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Numerical analysis of heat and water transport in the unsaturated zone in the presence of a shallow water table

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The interaction between soil water and heat fluxes in the entire unsaturated soil with a 100-cm water table was numerically simulated in the field environment during one year period. Simulated soil water contents and temperatures at various depths were validated by the observed data in the lysimeter at a hydrology experimental station in Huaihe River basin. Temporal variations in soil water and heat fluxes for one year period were calculated at depths 0, 10 and 50 cm, respectively. Results show that both soil water and heat fluxes had bigger values during warm and rainy seasons and smaller values during cold and dry seasons, with these values decreasing markedly with depth. The soil temperature could induce distinctly daily and seasonal patterns in dynamics of soil water and heat fluxes in shallow and deeper layers, respectively. Annual cumulative water fluxes in the profile indicated that the contribution of non-isothermal flow to total water flux was important. On the other hand, for annual cumulative heat fluxes in the profile, a large portion of soil heat flux was transported by the liquid water flow and even could reach the saturated zone. Latent heat due to phase changes mainly occurred in shallow layers and became the biggest component in the total soil heat flux near the soil surface. For total averaged effects for the year, evaporation occurred within the equivalent depth of 0.5 cm, immediately below which was the condensation zone that extended to water table.