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# Multi-Objective Optimization of a Global Glacier Mass Balance Model

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Glacier mass loss across most of the world contributes a major part of the contemporary and projected 21th century sea-level rise. In addition, glaciers constitute important freshwater reservoirs for some regions of the world. As with other components of the Earth system, the future of the glaciers' mass balances and their contribution to sea-level rise can only be projected using numerical models, which have to be validated using in-situ (or for more recent periods, remotely sensed) observations. Since all models rely on some form of parameterizations, there are is a need for optimization.
In this work, a model for computing monthly mass balances of the glaciers on the global scale was forced with seven different data sets of near-surface air temperature and precipitation anomalies, as well as with their average. Additionally, four global parameters of the model's main mass balance equations were varied systematically within a physically plausible range. We then identified an optimal parameter combination (including the forcing data set) by validating the model results against in-situ mass balance observations, using three criteria: model bias, temporal correlation, and the ratio between the observed and modeled temporal standard deviation. Although the model turned out to be relatively resilient to changes in the global parameters, we found that changes to the boundary conditions require an adjustment of parameter values. While the root mean square error of the model results was slightly increased due to the applied optimization strategy, our better understanding of the parametric model uncertainty and the systematic exploration of the parameter space increase our confidence in the reconstruction. Through the optimization, the reconstructed values of the past glacier contribution to sea-level rise increased from 83.1 ± 3.1 to 100.0 ± 13.4 for the period 1902 to 2016, and from 27.5 ± 0.5 to 31.1 ± 0.7 for the period 1980 to 2016.