

Review of Manuscript:

Carbon dynamics and changing winter conditions: a review of current understanding and future research directions

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General:

This manuscript reviews the literature pertaining to effects of winter climate on ecosystem C dynamics. This topic is timely and a review will well serve the scientific community. This paper has good content and cites relevant studies. However, I found the writing to be vague in many places when discussing C fluxes and the season. As written it is often difficult to discern which season is being referred to when discussing a response variable. In addition, the pool of C being referred to is sometimes vague (e.g., in some cases you mention C concentrations, but it is not clear if you are referring to soil, soil solution, etc.). There are a couple of references that the authors might consider adding to this manuscript. Please see my detailed comments below.

Introduction:

15765 L8: “DOC has also” to “DOC also has”

Methods:

15767 L10: “Exiting” to “Existing”

Results:

15769 L11: I might change “decreased in both snow removal....” To “were lower in both snow removal....” Because the ambient plots were unaltered and as such their DOC fluxes were unaltered.

15769 L13-15: Why is this temperature distinction important?

15769 L16-17: I think this is a case where either and or should be used in place of neither and nor to prevent use of the double negative.

15769 L15-20: Is it important to draw distinctions in experimental design and questions posed between these studies? The former was simulating snowmelt compared to irrigation post-treatment. Also, I could be recalling incorrectly, but wasn't the response observed by Henschel et al. after 1 f-t cycle that was followed by sustained frost?

15770 L27-28: Does rising levels of CO₂ mean higher rates of soil respiration? If so, I think that should be explicitly stated.

15771 L3: “A three times decrease”?

15772 L6: The same area as what?

15771 L14-16: Is there a biome component to this story? i.e. are there differences in response to soil frost across biomes?

15771 L17: What is meant by “frost induced organic carbon”?

15772 L7: Here, and other places in this paragraph I think it would be useful to specify that you are talking about DOC concentrations (if that is indeed what you are referring to) so as not to be confused with actual mass of DOC being lost in streams.

I think this is an important distinction to make because higher concentrations do not necessarily mean greater losses of DOC.

15772 L15-18: I find this sentence a little confusing and perhaps inconsistent with the preceding text. Here you indicate that DOC export is higher DURING warmer winters, but the preceding text covers DOC export during several different seasons, depending on the study. I think this needs to be clearer here and it might be useful to discuss some sort of seasonality that might exist in the response of DOC export and/or some sort of bias in season(s) sampled by previous studies. This is also a good place to specify what is meant by 'export' of DOC...i.e. mass vs. concentrations.

15772 L19: Using "continuous" here makes it seem like automated chambers were used, is this what is meant?

15772 L21: Perhaps change to "After measuring rates of soil respiration fro 17 months in northern China..."

15772 L21-25: Im not sure these 2 sentences are necessary because it seems a bit out of place to start discussing soil warming during the growing season when the rest of the paper has dealt with winter manipulations. Also, in the context of this manuscript, Im not sure how useful it is to say that winter rates of soil respiration are not different between ecosystems. That seems a bit ancillary here and perhaps just a nuance of the study cited. The use of "between" twice in the second sentence is confusing.

15772 L25-27: Again, the wording of the description of the soil respiration study (i.e. "In a one season CO₂ efflux measurement") conveys something different than what I think is meant here. You can also simply say that soil CO₂ efflux declined throughout the winter.

15773 L2-5: I don't think these two sentences add anything useful to the paper...it is pretty well established that growing season rates of soil respiration are higher than those during the winter.

15773 L7-8: What is meant by "turning warmer spring to seasons with increased net CO₂ uptake"?

15773 L10: Change to "the Sierra Nevada Mountains"

15773 L11: Concentrations where?

15773 L16-17: Lower rates of Rs when?

15773 L18-19: Total C or labile C?

Discussion:

15773 L26: Important for CO₂ production during winter? Growing season? Because fluxes during multiple seasons are discussed throughout the paper I think it is important to specify the season you are referring to each time.

15774 L4-5: C concentrations in what? Soil? Soil solution? Streams?

15774 L26: Are you referring to the soil C pool here?

15774 L27-28: Losses during winter? During each event?

15775 L1: If I recall correctly Campbell et al. did not measure most of these fluxes during the winter, but during the growing season. Further, that study was looking at a sustained soil frost, not F-T cycles. I think it is important throughout to explicitly indicate which season you are referring to.

15775: For this first paragraph you might want to look at Reinmann et al. 2015, Ecosystems who discuss short-term impacts of soil frost on aboveground respiration and tree growth/C storage.

15775 L19-21: The wording in this sentence is kind of odd. You might just say that “There are almost always differences....”

15775 L27-28: I think you should elaborate on this point. How might soil type and organic matter content influence the response to soil frost?

15776 L18-24: Can you take this to the next step and indicate whether this has an impact on annual export vs. the timing of export?

15778 L1-2: “shifts to soil temperature to soil moisture” does not entirely make sense, should it read “then to soil moisture”?

15778 L13: Is this due to the effects of snow cover on soil frost?

15778 L26: Snow “disappearance” to “snowmelt”?

15779 L14: change to “towards THE south”

15780 L14: Remove “to” from “reach to”

15780 L16: “rises” to “rise”

15781 L3-6: “leafing” to “leaf-out”. Perhaps provide a citation for each of these responses?

15781 L8-9: See Hufkens et al. 2012 in GCB who discuss effects of spring warming and a late frost on sugar maples in the northeastern U.S.

15782: It is hard to see how the modeling paragraph fits in because there is not much of a focus on the winter processes. Could you add a few sentences to tie that in? I think discussing modeling prospects is important, but it would be great to tie it in a little more to winter processes. Do models explicitly model or take into account winter?

15782 L25: Add a colon after “consider.”

Figures:

Fig 1: Align letters in pictures and make them the same font size.