Patterns of surface energy exchange and evapotranspiration in relation to water availability in an oasis-desert ecotone

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Abstract

A knowledge of the exchanges of energy and water over the terrestrial surface is the first step to understand the ecohydrological mechanisms, particularly in water-limited ecosystems in the dryland environments. However, patterns of energy exchange and evapotranspiration (ET) are not well understood in the oasis-desert ecotone, which plays an important role in protecting oasis against the threat of desertification in northwestern China's arid regions. Here the continuous measurements of surface energy fluxes were made using eddy covariance in conjunction with auxiliary measurements for two years (2014-2015) at a shrubland within an oasis-desert ecotone in the arid regions, northwestern China. Statistical analysis on 30-min time scale indicates that about 50% of daytime net radiation (Rn) over the shrubland is dissipated as H on average, which peaks in spring; one third Rn is consumed by soil heat flux (G). Only 9% of Rn was consumed for latent heat flux (λE), which peaks in summer (21% in 2014 and 16% in 2015), corresponding to the season with highest rainfall among all seasons. Daily mean ET is about 1 mm·d-1 during growing season of the shrub species. The rapid and transient increase in ET occurs following a rainfall event. A switch in surface soil moisture from 0.04 to 0.11 m3*m-3 causes an increase in Rn by about 11% and λE by 151% at the shrubland, respectively. Accumulated annual ET were 195 and 181 mm in 2014 and 2015, respectively, exceeding the corresponding P by about 87 and 77 mm, indicating that groundwater may be another important source of water for ET over the shrubland aside from P. These results provide valuable insight into the mechanisms of sustaining energy and water balance at the ecotone, and then produce some management guidelines for allocating water resources and protecting vegetation.

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