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A consensus estimate for the ice thickness distribution of all glaciers on Earth

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Knowledge about the ice volume and thickness distribution of the glaciers on Earth is of central importance for a number of investigations: Assessments of potential sea level rise, projections of future glacier change, and estimates of future freshwater availability in glacierized regions all depend on the ice volume stored in present-day glaciers. A range of methods that estimate the ice thickness distribution from characteristics of the glacier surface has lately been presented, and the recent Ice Thickness Models Intercomparison eXperiment (ITMIX) showed the added value of combining various such methods to increase the result's robustness.

In this study, we use an ensemble of up to five ice thickness estimation methods to provide a consensus estimate for the volume and ice thickness distribution of all about 215,000 glaciers outside the Greenland and Antarctic Ice Sheets. Our estimate are based on glacier outlines from the Randolph Glacier Inventory version 6.0, a range of different Digital Elevation Models (DEMs) including, amongst others, the recently released ArcticDEM and the Radarsat Antarctic Mapping Project DEM, and ice thickness inversion schemes rooted into principles of ice flow dynamics.

The joint estimate indicates a total ice volume of $158 \pm 41 \times 10^3\,\mathrm{km}^3$, which is equivalent to $0.32 \pm 0.08\,\mathrm{m}$ of sea-level change when the fraction of ice located below present-day sea level (roughly 15%) is subtracted. More importantly, our results indicate that the glaciers of High Mountain Asia might store about one quarter less ice than suggested by a previous estimate based on comparable methods. We show that the revised estimate has implications for the projected glacier evolution, moving the timing by which the region is expected to lose half of its present-day area forward in time by about one decade.