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A Model for coupled heat and moisture transfer in permafrost regions of three rivers source areas, Qinghai, China

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Soil freezing occurs in winter in many parts of the world. The transfer of heat and moisture in freezing and thawing soil is interrelated, and this heat and moisture transport plays an important role in hydrological activity of seasonal frozen region especially for three rivers sources area of China. Soil freezing depth and ice content in frozen zone will significantly influence runoff and groundwater recharge. The purpose of this research is to develop a numerical model to simulate water and heat movement in the soil under freezing and thawing conditions. The basic elements of the model are the heat and water flow equations, which are heat conduction equation and unsaturated soil fluid mass conservation equation. A full-implicit finite volume scheme is used to solve the coupled equations in space. The model is calibrated and verified against the observed moisture and temperature of soil during freezing and thawing period from 2005 to 2007. Different characters of heat and moisture transfer are testified, such as frozen depth, temperature field of 40 cm depth and topsoil moisture content, et al.

The model is calibrated and verified against observed value, which indicate that the new model can be used successfully to simulate numerically the coupled heat and mass transfer process in permafrost regions. By simulating the runoff generation process and the driven factors of seasonal changes, the agreement illustrates that the coupled model can be used to describe the local phonemes of hydrologic activities and provide a support to the local Ecosystem services.

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