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A stable isotope study of water movements with typical vegetation cover in the North China Plain

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The stable isotope 2H and 18O are often used as natural tracers in subsurface water pathways in semi-arid areas. The stable isotopic compositions in precipitation, soil water and groundwater were observed to assess the temporal variations in soil water flow at three sites covered by grass (Carex humili and Carex lanceolata) (site A), poplar (Ponulus hopeiensis) (site B) and winter wheat (Triticum asetivum) and summer maize (Zea mays) (site C) in the shallow groundwater area in the North China Plain (NCP) from April 2012 to October 2013. Precipitation isotopes resulted in a meteoric water line of δ2H =7.6δ18O -3.7 and showed a typical seasonal variation for δ2H (-98.9 to -13.3) and δ18O (-12.0 to -1.7). The seasonality in the shallow groundwater was further subdued due to the evaporation and mixing and diffusional exchange with stored water held in the soil pores within the unsaturated zone. Shallow groundwater was mainly recharged by precipitation in the rainy season. Soil water isotope profiles were sampled at depths of 10 cm down to 150 cm every 10 cm for the three sites. The vertical profiles of soil water δ18O showed large variations in the superficial 10 cm layer under the precipitation input and evapotranspiration effects. The soil water δ18O decreased and soil moisture increased with depth (70 cm) due to continuously evapotranspiration for the three sites though that at site B showed more positive δ18O values and smaller soil moisture than those at site A and C. The signal of individual rainstorm event in the summer with low δ18O values could be traced down to a depth of 40 cm that mixed with antecedent mobile soil water and to 120 cm due to a fast and direct preferential infiltration of the input rainwater that bypassed the upper soil layer at sites B and C. Keywords: stable isotopes; soil water pathways; groundwater recharge; North China Plain