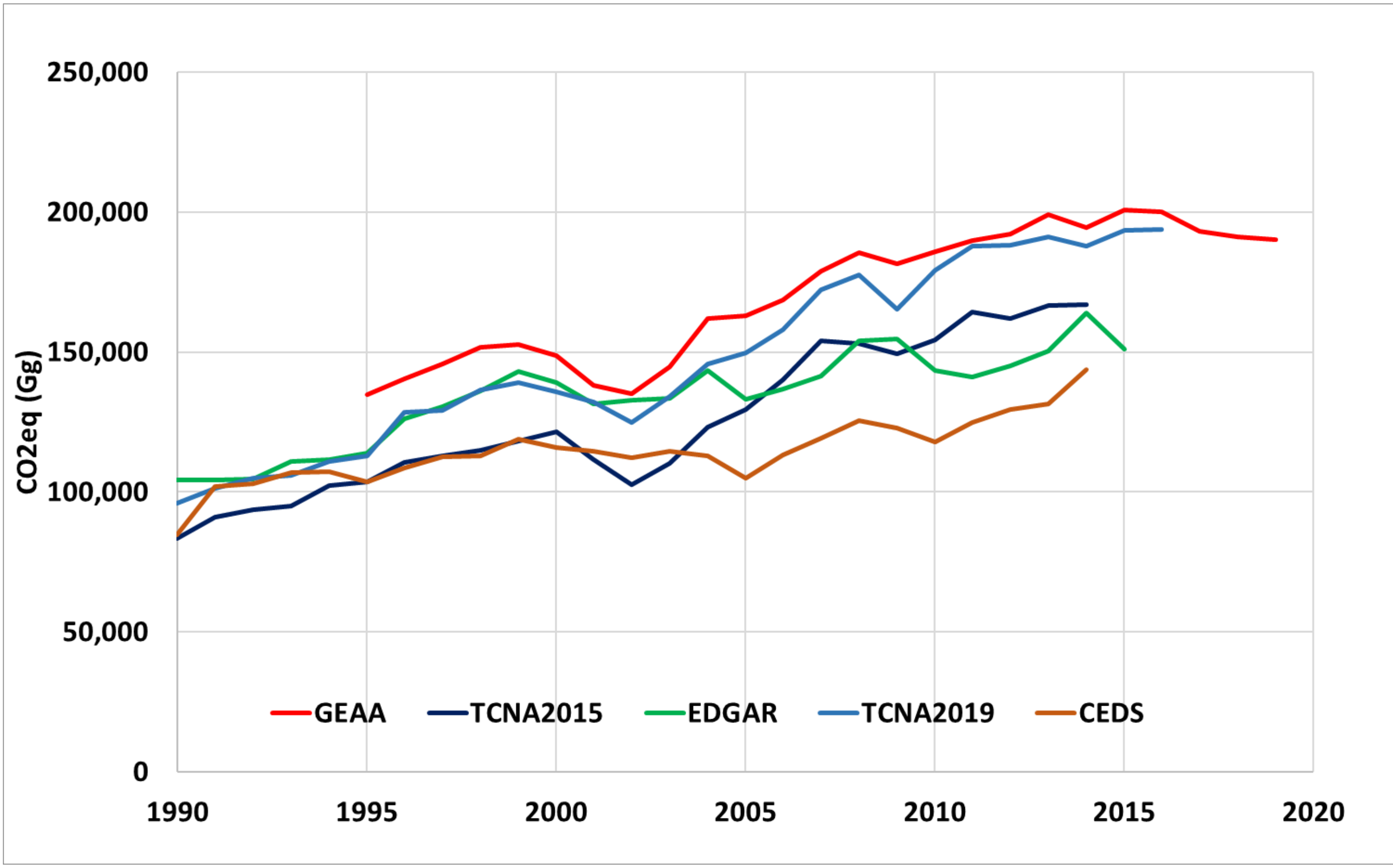


Figure A7. Comparison of annual GHG emissions for the energy sector between the different inventories considered in this work (see Table A7.).