PREDICTABILITY OF SUMMERTIME NORTH AMERICAN PRECIPITATION

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The predictability of summertime rainfall over continental North America is closely tied to the predictability of large-scale vertical motion. Previous studies have assessed the predictability of summertime anomalies mostly in terms of 500 mb heights, but the dynamical variable of direct relevance to rainfall is vertical velocity, which is determined more by the height gradients than by the heights themselves. This study investigates the links between anomalous North American rainfall, vertical motion, and remote SST forcing. Its basic premise is that rainfall anomalies over the United States are a local manifestation of circulation variability over a much wider domain, with some enhancement by local soil-moisture feedbacks.

We first show, in long-term observations and in very large (100+ member) ensembles of seasonal AGCM integrations, that there is a close relationship between anomalous summer rainfall and 500 mb vertical velocity (omega) over North America. Given the 500 mb omega field, one can thus predict rainfall. The question, of course, is to what extent the 500 mb omega itself is predictable. As stated above, its predictability could be substantially lower than that of the 500 or 200 mb heights. To clarify this, we generated 90-member ensembles of the JJA 1988 and JJA 1987 seasons using the NCEP AGCM with prescribed observed global SST conditions during these summers. We chose these cases partly to relate our results to many previous studies of the 1988 U.S. drought and the 1987 weak Asian monsoon that all used much smaller GCM ensembles. The SST-forced predictability in our experiments was assessed in terms of the signal to noise ratio S, i.e. the ratio of the ensemble-mean anomaly to the ensemble-spread. Hemispheric maps of S, constructed for 200 mb heights, 500 mb heights, 500 mb omega, and rainfall, were revealing. As suspected, the S-values for rainfall were generally very similar to those for 500 mb omega, smaller than those for 500 mb heights, and much smaller than those for 200 mb heights. The spatial pattern of S for precipitation was also almost identical to that for 500 mb omega. Based on these experiments, one would conclude that over much of the continental United States, the 200 mb height anomalies during these two summers were reasonably predictable, but that the 500 mb heights, 500 vertical velocity, and rainfall were much less so. Comparisons of the ensemble-mean anomalies with the OBSERVED anomalies further confirmed this diagnosis. Our study provides important new evidence that the predictablity of summertime U.S. rainfall may be modest. However, it also suggests that one might reach a more optimistic conclusion by conducting similar experiments with a higher-resolution GCM that is better able to capture the SST-forced height anomaly gradients than the T42 GCM used here.