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Mass balance of a tropical glacier and its sensitivity to climate fluctuations: Kilimanjaro, 5873 m a.s.l.

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Continuous meteorological measurements obtained at 5,873 m a.s.l. on Kersten Glacier, a slope glacier on the southern flanks of Kilimanjaro, are used to run a physically-based mass balance model for the period February 2005 to January 2006. Short-term measurements of subsurface temperature and turbulence were also available for model calibration. Results show that net shortwave radiation is the most variable energy flux at the glacier-atmosphere interface, governed by surface albedo. The majority of the mass loss ($\sim$65%) is due to sublimation (direct conversion of snow/ice to water vapour), with melting of secondary importance. Sensitivity experiments reveal that glacier mass balance is 2-4 times more sensitive to a 20% precipitation change than to a 1 K air temperature change. These numbers also hold when the model is run with input data representative of a longer-term (1979-2004) mean period. The main cause of this sensitivity characteristic is the strong albedo feedback, which is significantly stronger than on midlatitude glaciers. Results suggest that precipitation availability is crucial to glacier retention on Africa's highest mountain. In light of recent glacier history on Kilimanjaro and large-scale climate dynamics, this conclusion is supported by a paleoclimate simulation with a coupled atmosphere-ocean general circulation model.