

Earth Syst. Sci. Data Discuss., referee comment RC1
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Comment on essd-2021-233

Anonymous Referee #1

Referee comment on "The ABCflux database: Arctic–boreal CO₂ flux observations and ancillary information aggregated to monthly time steps across terrestrial ecosystems" by Anna-Maria Virkkala et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-233-RC1>, 2021

Summary

The ABCflux dataset and companion manuscript provides, to my knowledge, the largest compilation of Arctic and boreal region carbon dioxide flux data, including net ecosystem exchange, and component ecosystem fluxes. This compilation therefore represents an unprecedented resource for synthesis studies aiming to understand high latitude carbon cycling and its vulnerability to rapid high latitude global changes. The manuscript summarises the data acquisition and acquisition process undertaken and provides useful visualizations of the dataset that inform the reader of the main characteristics of the carbon exchanges, broken down by measurement approach, as well as dataset spatial and temporal coverage and representativeness. Overall the manuscript is well written and the dataset is comprehensive, logically structured, and carefully compiled, without any obvious errors. However, I have several minor-moderate remarks below about the manuscript and the dataset that should be addressed.

The main comment I have for this dataset and manuscript relates to pre-processing decisions, specifically the gap-filling methods for the eddy covariance data and the aggregation of the data to monthly fluxes, and the potential effect of these two decisions on uncertainties. Text describing these decisions and their effects on uncertainties is treated summarily in the manuscript text, or not at all, and therefore text should be strengthened/added as required. If a clear justification of these decisions cannot be provided, I think the dataset could be revised to include both a raw data file and a monthly-aggregated data file (the current version) to allow for more customization/fidelity for data users.

Comments on the Manuscript

249 - Could you justify more why the decision was made to aggregate to monthly

timesteps as opposed to providing raw data and index columns that would allow for users to do their own aggregations.

Table 1 - I am not sure what is meant by "Soil respiration (or NEE)..." in the Natali et al. (2019) entry. Was only one of Rsoil or NEE ever used? Or is it more accurate use "and" as in the entries for the other studies?

2.1.2 Flux repositories - I am confused about the processing pipeline for these tower data. This paragraph should be restructured to follow the steps in a linear sequence as much as possible. Gap-filling is normally performed after USTAR filtering, but it comes first here. What is meant by "When only daily gap-filled data were supplied"? Aren't the data half-hourly? I also do not understand what the second-to-last sentence (line 349-350) means.

2.1.3 solicitation - what type of data were these?

Line 373 - "needed to be filled"?

2.2 - There is no information on quality screening for chamber measurements. Can it be assumed that the published values are reliable?

Fig 5. Caption is not accurate. Should be a letter for each panel

Table 4 - This table is bit lacking. Separating the flux from uncertainties makes it hard to read, and the component fluxes can be computed from each other, and thus not terribly informative.

4.1 639-666: I think something that has not been addressed completely is the fact that to compute a daily or monthly aggregated flux from a few chamber measurements one has to not only aggregate, but also upscale significantly more in the temporal domain than compared to EC, which likely has more temporal coverage. A chamber measurement for one half hour may agree closely with an EC measurement of for the same half hour, or perhaps for some period of that day, or perhaps even for that month. However, surely the uncertainty around the upscaled chamber flux must be much larger than the EC aggregation which may have a large number of temporal replicates and is an integration of a larger area? I would like to see this issue expanded upon in this section.

4.2 - 698-730: Building on my earlier comment about the details of the post-processing

of EC data (in particular gap-filling choices). I wonder here why the filtered (but not gap-filled) flux columns were not provided alongside the gap-filled and partitioned columns? It seems this would enable quick comparisons for various topics of concern. For instance, how does gap-filling affect monthly aggregations? How much does gap-filling affect mechanistic conclusions of modeling exercises?

4.3 Representativeness - the discussion of geographic bias is useful, as is the comment about biome coverage. However, there is not much detailed consideration of the coverage with respect to the environmental covariates measured. A representativeness analysis like that of the following could be beneficial:

Hoffman, F. M., Kumar, J., Mills, R. T., & Hargrove, W. W. (2013). Representativeness-based sampling network design for the State of Alaska. *Landscape Ecology*, 28(8), 1567–1586. <https://doi.org/10.1007/s10980-013-9902-0>

Delwiche, K. B., Knox, S. H., Malhotra, A., Fluet-Chouinard, E., McNicol, G., Feron, S., et al. (2021). FLUXNET-CH₄: a global, multi-ecosystem dataset and analysis of methane seasonality from freshwater wetlands. *Earth System Science Data*, 13(7), 3607–3689. <https://doi.org/10.5194/essd-13-3607-2021>

Comments on the Dataset:

The number of observations does not match data description. I assume this is because the observation `unit` referred to in the text is not a month/site combination, but rather the flux/month/site combination? I think it would be better to report the month/site combination and describe how much of those month/sites have each component flux of interest. Especially since the unique ID (first column) refers to a month/site combo).

Can you explain more the lack of **data citations** for 30% of the observations?

I noticed none of the `data_maturity` is "preliminary" or "reprocessed" why are these provided? For future database expansion?

Why is measurement month named `Interval`? That is not intuitive.

Could `Measurement_frequency` be changed to provide the exact number of observations aggregated for the month? Instead, it could be named `Measurement_count`. Additionally a column for `Gap_count` could be provided and grouped with `Gap_perc` column. I think this would provide more useful information and data for dataset manipulation.

`Gap_perc`: why is there only 17% coverage for this variable? Shouldn't it at least be the same as the next variable (Tower_QA_QC.NEE.flag)? This also raises the question of how to interpret aggregations from sparse chamber measurements (i.e. are you effectively gap-filling?). I assume the real gap-filling is only done for EC, therefore, somewhere you should make a clearer distinction between your methods and assumptions between EC and chamber aggregations.

`Tower_QA_QC.NEE.flag` variable is confusing. It seems to involve both the amount of gap-filled data and the quality of the gap-filing. Please provide a clearer explanation how to interpret the value between 0 and 1.

`Method_error_NEE_gC_m2` why does this variable only have 23% coverage, when the NEE aggregations are for 91% of the dataset? More information needs to be provided about under what circumstances it was deemed possible to compute an error and why. It seems to me that it may be possible to estimate an error or an uncertainty for any aggregation (chamber or EC tower).

Finally, can the authors please justify why they did not include any standardized variables extracted from geospatial products to make the dataset more ready for use? Things like MAT, MAP, and elevation could easily be filled using the WorldClim and GeoMorpho products respectively.