Simulation of Cold Processes in the CMIP6 Land-Historical Simulations

LAWRENCE MUDRYK[1], ELEANOR BURKE[2], GERHARD KRINNER[3], NATE COLLIER[4], CHRIS DERKSEN[1], AND DAVID LAWRENCE[5]

ABSTRACT

Model evaluation is a necessary component of climate research. While the snow and soil components of land-surface models have been previously evaluated using standalone simulations (Dirmeyer *et al*., 1999; Slater *et al*., 2001; Dirmeyer, 2011), the Land Surface, Snow and Soil moisture Model Intercomparison Project (LS3MIP; van den Hurk *et al*., 2016) is the first CMIP framework that coordinates both components and integrates them into the larger suite of CMIP experiments. Here we analyze output from the 'land-hist' global land surface simulations, forced by historically observed meteorological conditions, and compare them to the fully coupled and AMIP historical CMIP6 simulations.

We focus on high-latitude processes and variables, in particular snow and permafrost. For both snow and permafrost there is better representation of trends and historical variability in the 'land-hist' simulations. NH snow mass and snow extent variability and trends correlate better with observations in the historically forced simulations. Likewise, these simulations better represent historical permafrost loss rates for nearly all analyzed models.

However, there remain residual structural and parametrization errors in both variables. While for alpine snow mass, the 'land-hist' ensemble mean shows better agreement with observations and smaller errors for individual models (reduced spread about the observations) this is not the case for non-alpine snow, which has larger systematic errors relative to the observations. We analyze these differences in terms of the balance of accumulation and ablation across both regions. Similarly for permafrost, errors in the functional relationships that control permafrost extent and soil temperature are large and result in limited to no improvement in climatological permafrost extent in the historically forced simulations. These results suggest that the added value of standalone land model simulations in the suite of CMIP6 experiments may depend on both the variable and region of interest.

[1] Environment and Climate Change Canada, Toronto, ON, Canada
[2] Met Office Hadley Centre, Exeter, UK
[3] Institut des Géosciences de l'Environnement, Université Grenoble Alpes, Grenoble, France
[4] Oak Ridge National Laboratory, Oak Ridge, TN, USA
[5] National Center for Atmospheric Research, Boulder, CO, USA