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Comment

***Interactive comment on* “Evaluating the agreement between measurements and models of net ecosystem exchange at different times and time scales using wavelet coherence: an example using data from the North American Carbon Program Site-Level Interim Synthesis” by P. C. Stoy et al.**

**Anonymous Referee #1**

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Review of “Evaluating the agreement between measurements and models of net ecosystem exchange at different times and time scales using wavelet coherence: an example using data from the North American Carbon Program Site-Level Interim Synthesis” submitted to Biogeosciences.

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This article evaluates twenty ecosystem models against measurements of the NEE from the ten eddy covariance research sites provided by the NACP program. The authors found that

- 1) Models with prescribed phenology often fit NEE observations better on annual to interannual times scales in short vegetation
- 2) Models that calculate NEE as GPP-ER showed better fit on monthly to seasonal time scales in two coniferous forests
- 3) Models that incorporated foliar nitrogen data were successful at capturing NEE variability on multiple year time scales at Howland Forest, Maine
- 4) Few NACP models correctly predicted fluxes on seasonal and interannual time scales.

I believe that the contents in this article are meaningful to the community and will be of interest to audience of “Biogeosciences”. I also enjoyed reading this article and the ideas in this article. I hope that several issues below make much better readability for its contribution to the community.

1. Wavelet coherence analysis needs continuous data without any data missing. This indicates that the results of wavelet coherence and their interpretation may (or may not) be sensitivity to the gap filling methods. First, if the authors applied the gap-filling of NEE based on Barr et al. (2004), daytime gaps in NEE were estimated by GPP minus ER and GPP and ER estimated independently from the light-response curve and temperature dependency of ER. The authors concluded that the models calculating NEE as GPP-ER were superior only on monthly to seasonal time scales in two coniferous forests, and I want to know this result depends on the gap filling methods of the observed NEE (e.g., look-up table of NEE). Second is related to gap filling of climatological conditions. As the article showed clearly, the models showed different responses to the climate conditions and the climatological conditions have

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been used for driving the model. Therefore, I wonder if the gap filling method can result in some uncertainty in interpreting the variations among the models. So I just want to know if the authors can test these sensitivity issues by comparing wavelet coherence results of different gap-filling methods.

2. In Abstract, the authors wrote that “. . . ., multi-year oscillations in climatological drivers, and . . . are known to be important for determining ecosystem function.” I fully agree with this opinion and so I wonder if the authors can do wavelet coherence of climatological drivers and peaks of their wavelet coherence can be related to the peaks in the figures. Especially, if there are peaks in the wavelet coherence of the modeled or observed NEE that are not seen in the model outputs, it tells that the modeled or observed NEE are sensitive to small changes in climate conditions, thus indicating that biology may be important.

3. NEE is the composition of two independent processes, GPP and ER. I wonder if separate analysis of wavelet coherence of GPP and ER can provide more insight on the model performances.

4. As the authors pointed out in Introduction (from line 18 page 2044), a few papers reported the NACP model performances regarding phenology, better fit from the model calculating NEE from GPP minus ER and etc. These findings are also emphasized again in this article and it needs some clear description on which more can be obtained from wavelet coherence. In particular, the authors said that “less certain is how models match measurements on multiple time scales as they respond to climatic and biological forcings that act on multiple time scales”. Therefore, I think that analysis in time scales of climatic forcings must be discussed before moving to wavelet coherence of the models.

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5. Figure 1: I wonder what was happening in the early measurement period ( 1991 and 2004) and described as blue color.

6. P3050 / L10 – 19: I want some discussion on the performance of ED2 in Figure 3 compared to the others

7. P3052 / L5:  $10^{3.5}$  (i.e. 3 months) may be revised to  $10^{3.3}$  (i.e. 3 months) or  $10^{3.5}$  (i.e. 4 months)

8. P3052 / L21 – 27: Please indicate which figure supports these sentences.

9. P3052 / L27 – P3053 / L2: The authors said that “Remote sensing is often unsuccessful for capturing grassland phenology (Reed et al., 1994), due in part to the fact that the shift from green to brown biomass is critical for modeling NEE but can be subtle and difficult to ascertain remotely (Sus et al., 2010)”

It seems to me that this sentence is saying that the prescribed phenology is not good for modeling in grassland. However, the authors found that the models that prescribed phenology showed better performance at the cold, non-forest sites. I am curious about consistence between these two sentences in the article.

10. I want to know the exact meaning of white-colored area in Figs 5-9. If I correctly understand, this white-colored area can be when two types of models are either significant or not significant simultaneously. Sometimes, it seems important to distinguish these two different conditions on the model performance.

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11. It seems to me that Section 3.8 did not show any important results but discuss some issues in interpreting wavelet coherence. So, I suggest this subsection is moved to conclusion, rather than the independent subsection in Results and Discussion.

12. It seems to me that paragraphs in Conclusion are saying what is not discussed in Results and Discussion. In particular, because the data assimilation is discussed in Appendix A, any comments on LoTEC are not relevant in Conclusion. I suggest that Appendix A is moved to Results and Discussion. Also, I could not find any evidence to support the paragraph from Line 2 to 10 in Page 3056.

13. There is one previous study to use wavelet coherence for evaluating ecosystem model and to discuss results from wavelet coherence with phenology (Hong and Kim, 2011, Impact of the Asian monsoon climate on ecosystem carbon and water exchanges: A wavelet analysis and its ecosystem modeling implication, Glob Chan. Biol, 17, 1900-1916). Proper citation of this study should be done.

14. I want any explanations in the spacious white-colored area in Figs 6G, 6I, 7G, 7I, 8G, 8I, 9G, and 9I, if possible.

15. The title of Detto et al. (2012) in Reference is wrong. Correct title is Detto et al. (2012) Causality and persistence in ecological systems: A nonparametric spectral Granger causality approach, Am. Nat., 179, 524-535.

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