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Observed land-atmosphere coupling from satellite remote sensing and re-analysis

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The lack of observational data for use in evaluating the realism of model-based land-atmosphere feedback signal and strength has been deemed a major obstacle to future improvements to seasonal weather prediction by the Global Land-Atmosphere Coupling Experiment (GLACE). To address this need, a 7-year (2002-2009) satellite remote-sensing data record is exploited to produce for the first time global maps of predominant coupling signals. Specifically, a previously implemented convective triggering potential (CTP) – humidity index (HI) framework for describing atmospheric controls on soil moisture-rainfall feedbacks is revisited and generalized for global application using CTP and HI from the Atmospheric Infrared Sounder (AIRS), soil moisture from the Advanced Microwave Scanning Radiometer (AMSR), and the U.S. Climate Prediction Center (CPC) merged satellite rainfall product (CMORPH). The global land area is categorized into four feedback regimes: atmospherically-controlled, wet soil-advantage, dry soil-advantage, and transitional, computed for the locally-defined convective rainfall season. Classification maps are produced using both the original and modified frameworks, and later contrasted with similarly derived maps using inputs from the NASA Modern Era Retrospective-analysis for Research and Applications (MERRA) reanalysis. The combination of methods and data sources employed in this study enables evaluation of the sensitivity of the classification schemes themselves to their inputs, but also the uncertainty in the resultant classification maps. The findings are summarized for 20 climatic zones and three GLACE coupling hot spots, as well as zonally and globally. Of the four-class scheme, the dry soil- and wet soil-advantage regimes account for the smallest and largest coverage globally. Despite vast differences among the maps, many geographically large regions of concurrence do exist. Although, regime compositions were mixed for the hot spots. Through its ability to compensate for latitudinally-varying CTP-HI-rainfall tendency characteristics, as observed in this study, the revised classification framework overcomes limitations imposed by the original framework. Overall, findings underscore the relevance of CTP and HI in coupling studies and their potential value in future model evaluation, rainfall forecast, and/or hydrologic consistency applications. By identifying regions where coupling persists using satellite remote sensing, this study provides the first observationally-based guidance for future spatially and temporally focused studies of land-atmosphere interactions.