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Seasonal effects of irrigation on land-atmosphere latent heat, sensible heat and carbon fluxes in semi-arid basin

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Irrigation, which constitutes ∼70% of the total amount of fresh water consumed by the human population, is significantly impacting the land-atmosphere fluxes. In this study, using the improved Community Land Model version 4.5 (CLM 4.5) with an active crop model, two high resolution (∼1 km) simulations investigating the effects of irrigation on Latent Heat (LH), Sensible Heat (SH) and Carbon Fluxes (or net ecosystem exchange, NEE) from land to atmosphere on the Heihe River Basin in northwestern China were conducted using a high-quality irrigation dataset compiled from 1981 to 2013. The model output and measurements from remote sensing demonstrated the capacity and viability of the developed models to reproduce ecological and hydrological processes. The results revealed the effects of irrigation on LH and SH are strongest during summer with a LH increase of ∼100 W/m2 and a SH decrease of ∼60 W/m2 over intensely irrigated areas. However, the reactions are much weaker during spring and autumn when there is much less irrigation. When the irrigation rate below 5 mm/day, the LH generally increases, whereas the SH decreases with growing irrigation rates. However, when the irrigation threshold is in excess of 5 mm/day, there is no accrued effect of irrigation on the LH and SH. Irrigation produces opposite effects to the NEE during spring and summer. During the spring, irrigation yields more discharged carbon from the land to the atmosphere, increasing the NEE value by 0.4–0.8 gC/m2/day, while the summer irrigation favors crop fixing of carbon from atmospheric CO_2, decreasing the NEE value by ∼0.8 gC/m2/day. The repercussions of irrigation on land-atmosphere fluxes are not solely linked to the irrigation amount, and other parameters (especially the temperature) also control the effects of irrigation on LH, SH and NEE. The study indicates that how a land surface model with high spatial resolution can represent crop growing and its effects over basin scale.