Impacts of the aquifer depletion on ground surface temperature in north China plain

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It has been observed that the ground surface temperature (GST) in north China plain (NCP) has kept raising since 1970s. At the same time the depth to water table (DWT) has been increasing due to groundwater (GW) over-pumping during the same time period in the same region. Are these two events coincidences or related? In this study a coupled ParFlow.CLM model representing subsurface and land-surface processes was built to answer this question and investigate the impacts of GW pumping and irrigation on the GST in NCP. The model was validated using the water and energy fluxes reported and from the JRA-55 reanalysis. Results of numerical experiments show the subsurface acts as a buffer to temporal variations in heat fluxes at the land-surface, but long-term pumping can gradually weaken this buffer, resulting in increases in the spatio-temporal variability of GST, as exemplified by hotter summers and colder winters. Considering that changes of water table depth (WTD) significantly affect land surface heat fluxes when WTD ranges roughly between 0.01–10 m, the water table decline of 0.5 m/year simulated by the model due to pumping disturb GST for about 20 years from the pre-pumping WTD in the NCP, before the WTD exceeds 10 m. The variations of GST are expected to be faster initially and gradually slow down due to the nonlinear behaviors of GST with WTD. The findings from this study in the NCP may also have implications for other regions with GW depletion.

Keywords: Ground surface temperature , Groundwater over-pumping, North China plain, Intergrated hydrological modeling, ParFlow.CLM

