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Interactive comment on "Radiocarbon Measurements of Ecosystem Respiration and Soil Pore-Space CO_2 in Utqiaġvik (Barrow), Alaska" *by* Lydia J. S. Vaughn and Margaret S. Torn

Anonymous Referee #2

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General comments: The authors present soil respiration quantity and 14CO2 signature as well as soil pore 14CO2 data of high-latitude soils during the thawing seasons of 2012 -2014. Acquiring this type of data in these regions is not trivial and the data provides some interesting insights into the seasonally and spatially variable carbon respiration in this region. The data is provided under the given link and the R codes used for the graphs and modeling are provided on github. Overall, the data and presented insights are valuable and merit publication.

Some aspects regarding the sampling documentation, blank analyses, statistics as well as data use in models could be improved upon in order for this dataset in order

to reach its full potential. Specifically, as micro topographic variability was identified as a key driver for variability in 14CO2 trends, a visualization and quantification of that topography would be helpful. Furthermore, respiration data of soil carbon is directly linked to the solid bulk soil carbon – however, that there is no data on this pool. Although analytical precision data was provided, no data on procedural blanks were provided. This type of sampling and measurements take many intermediate steps, and if available it would be good to have procedural blank data in addition to just the OXAs (e.g. Hanke et al., 2017). Especially because the samples were processed not in one batch but rather over a number of years (2014-2017). Regarding statistics, there are some points were statistical terms such as standard deviation is used when n=2, or box plots with quartiles are implemented when n = 3 or 4. This is could be seen as misleading and result in misinterpretation. See specific comments for suggestions how this can be improved. Considering that this is a journal aimed at geo-data and use of this data in other studies, the authors could add details regarding which specific types of models could benefit from this data. This could improve how this data is used in the future stages.

Specific comments: Regarding the novelty of the data and methods, the data is novel and focuses on a region which is undergoing rapid environmental change. Data is based on established sampling and analytical methods.

Regarding the data being used in the future: The authors refer to the data being used in 'models', but could perhaps provide more detail. At some point, they refer to a publication (He et al., 2016) that uses Earth System models, but I can imagine that there could be a larger scope of the implementation of this data in models. One major piece of information which is missing - which is likely important for these types of models - is the size and 14C signature of the solid soil carbon. It is unknown how the amount of respired carbon relates to this –presumably much larger – pool.

One additional aspect which can be improved upon in order to increase the value of this data is an improved description of the morphology of the micro topographic features

that were sampled. The authors underline that micro topography has a strong impact on 14C signature of respired carbon, but there are no pictures or sketches. I would recommend adding photographs or a sketch showing the features. Furthermore, in order to be able to extrapolate this data, it would be helpful to know how often which type of polygon types occurs. That way, the signal could be averaged for this region.

The materials and methods are described in sufficient detail and the R code and data themselves are provided. The article itself is appropriate for the publication of this dataset because it clearly describes how the samples was acquired and data was measured. As mentioned previously, if there is data on the bulk carbon quantity and signature from other papers, it could be valuable to cite and integrate that. Presently it is not present in the paper.

Data Quality & accessibility: The data is accessible & codes are available on git. There are even some 2-pool model codes on git which I believe are not used in the paper. Error estimates could be improved upon. Mostly only the analytical error is provided. I am missing the procedural blank, which is especially important as the samples were measured over three years. The sample sizes for 14C measurements are also not provided. Smaller samples are more susceptible to contamination (Hanke et al., 2017). Ideally, there would be more sample replicates. However, considering the difficulty of the sampling and the significant cost of 14C measurements it makes sense that no extensive replication done in this case.

There is also a potential bias in the soil respiration data that has not yet been addressed. The authors state that when the soil was water saturated, it was not possible to measure pore CO2. It is very likely that there is a difference in carbon decomposition speed between water saturated and non-water saturated soils. Therefore, if only the non-saturated soils soil pore CO2 is measured, there could be a bias in the interpretation. Authors should address this in the discussion.

Dataset quality. Data seems in the range of what can be expected from these types

of cold soils. Dataset presentation: The graphs can be improved upon on a number of points, especially concerning the usage of some statistical terms, as detailed in the section technical comments. Note that box plots are not designed for data where n = 3. Nor is standard deviation applicable if n = 2. Standard deviation is a measure to see what the spread of data is, but with n= 2 you don't really have a spread. Publication length: The length of the paper is good, the figures and table are appropriate. If the authors provide more information of the sampling and micro topography, the dataset could be used in the future after reading the paper & downloading the data

Technical comments are attached in PDF format

References Graven HD (2015) Impact of fossil fuel emissions on atmospheric radiocarbon and various applications of radiocarbon over this century. Proceedings of the National Academy of Sciences, 1–4. Hanke UM, Wacker L, Haghipour N, Schmidt MWI, Eglinton TI, McIntyre CP (2017) Comprehensive radiocarbon analysis of benzene polycarboxylic acids (BPCAs) derived from pyrogenic carbon in environmental samples. Radiocarbon, 59, 1103–1116.

Please also note the supplement to this comment:
https://www.earth-syst-sci-data-discuss.net/essd-2018-29/essd-2018-29-RC2-supplement.pdf

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2018-29, 2018.

Technical comments

Page	Line	Comment
1	11	Specify model
	12	Specify use of D14C
	25	You state the flux is critical – is there any quantification?
2	12-15	Sentence is very long & not clear.
	Study site section	If possible, add a sketch of polygon and add how dominant each polygon type is
4	Surface emissions	Inserting the chambers into the soil may disturb the soil and increase gas exchange with the deeper soil: this should be addressed in the discussion
5	2-3	'measurements lacking a linear range were not included in the dataset' Do you mean samples that fall outside of the linear range, or complete measurement series?
	16	Pore CO_2 was not measurement for water saturated soils. This may bias final interpretations. Please address
	14	Low-concentrations pore CO_2 measurements were omitted except when value was clearly not-atmospheric. Does that mean that the excluded samples all had an atmospheric signature?
6	11	Tr or mean the of carbon in plants is either assumed to be 0 or 5 year. Whilst cited sources give a which wider range. Even decomposing pine needles in a temperate zone are generally 8 years old. In such cold environments with slow growth rates one could expect even older ages of plant-derived carbon into the soil. Is this assumption realistic? Please add some further justification.
	21-25	When two turnover times are equally likely (Graven, 2015), it could also be helpful to have measured the bulk soil signature. If this is indeed not available, this is the best fix possible, but it is not ideal.
7	14	When describing the effects of the polygons and microtopography, a sketch or image would be helpful for the understanding of the reader
8	10	Authors state that pre $^{14}CO_2$ becomes increasingly negative with depth, but this is not the case for three profiles (as mentioned later in the text on line 18
	13	Author sate that there are minimal contributions from plant-respired carbon. Did they do a mass-balance? Or is this a qualitative statement? Please specify.
	13-17	These statements support Figure 4. For better flow, maybe move towards end of section
	19	Figure 2 should be 4
	25-26	When trying to understand soil carbon stability and decomposability, it would be good to not only determine the age of respired CO_2 but also the age of the bulk soil carbon. If this is not

Fig. 1.

		available for these profiles, but similar ones, it would be good to benchmark the data.
9	9	Authors state: "due to sampling limitations, soil profile 14C data are available from only a subset of polygon types [...] In tables 1 & 2 I only see soil CO2 measurements, no bulk. Did they mean to refer to pore CO2?
	35	'later in season' please be more specific
Tables	1	Standard deviation with n = 2 does is not appropriate and can be seen as misleading (go back to calculation). It is supposed to give the range of sample variability, but for n =2 that is not applicable. Consider an alternative, e.g. giving the average
	2	HC1-center: Measurements were done at different depths during different years. Or is it a typo? If not, considering the inter annual variability, is it reasonable to compare the data? Please clarify. For HC3 center for the same depth there are large differences in 14C
Figures	1	It appears that boxplot R are used for n =2-5. It may not be the most appropriate way of presenting the range of data. Also add in the explanation that when R boxplots are visualized, data that falls outside the range is statistically speaking an outlier. Also indicate what the solid line in the box means. Also considering adding a striped line for the mean Considering using this plot to highlight the important finding that during high-summer, all respiration is from year to decadal old C, whilst later in the season, whilst the deeper soil continues to warm, older (stabilized) C is lost.
	2	Consider changing axis (starting at 0.3) in a to highlight differences in respiration
	3	Legend should be month-year This graph shows an interesting trend which has not been explicitly discussed in the text, but which could be valuable for the data interpretation. There could be two end member type of behaviours: High summer (2013-07), high respiration of topsoil C releases bomb-enriched carbon. Late summer (2014-09) releases a low amount of old, stabilized carbon. 2013-09 could be an intermediate type where there is mixing from both pools, providing a spread of ages and concetrations.
	4	Colour spread is not optimal, some colours are near-identical. Considering changing. Also consider highlighting the 3 soils which some younger respired C at depth, or grouping samples by polygon type.

Fig. 2.