Dear Anonymous Referee #2

Summary: The authors present the new ODIAC2016 gridded (1deg by 1 deg), global, monthly FFCO2 emission dataset and the underlying ODIAC V3.0 emission model. The ODIAC model relies on multiple open-source datasets to improve the existing emission inventory provided by CDIAC. The specific target is to provide a better spatial and temporal disaggregation of sources (using e.g. nightlights, gas flaring, bunker fuel statistics), which is a critical improvement, if this dataset is to be used in atmospheric transport models or large scale inversion systems. The authors discuss the construction of the new emission model and its limitations. The study is well-written and the scientific methods chosen are sound. Despite the large amount of processes captured, the paper is quite comprehensive in its description, but should focus more on one critical point its discussion – the vertical disaggregation of emissions in ODIAC v3. This will be highly relevant for regional scale atmospheric transport modellers, but can be easily added to the existing manuscript. If this general comment and minor comments are addressed, I fully recommend the publication of the manuscript and would assume that this dataset is of extraordinary interest to the community of regional and global GHG modellers as it is unique in its approach and of high quality.

Thank you for your review and the time. I fully agree that the vertical disaggregation is very important from atmospheric modeling viewpoint. See our response to your comments below.

General comments: The section on spatial disaggregation fails to clearly address the issue of emission heights. Aviation emissions are distributed according to AERO2k but are then aggregated to a single layer – but at which height? Especially, for Northern Canada, where emissions increase by 5 orders of magnitude in some regions in ODIAC2016 compared to CDIAC the chosen injection height might be critical. Furthermore, it is unclear which emission height is assumed for flares and point sources – the impact on regional scale models could be significant. This should be discussed more clearly.

We fully agree with the reviewer that on the emission injection height information is important. As the reviewer pointed out, aviation emissions are concentrated over places like North America, Europe and East Asia and the representation of those emissions should have some impact especially in regional simulations. In ODIAC model, we internally carry an injection height information from AERO2k. We however provide the aviation emissions as a part of international bunker field as a single layer, without specifying certain height. Providing the emission in a single layer is a common practice as done by other existing gridded emission inventories such as EDGAR (and FFDAS which adopts EDGAR international bunker emissions as is). We are currently studying the sensitivity study of the injection height using transport models, as discussed in 7.2.3. Upon completion of the sensitivity study, we would like to document and report in a future manuscript and include the injection height information in ODIAC emission product.

We also do not have injection height information for other emission sources such as power plants and gas flares. This is simply because of lack of the global data. We believe many of other global emission data products share this difficulty. We propose to add this sentence at the end of 7.2.1.

"Currently, the point source emissions in ODIAC do not have an injection height due to the lack of global information. This limitation is share with other existing global emission data products."

Specific comments:

Caption figure 1: 'ODAIC 3.0' -> 'ODIAC 3.0'

Fixed.

P3 L43: please be more specific – 'timely manner' = we can expect annual release of updates to ODIAC2016?

Yes, you are correct. With the phrase "timely manner", we wanted to emphasize that we plan to work on annual emission data update as soon as underlying data become available and deliver the data to the science community. We propose to rephrase the sentence

"Our emission modeling framework was also designed to produce an emission data product in a timely manner, with updated information."

As

"Our emission modeling framework was also designed to produce an annually-updated emission data product in a timely manner.

P6 L17: 'carbo' -> carbon

Fixed.

P7 L11: The product discussed in this manuscript has 1deg by 1deg resolution according to P4L32, but section 4 is not always explicit about the resolution of the disaggregation (or this is sector specific). I assume 1km by 1km was used for some sectors and then a re-aggregation to 1deg by 1deg was performed for the global ODIAC2016 product?

You are correct. We propose to indicate spatial resolution (1km) of disaggregation in the main text where it is missing. Most of the places we believe we indicate the emission disaggregation spatial resolution. We hesitate to add the spatial resolution in the section title as we also provide the 1-deg product. We also propose to add the word "aggregated" for the 1-deg product as appropriate for

clarification (See Section 2). Please see the revised manuscript.

P7 L13: Please specify at which resolution the data was disaggregated here

See our response above.

P7 L18: Needs details on what is considered a point source (only data from a specific database or a emission rate per site?) and what is a non-point source. P7 L29 indicates that non-point source is the default category for point sources that can- not be correctly located.

We used CARMA database (emission intensity and geolocation) to map point source emissions. Unlike EDGAR database, CDIAC emission data are fuel-based emission estimates (similar to IPCC reference method) and do not distinguish specific IPCC-like sector emissions. We have been used CARMA to divide land emissions into two emission types (namely point and non-point). We dedicated 3.3 to describe how we re-categorize CDIAC emission categories to our own ODIAC categories.

The sentence at P7 P29 mentioned that cement production emissions are ideally mapped as a point source. But simply due to the lack of global information, we distributed the cement emissions as a non-point source using nightlight data. As described in section 3.3 and after, the nonpoint source category is not for the emissions that cannot be correctly located. I believe this was clear with the sentence.

P7 L36: What happens to other emissions in flare pixels? What is the impact of overlaps of urbanised area nightlights and O&G extraction regions e.g. in the Barnett shale (Dallas-Fort Worth region) or Niger Delta? Is this a potential bias or insignificant?

Although we map those emissions separately w/o overlapping, we are using the separate gas flaring nightlight data to map the emissions, but the nightlight data do not include recent emission changes. This is a potential source of biases due to our model representation error. As we discussed in the manuscript, we hope the use of VIIRS data would at least mitigate the errors. We expect the use of VIIRS data would allow us to reduce the representation and mapping errors and quantify the biases.

P8L10: 'we does not' -> 'we do not'

Fixed.

P8L24: was this climatology based on external driver (e.g. correlation of seasonal emission changes with seasonal temperature changes/anomalies) or just mean seasonal cycles of emissions for the years 2000-2010? A recent study by Breon et al. suggests a significant impact of temperature anomalies on FFCO2 emissions (http://iopscience.iop.org/article/10.1088/1748- 9326/aa693d) and we could expect an impact on seasonality of emissions from this as well.

The climatology is the mean seasonal cycles of national emissions. Thank you for referring to Breon et al. (2017) work which we were not aware. The use of HDD/CDD is a common approach to infer seasonal changes in energy-related emissions. We should be able to do some correction to the mean or create seasonality, but it is uncertain if that would make our seasonal estimates close to the truth. It would make sense to do logically, but there is no objective measure to confirm the expected improvement. It is possible that we might add some biases. We prefer to stick to CDIAC seasonality that is developed based on statistical data. We acknowledged the potential biases at 7.3 in the manuscript

Fig2. Refers to CDIAC/GLB+projection while Table 1. Ignores this and shows ODIAC2016 in comparison to the three others. Please consider removing this inconsistency.

CDIAC/GLB+proj and total ODIAC2016 are identical. We propose to change the legend in Figure 2

from "CDIAC/GLB+Projected"

to

"CDIAC/GLB+Projected (ODIAC2016)".

Fig3. Caption: 'top 20 emitting' -> top 10 emitting

Fixed.

*Figure 6 and 7: I assume the caption or colour scale is wrong here and units are NOT 'The units are tonnes carbon/year/ cell (1×1 degree)' Emissions of 1 tonne carbon/(a*cell) a 1deg by 1deg grid cell seem extremely unreasonable. Additional suggestion: Show a histogram of differences between ODIAC and other inventories here (or in appendix).*

Thank you so much for catching this. The unit is million tonnes of carbon per year (MTC/yr). "Unit: MTC/yr" will be to Figure 6 and 7. We created a set of histograms based on the same result. We plan to add this figure as Appendix A2.

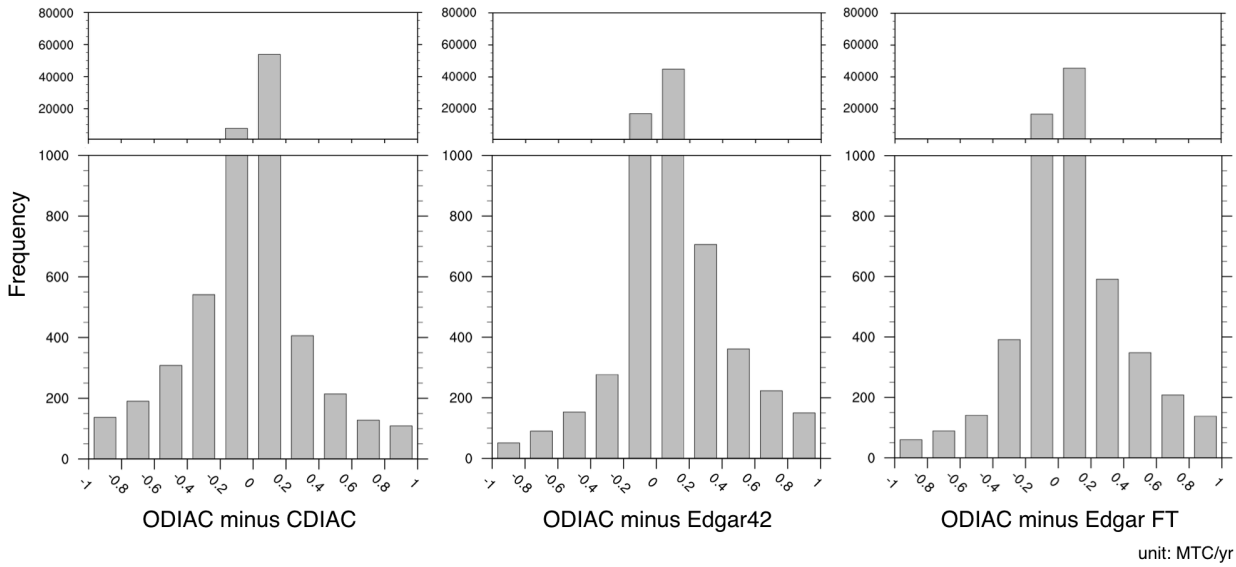

Fig. A3. Histogram of the inter-emission data differences from ODIAC. Values are given in the unit of million tonnes carbon per year (MTC/yr).

In addition to the reviewer's suggestions, we propose to add some text to describe the updated year 2017 versions of the ODIAC emission data product (ODIAC2017, 2000-2017). We also made minor editorial modifications to the main text to improve the readability. See the revised manuscript.

Thank you so much for your comments and suggestions.