Does too much soil water damage Siberian larch forest? Instantaneous response and long-term tolerance of a forest to environments

Takeshi Ohta[1]; Ayumi Kotani[2]; Taro Nakai[3]; Trofim C. Maximov[4]

[1] Bioagricultural Sciences, Nagoya Univ; [2] Nagoya Univ.; [3] JST/CREST; [4] IBPC, RAS, Russia

Low evapotranspiration and photosynthesis in Siberian forests were found to result from dry atmospheric and soil conditions (Matsumoto et al., 2008). Evapotranspiration normalised by potential evapotranspiration (E/Ep) increased linearly with soil water content (SWC) in the surface soil layer (Ohta et al., 2008), and a significant increase in SWC was found in Eastern Siberia (Iijima et al., 2007). An increase in SWC usually results in increased evapotranspiration, but the opposite was true at an Eastern Siberian larch forest in 2007 and 2008.

A field campaign has been carried out since 1998 at the Spasskaya Pad Experimental Forest of the Institute for Biological Problems of the Cryolithozone (IBPC), Russian Academy of Sciences (RAS), located along the middle reaches of the Lena River. Sensible and latent heat fluxes from the understorey have also been measured since 2005.

In the period from 2002 to 2007, SWC in the 0 to 50-cm depth layer increased from 40 to 160 mm, with values higher than 120 mm in 2005, 2006 and 2007. E/Ep increased with SWC until 2006 (Ohta et al., 2008) but decreased in 2007 even though SWC was still increasing. This result implies that regulation of evapotranspiration by vegetation was more important than the variation in potential evaporation during 2007. In addition, evapotranspiration from the understorey did not change remarkably in 2005, 2006 and 2007, although evapotranspiration from the whole ecosystem dropped in 2007. This result indicates that the decrease in E/Ep for the whole ecosystem mainly resulted from a change in overstorey evapotranspiration. The root system of the overstorey vegetation must extend to a deeper soil layer compared to the root system of the understorey vegetation. These results suggest that evapotranspiration from the overstorey vegetation decreased when its root system was damaged by too much SWC over too long a period after 2005.

Increased SWC usually results in the enhancement of evapotranspiration and photosynthesis when modelling vegetation effects on interactions of the atmosphere and land surface. Extreme drought is known to reduce the carbon dioxide exchange in forests (Ciais et al., 2005), but extreme wetness also reduces forest activities, as mentioned above. However, how long and/or how severe such stresses have to be to cause major damage or death in vegetation remain unknown. We must understand not only the instantaneous responses of vegetation to environmental conditions but also the resistance of vegetation to certain environmental conditions such as coldness, hotness, drought and wetness to evaluate vegetation effects on water, energy and carbon cycles at interannual and decadal temporal scales.

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