Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2020-367-AC1, 2021
© Author(s) 2021. CC BY 4.0 License.

Open Access Earth System Science Data Discussions

Interactive comment on "The consolidated European synthesis of CH_4 and N_2O emissions for EU27 and UK: 1990–2018" *by* Ana Maria Roxana Petrescu et al.

Ana Maria Roxana Petrescu et al.

a.m.r.petrescu@vu.nl

Received and published: 12 March 2021

Dear Topical Editor Nellie Elguindi, Dear Referees and Editorial Board of ESSD,

As requested, we are submitting responses to the referees' comments. We will provide as well a track-change version of the manuscript. We will not refer here to grammar or language corrections, but they will appear in the marked-up manuscript. The lines in the following answers refer to the track-change version of the manuscript.

Interactive comment on: "The consolidated European synthesis of CH4 and N2O emissions for EU27 and UK: 1990–2018" by A.M.R. Petrescu et al.

REPLY TO THE REFEREE #1 The authors thank Referee #1 for the thoughtful and helpful comments and for the fact that the Referee acknowledges the manuscript as being a comprehensive collection of data, very useful for modelers and the whole scientific community and for quantifying the progresses towards mitigation target assessed through the global stocktake. Below we provide answers to the general and specific comments posted by Referee #1. One general comment: as requested by our co-author Rona Thompson, the N2O inversion model PYVAR was renamed with CAMS-N2O (Figure 9).

General evaluation: This study is intended to be updated annually, similar to the GCP papers (Friedlingstein et al., 2019), and to evolve into a complete synthesis of bottom-up and top-down GHG estimates of European countries and ecosystems. While the GCP provides the global carbon budget, the current study starts a series of datasets for EU. These are essential for the GHG Monitoring and Verification Support (MVS) capacity that the EU envisages to build in support of the enhanced transparency framework of the Paris Agreement (e.g. Janssen-Maenhout, 2020). Our data access is similar to that provided by GCP. "The manuscript is well structured and well written in general. However, some descriptions and clarifications of all the data provided in this study will be essential for readers to be actually benefit from the compilation done in this study. For example, to facilitate the use of the data by others, it could be very useful to provide a detail instruction explaining how the data shared on zenodo was structured" The Zenodo data https://doi.org/10.5281/zenodo.4590875 (this is the new doi number, data version v2) are the data for the figures, according to the policy of ESSD, and we believe is sufficient to ensure easy replicability. For most of the raw gridded data underlying these aggregated data (i.e. for EU27+UK) the co-authors would prefer to be first contacted, in line with their own data policy. We chose to add their contact details or the direct link from where the data can be downloaded (if free) in Appendix B, Table B2. As the referee suggested, we compiled all the aggregated data files (associated to each figure) in one aggregated file with different spreadsheets per figure and for the files containing the means we added as well the entire time series from where this

mean value was calculated. Regarding the description of the datasets, in the revised version we clarify the situation of data availability accordingly: Line 154: “References are given in Table 2 and the detailed description of all products in Appendix A1-A3.” In Appendix A1-A3 we describe each source containing information on spatial resolution, time steps and we updated as well the data in the excel sheets to ensure a better readability as suggested by the referee. “how to read and process them automatically (e.g., providing a R/python program/package)” Given that all data is already provided in a basic input table csv file(s), we think that this is enough to ensure plotting, and for the precise replicability of the style/layout of the figures, if needed, we could make codes available upon request. We added on L185 the following sentence: “Upon request, we can provide the codes necessary to plot precisely the style/layout of the figures.” “I also noticed that the files provided on zenodo are only the numbers used to plot the figure shown in the manuscript and were separated to many small csv files with one line only and less than 1k size. I believe the date provided should be well organized for users (e.g., one file with overviews presented and multiple sheets each for a sector etc.). As a reader, I would mostly be interested in the original data presented in this study including country-specific values rather than aggregated to a few regions only.” The scope of this synthesis is to present the data sets for EU27+UK. For original gridded data as well as for the complete data of all other regions/countries not used in this study (italic in Appendix A, Table A1), due to data provider policy, it should be requested directly from the specific contact (Appendix B, table B2). The data policy of the VERIFY project (consortium governing document) which supported most of the research presented here restricts the free use of raw data (gridded products) for the first 12 months after its publication, as it may not be entirely published by the data providers. Therefore, we agreed to only make public aggregated data (time series, means/min/max values and aggregated uncertainties). Given that this paper discusses only EU27+UK grouping we provide the aggregated time series only for that region. We intend to submit to ESSD yearly updates for the European GHG budget and once the new update will be published the old version of previous synthesis will be made publicly available

through the VERIFY web-site (http://verify.lsce.ipsl.fr/index.php/products). For a better explanation we added on L705 the following statement: “The raw gridded data, according to the VERIFY consortium governing document, will be made publicly available 12 months after its publication in ESSD, through the VERIFY web site”. We provide as well at http://webportals.ipsl.jussieu.fr/VERIFY/FactSheets/ all figures and country-specific data, which are not included in the study but are specifically requested as a VERIFY project output. This publication represents a scientific compilation of these results and we clearly state (Lines 185-190) that all details as well as data for countries/groups of countries can be found on the VERIFY web portal. To access the web portal one needs to register once in order for us to understand the extent of public interest in the data, but there is no restriction on downloading the data. The figures can be saved and data behind figures can be downloaded.

“As mentioned in the introduction, this manuscript focus on three questions. And in the summary and concluding remarks, they are more or less discussed. But I would expect more structural synthesis of the potential answers for these three questions.” For a first compilation and study of this type for the EU27 and UK we tried to identify some questions and, as mentioned in the introduction, at this point in time we are not able to provide complete answers to these specific questions, but they were set in order to provide continuity and give scope to the next synthesis. As we stated “A comprehensive investigation of detailed differences between all datasets is currently beyond the scope of this paper”. In the conclusions we discuss the findings in more detail but it will take significantly more research to define concrete actions on how these issues can be solved. “In addition, the only 2018 value was provided by MS-NRT as preliminary estimate. All the comparisons were done before 2017. Thus I would think the title should be changed to 1990-2017.” It is true and we agree with the reviewer’s comment that the actual comparison is done until 2017. Next to MS-NRT values, only ECOSSE (Fig. 6d Agriculture N2O emissions) provided us with time series until 2018. Therefore, we will change the title and text accordingly (L46, L149, L152) We will upload next to our responses the track-changes version of the manuscript. Response to specific

comments and changes in manuscript: Other remarks: L66: “compared to 0.9 Tg N2Oyr-1 from the BU data” may not be necessary. We deleted this statement. L148-160: It is not clear which gas or gases were referred to in this paragraph. The first sentence of the paragraph L148 states that we refer to CH4 and N2O, but to clarify on line 155 we added the following: “For both CH4 and N2O BU approaches, we used inventories of anthropogenic emissions covering all sectors (EDGAR v5.0 and GAINS) and inventories limited to agriculture (CAPRI and FAOSTAT). For CH4 we used one biogeochemical....”

L158: The abbreviation “LULUCF” was not explained before this line. On Line 160 we added the following explanation: “Biomass burning emissions of CH4 from land use, land use change and forestry (LULUCF) sector account for...” L163: “from” is redundant. Was deleted L171: Should it be “come from” instead “belong to”? Thank you, we replaced with “come from” L174: Please check the name of Tables in Appendix A. Why not using Table A1 and A2? This is true, thank you, we replaced Table A with Table A1 and Table AA with Table A2. Footnote 5: Why only Vol 5 of IPCC was cited? I believe methods from many other sectors and Volumes were used. We do cite here IPCC 2006 and IPCC refinement 2019, and not only vol. 5. Footnote 6: You mean “With natural CH4, we . . .” We added the following explanation: The term natural refers here to unmanaged natural CH4 emissions (wetlands, geological, inland waters) not reported under the UNFCCC LULUCF sector.

L225-230: It still is hard to understand how the emissions were scaled. Thank you, We added in Appendix A2, geological flux description (L 1137) the following explanation: “To calculate geological CH4 emissions we used literature data for geological emissions on land (excluding marine seepage) (Etiope et al., 2019; Hmiel et al., 2020). From the gridded geological CH4 emissions by Etiope et al., and using the land-sea mask for EU27+UK (to exclude marine seepage), geological CH4 emissions from the land of EU27+UK are 8.83 Tg/yr. Then we scaled this number by the ratio of global geological CH4 emissions estimated by Hmiel et al. and by Etiope et al., thus obtain-

ing a value of 8.83*5.4/37.4=1.3 Tg/yr (marine and land geological).. The global total geological CH4 emissions reported by Etiope et al. and Hmiel et al. are 37.4 Tg/yr and 5.4 Tg/yr, respectively.” In his paper Hmiel et al 2020 compared his numbers to those of Etiope et al 2019 and wrote the following explanation: "(1) the uncertainties associated with global upscaling of geological emissions from discrete measurements result in overestimation by an order of magnitude, or (2) geological CH4 emissions quantified by these measurements were not present in the preindustrial era and may have been triggered by fossil fuel extraction from hydrocarbon reservoirs or other anthropogenic activity such as groundwater aquifer depletion. If the latter is true, such emissions cannot be considered natural."

L235: There is no Table 5. That is correct, in L272 we corrected the number to now it refer to Table 2. L266: “SURF” was not explained before. We added on L 269 the surface station (SURF) explanation. L268: The last sentence is not clear. We think the sentence the referee refers to is: “None of the regional inversions use GOSAT prior data as all base their prior data on SURF stations” In the previous paragraph L264-L269 we explain that global inversions base their prior information on both GOSAT and SURF data. We made this statement as regional inversions will not use GOSAT but only SURF. We changed on L271 to: “All regional inversions use observations from SURF stations as a base of their emission calculation”.

L296: It seems not only anthropogenic emissions were described in section 3.1. This is true, we deleted the word anthropogenic, as natural emissions appear as well in 3.1.3 and 3.1.4. We did the same for the N2O section 3.2.

L298: What are the differences between European and regional total? It looks like sub-regional total. We are sorry but we do not understand this comment and what sub-regional total refers to. If the comment addresses results from Figure 1, our aim was not to compare the regions to the total EU but instead to highlight differences between BU and TD estimates within the region and between regions.

L342: It is not clear how a less dense network of surface stations cause the BU = TD estimates. Some further explanations are needed. We replaced this sentence: “For Eastern Europe we note that BU anthropogenic estimates have the same magnitude as the TD. We hypothesize that this could be due to a less dense network of surface stations.”. with the following explanation (L348-353): “For Eastern Europe we note that BU anthropogenic estimates have the same magnitude as the TD. One possible explanation is linked to the fact that in TD estimates (i.e. using atmospheric inversions) the fluxes are strongly constrained in regions with a high density of observations. Where there are few or no observations, the fluxes in the inversion will stay close to the prior estimates, since there is little or no information to adjust them. The prior estimates are, in fact, the BU estimates, which means the TD and BU estimates will be similar.”

L534: Is there any reason that the GOSAT-derived estimates are so different from SURF-derived ones? Regarding the difference between global and regional inverse estimates, one possible explanation is that satellites (including GOSAT) are not as sensitive to the lower troposphere (the part of the atmosphere closest to the fluxes) as ground-based observations. Therefore, it can be that the inversions with GOSAT miss some of the information that is available from the ground-based observation.

L538-542 (and also across the manuscript): Can the uncertainty of the trends be given? In addition, it would be interesting to compare the trends of the common period 2010-2016. Otherwise, they are not comparable. We thank referee for noticing this inconsistency. Looking at Figure 5, we feel that neither SURF nor GOSAT ensemble shows a linear reduction from 2010-2016, therefore we replaced the paragraph: “Regarding trends, for total CH4 emissions (Figure 5a), the SURF and GOSAT ensemble show a decreasing trend of -1.2 % yr-1 and -0.6 % yr-1, respectively, over the period covered by each of them (SURF: 2000-2016; GOSAT: 2010-2017). For anthropogenic CH4 emissions (Figure 5b), the SURF ensemble shows a decreasing trend of -1.4 % yr-1 compared to -1.5 % yr-1 for the NGHGI over 2000-2016, while the GOSAT ensemble shows a decreasing trend of -0.8 % yr-1 compared to -0.9 % yr-1 for the NGHGI

over 2010-2017.” and instead of providing the annual decreasing rates, we only provide the change from 2010 to 2016 (L546-L551) as following: “For the 2010-2016 common period, the two ensembles of regional and global models give an anthropogenic CH4 emission mean (Figure 5b) of 17.4 Tg CH4 yr-1 (GOSAT) and 23.7 Tg CH4 yr-1 (SURF) compared to 19.0 $\pm$ 1.7 Tg CH4 yr-1 for NGHGI (Fig. 5b). For the same period total CH4 emissions (Figure 5a) from the SURF and GOSAT ensemble decrease by 0.5% and 4.6%, respectively. For anthropogenic CH4 emissions (Figure 5b), the SURF and GOSAT ensemble show a decrease of 1.1 % and 6.3%, respectively, compared to 7.3% for the NGHGI from 2010 to 2016”.

We also added to the Figure 5 caption the following sentence related to the common period to calculate the means: “Two out of 11 SURF products (GELCA-SURF_NIES, TOMCAT-SURF_UOL) were not available for 2016”.

L555: Can the authors give range or % uncertainty of TD estimates for a comparison? We added the following sentence on L572: “for the EU27+UK, global inversions show a min/max range of 25-32 % while regional inversions show a variability range of 9-11 % compared to the mean 2011-2015 value”. L581: The total EU27+UK GHG emissions in CO2eq here is different from that in section 3.1.2. Please check. Thank you for your observation. It is different because in section 3.1.2 the values include emissions from LULUCF while in section 3.2.2 exclude LULUCF. We changed accordingly, referring in both sections to “include LULUCF” (L596). Figure 8: Is there any explanation of the sudden shift of EDGARv5.0 estimates in Fig. 8e? Thank you. Yes, the sudden shift in total emissions is driven by a shift after the year 2000 for EDGAR v5.0 waste N2O emissions is due to the waste water treatment domestic (WWT.DOM.N2O) activity data. For the v5.0_FT2018, version used in this plot, EDGAR was updated for the period 2000-2016 using FAO statistics on "protein_supply_kg_cap_yr". For the previous period 1970-1999 the time series from EDGAR v4.3.2 were kept unchanged. This particular jump is due to France. We added this explanation in the manuscript, L636

L650-652: It is not clear how the higher TD estimate can be attributed to the seasonal

cycle. More explanations are needed. “The higher emissions from the TD estimates could be attributed to the seasonal cycle (e.g. fertilizer application) not accounted for in the NGHGI reporting.” We have changed the above sentence to the following (L679-L683): “The higher emissions from TD estimates may be at least in part due to the fact that they include natural emissions of N2O, which are not considered in NGHGI reporting. One estimate (from the O-CN land ecosystem model) is that the natural emissions could amount to 11% of those reported in NGHGI for the EU27+UK region. In addition, the EFs used in NGHGI reporting are very uncertain (up to 300% for direct agricultural emissions) so there may be a systematic error in these”

L705: This sentence is not correctly written. On new L737 we reformulate as following: “Some studies (Fronzek et al., 2018) show that model ensembles work well in simulating highly uncertain variables.” L706: “than” rather than “then”. We corrected. L710: “fewer observations” in a specific region? I believe for global inversion, the total number of observations are more than those used in regional inversions. “The global models are less well constrained as they have lower resolution (hence larger representation errors) and often use fewer observations.” We replaced the above yellow sentence to the following (L743-747): “The global models use fewer observations for Europe compared to the European regional inversions, and thus are expected to have larger uncertainties for the European fluxes. In addition, the global models are at coarser resolution, and thus likely have larger model representation errors compared to the regional ones, which may contribute to further systematic uncertainty for the European fluxes.”

Table A: there are so many different grouping of European countries, which is very confusing. Why such groupings are used? Should it be further classified e.g., as countries, geographical sub-regions etc.? It is true that this study focuses only on EU27 and UK data with aggregated data for the five regions presented in Figures 1 (CH4) and 6 (N2O). In the revised version, this purpose is made clearer to the reader of Table A1 in its caption: “Table A1: Country grouping used for reconciliation purposes between BU and TD estimates. The countries and groups of countries in italic are not

directly used by this study but their figures and data are available on the VERIFY project web portal at: http://webportals.ipsl.jussieu.fr/VERIFY/FactSheets/.” Because VERIFY is the funder of this work and the project committed to provide European Commission with a regional and country based analysis of GHG estimates, we see the need of mentioning all those diverse groups and countries in the Appendix table A1.

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2020-367, 2020.