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Relevance of future snowfall level height in the Peruvian Andes for glacier loss in the 21st century under different emission scenarios

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In many regions of Peru, the competition for limited hydrological resources already represents a large risk for conflicts. In this context, and within the circumstances of climate change, there is a great interest in estimating the future loss of Peruvian glaciers.

Solid precipitation on glaciers, which affects the shortwave radiation budget via its effects on albedo, in general reduces ablation. For that reason, the height of the upper level of the transition zone between liquid and solid precipitation (snowfall level height) is considered to play a critical role. This snowfall level height is linked to air temperature. The observed and projected warming of the atmosphere is therefore affecting the glaciers amongst others by changing the snowfall level height. Despite the potential significance of these changes for Peruvian glaciers, the relations between snowfall level heights, glacier extents and climate scenarios have been poorly investigated so far.

In our study, we first analyse the snowfall level heights over the Peruvian Cordilleras. Second, we investigate the relationship between the present snowfall level heights and current glacier extents. As a third step, we derive projected changes of snowfall level heights from GCMs for the RCP2.6 and 8.5 emission scenarios and use them to roughly estimate the end of XXI century glaciation for the Peruvian Cordilleras.

Our results indicate a large difference in future glacier extent between the high-emission (pessimistic) RCP8.5 and the low-emission (optimistic) RCP2.6. If global emissions can be substantially reduced, a significant part of the glaciated area of Peru can be maintained. On the contrary, if mitigation is unsuccessful, most of the glacier mass in Peru will be lost during the 21st century. In both cases, but even more so for the high-emission scenario, adaptation will play a critical role and should focus on improvements in water resource management which is essential on a local to regional scale.

Air temperature plays a critical role for glacier mass budgets by determining the precipitation phase rather than by determining ablation. The approach suggested here relies on this stable connection and is therefore appropriate for detecting differences between both analysed emission scenarios. However, the model is simple and neglects or simplifies other relevant energy fluxes and important processes as well as further possible changes. In addition, the method does not consider future changes of further climate variables such as precipitation. Uncertainties of the approach are thus related to the simplification of numerous processes and fluxes. Nevertheless, the approach presented here may be a relatively robust alternative to other simple estimations of future glacier extents.