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# Modeling mass balance of a tropical glacier in the Peruvian Andes

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Glacier mass balance models ranging in complexity from regression models to process based energy balance models have been applied on tropical glaciers in South America for glaciological and hydrological issues.

Within a case study on Shallap glacier in the Peruvian Cordillera Blanca we calculated 4 years of glacier mass and energy balance, using a process based model at high spatial and temporal resolution. We investigated the contribution of the terms of the energy fluxes to surface melt at seasonal and annual time scales. We compared the calculated mass balance values obtained from the process based model with the ones obtained from a basic temperature based regression model for monthly and annual time scales. The results match surprisingly well for the entire period with decreasing model skill on increasing temporal resolution.

As the 4 year test period was characterized by relatively low variability in annual mean temperature, we increased annual temperature variability by $\pm$ 1° C for a 2 year test period, which is a likely upper limit of annual temperature variation expectable from long term records and within possible future climate conditions. We again compared the model outputs and found that the process based model markedly responds to the change in atmospheric forcing. In contrast, the regression model does only show minor response to increased temperature variability.

We show that missing information (e.g., area altitude distribution) and badly captured processes (e.g., temperature impacts on surface albedo) within the regression model are the most likely reasons for the different model behaviors. While considering topographic information within simple models is possible, we conclude that high variability in surface albedo (typical for ablation zones of a Tropical glaciers) poses a tough challenge for calculating surface mass balance or melt water production on seasonal to monthly time scales with temperature based regression models. On multi-annual time steps, we demonstrate that for the present glacier extent, increased temperature variability (with constant mean temperature) would decrease mean surface albedo. This impact is not captured by simple regression models and could lead to lower model skills for future or past climate conditions compared to present days calibration and evaluation periods.