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Interactive comment on "An investigation of the thermo-mechanical features of Laohugou Glacier No. 12 in Mt. Qilian Shan, western China, using a two-dimensional first-order flow-band ice flow model" *by* Y. Wang et al.

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article

amsmath amssymb graphicx a4wide

Response to K. Poinar

Yuzhe Wang

We would like to thank Dr. K. Poinar for giving constructive and encouraging comments on our paper; they were very helpful to improve our manuscript. Our responses to all the comments are given below. The original reviewer's comments are given in italic, and our responses are given directly below in regular.

Specific comments

*The model appears to be state-of-the-art, and the limits of its application are discussed (omission of west branch). I think it would be beneficial to include a bit more discussion (and perhaps, but not necessarily, numeric estimation) of how inclusion of the secondary branch of the glacier would improve the results. (I think *why* it should improve the results is clear, but *how much* is not clear, and *where* is not in the expected locations.) To be clearer on my *where* point: it appears that the area of largest disagreement between measured/modeled velocities (5.3 to 7 km) occurs just upstream of the junction with the west branch (âĹij4500m elevation or âĹij7 km). One would expect any effects of the west branch to be downstream of the junction.*

Thanks for your good suggestion. The underestimation may possibly result

figures_response/Fig_exp_converge_slip.pdf

Fig. 1. Modeled ice velocities for experiments E-ref (blue line), E-W (red line), and E-WS (green line). The glacier widths in the zone bounded by the vertical dashed lines are uniformly increased by 450 m.

from the neglect of the convergent flow from the west branch and an enhanced basal sliding which is not captured by our model in the confluence area (see our responses to the other two reviewers). To verify this hypothesis, we conduct two other experiments, E-W and E-WS. In E-W the glacier widths are increased by 450 m at km 5.8 – 7.3 as a proxy of including the impact of the convergent flow from the west branch (Fig. 1). In E-WS, except for the same glacier width increase as in E-W, we also increase λ_{max} by 200% and decrease m_{max} by 60% for accelerating the basal sliding at km 5.8 – 7.3 (Fig. 1). We can clearly find that while both factors have a non-negligible contribution to the model results, the basal sliding may play a bit more important role in the confluence area. The basal sliding velocities in experiment E-WS can be raised to 9.5 m a^{-1} at km 6.2. The mean ice surface velocities modeled by E-W and E-WS in the distance of km 5.3 – 9.1, are larger than those of E-ref by 2.1 m a^{-1} and 4.9 m a^{-1}, respectively. This indicates a need of considering glacier flow branches and spatially variable sliding law parameters in real glacier modeling studies.

This paper also appears to be the first presentation of the temperature data from the four boreholes, so a little more detail here would be appropriate.

The description of the three shallow boreholes is more complete than for the deeper, and I would argue more important to the paper, borehole. For instance, how long were the sensors operational within the ice (were the temperatures able to equilibrate), and what is the error on the readings? How precise are the depths? The data in Figure 4(b) look smoother than I have usually seen from deep boreholes, leading to these questions.

Good suggestions. We now have added more details about the measurement of deep borehole temperatures.

“To determine the englacial thermal conditions of LHG12, we drilled a deep ice core (167 m) in the upper ablation area of LHG12 (approximately 4971 m a.s.l., Fig. 1). In October 2011, ice temperature were measured to a depth of approximately 110 m using a thermistor string after 20 days of the drilling, as shown in Fig. 4d. The string consists of 50 temperature sensors with a vertical spacing of 0.5 m and 10 m at the ice depths of 0 – 20 m and 20 – 110 m, respectively. The accuracy of the temperature sensor is around $\pm 0.05\,^{\circ}\mathrm{C}$ (Liu et al., 2009).”

My other suggestion is to improve the clarity of Figures 5, 6, and 7. Although the legends do indicate what is being plotted, they are small and encoded. This could be fixed easily by adding a title to each plot (“Varying bedrock bump wavelength”) and/or adding this to the caption.

This is a good idea, and we now have added the title for each panel.

The caption for Figure 9(d) gets measured / modeled temperatures backwards.

Fixed.