Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2019-199-AC2, 2020

Open Access Earth System Science Data Discussions

Interactive comment on "European anthropogenic AFOLU emissions and their uncertainties: a review and benchmark data" *by* Ana Maria Roxana Petrescu et al.

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Received and published: 18 February 2020

REPLY TO THE REFEREE #2 The authors thank Referee #2 for the thoughtful, helpful and very detailed comments and for the fact that they acknowledged the manuscript as being a comprehensive compilation of GHG AFOLU data. In the revised version we implemented the reviewer's suggestions regarding the structure, metadata and specific technical comments which were well appreciated.

General evaluation:

As mentioned above in our response to Reviewer 1, this study is intended to be annu-

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Discussion paper

ally updated, similar to the GCP papers, to become a complete synthesis of bottom-up and top-down GHG estimates of European countries and ecosystems. While the GCP provides the global carbon budget, this study starts a series of datasets for EU. These are essential for the GHG Monitoring and Verification Support (MVS) capacity, the EU envisages to build in support of the enhanced transparency framework of the Paris Agreement. The European Commission decided to take up under the long-term Copernicus a new service for monitoring anthropogenic CO2 emissions, which is under construction (Janssens-Maenhout et al., 2020).

As the referee commented, the other components (e.g. CO2 emissions from fossil fuels) and introduction of inverse estimates will be soon finalized in an updated synthesis of this current study.

Indeed, uncertainties are, at this stage in the project, only available for UNFCCC and EDGARv4.3.2 and we agree to the fact that more is needed to evaluate the validity of model results and various data sources. As also suggested by Referee #1, We will, therefore remove the word “uncertainties” from the title: "European anthropogenic AFOLU greenhouse gas emissions: a review and benchmark data".

Regarding the more comprehensive documentation for the excel tables, we added in Appendix A, Tables 1A1 and 1A2 an extra column providing the Emission Data availability (download links or contact persons). In order to read the data using different programming language, we would advise to use the original downloaded time series (as described in Tables 1A1 and 1A2). For data policy purposes we cannot provide all these detailed data for all sources. EDGAR v4.3.2., FAOSTAT and UNFCCC NGHGI 2018 are public databases therefore we added the original files "metadata_" to the new zenodo link https://zenodo.org/record/3662371#.Xkui-WhKjIU. CAPRI and CBM original time series were as well uploaded. For the rest of the data the co-authors would prefer to be first contacted before providing their full times series, in line with their data policy (H&N, EFISCEN, GAINS, TRENDY v6, BLUE).

We took on board the comment on re-writing the Appendix B UNFCCC description, therefore, the new version of the manuscript includes a more comprehensive and more consistent text, therefore, the specific line by line responses do not include those belonging to the old UNFCCC description.

Response to specific comments and changes in manuscript:

Please note that the line numbers changed. We refer below to the line numbering from the first submission version you kindly reviewed. Line 75: We added the footnote no. 2 with Annex I definition Line 77: We removed the year-2 terminology from the text Line 79: We added the reference to the Paris Agreement (2015) Line 80: We Explained in the text that CO2e refers to CO2 equivalents. We also kept throughout the text the CO2-eq format. Line 81: We added footnote no. 5 explaining the GWP concept. We added as well the reference to IPCC 2014, AR5 report. Line 81: We added footnote no. 4 explaining that FOLU is the same with LULUCF. For consistency, we refer throughout the text to LULUCF. The main reason for naming FOLU LULUCF is that FOLU represents together with Agriculture (AFOLU) a new sector under IPCC AR5, while countries report under the UNFCCC NGHGI net CO2 emissions and removals from LULUCF. Also, widely used in the literature we see the terminology incl./excl. LULUCF. Lines 81 and 87: No, there is no difference between the two expressions, we inserted everywhere for consistency the “NGHGI 2018 estimates” throughout the manuscript. Figure 1: we extended the explanations in a new Caption. We explained as well the concept of remaining and converted land. We added footnote 6 to explain the UNFCCC LULUCF classes. Line 106: Same as line 81, explained in footnote 4 Line 112 and 120: No, these emissions do not include LULUCF estimates, we added ion brackets (excl. LULUCF). We also added a sentence explaining why we exclude the CH4 emissions from LULUCF. Line 131: Yes, CH4 and N2O results from top-downs estimates will be included in the following synthesis. We therefore, as suggested, moved this sentence to Conclusions Line 152 and Table 2: We added the CO2 emissions from LULUCF to Table 2 Line 154: we replaced “observational

data streams" to "modelled and reported data-streams" Figure 2 legend: we added the following section "The values in this study are defined from an atmospheric point of view, which means that positive values represent a source to the atmosphere and negative ones a removal from the atmosphere." to the introductory paragraph of section 2. Line 198-200: we moved the CO2 information to the introductory paragraph of section 3. Line 325: We updated the Figures 3 and 7 by adding as well the difference between 2012 and 2005. 2012 is the last common year where all data sources have estimates. We updated the text and figures discussion accordingly. Line 386: We replaced "sources" with "estimates". The data belongs to CH4 emissions from wetlands, so yes, are natural CH4 emissions. Line 466: We updated the DGVM definition as following: "DGVMs calculate NBP as the net flux between land and atmosphere defined as photosynthesis minus the sum of plant and soil heterotrophic respiration, carbon fluxes from fires, harvest, grazing, land use change and any other C flux in/out of the ecosystem (e.g. DIC, DOC, VOCs)" Line 499: If afforestation is removed the sink will decrease, we therefore corrected the statement. For consistency, we changed as well the colors of Figure 10 to match the UNFCCC and FAOSTAT colors used in Figures 2,3,5,6,7,8. Line 516: We added the footnote 9 explaining what FRA means. The link was as well corrected. Line 543-546: We rephrased this paragraph: "Some of these are found in northern Europe (e.g. Finland and Sweden), while others are in the far south, i.e. the south of Spain. In 2015 just above one fifth of the EU28's area (21 %) was covered by grassland. There is a broad range across EU Member States, with Ireland having 56% of its total land area as grassland and Finland and Sweden less than 6 % of the land (EUROSTAT: https://ec.europa.eu/eurostat/statistics-explained/index.php/Land_cover_statistics)." Line 557: We added a paragraph stating which countries are triggering the high grassland estimates: "The high estimates of grassland emissions in 2016 UNFCCC NGHGI submissions are explained by increased emissions in Austria, Denmark, Croatia; Sweden changed from being a sink in 2015 to being a very high source in 2016 and Hungary and Greece reported lower sink. Ireland was the only country which reported a higher sink in 2016 com-

pared to 2015" Line 625: Yes, Houghton estimates are the same as H&N estimates, we changed the text accordingly. Figure 13: We uploaded on the new zenodo link https://zenodo.org/record/3662371#.Xkui-WhKjIU the data for Figure 13. We deleted the term "Model (cumulative 1990)" and updated the names of the data sources and colours for consistency with the other Figures (e.g. Figure 10) in the manuscript. Line 676: Yes, it is true, we deleted the word "InGOS" and left the reference. Line 728: Freshwater CO2 is not a disturbance, we rephrased: "carbon lost due to a disturbance (e.g. forest fire, harvest)" Figure 14 legend: We provide a clearer figure caption Line 811: We added some sentences at the end of the Conclusions paragraph. Line 815: total emissions column: refers to the XCO2 = the column-averaged dry-air mole fractions of CO2 and XCH4 = the column-averaged dry-air mole fractions of CH4 Line 815ff: we added the two references as suggested together with a sentence on regional inversions. Appendix B UNFCCC: the whole description was re-written – this refers also to the remaining remarks Line 884ff: the new UNFCCC updated text includes a clearer explanation on Monte Carlo simulations and uncertainty approaches according IPCC 2006 guidelines. Table B1: No sectors are missing; the table explains which sub-sectors are aggregated for uncertainty calculation purposes. Line 977: we added the following explanation: The correction factor is used as an empirical adjustment, based on Monte Carlo simulations, to correct for the deviation introduced by using the "standard" uncertainty calculation method suggested by IPCC error propagation which is only a first order approximation; for large uncertainties (as they accumulate in the propagation chain) the method systematically underestimates the uncertainty half range.

Response to the technical corrections:

Line 61: We inserted the explanation of DGVM Line 87 and Figure 1: We use now consistent CO2-eq everywhere in the paper Line 129: changed to top-down GHG emission estimates Table 1: We added a line for each gas to better separate between the three sections. Table 2: We changed the structure of the table by adding lines in between ac-

tivities Figures 2,5,6,10 legends: we kept throughout the whole study UNFCCC NGHGI 2018 Line 345: We replaced the reference with the name of the excel table Line 345: We rephrase to be clear that “count as much as” refers to the listed countries Line 346: reported to UNFCCC is correct Line 394: changed to depend Line 395: changed to ..estimate to have.. Line 425: added to the list of abbreviations the GHGI acronym Line 450: changed to separately Line 451: added comma before because Line 457: We clarified the sentence structure Line 576: we rephrased the sentence as following: “DGVMs estimate net land use emission as the difference between a run with and a run without land-use change, and their estimate includes the loss of additional sink capacity, that is, the sink that favors the environmental changes(e.g. CO2 fertilization)..” Figure 12: We added explanation to the caption regarding the definition of anthropogenic land in DGVMs. The GCP version is the 2018 (Le Quere et al., 2018) Line 666: we removed “takes” Line 685: “According to” added Line 730: we removed “last” Line 741: added “the” temperature. This phrasing is in line with the IPCC 1.5oC report (https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf) and Paris Agreement: “The Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. “ We added “as set by the PA” Line 768: we deleted the two stars as they have no meaning Line 783: changed to country reports Line 788: it is following not flowing Line 819: the reference is correct, the JRC report include results from the InGOS project. We deleted the word “InGOS” Line 899: we intended “uncertainties” we deleted “level” Line 983: CAP Common Agriculture Policy , we added it to the list of acronyms We added as well the three references as you kindly suggested.

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