New Project for IPY:Response of High Arctic tundra ecosystem to climate change

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Current climate change predictions indicate that warming will be more pronounced at high latitudes in the Northern Hemisphere. On a High Arctic glacier foreland, Nakatsubo et al. (2005) reported that the soil organic layer is very thin even in the later stages of succession. If this thin organic layer decreases as a result of climate change, it would profoundly affect the structure and function of whole ecosystems. Thus, understanding the ecosystem carbon cycle is needed to predict future ecosystem response to climate change on the High Arctic glacier foreland.

Recent decades, glaciers throughout much of the Northern Hemisphere have lost mass. Since glacial retreat provides new habitat for plant colonization and hence organic carbon accumulation, to predict future ecosystem response to climate change on the High Arctic glacier foreland, it is also important to consider future glacial retreated area as well as present one.

In this report, we introduce a new project for IPY 2007-2008. This project aims 1) to estimate changes of glacial retreat and vegetation distribution for past 30 years using remote sensing data and 2) to construct a compartment model to evaluate structure and function of various vegetation types. At the same time, we will investigate the relationship between carbon cycle and ecosystem development. Finally, we will predict changes in the distribution and function of the ecosystem on the future glacier foreland.

The study site is located on the glacier retreated area in Ny-Alesund, Svalbard, Norway. Plant succession was observed on the glacier foreland. Vegetation cover was less than 10% from tip of the glacier to about 1 km distance. More than 1 km apart from tip of the glacier, vegetation cover increased rapidly and surpassed 40%.

The project consists of three scientific articles, plot-based study, remote sensing observation and model analysis.

Prot-based study is conducted to clarify plant species composition, biomass, photosynthesis and respiration characteristics, biochemical composition of leaves, spectral profile of reflected radiance for various vegetations, soil respiration and soil carbon and nitrogen contents under various vegetations.

In a preliminary study of spectral profile of reflected radiance for various vegetations, it was revealed that the biomass distribution in this region can be evaluated by remote sensing. On the other hand, we also found the relationship between vegetation cover and soil carbon content.

To know the scale of expanding area of deglaciated terrain, satellite data and aerial photos are used to observe position of glacial tip for the past 30 years. The results of plot-based studies such as plant species composition and biomass, and the data of spectral profile of reflected radiance are used to obtain a suitable algorithm to identify vegetation type and plant biomass on the deglaciated area. Distribution changes of the vegetation for the past 30 years on the deglaciated area are estimate using remote sensing data and the algorithm. In addition, we will make a microtopographical, radiation and soil water content map to investigate the relationships between vegetation and environmental factors on the glacier foreland.

A Compartment model of the carbon cycle is constructed to analyze various ecosystem characteristics. Relationships between microtopograph, microclimate and vegetation structure and function are investigated using remote sensing data and the compartment model. Then, we will reconstruct the history of ecosystem carbon dynamics for the past 30 years on the glacial retreated area to evaluate ecosystem response on the environmental factors. After that, future ecosystem responses to climate change on the glacier foreland will be predicted.