Comparative long-term forest ecosystem study in circumpolar region.

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Our forest ecosystem research was conducted in the circumpolar region, including Eastern and Central Siberia, Interior Alaska, Northwest Territories, Canada, and Finland-Estonia region. The research area includes four types of permafrost conditions, i.e. continuous, discontinuous, sporadic permafrost, and permafrost-free soils. The dominant conifers among surveyed sites are region-specific. Evergreen conifers are dominant species, except in Eastern and Central Siberia. The deciduous conifer larch (genus *Larix*), is the only dominant in areas with continuous permafrost.

The permafrost larch forest ecosystem shows unique features in terms of forest biomass allocation and root system development (Osawa et al. 2010). Our long-term forest census and stand reconstruction results using tree ring analysis among several sites show specific growth patterns among sites. A root biomass and fine root dynamics study was also conducted in Siberia, Interior Alaska, NWT Canada, and Finland-Estonia sites. The ratio between above-ground and below-ground forest stand biomass was nearly 1 to 1 in the continuous permafrost region of Siberia (Matsuura et al. 2005, Kajimoto et al. 2006).

The moss-lichen complex organic layer that develops on the sparse coniferous forest floor plays a significant role in determining the depth of permafrost thaw (20 to 890 cm) during the growing season and patterns of biomass accumulation (Noguchi et al. 2012). Upland black spruce stands that develop on north-facing slopes with discontinuous permafrost following forest fires exhibit a critical relationship between permafrost thaw depth and biomass accumulation. In regenerated black spruce stands of the same age cohort, greater depth of thaw during the growing season results in greater biomass accumulation. Similar positive patterns of permafrost thaw depth and biomass accumulation were observed in Siberia and Interior Alaska (Matsurua unpublished data).

The relationship between biomass accumulation and the environmental conditions that regulate belowground process may be one of the key ecological factors impacted under changing climate conditions in the future. Our research covers greenhouse gas (GHG) fluxes in permafrost forest soils (Morishita et al.2014). Soil organic carbon (SOC) storage regime varies among circumpolar forest ecosystems. The nature and origin of the soil parent materials greatly affects soil carbon storage. Although most of the circumpolar region was glaciated during the Pleistocene era, eastern and central Siberia, and central Interior Alaska were not glaciated. Such differences in geological history lead to a variety of SOC accumulation regimes in circumpolar forest soils. Soils in regions that were not glaciated during the Pleistocene, such as soils of the continuous permafrost region in Siberia, have much greater SOC accumulation, while soils that developed following glacier retreat have less

SOC (see Figure). Another factor which affects the SOC regime and soil characteristics is the process of soil genesis in cold climate regions. There is a large difference in the carbon-to-nitrogen (C/N) ratio values between soils originating from fluvial parent material and soils that developed from the in situ weathering of rock fragments (see Figure, Matsurua unpublished data).

Our field survey results demonstrate that circumpolar forest ecosystems are not uniform. Each region has a unique geological history and process of ecosystem development. We propose an international research platform to enhance long-term and comparative research under a changing climate.

References

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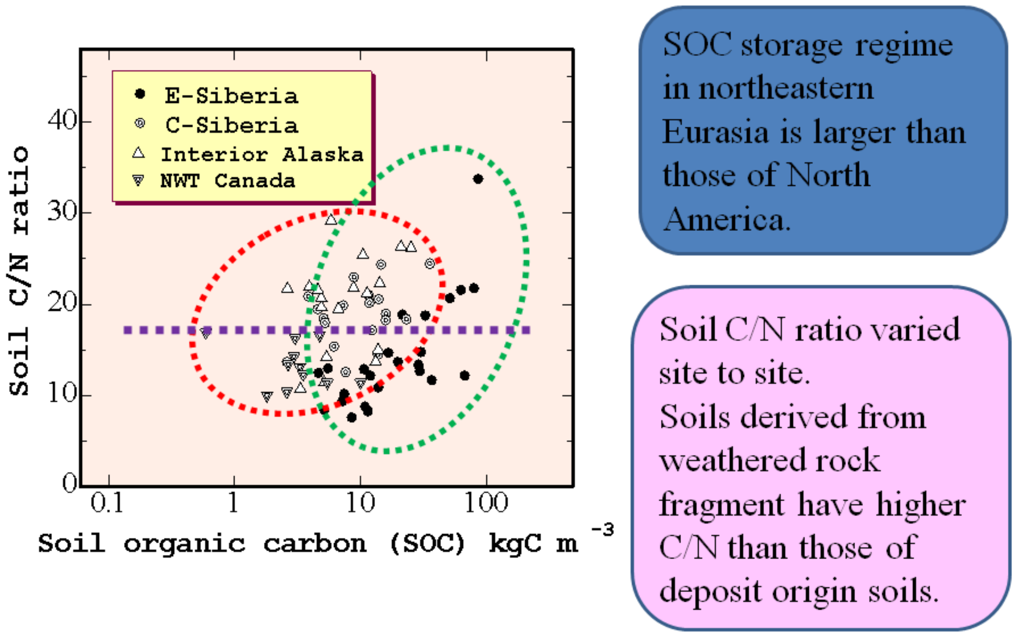

1) SOC storage regime in NE Eurasia was larger at one order of magnitude than that in North America. (Mann-Whitney U test, p=0.0000)
2) Soil C/N ratios in eastern Siberia were lower than those in central Siberia. (Mann-Whitney U test, p=0.0021)
3) Soil C/N ratios in NWT Canada were lower than those in Interior Alaska. (Mann-Whitney U test, p=0.0164)