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A land surface - boundary layer feedback mechanism in a GCM simulation

A. Molod (1), H. Salmun (2), D. Entekhabi(1)

(1) Massachusetts Institute of Technology, USA (2) Hunter College of CUNY, USA
amolod@mit.edu

A land surface - boundary layer feedback mechanism was identified in modeling studies (Molod et al., 2004) in which the response to a moisture neutral perturbation in the characteristics of the boundary layer turbulence was manifest in both a drying and a moistening regime, depending on the local surface conditions. The implication of the model study is that there exists a predisposition towards the establishment of reinforcing feedbacks in either a drying or a moistening regime. In the drying regime an increase in boundary layer temperature and moisture results in a reduced relative humidity, and the feedback proceeds with a reduced relative humidity, which leads to less precipitation, drier soil, less evaporation, warmer canopy temperature, more eddy diffusion and warmer temperatures aloft. In the moistening regime, the increase in boundary layer temperature and moisture leads to an increase in relative humidity, and the moist regime of the feedback results in anomalies opposite in sign to the dry regime. The existence of the drying regime of the feedback was also shown using 'High Turbulent Kinetic Energy (TKE)' and 'low TKE' composites computed for the fields which are part of the feedback loop. The composites were computed based on the summer months during which the TKE is above the JJA mean and the months during which the TKE is below the JJA mean.

The presence of the moistening or drying regime was shown in Molod et al. (2004) to be related in part to the evaporative fraction. To establish a robust relationship between the presence of a predisposition towards a moist or a dry regime and the evaporative fraction, scatter diagrams of the sign of the perturbation minus control differences of evaporation versus the evaporative fraction will be presented. Monthly mean fields as well as five and ten-day averaged fields are used for these scatter diagrams, to determine whether the seasonal mean behavior is present at the shorter time scales, and

the scatter diagrams will be shown for each season. Additional fields identified as elements of the feedback loop, such as the boundary layer relative humidity and precipitation fields, will also be evaluated in this manner to clarify which local conditions are important in determining the sign of the response to the perturbation. Fields not part of the feedback loop but found to be relevant by other studies, such as the magnitude of the surface wind and the net radiation at the surface will be examined in this manner as well.

Molod, A., H. Salmun and D. Waugh, 2004: The Impact on a GCM Climate of an Extended Mosaic Technique for the Land - Atmosphere Coupling. J. Climate, 17, 3877-3891.