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Arctic terrestrial model intercomparison and its site-specific difference - physical process and biogeochemical cycle.

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GRENE-TEA Model Intercomparison Project (GTMIP) is one of the modeling group's activities in the terrestrial research project of the GRENE Arctic Climate Change Research Project (GRENE-TEA). One of the challenges for Arctic model development is scarcity of site observation data available for validation of the models. GTMIP stage 1, site simulations at GRENE-TEA observation sites using the common driving data which was elaborately combining reanalysis and site observation data, assesses the inter-model variations and the site-specific differences, investigates their attributions to the implemented processes and their complexity of the models, and propose possible improvement of physical and biogeochemical processes for modeling of the Arctic terrestrial (excl. glaciers and ice sheets).

So far, 16 terrestrial process models participate in GTMIP stage 1: a permafrost model (FROST), physical snow models (SMAP and SNOWPACK), land surface models (2LM, HAL, JULES, MATSIRO with several versions, and SPAC-Multilayer), physical and biogeochemical soil dynamics model (PB-SDM), terrestrial biogeochemical models (BEAMS, Biome-BGC, STEM1 and VISIT), dynamic global vegetation models (LPJ and SEIB-DGVM coupled with a land surface model (Noah-LSM) or standalone), and a coupled hydrological and biogeochemical model (CHANGE). Driving and validation data were produced for the four GRENE-TEA observation sites; Fairbanks (USA), Kevo (Finland), Tiksi (Russia) and Yakutsk (Russia), which have different characteristics in snow accumulation, permafrost condition, vegetation and continentality. The 30plus-year forcing data is primarily prepared from reanalysis data to compensate missing values and limitation in the coverage period of the observation data. First, we made 30 minutes-interval forcing dataset (level 0.2) based on ERA-Interim. Air temperature and precipitation are corrected with CRU and GPCP respectively. Then, the site specific data (level 1.0) was created by fitting the level 0.2 data to the observation data at a site to inherit the characteristics of the site with enough temporal coverage for driving models. Target period was set from 1980 to 2013 (34 years). Model outputs are compared and evaluated in terms of the metrics in the five categories: energy budget, snowpack (annual maximum snow depth, snowpack duration etc.), phenology, subsurface thermal and hydrological condition (ground temperature profile, active layer/seasonal freezing thickness etc.) and carbon budget.

Physical models reproduced mean annual latent heat flux better, especially at Fairbanks and Yakutsk, than biogeochemical models that tend to show larger values than the observed, and great inter-model variability at Kevo. While dedicated snow models are good at reproducing maximum snow depth except for Tiksi, those models with invariant snow density show relatively lower value than the observation. At Tiksi, a tundra site on an Arctic coast, all the models overestimate snow depth. Annual gross primary production is reproduced well at Yakutsk. However at Fairbanks, the inter-model variation is large. Annual net ecosystem production (NEP) does not have such large inter-model variation at all sites examined. However, at Fairbanks, model outputs relatively overestimate to the observation value. On the contrary, NEP is underestimated at Yakutsk. Causes and attributions of the variability in reproducibility of the models will be discussed further.

Keywords: Circum-Arctic region, Terrestrial process model