Introducing soil freezing into a land-surface scheme with physically-based hydrology

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We present a new physically based soil freezing scheme implemented in the multilayer soil hydrology of the ORCHIDEE land surface model, which is part of the French coupled climate model IPSL-CM. This new scheme is designed to represent the essential hydrological and thermal effects of soil freezing, and, indirectly, their effects on the soil carbon storage. We show that accounting for soil freezing significantly improves the representation of several essential variables characterizing the state of the boreal land surface. However, biases subsist in the current version of the model and several of them can be traced to deficiencies in the treatment of snow. We therefore present the results of sensitivity tests with modified snow albedo and snow conductivity parameterizations.