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Discussions

Interactive comment on "Numerical simulations of the Cordilleran ice sheet through the last glacial cycle" *by* J. Seguinot et al.

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To A. Stumpf,

Thank you very much for your constructive review. We are very thankful to receive feedback from the glacial geology community, more particularly so here on The Cryosphere Discussion which traditionally has a stronger presence in quantitative glaciology.

Seguinot et al. present a well designed numerical model for the Cordilleran Ice Sheet (CIS) in North America for the last two glaciations occurring over the past 120000 years. Although the constraints on such a model are not yet all fully understood, their proposed simulations attempt to take account all the complexity of the glacial system,

and utilizes a variety of data sets. The modeling confirms what geologists have observed in the field; there was a fast decay of the CIS during MIS 2 and MIS 4 and non-glacial conditions existed during MIS (Olympia Nonglacial Interval; e.g., Plouffe and Jette, 1997). I applaud them for undertaking of such a difficult task, and notifying the reader where input data is sparse or inconclusive.

Thank you very much for this positive summary of our work and for your appreciative words!

I provide the following general comments and observations which may help the authors in revising the manuscript for final publication. Many of these points are both my personal suggestions and also the recommendations of others currently researching the CIS or who have completed studies in the past.

1) With the large amount of research that has been undertaken to map the landforms and deposits of the CIS by federal and provincial scientists, academic faculty, and undergraduate and graduate students and determine the extent, volume and dynamics ice sheet, the impression left on the reader by the opening sentence would be incorrect. These studies have greatly advanced our understanding of the CIS, and could be an important dataset to test against the modeling. Stumpf et al. (2014) provides a list of some of these studies.

By no means our opening sentence was meant to undervalue the large amount of geological work performed on the Cordilleran ice sheet, much of which has been reviewed and discussed against our model results in later parts of the manuscript. Despite all the work done, our impression is that the Cordilleran ice sheet, due to its complexity, remains less understood than its Laurentide and Eurasian counterparts, especially when it comes to reconstructing the dynamics of the different phases of advance and retreat of the ice sheet through the last glacial cycle. This is the impression that we tried to convey in the first sentence of the abstract. To avoid any further misunderstanding, we replaced the opening two sentences with:

> *After more than a century of geological research, the Cordilleran ice sheet of North America remains among the least understood in terms of its former extent, volume, and dynamics. Because of the mountainous topography on which the ice sheet formed, geological studies have often had only local or regional relevance, and shown such a complexity that ice sheet-wide spatial reconstructions of advance and retreat patterns are lacking.*

2) To help the reader better understand the maps presented, I would recommend some spatial information be added (e.g., latitude/longitude grids; political boundaries; lakes and rivers, place names etc..).

Graticules, rivers and lakes were added to all maps, the latter two as a background to model result so that they do not interfere with them. Because we feel that more geographic information would disturb the visibility of the main figure contents, we have also reworked and enlarged Fig. 1 (location map) to replace abbreviations by full geographic names, which should also help the reader to follow discussions in the text.

3) Was the model tested against regional-scale ground-based data (e.g., Ferbey et al., 2013) to constrain ice divide positions, ice flow direction, and ice sheet thickness?

The model was tested qualitatively against an extensive body of glacial geology literature, which is the topic of Sect. 4 (Comparison to the geologic record). The model was not tested quantitatively against geologic evidence, because we did not know of any publicly available dataset covering a significant part of the model domain until reading your comment.

Therefore, we thank you very much for pointing to us the recent map and dataset by Ferbey et al. (2013). Indeed, it would make much sense to compare this database

against modelled basal velocities in the future. However, we feel that such a quantitative comparison is premature at this stage. In fact, modelled basal velocities are sensitive to hydrological properties of the subglacial till (cf. our response to A. Jarosch in this discussion), and even more to thermal conditions at the base, which in turn are largely influenced by geothermal heat flow, kept constant in this study.

4) For the central sector of the CIS, Stumpf et al. (2000) provides some insight into the chronology and effectiveness of glacial erosional during the MIS. In figure 5, and in the accompanying text, they describe how landforms on the surface formed. For example, in lake valleys east of the Skeena Mountains, it appeared the major glacial streamlined landforms were formed during a longer glacial advance phase, with ice flow paralleling the valleys, and later flows, some perpendicular the valley flow, only weakly impacted them.

Thank your for pointing this out. We have added a reference to Stumpf et al. (2000) in the discussion of the erosional imprint on the landscape (Sect. 4.2.3).

5) Stumpf et al. (2000) was the first study to extensively document a predominant westerly directed ice flow across high elevations in the Skeena and Coast Mountains. This flow direction appeared to continue into the late-glacial period. Other subsequent studies also confirm that late-glacial readvance eastward out of these mountains and retreat of ice margins westward into these mountains was limited.

Thank you. We have added a reference to Stumpf et al. (2000) in the discussion of deglacial flow directions (Sect. 4.3.3).

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