

Interactive comment on “Exchange of CO₂ in Arctic tundra: impacts of meteorological variations and biological disturbance” by Efrén López-Blanco et al.

Anonymous Referee #1

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Lopez-Blanco and colleagues present a study of ecosystem CO₂ dynamics across eight snow-free seasons for a wet fen tundra ecosystem in west Greenland. The authors compare ecosystem respiration (Reco) and gross primary production (GPP) with key climatic drivers to characterize how ecosystem CO₂ dynamics will change with climate. Comparisons are made at hourly, daily, and seasonal timescales to understand how drivers of ecosystem CO₂ dynamics change across temporal scales. Additionally, the authors compare several eddy covariance partitioning methods in order to assess uncertainty associated with interpretation of EC derived estimates of Reco and GPP. The main finding is that large interannual variations in Reco and GPP with climate are compensatory, and so net ecosystem exchange (NEE) of CO₂ remains quite stable

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across climatically diverse snow-free seasons. This is a valuable analysis of a fairly long EC data set, particularly for a tundra ecosystem. Overall I find the methodology to be quite sound and recommend several relatively minor but important revisions before the manuscript is considered further for publication. The following paragraphs describe more major issues, and are then followed by specific comments.

The introduction should be improved in several ways. First, the paragraph on flux partitioning seems out of place. The first and third paragraphs highlight research surrounding tundra/Arctic C cycling, and are bisected by the paragraph on partitioning. It would make more sense to first discuss carbon cycle dynamics and then highlight challenges associated with EC partitioning; so switch paragraphs two and three.

In the results it seems that sections 3.3 should come before section 3.2; first describe the partitioning comparisons and then get into the results. Related, I don't see where you mention which partitioning/gapfilling methods you report. It would make sense to first present the flux processing results, and then state which date you'll present moving forward. Also, it is general good to have the figures ordered as they appear in the text. Currently order is Fig 5 -> Fig 4 -> Fig 3.

The last major area for revision is related to the broader implications of your results – specifically, how transferable are they? There is some of this in section 4.3, but it could be expanded there, and perhaps in section 4.1. Specifically, it occurs to me that this research site receives a relatively high amount of precipitation relative to many other tundra ecosystems, and has no permafrost. As such, the NEE responses to climate at other tundra sites may likely be more variable. It would be worth discussing this a bit further. Secondly, it is difficult to talk about ecosystem CO₂ source/sink dynamics without some discussion of non-growing season processes. Papers by Zona et al and Commanine et al (very recently) indicate the importance of non-growing season C dynamics. Also, given the fact that you are using net sink timing to define the growing season, I wonder what effect previous growing season or previous winter conditions might have on your results? For example does a wet summer followed by a warm winter

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lead to high Reco the following year? There are very likely some interesting time-lag effects influencing the patterns you observe. Again, you allude to these processes, for example, by mentioning previous winter temperatures, but I think a more targeted and thoughtful discussion on temporal lags/dynamics would be useful. Actually, it would be helpful to report non-growing season climate data, and perhaps even analysis of these sorts of time lags. I do not think the latter is absolutely necessary, because this paper already contains a lot of information, but it could be informative either here or in another paper.

(I will also note here that it seems odd to place the section on EC processing between to two sections discussing CO₂ dynamics).

Minor edits:

Lines 40-44: You should explicitly state that you are referring to soil C stocks – this doesn't come until the very end.

Line 76: Why do you mention C a need for sites with C stocks if you don't present them in the paper?

Line 102: This line is a bit too informal; it's not Skip's map, it was a large collaborative effort. It would be more appropriate to report the class and the name of the map and the paper describing the map. Walker, D. et al. (2005), The Circumpolar Arctic vegetation map, *Journal of Vegetation Science*, 16(267-282).

Lines 103-104: I don't understand this, what does it mean that the site 'went out of the Arctic zone'?

Line 142: What is Papale et al In Prep? Perhaps indicate that this is via personal communication as well, if that is the case.

Line 264: This is a very simplistic and incomplete view of the residence time of fixed C. I'm not sure you can say anything meaningful about C residence time with discussing fluxes between pools and storage, which aren't really addressed in this manuscript.

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Line 279: This could be worded clearer; at first I thought you were saying the PAR values peak at 6am, which was confusing. Perhaps explicitly state that the predictive importance of PAR peaks at this time.

Line 287: The model 'catching' something is perhaps a bit too colloquial. Better to state that it revealed or indicated a decline in the importance of PAR in 2011.

Line 295: You can only say that NEE is insensitive to climate during the snow-free season.

Line 300: 'NEE exchange' is redundant, just use NEE (here and elsewhere).

Line 330: Lots of typos here.

Figures 4 & 7: It would be good to include a legend indicating what the colors represent, in addition to the text description.

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