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Seasonal Land-atmospheric Coupling Strength

by

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Abstract

Recent studies identified several "hot spots' in terms of strong coupling between soil moisture and summer rainfall. Nevertheless, it is argued that a somewhat too-tight coupling between the land-surface and the atmosphere (manifested by too large surface evaporation) might lead to a wrong relationship between soil moisture and precipitation. To addresses this fundamental coupling issue, we used multi-year AmeriFlux data across a wide range of land-cover and climate regimes to reconstitute the surface exchange coefficient, C_h, which governs the transport of sensible and latent heat fluxes from the surface to the atmosphere. Results show a general trend of stronger coupling for tall canopy (e.g., forest) than that for shorter vegetation (crops and grass). However, the Noah model underestimated (overestimated) values of C_h for forest (short vegetation), implying an insufficient (too efficient) coupling for tall canopy (short canopy). Model simulations were conducted by experimenting different formulations to relate the roughness length for heat and moisture (Z_{ot}) to the roughness length for momentum (Z_o). Results show that by adjusting of a coefficient C_{zil} in the current formulation for calculating Z_{ot}, the Noah LSM is able to reproduce the observed C_h and surface fluxes.

To evaluate impacts of surface coupling on summer convective precipitation, we used the WRF/Noah coupled model to study a 6-day heavy-precipitation episode during the International H_2O Project (IHOP) field campaign, June 2002, over the central United States. We varied surface coupling strengths from strong coupling to weak coupling in WRF. The area-averaged early evening maximum precipitation values for strong-coupling runs precede those of weak- coupling runs by ~ 2 h and are on average almost twice as large. The maximum amounts in the weak-coupling runs are more consistent with the Stage-IV radar-derived rainfall analyses. This significant summer-precipitation sensitivity to the land-atmospheric coupling strength is comparable than that associated with differences in land-surface parameters, such as soil moisture, over model forecasts of similar duration. Using offline simulations over complex terrain, forested sites in central Colorado Rockies, we compared winter-season coupling strengths represented by six widely-used land-surface models. We also analyzed the relationship between coupling strength, turbulent and radiative fluxes within and under canopies, and weekly changes in snowpack.

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~ All are welcome ~