

## Addendum to reviewer reply on AC1-hess-2021-44 by Mauro Fischer, University of Bern

*Regarding the use of these regional/country averages mass balance time series, we agree that this is not the best approach. Still, we are rather limited because of limited observations. The ideal option would be to have long-term mass balance time series available for all glaciers in each catchment. In reality we are far from that situation. The reviewer suggests to not average mass balance time series per country because of significant regional climatic conditions. Using geodetic mass balance data, or mass balance data calculated from a model, as done in the studies referred to by the reviewer, is not really an option here, as we need annual variations and would like to base this study solely on observations rather than mixing observations and simulations. We would thus need to find a way to extrapolate the few observations that exist, to all the other glaciers in the studied catchments. The study of Huss (2012) nicely illustrates different options to do that, i.e. arithmetic average, using glacier hypsometry or multiple regression. Although Huss did such an analysis for the European Alps, doing something similar for southwestern Norway and western Canada is beyond the scope of this study. The only option left would be to find out which catchments have a measured glacier in their boundaries that has long-enough time series to do a correlation analyses with the level of compensation. Area-weighted averages will not need to be used then, as it is unlikely that more than one glacier in the same catchment is measured. This will reduce the number of catchments analysed in this part of the study significantly, but may represent better the relation between mass balances and level of compensation and will be worth testing.*

**Reply:** I am totally aware of the fact that long-term measured mass balance data is lacking for a lot of catchments you analyzed. Still, at least for areas with comparatively (spatially) very dense and rather long-term measured mass balance time-series like Switzerland or Austria (or maybe even southwestern Norway?!), I think it would be worth taking only mass balance data from glaciers with “comparable regional climate conditions” for analyses of your catchments (e.g. differentiate between catchments of the northern slopes of the alps, of the inner (high) alpine regions (there also between west and east), and of the southern slopes of the Alps), see for instance Huss, M., Dhulst, L., & Bauder, A. (2015). New long-term mass-balance series for the Swiss Alps. *Journal of Glaciology*, 61(227), 551-562; you will see that, at least for Switzerland, there are quite a few long-term mass balance time series that you could use... For Austrian measured mass balances, you could also contact the WGMS national correspondent Andrea Fischer, for Norway Liss Andreassen (NVE), for western Canada, I am sure Brian Menounos (University of Northern British Columbia) would be willing to help you out with further detailed information. Have also a closer look at the detailed database of measured mass balances worldwide provided through [www.wgms.ch](http://www.wgms.ch). As this is, in my opinion, an important part of your study, it would be worth spending some more time and effort here I think, always aiming at taking long-term measured mass balance data with a regional and climatic context regarding individual catchments you analyze. – And if you have more than one mass balance time series to compare with one individual catchment, take area-weighted values!

### Addendum by reviewer 22.02.2021

Dear Marit and Co-authors, what I wanted to add here is that of course you will have to consider the glacier size class distribution of the catchments you analyze in order to choose which and how many long-term mass balance time series you take into account for your new calculations. Example: If you have mass balance data for a small glacier in one catchment you analyze, but the glacier size class distribution of the catchment is more “towards larger glaciers”, i.e. there are also larger glaciers in the catchment, then it would be wrong as well to only take mass balance data from this single small glacier situated in the catchment you analyze (as catchment-wide mass balances will be strongly influenced by larger glaciers)... So to add on my comment above here: I would just try to take as many long-term mass balance data as you have for glaciers in the same region and with more or less the same climatic conditions as for the catchments you analyze, and then take area-weighted values of these to compare them with  $C$  values of the catchment you analyze (or you use other proposed approaches to extrapolate measured mass balance data to specific regions or catchments, as for instance discussed in Huss, M. (2012). Extrapolating glacier mass balance to the mountain-range scale: the European Alps 1900–2100. *The Cryosphere*, 6(4), 713-727.). Kind regards and all the best, Mauro