Poster #1-15

Evaluating Soil Thermal Hydrology Models Against Field Observations in Arctic Polygonal Tundra

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Numerical simulations are essential tools for understanding the complex hydrological response of the Arctic regions to a warming climate. However, strong coupling among thermal and hydrologic processes on the surface and in the subsurface and the significant role that subtle variations in surface topography have in regulating flow direction and storage within a polygon lead to significant uncertainties. Careful model evaluation against field observation is thus important to build confidence. Here, we evaluate the Advanced Terrestrial Simulator (ATS) (Coon et al. 2016; Painter et al. 2016) against field observations in polygonal tundra at the Barrow Environmental Observatory. ATS represents important physical process such as lateral surface and subsurface flows, advective heat transport, cryosuction, and coupled surface energy balance. We conducted two- and three-dimensional simulations on generic surface microtopography considering radial symmetry of ice-wedge polygons. We drove the simulations with meteorological data and observed water table elevations in polygon troughs, and compared simulated water table elevations in the polygon centers to observed values. The simulations were found to be sensitive to parameters in the bare-soil evaporation model, the soil horizontal hydrologic conductivity, and trough-to-rim elevation difference. With modest amount of calibration of the soil properties and evaporation model parameters, the simulations were found to be consistent with observed water tables, active layer thickness, and observed soil temperatures at several depths in trough, rim, and center. This study demonstrates the improved representation of important process such as soil moisture, evaporation and thawing, and identifies a set of parameters for watershed-scale models.

Painter SL, ET Coon, A Atchley, M Berndt, R Garimella, JD Moulton, D Svyatskiy, and CJ Wilson. (2016). Integrated surface/subsurface permafrost thermal hydrology: Model formulation and proof-of-concept simulations. Water Resources Research 52: 6062-6077.

Coon ET, JD Moulton, and SL Painter. (2016). Managing complexity in simulations of land surface and near-surface processes. Environmental Modelling & Software 78: 134-149.