Establishment of Land-atmosphere Feedback Regimes using Flux Site Observations

Sungyoon Kim[1,2] (skim307@gmu.edu) and Paul A. Dirmeyer[1,2]

[1]George Mason University, Fairfax, VA, USA

[2]Center for Ocean-Land-Atmosphere Studies, George Mason University, Fairfax, VA, USA

The land surface water and energy balances are important factors in understanding the Earth's climate system related to the coupling between land and atmosphere. This study employs principal component analysis (PCA) combined with Granger causality and Pearson's correlation to investigate more accurate land-atmosphere (LA) interactions using soil water content (SWC), surface latent heat flux (LE), surface sensible heat flux (H), and surface net radiation (RAD). The analysis focuses on identifying the most influential components in flux observation sites across four seasons. Our findings indicate that H is a crucial factor in LA interactions for all seasons, and LE becomes more an important driver in summer than in other seasons. In contrast, SWC, despite its link to the surface water budget, is less influential compared to energy balance terms. Effects of RAD vary seasonally, being more significant in energy-limited regimes during spring and summer. The 2-dimensional LA coupling matrix, delineated into four quadrants based on the correlation signs between SWC/LE and SWC/H, facilitates the classification of distinct LA feedback regimes. The LA matrix provides a clearer understanding of both water- and energy-limited regimes. This result suggests that H and LE are key drivers in both water- and energy-limited regimes. Detailed analyses reveal that different regimes exhibit unique characteristics depending on factors like temperature, humidity, and energy availability. Spatial analysis of observation sites shows significant LA interactions mainly in middle latitudes, influenced by solar radiation. The global distribution of LA feedback regimes underlines the complexity of defining LA coupling regimes, which vary according to geographic location, local climate, and land/vegetation types. These insights will be vital for enhancing the predictability of climate models and comprehending the intricate interplay between different surface conditions in LA interactions.