Response to Anonymous Referee #1

Yuzhe Wang

We are grateful to the reviewer for providing insightful comments and contructive suggestions, which substantially improved the manuscript. Our response to all the comments is given below.

Suggestions

First, calibrate a steady state temperature field by trying to match (closely) the bottom part of their temperature profile (probably using an ELA more representative of a steady state for the glacier mass balance rather than using the ELA of one particular year!!)

Agreed. For the dianostic simulations, we tested many combinations of parameters in the surface thermal boundary condition (i.e. ELA, T_{dep}, and c). The performance of each model run was evaluated by the root-mean-squres (RMS) of the differences between the lower part (below 40m deep) of measured and modeled temperatures in the deep borehole (Fig. 1). By this sensitivity experiment, we selected ELA = 4990 m a.s.l., $T_{\mathrm{dep}} = -2.1\,^{\circ}\mathrm{C}$, and $c = 4\,^{\circ}\mathrm{C}$.

Fig. 2 shows the diagnostically modeled velocity and temperature fields. Measured and modeled borehole temperature profiles are in very good agreement (Fig. 2d). Modeled surface velocities also fit well with the observations (Fig. 2e). It should be noted that we used a relaxed free suface for diagnostic simulation (see more details in our revised manuscipt).

Then, if no air temperature time series are available, the author should try different past air temperature scenarios in order to get transient temperature field in accordance with the englacial temperature measurement they have. The transient scenario have to include both transient surface temperature and ELA evolution. Also I suggest the author to look if some reanalysis product of air temperature are available in the region for constrain the transient model.

In this version, we've reconstructed the daily surface air temperatures on the studied glacier using the air temperature data from surrounding meteorological stations. We also collected gridded precipitation datasets covering the Qilian Shan. The downscaled meteorological data was used to force a surface mass balance model to determine the ELA of the glacier. More details about the data processing and the model improvements were included in the revised

manuscipt and the supplement.

Comments

Sorry if I was unclear but I suggested to the author to use in the ablation area a parametrization that link Tair to Tsbc (Tsbc = Tair + c) for performing transient simulation. What does the use of such parametrization bring now in this revised manuscript??? This is not improving the way that boundary condition are addressed. Figure 7 can be deleted.

Thanks for clarifying the parameterization. In this revised version, we calibrated the parameter c by fitting the lower part (below 40m deep) of the temperature profile between the modeled and the measured (see our first response).

Author should not use one particular year of ELA (2011 here) for modeling a steady state temperature but should use the mean ELA over the last 50 years or at least something close to the steady mass balance ELA... This lead also to wrong surface boundary condition.
Agreed. Please see our first response.

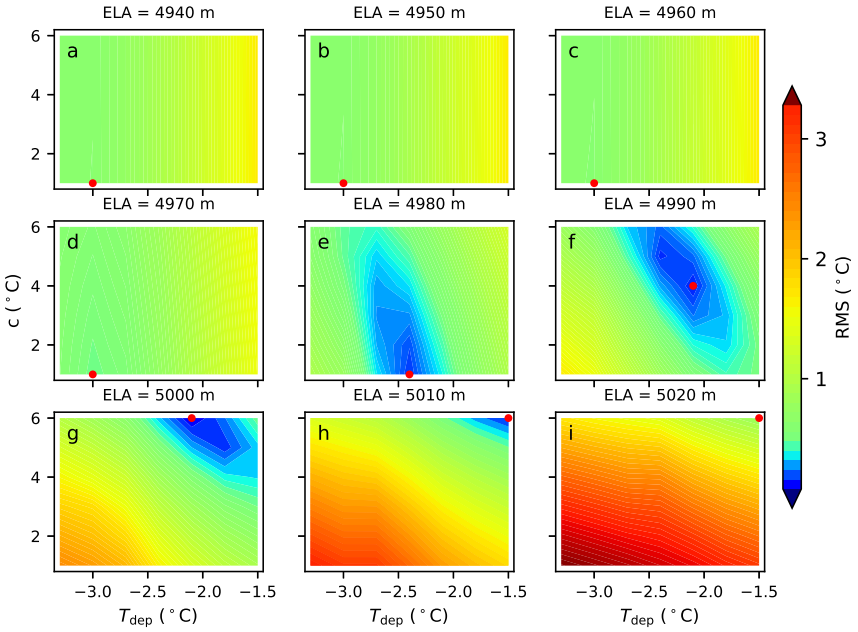

Figure 1: Root mean squares (RMS) of differences between measured and modeled temperature profiles in the deep borehole. The red circle indicates the minimum of RMS. The parameter T_{dep} is varied from $-3.3\,^{\circ}\mathrm{C}$ to $-1.5\,^{\circ}\mathrm{C}$ with a step-size of $0.3\,^{\circ}\mathrm{C}$, while c is varied in the range of $1 - -6\,^{\circ}\mathrm{C}$ with a step-size of $1\,^{\circ}\mathrm{C}$. The equilibrium line altitude (ELA) is fixed in each panel.

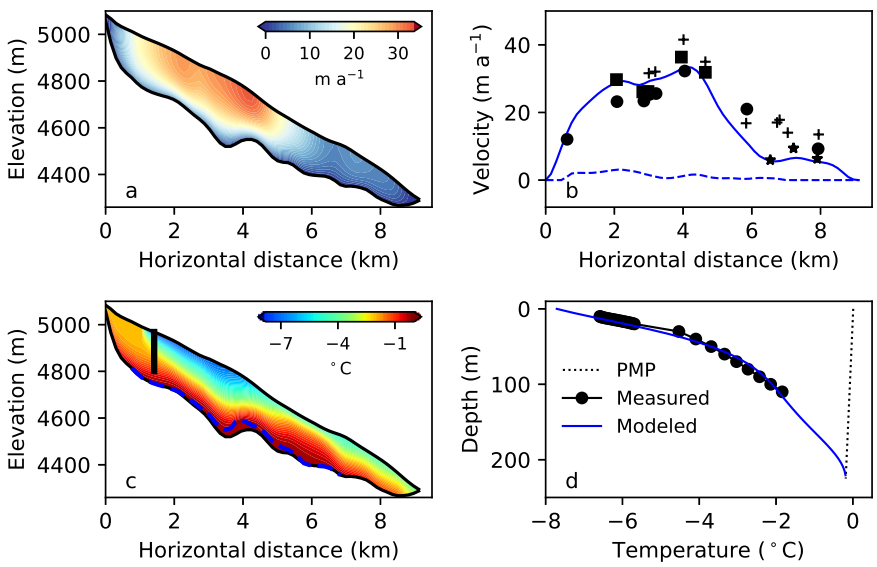

Figure 2: Comparison of measured and diagnostically modeled horizontal velocities and ice temperatures of LHG12. (a) Modeled distribution of horizontal ice velocity. (b) Measured (symbols) and modeled (solid line) surface and basal (dashed line) horizontal velocities. The symbols are measured surface ice velocities (see the manuscript). (c) Modeled distribution of ice temperature. The blue dashed line indicates the CTS position, and the black bar shows the location of the deep ice borehole. (d) Modeled (blue line) and measured (dots) ice temperature profiles for the deep borehole. Pressure-melting point is shown by the dotted line.