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Interactive comment on "An estimate of global glacier volume" *by* A. Grinsted

M. Huss

matthias.huss@unifr.ch

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The paper by Grinsted presents an estimate of global glacier ice volume based on the Randolph Glacier Inventory (RGI) and volume-area scaling laws. There is a focus on uncertainties in volume-area scaling, and on how this approach might be improved. The final result of the study is that existing glacier ice volume estimates might be significantly too high. This finding potentially has a significant impact.

I appreciate that the problems and uncertainties of volume-area scaling are addressed in this study, but I have also noted a number of – in my opinion – important issues that should be taken into account for a revised version of the paper.

Methods: The description of the methodology to estimate ice volume needs to be significantly improved. I was unable to understand which statistical approaches were used to obtain the final results. Table 2 provides several different scaling laws but the

details are not described in the text. Obviously, regressions were performed with area, elevation range, length and continentality. However, results of these regressions are neither shown, nor discussed.

Statistical performance: I am missing a clear description of the statistical performance of the fitted regression curves. How well do the fits perform? Which variables should be included in the multiple regression to obtain the best results? It also might be worth thinking about showing correlations of area with *thickness* instead of volume (see e.g. Cogley, 2012). Looking at Figure 1 it seems as the correlation is excellent. However, this is largely explained by the fact that V already contains A, and the actual spread of thickness predicted by area is suppressed.

Thickness data uncertainty: The entire study is attached to the measurements of mean thickness of roughly 200 glaciers. Therefore, the uncertainties in these input data should be critically discussed. Many of these thickness values are several decades old and volumes were partly calculated from extrapolating observed thickness of just a few profiles. Basically, no study has yet 'measured' the volume of a whole glacier... I expect that the large uncertainties in these 'ground-truth' data could be very critical to the fitted regression curves.

Glacier areas derived from the RGI: The total regional glacier areas given in Table 1 do not agree with the latest evaluations by Arendt et al. (2012), i.e. the producers of the RGI. This issue should definitely be corrected in a revised version of the paper.

Glacier complexes: The issue of the separation of glaciers in the RGI is already shortly discussed by the author. The problem is however not resolved. Many shapes of the RGI contain glacier complexes, i.e. many individual glaciers that are perceived as a single one. This has a huge impact on volume calculated using scaling. In order to apply scaling-laws, individual glaciers should be separated first.

Ice caps: Where does the threshold of 25 km^2 between glaciers and ice caps come from? Whereas a value like this might be appropriate for the Arctic, it is completely

unrealistic in all other regions: In Alaska, High Mountain Asia, and other alpine mountain ranges there are numerous glaciers larger than 25 km^2, but not a single ice cap. As it is shown by the author, the selected exponent γ has an important impact on the calculated volume. So the division of glaciers and ice caps should be addressed in detail in order to keep track of the uncertainties.

Figure 2: I note that the values for c in the scaling relation used by Radic and Hock (2010) stated in this figure do not agree with the Radic and Hock-study.

Other approaches: The last sentence states that 'more sophisticated approaches' should be used to reduce the uncertainties in volume-area scaling. In that sense the author might consider discussing the recent study by Huss and Farinotti (2012) that calculates global glacier ice volume based on the RGI without relying on volume-area scaling, and also presents a comparison to previous studies.

References

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