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Study on vapor transfer processes into the atmosphere from vegetated surface in an arid region

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1. Introduction

One of the biggest issues in the 21st century is the water scarcity. It is estimated that almost half of the global population will not be able to access fresh water by 2030 (World Water Assessment Programme, 2009). Especially, in arid region, ensuring fresh water has been a critical issue. Mongolia is one of the countries suffering from water shortage, and is in an ecotone which is in general vulnerable to climate change. Also, they have been overgrazed due to the introduction of market economy in 1990. As a result, a little change of water cycle may affect ecosystem balances drastically in such a dried area. Therefore it is important to understand the water cycle in an arid region to ensure for sustainable water use.
Numerous studies had investigated vapor transfer processes in many regions but comprehensive analysis of evapotranspiration including soil water behavior and plant activity is limited. In this study, we aim to investigate the characteristics of vegetated surface-atmosphere water vapor transfer processes with consideration of soil water behavior and plant activity.

2. Materials and Methods

The study was conducted at Mandalgovi, Mongolia which belongs to an arid region and has mean annual precipitation of 155 mm (1993~2003). This area is dominated by Caragana microphylla (shrub) and Allium polyrrhizum (herbaceous plant). We derived water flux from these plants and bare ground by chamber method in which water vapor density was measured each second in the chamber by covering the surface. Also, stable isotopic composition (D and 18O) in different water pools (plants, soils, groundwater and precipitation) was measured to determine the origin of the water which plants utilize.

3. Results and Discussion

It was found that water flux from transpiration (TR) was larger than that from evaporation (EV) on the per unit surface area basis. TR rate of herbaceous plants was larger than that of shrubs. Estimation of the whole vapor transfer from surface to atmosphere in the study area (before herbaceous plants appear), indicated that TR to EV ratio was about 3:8 even though the green coverage was only 3.12%. The EV fluxes increased significantly after the successive rainfalls, and then gradually dropped back to the initial rate in three days while TR rate of shrub did not respond to the rainfalls. A multiple regression analysis has shown that shortly after a rainfall, EV rate was affected by soil temperature, soil water content and solar radiation while it was influenced only by solar radiation for the dry period. The TR rate from shrubs was higher in June than in July. It was because the soil water content at about 70 cm depth which is the absorption depth of shrubs was more abundant in June.

Keywords: arid region, evapotranspiration, chamber method, isotope