Biogeosciences Discuss., referee comment RC2
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Comment on bg-2022-167

Anonymous Referee #2

Referee comment on "Using atmospheric observations to quantify annual biogenic carbon dioxide fluxes on the Alaska North Slope" by Luke D. Schiferl et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-167-RC2, 2022

I reviewed this manuscript for a previous submission. This remains an extremely impressive and comprehensive model- and observation- based analysis of tundra carbon cycling. The authors go through a fairly exhaustive list of modeling scenarios in a valiant attempt to explain a very limited set of observed growing season and cold season emissions. The results provide a very nice analysis of different model representations of seasonal dco2 timing and magnitude.

The discussion section hasn't changed much. It could still use more qualitative discussion of results, with more references to the literature (here are several paragraphs with no references) to help explain/support findings.

Given the large ensemble of model scenarios, I was hoping to see a more focused discussion of how these difference scenarios (ecosystem parameterization, vegetation distribution, meteorological inputs) affect regional carbon balance, as a way to characterize uncertain and inform future modeling efforts. These scenarios are discussed sporadically throughout, but I think it would help to add separate section to the Discussion summarizing these effects.

L363-368: It's not clear why a "PF-Model Derived Soil Temperature" is required to more accurately capture soil freezing processes. Is this process unique to PF affected regions, or are there other factors at play related more generally to soil thermodynamics, hydraulic properties, freeze-thaw dynamics, etc?

L373-374: Would more SOC, or more labile soil C (e.g., Jeong et al 2018), help to elevate fall soil C emission rates?

L449-451: Could you please elaborate on the “expected” response of tundra ecosystems to light and heat/temperature?

L452-459: It is interesting that coastal ecosystems are more representative of North Slope, due to increased sensitivity to light. Is this a statement of a specific vegetation type, or more general statement that north slope vegetation is more sensitive to light, for example as an adaptation to long dark cold seasons. This discussion really could use some references to the literature to support some of these claims. Also reading ahead to 596-608 suggests that “net flux” could also be affected by respiration due to topography and soil inundation. Could the authors please speculate on the competing roles of vegetation/GPP vs topography/soil water/TER on GS net flux?

L460-465: This paragraph basically says that net uptake increases sometimes because of SIF, but we don’t know why. I think more effort is needed to explain why. If its not because of air temperature or PAR, could it be soil temp? soil moisture? longer growing season? Different freeze/thaw dynamics?

L493-495: Please elaborate on the processes driving the “physical release of CO2 from soil.” I’m confused what could be the source of carbon if not from microbial activity. Please also comment on the possible role of emissions from permafrost and talik

L516-528: It’s surprising to see no mention of existing or future satellite datasets, which are getting better at resolving cold season emissions (e.g., Byrne et al., 2022)

Jeong, S. J., Bloom, A. A., Schimel, D., Sweeney, C., Parazoo, N. C., Medvigy, D., … Miller, C. E. (2018). Accelerating rates of arctic carbon cycling revealed by long-term atmospheric CO2 measurements. *Science Advances*, *4*(7), 1–7. https://doi.org/10.1126/sciadv.aao116

Byrne, B., Liu, J., Yi, Y., Chatterjee, A., Basu, S., Cheng, R., Doughty, R., Chevallier, F., Bowman, K. W., Parazoo, N. C., Crisp, D., Li, X., Xiao, J., Sitch, S., Guenet, B., Deng, F., Johnson, M. S., Philip, S., McGuire, P. C., and Miller, C. E.: Multi-year observations reveal a larger than expected autumn respiration signal across northeast Eurasia, Biogeosciences, 19, 4779–4799, https://doi.org/10.5194/bg-19-4779-2022, 2022.