Parameter uncertainty of Hydro-glaciological model estimates derived from non-stationary climate conditions.

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Abstract Text:

Geodetic mass balance (GMB) estimates offer the opportunity to mitigate the data scarcity that affects calibration and evaluation of hydro-glaciological models in mountain areas. New analytic techniques allow to obtain GMB from historical aerial photographs, extending the record to pre-satellite decades. This study analyzes how the calibration and performance of a physically based hydro-glaciological model varies when using a set of GMB spanning different hydro-climatic periods. For this purpose, we modeled the changes in volume and runoff from the Universidad Glacier, the largest mountain glacier in the extratropical Andes north of Patagonia (27 km ; -34.7°N; -70.34°E) between the years 1955-2021. An energy balance model was implemented using the CRHM platform, considering different processes relevant to high mountain hydrology such as gravitational redistribution and blowing snow. Our modeling approach includes off-line routines for ice thickness redistribution and interannual changes in ice albedo, implemented into the CRHM model. To calibrate the model, 8 GMB periods between 1955-2019 were available. Different cases were considered by varying the availability of DEM's, generating different periods of mass balance. We observed that models calibrated only with GMB between 1997-2019, a period characterized by high temperatures, estimated a 24% decrease in volume between the years 1955-2019. In contrast, models calibrated with GMB from 1985 or earlier, a period with higher accumulation, simulated a 13% glacier volume loss, closer to the 17% observed loss. The runoff simulated by the models calibrated with GMB in the period 1997-2019 is 13% higher than the models calibrated with GMB that covers earlier periods. In addition, the best-fit models show an increase in runoff of 11% in the period 2000-2020 compared to the years 1980-2020