Geophysical Research Abstracts
Vol. 18, EGU2016-4456-2, 2016
EGU General Assembly 2016

Comparison of the Snow Simulations in Community Land Model Using Two Snow Cover Fraction Parameterizations

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Snow cover is an important component of local- and regional-scale energy and water budgets, especially in mountainous areas. This paper evaluates the snow simulations by using two snow cover fraction schemes in CLM4.5 (NY07 is the original snow-covered area parameterization used in CLM4, and SL12 is the default scheme in CLM4.5). Off-line simulations are carried out forced by the China Meteorological forcing dataset from January 1, 2001 to December 31, 2010 over the Tibetan Plateau. Simulated snow cover fraction (SCF), snow depth, and snow water equivalent (SWE) were compared against a set of observations including the Interactive Multisensor Snow and Ice Mapping System (IMS) snow cover product, the daily snow depth dataset of China, and China Meteorological Administration (CMA) in-situ snow depth and SWE observations. The comparison results indicate significant differences existing between those two SCF parameterizations simulations. Overall, the SL12 formulation shows a certain improvement compared to the NY07 scheme used in CLM4, with the percentage of correctly modeled snow/no snow being 75.8% and 81.8% when compared with the IMS snow product, respectively. Yet, this improvement varies both temporally and spatially. Both these two snow cover schemes overestimated the snow depth, in comparison with the daily snow depth dataset of China, the average biases of simulated snow depth are 7.38cm (8.77cm), 6.97cm (8.2cm) and 5.49cm (5.76cm) NY07 (and SL12) in the snow accumulation period (September through next February), snowmelt period (March through May) and snow-free period (June through August), respectively. When compared with the CMA in-situ snow depth observations, averaged biases are 3.18cm (4.38cm), 2.85cm (4.34cm) and 0.34cm (0.34cm) for NY07 (SL12), respectively. Though SL12 does worse snow depth simulation than NY07, the simulated SWE by SL12 is better than that by NY07, with average biases being 2.64mm, 6.22mm, 1.33mm for NY07, and 1.47mm, 2.63mm, 0.31mm for SL12, respectively. This study demonstrates that future improvements on snow simulation over the Tibetan Plateau are in urgent need for better representing the variability of snow in CLM. Furthermore, these findings lay a foundation for follow-up studies on the modification of snow cover parameterization in the land surface model.

Keywords: snow cover, CLM, Tibetan Plateau, simulation.