Submitted Abstract

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Abstract

The coupling of glaciers to climate makes glacier morphology a useful measure of paleoclimatic conditions and allows for climate model-driven glacio-hydrological predictions in water-stressed regions. Predicting how climate change is impacting glacier water storage and inversely, inferring paleoclimatic conditions from glacial geomorphology depends on reliable models of glacier flow and mass balance. This is especially significant in Peru's Cordillera Blanca. While the C. Blanca remains the most extensively glacierized tropical mountain range on Earth, its ice-sculpted landscape suggests that glaciers existed at much lower elevations during certain periods of the Holocene. Today, the rapidly shrinking glaciers of the region remain vital water reservoirs for Peru's Pacific coast, buffering water insecurity during the dry season. This study uses synchronous mass balance and glacier thickness datasets to calibrate the coupled mass balance and ice flow modules of the Open Global Glacier Model (OGGM). Two moraine positions representing semi-stable glacial conditions during the early (10.8ka BP) and mid-Holocene (6.2ka BP) are then used to constrain model glacier terminus elevations. Using a Monte Carlo approach, we identify all possible temperature-precipitation perturbation combinations that reconstruct the respective steady-state paleoglaciers, while incorporating parameter uncertainties determined during model calibration. A second constraint on paleoclimatic conditions is derived from the same approach using equilibrium line altitudes, rather than terminus elevations. Relative to the 1985-2015 CE climatic baseline, our results suggest that valley temperatures were 1.8˚C and 1.5˚C lower during the early and mid-Holocence accompanied by hydroclimatic conditions that were 4% and 14% wetter, respectively.