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Role of Turbulent Heat Fluxes over Land in the Monsoon over East Asia

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ABSTRACT

Atmospheric heat and moisture over land are fundamental drivers of monsoon circulations. However, these drivers are less frequently considered in explaining the development and overall intensity of monsoons than heat and moisture over the ocean. In this study, the roles of turbulent heat fluxes over land in the monsoon system over East Asia are examined using Climatic Research Unit observations and European Centre for Medium-Range Weather Forecasts reanalysis, and they are further explored using simulated sensible (H) and latent (LE) heat fluxes from an ecosystem model (Predicting Ecosystem Goods and Services Using Scenarios or PEGASUS). Changes in the H fluxes over the land during the pre-monsoon season (March-May: MAM) affect the differential heating between land and ocean, which in turn controls monsoon development. In July, an intensified contrast of the mean sea level pressure between land and ocean is observed during the years of stronger land-sea H contrast in MAM, which results in enhanced onshore flows and more rainfall over southern East Asia. After monsoon onset, the contrast of H is influenced by monsoon rainfall through the cooling effect of precipitation on surface air temperature. During the monsoon season (June-September: JJAS), LE fluxes are more important than H fluxes, since LE fluxes over land and ocean affect overall monsoon intensity through changes in the land-sea contrast of turbulent heat fluxes. Significantly increased monsoon rainfall over western East Asia is observed during the years of larger LE over the land in JJAS. In ecosystem modeling, we find that the monsoon can be weakened as potential (natural) vegetation is converted to bare ground or irrigated cropland. Simulated H fluxes in MAM and LE fluxes in JJAS over the land significantly decrease in irrigated crop and bare ground scenarios, respectively, which play crucial roles in controlling monsoon development and overall intensity.

KEYWORDS

Heat Fluxes, Monsoons, Land Cover/Land Use Changes, Ecosystem Modeling, East Asia

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