**Biogeosciences
Discussions**

Interactive
Comment

Interactive comment on "Exploring the sensitivity of soil carbon dynamics to climate change, fire disturbance and permafrost thaw in a black spruce ecosystem" *by* J. A. O'Donnell et al.

J. A. O'Donnell et al.

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Response to Reviewer Comments

1. Page 8856, Lines 16-18: Based on your abstract, it seems that the main objective was to test the sensitivity of soil OC storage to a suite of individual climate factors and fire severity. Then here in the introduction you state that you are looking at RELATIVE sensitivity of ADL and soil climate effects. Are you using changes in ADL as a surrogate for fire severity? I am left uncertain about what the true objective of your manuscript is based on the discrepancies in your abstract and then your introduction. I think you would be hard-pressed to attribute all differ-

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ences in ADL to differences in fire severity. Therefore, is this paper interested in fire severity or ADL or both?

The reviewer has brought up some good points and we appreciate the opportunity to clarify our experimental design and research objectives. Our overarching objective is correct as stated in the abstract. To clarify the experimental design and research objectives, we modified the text in the introduction (lines 87-89) to be more consistent with the objective statement in the abstract.

Fire severity, in this study, is defined as the fraction of organic soil horizons consumed during a wildfire event (lines 254-258). In O'Donnell et al. (2010), we reported the empirical relationship between active layer depth (ALD) and organic horizon thickness across stand ages. Here, we used the Geophysical Institute Permafrost Laboratory model to simulate ALD across stand ages. To determine the effect of fire severity on ALD, we simply prescribed the fractional loss of organic horizon thickness in the GIPL model and then ran the model to simulate the effect on ALD. Given this approach, we are not using ALD as a surrogate for fire severity. We agree that differences in ALD across treatments are due to more than just fire severity. By using the GIPL model, we were able to simulate ALD as a function of *both* climate drivers and fire severity.

1. Page 8860, Section 2.3: Please add more detail to your study area. A map, lat/long, climate description. How were other potential driving variables in terms of soil carbon accumulation (and other soil properties such as organic horizon depth, soil thermal dynamics, active layer, etc.) accounted for or held constant. For instance, topography, understory composition (which will be different in different aged stands), stand density, etc.

In response to both reviewers, we have now added more detail to the study site description, including latitude and longitude coordinates (line 184), topographic information (lines 184-186) climate information (lines 187-191), and vegetation descriptions

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across stand ages (lines 192-201). We kept the reference in the text to O'Donnell et al. (2010), which provides even more detailed site information and a map. To address the characterization of organic horizon depth and active layer variation across stand ages, we added the reference O'Donnell et al. (2010; line 205), where these measurements were originally reported.

1. Page 8863 Section 2.5: I found this section fairly confusing to follow. I would encourage the authors to reread this section from a non-modeling perspective and see if it can be written in more useful language. In particular, I would spend more time walking the reader through Figure 1.

We made many changes to the text in Section 2.5 to improve clarity for the reader. We now walk the reader through Figure 1 to better explain the linkages between model inputs (climate data, fire severity) and the nature of the coupling between the GIPL and Fire-C models (lines 269-272). We also added text to specify which changes were prescribed in the Fire-C model to differentiate between historic and future simulations (line 273-278). We also added text references to other sections of the manuscript (e.g. *Section 2.2.3*) that further describe model structure and function (lines 269, 277, 278). Finally, we removed modeling jargon from several sentences to improve readability for both modelers and non-modelers alike.

1. Page 8867, Section 4.1, Lines 16-17: Microbial decomposition? I am confused. I didn't think microbial decomposition was an input into either the GIPL or Fire-C model. How can you positively identify this as a mechanism? I think you should state that based on your model runs, you are able to hypothesize on two mechanisms that may contribute to organic carbon losses.

In response to the reviewer's suggestion, we changed the text here to state, "Through our modeling analyses, we were able to isolate two potential mechanisms underlying OC losses."

Interactive comment on Biogeosciences Discuss., 7, 8853, 2010.