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A review of methods to estimate regional and global glacier mass balances

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Glacier changes are recognized as independent and high-confidence natural indicators of climate change. Past, current, and future glacier changes impact on local hazard situations, the regional water cycle, and global sea level. For the last IPCC reports, regional mass balance estimates were based on the multiplication of (annual or pentadal) averaged/interpolated mass balances from available observations with the total glacier surface area of corresponding regions. For data-scarce regions, these results were complemented with estimates based on satellite altimetry and gravimetry. These approaches are challenged by the relatively small number and inhomogeneous spatio-temporal distribution of in-situ measurement series and their often unknown representativeness for the respective mountain range as well as by scale issues of current satellite altimetry (only point data) and gravimetry (coarse resolution).

The present contribution aims to advance regional and global mass balance estimates based on glacier observations from the ground and space. We describe limitations of the methods used in past IPCC reports and further develop new approaches to make the most of recent improvements with respect to available datasets, including (i) a consolidated glaciological mass balance dataset with many of the long-term data series validated – and if necessary – calibrated, (ii) geodetic volume change assessments for entire mountain ranges from recently available and comparably accurate DEMs, and (iii) a global glacier inventory including information on area, topography and hypsometry. The combination of these emerging datasets and a correspondingly advanced methodology provide the foundation for updated and improved estimates on regional and global mass balances for upcoming IPCC reports.