Review of 'Brief communication: Ad hoc estimation of glacier contributions to sea-level rise from latest glaciological observations' by Zemp et al. (2019, The Cryosphere Discussions, doi: 10.5194/tc-2019-180)

In this manuscript, Zemp and co-authors introduce a new method to derive 'ad hoc' estimates of regional glacier loss based on a sample of glaciological observations. They use the method to provide estimates for the regional glacier mass changes for 2016/17 and 2017/18 and sum these regional values to obtain an estimate of the total sea-level contribution from glaciers for these years.

The method introduced and described by Zemp and colleagues is simple and efficient, and is well described in this brief communication. It will be of great use when determining the sea level contribution from glaciers for recent years, which will be particularly useful when providing up-to-date numbers e.g. for the upcoming IPCC sixth assessment report. The contribution is thus timely, although it would be interesting if the data included for the year 2017/18 could somewhat be extended (more on this below). I do have some questions and suggestions that could improve the clarity of the manuscript, but these are generally relatively minor. My questions/suggestions have therefore been arranged per section, and not by 'major', 'minor' and 'technical' comments. The list may seem relatively long at first, but the vast majority of comments should be easy to address.

Abstract

- p.1, l.12: 'the glaciological method': clear for people who are in the field of glacier mass balance, but not straightforward for other glaciologists. Would maybe be good if you can describe what the 'glaciological method' is in a few words
- p.1, l.15: Another clarification here, what does 'ad hoc estimate' mean: again not sure that this would be directly understandable. Also given the fact that it appears in the title, would be good to explain shortly: this 'ad hoc' estimate refers to the fact that this is a kind of 'on-the-go' / 'specific' / 'best given the available data' / …. estimate (what you think describes it best)?

Introduction

- p.1, l.20: 'substantially contribute to regional runoff': could also add references to two important new regional studies focusing river runoff and the role of glaciers: Biemans et al. (2019) and Pritchard (2019)
- p.1, l.28-29: 'In view of the IPCC Special Report on the Ocean and Cryosphere in a changing climate (2019)' → has been released by now: add a reference to SPM (IPCC, 2019) or specific chapter
- p.2, l.2: 'for the comparison with estimates based on other methods (e.g. spaceborne gravimetry or altimetry)': could you be a more specific here? Which studies are you referring to?
- p.2, l.4: 'In view of the global stocktake': what is this?
- p.2, l.5-8: 'the approaches underlying these results are unsuitable for providing annual updates on the basis of new glaciological observations acquired each year due to generic lack of updates from multi-annual geodetic surveys (from DEM differencing)': OK, this is true. But is likely to change in the coming years, with DEMs becoming more reliable (more precise and with less errors and artefacts) and available more regularly (likely at sub-annual intervals in the near future). Would be good if could comment on this and put this a bit in perspective: probably the conclusion, where you stress the importance of continued field observations, would be good to do this
- p.2, l.8: 'a computational framework': sounds like a (complex) numerical model you are using. Would suggest omitting the 'computational'

Data and methods

- p.2, l.26: 'regional area in the survey year of the RGI': how is the survey year for a given region defined? Reason why I ask is because some of the RGI regions do not have a single survey year, but consist of outlines derived over various years, right?
- p.2, l.26: 'delta-S/delta-t the annual area-change rate': could you provide a hint about how this is determined? I understand that not all elements from Zemp et al. (2019) can be repeated for

the sake of brevity, but here would be nice to be able to have an insight without having to look into the other paper.

- p.3, l.22: 'anomaly from the mean balance over the calibration period from 2006/07 to 2015/16': not sure I entirely understand. Do you refer to the anomaly 'compared to' or 'with respect to' 'the mean balance….'? Consider reformulating to make this clearer.
- p.3, l.22: the reference period is chosen as 2006/07 to 2015/16: could you put this in perspective? i.e. why is this 10-year reference period chosen and why not for instance a longer time period (e.g. 15 to 20 year period) or another 10-year period? Is this mainly related to the fact that glaciers have changed a lot, or is this maybe related to the sample size when going further back in time?
- p.3, l.22: a follow-up question: what influence does the choice of the reference time period have? Would for instance be interesting to see how the sea level contributions for 2016/17 and 2017/18 are affected by the choice of the reference period (i.e. get insight in the sensitivity of your results to the reference time period choice).
- p.3, l.25: equation 2: are $B_{glac,Y,g}$ and $B_{glac,g,i}$ defined?
- p.3, l.26: 'results show that equation=0': formulation sounds a bit strange to me, as I suppose this is a direct consequence of how it is defined (and not really a result). Consider reformulating this: 'Over the calibration period equation=0' (i.e. omit the 'results show that')
- p.3, l.31: 'G': G corresponds to number of glaciers?
- p.4, l.1: equation 3. can you explain why it is not weighted by glacier area? Would intuitively expect this, but probably related to misunderstanding from my side. May be good to shortly explain in text also.
- p.4, l.14: equation 5: where is this 'regional bias of the glaciological sample' used later on?
- p.4, l.16: 'regional glacier area S': may be good to specify that this is the value for that particular year. This becomes somewhat clear later in the sentence, but nevertheless good to stress this to avoid any possible confusion.
- p.4, l.26-27: you explain that reference glacier from neighbouring region is used when no glaciological observations are available for a given region. Little data, so probably not many good options, but this is nevertheless a rough approximation, especially given the distance between the region. Three questions here:
    - How do you define which one is the neighbouring region when there are several options?
    - How large is the effect of choosing glaciers from another region: could you quantify this? e.g. with a kind of 'leave-one-out cross validation'?
    - Is there no better criterion than proximity of the regions to fill the gap? i.e. would it for instance make sense to determine which regions correlate best for a given reference period in the past (which may not always be the neighbouring I guess) and use this information to fill up the gaps?
- p.5, l.2: 'For each region, we calculated the…': here, or in Zemp et al. (2019)?
- p.5, l.2-3: '1.96 time the (sample) standard…': why 1.96?

Results and discussion

- Global average specific mass change of -0.5 and -1.0 m w.e. yr^{-1} for 2016/17 and 2017/18 respectively. Uncertainty on these values? Same relative uncertainty as for the global mass change in Gt yr^{-1} and the sea-level contribution?
- p.5, l.18-25:
    - Only little data available for 2017/18. Is well explained why that is, but a pity that is a somewhat incomplete dataset. Would be nice if this could be updated when finalising this manuscript, with the latest data included. Numbers will be used (potentially copied without context?) by other scientists and would therefore be good if these are (close to) the final numbers (i.e. with more glaciers).
    - It is interesting to see how the method works with different sample sizes, but from the setup used so far it is difficult to estimate what the influence is on the regional mass balances, the global sea level contribution and its uncertainty. Would be very useful if some experiments would be performed to quantify this: e.g. taking only 20-40-60-80-..glaciers and to see where is it crucial to have data: i.e. which regions influence the final numbers the most and where it is problematic (large increase in uncertainty) when data lacks?

- p.5., l.11 & l.21: uncertainty on the global mass change is substantially lower for 2017/18 (138 Gt yr^{-1}) compared to 2016/17 (249 Gt yr^{-1}). Why is this? Would intuitively expect the opposite, given the limited number of glaciers considered in 2017/18 (70) vs. 2016/17 (150). This comment is related to previous suggestions to quantify the effect of glacier sample size and the effect of the location/region on the uncertainty.
- p.5, l.21: mass loss of 512 Gt yr^{-1}: would reformulate to mass change of -512 Gt yr^{-1} to be consistent with formulation for 2016/17 and avoid any confusion. My first reaction when reading this was: 'oh, a positive mass balance?' and then I re-read it and saw that here you refer to a loss vs. a mass change.
- p.5, l.25: '…contributor**s**.'
- p.6, l.9: 'again relative good agreements again in the…' (omit one of the two again's)
- p.6, l.14-15: 'in years with small data samples and strong anomalies it remains arguable which of the two approaches better represents…': would it be feasible to quantify this? Would be interesting addition.
- p.6, l.28: at the end of this paragraph: would expect that you explain what the consequence of this statement is: e.g. "This does imply that…"
- p.7, l.7: 'regional biases range between -0.6 and +0.5 m w.e. yr^{-1}': this is quite large, in the order of the signal almost, no?
- p.7, l.5-16: ok, interesting! But what if you work with a method more sophisticated than taking values from neighbouring regions? (see earlier comment on this)

Conclusion

- Explains nicely why this work is important and why we need such updates. When you present contributions to sea level (p.7, l.23-24), could you compare these numbers to the contribution from the ice sheets and thermal expansion? (for these 2016/17 and 2017/18 specifically, and if not available, with the numbers from the last years/decade) Would be good to stress, once again, the important sea-level contribution from glaciers, which ice sheet modellers quite often tend to forget/underestimate..
- p.7, l.25-28: importance of glaciological sample is stressed. Fully agree and think that this study nicely supports this statement. It would however also be justified to put this a bit in perspective and explain that in the future we will be able to rely more and more on remote sensing observations. These observations will become available at higher resolution, with smaller uncertainties and biases, and most importantly: at a high temporal resolution (with sub-annual update). As such, they could therefore be used in addition to glaciological measurements (still a long way to go for replacing them…), making us less dependent on direct field measurements.

References

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