Geophysical Research Abstracts
Vol. 21, EGU2019-18260-2, 2019
EGU General Assembly 2019

Improved simulation of freeze-thaw process in land surface model based on new scheme for phase change and considering soil water–heat transport coupling

Kai Yang, Chenghai Wang, Feimin Zhang, Kechen Li, and Jiamin Li
College of Atmospheric Sciences, Lanzhou University, Lanzhou, China

Current most land surface model neglect the effects of interactions between water movement and heat transfer in the soil. Such effects are critical for a complete understanding of water–heat transport within a soil thermohydraulic regime. In this study, a Fully Coupled water-heat transport Scheme (FCS) is incorporated into the Community Land Model version 4.5 (CLM4.5) to replaces its original isothermal scheme, which is more complete in theory. Observational data from five sites are used to validate the performance of the FCS. The results show that the FCS improved the simulation of soil moisture and temperature. FCS better reproduced the characteristics of drier and colder surface layers in arid regions by considering the diffusion of soil water vapor, which is a non-negligible process in soil, especially for soil surface layers, while its effects in cold regions are generally inverse. It also accounted for the sensible heat fluxes caused by liquid water flow, which can contribute to heat transfer in both surface and deep layers. The FCS provides the details of soil heat and water transportation, which benefits to understand the inner physical process of soil water-heat migration. To further improve simulation of soil freeze-thaw (FT) process, modifications of the FT parameterizations in CLM4.5 are proposed, which includes use of virtual temperature (Tv) instead of constant freezing point, introduction of phase change efficiency (ε) and consideration of inferred impacts of phase change on soil heat conduction. Compared to original parameterizations in CLM4.5, these modifications can reproduce the features of daily and diurnal variations in soil moisture, especially during soil thawing process, and make simulation in FT process closer to the observations.