

## ***Interactive comment on “Understanding the representativeness of FLUXNET for upscaling carbon flux from eddy covariance measurements” by Jitendra Kumar et al.***

**Anonymous Referee #2**

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This study targets one of the fundamental but still challenging aspects of FLUXNET data sets – the representativeness issue. The authors adopt a similar approach to their previous works, where the k-mean clustering technique is applied to determine the dissimilarity among pixels in the multidimensional environmental space and to assess the representativeness of FLUXNET site locations and available data sets. Based on the data availability of the FLUXNET2015 data set, the study also shows the potentials and limitations of such data set in extrapolating in space and in time.

Overall, I think the manuscript is generally well-crafted, and there are a number of potentially important messages could be delivered and learned by data contributors, managers, and users. For the three proposed objectives of the study (Line 28-35,

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Page 2), I think the study is sufficient to answer the first two about the quantification of FLUXNET representativeness and its temporally variable nature. I have some concerns and questions about the third objective, which aims to upscale the data to a much broader extent in space and in time (see comments below). There are a few places in the current manuscript that needs careful revision and re-organization for clarification and avoiding misinterpretation. Here, I list my general and a few specific comments.

General Comments:

[1] My major concern is the justification of the upscaling approach and/or the interpretation of the upscaled products. The authors repeat a couple of times in the manuscript about the potential bias/uncertainty of the upscaling practices. I think the message is important. Given that the original data availability is unevenly distributed in space and in time and the upscaling approach is pure empirical, one shouldn't be too surprised to see the unexpected predictions in areas or periods with limited data (e.g., Figures 7-9). The question is “how would the authors like readers to view and interpret their GPP predictions?” On the one hand, since this is a data-publishing journal, I'd expect a large portion of discussion meant to support or justify the dataset – a new gridded monthly GPP product. If the authors intend to do so, then I think there are several places in the upscaling processes needed to be clearly defined, modified, or better justified. On the other hand, if the goal of the upscaling practices is to demonstrate and address the representativeness of FLUXNET data sets, then the final data products of this study might be more appropriately interpreted as representativeness metrics. Either way would be valuable, but it's problematic trying to do both or something in-between. I'd hold off some specific comments following this thread of discussion for now, as I feel that the authors first need to decide the ultimate goal of the study and data products, and tailor the analysis and manuscript organization accordingly.

Some examples related to the justification of upscaling: How to adequately incorporate phenology in the prediction? How to deal with the difference of land cover (or vegetation cover) within the ecoregions? Certain ecoregions and periods have very sparse data

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coverage. Would it be appropriate to upscale in these cases? It may also need a section to discuss the robustness and uncertainty of the upscaling approach, e.g., cross-validation.

[2] The comparison of the upscaled GPP to MTE GPP is interesting, but requires some more works to help clarify the difference. Currently, it's difficult to interpret the difference. Both upscaling products started from different versions of FLUXNET data sets. The algorithms and variables (environmental factors) used in upscaling practices were also different (e.g., different variables, resolutions, and different ways to incorporate the seasonal/interannual dynamics...). A more careful and comprehensive comparison would be valuable, which could help better interpret the data products, to show potential areas needing more data, or to pinpoint the limitations of each upscaling approach.

[3] As also pointed out by others in the short comments, please be sure to follow the data policy of using FLUXNET data sets. There's no site list attached, but it seems the sites used in the study contain both Tier 1 and Tier 2 sites (??), which have slightly different requirements for credits and acknowledgements. Please make sure fulfilling the data policy when revising the manuscript.

#### Specific Comments

[1] Line 25-27 Page 2: Theoretically, there are at least a few steps involved in upscaling the tower data to a landscape- or global-scale estimate. A number of studies focused on the upscaling from tower footprints (varying through time) to grid pixels that were seen by satellite remote sensing or reanalysis data products. The focus of current study is more on the later steps, which assumes that flux data adequately represent the pixel properties, and exercise the upscaling from pixels to pixels. Please revise the description (here and all followings).

[2] Line 7 Page 3: It depends on the ultimate goals of the study (referred to general comment [1]), but the authors might need to explain shortly or justify why choose

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GPP\_DT\_CUT\_REF over other available GPP products in FLUXNET data set.

[3] Table 1: It's not clear about the temporal resolution of these variables. Are they yearly variables (1 value for each pixel for each year), or long-term averages (1 value for each pixel for all years)? These details also miss later in the upscaling practices (e.g., 2.5.1). It's not clear to me how the upscaling is done on monthly time series, as most of the variables listed here are yearly or long-term averages.

[4] Section 2.3, Figure 2: I wonder if it's feasible to introduce IGBP (or other vegetation/land cover gridded products) into the classification or clustering analysis. There are certainly finer-resolution details missing in the current classification, e.g., the Midwest croplands vs Northeast US temperate forests. I wonder whether adding IGBP may or may not help improve the upscaling predictions.

[5] Section 2.4: Some of the descriptions in this section are duplicated to those in the Introduction. Please consider trimming or reorganizing them.

[6] Line 1-20 Page 6: Need a short sentence to describe how the Euclidean distance is translated to dissimilarity or representativeness.

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