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Global warming and permafrost: Closing the gap between climate model simulations and local permafrost dynamics

M. Stendel (1), J.H. Christensen (1) and V.E. Romanovsky (2)

(1) Danish Climate Centre / Danish Meteorological Institute, Copenhagen, Denmark, (2) Geophysical Institute, University of Fairbanks, Alaska, USA (mas@dmi.dk, +45 3915 7460)

The zonation of present-day permafrost can be estimated from model-simulated deep soil temperatures by accounting for heat conduction in the frozen soil using output from state-of-the-art coupled atmosphere-ocean GCMs. However, different soil properties, ice contents etc. cannot be resolved. On the other hand, descriptions of the fine heterogeneous soil structure exist only for limited areas in the Arctic. By means of semi-empirical procedures for the local scale, a more realistic depiction of permafrost zones and active layer thickness results, while we at the same time can avoid problems inevitably associated with the explicit treatment of soil freezing and thawing processes. However, the coarse resolution of typical climate models presently hampers a realistic description of soil characteristics within a model grid box since both soil and topography are far from homogeneous at these scales. This limits the practical application of the technique to idealised cases.

The gap between typical comprehensive climate modelling on the one hand and local permafrost models on the other can be narrowed by introducing a high resolution regional climate model to downscale surface climate characteristics to a scale comparable to that of the permafrost model. We present results that document the potential in our approach and discuss estimates of active layer depth changes which can be expected as an outcome of global warming.