ACINN Graduate Seminar, Innsbruck University
Location: Mehrzweckraum on the Ground Floor of GeiWi-Tower
Wednesday, 15 Dec 2021, 12:00

The mass and energy balance of Peruvian glaciers and an assessment of modelling approaches

Catriona Fyffe*)

Research Fellow for PeruGROWS and PEGASUS, Northumbria University, Newcastle-Upon-Tyne and Visiting Fellow at the Swiss Federal Research Institute WSL, Birmensdorf

Peruvian glaciers are important contributors to dry season runoff for agriculture and hydropower, but they are at risk of disappearing due to climate change. By applying a physically-based, energy balance melt model at five on-glacier sites within the Peruvian Cordilleras Blanca and Vilcanota it is possible to determine the most important components of the surface energy balance of Peruvian glaciers and how sensitive they are to climate change. Net shortwave radiation dominates the energy balance, and despite this flux being higher in the dry season, melt rates are lower due to losses from net longwave radiation and the latent heat flux. The sensible heat flux is a relatively small contributor to melt energy, since air temperatures remain relatively low. At three of the sites the wet season snowpack was discontinuous, forming and melting within a daily to weekly timescale, and resulting in highly variable melt rates closely related to precipitation dynamics. Cold air temperatures due to a strong La Niña year at Shallap Glacier (Cordillera Blanca) resulted in a continuous wet season snowpack, significantly reducing wet season ablation. Sublimation was most important at the highest site in the accumulation zone of the Quelccaya Ice Cap (Cordillera Vilcanota), accounting for 81% of ablation, compared to 2-4% for the other sites. Air temperature and precipitation inputs were perturbed to investigate the climate sensitivity of the five glaciers. At the lower sites warmer air temperatures resulted in a switch from snowfall to rain, so that ablation was increased via the decrease in albedo and increase in net shortwave radiation. At the top of Quelccaya Ice Cap warming caused melting to replace sublimation so that ablation increased non-linearly with air temperature. The resulting ablation timeseries at each of the sites can be used to calibrate a simpler enhanced temperature index melt model, which is more appropriate within hydrological models or where input data is more limited. This analysis showed that enhanced temperature index melt models struggle to represent accurately the diurnal melt cycle and ablation at high elevation sites where sublimation processes dominate. Nevertheless, calibration does allow the overall magnitude of melt at lower elevation sites to be reasonably well represented.

*) Partners: Emily Potter, Stefan Fugger, Andrew Orr, Simone Fatichi, Edwin Loarte, Katy Medina, Robert Å. Hellström, Maud Bernat, Caroline Aubry-Wake, Wolfgang Gurgiser, L. Baker Perry, Wilson Suarez, Duncan J. Quincey and Francesca Pellicciott