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Towards the estimation of the surface energy balance in the Arctic using a remote sensing thermal-based model

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The Arctic has become generally a warmer place over the past decades leading to earlier snow melt, permafrost degradation and changing plant communities. Increases in precipitation and local evaporation in the Arctic, known as the acceleration components of the hydrologic cycle, coupled with land cover changes, have resulted in significant changes in the regional surface energy budget. Quantifying spatiotemporal trends in surface energy flux partitioning is a key to forecasting ecological responses to changing climate conditions in the Arctic. An extensive local evaluation of the two-source energy balance model (TSEB) - a remote sensing-based model using thermal infrared retrievals of land-surface temperature - was performed using tower measurements collected over different tundra types in Alaska in all sky conditions over the full growing season from 2008 to 2012 and it is currently being applied to 4 flux towers in Greenland. Based on comparisons with flux tower observations, refinements in the original TSEB net radiation, soil heat flux and canopy transpiration parameterizations were identified for Arctic tundra. In particular, a revised method for estimating soil heat flux based on relationships with soil temperature was developed, resulting in significantly improved performance. These refinements result in mean turbulent flux errors generally less than 50 W/m2 at half-hourly timesteps, similar to errors typically reported in surface energy balance modelling studies conducted in more temperate climatic regimes. Model refinements found in this work at the local scale build toward a regional implementation of the TSEB model over Arctic tundra ecosystems, using multiplatform (MODIS, AVHRR, Landsat, etc) and multitemporal thermal satellite remote sensing to assess response of surface fluxes to changing vegetation and climate conditions.