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Assessment of uncertainties in multi-parameterization ensemble simulations of snow depth

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On account of the latest community Noah land surface model with multi-parameterization (Noah-MP) schemes and that its uncertainty breadth in simulation results is difficult to be determined, this study assessed sensitivity and uncertainty in snow multi-parameterization ensemble simulation experiments using meteorological observed data from eight meteorological stations which from different snow climates. Snow depth was taken as simulation variable, a total number of 20736 Noah-MP physics ensemble simulations were conducted in each site by randomly combining different parameterization schemes of physical processes without considering the uncertainties of forcing data and model parameters. First, the sensitivity of snow depth to physical processes was analyzed in each site. Then, the uncertainty breadth of sensitive physical processes were further compared based on the results of sensitivity analysis. In order to integrate the advantage of each combination scheme, Bayesian model average (BMA) was used to generate more reliable simulations in each site. The results of sensitivity analyses show that physical processes first-layer snow or soil temperature time scheme, lower boundary condition of soil temperature and partitioning precipitation into rainfall and snowfall show sensitivity in all sites, surface exchange coefficient for heat and snow surface albedo show sensitivity in most sites, dynamic vegetation and canopy stomatal resistance show sensitivity in part of sites. After removing the parameterization schemes that are notably reducing simulation performance in sensitive physical processes, the uncertainty breadth in ensemble simulations decreased significantly. BMA is an effective tool for accounting for the diverse capabilities of different combination schemes and generates a more credible range of snow depth change based on multi-parameterization ensemble simulations and training data.