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Improved representation of surface-groundwater interactions in land surface models

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Surface-groundwater interactions are important and determine the evolution of hydrologic variables such as soil moisture, evapotranspiration and surface runoff. Despite its importance, groundwater is not explicitly represented in many land surface schemes, used in climate models. In this study, the Canadian Land Surface Scheme (CLASS), which is used in the Canadian regional and global climate models, is modified to include groundwater dynamics. The impact of these modifications on the regional hydrology is assessed by comparing three simulations, performed with the original and modified versions of CLASS, driven by atmospheric forcing data from the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis (ERA-Interim), for the 1980–2011 period, over a northeast Canadian domain. The modified and original versions of CLASS differ in the underlying boundary condition for soil layer hydrology, with one version being based on gravitational drainage from an original version of CLASS and the other one is newly proposed unconfined groundwater at the depth of bedrock layer. Results suggest statistically significant increases in soil moisture, during the spring and summer seasons, for the simulation with the new groundwater scheme, compared to the original version of CLASS, which is also reflected in the increased summer surface runoff and streamflows in this simulation with modified CLASS, over most of the study domain. The streamflows in this simulation is in better agreement to those observed. This study thus demonstrates the importance of groundwater scheme in land surface models for realistic simulation of hydrological processes.