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A spatially resolved estimate of High Mountain Asia glacier mass balances from 2000 to 2016: changes on debris-covered glaciers and comparison to ICESat and SPOT5-SRTM estimates

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High Mountain Asia hosts the largest glacier concentration outside the polar regions. Past studies that covered the entire region or large parts of it have used methods that can only provide regionally-averaged glacier mass balances to assess the High Mountain Asia glacier mass change. Here we compute the mass balance for about 92 % of the glacierized area of High Mountain Asia using time series of digital elevation models derived from ASTER satellite stereo-imagery. We calculate an average region-wide mass balance of -16.3 $\pm$ 3.5 Gt yr-1 (-0.18 $\pm$ 0.04 m w.e. yr-1) between 2000 and 2016, which is less negative than most previous estimates. Region-wide mass balances vary from -4.0 $\pm$ 1.5 Gt yr-1 (-0.62 $\pm$ 0.23 m w.e. yr-1) in the Nyainqentanglha ranges to +1.4 $\pm$ 0.8 Gt yr-1 (+0.14 $\pm$ 0.08 m w.e. yr-1) in the Kunlun Shan, with large intra-regional variability of individual glacier mass balances (standard deviation within a region $\sim$0.20 m w.e. yr-1).
Specifically, our results shed light on the Nyainqentanglha and Pamir glacier mass changes, for which contradictory estimates exist in the literature. In particular, we compare our results with previous estimates based on SPOT5-SRTM DEM differencing and ICESat-based estimates to explain the sources of discrepancies. As our estimates resolve individual glacier mass balances, we also conduct an analysis which confirms the absence of statistically significant different behavior between debris-free and debris-covered glaciers in terms of glacier-wide mass balance.