Effect of seasonal freeze-thaw process on spatial and temporal distribution of soil water and its infiltration to recharge groundwater

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Abstract

Clarifying the distribution and dynamics of soil moisture during the freeze-thaw process is crucial for surface ecology and is an objective requirement to investigate the mechanism of changes during the groundwater recharge process in a freeze-thaw zone. Based on the monitoring data of soil moisture and temperature in the Changbai Mountain area, the freeze-thaw process is classified into four periods. This study investigates the hydrothermal migration processes during different periods. The simultaneous heat and water model is used to simulate and analyze the infiltration of soil moisture into groundwater under five precipitation guarantee rates. The results are as follows: (1) The smaller the soil depth, the stronger is the correlation between soil temperature and air temperature during the freeze-thaw process. (2) The redistribution of soil moisture before and after freeze-thaw is significantly affected by the soil texture, and soil permeability affects the recharge of soil moisture from the upper region to the lower region during the thawing period. (3) Groundwater receives vertical infiltration recharge mainly during non-freezing and is supplied by freezing and snowmelt recharge during the stable thawing period. The percentage of soil water infiltration during the stable thawing period in the total annual infiltration increases gradually with the precipitation guarantee rate.

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