環北極陸域の現状と変化将来予測に向けて

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Current status of pan-Arctic terrestrial ecosystem and its possible changes

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Arctic and sub-arctic terrestrial ecosystems are currently experiencing significant changes. Terrestrial ecosystem of pan-Arctic shows a considerable different feature such as vegetation from region to region. It shows not only latitudinal but also longitudinal variations, and distribution of permafrost is one of the most important factors. Warming is not equal for whole arctic region, and response of ecosystem is also different from region to region. We therefore conducted observations at various and typical ecosystems in pan-Arctic under GRENE-TEA project to know current status of each ecosystem and to better understand the systems for possible future changes. Collaborations among various kinds of models and between models and observations are also important components of GRENE-TEA project. Observations were conducted in Svalbard for polar desert ecosystem, Fenoscandia, central Siberia, Alaska, and Canada for forest census, taiga, tundra, and taiga-tundra boundary ecosystems in eastern Siberia, Alaskan lakes for methane emissions, and Canada, Alaska, and Siberia to establish permafrost observation network. Spasskaya Pad Experimental Forest near Yakutsk, which is one of the supersites in taiga, and Poker Flat near Fairbanks are also in our observation sites. Kodac site near Chokurdakh in Russian Arctic in eastern Siberia was established to be a supersite.

From many observation sites of GRENE-TEA, reductions of tree growth, forest biomass, or net ecosystem exchange accompanied with warming have been reported with various environmental changes such as vegetation, formation of thermokarst lakes, or flooding from the observations. Our results show that warming does not always enhance net primary production.

Tree-ring analysis is one of the possible ways to investigate with the same protocol relatively easily over the pan-Arctic. Tree-ring analysis for boreal forest ecosystems in sub-arctic regions show that warming causes reduction of tree growths in continental dry regions such as eastern Siberia (Tei et al., 2014) and inner Alaska (Barber et al., 2000) due to temperature-induced drought, suggesting further reduction of tree growth by future warming. However, the negative effect of warming on tree growth is not well reproduced in DGVM (SEIB-DGCM, Sato et al., 2007), in which simulated net annual primary production of trees also increases without any negative effect of warming, if the amount of precipitation increases. Obviously improvement of models is required for future projection.

Inter-comparison of various kinds of models is challenged by GRENE-TEA model group. Activities of GRENE-TEA model intercomparison project (GTMIP) were collaborations of various kinds of models with different scale and discipline and also collaborations between modelers and field scientists (Miyazaki et al., accepted).

New findings on Arctic terrestrial ecosystem from observations and modeling works in GRENE-TEA projects contribute to the future improvements of models and providing forcing and evaluation data for future projection.

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