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Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016

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Glaciers distinct from the Greenland and Antarctic Ice Sheets cover an area of approximately 706,000 km2 globally with an estimated total volume of 170,000 km3, or 0.4 m of potential sea-level rise equivalent. Retreating and thinning glaciers are icons of climate change and impact regional runoff as well as global sea level. For the previous reports of the Intergovernmental Panel on Climate Change (IPCC), mass-change estimates were based on the multiplication of averaged or interpolated results from available observations of a few hundred glaciers with regional glacier areas. For data-scarce regions, these results had to be complemented with estimates based on satellite altimetry and gravimetry. These past approaches were challenged by the small number and heterogeneous spatio-temporal distribution of in situ measurement series and their often unknown representativeness for the respective mountain range as well as by spatial limitations of current satellite altimetry (only point data) and gravimetry (coarse resolution).

In view of the upcoming IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), we gathered an international team of experts to provide a new estimate of glacier contributions to global mean sea level. Here we present a new approach that combines the temporal variability from glaciological observations with improved spatial coverage from geodetic observations. Our new approach suggests that glaciers contributed 27 $\pm$ 22 mm to global mean sea-level rise from 1961 to 2016. Regional specific mass-change rates for 2006–2016 range between -0.1 and $^{-1}.2$ m water equivalent per year, resulting in a global sea-level contribution of 335 $\pm$ 144 Gt per year or 0.92 $\pm$ 0.39 mm per year. The current glacier mass loss is thus equivalent to the sea-level contribution of the Greenland Ice Sheet, clearly exceeds the loss from the Antarctic Ice Sheet, and accounts for 25% to 30% of the total observed sea-level rise.