Review: Increasing precipitation due to climate change could partially offset the impact of warming on glacier loss in the monsoon-influenced Himalaya until 2100 CE

Summary

This study focuses on Khumbu Glacier in the Everest region of Nepal and how changes in temperature and precipitation affect its evolution until 2100 for two different emission scenarios. For this, the study relies on downscaling meteorological inputs from RCMs using AWS data, forcing a distributed energy-balance model with these inputs, and finally forcing a glacier evolution model with its outputs. They found that an increase in precipitation can offset some of the expected glacier loss for intermediate future scenarios (RCP4.5). This effect could not be observed for high-emission scenarios (RCP8.5), as the larger temperature increase compared to intermediate scenarios leads to a higher fraction of liquid rather than solid precipitation.

General Comments

- In the introduction, at several places you talk about the detached debris-covered tongue (e.g. L81ff and L119) . Could this be merged in one place to make it easier for the reader to follow and reduce repetition?
- *2.1 Glacier model experimental design*: It is not clear to me from this section how COSIPY and iSOSIA work together and at which stage of the setup each model is used. It would be helpful to explain the individual inputs and outputs of the two models and clearly state how the two models are used during spin-up, the transition until 2015, and the future projection (e.g., what setup of COSIPY was used as input to iSOSIA at the different stages, or was an input different from COSIPY used to drive iSOSIA at some stages?). In its current form, I am not able to follow the model setup.

Specific Remarks

- L22: What do you mean by “precipitation is not often represented in glacier projections”? At a minimum, glacier models use temperature and precipitation for making predictions into the future.
- L81–L98: What is the connection of this section to the research question (maybe defining the area of interest, only the active glacier)?
- L158: Can the complete ice-free model domain be displayed in Figure 1c?
- L160: What other meteorological forcing parameters were used for defining the starting point? You describe only ELA and an atmospheric lapse rate, but how was,

for example, accumulation rate defined? And which COSIPY model configuration was used for this? Or is another mb model used? It is not clear which mass-balance forcing is used for the spin-up.

- L168–L171: Where do you discuss the results of this? Which observations did you use? How did you select NOAA RCM quantitatively?
- L171–L174: How exactly did you define the ice-free topography? In L159 you state that you used ice thickness from Farinotti et al. (2019), but here you state you add the dynamically detached debris-covered tongue to the model domain as a static topographic feature. Do you only add the tongue as a static feature after 2015? Please explain in more detail which ice-free topography you are using.
- L175–L176: Does this mean you use a 5-year mean mass balance (2015–2020 and 2095–2100) for forcing, or do you repeat those 5 years cyclically for 200 years and 80 years, respectively?
- L180: How did you define dry, moderate, and wet quantitatively? How large are the actual differences?
- L188: Why are you discussing lapse rates here? What exactly did you use them for (what simulation did you perform with different lapse rates)? Can you introduce where the lapse rates are used (in the COSIPY simulation?) and what other variables are used by COSIPY at this point (in Figure 2a it states COSIPY uses 9 climate variables)? Please make clear at each point in the text whether you are discussing COSIPY or iSOSIA.
- L191–L207: This reads as a discussion about the influence of avalanches rather than an explanation of the glacier model experimental design. It feels out of place here. I also do not understand from this section how avalanche contributions are accounted for in the model chain (only in COSIPY, only in iSOSIA, or in both?).
- L349: “and and”
- L364–368: Where are the results of this sensitivity study, or the values used in the end? Ah, it is in section 3.1. Maybe add a reference here.
- L373: At which temporal resolution are you forcing COSIPY?
- L381–383: How was COSIPY used within iSOSIA exactly? Did you provide the resulting mass-balance maps to iSOSIA?
- L385: Which spatial grid is iSOSIA using? The same as COSIPY?
- L400–L401: What do you mean by “no change in forcing applied between time steps”?
- L401–L402: Do you mean you are not including elevation-change feedbacks within COSIPY?
- L427: Why is there no reference to Fig. 8? It looks like in Fig. 8 you conducted some sensitivity experiments regarding h0, but I cannot find any link to this in the text.
- L527: Just by looking at EB7910 in Fig. 5, it does not look like the energy available for melt (Q_melt, red line) and the sensible heat flux (Q_sens, yellow line) are perfectly correlated (r=1).
- L547: You could use MAAT here.
- L572: With which metrics did you assess that NOAA provides the best starting point?
- L588–L594: What is the maximum velocity in this study? As I understand it, the 220 m a−1 are observed and the 118 m a−1 are from a previous study.
- L611ff: In Fig. 2e you separate precipitation between monsoon and non-monsoon, but here you talk about summer and winter precipitation.

- L712: From where do you take the observed accumulation rates and distribution, and why are those not included in Fig. 1d?
- L821: Rounce et al. (2023) starts its simulations in the year 2000.
- L1222: Fig. 1c: No satellite image, as stated in the caption.
- L1222: Fig. 1d: Why do you not show ELA for RCP8.5? Is it above crest height?
- L1266–L1267: How are you extracting the present-day ice surface elevation from Farinotti et al. (2019)? As far as I know, it is a dataset of ice thickness, which is valid at the RGI outline date. How do you obtain the 2015 surface elevation from this? Is the corresponding outline date 2015 in RGI?