J1.1 OBSERVING, UNDERSTANDING AND PREDICTING WARM SEASON CONTINENTAL RAINFALL

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Abstract

Despite substantial advances in numerical prediction, forecasts of summertime rainfall are vexingly poor at all ranges. Inadequate representation of convection in weather and climate models is widely suspected to be a principal cause for this unskillful performance. Deficiencies in the parameterization of organized convection and the lack of a well-defined scale-separation seem to underlie this problem. Given the prospects for explicit representation of convection in future forecast models, practical limits to the predictability of convection weigh heavily in the minds of today's researchers and practitioners.

Carbone et al. (2002) analyzed a unique four-year time series (1997-2000) of radar-rainfall observations over the continental U.S. and some autocovariance properties thereof. The time series allowed them to quantify continental-scale patterns of summer precipitation. Coherent rainfall events were routinely observed to exhibit unexpected longevity, mainly associated with organized convection, lower boundary forcings, and coherent propagation. To some extent, the results challenge conventional wisdom about the role of transient synoptic forcing (e.g. shortwaves) as contrasted with a quasi-static synoptic condition that is susceptible to deep overturning. The observed longevity and coherence of rainfall seems to infer a heretofore unrecognized predictability of rainfall in the absence of "strong forcing", scaling upwards through the mesoscales.

Future forecast techniques are likely to include the use of cloud resolving models (CRMs) and ensembles thereof; statistical techniques applied directly to observations; and extensive post-processing of model data. The realm of hybrid statistical-dynamical methods (e.g. Davis et al., 2002) presents numerous paths toward improved predictive skill in probabilistic forecasting.

One promising method of diagnosis and prediction involves the use of neural networks. Kim and Barros (2001) adapted and quantitative forecasting model for both rainfall and streamflow at selected watersheds, using both radar and NWP output. The self-learning nature of a neural network allows it to forecast without extensive prior knowledge of all the processes involved. At least two types of neural network based forecasting systems can be developed: the first by augmentation of data structures, incorporating topological and propagation characteristics of coherent rainfall features in the observations; the second by using indices of the relevant dynamical states derived from analysis of CRM simulations. Such techniques may prove especially useful for hydrological application in the prediction of floods. Broader impacts include building bridges between the deterministic prediction of precipitation and stochastic hydrology, and the improved numerical prediction of precipitation.

Examples of mesoscale rainfall structures and their continental scale coherence will be shown in the oral presentation. Early results from relevant CRM simulations will be compared to the observations and also presented in more detail in a companion paper by Moncrieff and Liu (2003). Examples of purely statistical and statistical-dynamical approaches to improved prediction will be exhibited and discussed.

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