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Estimating the glacier contribution to sea-level rise over the past 200 years

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There is abundant evidence that eustatic sea level has been rising for at least the past two centuries. Although the error bars are significant, the general view is that this rise has been between 15 and 25 cm for the period 1850-2000. Thermal expansion of ocean water, changes in terrestrial storage of water, mass loss of smaller ice caps and glaciers, and possible long-term imbalances of the mass budgets of the Greenland and Antarctic ice sheets have been listed as the most important processes contributing to the observed sea-level rise. In order to make reliable future projections of sea-level rise, it is really crucial to understand, and be able to reproduce, the contribution of each of these components over the past centuries.

In this study, we present a new estimate of the contribution of glaciers and small ice caps to the sea-level rise over the period 1800-2005. We directly use data on geometric changes of glaciers. Hereby, we avoid the problems associated with the modelled mass balance sensitivity approach that needs climate data as input and has the problem of defining an proper initial state.

Length records form the only direct evidence of glacier change that has potential global coverage before 1950. Hence, we exploit the available information on changes in glacier length. At the moment, we have 335 glaciers length records worldwide that start before 1945. The length changes of these glaciers show a worldwide coherent signal; from the middle of the 19th century up to present glaciers retreated. We calculate a globally representative signal from the 335 glacier length records. By means of scaling, we deduce a global glacier volume signal, that is calibrated with the mass-balance and geodetic observations of the period 1950-2005. We find that the glacier contribution to sea-level rise was 8.2 $\pm$ 2.1 cm for the period 1800-2005 and 9.1 $\pm$ 2.3 cm for the period 1850-2005. These values are significantly larger than previous estimates, for instance as reported in the latest IPCC report.