Referee Comments, 9 juli 2021

'Description of a global marine particulate organic carbon-13 isotope data set'

Verwega et al., 2021 (ESSD)

(https://doi.org/10.5194/essd-2021-159)

General Comments

Dear Maria-Theresia Verwega and colleagues,

Thank you for your thorough and well-written manuscript. You have provided both the observational and modelling communities with a useful and unique d13C_POC compilation that can be applied to a wide range of research questions and technical (model) evaluations. The details on the temporal and spatial distribution of the data are clearly presented and in general supported by informative figures. I first have some general comments to make:

1. Even though your Introduction reads very well, I think it contains relatively few references. Consider adding some more references. A general one like Zeebe & Wolf-Gladrow (2001) for example?

2. You vary a bit in naming the two grids: The 'coarse grid', the 'UVic grid', 'the main dataset'. I think it is clearest if you refer to them as the 1x1 grid and the 1.8x3.6 grid, and only mention UVic/coarse/fine in the general introduction to the data at the beginning of Sect 3. If you want to present the 1.8x3.6 degree dataset as your main dataset, clarify this early on. In any case, choose a uniform naming.

3. Related to comment (2), why do you choose to present the data in the 1x1 and 1.8x3.6 grids? The 1x1 is commonly used and in WOA format so this one I understand well. As a modeler not working with the UVic model, which I expect most of your dataset users will be, I would be interested in using either the raw data or a gridded 1x1 dataset with the time axis preserved (that is, Year and Month info). Splitting the 1x1 dataset up in decades like you did for the UVic grid could then also be helpful for users. Why do you focus on the UVic grid as the main dataset? As you might understand, I expect the 1x1 grid to have more potential to be used by the broader community.

4. For e.g. your presentation in Sect. 5.2, Sect. 5.3 and Sect. 6, unless d13C_POC at the surface is similar to d13C_POC at depth (unlike d13C_DIC), a depth-average might not be meaningful everywhere. I would then assume taking the surface values only is best. Adding a figure on d13C_POC vs depth in your section on vertical distribution of the data would clarify this. In P20, l325 you indeed state that you only took the euphotic zone – why here and not in other places?

5. Is it possible to give an educated guess on the uncertainty of d13C_POC? This may vary per decade / sampling method / cruise, and I can imagine the source data do not give such estimates themselves. But your experience may give the reader an estimate of the uncertainty, which is valuable for any further analysis.

6. Last, I found that the dataset, even though in practical NetCDF format, does not contain enough information and does not follow conventions well enough to be worked with easily. Please see my comments in a separate Section 'The dataset'.

See also my Specific Comments below, as well as a few Technical Comments.
I am happy to recommend your manuscript for publication after you have clarified my comments and hope they are useful for improving the manuscript.

Best regards,

Anne Morée

Specific Comments

P1, l8-9: the consistency with observations is a bit inherent as you compile all available observations? Also, barely any comparison is made in the text with older literature/data for consistency.

P2, l32: This is an example of a location where more and more relevant references would be in place (Rocha and Passow, 2014 only is limited to refer to for the reader to understand the role of the biological pump in sequestering C).

P2, l43-49: In this section you describe the fractionation during photosynthesis. I think it is important to mention somewhere in your introduction that there are three reactions where the C isotopes fractionate: calcification, photosynthesis and air-sea gas exchange and include relevant references. And that the relative importance of these processes depends on location: e.g. (Gruber et al., 1999; Morée et al., 2018; Schmittner et al., 2013).

P2, l54: Underline your statement with some references from both the land biosphere and marine realm. For example, the Suess effect is visible in the ocean in d13Cof DIC (Eide et al., 2017).

P3, l57-60: To what extent are changes in the other fractionation pathway, air-sea gas exchange relevant to your study? The temperature dependence of fractionation during air-sea gas exchange (Zhang et al., 1995) suggests that in a warming world fractionation is weaker over the air-sea interface. Also, Young et al. (2013) reconstructed that the fractionation factor during photosynthesis is changing due to rising CO2 concentrations. If the d13C_DIC in the euphotic zone is different due to the Suess effect, your d13C_POC is affected. In an ESSD article the discussion on this is not necessary, but I think it is important to point the reader to such studies that are relevant for the interpretation of your dataset.

P3, l62: Please make the transition from the previous paragraph to this one more fluent.

P3, l65: When it comes to the implementation of the C isotopes in the ocean component of ESMs, some recent advances could be highlighted here as well: e.g. (Liu et al., 2021; Tjiputra et al., 2020).

P3, l69-74: Please add some references as examples of your statements (especially in line 71).

P3, l80: what do you mean with multilateral here?

P3 l87 – p4, l90: This sentence is inconsistent with/incomplete as compared to p3, l76-78: You say here that you included unpublished data Lorrain and Tuerena but earlier just Lorrain. And you don't cite Tuerena et al. (2019) here which you did before.

P4, l107-110: Repetitive; You mention twice in this section that this is the Tuerena data set.

P5, l129: Wherever … one type ; this sentence is difficult to read, please rephrase. It is also not clear to me how you choose between the similar measurements, and what made them similar (the value?). Are the two following sentences the only two times you have done this? In that case the sentence could end with a ':'.

P5, l141: Why provide it on the UVic grid except for that they have d13C_POC as output? Wouldn't it be more logical to present it on the WOA 1x1 degree grid and provide for example a Ferret/CDO/NCO guide on how to change it to a different grid format (or do you loose too much information in this case, regridding twice)? Also, based on this paragraph I would expect 3 files in the dataset – I think this is a good place to tell the reader how many files you have (and therefore also that you split them up in decades), what their purpose is, what they contain, etc.

P6, Table 1: Do I read it correctly that dataset Degens et al (1968) till Wada et al. (1987) all had their longitude changed? This is not entirely clear because it is empty behind all rows except for Degens'. If the Table should be read such that multiple rows have undergone the same change, I would suggest using curly brackets and centering the change description behind those.

P7, l 156: Why did you leave out the sample day? This does not really confirm your statement that you have taken as many details as possible (p4, l114).

P7, Sect 3.2: Could to the interpolated data description be added what the dimensions are of each dataset (lon, lat, depth, time?) and the size of these dimensions?

P8, Table 3: coverage of Depth, how can that be out of 4754 datapoints? The maximum is 4732, right?

P8, l174: Why did you exclude some data here (because they e.g. lack depth information?)? Do you mean you used the data with full spatial-temporal coverage (thus datapoints that have lon, lat, depth and year and month? – please specify). I assume that if you for example not have the spatio-temporal full metadata information, you could also not add them to the UVic grid dataset (but P9, l186 suggest you did – how?)?

P12, l233-243: 'Overall, after accounting for spatial sampling bias by comparing with regions, the different methods are generally consistent with each other (Figure 3).' I do not conclude that as easily from Fig. 3, how did you account for spatial sampling bias by comparing with regions? (clarify this and check also p20, l355). I think you mean with*in* regions as stated in the abstract, but then still I do not see where you have made a comparison between the sampling methods within several different regions (Fig. 3 is just the Atlantic). Also, why not use the biome regions here for consistency with your other regionally presented data?
And in the paragraph that follows, if e.g. net data make up most of the data of the full Atlantic, then it is no surprise that the full data KDE is similar to the net data? In order to discuss Fig. 3, does one not need a plot of what fraction of the data is coming from what sampling method? E.g. as plot of number of data versus time with contributions from the different sampling methods or something similar? Do these differences between the methods maybe give us an impression of the uncertainty of the d13C_POC values (see also my general comment 5).

P12, l240: Besides discussion the variance, I think it would be interesting to provide the reader with information on differences in the mean/median between the methods (e.g. in a region/the regions in Fig. 3 but also globally compiled).

P12, Sect 5.1.: Here you discuss mostly the density/number of data at a certain depth, take over the global ocean. It would be interesting to hear how this varies with region (so e.g. fewer very deep data in remote locations, etc.) and a plot of d13C_POC versus depth (global mean or region, whatever is more meaningful/informative) as a Fig. 4b for example.

P13, Sect 5.2: How can the coarse resolution dataset be independent of time – clarify how you merged the time dimension? Are the d13C_POC values of depth-averaged lon,lat data meaningful – the value would depend on how many deep measurements are included (or is deep d13C_POC similar to surface d13C_POC?). Why not just show the locations of the data with a black marker in Fig. 5 in order to show their horizontal distribution?

P14, Table 4: I think these data er more logically represented as a histogram. If you think it is important to show the exact values, this could even be added into the histogram.

P14, Sect 5.3: Did you average over all depths or use surface values? Also, I did not understand the first sentence of the Section (in which figure is this shown?): for which decade is Fig. 6 made? In Fig.6, instead of a mean vs. biome wouldn't a mean versus latitude plot contain more information as it then is not discretized into these biome intervals? Or do you need to define zones because of low spatial data coverage?

P16, l291: Maybe help the reader by stating what that means for seasonal availability for each hemisphere?

P17, l 302: define 'enough' in 'enough datapoints' (also in the caption of Fig. 8).

P19, Fig. 8: In the caption you write that b and d are means, but in the title and text (p17, l303) it says median – what is it? I think connecting the mean/median values with a line is a bit confusing especially in d – why not present the values in a small table?

P20, l352: not specific enough, why not specify which areas?

Technical corrections
P1, l2: They have _for example_ been used to?
P1, l16: via _its_ atmospheric form
P2, l 40: …- 1) : 1000 and remove the '.' at the end
P2, l55: reference?
P3, l69: improve our understanding _of_ marine carbon
P4, l11: _and_ KH13.
P4, l114: Table 3 referred to before table 1 and 2?
P5, l140: remover the '.' in front of (Verwega et al., 2021).
P9, l190: refer to Figure 1?
P9, l194: refer to Figure?
P9, l201: 'what indicates very little data points lying' should be 'which indicates that very few data points lie'
P16, l 285-287: change /permil to ‰
P18, l310: 'highest maximum' seems double, reformulate?
P20, l344: change to 'two different global grids', the word resolution here reads not well in this position. Or rephrase.
P20, l345: _relative_ to their mean? As _an anoma_ly to their mean?
P23, l383-386: 2003a and 2003b instead of 2003an and 2003av?

The dataset
1. Only after opening the dataset it became clear to me that the decadal files have all data of that decade saved together in one file (right? Or is the mean for each location?). The poc13_univ_i1.nc file was also unexpected based on the text, and seems to contain all data merged over time, but not over depth. This relates to my comment on P5, l141 – tell the readers how many files they will find and what they contain.
2. The TANN dimension has no description (ie netcdf attributes) but 'TANN:axis = "T" ', please add more information: The netcdf files state that the files follow the CF-1.6 convention. However, when checking this (https://pumatest.nerc.ac.uk/cgi-bin/cf-checker.pl), this seems not to be true for TANN. There is also TYR in the poc13_year_month_woa_c1.0.nc file with the same issue. The dimension 'record' in the last file also confused me.
3. I think the naming of the x and y axis (which represent lon and lat) is not very intuitive or standard – why not use lon or long and lat?
4. Global&variable attributes: If your files end up being saved on a computer somewhere, based on the file name one would not be able to know what they exactly are, who made them, how they were made, etc. I think the absence of this information in the files themselves is important and should be addressed. Try to describe them in such detail that if none of the authors can be contacted for extra information and help, that the dataset is still usable. E.g., in the global attributes, include references to all

sources (Table 1 and 2), reference to this article, a title, datetime_start, datetime_stop, size, contact, license (CC-BY 4.0?), method/how the dataset was made, description, and any other attributes of potential use. For all attributes and dimensions make sure to give them at least where applicable units, long_name, standard_name, _FillValue, missing_value, description. Also, DEPTH has a strange missing_value.

5. In the poc13_year_month_woa_c1.0.nc file, is dimension 'record' the month and TYR the year? Why are these not in one time dimension? A 5 dimensional variable, which it is now, is difficult to work with (for example, CDO can't do it).

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