NCAR CLIMATE & GLOBAL DYNAMICS

CGD Seminar Series

The GLACE-Hydrology Experiment: Effects of Land-Atmosphere Coupling on Soil Moisture Variability and Predictability

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For live stream information, visit the CGD Seminar Webpage

ABSTRACT

The impact of land-atmosphere anomaly coupling on land variability is investigated using a new two-stage climate model experimental design called the "GLACE-Hydrology" experiment. First, as in the GLACE-CMIP5 experiment, twin sets of coupled land-atmosphere climate model (CAM5-CLM4.5) ensembles are performed, with each simulation using the same prescribed observed sea surface temperatures and radiative forcing for the years 1971-2014. In one set, land-atmosphere anomaly coupling is removed by prescribing soil moisture to follow the control model's seasonally-evolving soil moisture climatology ('land-atmosphere coupled'). Then, the atmospheric output from both sets of simulations is used to force land-only ensemble simulations, allowing investigation of the resulting soil moisture variability and memory under both the 'coupled' and 'uncoupled' scenarios.

In mid-latitudes during boreal summer, land-atmosphere anomaly coupling significantly strengthens the relationship between soil moisture and evapotranspiration anomalies, both in amplitude and phase. This allows for decreased moisture exchange between the land surface and atmosphere, increasing the memory and often the variability of soil moisture. Additionally, land-atmosphere anomaly coupling impacts runoff variability, especially in wet and transition regions, and precipitation variability, although the latter has surprisingly localized impacts on soil moisture variability. As a result of these changes, there is an increase in the signal-to-noise ratio, and thereby the potential seasonal predictability of SST-forced hydroclimate anomalies in many areas of the globe, especially in mid-latitudes. This predictability increase is greater for soil moisture than precipitation and has important implications for the prediction of drought.

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