Open Access **Earth System** Discussions
Science Data

Interactive comment on "Global anthropogenic CO$_2$ emissions and uncertainties as prior for Earth system modelling and data assimilation" *by* Margarita Choulga et al.

Anonymous Referee #2

Received and published: 12 May 2020

The estimation of uncertainties in fossil fuel emissions inventories is an important goal. However, this paper is very difficult to follow. It needs major revision to clarify the details of the study undertaken, its results, and its context in the field. General comments are given below. Specific comments are also provided for the first few pages to give examples of the corrections needed, but the writing and presentation of the study throughout the other sections needs to be improved.

General comments

It is not very clear from the abstract what the actual data product is – emissions uncertainties by sector for each country? For individual grid cells?

Why are emissions uncertainties by sector for each country needed? Does the ECMWF data assimilation system calculate posterior fluxes for individual countries?

The paper does not address the uncertainties in spatial allocation of emissions at all, which could be much larger.

Introduction is not sufficient. It should describe - other studies that estimate emissions uncertainty, their methods and results - "the ECMWF model" (L113) and how it will use the results of this study - methods for spatial allocation of emissions to grid cells by EDGAR

The paper is not clearly organized into sections like methods, results and discussion. There is a lot of background material in the "Comparison and discussion" section.

All of section 2 is very unclear and hard to follow. It needs to be rewritten. What does it mean that "An adequate size for the inversion system of the ECMWF model is less than 50 and a covariance matrix of 7×7 has been chosen"?

What is the motivation for separating the super emitting power plants? What is an autoproducer?

In section 3 it is confusing to discuss Tier 1 calculations because it seems like the emissions themselves have already been specified. Are the emissions calculations also Tier 1?

Section 3.2 is hard to follow. Can the authors give an example, and specify which sectors are corrected?

Doesn't Equation 1 assume Gaussian uncertainties? What does it mean that "calculations were performed for upper and lower uncertainty limits separately"? For equation 2, the propagation of uncertainties for sums should not be in percent but in absolute units.

In Table 3 it appears that the lower limits for manufacturing are larger than the upper

limits.

Section 3.4 can be deleted.

Figure 3. It is impossible to read the numbers on the graphs. Why are all the countries shown here WDS countries?

Text on page 16 should be rewritten more clearly and not in bullet point form.

In Figure 4, the authors should add an additional bar to the chart representing total emissions because there is too much text at the top of each panel. Aren't all the datasets omitting biofuels? Why does the "other" category have so much higher uncertainty in CHE, also shown in Table 9? The sentence explaining this graph is very long and confusing.

Table 8 should include references.

Section 4.5 should be removed. Figure 6 is extraneous to this study and the simulations are not described at all, and Figure 7 appears to be already published in McNorton et al. 2020.

In the conclusions it says that "The CHE_EDGAR-ECMWF_2015 represents the 2015 fossil CO2 emissions prior at $0.1° \times 0.1°$ resolution that has been for the first time to our knowledge completed with full uncertainty information with global coverage." This is not true because the uncertainty in spatial allocation of emissions has not been considered. And what about the other datasets that report uncertainties listed in Table 1? Furthermore, there is not even a description of how uncertainties are specified at the grid cell level in this paper – the uncertainties seem to be only given for country totals. The dataset is only described in the Conclusions, but it should be described earlier in the paper with all the details on how grid cell values are specified.

For the actual datasets, users should be able to download these individually as needed rather than having to download everything in a large zipped folder.

Specific comments from the first few pages

Title – the results of this work are the uncertainties only, right? The emissions themselves are already reported by EDGAR? How much different are they from EDGAR? How will the uncertainties be used "as prior for Earth System Modelling"?

L12 How do emissions raise awareness? Rephrase.

L15 prior should be defined. The word prior is probably unnecessary here because the results could have more uses than just as a prior.

L15 Are power and energy different? If not, the same word should be used.

L17 Here and elsewhere (L25, Section 3.4) it seems misleading to say covariance and covariance matrices estimated when actually covariances are just assumed to be zero.

L18 Are the CO2 emissions really going to be included in IFS? I suspect they will be used with IFS in the CAMS reanalysis.

L21 How large are these changes to EDGAR emissions?

L26-31. Hard to understand. Please give some values on the uncertainties, and describe the sensitivity tests a bit more.

L36 I think you mean to say "climate change" rather than "the Earth's radiative balance and climate stability".

L37 'long carbon cycle" should be replaced by "fossil fuel" throughout. This definition is unclear and it would include wood.

L41 "early 2002s"?

L43-8. Sentence needs to be revised or deleted.

L51 Observation not Observatory

L61 emissions not concentrations

L63 What is the Mitchell 1984 reference, and why is it cited when referring to the year 2018?

L68 Andrew 2020 is not in the reference list

Table 1. FFDAS says resolution is annual, then in "Note" it says hourly. In general, the information given in "Note" for each dataset seems random.

L73 Global emissions are the same in CDIAC and ODIAC

L75 3 of the datasets in Table 1 include uncertainties, according to "Note"

L77-8 Unclear

L80 delete "with long carbon cycle"

L81-3 Uncertainties on a 0.1degree grid? What about your revised estimates of emissions?

L86, 90 Incomplete sentences, should start with "the"

L89 Delete – it's not true that there was a stagnation since 2015, it has increased since then.

L100 The Paris Agreement limit is not really 1.5C

Page 6. This entire page is difficult to understand.

L165-6 Needs reference