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Comparing approaches for glacier elevation change estimation using optical DEM time series

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Digital elevation models (DEMs) from optical stereo satellite imagery are widely used to quantify glacier elevation change through DEM differencing. However, incomplete spatial coverage and irregular temporal sampling limit the applicability of standard pair-wise DEM differencing over large glaciers, requiring the analysis of multi-temporal DEM time series.

Here, we compare methodological approaches for interpolating optical DEM time series to derive mean glacier elevation change rates using freely available datasets. We exploit SPOT-5 and ArcticDEM as high-resolution complements to the ASTER DEM record. Using the Hofsjökull ice cap (Iceland) as a pilot study, we assess the performance and transferability of a pixel-based Gaussian interpolation approach (Hugonnet et al., 2021) and introduce a computationally efficient elevation-band-based method. Validation is performed against independent elevation datasets, such as LiDAR and Pléiades, and through pairwise DEM differencing.

Our results show that the elevation-band approach provides reliable estimates of glacier-elevation change under sparse, irregular sampling conditions. Furthermore, with its low computational cost and flexibility, the method is well-suited for regional applications and for extending geodetic glacier mass-balance assessments beyond the ASTER era.

Hugonnet, R., McNabb, R., Berthier, E., Menounos, B., Nuth, C., Girod, L., Farinotti, D., Huss, M., Dussaillant, I., Brun, F. and Kääb, A., 2021. Accelerated global glacier mass loss in the early twenty-first century. *Nature*, *592*(7856), pp.726-731.