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Quantifying the uncertainty of global snow simulation using ensemble experiments of land surface model MATSIRO

Tomoko Nitta[1*], Kei Yoshimura[1], Shinjiro Kanae[2], Taikan Oki[3], Ayako Abe-Ouchi[1]

[1]Atmosphere and Ocean Research Institute, The university of Tokyo, [2]Graduate School of Information Science and Technology, Tokyo Institute of Technology, [3]Institute of Industrial Science, The University of Tokyo

Macro-scale snow simulation has been used to produce snow estimates and attribute the change of snow into hydrological variables. However, its uncertainties due to model structure, model parameters, and meteorological forcing have not been well documented. In the present study, we examined the uncertainty of global snow simulation due to the snow schemes, model parameters, and precipitation forcing, using ensemble simulation of MATSIRO land surface model. For snow scheme ensemble simulation, MATSIRO is augmented by SSNOWD subgrid snow cover parameterization, the liquid water storage, the prognostic density and the elevation mosaic schemes, and is simplified with the simplified snow albedo parameterization, no liquid water refreeze, and no partial snow cover schemes. They were forced with a global meteorological dataset, which combined the JRA25 atmospheric reanalysis data with 5 observed precipitation datasets. The simulation period is from 2001 to 2007 and the horizontal resolution is 1 degree by 1 degree. We used standard deviation of ensemble members to evaluate the uncertainty of monthly snow water equivalent for major Arctic river basins from October 2005 to June 2006. It is shown that the precipitation uncertainty is large and snow scheme and parameter uncertainty is small in the accumulation season. In ablation season, parameter uncertainty become larger, and the range of ensemble members is from half to twice of standard simulation. The uncertainty of snow scheme is also larger in the ablation season than the accumulation season. This study shows that more accurate precipitation observation may effectively reduce the uncertainty throughout the snow season, and improvements of snow schemes and appropriate evaluation of parameters may reduce the uncertainty in the melting season. We also evaluate the parameter uncertainty of 3 models with different complexity.

Keywords: snow, land surface model, uncertainty analysis