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Interactive comment on "Influence of high-order mechanics on simulation of glacier response to climate change: insights from Haig Glacier, Canadian Rocky Mountains" *by* S. Adhikari and S. J. Marshall

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Adhikari and Marshall (2013) provide a valuable comparison of output from three different models on a small dynamically simple alpine glacier in Alberta. The input data is sufficient to both constrain the models and provide a validation test of the model velocity distribution output. The model comparison indicates the advantages of the full stokes model. The detailed output on stress fields provides particularly useful insight to the dynamic response of small and thin glaciers responding to climate change. The suggestions below are for additional detail or clarification.

Specific Comments:

1713-8: It is worth noting that glaciers lacking a consistent accumulation zone will not survive even the current climate (Pelto 2010; 2011). Five out of ten years with no accumulation zone, AAR of 0, fits this description.

1713-9: An average AAR of 0.14 indicates a very negative mean annual mass balance (Ba) for Haig Glacier 2000-2012. A reference should be made to the mass balance of Peyto Glacier, the nearest glacier with a long term record that had negative mass balances each year from 2001 to 2011, with an average of -730 mm/a from 2000-2011.

1718-18: For both the PS and SD model briefly state what was the motivation for using each model? Is it for a differential diagnosis of the importance of the various stresses?

1722-12: Is there a quantitative measure of the velocity fit for each model from Figure 6g that can be provided?

1725-7: Given that the glacier has had no accumulation zone in 5 of the last 10 years is this an appropriate description and why would you expect the glacier to survive current climate?

1728-4: The over deepened basin should develop a small lake, which would impact glacier retreat. Even small lakes have been observed to enhance the retreat of glacier termini through increased ablation and when the ice is very thin breakup. If a lake does not form in the depression, why not?

1728-9: Figure 1 indicates peak mass balance near the divide. Given the eastward shift of the divide this indicates significant thinning of the accumulation zone, which would not occur if this was still an accumulation zone, given the slow dynamic response here. Pelto (2010) and Paul et al (2004) both note that thinning and retreat at the head of the glacier is a sign of glacier disintegration and loss.

1728-22: The output of Figure 12 for the areal extent and thickness of the glacier in 2050 are quite similar indicating the robustness of the output. Figure 9 documents the velocity for the different models for an advance scenario. It would be useful to see the velocity distribution at the 2050 time step for the modeled glacier in Figure 12.

1730-2: Reference to Bolch et al (2010) would place Haig Glacier in the context of other glaciers in the region during this approximate period.

1730-12: Is it worth contrasting the results here to those of Marshall et al (2011), which used a more heavily mass balance less dynamic model approach?

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