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Isotopic composition of atmospheric water vapor and its source and transport in the taiga forest, eastern Siberia

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The boreal forest in eastern Siberia prevails on the continuous permafrost under continental arid climate. Plant transpiration process in the forest plays an important role in the water cycle in eastern Siberia. In this study, the isotopic composition of atmospheric water vapor in a time scale of a few weeks was observed in eastern Siberian taiga in the mid to late summer periods in 2006, 2007, and 2008, with the isotope ratios of precipitation, plant sap water, soil water, and the water in organic layer in order to clarify how the forest transpiration works in the water cycle. The factors controlling the isotopic variation were examined, by comparing the isotope data with meteorological parameters. During these years, soil moisture content was increase and the condition was extremely wet in 2007, because of heavy rainfall and winter snowfall.

The delta-^{18}O values of atmospheric water vapor correlated positively with atmospheric mixing ratio in 2006 and 2008 (R^2 = 0.99 and 0.88, respectively). This was elucidated by two sources of the water vapor: one has high delta-^{18}O from plant transpiration and the other has low delta-^{18}O which was affected by rain events. On the other hand, no significant correlation was observed in 2007 when soil was extremely wet. This indicated that the evaporation from wet land surface was more remarkable than the plant transpiration in 2007.

A region with 500 km x 500 km in size was set around the observational site and horizontal water vapor fluxes at each boundary of the region were calculated using reanalysis data to compare with the isotope data. No significant correlation was observed between directions and delta-^{18}O values. Back trajectory analysis (HYSPLIT4 model) was made to know the source area of water vapor. The water vapor with high delta-^{18}O value was observed in the air advected from forest area where air temperature was relatively high, whereas the water vapor with low delta-^{18}O value was observed in the air advected from the area where air temperature was low and occasionally precipitation occurred. Contribution of two sources, transpired water vapor and water vapor affected by rain events, may control the isotopic variation of atmospheric water vapor.

These results revealed the significant role of the transpired water vapor with relatively high delta values generated from taiga in the water cycle in eastern Siberia. These results are useful for further investigation of water cycle including various model works.

Keywords: stable isotope of atmospheric water vapor, eastern Siberia, taiga, plant transpiration, precipitation