**Biogeosciences
Discussions**

Interactive comment on "Carbon dioxide balance of subarctic tundra from plot to regional scales" by M. E. Marushchak et al.

Anonymous Referee #2

Major comments

This manuscript describes the observations of ecosystem CO2 balance at a subarctic tundra area in Northeast European Russia using two different measurement techniques and two different up-scaling methods. The authors used measurements taken at two different scales (plot scale: chambers on terrestrial surfaces, gas gradient method from snow, and bubble collectors on lakes; landscape scale: eddy covariance) to upscale the measurements to a regional scale using two different up-scaling methods (Quickbird satellite image driven land cover classification and LAI map). The authors showed a good agreement of the CO2 balance for the EC footprint using these methods. This is a carefully conducted study that verifies that even under the most heterogeneous environment like tundra landscape, the ecosystem CO2 balance can be

well modeled and up-scaled using different measurement techniques. For this reason, I applaud the authors' efforts in conducting this type of study. I believe that the details of up-scaling method shown in this study will be very useful for future research and that it is highly relevant for the scope of Biogeosciences.

However, the current version of the manuscript still owes some level of clarity and details, especially in the methods description. The two up-scaling methods used in this study were land cover classification/land cover types and LAI map derived from Quickbird satellite image. Although this part may be one of the most important information in this study, the description of how these two were derived was quite confusing. I read this part several times, but only able to understand this by the end of the results section. I am still a bit confused how and why the land cover classifications were separated as is. The authors need to answer the following questions regarding this description. 1) Why did the authors separate the landscape into different land cover classifications? 2) Why were the two methods chosen? 3) How were they separated? The authors provided Hugelius et al. (2011) for detailed description, but they still need to provide some level of detail for this method in their study. In addition, the description in section 2.1 needs to be revised accordingly. The part on ecosystem CO2 balance in different land cover classification was also not discussed in the discussion section. I suggest expanding this idea and answer the question why the patterns are how they are based on the land cover classification and LAI in the discussion. More description on this part would be very useful for the readers. Another detail necessary for this manuscript was on modeling GP and ER. Modeling and up-scaling tundra GP and ER using different environmental variables have been done before. I am surprised how much the LAI explains variability in GP and ER in this study. But to support their conclusion, the authors need to provide more detail on each steps of modeling process. I'd like to direct the authors to similar studies conducted in tundra ecosystem: Lee et al. (2011) A spatially explicit analysis to extrapolate carbon fluxes in upland tundra where permafrost is thawing. Global Change Biology, 17, 1379–1393 and Williams et al. (2008) Upscaling leaf area index in an Arctic landscape through multiscale observations. Global Change

Biology, 14, 1517–1530. I recommend the authors first show correlations among the variables used in the models to show the readers how much auto-correlated each variable can be, and next show each step of model construction. The caveat of regression method in multiple variables is that the significance and confidence level increases with increased number of variables by nature. Therefore, each model needs to be compared by how much it is improved by adding more variables. I'm not sure after reading this manuscript whether the models were developed for each land cover classification and put together later for Figure 5, or if they were developed by pooling all the data from the beginning. Tied to this comment is that the auxiliary data collection was described only in supplementary information, but I think it would be more useful to be included in the main text to help the readers' understandings on how the data were collected. It seems that the environmental data were collected only from one weather station (actually two, but only one was used) and I'd like to know the authors' take on this, when the tundra landscape is very heterogeneous. Below are some minor comments that would help enhance the clarity of the manuscript.

Minor comments

- Throughout the manuscript, the word 'data' was treated singular. Please revise it to be plural.

- Throughout the manuscript, the term plot scale and microsites were used to describe the measurement scale, how did they differ? Does this need to be consistent? In addition, how do LCC, LCT, and microsites differ? Please clarify throughout the manuscript. This is also making Table 2 very difficult to understand.

- P9946L15-18: I think there is too much logical gap from the previous sentence to this one. How was this achieved?

- P9948L20: Describe what plot measurements were.

- Section 2.4.4: Provide why this was conducted.

- P9954L24: Where were these 13 LCTs described?

- P9955L5-6: Where did this idea come from? Is there a reference or is this done conventionally?

- P9956L13: 'hot' is this supposed to be 'high'?

- Section 3.4: I don't really understand the necessity of this section in this much detail with this many figures. The earlier graphs already explain much of seasonality. I recommend either downsizing this section or focus on growing season vs. non-growing season. In addition, I think there is not enough information to show interannual variations unless the authors are going to go in depth on showing what caused the interannual variability.

- Section 4.2: I think it would be very helpful for the future research, if the authors can give some suggestions for addressing the problem of the difference between the two measuring techniques. In this section, the authors give a good overview of why this may be happening, but a suggestion for how to address this issue or how to fix this problem would greatly help the readers.

- Section 4.4: I don't really think that this study was much relevant to addressing this topic. The authors did not conduct this research under the assumption of changing climate. If they would like to include this section, the authors need to go over in depth description on how their model or observations change with climate and climate variability. Either route seems fine, but I believe this manuscript can do without the climate change effect.

- Table 4: What is WT?

- Fig3: What do these lines represent? What does Fen and B. nana tundra heath represent in the figure?

- Fig4: What are the different colors in figure top-right represent? Indicate positive and negative values in the figure to make the figure stand alone from the text. How about

labeling a, b, c, d for each panel to clarify the description of the figures? Were the data pooled from all the sites?

- Fig6: X-axis is missing

- Fig12: X-axis is missing

- Tables S1 and S2 need more detail. The units and abbreviations are not described.