Session: C31 Poster: W136A

Local Land-Atmosphere Coupling (LoCo): A global inter-comparison of modeled and observed land-atmosphere coupling

Craig Ferguson[†]; Eric Wood
[†] Institute of Industrial Science, The University of Tokyo, Japan
Leading author: cferguso@rainbow.iis.u-tokyo.ac.jp

The findings of the IPCC Fourth Assessment (AR4) ensemble global climate model (GCM) simulations revealed that the strength of land surface-atmosphere interaction (henceforth, coupling) inherent to each participating GCM played a role in determining the frequency and severity of projected drought. Alan Betts has argued that coupling strength is an important, if not thee most fundamental criterion for evaluating hydrological model performance. Nevertheless, the lack of sufficient observations of coupling at appropriate temporal and spatial scales has made achieving 'true' coupling in models an elusive goal. In this study, we use satellite-based estimates of surface soil moisture (SM), evaporative fraction (EF), and cloud base height (or lifting condensation level, LCL) to evaluate the realism of surface controls on evapotranspiration and near-surface humidity in the Global Land Data Assimilation System (GLDAS) suite of land surface models (incl. VIC, Noah, Mosaic, and CLM), the calibrated VIC-Princeton Global Forcing (PGF) model, as well as the NASA Modern Era Retrospective-Analysis for Research and Applications (MERRA) reanalysis. We claim that the satellite-based estimates of coupling are the nearest to ground truth coupling that currently exists. Specifically, we use Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) soil moisture, Surface Radiation Budget (SRB)-based evapotranspiration, and Atmospheric Infrared Sounder (AIRS)-derived cloud base height to compute daily correlations of SM, EF, and LCL globally during locally-defined convective seasons. Using all combinations of surface and near-surface satellite and model-based products, we also produced ensembles of hybrid coupling strengths, which formed the basis for mapping regions of consensus weak or strong coupling. Due to satellite data availability, focus is placed on a four year period from 2003-2006. The results address a wide range of issues including: input dataset forcing, model parameterizations, and model calibration. Notably, we found that the VIC-PGF model that had been calibrated to basin-scale monthly runoff did not necessarily compare well with satellite-based estimates of daily coupling. This raises the question of whether models can be expected to perform well at both temporal scales? If so, matching the true coupling strength in models would appear to be the first step towards this end.