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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Seasonally frozen soil modifies patterns of boreal peatland wildfire vulnerability" *by* Simon J. Dixon et al.

Simon J. Dixon et al.

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We'd like to thank the reviewer for reading the paper and for providing comments to help improve the manuscript. We agree that the issue of understanding controls on near surface water balance and the links with seasonal frost and wildfire potential is a relevant question that is deserving of attention.

The reviewer has referred back to the detailed comments provided by S. Carey and so we will not duplicate some of our replies here, but restrict ourselves to addressing their specific comments.

The reviewer highlights that the Hydrus 2D model is unsuitable for replicating the system in question, as it is not capable of simulating heat and mass transfer in frozen

ground, and uses only simplified geometry for the frozen layer(s). On this point we completely agree with them, however, the aims and objectives of this study are not to simulate all the processes within the target system. As detailed in the response to S.Carey, the study is using exploratory (or heuristic) modelling in order to understand the magnitude and directionality in water balance response to the presence of a frost layer acting as an aquitard. This can be considered as a first step in understanding how near surface water balance can respond to the presence of a frost layer acting as a barrier to vertical flow of water from deeper in the soil profile. By isolating one aspect of the system (ice layer as barrier to water flow) in a simplified numerical modelling framework we are able to explore the comparative influence of this effect on near surface water balance. The reviewer comments that "clearly the descent and decline of the ice lenses is what is important here", however, without first establishing that the presence of the ice lenses can affect the near surface water balance (as we show it can only under some conditions here) the dynamics of this feature would be a moot point. Indeed, as we show in the manuscript there are peat types which will not lose substantial amounts of water through evaporation during prolonging dry periods, and for these peat types the decent and decline of the ice layer will have no effect on their near surface water balance. This is the inherent value and interest in using simplified numerical modelling set-ups - the ability to isolate different variables and examine the degree to which they influence the overall system behaviour.

As detailed in our response to S Carey, we propose to add clarification of the heuristic modelling aims at the start of the manuscript to help prevent confusion, and to expand the aims section to clearly state the areas which are beyond the scope of this exploratory study.

The reviewer has some concerns regarding the water conserving/productive peat properties concept, however, as detailed in the methods section this is based on previously published work. In response to S.Carey's comments we have suggested some amendments to provide an additional precis of the concept for readers who have not read the

other papers, which will further clarify the rationale in using these values.

The reviewer also expresses concerns that the conclusions are speculative and not valid, however, within the context of an exploratory modelling framework the conclusions are supported by the modelling and are restricted to comparative conclusions between our modelling scenarios. We agree that more detailed and complex numerical modelling could provide insights into the role of frost decent and geometry on near surface water balance, however such detailed predictions are beyond the narrower scope of this study.

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