Poster #2

Wetter or Drier? Large Uncertainty in Permafrost Hydrology Projections

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With the historic and predicted deepening of the permafrost active layer, there is a large uncertainty in future projections of hydrological conditions across the Arctic. Since the soil hydrologic state exerts a strong influence on the rate and pathway of soil organic matter decomposition into CO_2 or CH_4, there is a strong need to examine and better understand model projections of hydrologic change and how differences in process representation affect projections of wetting and/or drying of permafrost landscapes. This study aims to advance understanding of where, when and why arctic will become wetter or drier. In particular, we compared simulations of 8 permafrost "enabled" land models ran from 1960 to 2299 period and assessed differences in simulated soil moisture (0-20cm layer) and hydrology variables (runoff and evapotranspiration) across the permafrost region. There is a qualitative agreement between most models but projections vary dramatically in magnitude. Climate models project intensification of precipitation across the Arctic domain while land models indicate that runoff and ET will both increase. In general, the water input to the soil (P-E) also increases, but models project a contradictory general long-term drying of the top soil under a high emissions climate scenario. Simulated drying can generally be explained by increases in active layer thickness and permafrost loss resulting in the transport of near-surface moisture to deeper layers and, where permafrost in a grid cell thaws completely, increased subsurface drainage. Variability among simulations is largely attributed to parameterization and structural uncertainty between participating models, particularly the diverse representations of evapotranspiration, water table and soil water storage and transmission. A limited set of results from single forcing experiments suggest that the warming effect in the sensitivity analysis was the principal driver of soil drying while CO_2 and precipitation effects had a small wetting influence. This analysis serves as a baseline to identify key process representation gaps and opportunities to improve representation of permafrost hydrology and associated projections of carbon and energy feedbacks in land models.