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Glacier-specific elevation changes in western Alaska

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Deriving glacier-specific elevation changes from DEM differencing and digital glacier outlines is rather straightforward if the required datasets are available. Calculating such changes over large regions and including glaciers selected for mass balance measurements in the field, provides a possibility to determine the representativeness of the changes observed at these glaciers for the entire region. The related comparison of DEM-derived values for these glaciers with the overall mean avoids the rather error-prone conversion of volume to mass changes (e.g. due to unknown densities) and gives unit-less correction factors for upscaling the field measurements to a larger region. However, several issues have to be carefully considered, such as proper co-registration of the two DEMs, date and accuracy of the datasets compared, as well as source data used for DEM creation and potential artefacts (e.g. voids).

In this contribution we present an assessment of the representativeness of the two mass balance glaciers Gulkana and Wolverine for the overall changes of nearly 3200 glaciers in western Alaska over a ca. 50-year time period. We use an elevation change dataset from a study by Berthier et al. (2010) that was derived from the USGS DEM of the 1960s (NED) and a more recent DEM derived from SPOT5 data for the SPIRIT project. Additionally, the ASTER GDEM was used as a more recent DEM. Historic glacier outlines were taken from the USGS digital line graph (DLG) dataset, corrected with the digital raster graph (DRG) maps from USGS. Mean glacier specific elevation changes were derived based on drainage divides from a recently created inventory. Land-terminating, lake-calving and tidewater glaciers were marked in the attribute table to determine their changes separately. We also investigated the impact of handling potential DEM artifacts in three different ways and compared elevation changes with altitude.

The mean elevation changes of Gulkana and Wolverine glaciers (about -0.65 m / year) are very similar to the mean of the lake-calving and tidewater glaciers (about -0.6 m / year), but much more negative than for the land-terminating glaciers (about -0.24 m / year). The two mass balance glaciers are thus well representative for the entire region, but not for their own class. The different ways of considering positive elevation changes (e.g. setting them to zero or no data) influence the total values, but has otherwise little impact on the results (e.g. the correction factors are similar). The massive elevation loss of Columbia Glacier (-2.8 m / year) is exceptional and strongly influences the statistics when area-weighting is used to determine the regional mean. For the entire region this method yields more negative values for land-terminating and tidewater glaciers than the arithmetically averaged values, but for the lake-calving glaciers both are about the same.