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著者	KODAMA Yuji, ISHII Yoshiyuki, NOMURA Mutsumi, SATO Norifumi, YABUKI Hironori, OHATA Tetsuo
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Seasonal variation of heat fluxes over tundra near Tiksi, Siberia

Yuji Kodama[1], Yoshiyuki Ishii[1], Mutsumi Nomura[2], Norifumi Sato[1], Hironori Yabuki[3], and Tetsuo Ohata[1]

1 Institute of Low Temperature Science, Hokkaido University, Sapporo 060-0819 Japan, **2** Experimental Forest, Hokkaido University, Toikanbetsu, Horonobe 098-2943 Japan, **3** Frontier Observational Research System for Global Change, 7F, Seavans-N, 1-2-1 Shibaura, Minato-ku, Tokyo 105-6791 Japan

Micro-meteorological observations as a part of Asian AWS (Automatic Weather Station) Network (AAN) have been carried out in the flat plain of a tundra region near Tiksi, Eastern Siberia, in order to better understand the water cycle over tundra. Tundra area has a unique water cycle due to the existence of frozen ground, snow drfit and tundra vegetation. The frozen ground limits the subsurface infiltration. Meltwater from the snow drift is a source of stream water in an early part of summer, when precipitation is small. The low vegetation distribution, such as lichen, moss and sedge, play an important role in the evaporation over the tundra watershed, although the soil water content in turn determines the vegetation distribution. The mosses and lichens do not have stomata, and the evapo-transpiration is like that of a wet sponge. When the surface is totally wet, evaporation is substantial, but when the surface becomes dry, the evaporation becomes small and the surface temperature becomes high, even though a few centimeters below the surface is very wet and cool.

Heat balance components over tundra surface were estimated using the data from the instrumented 10 m tower as well as the measurements of soil temperature and water contents in the active layer. The net radiation was calculated using measured global radiation, reflected radiation, downward longwave radiation and upward longwave radiation. Sensible and latent heat fluxes were calculated using a bulk method, which formulae were introduced by Thom (1975). The conductive heat flux in soil was calculated from the temperature gradient between surface and the soil at the depth of 0.05 m, and a variable heat conductivity depending upon the surface soil moisture. In order to close the heat balance equation, surface temperature was estimated by an iteration method, and then the each flux was calculated. The net radiation was largest in the middle of June and gradually decreased towards September. The sensible heat flux and the latent heat flux were fluctuated in the same manner except for southwesterly winds. For the southwesterly winds, the sensible heat flux was small and sometimes the direction of the flux was towards surface, while the latent heat flux was becomes large and towards atmosphere from the surface. The conductive heat flux in soil was large right after the snow ablation, then almost constant throughout the summer. Because of the existence of the frozen layer, the diurnal variation of the conductive heat flux in soil right after the snowmelt was unique: the difference of surface temperature from the soil temperature at the depth of 0.05m was positive all day long.

The wind direction dependency of the heat fluxes was found in the seasonal variation of heat balance components. The results are: 1) the prevailing wind directions are easterly and northeasterly, 2) the easterlies are cold and damp (the air mass coming from the Arctic Ocean) and the southwesterlies (the air mass coming from the continent) are warm and dry, 3) the sensible heat flux is large for easterlies and smaller for southwesterlies, 4)the latent heat fluxes are large for northeasterlies and larger for southwesterlies. The change in frequency distribution of the wind direction could result in a different heat fluxes over tundra surfaces.