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Multi-decadal elevation changes of Arctic glaciers

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The Arctic is one of the fastest-warming regions in the world, and Arctic glaciers have been identified as one of the largest sources of global sea level rise in recent years. In addition to sea level rise, Arctic glacier mass loss has implications for local and regional changes in ocean chemistry and circulation, and oceanic and terrestrial ecosystems. In spite of this overall importance, Arctic glacier changes are poorly constrained on a spatial and/or temporal basis, with regional estimates coming either from spatially-coarse gravimetry estimates, extrapolations using sparse satellite altimetry measurements, or extrapolation using in-situ mass balance for small numbers of individual glaciers. While these approaches provide a good picture of changes across the region, they provide limited information about changes on an individual glacier or mountain range scale, or on non-observed glaciers. Newly opened satellite image archives, combined with new processing techniques as well as increased computing power and storage capacity, provide the opportunity to observe and investigate glacier processes and changes regionally on enhanced spatial and temporal scales.

Using MMASTER, a processing pipeline based on the MicMac open-source photogrammetry suite, we have processed over 20000 ASTER scenes covering the Arctic over the period 2000-2018. These DEMs, in combination with the recently-released ArcticDEM v3.0 archive and IPY-SPIRIT SPOT5-HRS DEMs, provide an unparalleled spatially- and temporally-resolved picture of glacier elevation and volume changes across the Arctic over the past two decades. Using older images and data sources where available, we provide a longer-term perspective on the changes observed. Finally, we compare our satellite-derived estimates of glacier change in the Arctic to in-situ mass balances and satellite gravimetry.