Submitted Abstract

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Abstract

The trajectory of glacier mass and meltwater runoff changes in the tropical Andes under 21st century climate change is likely to be complex due to the combined influence of melt, sublimation and ice flow processes which will bring about highly non-linear responses to rises in near surface air temperature. Results from the Glacier Model Intercomparison Project have shown that simulations of glacier mass changes in the tropics are especially uncertain and highly sensitive to differences in the formulation of fundamental processes including the surface energy balance and ice flow dynamics. Computational and observation data constraints have typically led researchers to employ simplified representations of these processes for the purpose of climate change impact studies. For tropical glaciers, these simplifications have the potential to miss important non-linearities in future glacier mass and runoff changes.

This study presents a physically-based glacier modelling approach that integrates two existing model codes: i) JULES which employs a full surface energy balance model of snow and ice to simulated ice mass changes; and ii) OGGM which employs a flowline representation of the shallow ice equation to simulate ice flow. The integrated approach is applied to over 500 glaciers in the Vilcanota-Urubamba basin in Peru, home to the second-largest tropical glacierised mountain range in the world.

This study first interrogates the simulation efficiency by comparing the model simulations to glaciological and geodetic mass balance data collected in the region. Through sensitivity analysis a process-level assessment of sources of uncertainty is then undertaken. The results from this analysis indicate that overall surface mass balance simulations are good and that the representation of surface albedo dynamics are a key source of uncertainty in simulations. Finally, the model is driven with CMIP5 climate change projections to explore the evolution of mass changes in the region over the 21st century.