The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-296-RC1, 2020

The Cryosphere Discussions

Interactive comment on "Possible biases in scaling-based estimates of mountain-glacier contribution to the sea level" *by* Argha Banerjee et al.

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Received and published: 16 January 2020

The paper is interesting, well-written, and has the potential to be useful for understanding biases in scaling-based projections of glacier volume evolution. However, I have a few major concerns which prevent me from recommending publication.

Major issues:

1. For the linear-response model based projections, the authors write that they fit the four parameters (area and volume sensitivities and response times) for each glacier based on the SIA data. They then validate the projections obtained using these pa-

rameters on the same SIA data. This is using the same data for fitting and validation, so it is not surprising that it replicates the data fairly well. Testing this method requires validation data that is not part of the fitting. A possible way to do this would be to only use a portion of the time-series of each glacier to fit, and validate on the rest (for example, fit on the first 50 years, project into the future, and validate on the 450 remaining years).

There is this this sentence which I was not clear on: "We have verified the linear-response model obtained by fitting the SIA simulation results for the ensemble of 551 central Himalayan glaciers, similarly outperforms the scaling-based method for another set of 143 glaciers from the western Himalaya (figure A2)." Were the parameters obtained for the central Himalayan glaciers somehow extrapolated to the western Himalayan ones? Or were the parameters fit for every western Himalayan glacier as well? It is not clear from the description. If the authors use an extrapolation method, it would be important to describe it.

2. The linear-response method is being proposed as an alternative to scaling-based methods for projecting glacier volume evolution. However, I am not clear on how this would be implemented in practice. The climate sensitivities ΔV_inf and ΔA_inf characterize the response of an initially steady-state glacier to a perturbation in the ELA. How can this be used to project evolution of a glacier that is already transient, and in a situation where it is not a single perturbation in the ELA, but that the ELA is continually rising?

3. Furthermore, it seems that the linear-response method would require a relatively long time-series of the area and volume evolution of each glacier in order to fit the parameters, which is often not available. I would like to see a discussion of the data requirements and feasibility for use in sea-level projections.

4. Although it is true that there are a priori arguments for what the scaling exponent gamma should be, in practice it can be quite different, even for simulated glaciers (e.g.,

Radić et al., 2007). So for use of the scaling-based method as a statistical projection method it would be more fair, in order to compare to the linear-response method, to estimate the scaling exponent from the SIA runs. Although Radić et al. (2007, 2008) showed that the volume evolution over 100 years is not very sensitive to the exponent, this may be different for the 500-year simulations. Also, how were the constants of proportionality c determined for each glacier?

In fact, we could expect that fitting the exponent and constant of proportionality individually for each glacier, as would be possible if a sufficiently long-time-series data were available for every glacier, would considerably reduce the bias of the scaling-based method.

Other issues: 1. The authors remove some glaciers from consideration in several parts of the paper, such as those that had fractional changes of more than 50% over 500 years, and those with response times higher than 300 years. Also, in another part of the paper, glaciers with large values of ΔA_inf/A are removed, and another cut-off on ΔV_inf/V is imposed. I don't see an adequate justification of why these were removed, and doing so biases the results. 2. "The minor differences are due to the time-invariant scaling assumption made here." Please clarify in more detail what is the difference between your derivations and those of Harrison (2001). 3. In Fig. 1B, scaling the SIA results by 10 for visual comparison is confusing. It's also hard to distinguish which are the thick and thin lines.

Minor issues: L9: "glacier" -> "glaciers" L51: "have" -> "has" L80: "using" -> "using a" L120: Missing parenthesis L166: "appearing" -> "appearing in" L175: "till" -> "until" L185: Should this be 551 glaciers? L191: "receives" -> "receive" L194: "These" -> "these" L258: "possible a" -> "a possible" L261: Missing parenthesis, "an" -> "and" L295: "are" -> "is" L299: "intruding" -> "introducing"

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