B-9.2 Global warming effects on the alpine and subalpine vegetation of Japan

Contact Person Hirosi TAODA
Forest Environment Division, Forestry and Forest Products Research Institute,
Forestry Agency.
PO. Box 16, Tsukuba Norin, Ibaraki, Japan 305
Phone (081)0298-73-3211 (ext.355), Fax 0298-74-3720
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Abstract

We investigated the relationship between environmental conditions and plant communities to evaluate the global warming effects on alpine and subalpine vegetation in Japan. Our studies are as follows: effects of earlier snow release on both snow patch vegetation and soil structure; melting processes of snow patch and the phenology of the alpine vegetation; the estimation of climatic conditions in past ages using the analysis of soil structure; estimation of drying procedure of high moor ; Regeneration processes of subalpine conifer forest; effects of external factors on canopy structure and dynamics of dwarf pine scrub; shifting of the distribution pattern of forest zone; the analysis of tree growth by means of annual ring.

Key Words *Pimus pumila* scrub, *Abies veitchii* forest, warming index, podozol, snow patch, phenology, annual ring

1. Introduction

The most simple and distinct effect of global warming on plants is the shift of vegetation zones toward higher latitude and altitude. The effects on the ecosystems of alpine and subalpine zones may be the most conspicuous since the areas of high altitude into which the plants can immigrate are usually very limited.

2. Research objective and method

The objective of our studies is to predict the effect of the global climate change on local ecosystems through the investigation of habitat conditions of representative plant communities. We study the relationship between the alpine and subalpine plant communities, forests, scrubs, alpine meadows, and the climatic (snow, wind, rainfall, mist, temperature, etc.) or edaphic (topography, geology, soil, etc.) conditions.

3. Result & Discussion

(1) Change of snow patch and phenology

We studied the melting process of snow patches in two viewpoints. One is to estimate the past climatic change and the other is the phenological effect on the surrounding vegetation. We can find peat layer where the snow patch disappeared before August and plants grow enough to deposit litter. In the snow patch grasslands in Oou Mountains, peat soils indicate earlier snow release and warmer condition, than mineral soils. At Mt.Kodake and Mt.Zarumori, the surface peat layers occurred since ca.1,000 BP., so called "the little optimum" warm period. Pollen analysis and carbon contain rates of soils show the same result. There were few arboreal plants even in the warmest period called Climatic optimum. Some deciduous broadleaf tree species began to distribute, and carbons contain in soil rose after the period.

The phenological model of the alpine vegetation is establishing, which describes the microclimatic environment around the vegetation affected by the conditions of snow patch. The depth of snow patch and its melting processes will be fluctuate along the climate change. We compared the soil temperature in different three depths (2,5,7cm) crossing the snow patch with the surface runoff waters. Energy budgets at the snow surface and vegetation cover are

calculated. The estimation of melting process of snow patch confirmed with the actual observations.

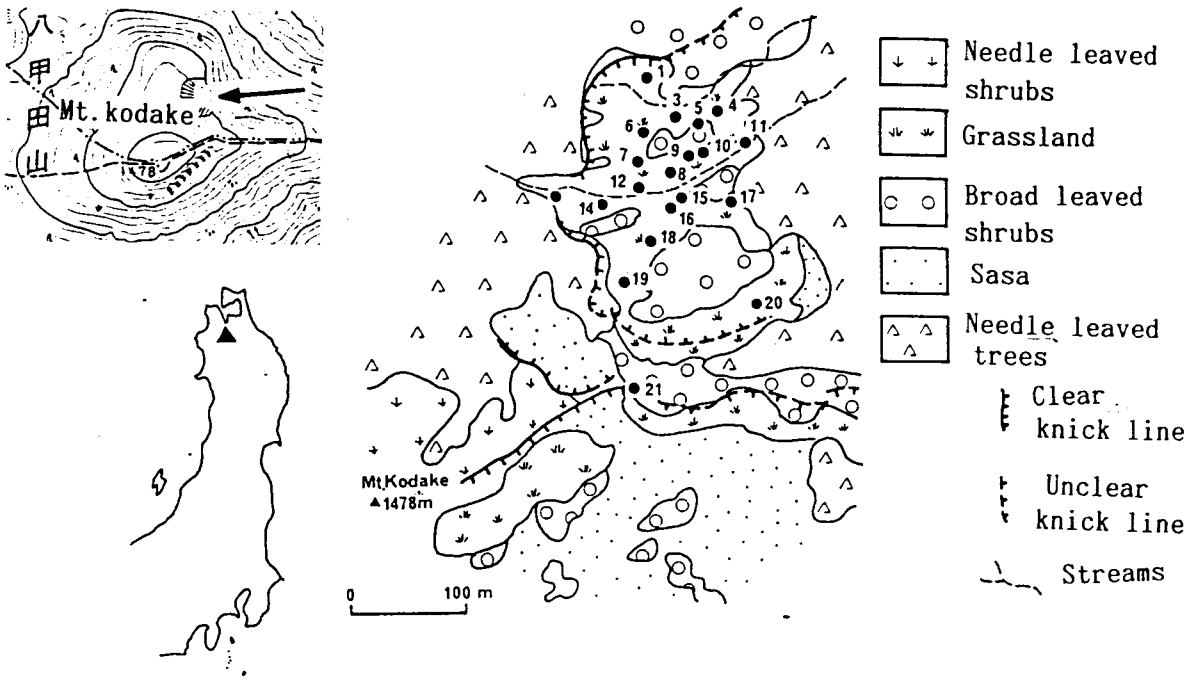

Fig. 1 Vegetation and landform of Mt. Kodake snow patch

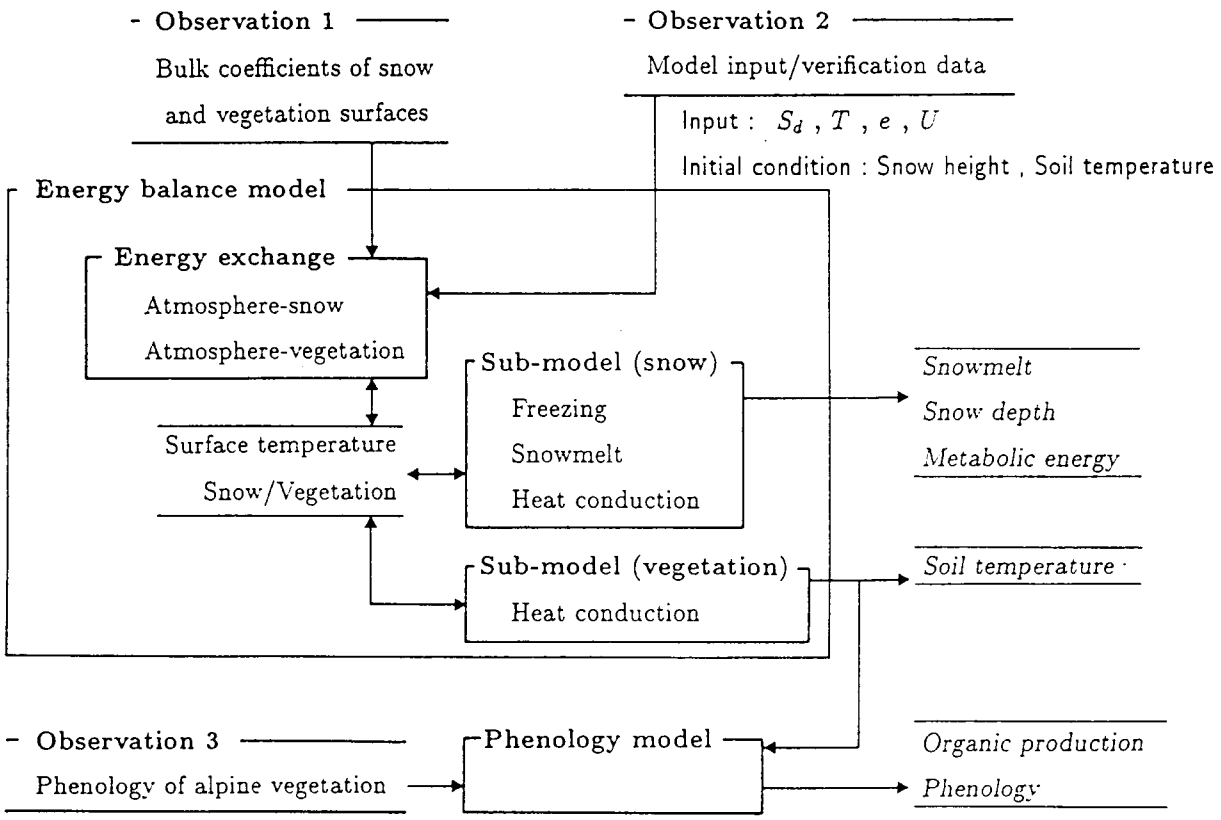

Fig. 2 Study flow on the change of snow patch and phenology

(2) Regeneration and growth of subalpine conifer forest

We analyze the regeneration processes of *Tsuga diversifolia* forest, in Chichibu mountains, after man-made disturbance of twenty years ago (strip harvesting). The initial harvested strips were occupied by *Betula ermanii* (6 to 8m high) and Tsuga diversifolia grew sparsely under the Betula but Abies species were poor. Evergreen conifers, *Abies veitchii* and *A. mariesii*, are abundant in the seed tree strips, where remained trees were released 12 years after the initial cutting. Their height ranged from 6m to 9m. The differences of regenerated tree species were affected to the disturbance of forest floor. The global warming may accelerate the change of seedling environment drastically and make unfavorable conditions for conifer species.

To clarify the ecological changes of *Tsuga diversifolia* forests according to the global warming effects on the characteristics of Podzolic soils. We set seven monitoring plots between 1120m and 2725m in Akaishi mountains. Each plot consists of different dominant tree such as *Quercus*, *Larix*, *Tsuga*, *Abies* and *Pinus*. We set litter bags that contain the leaves and twigs of *Tsuga diversifolia* at all plots and try to compare the decomposition rate depending on climatic and biological conditions. Air temperate near the ground kept nearly 0 during winter in the high elevation plots and risen rapidly after melting the snow. Though, we could not clarify the relationship between the litter decomposition rate and annual microclimate at each plots. There is exact linear regression between the altitude and the decomposition rate. We will discuss the effects of air and soil temperature and soil water condition on litter decomposition and characteristics of Podzolic soils.

A population dynamics of *Pinus pumila* with the global warming was assessed by analyzing the interaction between canopy strunture, productivity and external conditions for the pine scrub at Mt. Kimpu in Chichibu mountains. Leaf area index and biomass increment rates of the pine stands became larger on the south-facing slope than those on the northern slope. The differences in growth potential related to the site deference in soil-temperature rather than those in air-temperature and irradiation. This suggests that the increase in temperature, especially in soil-temperature, enhance growth and development of *P. pumila* scrub on the alpine zone, which acts against invasion of the other subalpine conifers.

Table 1. Leaf area index, annual increment rates of aboveground biomass and external conditions in the Pinus pumila scrub at Mt. Kinpu, middle Japan

	North slope	South slope
Leaf area index (m^2 m^{-2})	2.2 - 2.8	2.6 - 3.5
Biomass increment (ton $ha^{-1}y^{-1}$)	0.44 - 0.49	0.61 - 0.74
*Air temperature (C)	12.6	12.8
*Soil temperature (C)	10.6	12.8
*PFD (mol $m^{-2}d^{-1}$)	29.5	30.4

* Daily mean values between June and September in 1992.

We collect tree ring samples of 10 species growing in the high altitude in middle Japan. Ring width and maximum density are compared with the meteorological data. Ring structures of the same species were similar to each other in a site but they were different site by site. The mean temperate and rainfall during growing season had fairly well correlation with ring width. The effect of global climate change may be masked by the local site conditions.