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Statistical climate data analysis and ensemble modeling to assess climate-driven changes in hydrological dynamics in the Nam Co basin, Tibet, China

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The Tibetan Plateau, often called the third pole, is considered as one of the most vulnerable regions being affected by global climate change. Since little knowledge is given on the effect of changing monsoon dynamics, temperature rise and increasing glacier and permafrost melt on the Tibetan hydrology, a project was initiated to study their spatio-temporal impact on the regional water balance. The high elevation inland lakes on the Tibetan Plateau serve as a sensible indicator for the impact of changing climate since lake level fluctuations sensitively indicate changes in regional water balance mainly caused by changing precipitation pattern and amount, rainfall/snowfall ratio, snow and glacier cover or melt water amount, etc. As shown by the remote sensing based analysis of lake extent and lake level changes of the largest lake on the high Plateau, the increase of the glacial-fed lake Nam Co (30°N/90°E, 4718 m a.s.l.) in the previous decades indicates that the Nam Co basin (10 800 km^2) located in central Tibet is experiencing noticeable changes in the hydrological dynamics. Those changes need to be clarified to comprehensively understand the interactions between hydrological and climatic processes on the Tibetan Plateau. There are already some studies of the lake variation of Nam Co but these mostly qualitative analyses state both glacial melting and precipitation as the major lake supply. To quantify the main factors for the lake expansion the calculation of the water amount circulating in the hydrological system is required by modeling the underlying hydrological processes and components. Therefore, the distributed hydrological model J2000 was adapted to high-altitude conditions and extended by a glacier and a lake module. The major challenge for water balance studies in this remote and severely ungauged region is the lack of reliable data for model input. In the last decades gridded climate data sets have been developed to bypass these data gaps. To assess their spatial and temporal deviations various data sets (ECHAM5, CRU, APHRODITE, TRMM), which are based on different input sources such as ground observation, satellite estimates and climate model simulations, were compared among each other and against corresponding observation data by calculating statistics of differences as well as climatic trends. Since the several data sets exhibit remarkable differences in their spatial distribution and temporal variability, an ensemble climate data set was applied as input to the model in order to estimate the impact of the data uncertainty on the water balance calculation of Nam Co. Despite the data uncertainty spatially distributed estimates of precipitation, potential and actual evapotranspiration from the land surface and the lake itself, glacier and snow melt and runoff generation could be obtained for the last decades in monthly and daily time steps. Comparisons with the very rarely available hydrological quantities measured by the Institute of Tibetan Plateau Research (ITP), who measured a lake level rise of 29 cm/yr (2005-2008) and estimated 27cm/yr (2000-2009) from radar altimetry, could be reproduced by the model.