Coherence of rainfall propagation as simulated in the Weather Research and Forecasting model using two different convective schemes

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Introduction

Convective rainfall forecasting continues to be a challenge for Numerical Weather Prediction (NWP) models. This study looks at rainfall forecasts from a model using two different convective schemes along with observed data. Davis et al. (2003) cite the convective schemes as the main challenge to NWP as they tend to trigger precipitation too early and propagate it too slowly. The goal is to see if mesoscale convective rainfall propagation is depicted better in one of the two cumulus parameterization schemes by comparing hits and misses.

Data Source and Method

Model data was obtained from the WRF-ARW (version 2.1.1) run at Iowa State University on a domain shown in Fig. 1 at a grid spacing of 15km. Both the Betts-Miller-Janjic (BMJ; Betts 1986, Betts and Miller 1986, Janjic 1994) and Kain-Fritsch (KF; Kain and Fritsch 1993 and Kain 2004) convective schemes were run with Ferrier et al. (2002) microphysics. Observed data (Obs) was obtained from NCEP's Stage IV multi-sensor analyses.

To calculate convective precipitation propagation, time-longitude, or Hovmöller diagrams, were used as shown in Fig. 2. Radar data with watch boxes overlaid were used to determine if precipitation was convective and propagating.

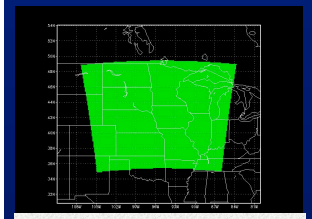

Figure 1: The model domain for this study covering the time period of 26 March - 22 May 2006.

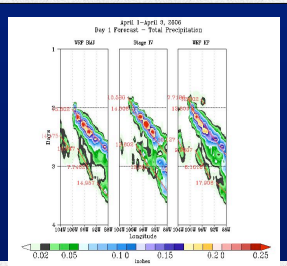

Figure 2: Example of calculating propagation speed for BMJ, Stage IV observations, and KF during the period of 1 April - 3 April 2006 in Hovmöller space.

Main Points

- No separation between the BMJ and KF hit and miss events in Fig. 3 allows for no definitive forecasting tool.
- There is no significant difference between the BMJ and KF propagation speeds (Fig. 3) at any one time (Fig. 4).
- Most cases in Fig. 4 represent a hit between KF and BMJ for the same events.
- Between 03-12 UTC, there are fewer events than at 00 UTC and 21-03 UTC (Fig. 4) with even fewer events at forecast hours 45-48.
- KF has a tendency to start convection earlier than BMJ (Fig. 5).
- Boundary conditions performed well (Fig. 5) with the BMJ capturing 60% of events while KF captured 70%.

Future Work

A larger dataset utilizing this method to study convective schemes is needed to cover more weakly forced cases. This may lead to separation between the convective schemes that might provide a conclusive forecasting tool for ensemble modelers.

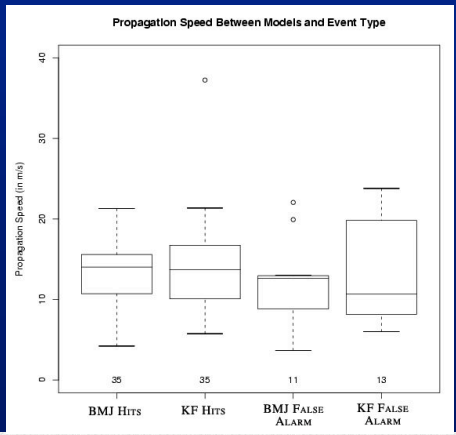

Figure 3: Propagation Speed box plot showing lack of separation between BMJ and KF as they have similar number of cases. BMJ Hits signifies when the BMJ/KF/Obs or BMJ/Obs hit. This is similar for KF Hits where KF/BMJ/Obs or KF/Obs hit. BMJ and KF False Alarm signals when BMJ or KF produced precipitation, but no precipitation was observed.

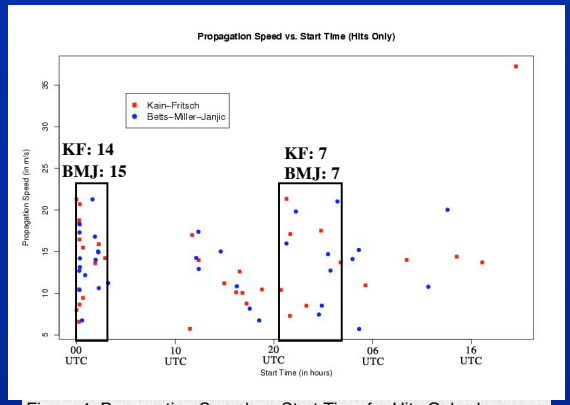

Figure 4: Propagation Speed vs. Start Time for Hits Only shows no noticeable difference in propagation speed between KF and BMJ. The boxes highlight the impact of data assimilation (00 UTC) and the subsequent diurnal cycle of nocturnal convection (21-03 UTC).

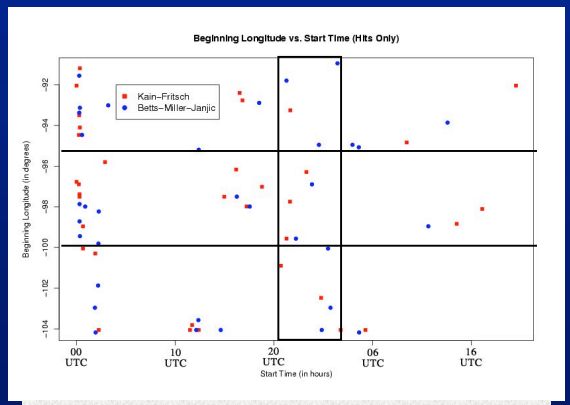

Figure 5: Beginning Longitude vs. Start Time for KF and BMJ Hits Only displays that events occurred very close to the edge of the domain. In addition, hits were achieved across the entire domain at 00 UTC.

Questions and More Information

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