Press Releases

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JAMSTEC

Revealed Impact of Snow Cover on Soil Thermal Regime in Pan-Arctic Permafrost Regions

1. Overview

Dr. Hotaek Park, Senior Researcher, Research and Development Center for Global Change, Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) demonstrated that snow cover has a larger impact than air temperature on ongoing changes in soil temperature (T_{SOIL}) in the pan-Arctic permafrost regions.

The current climate warming has rapidly led to permafrost degradation and increase in soil temperature (T_{SOIL}) in the pan-Arctic area. It has been pointed out that the rate of increase in soil temperature (T_{SOIL}) is higher than that in air temperature because of the insulation effect of snow cover, though the contribution has not been known in detail. This study evaluated impacts of air temperature and snow cover given on soil temperature (T_{SOIL}) quantitatively on a large scale by using model experiments to the treated snowfalls and air temperature. As a result, it found that snow depth gives more effect on permafrost temperature by 50% or more than air temperature in permafrost regions (in particular, in eastern Siberia and Alaska).

While air temperature is considered to be a primary factor for affecting soil temperature, it indicated that some areas are more sensitive to changes in snow depth, and thus, the pan-Arctic region has a different climate characteristic by region. It gives a significant insight to elucidate yet-to-be identified climate changes in the pan-Arctic region.

Global warming is likely to affect snow cover in permafrost regions in the future. It is suggested that snow cover, in addition to effects produced by changes of air temperature, will contribute to making the change even larger. Further study is required to elucidate the mechanism.

This study result has been published on the U.S. online journal, *Climate Dynamics* on October 14.
Title: Effect of snow cover on pan-Arctic permafrost thermal regime
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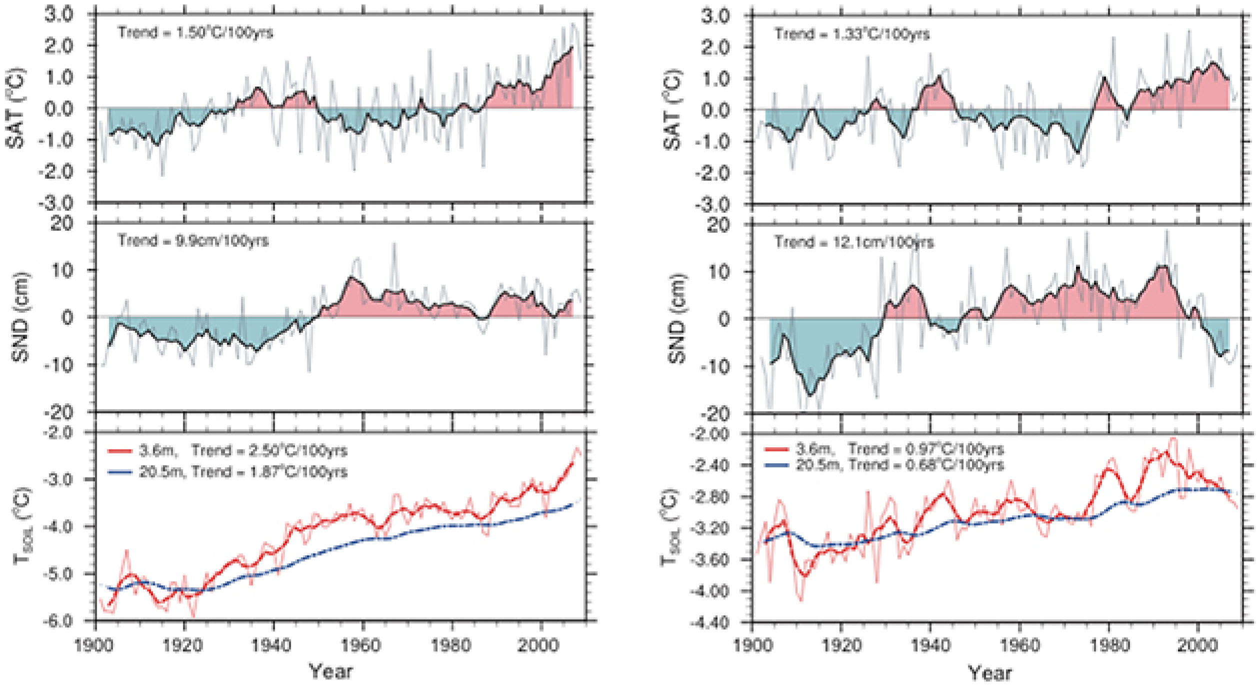

Fig 1: Time series of annual mean surface air temperature (*top*), simulated winter mean snow depth (*middle*), and simulated soil temperatures (*bottom*) at depths of 3.6 and 20.5 m in Siberia (60°N–70°N, 100°E–140°E; left) and North America (60°N–70°N, 120°W–160°W; right)

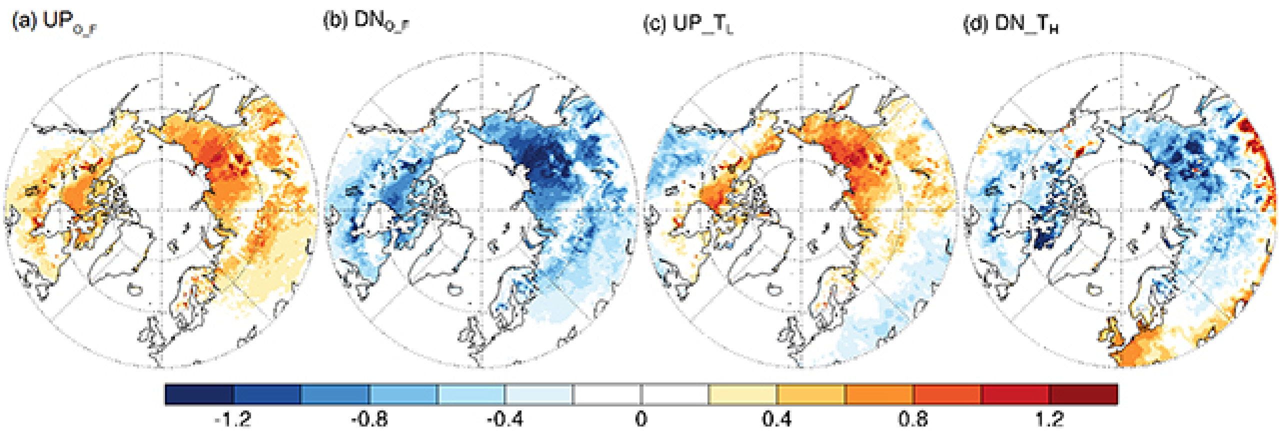

Fig. 2: Differences in the averaged soil temperature of (a) UP_{O_F}, (b) DN_{O_F}, (c) UP_T_{L}, and (d) DN_T_{H} against the control experiment (CTRL) at depths of 20.5 m. The values represent differences derived from 1981–2009. UP_{O_F}: precipitation was increased by 30 % from the amounts projected in the CTRL during October–February, DN_{O_F}: precipitation was decreased by 30 % from the amounts projected in the CTRL during October–February, UP_T_{L}: monthly air temperatures were held at 1911–1930 climatological levels with the treatment of UP_{O_F} for precipitation, DN_T_{H}: monthly air temperatures were held at 1991–2009 climatological levels with the treatment of DN_{O_F} for precipitation.

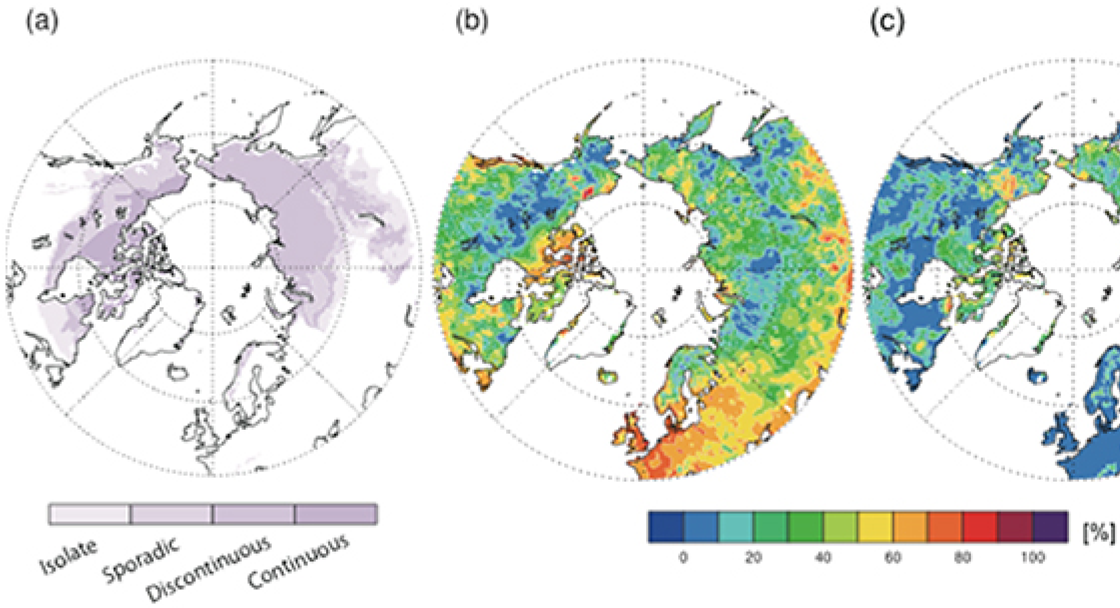

Fig. 3: (a) Permafrost distribution in the northern hemisphere.
The contribution of (b) annual mean surface temperature and (c) simulated winter snow depth to changes in soil temperature at a depth of 3.6 m during the period 1971–2009. It shows the contribution of snow cover for soil temperature is larger than that of air temperature, in particular, in eastern Siberia and Alaska.

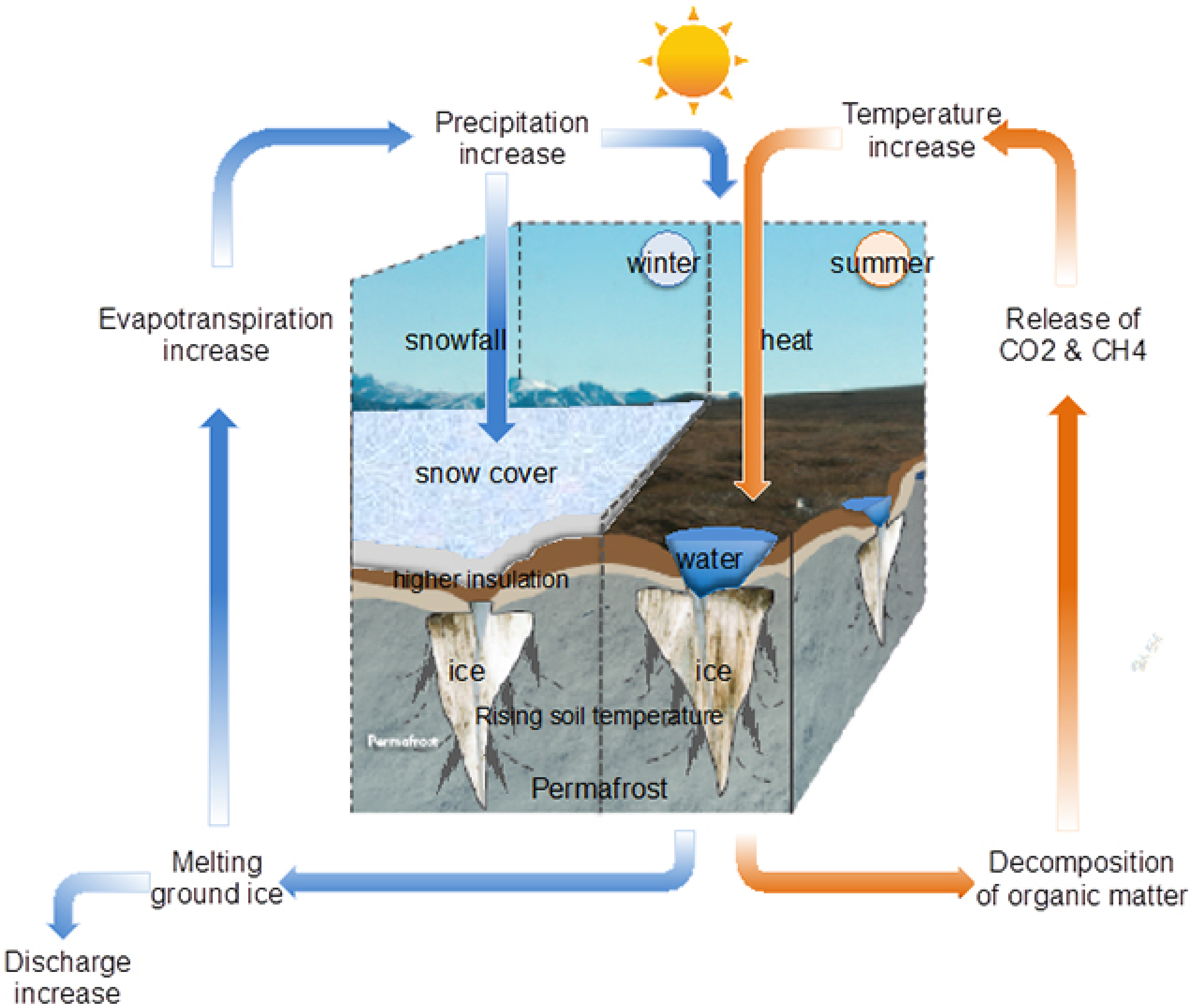

Figure 4: Diagram showing effect of soil temperature change due to snow cover on the Arctic climate system

Table 1. Summary of the model experiments discussed in this study

	Air temperature	Precipitation
CTRL	–	–
UP_{O_D}	–	30 % added to precipitation from October to December
UP_{D_F}	–	30 % added to precipitation from December to February
UP_{O_F}	–	30 % subtracted from precipitation from October to February
UP_T_{L}	Monthly air temperature held at 1911–1930 climatological levels	30 % subtracted from precipitation from October to February
DN_{O_D}	–	30 % subtracted from precipitation from October to December
DN_{D_F}	–	30 % added to precipitation from December to February
DN_{O_F}	–	30 % subtracted from precipitation from October to February
DN_T_{H}	Monthly air temperature held at 1991–2009 climatological levels	30 % subtracted from precipitation from October to February

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