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Advances in the representation of permafrost and permafrost hydrology in an ESM

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Global climate models project that the northern high latitudes will get warmer and wetter, changes which has the potential to induce numerous changes to the Arctic environment. Principally, a warmer and wetter climate may lead to large-scale thawing of permafrost which could initiate a diverse array of changes to Arctic vegetation, hydrology, and carbon cycling (e.g. expanding shrub cover, changes in lake and wetland distributions, and the potential release to the atmosphere of significant quantities of soil carbon as either CO2 or CH4). The magnitude of these potential terrestrial Arctic feedbacks remains difficult to quantify and the extent to which they might interact with each other is even less well-understood. Recent improvements (e.g. Lawrence et al.,2008; Lawrence and Slater, 2008) to the Community Land Model (CLM4) enhanced this model's capability to represent permafrost and changes in permafrost in the Community Climate System Model (CCSM4). We will present results from recently completed fully coupled 1850 to 2100 CCSM4 simulations (CLM4 is the land model of CCSM4) and will compare these results to prior coupled model simulations (with CCSM3). The impact of climate biases will be assessed. In addition, we will briefly describe ongoing efforts to improve the representation of cold region soil carbon dynamics and to introduce a prognostic wetland scheme into CLM. These efforts will form the basis for additional simulations in which the role of permafrost degradation and associated changes in Arctic hydrology (due to precipitation increases or landscape modification due to thermokarst activity) on the biogeochemical response (e.g. CO2 or CH4 emissions) to Arctic climate change will be assessed.