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The Scale and Persistence of soil Moisture Anomalies as Simulated in a Global Model

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Introduction

Short term variability of climate is intimately connected with soil moisture variability. Soil moisture provides the storage and subsequent return to the atmosphere, through evaporation and transpiration, of precipitation anomalies over land. GCM simulations enable consistent identification of correlations and dynamical connections between the hydrologic variables, many of which are incompletely observed. One way to facilitate understanding with these increasingly intricate models is to perform sensitivity studies in which a boundary condition or process is prescribed. In this study we will report on a sensitivity study in which a GCM with a sophisticated land surface representation is used to investigate soil moisture variability in the model climate.

The simulations to be used in this study were made at R15 resolution (approx. 4.5 deg lat. by 7.5 deg lon.) with prescribed sea surface temperatures (SST) in the GENESIS model (Thompson and Pollard, 1994), which is coupled to a Land Surface Transfer model (LSX) at 2 deg by 2 deg resolution (Pollard and Thompson, 1994). All the results presented here were taken from the monthly averages of the model results.

The LSX model accounts for the physical effects of vegetation with two layers specified at each grid point. Vegetation attributes such as leaf area indices, fractional cover, leaf albedos, etc., were taken from the global dataset in Dorman and Sellers (1989). A six-layer soil model extends from the surface to 4.25 m depth.

SST's were prescribed in two ten year experiments using monthly SST values with the daily value being interpolated from the nearest two months. In the first experiment monthly climatological values were used, and in the second, the Atmospheric Model Intercomparison Project (AMIP) observed SST's for the years 1979 through 1988 were used (Gates, 1992). Thus, the former experiment gives a measure of the intrinsic model variability, to be compared with that of the latter experiment, which includes month-to-month variability due to ocean forcing.

Discussion of results

Driving the soil moisture variabilities is, of course, the precipitation variability. The coefficient of variation of annual precipitation (monthly rms/average) is shown in figure 1, with the observed forcing in 1a and the control experiment with climatalogical forcing in 1b. Characteristic maxima of precipitation variation are seen in the tropical Pacific, desert areas, and Eastern Asia. Similar results have been obtained with other models (Koster and Saurez, 1994). These plots give an indication of the areas of the most effected by interannual SST variations.

An example of teleconnection in the data is shown in figure 2, which shows the strong correlation of surface temperature in the north atlantic with the Sahel level 2 soil moisture 1 month later. This value represents the soil moisture fraction for the layer from 5 cm to 15 cm depth. Figure 2a gives the AMIP results and figure 2b the Control results. Only contours for a value greater than 0.5 are shown. The 1 month lag correlation has higher values than for any other lag period.

The level 2 soil moisture autocorrelation lagged 1 month is shown in figure 3, with the AMIP results in figure 3a, the Control results in figure 3b. In both experiments there is a characteristic minimum in the autocorrelation running across the Americas and Eurasia from northwest to southeast, indicating that in these regions the variations of soil moisture are dominated by short term events. The soil moisture correlations may provide an indication of the effective variations in precipitation due to storm tracks. The difference in the experiments shows that the storm track trace, as shown by the moisture variations at least, moves further equatorward when the interannual SST variations are included.

References

Gates, W. L., 1992. The atmospheric model intercomparison project, *Bull. Am. Met. Soc., 73*, 1962-1970.

Koster, R. D., and J. J. Suarez, 1994. The relative contributions of land and ocean processes to precipitation variability. Preprint, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771.

Pollard, D. and S. L. Thompson. 1994. Use of a land-surface-transfer scheme (LSX) in a global climate model: the response to double stomatal resistance. *Glob. Planet. Change*, in press.

Thompson, S. L. and D. Pollard. 1994. A global climate model (GENESIS) with a lan-surface-transfer scheme (LSX). Part1: present dlimate simulation. J. *Climate*, in press.

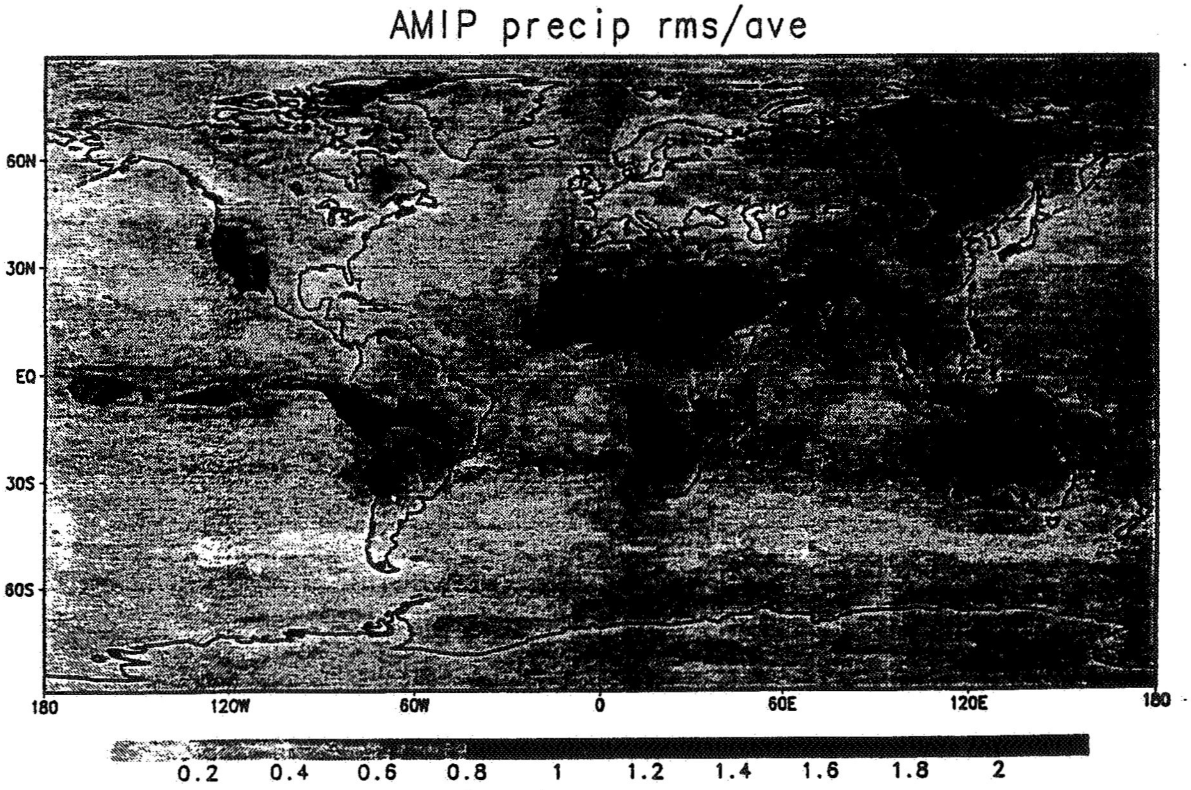
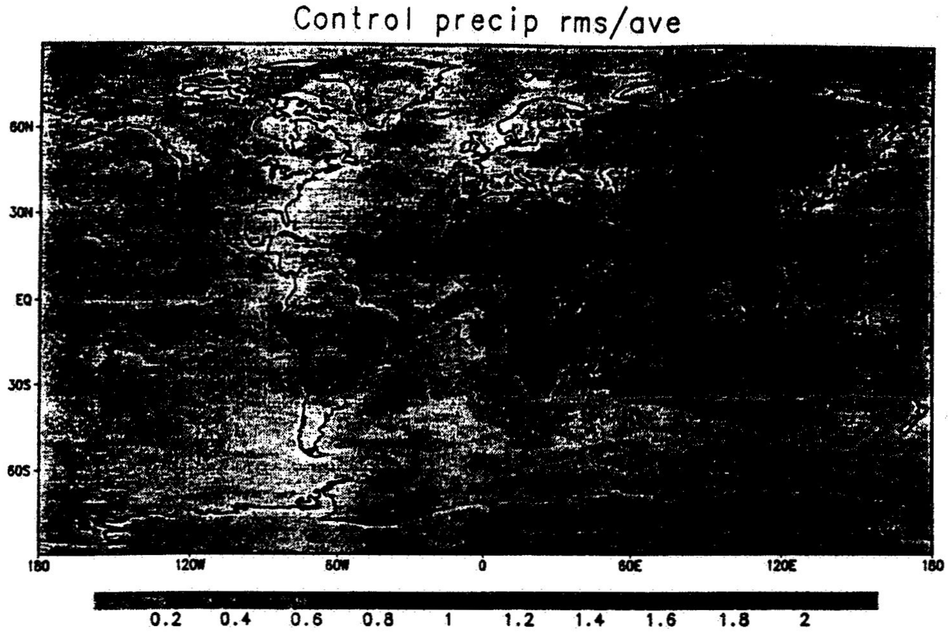


Figure 1. Precipitation coefficient of variation (rms/mean) for monthly variations of GENESIS model results forced by prescribed SST. a: AMIP experiment (1979-1988 SST variations).



b: Control experiment (climatological SST).

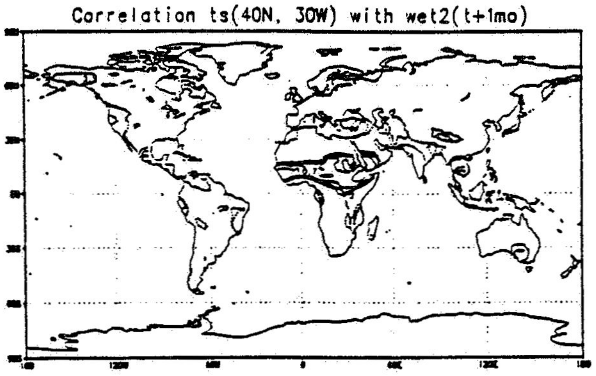
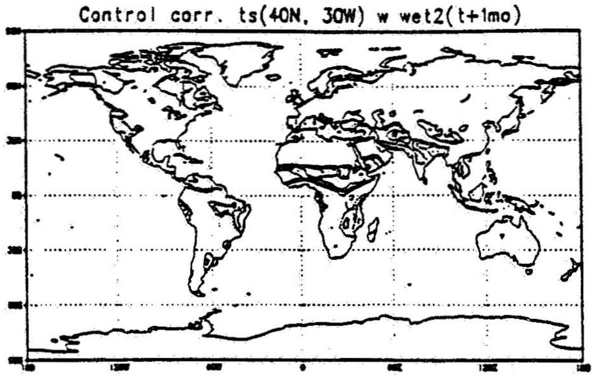


Figure 2. Correlation between North Atlantic SST and 1 month lagged soil moisture (5cm to 15 cm layer). a: AMIP experiment (1979-1988 SST variations).



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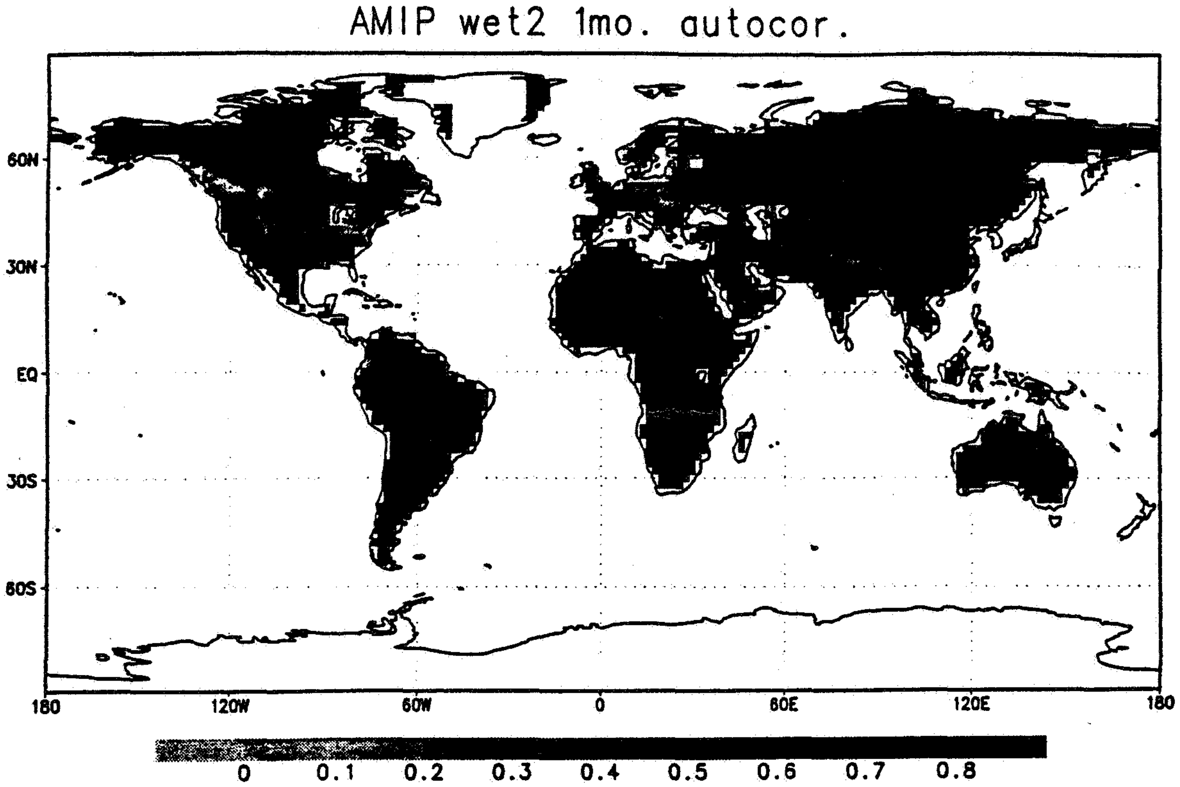
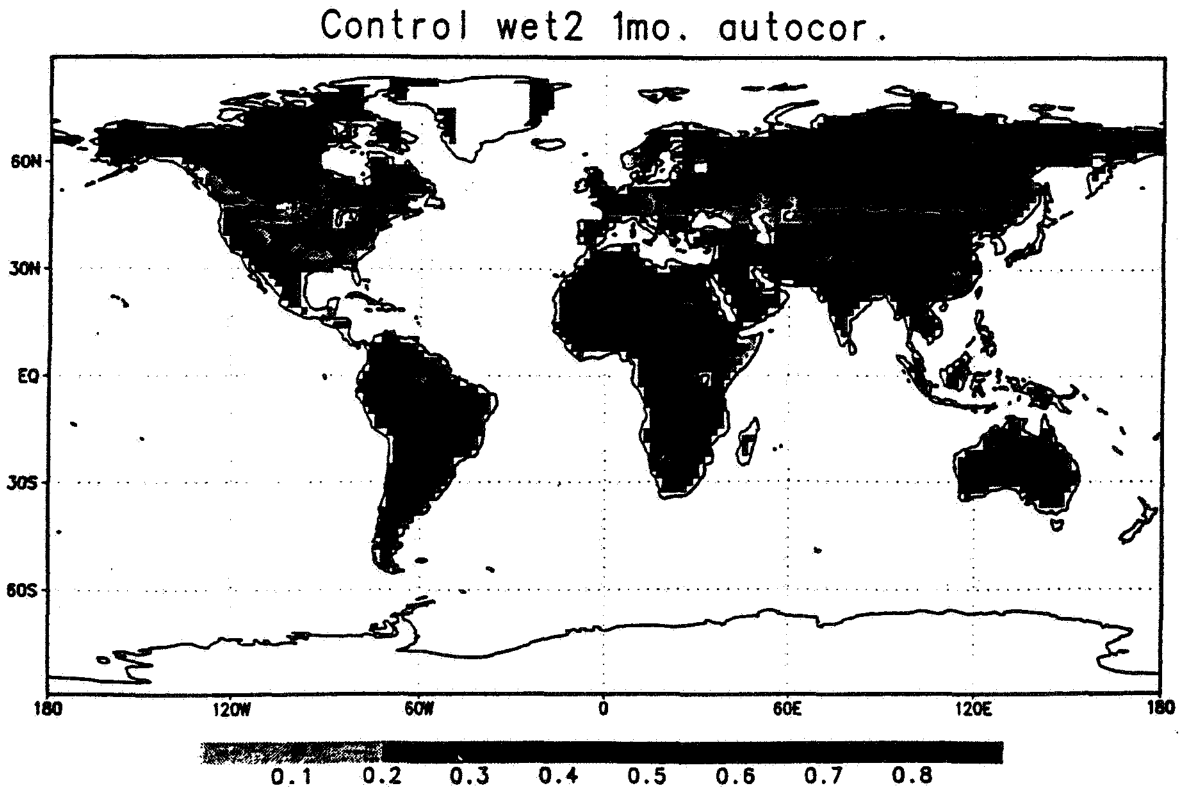


Figure 3. Autocorrelation of soil moisture (5 cm to 15 cm layer) lagged 1 month. **a:** AMIP experiment (1979-1988 SST variations).



b: Control experiment (climatological SST).