Geophysical Research Abstracts
Vol. 17, EGU2015-3152, 2015
EGU General Assembly 2015

Land-surface processes and monsoon climate system

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Differential thermal heating of land and ocean and heat release into the atmosphere are important factors that determine the onset, strength, duration and spatial distribution of large-scale monsoons. A global and seasonal assessment of land surface process (LSP) effects on the monsoon system has been made based on general circulation models (GCM) coupled to different benchmark land models, which physically represent either comprehensive, or partial, or minimal LSP representations. Observed precipitation is applied as constrain and differences in simulation error are used to assess the effect of the LSP with different complexity. The AGCM results indicate that the land/atmosphere interaction has substantial impact on global water cycle, while the monsoon regions have had strongest impact at intraseasonal to decadal scales. Among monsoon regions, West Africa, South Asia, East Asia, and Amazon regions have largest impact while some monsoon regions have less impact due to strong air/sea interactions and narrow land mass there. LSP reduces the annual precipitation error by 58% over global monsoon regions, about 35% observed precipitation. The partial LSP effect (excluding soil moisture and vegetation albedo) reduces annual precipitation error over monsoon region that equals to about 13% of observed precipitation. The LSP affects the monsoon evolution through different mechanisms at different scales. It affects the surface energy balance and energy partitioning in latent and sensible heat, the atmospheric heating rate, and general circulation.

The LSP effects have also been assessed in the land use land cover change experiment. Based on recently compiled global land-use data from 1948-2005, the GCM simulation results indicate the degradation in Mexico, West Africa, south and East Asia and South America produce substantial precipitation anomalies, some of which are consistent with observed regional precipitation anomalies. More comprehensive studies with multi-models are imperatively necessary.