Sensitivity of Model Verification Results to Object Identification Parameters Using Method for Object-based Diagnostic Evaluation – Time Domain (MODE-TD)

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Introduction

Spatial verification methods for object-based approaches are becoming more prevalent due to increases in both model resolution and the demand for identification of specific features in storms. Yet further investigation is needed to determine which spatial verification methods and specific configurations work best for certain forecast parameters, storm types, or regions of interest (objects). Unlike other statistical evaluation tools, MODE-TD has two horizontal spatial dimensions and time extending into the vertical spatial dimension which creates a 3D image, producing a more complete spatial view of the data.

This study investigated the use of MODE-TD configurations to identify objects for the purpose of evaluating both mesoscale convective systems (MCSs) and smaller, localized storms through verification of precipitation areas.

Model & Data

Observation Data

- Multi-Radar Multi-Sensor (MRMS) quantitative precipitation estimates
- Lambert Conformal grid

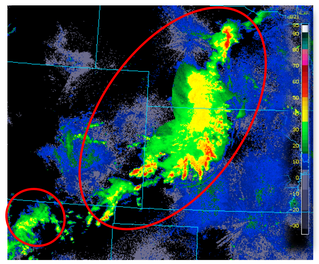
Model Data

- Weather Research and Forecasting (WRF) v3.7 with 3Dvar assimilation
- 280 x 320 km grid with 3km horizontal resolution
- 51 vertical levels
- Post-processed using Unified Post Processor (UPP) v2.2 and copygb

General Physical Parameterizations

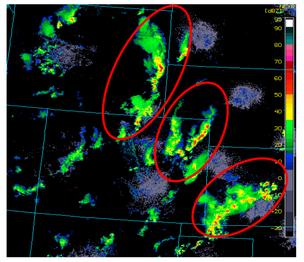
- Thompson microphysics scheme
- Kain-Fritsch cumulus parameterization
- Mellor-Yamada-Janjic boundary layer scheme
- Noah land surface model
- Rapid Radiation Transfer Model Global scheme for both long-wave and short-wave radiation

Case Studies



Case 1 (snapshot at 0425 UTC)

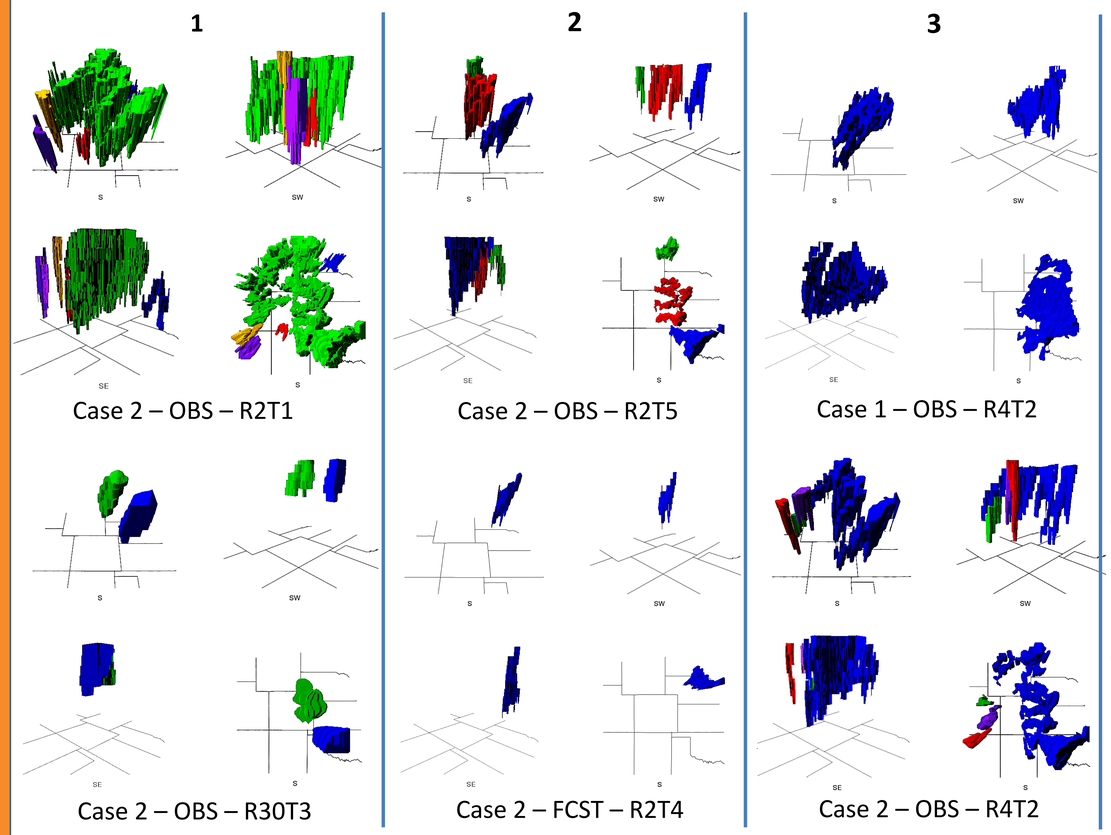
- MCS on 7/27/2015
- Propagated from eastern CO to central KS
- Life time about 4 hrs
- Half the size of KS at mature stage
- Well-defined rain core, precipitation area and a clear outflow boundary



Case 2 (snapshot at 0225 UTC)

- MCS & local storms on 7/15/2015
- Propagated from central CO to central plains
- Life time of more than 9 hrs
- Focused on local storms, especially those that formed behind the MCS

Outputs



- All images depict output objects from the MODE-TD in 4 different perspective views. Upper left panel views the objects from the **S**, upper right from the **SW**, lower left from the **SE**, and lower right is a **top-down** view with the S at the bottom of the image.
- **Column 1:** Upper image depicts objects with convolution radius (R) of 2 and convolution threshold (T) of 1 while the lower image depicts objects with R of 30 and T of 3.
- **Column 2:** Upper image depicts objects in Observed field (OBS) while the lower image depicts objects in Forecast field (FCST).
- **Column 3:** Images depict both cases with recommended MODE-TD configurations, R4T2; the upper image is case 1 while the lower image is case 2.

Results & Conclusions

1. **Volume and resolution of the objects decreased as Convolution Radius (R) and Convolution Threshold (T) increased** (Column 1)
   - R smoothed out the structure of the storms while T defined the objects by precipitation amount above the specified value
2. **Both cases showed a large discrepancy of precipitation amount, number of objects, and placement of heavy rain cores between the FCST and OBS fields** (Column 2)
   - Model underestimated the precipitation amount; led to fewer and smaller objects that were generated
   - Model displaced the heavy rain cores and thus the location of the objects
3. **Recommended configuration for both MCS and local storms verification: R4T2** (Column 3)
   - R4 separated the MCS and local storms objects; local storms tended to be eliminated when T > 2mm/hr in both cases

Analysis

1. Ran different combinations of R (size control) and T (precipitation filter) for a total of 56 sets for observation and for forecasted field

R (km)	2	3	4	5	10	15	20	30
T (mm/hr)	1	1.5	2	3	4	5	10	

2. Analyzed radar images – number of separated/individual MCSs and local storms, location of heavy rain cores… etc.
3. Evaluated the number of objects from radar images
4. Selected MODE-TD images that matched the number of objects from step 3 (MCSs and local storms were done separately)
5. Narrowed down the MODE-TD images according to the placement of heavy rain cores, duration, and translation of the storms
6. Verified the structure, contour, and detail of the selected MODE-TD objects

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- Radar Image Archive: Mesoscale and Microscale Meteorology Laboratory http://www2.mmm.ucar.edu/imagearchive
- MRMS data: National Severe Storms Laboratory http://www.nssl.noaa.gov/projects/mrms/

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