Effects of groundwater pumping on ground surface temperature: A regional modeling study in the North China Plain

You-Kuan Zhang¹, Chen Yang¹, and Xiaofan Yang²
¹School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, China (zhangyk@sustech.edu.cn)
²Faculty of Geographical Science, Beijing Normal University, Beijing, China

It is recognized that groundwater (GW) may play an important role in the subsurface–land-surface–atmosphere system and that pumping of GW may affect soil moisture which in turn influences local weather and climate through land-atmosphere interactions. In this study effects of GW pumping on ground surface temperature (GST) in the North China Plain (NCP) were investigated with a coupled ParFlow.CLM model of subsurface and land-surface processes and their interactions. The model was validated using the water and energy fluxes reported in previous studies and from the JRA-55 reanalysis. Numerical experiments were designed to examine the impacts of GW pumping on GST in the NCP. Generally, 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) can significantly affect land surface heat fluxes when WTD ranges between 1–10 m, the 0.5 m/year increase of WTD simulated by the model due to pumping can continue to raise GST for about 20 years from the pre-pumping WTD in the NCP. The increase of GST is expected to be faster initially and gradually slow down. The findings from this study may implicate similar GST increases may occur in other regions with GW depletion.