Submitted Abstract

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Title	Impact Of Recent Ground Thermal Changes On The Hydrology Of An Endorheic Tibetan Catchment And Implications For Lake Level Changes.
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Abstract

Ground thermal regime of high mountain catchments impacts the distribution between infiltration and runoff, latent and sensible heat fluxes, frozen and liquid subsurface water and the presence (or absence) of permafrost. In the context of global warming, hydrological modifications associated to ground thermal changes are of critical importance for extensive headwater regions such as the Qinghai-Tibet Plateau (QTP) and the Himalayas, which are major water towers of the world. Many watersheds of the QTP have seen their hydrologic budget modified over the last decades as evidenced by strong lake level variations observed in endorheic basins. Yet, the role of ground thermal changes in these variations has not been assessed.

Lake Paiku (central Himalayas, southern TP) has exhibited important level decreases since the 70s and thus offers the possibility to test the potential role of ground thermal changes and permafrost thaw on these hydrologic changes. We present distributed ground thermo-hydric simulations covering the watershed over the last four decades to discuss their implications on the lake level changes. We use the Cryogrid model to simulate the surface energy balance, snow pack dynamics and the ground thermo-hydric regime while accounting for the phase changes and the soil water budget. Because the surface radiative, sensible and latent heat fluxes in alpine environments are strongly dependent on the physiography, the model is forced with distributed downscaled forcing data produced with the TOPOSCALE model to account for this spatial variability. Simulated surface conditions are evaluated against meteorological data acquired within the basin, ground surface temperature loggers and remotely sensed surface temperatures. The simulations show that, contrary to large scale estimates of permafrost occurrence probability, an significant part of the basin is underlaid by permafrost (>20%). We also show that over the 1980-2020 period, ground temperature warmed up by 1.5 to 2°C per centuries. The permafrost limit rose from 5100 to 5300 m asl (in 40 years). Unfrozen surface conditions increased by around 25 days per century and evaporation increasing by +22% over the period. To represent the impact of these changes on the lake level, we included them in a simple hydrological budget calculation including the contribution of glacier melt and lake evaporation. This approach shows that ground thermo-hydric changes in the catchment have contributed to the lake level changes. These first results highlight the potential of thermo-hydric simulation to better quantify hydrological changes to come in the QTP.