

Effects of Horizontal Model Resolution on Convection

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Background

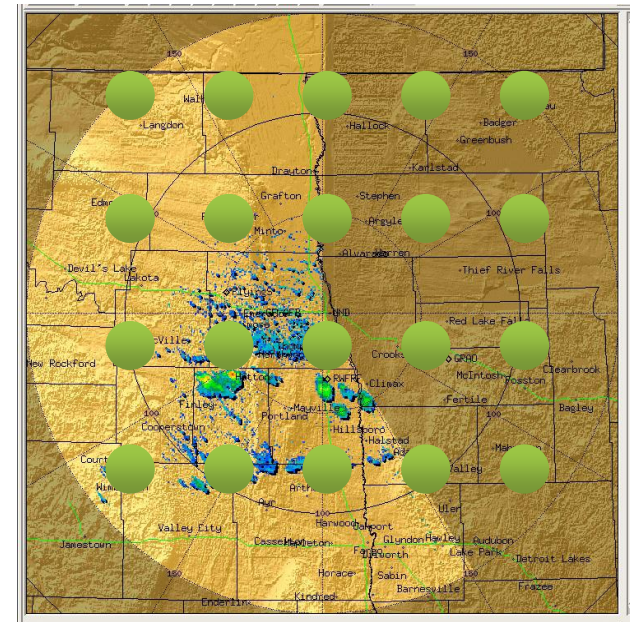
- During the summer of 2010, Polarimetric Cloud Analysis and Seeding Test 3 (POLCAST3) field campaign occurred.
- Goal: To research the effects of hygroscopic seeding flares in North Dakota's weather modification program.



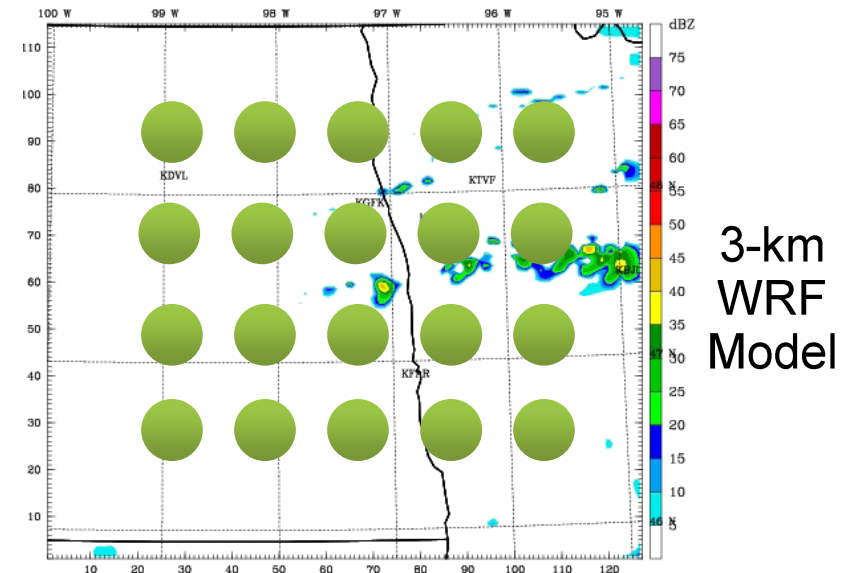
Background

- How accurate were the model predictions? What is the best way to verify forecasts?
- Exact location of convection is impossible to predict.
- Traditional skill scoring techniques are inadequate.
- Verification technique that accounts of spatial variations was needed.

21:02 UTC July 19, 2010



UND
Radar
(IRIS)

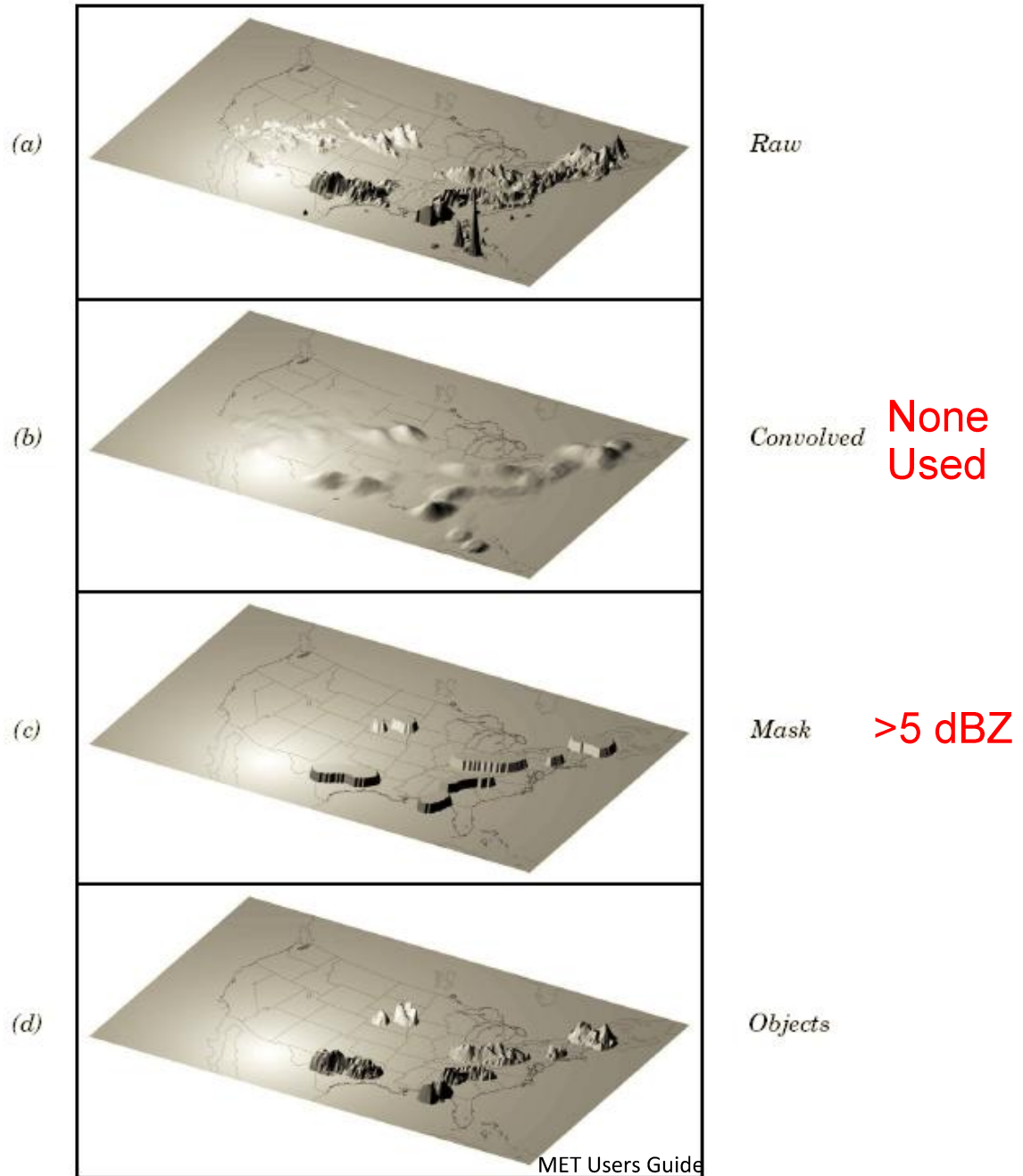


3-km
WRF
Model

Methodology

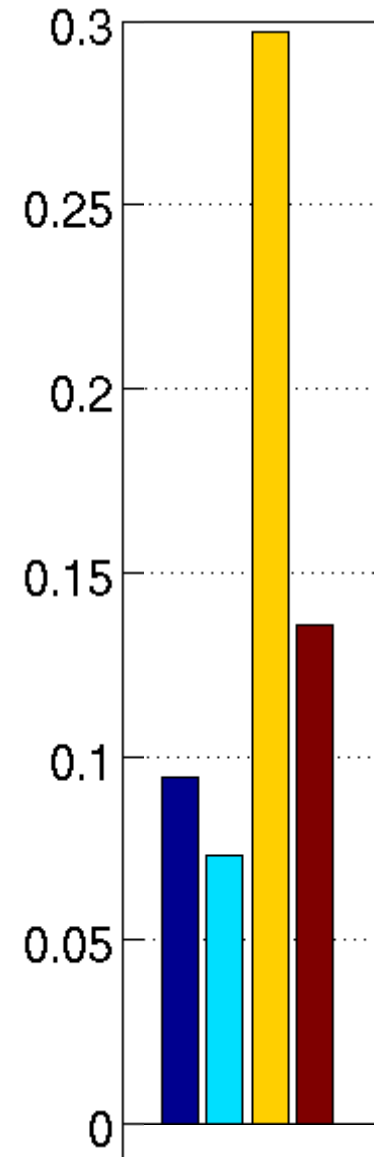
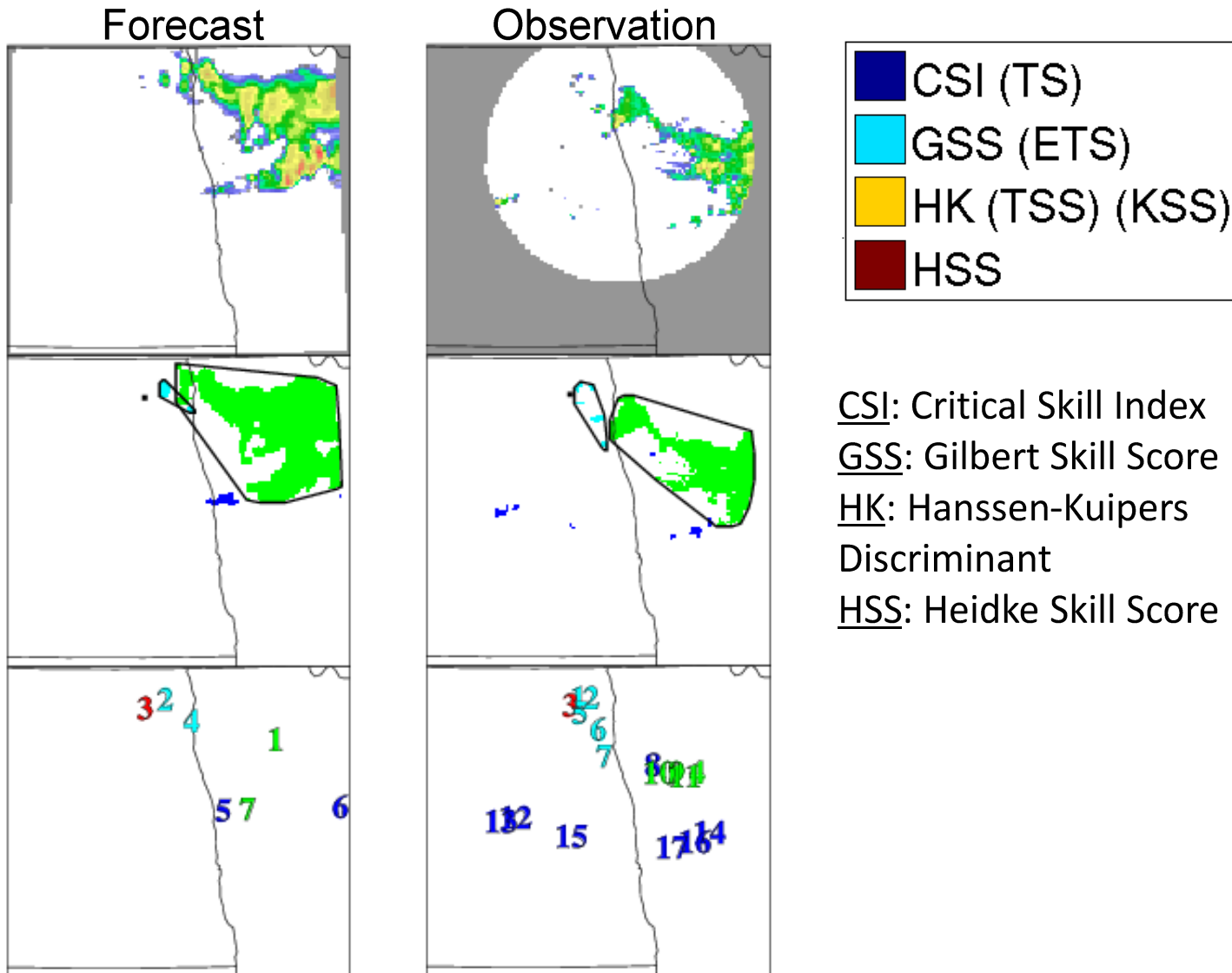
MODE

- Method for Object-based Diagnostic Evaluation (MODE).
- (a) Raw data field.
- (b) Apply circular convolution.
- (c) Mask data in certain regions or below certain thresholds.
- (d) Declare objects.



Methodology

MODE



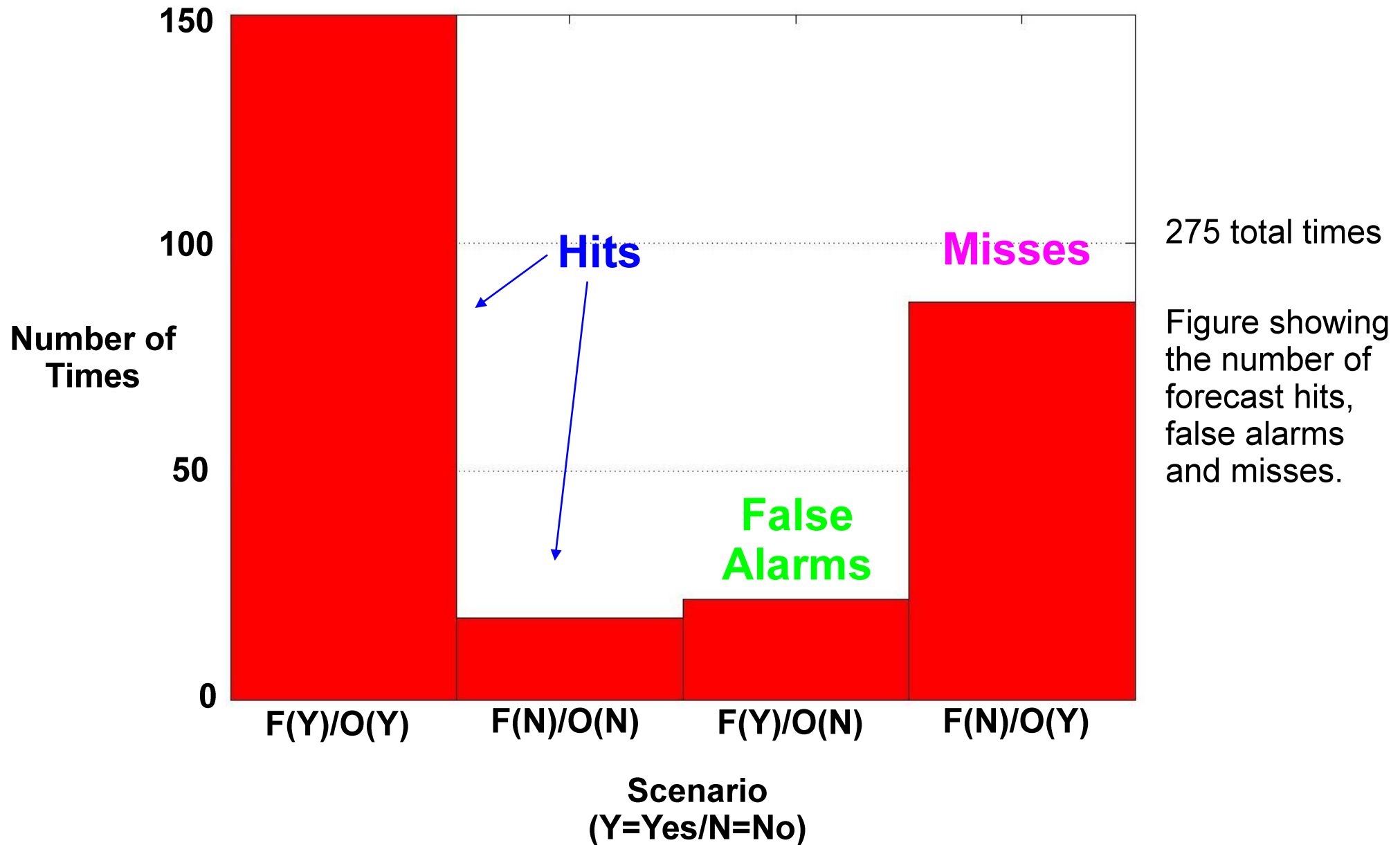
Example of MODE analysis, June 24th, 2010

Methodology

- MODE collects objects counts and area size
 - Can be used to determine forecast skill:
 - Areal Coverage
 - Difference in areal coverage of convection between fcst/obs domains
 - Binned Object Counts
 - Total number of fcst/obs objects binned by area
- For Forecast vs. Observation Comparison:
 - WRF forecasts were valid every hour. Comparison was made only when radar data existed within 30 minutes of a valid forecast.
 - Only forecasts 3 hrs to 24 hrs out were used.

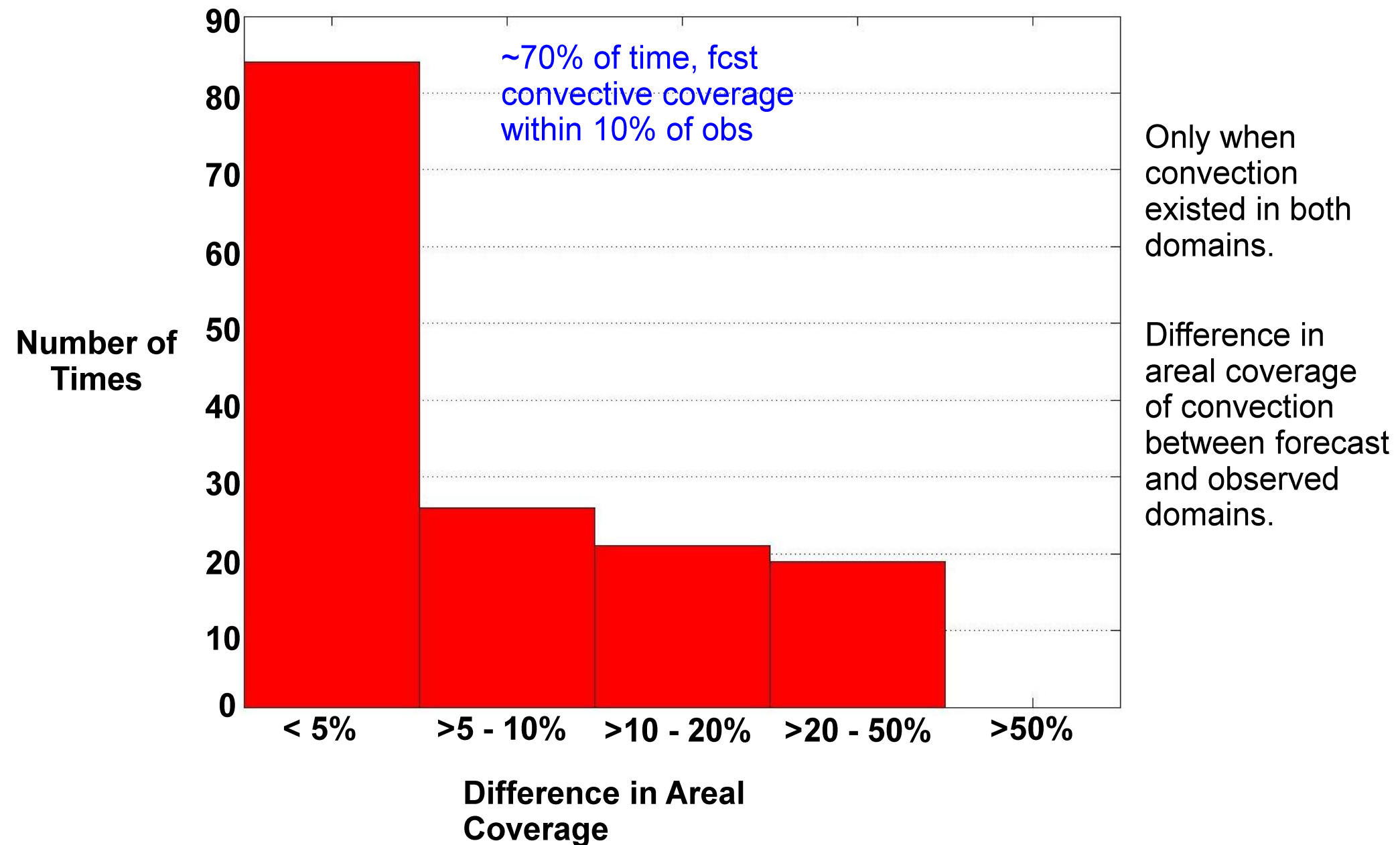
Results

Convection In the Domain



Results

Areal Coverage



Results

Object Counts and Sizes

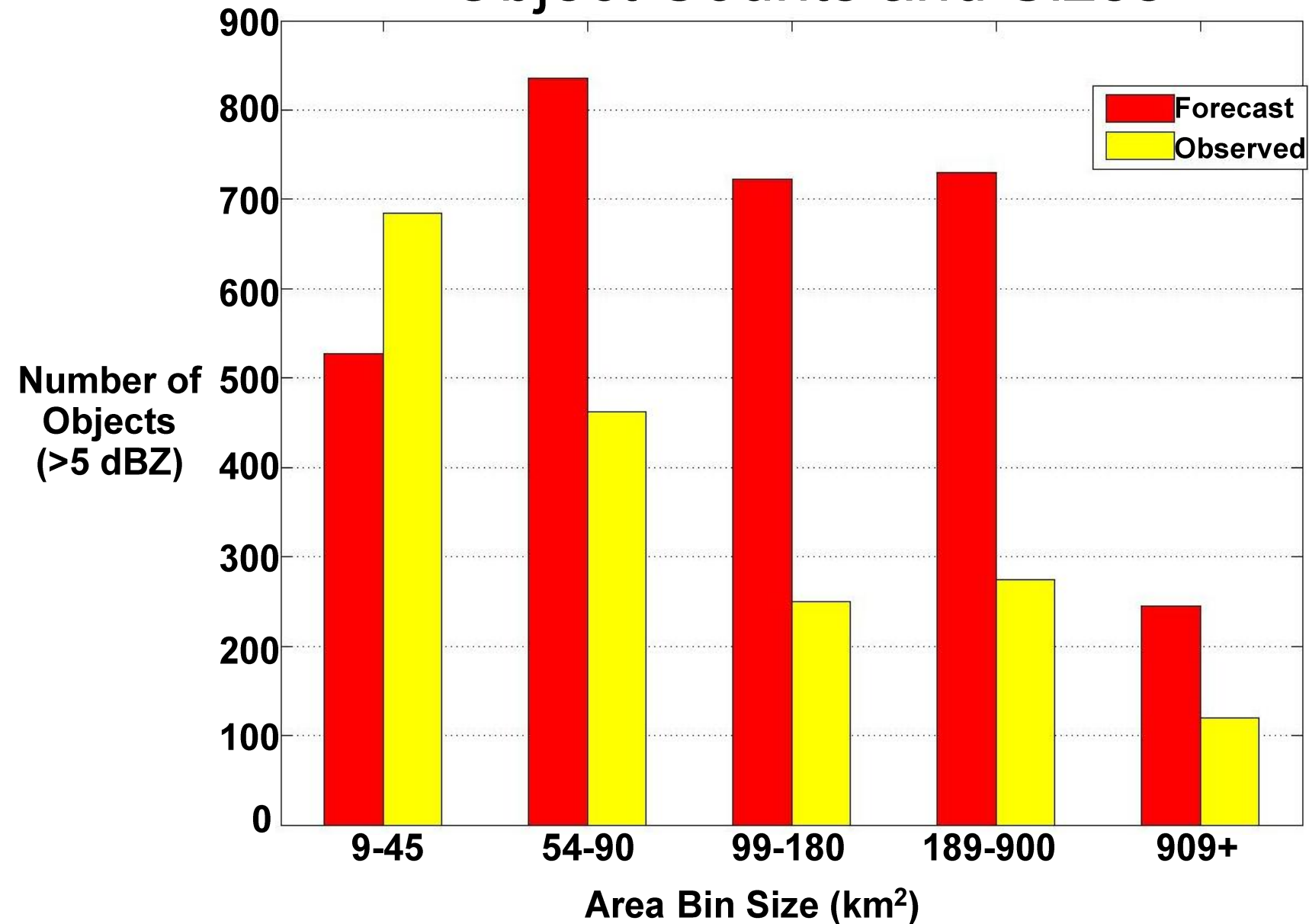


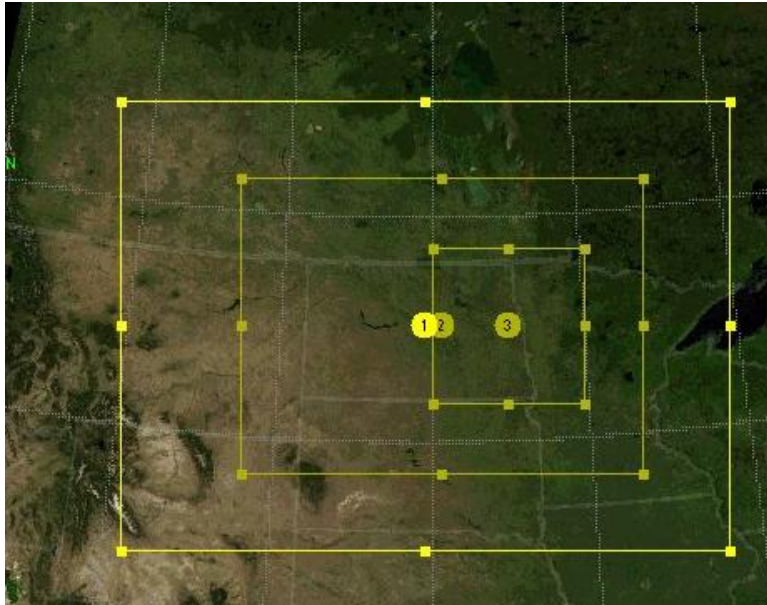
Figure showing
all forecast and
observed objects
binned by area.

Results

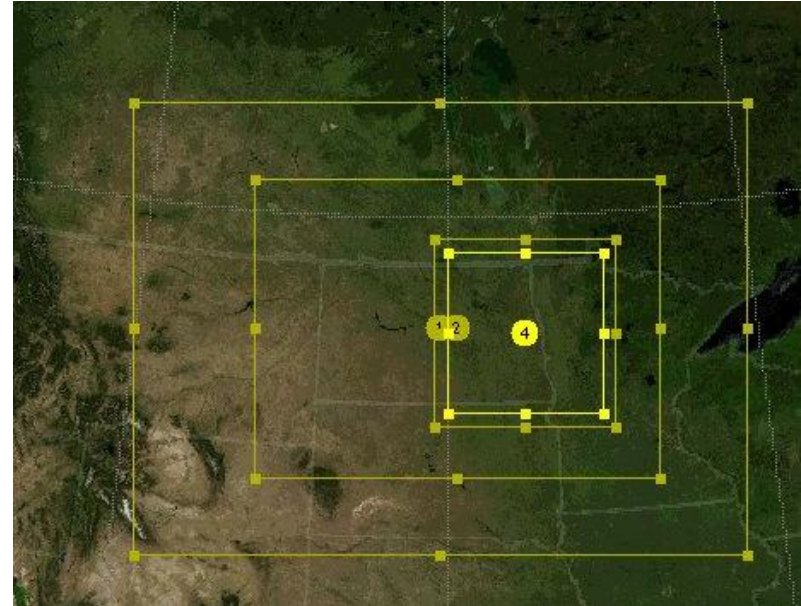
- Under-forecasting can be seen in the smallest bin, 9-45 km².
 - Corresponding to forecast misses
- Over-forecasting seen in all other bins, with significant over-forecasting in 54-90, 99-180, and 189-900 km² bins.
- Hypothesis:
 - 3 km resolution not resolving smaller-scale features.
 - 1 km should theoretically better resolve these features.

Model Setup

(a) 3 km Grid Structure



(b) 1 km Grid Structure



- (a) Outer grid is the parent 27 km, with a nested 9 km and nested 3 km grid (POLCAST3 structure).
- (b) 3 km grid was extended just enough to allow for the 1 km grid to be nested.

Model Setup

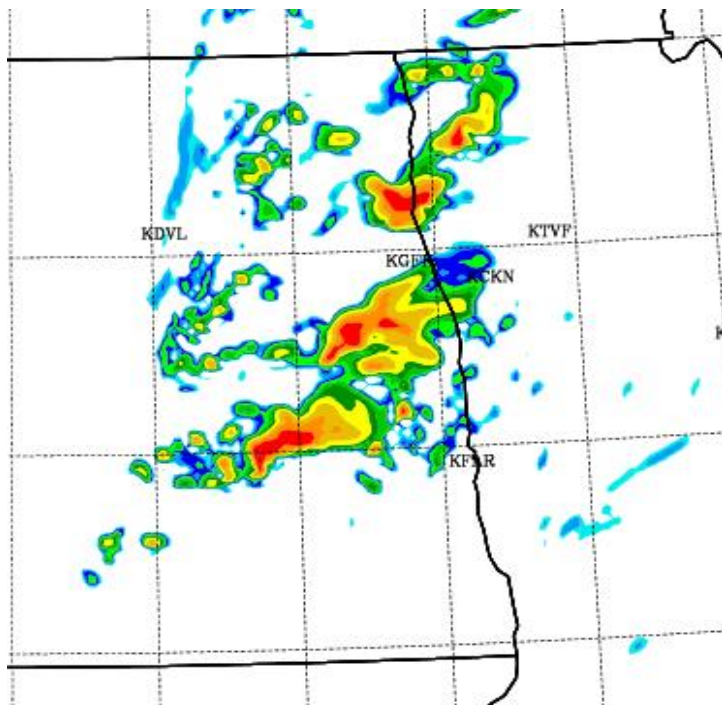
- WRF v3.2.1 (initialized 00z)
- Physics unchanged between runs

Microphysics	WRF Single Moment 6-Class
Longwave radiation	Rapid Radiative Transfer Model
Shortwave radiation	Dudhia Scheme
Surface Layer	MM5 Similarity
Land Surface	Noah Land Surface Model
Planet Boundary Layer	Yonsei University Scheme
Cumulus Parameterization*	Kain-Fritsch

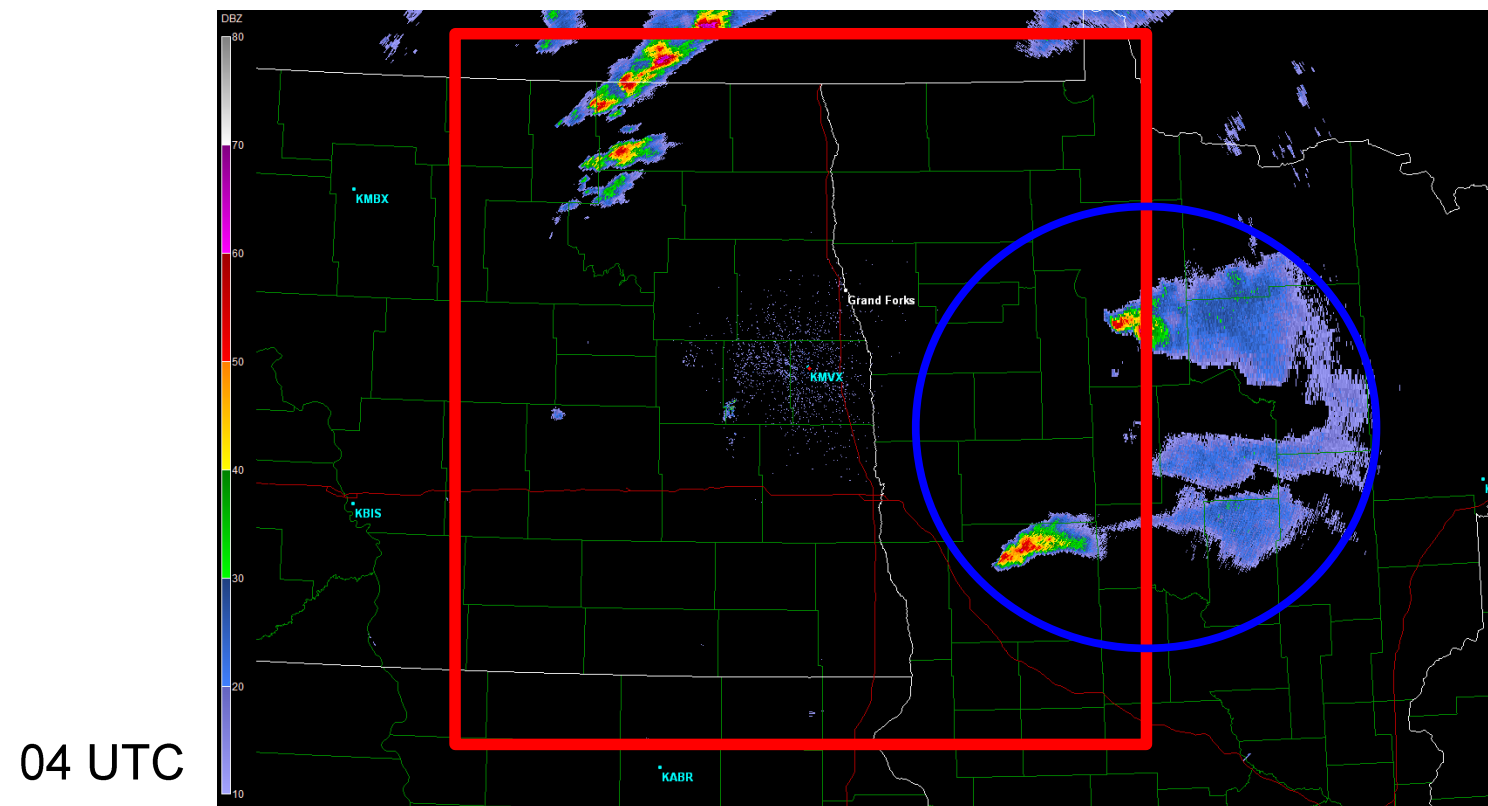
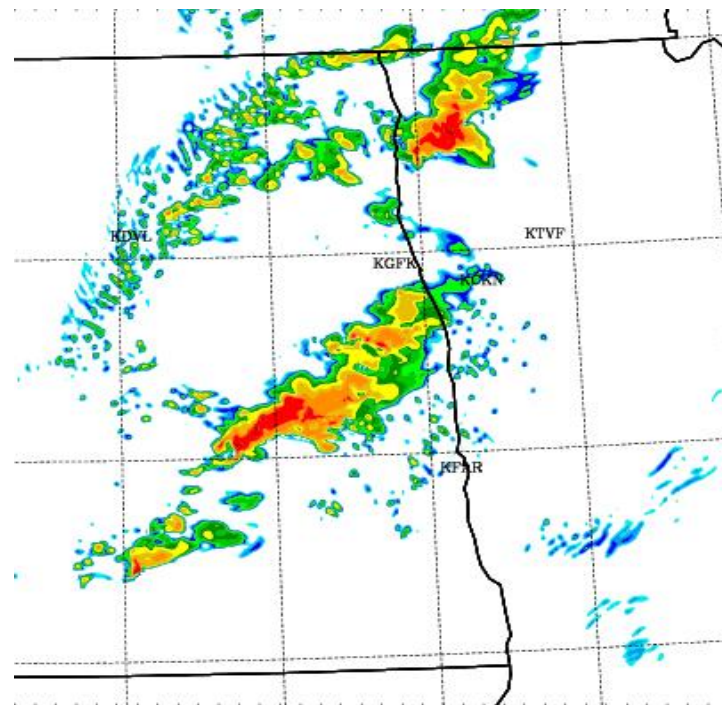
* - 27 km and 9 km grids only

- Initialized using NARR 32-km
- Case Day: July 14th, 2010

A vertical color bar representing the dBZ scale. The scale is marked with values 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75. The colors transition from light blue at the bottom (5 dBZ) through green, yellow, orange, red, and magenta to dark purple at the top (75 dBZ).

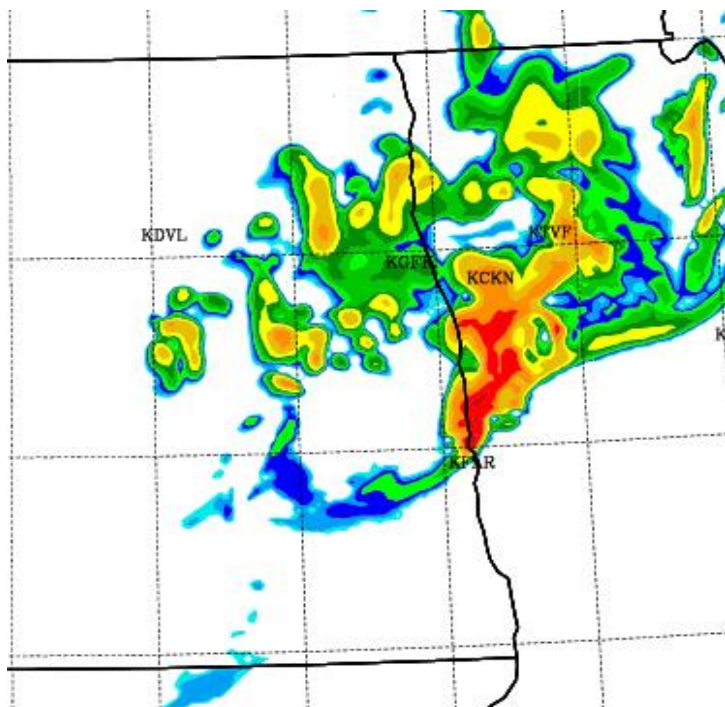
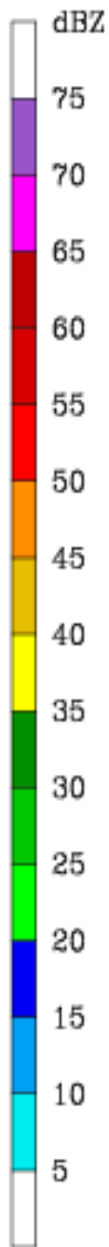


A vertical color bar representing the dBZ scale. The scale ranges from 10 to 80 dBZ, with major tick marks at 10, 20, 30, 40, 50, 60, 70, and 80. The colors transition from light blue at 10 dBZ, through green, yellow, orange, red, and magenta, to white at 80 dBZ.

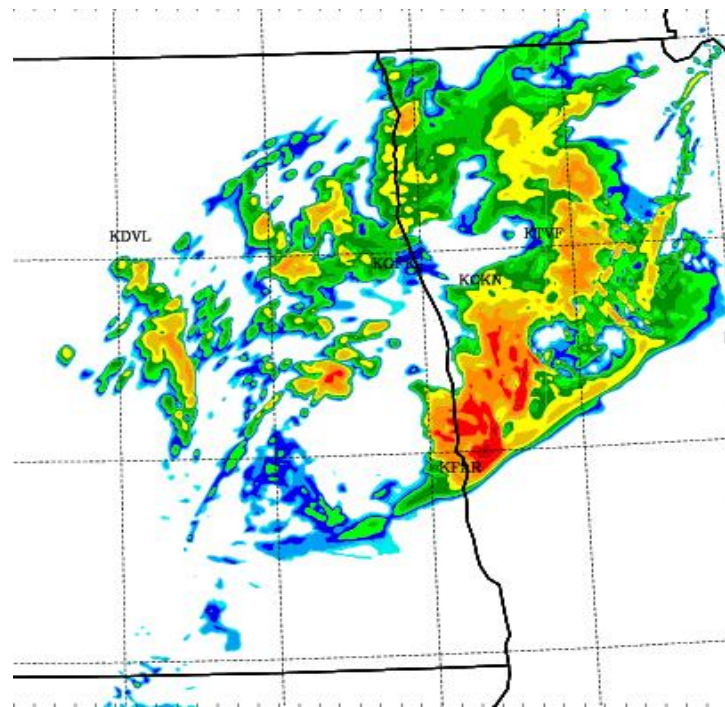


04 UTC

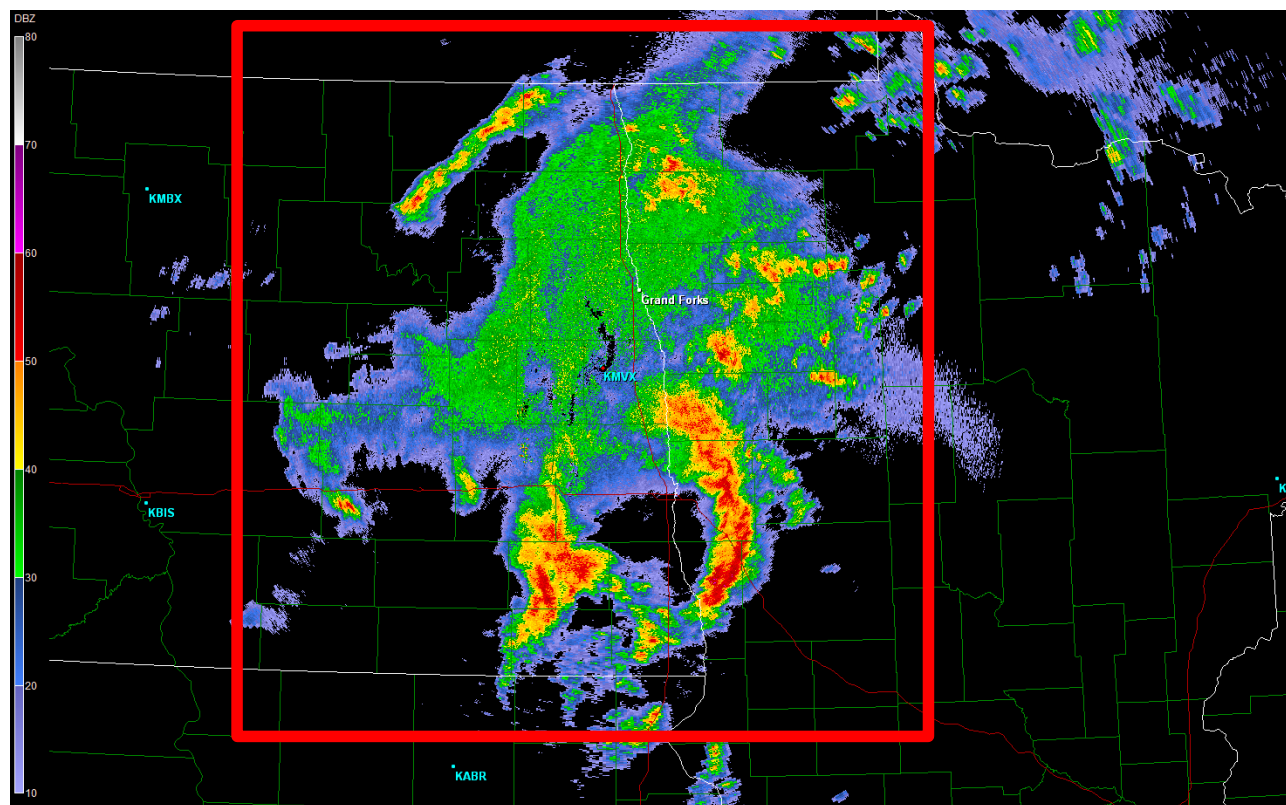
3 km



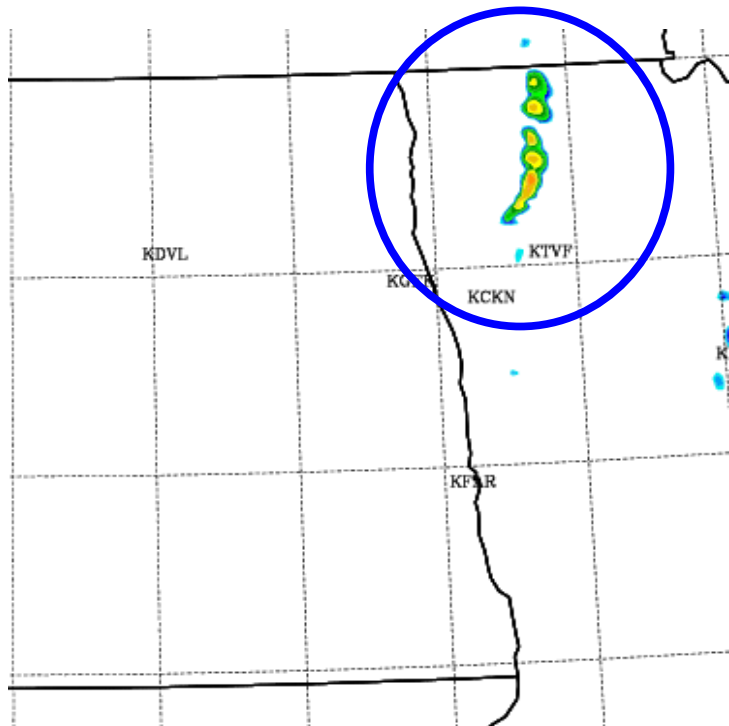
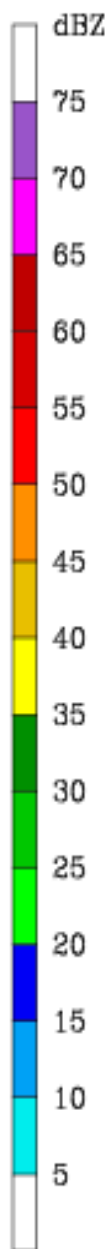
1 km



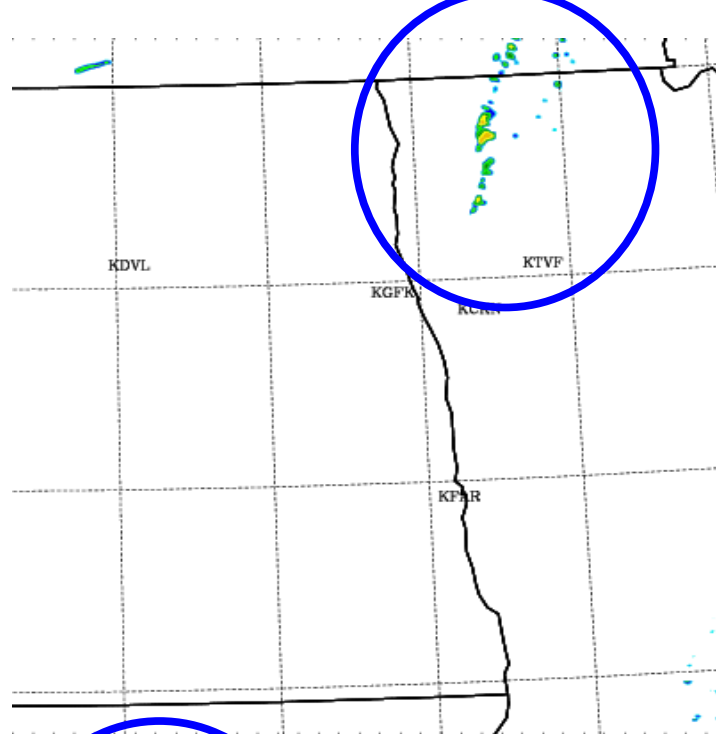
11 UTC



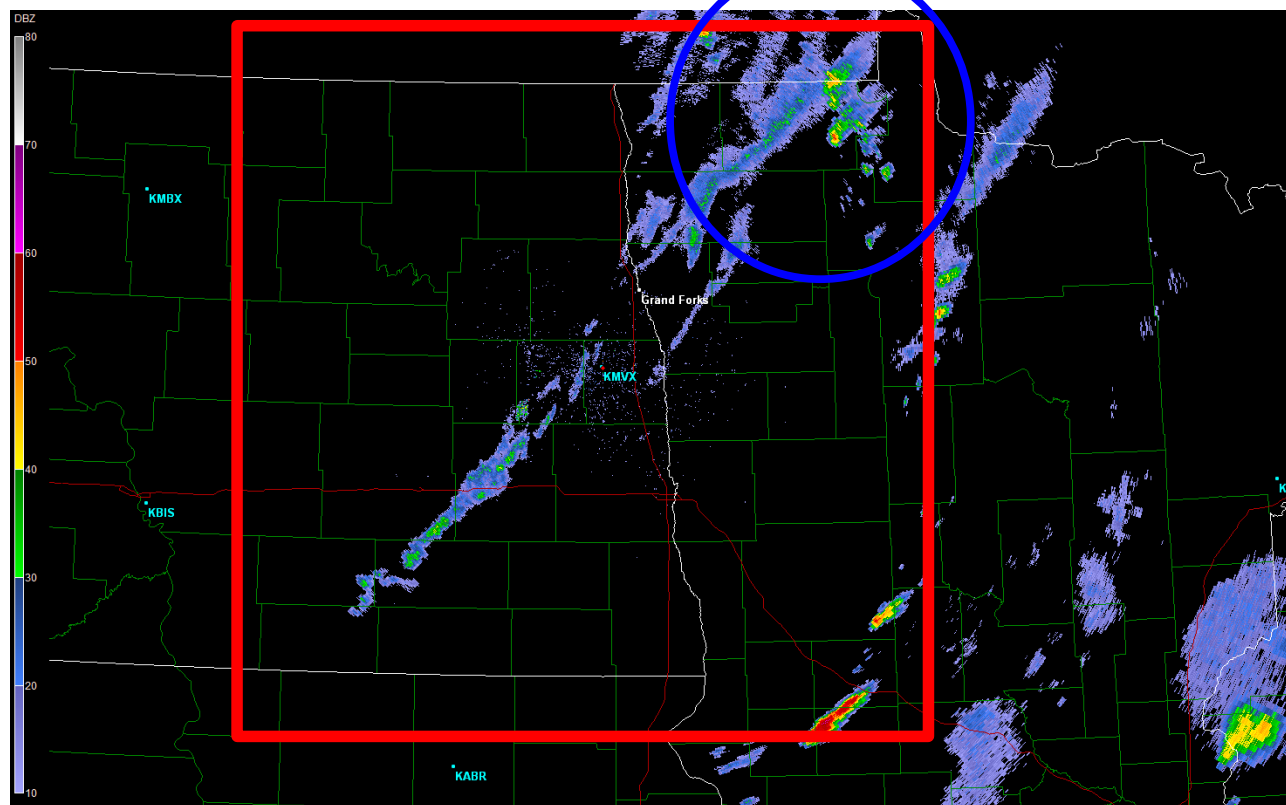
3 km



1 km

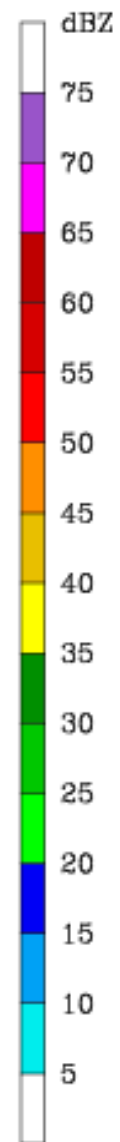
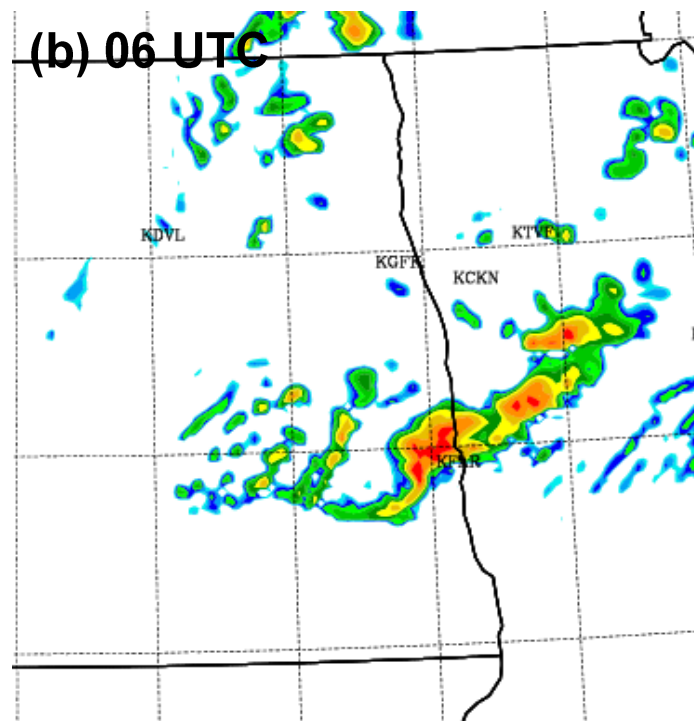
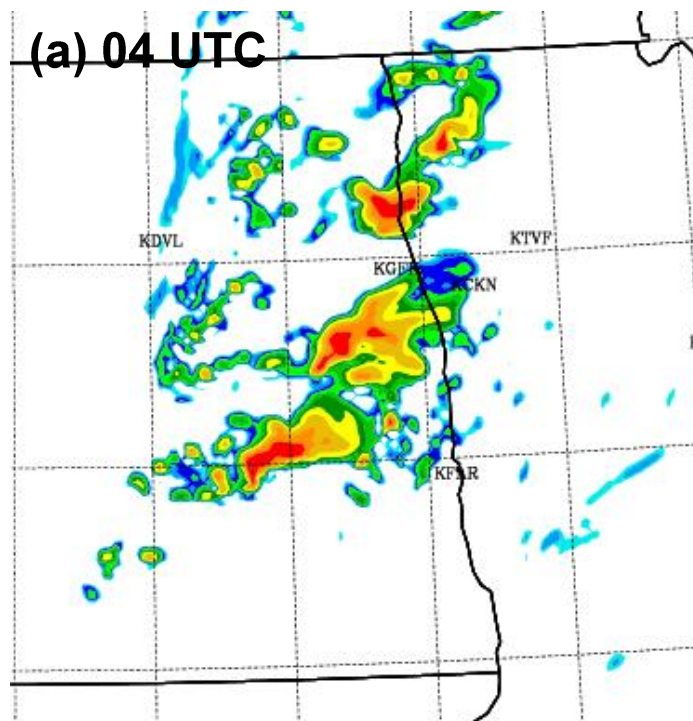


20 UTC

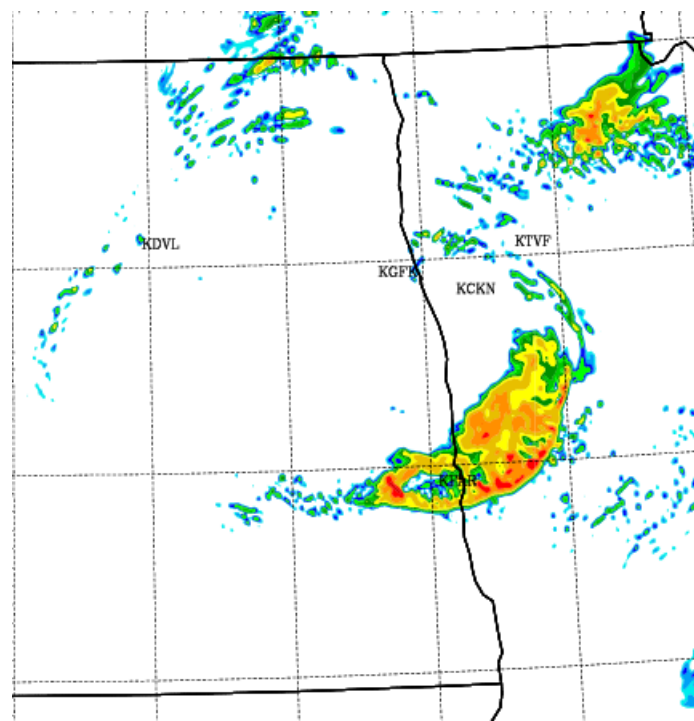
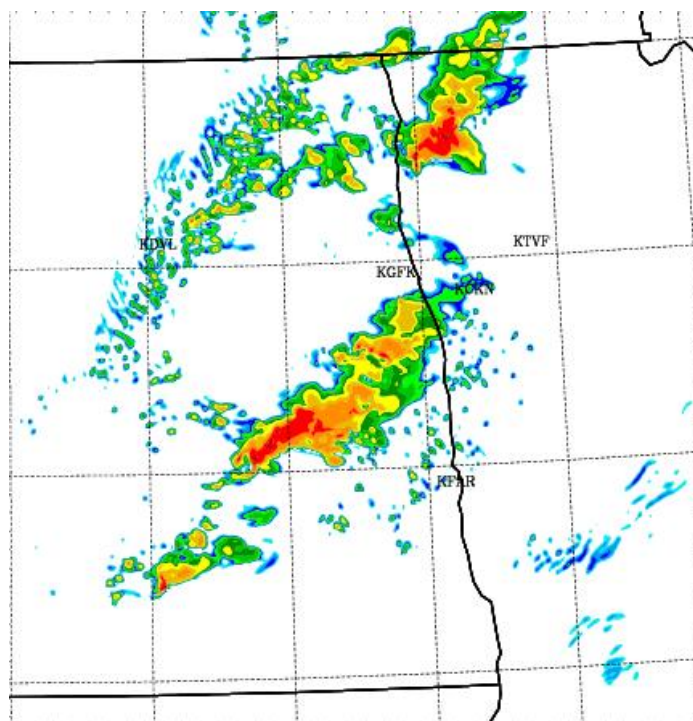


Simulated Reflectivity

3 km



1 km



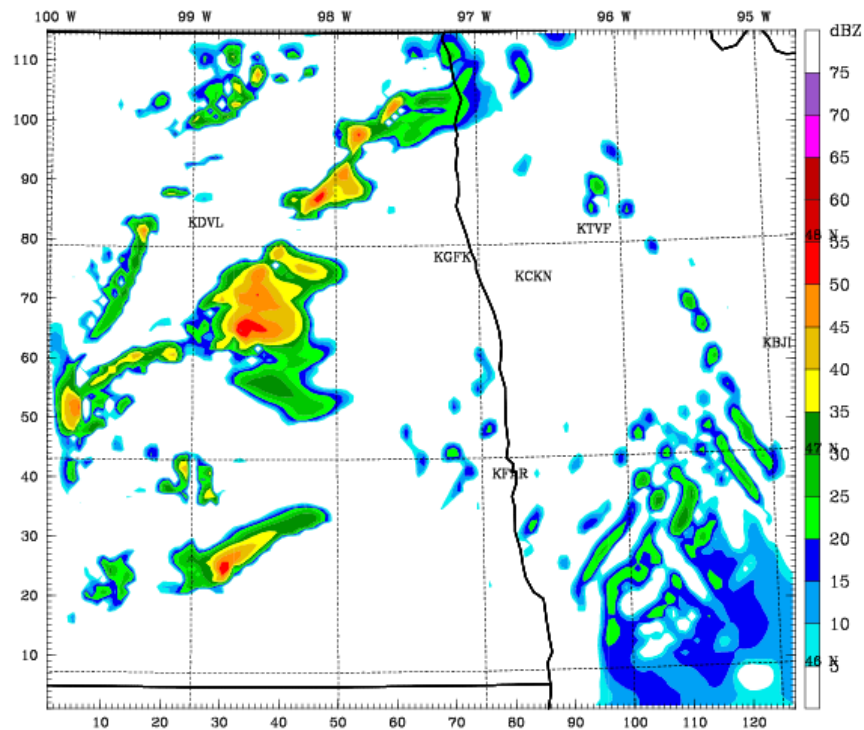
Conclusion

- 1-km provides more detail in mesoscale dynamics and processes
- Models runs look more identical to each other than observed
- Forecast skill
 - For the case study, there is no direct increase in forecast skill by switching from 3-km to 1-km grid spacing
 - More detail provide by 1-km may help forecaster subjectivity identify important features

Future Work

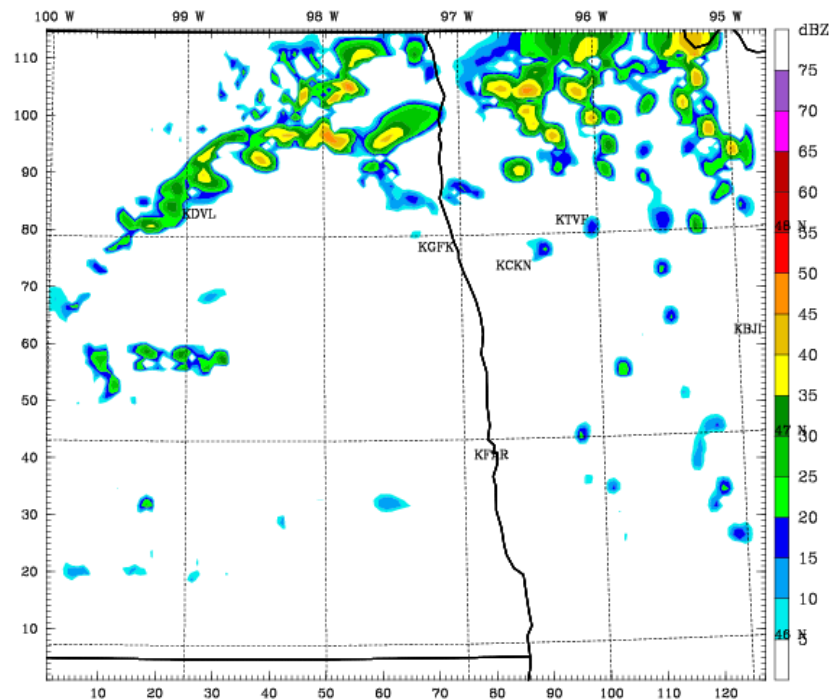
- Look at additional cases
- POLCAST4 field campaign ran 1 km and 3 km resolution model runs.
 - Output from model runs saved (40 km NAM)
 - Radar data needs to be processed
 - Will allow for quantitative results

Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 4.00 h Valid: 0400 UTC Wed 14 Jul 10 (2300 CDT Tue 13 Jul 10)
 Reflectivity () at height = 1.00 km



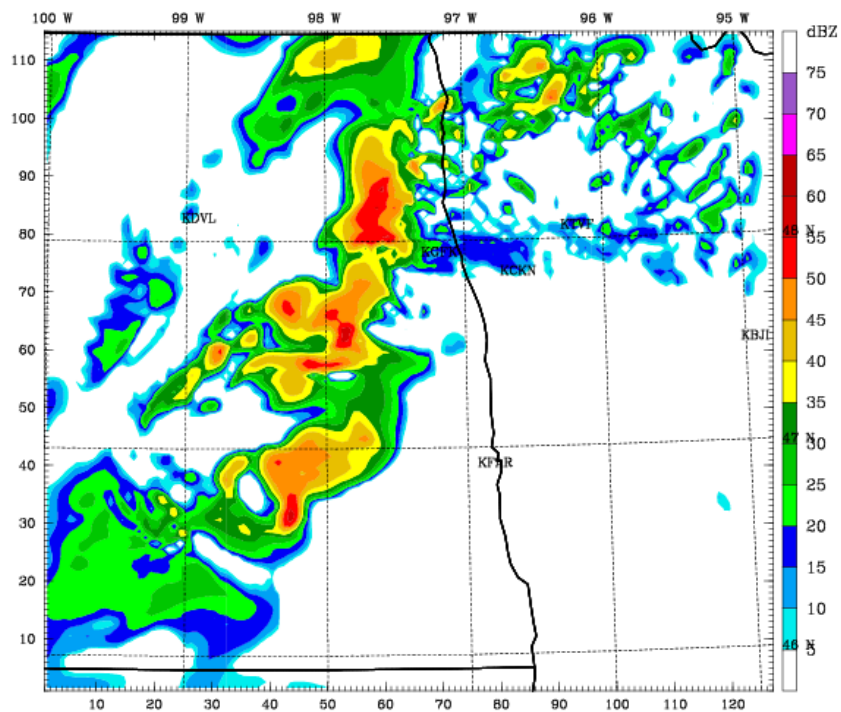
Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 6.00 h Valid: 0600 UTC Wed 14 Jul 10 (0100 CDT Wed 14 Jul 10)
 Reflectivity () at height = 1.00 km



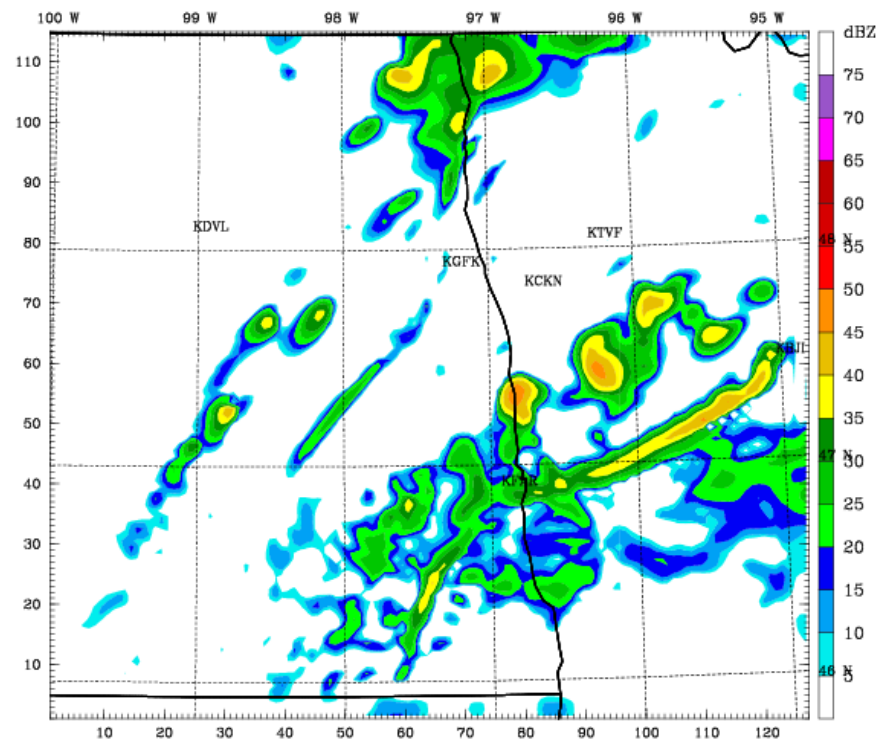
Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 10.00 h Valid: 1000 UTC Wed 14 Jul 10 (0500 CDT Wed 14 Jul 10)
 Reflectivity () at height = 1.00 km



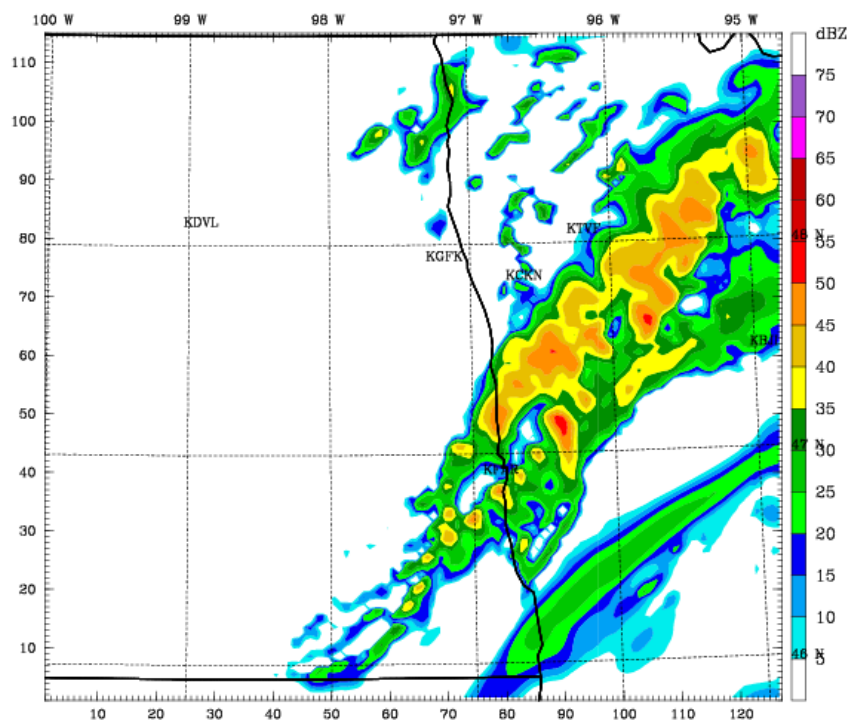
Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 14.00 h Valid: 1400 UTC Wed 14 Jul 10 (0900 CDT Wed 14 Jul 10)
 Reflectivity () at height = 1.00 km



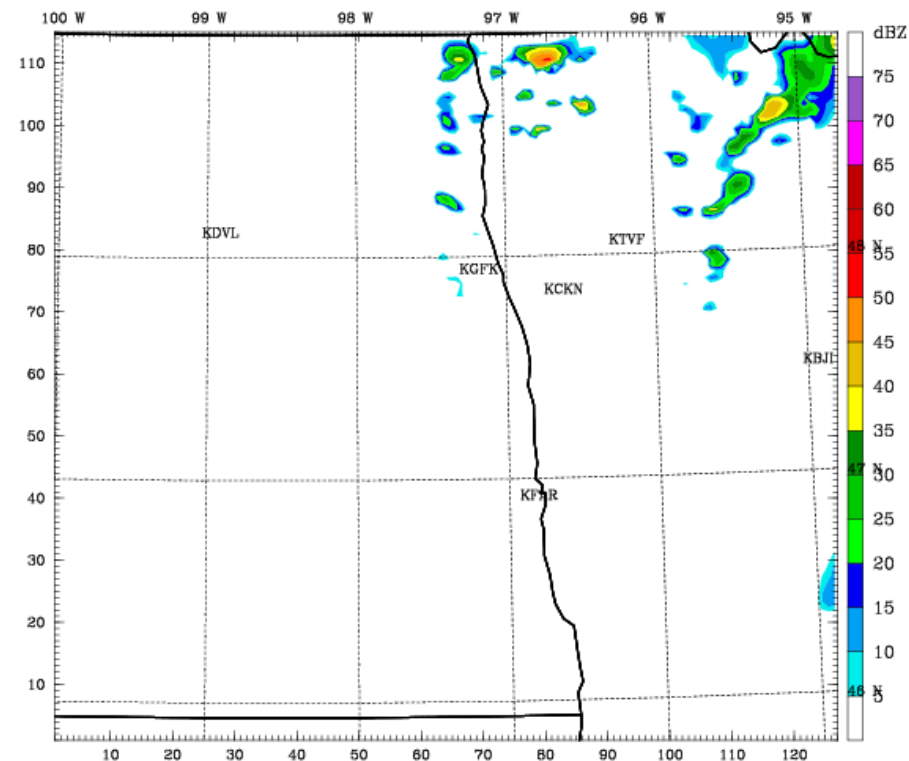
Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 17.00 h Valid: 1700 UTC Wed 14 Jul 10 (1200 CDT Wed 14 Jul 10)
 Reflectivity () at height = 1.00 km



Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

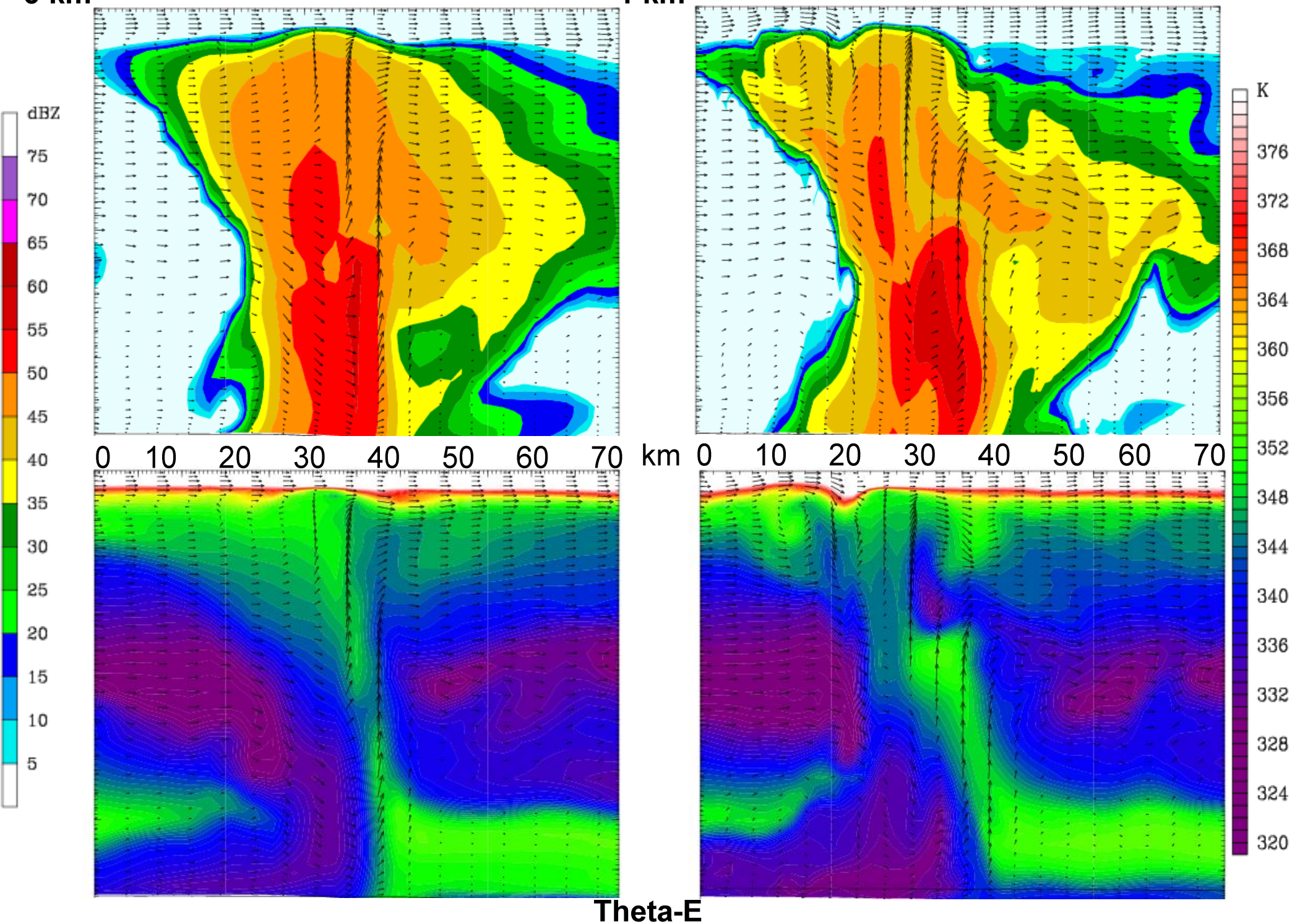
Dataset: 14d03 RIP: rip dbz Init: 0000 UTC Wed 14 Jul 10
 Fcst: 21.00 h Valid: 2100 UTC Wed 14 Jul 10 (1600 CDT Wed 14 Jul 10)
 Reflectivity () at height = 1.00 km

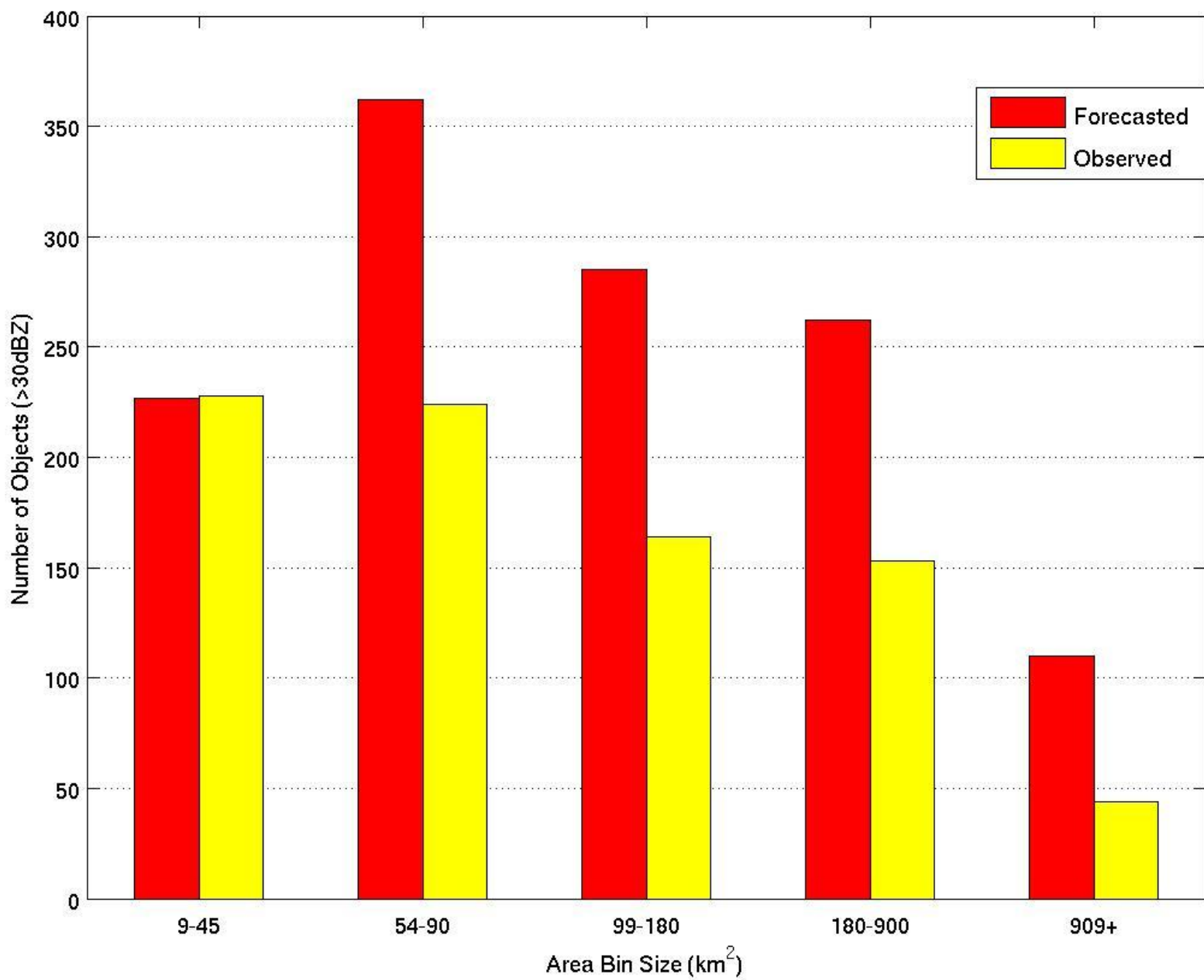


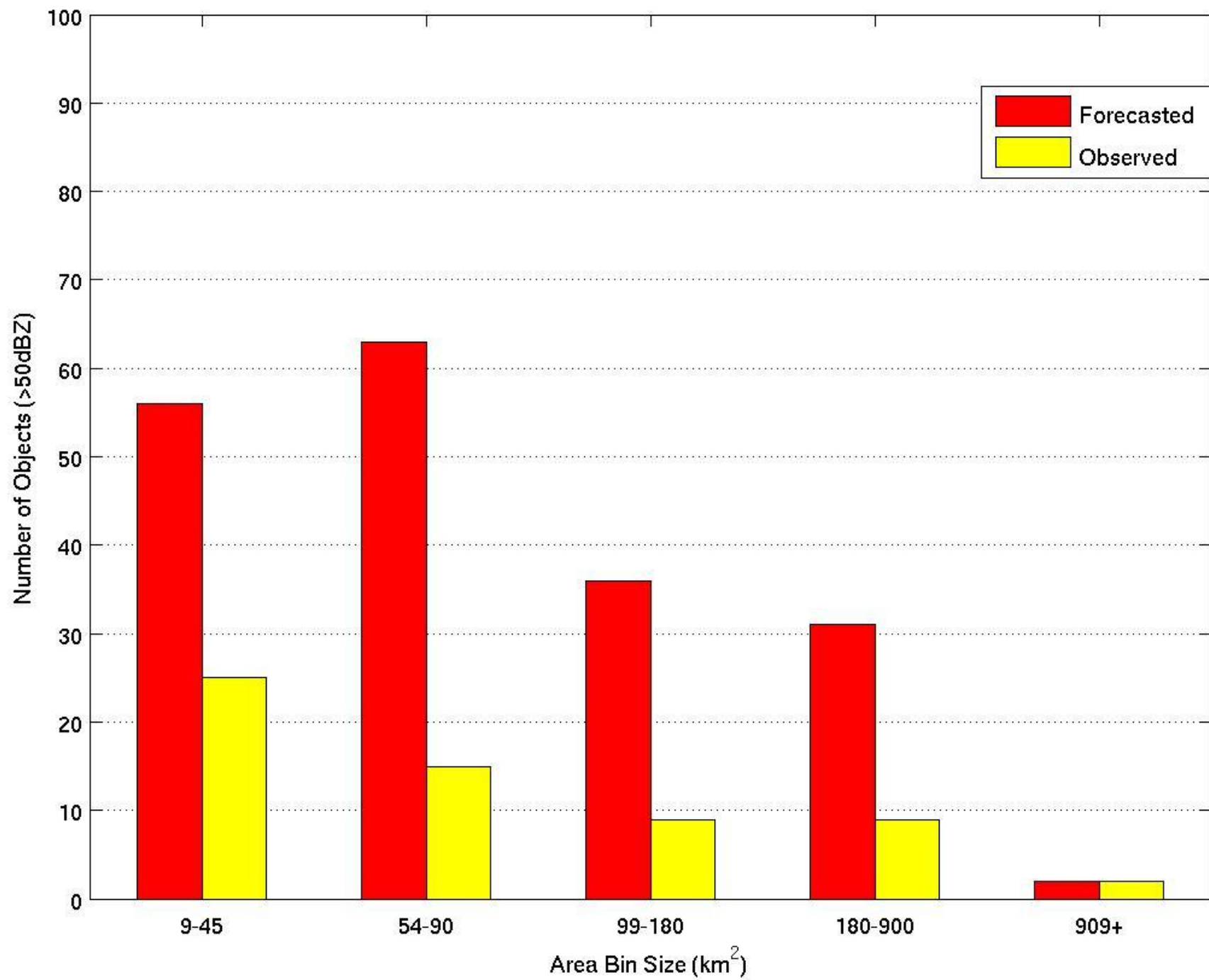
Model Info: V3.1.1 No Cu YSU PBL WSM 6class Noah LSM 3.0 km, 44 levels, 3 sec
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

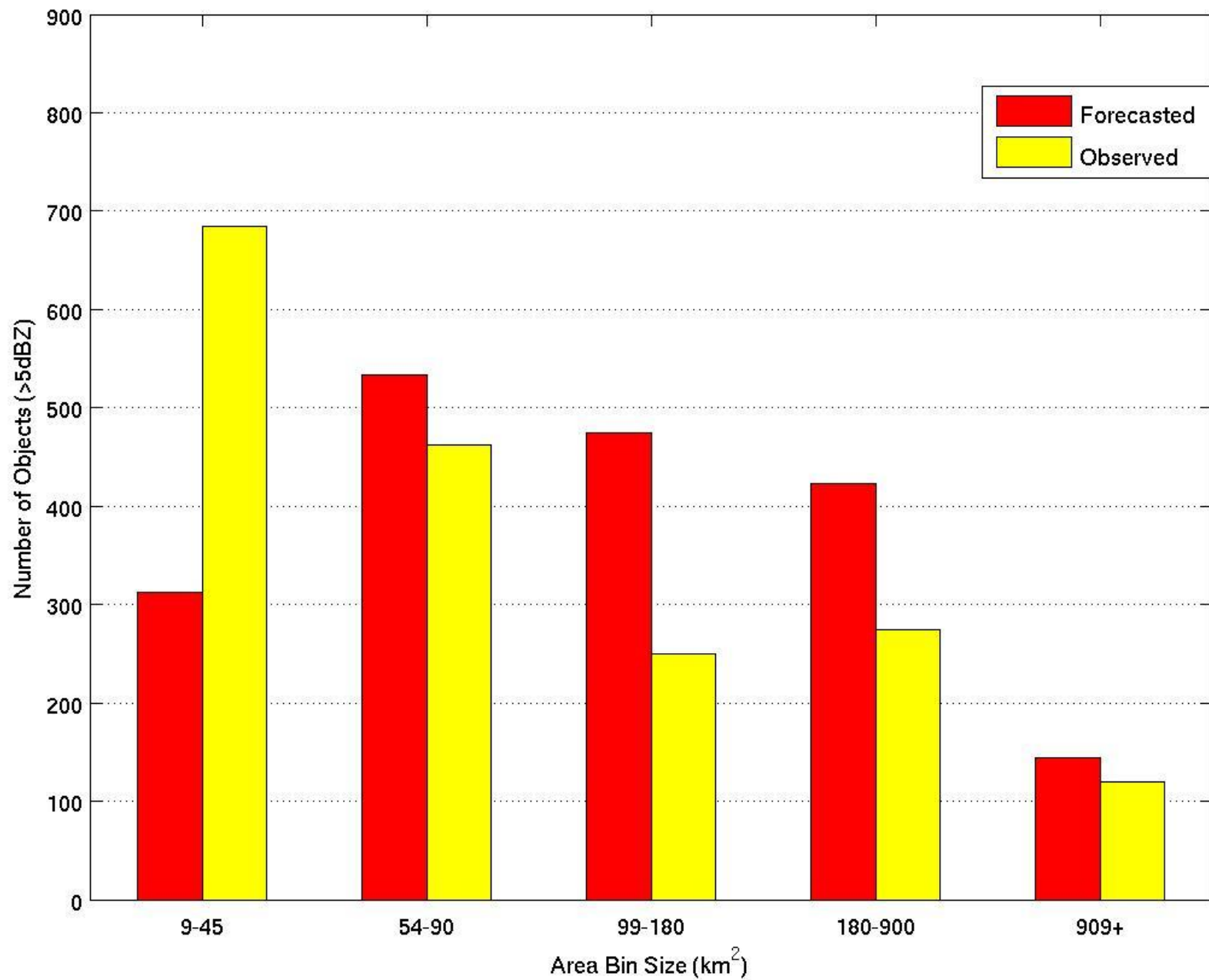
3 km

1 km



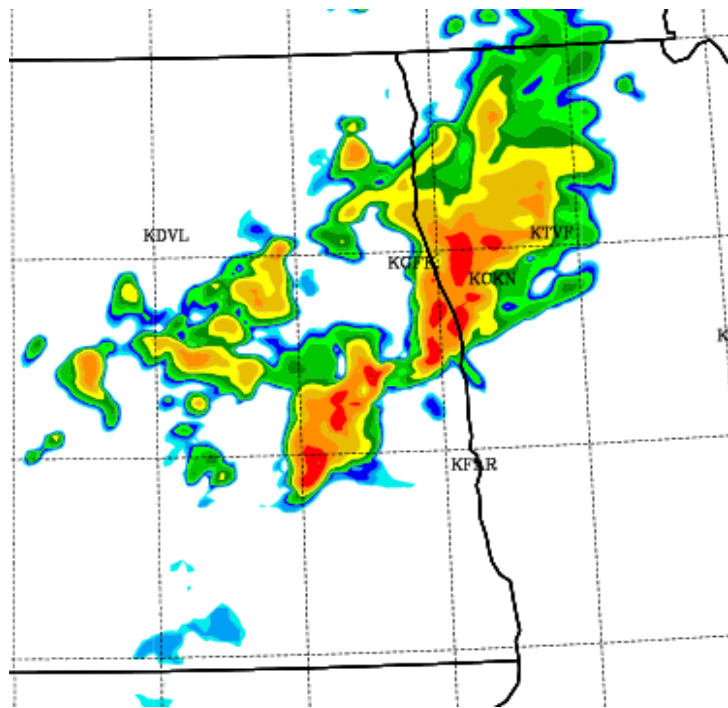




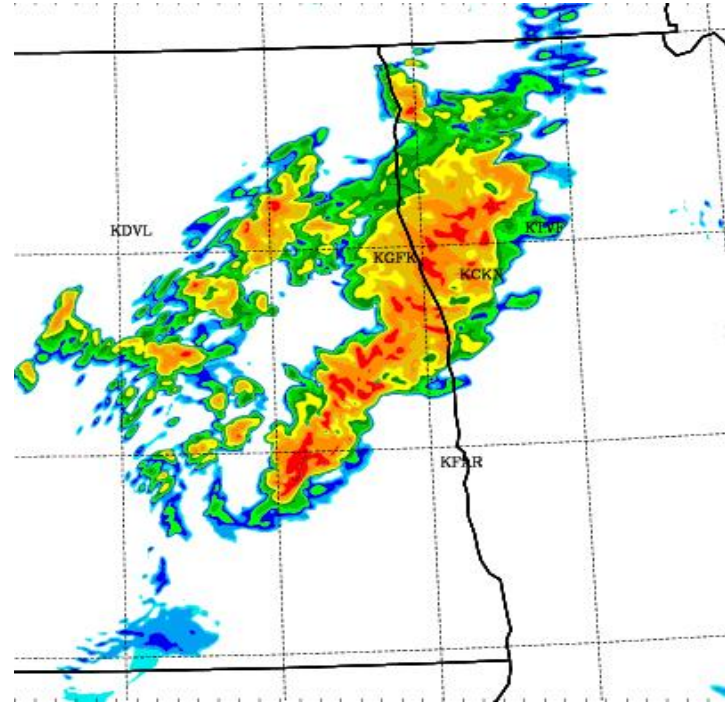


(Masked)

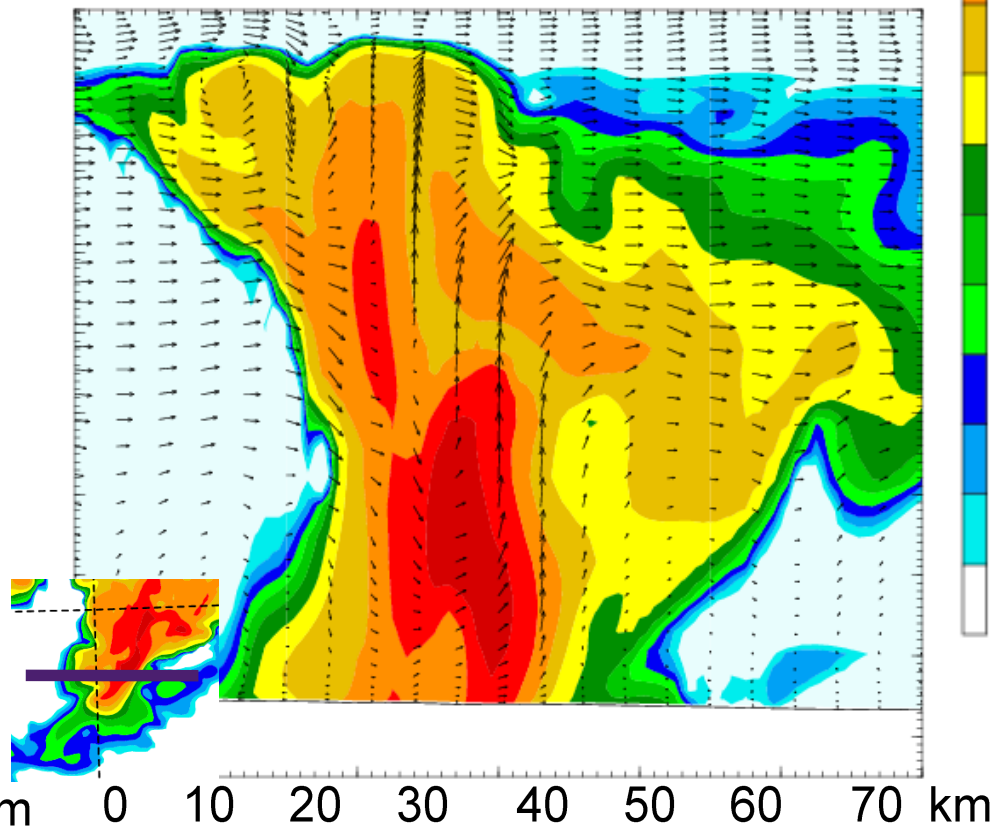
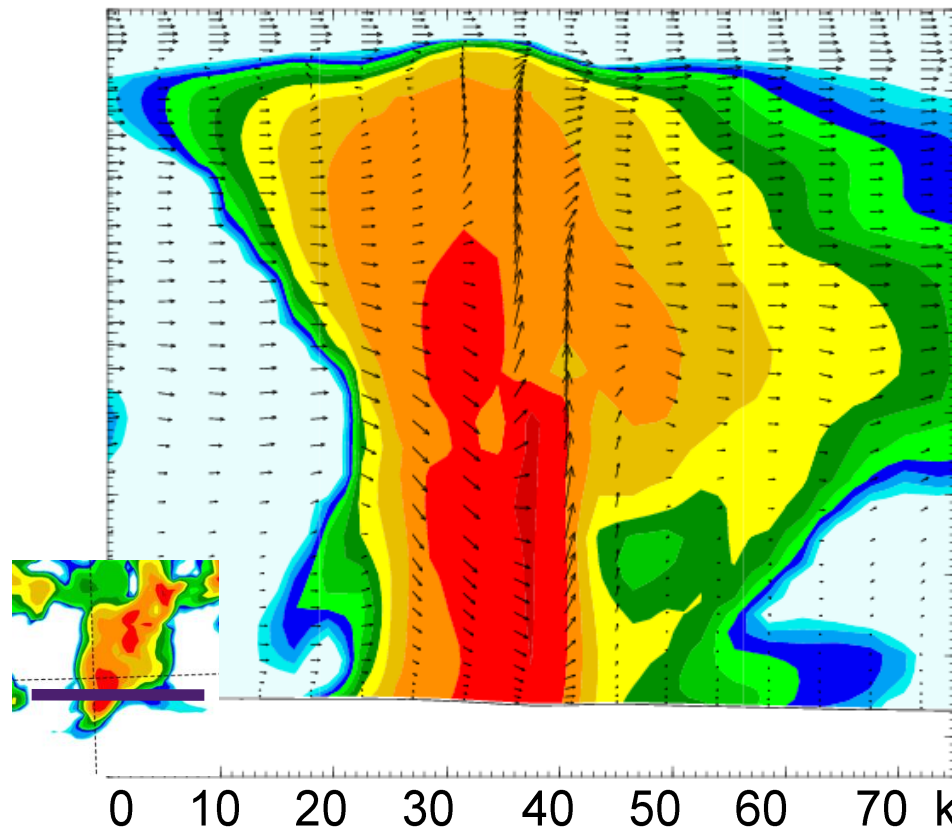
3 km



1 km



10 UTC



3 km

1 km

