Submitted Abstract

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Title	The Drivers & Elevation-Dependence Of Recent Multi-Decadal Changes In Tropical Glacier Morphology & Mass Balance Across The Cordillera Blanca, Peru.
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Abstract

Throughout the tropical Peruvian Andes, the cryosphere is destabilizing as climate warms, exposing downstream populations to complex challenges of increased geo-hazards and altered hydrology. The Cordillera Blanca, Earth's most glacierized tropical range, reaches 6768 masl at the summit of Nevado Huascaran. The extent to which climate change will affect this high-mountain environment or might be augmented with elevation remains unclear, especially since maintaining direct measurements is not feasible. Geodetic and glaciological mass balance measures remain scarce in the accumulation zone, and gridded measures of glacier surface characteristics spanning climatically relevant timescales do not exist. Nevertheless, glacier mass balance fluctuations in the tropical Andes have great potential to aid investigations of elevation-dependent climate change and local feedback processes.

This research helps fill these high-altitude knowledge gaps by leveraging four decades of in situ and remote observational data alongside recent computational advances to characterize the mass balance fluctuations of individual glaciers across the Cordillera Blanca and test tropical climate-glacier linkage hypotheses. In 2019, we conducted a series of sustained, highly coordinated observations from instruments in space, sky, and on the ground — including glaciological, geophysical, and geodetic measures collected in the Col and on the summit of Nevado Huascaran, as well as time-synchronous measures coordinated and aligned with IceSat-2. These in situ observations provided the ground-control and validation information necessary to extract DEMs from sub-meter satellite imagery aligned using high-precision airborne lidar and SRTM reference DEMs. From this novel time series, we extracted 63 unique epochs of high-resolution, gridded geodetic mass balance measures across the accumulation zone. We used Bayesian regression and cross-correlational frameworks to quantify the influence of glacier-specific morpho-geometric characteristics versus local-to-large-scale climate factors in determining glacier response patterns.

Here, we present recent seasonal-to-multidecadal patterns of elevation-dependent variables influencing tropical glacier-climate interactions alongside new insights concerning high-elevation accumulation trends in the tropical Andes evidenced by snow pit, ice core, geodetic, geophysical, and meteorological station observations. We identify the principal factors governing changes in glacier surface area versus mass balance and discuss differences between individual glacierized catchments that, despite sharing a similar climate, exhibit varied glacier responses. We discuss the complex nested feedback mechanism components modulating glacier changes along latitudinal, longitudinal, and altitudinal gradients. This research also identifies clear linkages between glacier response patterns, seasonal temperature and precipitation variability, and large-scale climate phenomena. We conclude by highlighting these distinct seasonal sensitivities of tropical glaciers to short versus longer-term climate variability.