Journal

Annals of the American Association of Geographers >

Volume 107, 2017 - Issue 2: Mountains

Physical Dynamics of Mountain Environments

Incorporating Autonomous Sensors and Climate Modeling to Gain Insight into Seasonal Hydrometeorological Processes within a Tropical Glacierized Valley

Robert Åke Hellström, Alfonso Fernández, Bryan Greenwood Mark, Jason Michael Covert, Alejo Cochachín Rapre & Ricardo Jesús Gomez

Pages 260-273 | Received 01 Dec 2015, Accepted 01 Jun 2016, Published online: 20 Oct 2016

Download citation https://doi.org/10.1080/24694452.2016.1232615 Check for updates

Abstract

Peru is facing imminent water resource issues as glaciers retreat and demand for water increases, yet limited observations and model resolution hamper understanding of hydrometerological processes on local to regional scales. Much of current global and regional climate studies neglect the meteorological forcing of lapse rates (LRs) and valley and slope wind dynamics on critical components of the Peruvian Andes' water cycle, and herein we emphasize the wet season. In 2004 and 2005 we installed an autonomous sensor network (ASN) within the glacierized Llanganuco Valley, Cordillera Blanca (9⊠ S), consisting of discrete, cost-effective, automatic temperature loggers located along the valley axis and anchored by two automatic weather stations. Comparisons of these embedded hydrometeorological measurements from the ASN and climate modeling by dynamical downscaling using the Weather Research and Forecasting model elucidate distinct diurnal and seasonal characteristics of the mountain wind regime and LRs. Wind, temperature, humidity, and cloud simulations suggest that thermally driven up-valley and slope winds converging with easterly flow aloft enhance late afternoon and evening cloud development, which helps explain nocturnal wet season precipitation maxima measured by the ASN. Furthermore, the extreme diurnal variability of along-valley-axis LR and valley wind detected from ground observations and confirmed by dynamical downscaling demonstrate the importance of realistic scale parameterizations of the atmospheric boundary layer to improve regional climate model projections in mountainous regions.