Developing a soil water index-based Priestley-Taylor algorithm for estimating evapotranspiration over East Asia and Australia

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Abstract

Evapotranspiration (ET) is an important component of hydrological processes. Accurate estimates of ET variation are of vital importance for natural hazard adaptation and water resource management. This study first developed a soil water index (SWI)-based Priestley-Taylor algorithm (SWI-PT) based on the enhanced vegetation index (EVI), SWI, net radiation, and temperature. The algorithm was then compared with a modified satellite-based Priestley-Taylor ET model (MS-PT). After examining the performance of the two models at 10 flux tower sites in different land cover types over East Asia and Australia, the daily estimates from the SWI-PT model were closer to observations than those of the MS-PT model in each land cover type. The average correlation coefficient of the SWI-PT model was 0.81, compared with 0.66 in the original MS-PT model. The average value of the root mean square error decreased from 36.46 W/m^2 to 23.37 W/m^2 in the SWI-PT model, which used different variables of soil moisture and vegetation indices to capture soil evaporation and vegetative transpiration, respectively. By using the EVI and SWI, uncertainties involved in optimizing vegetation and water constraints were reduced. The estimated ET from the MS-PT model was most sensitive (to the normalized difference vegetation index (NDVI) in forests) to net radiation (R_n) in grassland and cropland. The estimated ET from the SWI-PT model was most sensitive to R_n, followed by SWI, air temperature (T_a), and the EVI in each land cover type. Overall, the results showed that the MS-PT model estimates of ET in forest and cropland were weak. By replacing the fraction of soil moisture (f_{sm}) with the SWI and the NDVI with the EVI, the newly developed SWI-PT model captured soil evaporation and vegetation transpiration more accurately than the MS-PT model.

Keywords : Evapotranspiration, Priestley-Taylor algorithm, MS-PT, SWI-PT, East Asia, Australia

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