

# ***Interactive comment on “The trajectory of landcover change in peatland complexes with discontinuous permafrost, northwestern Canada”***

**by Olivia Carpino et al.**

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REVIEWER #2 The manuscript entitled “The trajectory of landcover change in peatland complexes with discontinuous permafrost, northwestern Canada” by Olivia Carpino et al. focuses on the Taiga Plains of Northwest Canada, where rapid climate warming has significantly reduced the area underlain by permafrost in peatland complexes. A massive landscape shift has occurred in recent years, from a forest-dominated landscape to a wetland-dominated landscape. The authors explore the current trajectory of land cover change in a 300,000 km<sup>2</sup> area of discontinuous permafrost in northwestern Canada by presenting spatiotemporal variability using a 600-km latitudinal span of

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this region. By combining extensive geomatics data with ground-based meteorological and hydrological measurements, a new conceptual model of landscape evolution was developed.

This model explains the observed patterns of land cover change caused by permafrost thawing and provides a basis for predicting future changes. This is a very interesting paper and provides deep insights into how future permafrost loss may change the Taiga forest. The conceptual model and the discussion of water and energy balances are also interesting. However, I feel that the paper is somewhat disorganized and needs a more unified structure. I also think the conceptual model needs to be validated, and I would recommend that the validation be described in terms of the results and discussion. Overall, the authors need to revise the manuscript before its publication. Although there are some issues, I recommend that this paper be published after revisions are made.

Response (R): We thank the reviewer for these suggestions. We will re-write the Introduction section, and add new text in the Results and Discussion section in advance of the presentation of the conceptual framework. These additions will provide a better context for the framework. The sections that follow the introduction of the framework will focus on the biophysical, hydrological, and micrometeorological functions of each land cover stage, and the consequent changes to these functions as one stage transitions to the next.

Specific comments (1) Sections 3.1 and 3.2 of the Results and Discussion in Chapter 3 are in a completely different vein, making it difficult to read. Section 3.1 discusses the latitudinal distribution of forest cover and permafrost. I feel it would be better to show the percentage of peat areas and wetlands along with latitude in Figure 3. Similarly, the spatial distribution of forests and wetlands can be shown in a figure similar to Figure 2. Also, the spatial distribution is clearly shown in Figures 2 and 3, but the valuable aerial photos and data of IKONOS are described in the method of Chapter 2, which have been analyzed since 1947. I would like to see a figure similar to Figures 2 and 3,

one that shows the changes over time based on the data analysis.

R: We agree that these two sections were entirely in a different vein. To address this, we will re-write the Introduction and introduce new text at the beginning of the Results and Discussion section to provide better context for the conceptual framework (as explained above). The percentage of peatland does not change with latitude in Figure 3 since it is based only on the peatland-dominated lowlands identified in Figure 2. However, we will add some annotations to Figure 3 to clarify the variation in the type of peatland that predominates over the latitudinal transition. Specifically, we will add: "Permafrost-free forest", "collapse scars", "forest with permafrost". In the figure caption we will indicate that "the latitudes where permafrost-free forest, collapse scars, and forest with permafrost are most prevalent are indicated".

(2) At the beginning of Section 3.2, a conceptual model of landscape change associated with the thawing of frozen ground is provided in Figure 4. The conceptual model is introduced so abruptly that it feels as though it has not been validated. Therefore, I would like to see the conceptual model validated on the basis of the analytical data in section 3.1. I would like you to show the results of the verification of the proposed model on the whole study region, using the data from Section 3.1, although it is valid for Scotty Creek. In addition, the purpose of this study was to characterize end members and intervening stages of the landcover transition. Please indicate the end members in Figure 4.

R: We agree that the conceptual framework was introduced too soon in the text without sufficient context and explanation in advance. However, the new Introduction section and new text in the Results and Discussion section that precedes the introduction of the conceptual framework will address this issue. The revised text will convey that the conceptual framework forms the basis of subsequent discussion on the form and function of each land cover stage. We will also clarify that in addition to presenting new data, this manuscript also draws upon the accumulated knowledge of hydrological studies on each of the land cover types presented in Figure 4. As such, the conceptual

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framework provides a synthesis of previous research in order to interpret the land cover stages, their form and function, and the processes driving their transition.

(3) There is no single designation for Scotty Creek; please clarify if Scotty Creek Research Station (SCRS) is the same as Scotty Creek, Scotty Creek basin or Scotty Creek watershed. I recommend that Scotty Creek be unified with SCRS or others. In addition, I feel that there needs to be a map of the meteorological and hydrological observations that are being made at SCRS. In particular, a description or table of the four component radiation observations is needed. In Figure 5, it is difficult to understand the changes in the four radiative components without a description of whether they are observations above the vegetation canopy or on the forest floor. Additionally, please show which stage of the conceptual model each letter (a)-(d) corresponds to.

R: A basin map with location of instrumentation will be included to provide reference for the read. SCRS will be removed and replaced with reference to the Scotty Creek basin. The Methods section will be revised so that it is clear where the sensors are located in relation to the tree canopy. The sensor type and name and location of the manufacturer were added to the text: "...using a CNR4 sensor (Kipp and Zonen, Delft, Netherlands).

(4) Lines 106-113: Here the characteristics of the energy balance of the forest canopy are described. However, the difference between wetlands and forests is also evident in the water balance. For example, the amount of precipitation reaching the ground due to rainfall and snowfall interception is smaller in forests, making them more prone to drying out than in wetlands. I think it is important to describe this point as well.

R: In the revised manuscript, we will emphasize the distinctions in hydrology for each of the dominant landcover types in the discontinuous permafrost zone. With this explanation, we will highlight, as suggested, the influence of the black spruce canopy of partitioning hydrological inputs in each of the landcover types similar to our description of the energy dynamics.

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(5) Line 135: Dry peat has been mentioned, but I think it is necessary to mention rainfall interception by mosses and other factors as a cause (e.g., Price et al., 1997, *J. Hydrol.*, Suzuki et al., 2007, HYP). The reason for the dryness of the peat layer is that mosses are thought to play a major role in blocking rainfall. It would be useful to describe the underlying vegetation of the forest, and such descriptions should be added.

R: Where mosses predominate, the ground surface is already saturated and the topography very flat, so blocking of precipitation does not have a major impact on the partitioning of precipitation input into runoff and storage. We will add to the text the following reference that provides the results of extensive vegetation surveys for each land cover type presented in Figure 4. Garon-Labreque MÉ, Léveillé-Bourret É, Higgins K and Sonnentag O. 2015. Additions to the boreal flora of the Northwest Territories with a preliminary vascular flora of Scotty Creek. *Can. Field-Nat.* 129, 349–67. [dx.doi.org/10.22621/cfn.v129i4.1757](https://doi.org/10.22621/cfn.v129i4.1757)

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