Water and energy cycles in the larch and the pine forests in the Eastern Siberia (Session 3: In-site Flux Observation studies)

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1. Introduction

Siberian Taiga is one of the vastest forests in the Globe. A little is known about the effects of Siberian Taiga on the water and energy cycles and their seasonal variation, especially in Eastern Siberia. A GAME-Siberia team started to observe the water and energy cycles in this area from 1996 with Russian scientists. The preliminary results obtained from 1998 to 2000 are presented in this report.

2. Site Description

There are two observation sites which are located from about 20 km north from Yakutsk city. One is the larch forest site and a AAN site. The mean stand height is 18 m, and the stand density is 840 trees/ha. Another is the pine forest site. The mean stand height is 6 m, and the stand density is 2600 trees/ha.

3. Results and Discussions

3.1. Inter-annual variation of energy balance above the larch forest

Figure 1 shows the seasonal variation of the sensible heat flux during the three warm period, 1998-2000. The sensible heat fluxes show maximal values at the end of May, just after snow melt seasons, in every year. The fluxes decrease, although the net all-wave radiation increases up to the end of June. It is reported that the latent heat flux increased quickly when the sensible heat flux dropped. These results suggest that the plant physiological activity strongly affect the energy balance above the canopy.

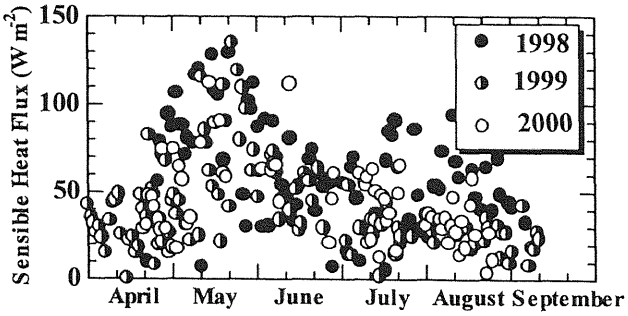

Figure 1 The seasonal variation of sensible heat flux above the larch forest, 1998-2000.

3.2. Transpiration in the larch forest

The latent heat flux above the larch forest has not calculated in 1999 and 2000, yet. But, transpiration rates were estimated in 1998 and 1999 by using the heat pulse method. Figure 2 shows the

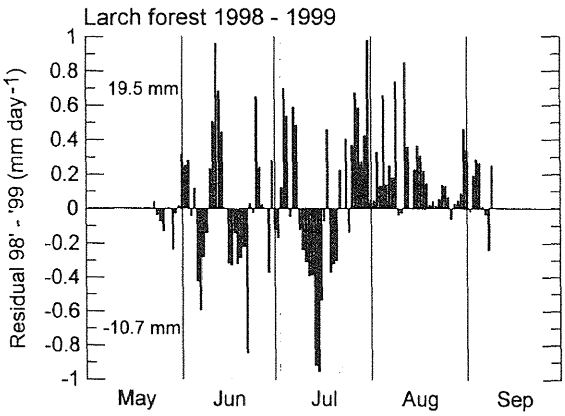

Figure 2 Differences between the 1998 daily transpiration and the 1999 daily transpiration in the larch forest.

differences of the daily transpiration rates between these two years. The amounts of precipitation from May to August were 81.5 mm and 235.7 mm in 1998 and 1999, respectively. Consequently, there was a significant difference on the soil moisture in the thawing layer between these two years as shown in Figure 3. Figure 2 indicates that the daily transpiration rates were larger in 1998 than in 1999 after the middle of June. On the other hand, it is

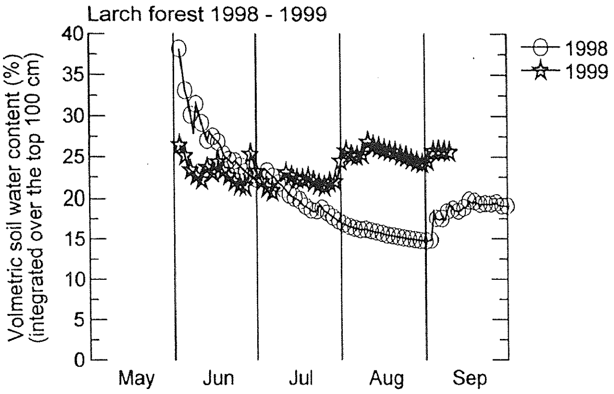

Figure 3 The seasonal variations of soil moisture in 1998 and 1999.

shown in Figure 3 that the soil layer was drier in 1998 than in 1999. Soil moisture did not control the transpiration rates in the observation range.

The stable isotope analysis reveals that the melting water of permafrost was spent for transpiration in a dry year and the rainfall water was used in a wet year. This result suggests that the thawing water of permafrost may compensate for the rainfall deficit on transpiration.

3.3. Energy and water exchange above the larch and the pine forests

The sensible heat flux increased rapidly just after a snow melt season, like as that above the larch forest, but the high flux density was kept up to the middle of August. Consequently, the percentage of the sensible heat flux above the larch forest versus that above the pine forest was 80 % just after the melting season, and the percentage decreased to 40 % at the middle of August. Figure 4 shows the relationship between the effective radiation and the sum of turbulent fluxes. The energy budget above

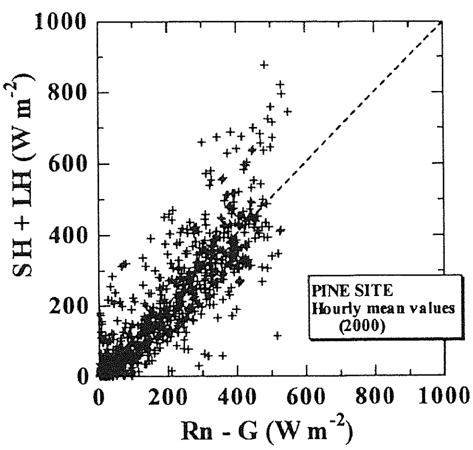

Figure 4 The relationship between the effective radiation (Rn - G) and the sum of turbulent fluxes (SH + LH)

pine canopy was almost closure, and the sum of turbulent fluxes exceeded the effective radiation sometimes. When the wind direction was north to west, the turbulent flux exceeded the effective radiation. On the hand, the latter exceeded the former under the opposite wind direction.

The parameters of Jarvis model (1976) on the canopy conductance were examined for the pine forest. The values of three parameters obtained in the pine forest were basically similar to those in the larch forest.

4. Summary

The followings are new interpretation about the water and energy cycles in the Eastern Siberia Forests

1) The plant activity affected strongly the energy balance above the larch forest.
2) Soil moisture did not control the transpiration rates during the observation period. Melting water of permafrost may compensate for the moisture deficit on the transpiration.
3) The energy balance above the pine forest was effected by the wind direction.
4) The parameters in Jarvis Model on the canopy conductance obtained for the pine forest was similar to those for the larch forest.