Submitted Abstract

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Title	Low-Cost Weather Sensor Network Points To Elevation Dependent Warming, Decreasing Precipitation And Decreasing Wind Speed In The Cordillera Blanca, Peru From 2006 To 2019.
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Abstract

Wet and dry seasons and strong diurnal variability of the outer Tropics and steep terrain dictate weather patterns in the northern Peruvian Andes. Herein we report on the instrumentation, installation, maintenance challenges, data gaps and error corrections necessary to analyze the 2006-2019 record of hourly measurements from an embedded sensor network (ESN) consisting of HOBO weather stations anchoring four low-cost, shielded Lascar El-USB2 dataloggers hanging in trees between the elevations 3,500 and 4,750 m a.s.l. in the pro-glacial Llanganuco Valley in the Ranrahirca sub-basin. ESN data were physically downloaded from dataloggers during annual June-August field expeditions and through partnerships with the water authority office and Huascaran national park office in Huaraz, Peru. HOBO data loggers were replaced with Iridium® satellite DataGarrison stations in 2014 to reduce data loss and allow real-time monitoring of weather patterns. We also report on two DataGarrison weather stations installed in 2014 at 3900 m within the Qualcayhuanca sub-basin and at 4700 m at Cuchillacocha which feeds into the sub-basin. Irrespective of limitations, we demonstrate the usefulness of these datasets. We found strong temporal variability in freezing-level height (FLH) connected to ENSO cycles and greater warming rates at higher elevations suggestive of valley fluxes that could impact the mass balance of glaciers. The FLH rose by 200 meters over the last decade with an average diurnal range from 150 meters during the wet to 420 meters during the dry seasons. While the observed rate of warming at 4000 m was less than 0.1 C/decade the warming at 4400 m was 0.7 C/decade and 0.5 C/decade at 4600 m. The linear trend of monthly near-surface lapse rates (LRs) suggests negative LR feedback from 9 C/km in 2006 to 7.5 C/km in 2019 with an average seasonal range in 2016 to 2019 from 6.5 C/km in the wet season to 8.5 C/km in the dry season. Although relatively weak averaging less than 2 m/s, wind speed at 4000m decreased from by 0.5 m/s over the last decade of the record. Rainfall at 4000m decreased slightly with significant decrease in heavier events over the last decade of the record. Our results and collaborations with climate modelers suggest that sustained, low-cost ESNs have value in climate studies and can help inform climate algorithms about important diurnal and seasonal cycles in glaciated Tropical mountains.