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Past and future evolution of Himalayan glaciers: a regional climate model study

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Over 800 million people depend on glacier melt water runoff throughout the Hindu-Kush and Himalaya (HKH) region. The region, also called as "Water tower of Asia", is the location of several major rivers basins, like Ganges, Brahmaputra, and Indus etc. Glaciers in the HKH region are the primary source of water for the perennial rivers. Previous studies have assessed glacier areas and volumes in the HKH region by remote sensing techniques and slope-dependent thickness estimations. We here present a study in which, for the first time a glacier parameterization scheme is dynamically coupled to a regional climate model and applied over the South Asian Himalayan mountain range. The glacier scheme interactively simulates the mass balance as well as changes of the areal extent of glaciers on a sub-grid scale. Various observational data sets, in particular a regional glacier inventory, have been compiled and were used to initialize glacier area and volume in the year 1989. A simulation for the period 1989-2008 using the ECMWF ERA-Interim reanalysis as atmospheric boundary forcing was carried out. Preliminary results show a simulated decrease of glacier area of about 20% between 1989 and 2008. The spatial patterns of glacier area change show a remarkable decrease, but do show some regions of increase especially over the Karakoram (western Himalaya), a region for which available observations-based estimates also indicate a positive mass balance anomaly. The positive relation between altitude and mass balance is qualitatively reproduced by the model. The model is able to approximately represent the equilibrium line altitude (ELA) for selected sub-region when compared to observed values but simulated ELA's seem to have a systematic negative bias which, in turn, suggests an overestimation of the mean regional mass balance. Our results indicate that observed glacier changes can be approximately reproduced within a regional climate model based on simplified concepts of glacier-climate interaction. This, in turn, underlines the general applicability of the model system for scenarios of 21st century climate and glacier change. Presently, two climate change simulations forced with two GCMs are under preparation and the results will be presented.