Reviewer 1:

We would like to thank Reviewer 1 on his/her comments. Our answers are given as following:

General comments:

We believe that we failed to stress the guiding idea of our paper. This is visible from reviewers' comments where he/she misses the reflections of the current findings to the research front line. Hereby, we would like to make a comment on that statement.

Projecting the future behavior of a valley glacier can only be done when a careful calibration with the past glacier record is done. This is the best way to assure that the initial state of a model integration is realistic. In fact, the choice of initial state determines the outcome to a large extent. Calibration with a historical record (normally glacier length) is best done by reconstructing the past mass balance forcing (e.g., Oerlemans, 1997). This implies the use of a control method, in which mass balance parameters have to be optimized to make the mismatch between observed and simulated glacier length as small as possible. For instance, if an equilibrium-line altitude (ELA) is adjusted every five years for a 200-year record, 40 parameters (values for the ELA) have to be found. This requires a few hundred runs with a dynamic glacier model. If one wants to apply this procedure to a set of glaciers, thousands of model runs have to be done.

It is clear that full-Stokes models (FSM) are too computer-time consuming in order to perform the defined simulations. Models based on the Shallow Ice Approximation (SIA) however, require several orders-of-magnitude less computer time, and are therefore more suitable for control simulations. For example, the computing time in SIA is less than a minute while for FSM is about an hour for a simple simulation of 500 years (for the present simulations, but also shown by LeMeur et al., 2004 and Schäfer et al., 2008).

Models based on the SIA capture most of the broad characteristics of valley glaciers, and therefore may be a good candidate for the type of numerical experiment described above (i.e., numerical experiment with a focus on complete picture of historic climatic variation). Most mountain glaciers are located in a mass balance field where the balance rate increases gradually with height. The landscape hypsometry then determines the equilibrium extent of a glacier. Ice mechanics set in because the thickness of a glacier depends on its size, and feeds back on the balance rate by the corresponding change in surface elevation. This implies that a dynamic model should first of all deliver the relation between glacier size (in terms of length) and mean ice thickness. For reasonable smooth topographies, it seems that SIA-models can do that well (e.g., Oerlemans 1986, 1997), even if some of the details of the ice mechanics are better represented in full-Stokes models.

In this paper, we investigate whether these ideas hold. We compare runs performed with an SIA model with runs of a full-Stokes model (FSM based on the Elmer/Ice code). We focus on the response of bulk glacier characteristics (length and volume) to different climatic forcings. Although there are studies examining general differences between SIA and FSM based on a single forcing function and one glacier bed profile (e.g., Pattyn, 2002 and

Leysinger Vieli and Gudmundsson, 2004), a study that systematically builds up the complexity of the defined problem by applying several configurations of climatic forcing and glacier bed characteristics has not been performed up to our knowledge. Also, we derive and test an equation (Equation 1. in the paper) that allows users of Elmer/Ice code to study glaciers in 2D simulations when glacier width is included. This equation is of a great importance because Elmer/Ice code does not have developed solver that accounts for changing glacier width in 2D set-up.

We acknowledge the reviewers' concern about missing to relate our results to the characteristic aspect ratio. Again, we repeat that the guiding idea of the present study is to examine the response of glacier length and volume to different climatic forcings. This can be done only if the simulations in two models start from the same steady state (that in this case becomes the new initial condition). In this new initial condition, the aspect ratio for all glaciers is <0.01. Alkhrona et al. (2013) argue that aspect ratio of 0.1 sets the limit of validity for SIA. This gives a credit to our simulations of glacier evolution under different climatic conditions. Moreover, having the computing time in mind, SIA simulations provide valuable results against which we can test the simulations from FSM model.

As the reviewer's comments are mainly focusing on the technical details of the study, we would like to emphasize one more time the main point of the paper: that the used FSM model shows consistent lag in climate simulations, an important message we try to transfer. This raises a question if a sophisticated ice-flow model, such as the one based on Elmer/Ice code, is capable of correctly simulating a response time of a real mountain glacier or is a simple model based on SIA more suitable for climate simulations (as we stated in the discussion section).

<u>More detailed comments:</u>

P.3, L.19: The comment will be included.

Presentation of bedrocks: In the present paper, we have included the equations used to shape the bedrock, but, for better clarity we will add a figure illustrating the bedrock (see the attached figure 1). Please note that the main difference between 4.1 and 4.2 is the glacier width. As already explained it in Section 2.2 (P.5, L.22-25), we first study the simple glacier with a uniform width that rests on a bed with a constant slope and second, that we study the glacier with an exponentially varying width that rests on a bed with a constant slope. We noticed a mistake in the title of Section 4.1 that probably lead to the confusion. The correct title should be: Constant bed slope and uniform glacier width.

References: We have overseen some important references, as correctly concluded by the reviewer. Newer references will be added.

Figures: The comment will be included.

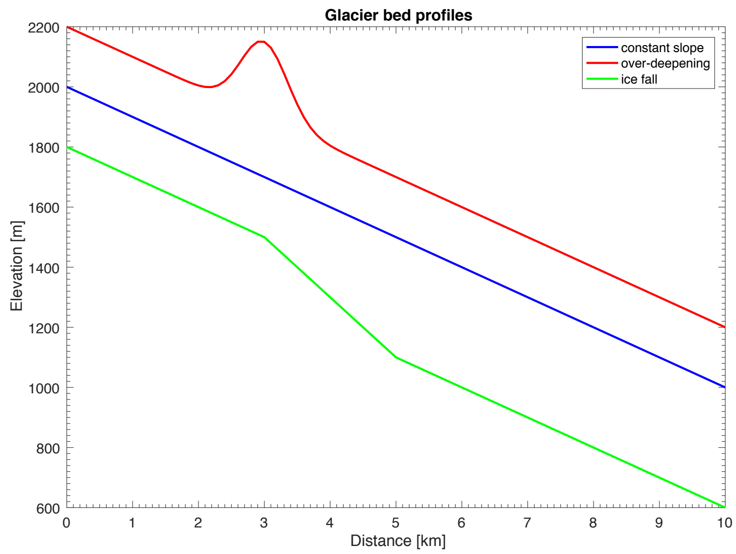

Figure 1. Model set-up showing three different glacier bed topographies. Note that red and green line are shifted along y-axis for 200 m.