Biogeosciences Discussions

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Comment on bg-2022-40

Ashley Ballantyne (Referee)

Referee comment on "Multi-year observations reveal a larger than expected autumn respiration signal across northeast Eurasia" by Brendan Byrne et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-40-RC1, 2022

Review of Byrne et al: Multi-year observations reveal a larger than expected autumn respiration signal across northeast Eurasia

Summary:

In this paper Byrne et al. evaluate the seasonal distribution of NEE at high latitudes using a combination of atmospheric CO2 measurements to inform model inversions of net C exchange in combination with satellite estimates of GPP to infer respiration. They note that anomalously low NEE in autumn can be attributed to greater Rh release. They also note a mismatch between their estimates and those derived from land surface models. They then provide an explanation whereby temperature lags within the soil can explain a certain fraction of this enhanced autumn respiration. This was a nice paper and could be publishable with some additional analysis and consideration of assumptions.

General Comments:

This paper profits from the high resolution XCO2 measurements which now allow us to estimate net CO2 fluxes at high resolution within specific bioregions and uncover different processes that may be affecting these seasonal fluxes. I found this analysis to be quite thorough and pretty convincing; however, I did have a few general comments. It seems as though the mismatch between observations and models may be dependent on the seasonal estimates of CUE and their assumptions. Perhaps it would be useful to look at total ecosystem respiration (GPP-NEE= TER) initially to see if the same mismatch is evident, this would suggest that the mismatch is not an artifact of the unique CUE applied over this region. Alternatively, one could use an independent estimate of CUE from an independent model (Konings et al. 2019) or use the same seasonal CUE for all regions.

Furthermore, see recent analysis on Siberian warming where there is a strong relationship between spring GPP and fall TER (Kwon et al. 2021). Although the timespan for the OCO-2 inversions is too short, this citation on seasonal anomalies may help to put these results in a longer temporal context.

I also had some comments on the soil model comparisons with the observation constrained estimates. The text (line 323) discusses regressions and statistics of those regressions, but the actual figure shows seasonal distributions from models and observations. The figure is pretty clean and easy to interpret, but the paper could benefit from a table in the main text that include your statistics, in addition to standard model performance statistics such as RMSE, MAE, and bias statistics. The model could also be tested against the eddy flux data estimates of Rh and these values could be reported in the table. This would help the reader evaluate which models are indeed superior. Also litterfall estimates seem an order of magnitude too high in Fig. s15 should peak at ~2 TgC day-1 as compared to NPP estimates in Fig. 3. This may just be a units problem but check the model.

See the attached PDF for my specific comments.

References:

Konings, Alexandra G., A. Anthony Bloom, Junjie Liu, Nicholas C. Parazoo, David S. Schimel, and Kevin W. Bowman. 2019. "Global Satellite-Driven Estimates of Heterotrophic Respiration." *Biogeosciences* 16 (11): 2269–84.

Kwon, Min Jung, Ashley Ballantyne, Philippe Ciais, Ana Bastos, Frédéric Chevallier, Zhihua Liu, Julia K. Green, Chunjing Qiu, and John S. Kimball. 2021. "Siberian 2020 Heatwave Increased Spring CO2 Uptake but Not Annual CO2 Uptake." *Environmental Research Letters: ERL [Web Site]* 16 (12): 124030.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2022-40/bg-2022-40-RC1-supplement.pdf