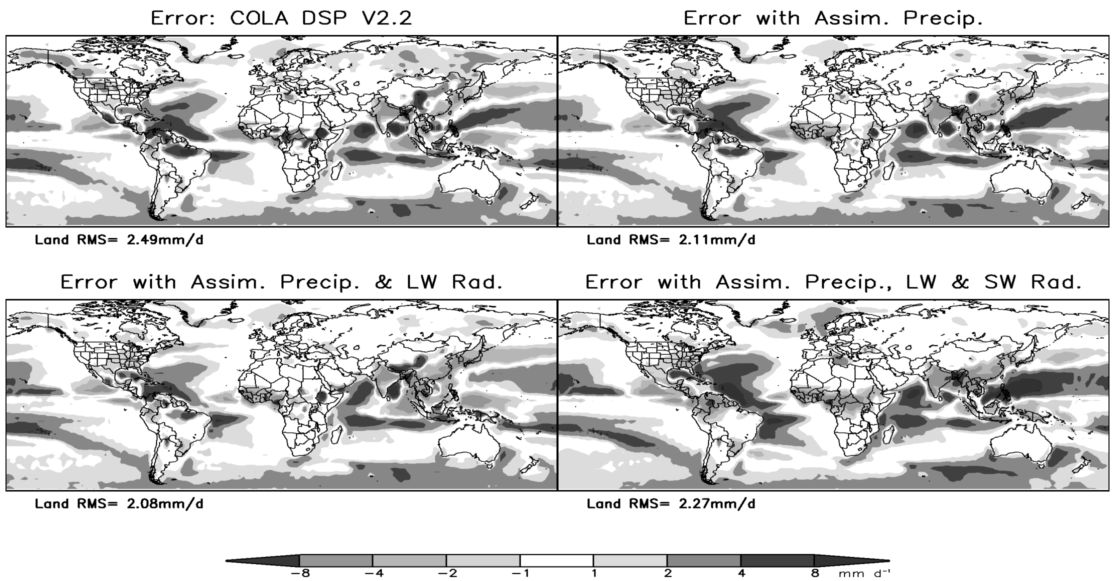
EVALUATING THE IMPACT OF REALISTIC LAND CONDITIONS IN DYNAMICAL SEASONAL PREDICTIONS

C. Adam Schlosser* and Paul A. Dirmeyer
Center for Ocean Land Atmosphere Studies, Calverton, MD 20705

* Current Affiliation: GEST/UMBC/NASA-GSFC Code 974, Greenbelt, MD 20771

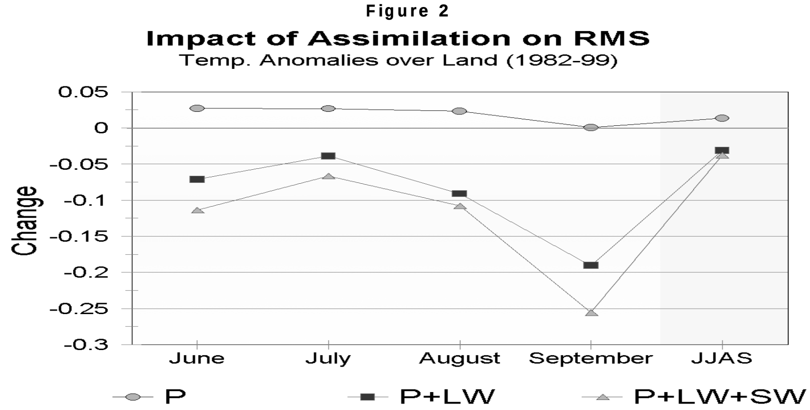
A suite of numerical simulations with the Center for Ocean Land Atmosphere (COLA) Studies' atmospheric general circulation model (AGCM) has been performed in conjunction with the Dynamical Seasonal Prediction (DSP) Project (Shukla *et al.*, 2000). These simulations aim to

Figure 1



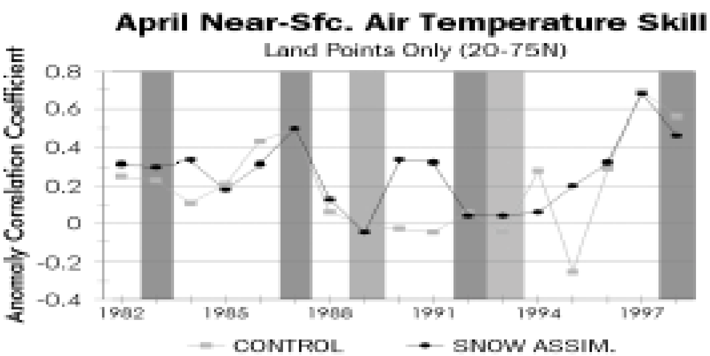
quantify the impact of realistic land conditions on predictability and skill in the COLA AGCM (run at spectral resolution T63 and 18 vertical levels). The numerical experiments cover three seasonal simulation periods: Northern Hemisphere winter (December-March), spring (March-June), and summer (June-September), and span the years 1982-1999. Within each seasonal simulation, a set of complementary runs is performed in which realistic precipitation, downward radiation at the surface, and land conditions (that includes soil moisture and snow depth) are prescribed in combination. Only the COLA land model, the Simplified Simple Biosphere Model (SSiB, Dirmeyer and Zeng 1999) that is coupled to the AGCM responds to these improved atmospheric forcings and initialized (or assimilated) land states. The suite of analyses that is presented quantifies the impact of the land-model's response on the skill and predictability of simulated atmospheric quantities.

Figure 2



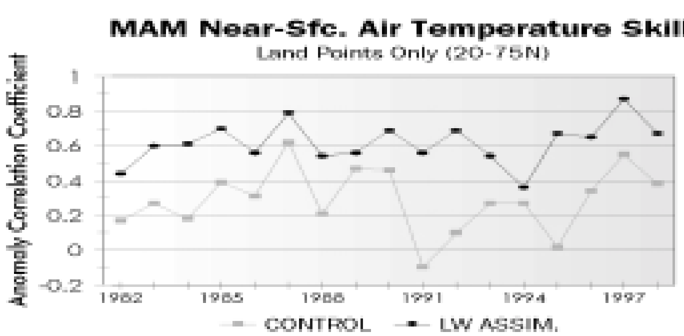
Assimilation of 'observed' precipitation and radiation to SSiB improves simulation to a certain degree. Fig. 1 shows the errors in global boreal summer precipitation averaged for 10-member ensembles during 1982-1999. Assimilating observationally-based precipitation fluxes to the land surface improves some of the wet biases in the GCM's simulated rainfall, but does little to improve surface temperature errors (Fig. 2). Adding in the assimilation of observed surface downward longwave radiation improves the simulation of rainfall only slightly, but produces a large improvement in surface temperature. When precipitation, shortwave and longwave radiation are all assimilated, there is a catastrophic shutdown of surface evaporation in the land surface model, which had been tuned for the excessively strong radiation and hydrologic cycle in the GCM.

Figure 3



Results from the spring (and winter) runs indicate that improved snow conditions play a beneficial role toward skillfully capturing the observed spatial patterns of interannual variations of near-surface air temperature. The improved skill that results from the global assimilation of snow depth observations into the winter and spring DSP simulations demonstrates the impact. However, the effect is primarily seen during the widespread ablation of the ephemeral snow cover, which typically occurs during April (Fig. 3) and appears to have its largest impact in the absence of any strong remote influences such as ENSO events (epochs depicted by shading red=El Nino and blue=La Nina in Fig. 3). Snow initialization tests (not shown) indicate that the impact of the realistic initialization is short-lived, but are strongly buffeted by model systematic errors in precipitation and radiation fluxes. Subsequently, biases are reduced and skill in the simulated variability is increased for near-surface air temperature at high-latitudes through the land model's response to realistic downward radiative fluxes, and in particular, longwave radiation. In particular, the improved skill in simulated spatial patterns of March-May (MAM) averaged near-surface air-temperature anomalies that results from assimilating realistic downward longwave radiation is considerable (Fig. 4)

Figure 4



Overall, retuning exercises may address these aforementioned symptoms, but the cause remains a poor simulation of surface radiation, convection and clouds in the GCM. In the end, physical parameterizations must be improved before enhancements in seasonal predictability through improved land surface initial conditions can be realized.

References:

Dirmeyer, P. A., and F. J. Zeng, 1999: An update to the distribution and treatment of vegetation and soil properties in SSiB. COLA Technical Report 78, Center for Ocean-Land-Atmosphere Studies, Calverton, MD, 27 pp.

Shukla, J., Paolino, D. A., Straus, D. M., DeWitt, D., Fennessy, M., Kinter, J. L., Marx, L. and Mo, R., 2000. Dynamical seasonal predictions with the COLA atmospheric model. *Q. J. R. Meteorol. Soc*., **126**, 2256-2291.