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WRF SIMULATIONS OF RAINFALL COHERENCE OVER THE CONTINENTAL U.S.

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1. INTRODUCTION

Recent analyses of a six-year time series of radar-rainfall observations have clearly established the temporal and spatial coherence of both stationary and propagating warm-season convection over the continental United States (Carbone et al. 2002). However, operational numerical weather prediction models have shown very limited skill in the prediction of both the diurnal cycle and movement of warm-season precipitation over this region. In the current study we use extended (1-10 day) WRF simulations with different configurations (e.g., grid resolution, model physics) to better understand sources of error in warm-season precipitation forecasts. Such understanding could lead to improvements in operational forecasts of warm-season precipitation and help elucidate dynamical mechanisms responsible for rainfall coherence.

2. METHODOLOGY

We are currently analyzing a 10-day simulation for a period (19-29 July 1998), during which observed heavy precipitation episodes initiating near the lee of the Rocky Mountains exhibit coherence on timescales of multiple diurnal cycles with spatial correlations over swaths greater than 1000 km. Our preliminary WRF simulation is continental in scale, utilizes 3-hourly updates from operational ETA model analyses as lateral boundary conditions, and employs 27-km horizontal grid spacing. This grid spacing is insufficient to resolve deep convection. Thus the current simulation utilizes the Kain and Fritsch (1990) cumulus parameterization scheme. Other physical parameterizations include an explicit cloud microphysical parameterization based on Lin et al. (1983) and a planetary boundary layer parameterization similar to that currently in use in the operational ETA model.

3. PRELIMINARY RESULTS

The extended simulation produces the observed late afternoon convection in the lee of the Rocky Mountains with reasonable accuracy. However, it fails to correctly simulate the subsequent eastward propagation in a systematic fashion during the ten day period. Long-lived eastward propagating convection is present in the simulation. However, both the location of the onset of the propagation (generally too far east) and its speed (generally too slow) are inconsistent with rainfall observations during the period. In the simulation the relatively slow phase speeds of the coherent deep convection during the latter portion of the period are well correlated with the phase speeds of simulated disturbances in the midtropospheric meridional flow. These simulated midtropospheric disturbances are stronger than observed, however the reasons for their anomalous strength in the interior of the simulation domain has yet to be determined at this writing. Some related shorter integrations using the same model configuration produced more accurate representations of propagating deep convection, but even in these simulations propagation was somewhat slower than observed.

4. FUTURE RESEARCH

We shall continue our comparison of additional model produced/derived fields with their observational counterparts for the current simulation and related simulations. There also is evidence from previous work (e.g., Davis et al. 2003) to suggest that anomalously slow propagation of deep convection may be related in part to insufficient downdraft strength in simulations that rely upon cumulus parameterizations. Thus, we plan to compare the simulated precipitation patterns in the current model setup with higher-resolution (cloud resolving) simulations that are better able to represent convective downdrafts. We expect that this analysis approach, applied to both the 10-day period of our preliminary simulation and to additional extended periods that comprise different large-scale regimes, will lead to a better understanding of the nature of errors in forecasts of long-lived heavy precipitation episodes during the midlatitude warm season.

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