

Interactive comment on “Leveraging the signature of heterotrophic respiration on atmospheric CO₂ for model benchmarking” by Samantha J. Basile et al.

Anonymous Referee #1

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This study uses globally modeled ecosystem CO₂ fluxes and an atmospheric transport model together with observed atmospheric CO₂ concentrations to evaluate different soil respiration models. This is done by comparing the inter-annual and intra-annual variability in CO₂ fluxes between model and observations. The global scale of the study makes this a rather rough comparison, which however is useful for identifying soil models that perform better at such scales.

In general, there seems to be a considerable amount of work and careful analysis carried out and the study had scientifically interesting results. The manuscript has good grammar and few typos. The introduction goes from the more general to the

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specific aims and summary of the methods and is well written. On the down side, much in the methods and results remains difficult to follow. Explaining the procedure in more detail will largely facilitate understanding the results and discussion. Generally, the text should be made more readable to a biogeochemistry audience that may not be familiar with the jargon and assumptions used in this specific field. Because there are many variables and procedures being used, it would help to more carefully define each part and consistently use the defined terms throughout the text. The manuscript should reach publication quality after these aspects are taken care of.

Specific remarks:

L44: is this not rather a "spatial" rather than "concentration" footprint?

L108: The term "phasing" is used in several places. Please describe its meaning on first use.

L114: remove "were"

L133-134: Please explain in more detail what you mean by diagnosing using one standard deviation.

L138-142: Six latitude zones are mentioned but 5 used later. Maybe clarify here that 2 zones are aggregated. Also, could you use the same naming for north and south (e.g. NHL, SHL, etc.).

L162-166: CLM can be run to simulate the mentioned fluxes. Why was CASA used instead?

L194: model structure?

L196-197: The procedure here is unclear. What do you mean by masked to land regions that align with the sampling zones? Do you mean the latitude zones defined earlier? Why do you specify "land regions", is it because there are ocean fluxes that need to be excluded? "mask" is a term that many reader will not understand. Why are

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monthly averages calculated if daily values are used for the transport model? Please add detail.

L197-199: A repetition of the zones does not seem necessary.

L203-204: Please give more detail, either here or below, of how exactly these are used as boundary conditions for the model.

L204: Do you mean the transport model is run for lat zones separately? How does it deal with the lat boundaries in this case?

L211: "data" rather than "fields"

L215: Explain here the model CO₂ flux inputs and outputs (presumably the boundary conditions mentioned before?) and clarify what fluxes are omitted (fossil fuels, etc)

L216: "minimize the"

L217: Confusing. Anthropogenic emissions are not modeled, so they cannot have an influence. Presumably you are relating this to the observations. Please reword.

L219: "closest to the observation sites, i.e. the"

L221: remove "calculations"

L222-225: This clarification should come before, when the averaging is explained. Although, as stated, atmospheric [CO₂] over the ocean should integrate the signal over large regions, it is not clear why the zones and averaging was necessary. Since model data can be obtained for the observation points, the residuals of these could have been analyzed directly.

L226-242: This section is not clear. L226: "spatial" you mean the lat zones? How exactly do you isolate the imprints? What do you mean by "tag"? I believe "track CO₂ tracers" is confusing since "tracer" relates to flow dynamics, but the analysis is about concentration changes(?). You mention "4 sets of fluxes" but aren't the observations

CO₂ concentrations. What is then being compared (you mention CO₂NEP variability is comparable to observations)? Are CO₂NEP and CO₂HR fluxes or concentrations? If these are the fluxes, should they not be introduced in the previous section?

L245-248: The calculation is not the variability but just the growth rate (or rate of change). Where does the annual IAV time series come from? Is it an annual average of the IAV series? Please clarify. Consider rewording, e.g. "The monthly and yearly rate of change of the the interannual anomaly (i.e. the IAV timeseries) was calculated as ...".

L248-250: This sentence is not understandable.

L251-253: "fitted to ... against ..." instead of "for .. with ...". Also, where does T IAV come from?

L255: "global temperature sensitivity"

L255-259: Was this reference calculated from IAV data or actual observations? What is this reference for?

L263-277: Global variability of what? What do you define as SD_{rel}, the ratio or the "IAV magnitude"? (presumably the latter, but be more explicit). In any case, the term IAV magnitude is confusing. Why not simply say IAV relative SD? The calculation should be made clearer. What are "regional values of simulated CO₂" (since all simulations made are regional CO₂). Why do you use the relative standard deviation (or CV). A high CV from a small flux can have a smaller impact on global values than a small CV from a large flux. The actual SD may be a better measure. Also, it seems to me that using a ratio between regions and global assumes an additive effect of each region, which might not be the case (what if the regional IAV CV is larger than the global value?). What do you mean by sourced only from a single region? Consider rewriting this paragraph/revising this analysis.

L283-285: Still at a loss of what CO₂NPP, CO₂HR are. Atmospheric values derived

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from...? Is it in any way logical that peaks in CO₂NPP are max in April (early spring) and min August (mid summer) in NHL?

L299-300: Does CO₂NEP not always consider NPP and HR together?

L338: Not if NPP increases more than HR.

Figure 2 and 3: If I understood correctly, values here are differences with the long term trend. To make this clearer, it would be good to note this in the caption.

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