

Simulated effects of irrigation on local climate in the Heihe watershed, China

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Abstract: In the arid area, such as the Heihe watershed in Northwest China, agriculture is heavily dependent on the irrigation. As a human-induced hydro process, irrigation modifies the local climate and water budget. In this study, using the WRF-NoahMP model with an realistic irrigation scheme, we simulated the irrigation-induced changes in surface energy/moisture budgets and modifications on local climate. The irrigation scheme was implemented following the roles that soil moisture is assigned a saturated value once the mean soil moisture of all root layers is lower than 70% of field capacity. Across the growth season referring from May to September, the simulated mean irrigation amount of the 1181 cropland gridcells is ~900 mm, which is close to the field measurements of around 1000 mm. Such an irrigation largely modified the surface energy budget. Due to irrigation, the surface net solar radiation increased by ~76.7 MJ (~11 Wm^{-2}) accounting for ~2.3%, surface latent and sensible heat flux increased by 97.7 Wm^{-2} and decreased by ~79.7 Wm^{-2} respectively; and local daily mean surface air temperature was thereby cooling by ~1.1°C. Corresponding to the surface energy changes, wind and circulation were also modified and regional water budget is therefore regulated. The total rainfall in the irrigation area increased due to more moisture from surface. However, the increased rainfall is only ~6.5mm (accounting for ~5% of background rainfall) which is much less than the increased evaporation of ~521.5mm from surface. The ~515mm of water accounting for 57% of total irrigation was transported outward by wind. The other ~385 mm accounting for 43% of total irrigation was transformed to be runoff and soil water. These results suggest that in the Heihe watershed irrigation largely modify local energy budget and cooling surface. This study also implicate that the existing irrigation may waste a large number of water. It is thereby valuable to develop effective irrigation scheme to save water resources.

Key words: Irrigation; Heihe watershed; WRF model; Local climate;