Earth Syst. Sci. Data Discuss., referee comment RC2
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Comment on essd-2021-299

Anonymous Referee #2

Referee comment on "Estimating CO_2 emissions for 108□000 European cities" by Daniel Moran et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-299-RC2, 2021

Interactive comment on “Estimating CO2 Emissions for 108,000 European Cities” by Moran et al.

This study represents valuable modelling work as a first attempt on estimating the CO_2 emissions from cities across Europe. The authors do a great job in identifying and mapping the emission (point) sources and their CO_2 emissions, and the methodology is clear and well explained, a very difficult task given the current state of the proxies’ availability and the incomparability between countries administrative units. As an exercise, the authors compare their estimates with data from two global inventories (ODIAC and EDGAR v6.0) and include the Norwegian case-study.

In the current context of the Paris Agreement and reduction pledges, countries should not base their reductions only on national level inventories but take into account cities’ individual contributions. In this context, this study is a valuable piece of information to be shared with local authorities. However, the authors should be careful on the sort of concrete messages they want to pass on to the cities. Would be of interest to add a section on how authors see their findings as contributing to local reductions (something like result-mitigation format) and which would, in their vision, be the most critical activities to challenge, in terms of CO2 reduction.

As mentioned below in the specific comments, I miss a paragraph on uncertainty calculation. The UNFCCC NGHGIs include in their NIRs (Annexes) uncertainties reported for each sector, sub-sector and activities. Solazzo et al., 2021 estimated as well uncertainties for EDGAR v5.0, year 2015. Even if uncertainty calculation is still not implemented in ESCI, I would strongly advise the authors to include some reference values for uncertainties from the above mentioned sources, as an idea of magnitude.

Overall the paper is well written and has a clear structure. The authors highlighted as well the limitations and future work, in a transparent and honest way, and to which I also

contribute with some ideas (see specific comments).

I recommend it for publication, subject to addressing the changes and suggestions, as highlighted above and below in the specific comments.

Specific comments:

Title: A bit confusing (108,000 cities) given the number in the abstract.

Line 23: the authors refer to ESCI as "inventory", I would introduce here the ESCI model name and rename it as "modelled estimates" or "modelled city inventory".

Line 24: nine instead of 9

Line 24-25: "UN's Common Reporting Framework" Reading all the manuscript, I would be consistent and call it everywhere UNFCCC Common Reporting Format (CRF).

Line 27: please add Zenodo link after "is available at...."

Line 33: European climate goals" I would add here references to the new target documents, Green Deal etc.

Line 40: delete "the" C40 and add comma after C40, C40 and GCoM are two different entities.

Line 49: no one = none

Line 53: Would be great to add a short paragraph about ongoing EU projects (CoCO2, PAUL)

Line 70: Next to what you list, top-down approaches also use inventories like EDGAR as proxies

Line 75: EDGSR is not a global top-down emission data product, it is a tier 1 bottom-up inventory providing as well gridded products. I think this sentence needs rephrasing

Also, please consider adding everywhere in the text EDGAR v6.0

Line 89: Worth mentioning hot-spot detection satellite studies for CO2 city/megacities emissions (OCO-2, OSSEs) also INFLUX experiments (USA)

Line 102: IPCC delete one C, and I think there is a confusion between IPCC and UNFCCC CRFs, please be aware that the CRFs you are referring to are not IPCC but UNFCCC. If you want to reference IPCC, then you have to mention the methodology for reporting according IPCC, 2006 and IPCC Refinement 2019. But again, reading the paper, you use the sectors according UNFCCC CRFs.

Line 103: The number is again inconsistent with the title and the abstract. Please consider referring to one unit (administrations, municipalities, cities etc.)

Line 106: after "existing model" please consider adding some examples of models

Line 109: please add EDGAR v6.0 and reference the datasets

Line 111: There three datasets are not models, consider naming it datasets, inventories

Line 113: I would rephrase as: "Additionally, our model is targeted to be useful to citizens and local governments, at city level, by identifying the sources of their city's CO2 emissions"

Line 115: emission attribution

Line 156: Again, it is not the IPCC CRFs you are looking at, is the UNFCCC CRFs

Line 167: in the context of LULUCF emissions I would include references to the a) to e)

points (e.g. Grassi et al, 2018, Petrescu et al., 2020 AFOLU, etc.)

Line 264: I would suggest using GPS information (e.g. TomTom) as done in the Carbon Monitor (https://www.nature.com/articles/s41597-020-00708-7)

Line 326: How is this allocation comparable with the IPCC methodology? international flights are not reported to national inventories. You perhaps overestimate here?

Line 350: If you use locations of farmland from CORINE, why don't you use it for retrieving information on AD (forest area) or use FAO FRA AD? You could only select the pixels belonging to city administration areas.

Line 358: not CRF report, but UNFCCC CRFs

Line 368: same as for aviation, international shipping should not be included if compared to UNFCCC reported numbers

Line 419: the title here is a bit confusing, ((Land Use, Forestry, and Stock Change) and you also mention waste. First you refer to sector 5: CRF Table 5 (not section), then you describe the category 4 (should be CRF Table 4) and then you get back to 5 again. I would open the discussion with a general sentence on the sinks from both Tables 4 and 5, and then detail on each sector.

Line 425: you can use everywhere the acronym LULUCF

Line 444, 449: EDGAR v6.0 inventory

Line 453-460: I understand you could not use the methodology of EDGAR in the first phase of writing the paper, but for review I would strongly suggest to contact M. Crippa and rewrite this paragraph adding the explanations regarding EDGAR v6.0 AD and methodology.

Line 471: space after 6.0

Line 473: Only here you introduce the EDGAR v6.0. Please consider doing this in the beginning of the study

Line 475: The three models/inventories

Line 477: would authors consider adding a table with categories covered by each dataset? Would help identifying shortcomings related to emission differences

Line 486: Please complete the units t CO2 / year , per cell?

Line 505: Figure 2 caption: I would rephrase: "ESCI reports higher cell-level variability ranging from 10^1 to 10^5 t CO_2/yr, while ODIAC reports most cells in the range of 10^2-10^4 t CO_2/yr." Also, please delete JRC (consistency purposes) and replace model to inventory or dataset.

Line 511: delete "Then we", "(ie. by city)" and "We compared results both" Rephrased should be: "Next, we converted the administrative region definitions from ESCI to a raster map compatible with

the EDGAR v6.0 and ODIAC gridded datasets and we compared the results aggregated by administrative

level across the models, at the city level (i.e. ....)."

Line 514: Figure 3, X axis: a) and b) per city-level instead of per region? c) and d) per country instead of per region?

Line 518: Here, as mentioned in the general review above, I would add a section on Uncertainties and review the values reported by UNFCCC NIRs and Solazzo et al 2021. Just to give a range of uncertainty to some of the activities.

Line 537 Figure 4: It is a nice figure but the legend is confusing, I would suggest instead of adding "a" in green and black, to draw a green and black rectangular (same as the cities names) around the CO2 and GHG and color them as well. As ESCI only simulates CO2 emissions, should be green, please change the caption with: "Comparison between ESCI results (green) and the community level emissions inventories of 44 European cities

(black)....”

Line 542: Please add a reference value, per capita or per 100,000 inhabitants for CO2 emissions , for someone who is not aware of city CO2 emissions levels, is not clear if 11kt is a high or low value.

Line 561: Please add colored gradient legends and units to be able to read these figures !. Add CO2 emissions to the caption.

Line 572 as a general comment: to be able to better compare between countries, perhaps in the next version of the model you could classify/rank the municipalities by inhabitants, 0-1000 villages, followed by towns (small, medium, large), cities and megacities (over a million).

Line 596 Figure 8: I see three times figure 8, is this the same or there is some difference between them? Add CO2 emissions to caption.

Line 599: please delete “level” after Figure 8)

Line 634: caption Table 2: Estimated CO2 emissions

Line 640: Figure 9: please consider refining the figure by clearing the text appearing on the upper left corner and add gradient colored legend with units for the CO2 emission. Add CO2 in the caption after “ESCI-estimates”

Line 656: Figure 10, please move the explanatory box on the left side of the orange dot to be able to see its size. Add CO2 after “spatialized”

Line 681: About the OSM coverage, you would perhaps consider, as I already mentioned, the GPS TomTom service for traffic

Line 685: you model could be enriched by including satellite information (OCO-2, GOSAT, OSSEs, Plume Monitoring Inversion Framework (PMIF) studies) for the detection of hot-sport point sources (refineries, power plants at the outskirts of the cities).

Lines 698-700: Would be nice to have a small section with a more detailed view of the authors on how their results could feed into local support practices, with some concrete examples, critical sectors and mitigation action. Also, I think local city councils should be able to provide cadaster schemes for an overview of building types and activities.