

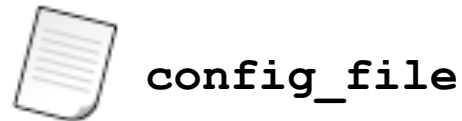
Running MODE and MODE Analysis Tool



Verifying WRF with Objects

Dave Ahijevych

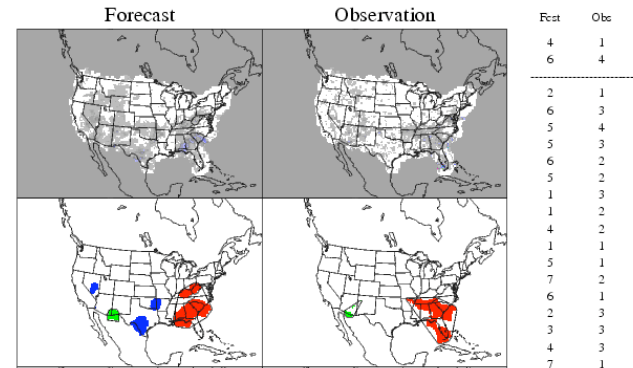
Running MODE - Input



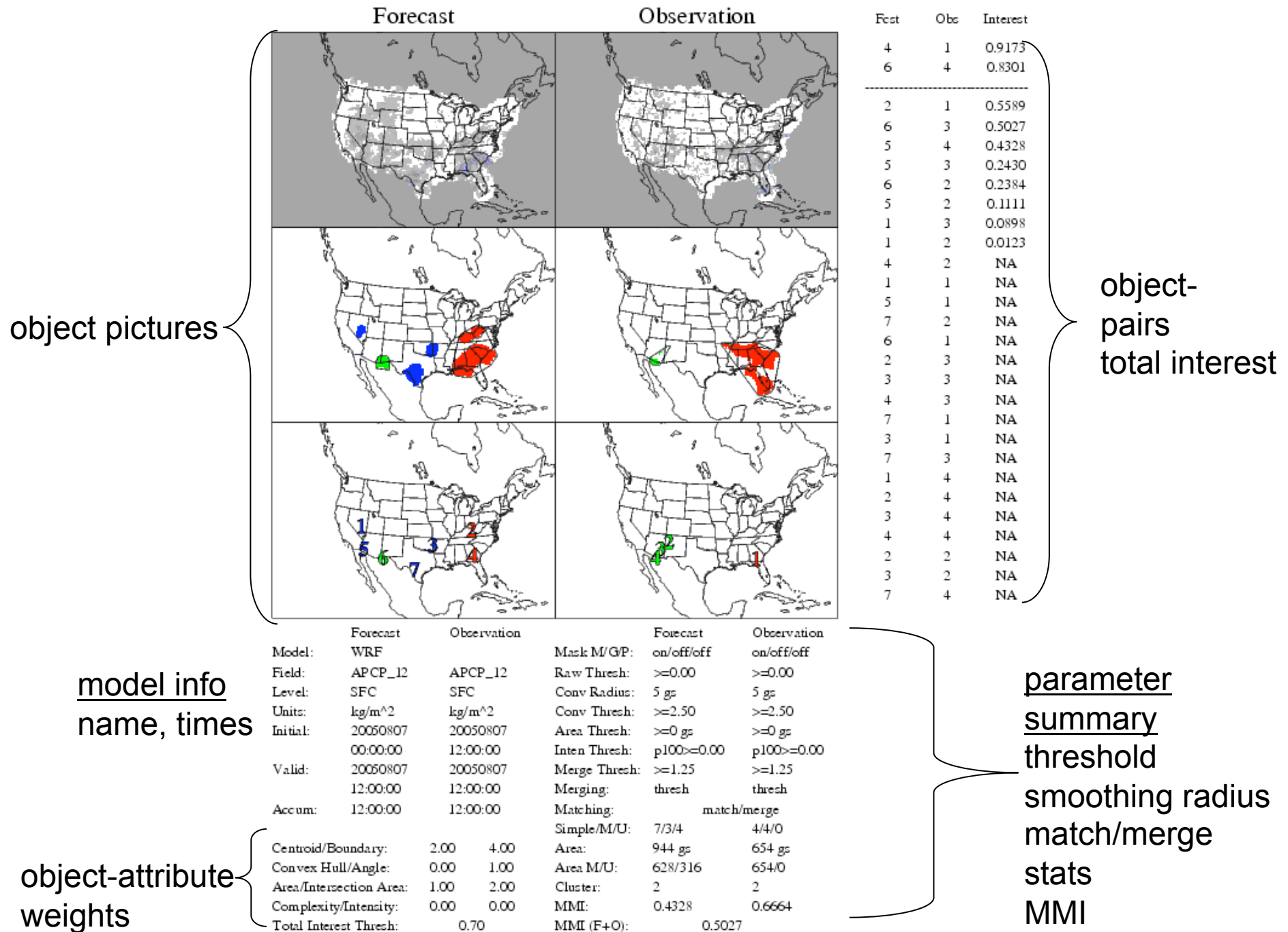
- 2 fields on the same grid
 - **F** (forecast_file) and **O** (observation_file)
- configuration settings (config_file)
- Usage
 - `mode forecast_file observation_file config_file`

Running MODE - Output

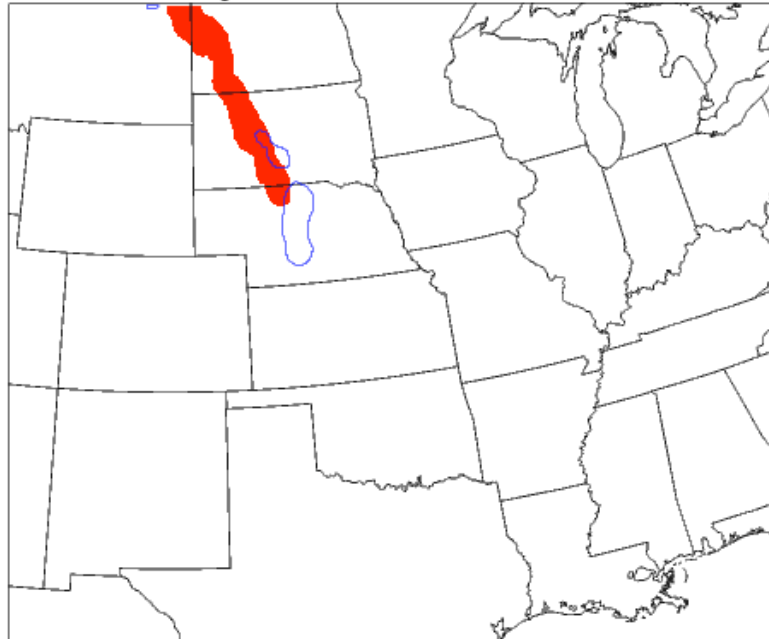
- PostScript
 - object pictures
 - parameter summary
 - total interest for each object pair



MODE: APCP_12 at SFC vs APCP_12 at SFC

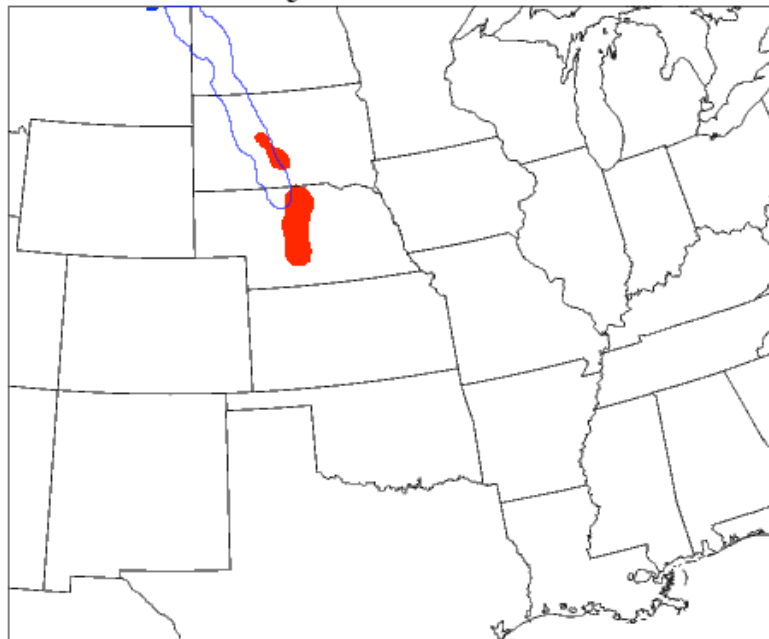


Forecast Objects with Observation Outlines



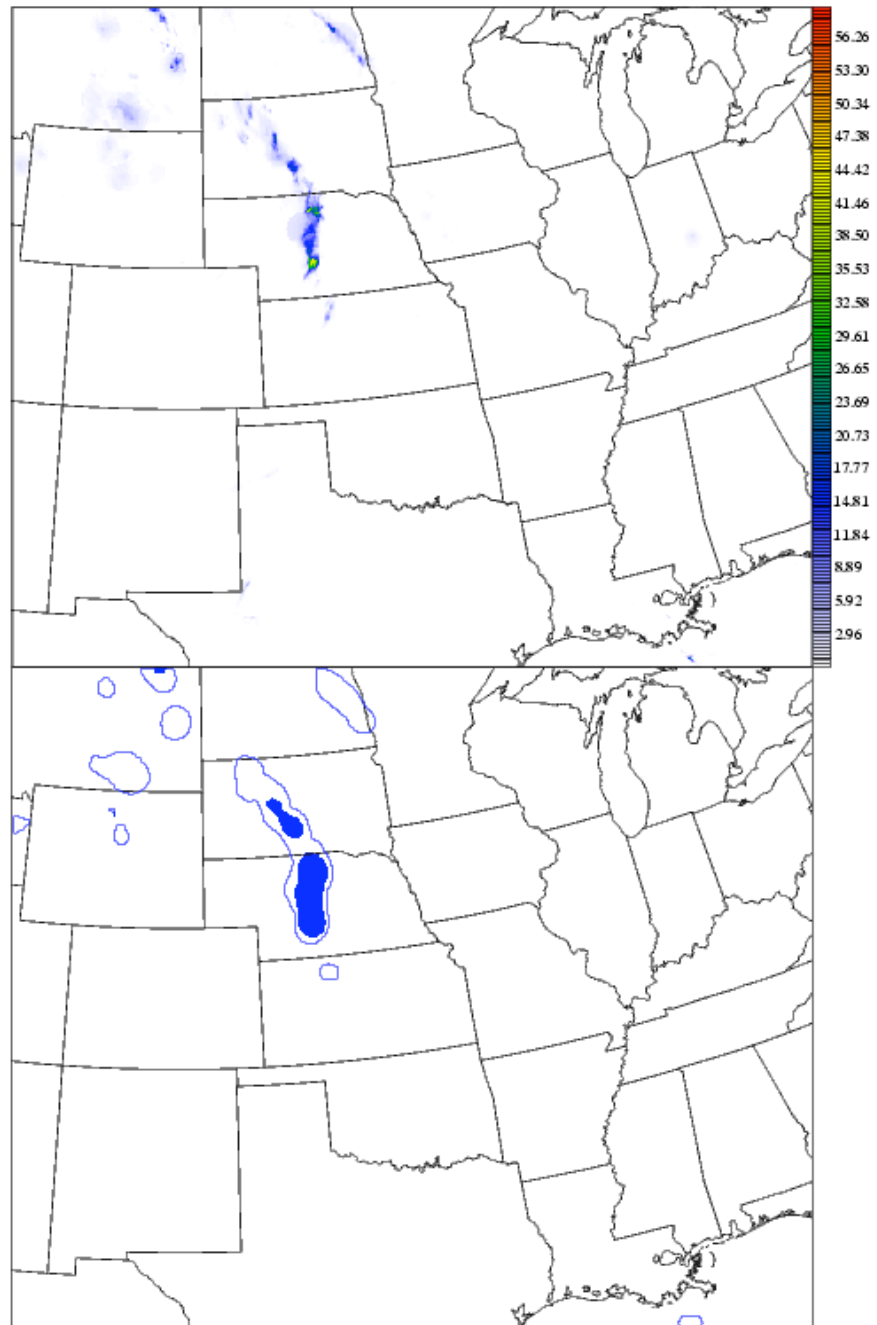
Forecast and Observation
Overlaid

Observation Objects with Forecast Outlines



Merging Objects with Double Threshold

Observation: Threshold Merging

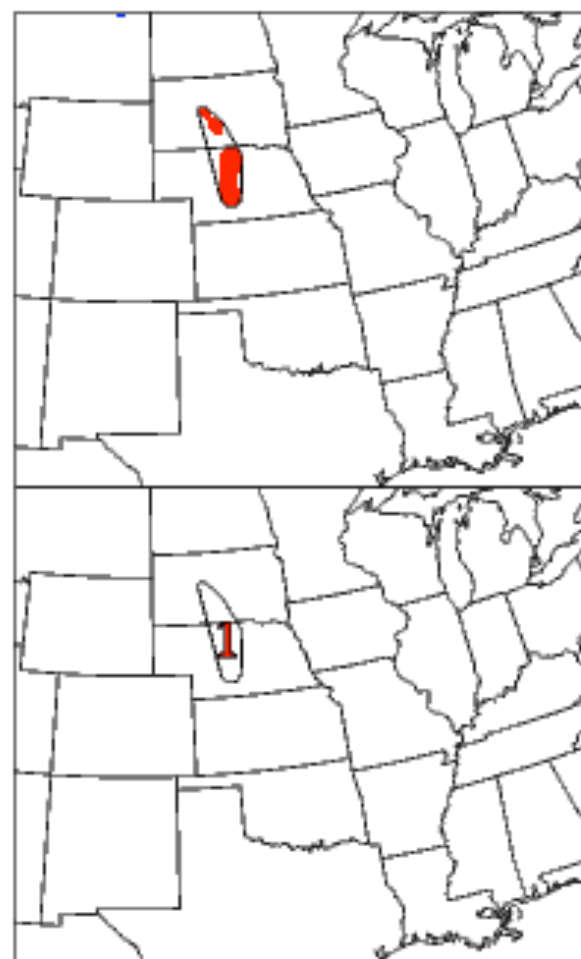


Cluster Object Information

Forecast



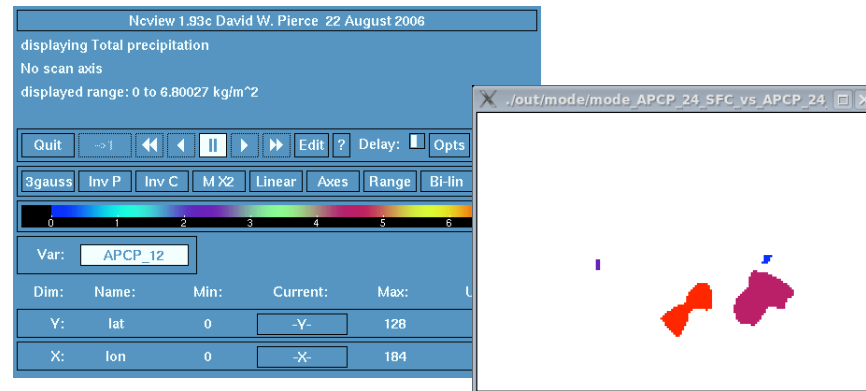
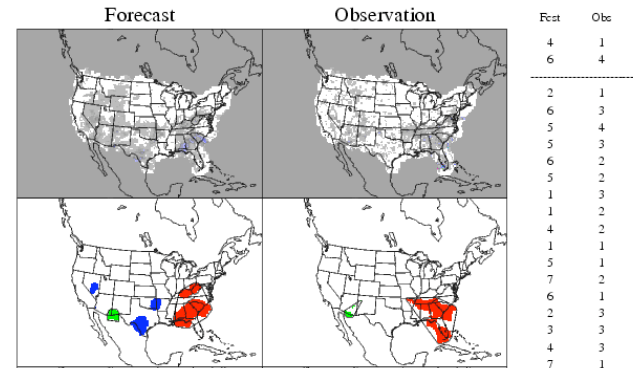
Observation



CLUS PAIR	CEN DIST	ANG DIFF	FCST AREA	OBS AREA	INTER AREA	UNION AREA	SYM DIFF	FCST INT50	OBS INT50	FCST INT90	OBS INT90	TOT INTR
1	97.32	12.16	4184	1762	358	5588	5230	5.33	4.06	16.51	15.57	0.7622

Running MODE - Output

- PostScript
 - object pictures
 - parameter summary
 - total interest for each object pair
- ASCII
 - object sizes, shapes, positions
 - stats for simple, paired objects and clusters
 - standard contingency table stats on smoothed and thresholded fields (objects)
- netCDF
 - gridded object fields
 - view with ncview



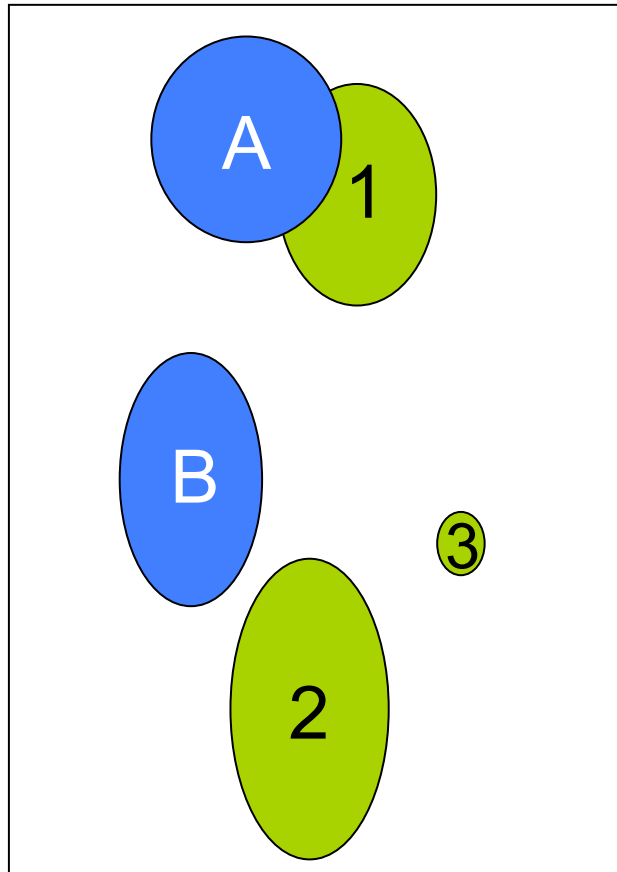
Interpreting MODE Output

- Sample Questions
 1. How well do objects match?
 - median of the maximum interest (MMI)*
 2. What fraction of objects are matched?
 - hit rate, threat score
 3. Displacement of matched objects
- Tool to answer questions
 - mode_analysis

* Davis et al., 2009: The Method for Object-based Diagnostic Evaluation (MODE) Applied to WRF Forecasts from the 2005 SPC Spring Program. Weather and Forecasting

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Median of the Max. Interest (MMI)



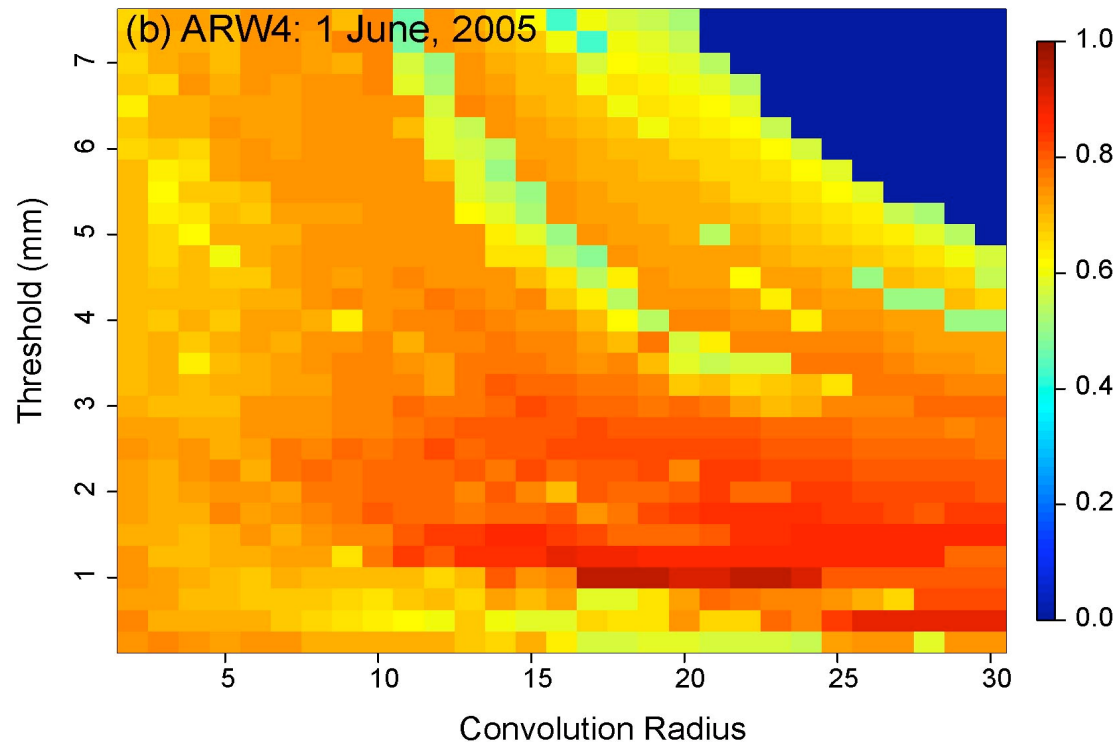
Interest Matrix

observed

forecast		
	A	B
	1	2
	3	
1	0.90	0.65
2	0.50	0.80
3	0.40	0.55

$$\text{MMI} = \text{median} \{ 0.55, 0.80, 0.80, 0.90, 0.90 \} = 0.80$$

Median of the Max. Interest (MMI) Quilt Plot



MMI as a function of convolution radius (grid squares) and threshold (mm) for 24-h forecast of 1-h rainfall

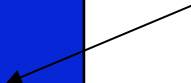
- This graphic is not in MET.
- Each pixel is a MODE run.
- R code on website.

What Fraction of Objects are Matched?

- Hit rate, Threat Score, Heidke Skill Score
- Other contingency table scores

	Observed object	Unobserved
Forecasted object	Match	False alarm
Not forecast	Miss	Correct null

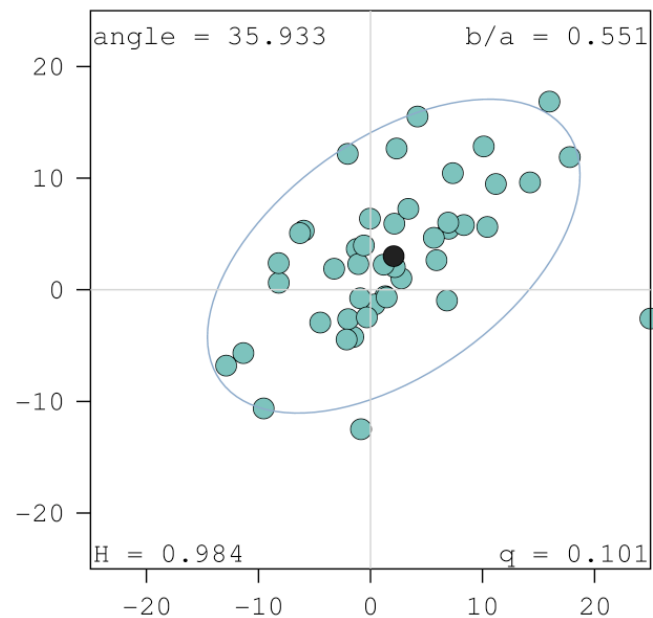
number or area of objects



MODE Analysis

- Displacement error of forecast clusters

*Composite Object Centroid Differences
over the Appalachian Mountains*



MODE Analysis Tool

Summary Example

Command Line

```
mode_analysis -summary \  
  -lookin mode_output/wrf4ncep/40km/ge03.\  
  -fcst -cluster \  
  -area_min 100 \  
  -column centroid_lat -column centroid_lon \  
  -column area \  
  -column axis_ang \  
  -column length
```

Output

Total mode lines read = 393

Total mode lines kept = 17

Field	N	Min	Max	Mean	StdDev	P10	P25	P50	P75	P90	Sum
centroid_lat	17	31.97	46.24	38.65	3.81	33.89	36.13	38.54	40.12	43.99	657.00
centroid_lon	17	-103.89	-85.20	-96.32	5.91	-103.15	-102.65	-96.26	-93.95	-86.78	-1637.49
area	17	180.00	8393.00	2955.06	2246.49	624.80	1206.00	2662.00	3958.00	5732.20	50236.00
axis_ang	17	-88.63	85.66	12.62	64.35	-70.77	-63.86	35.04	74.37	79.24	214.60
length	17	25.25	234.76	124.41	60.99	48.85	65.37	116.67	169.37	204.57	2114.90

MODE Analysis Tool

By-case Example

Command Line

```
mode_analysis -bycase -lookin mode_output/wrf4ncep/40km/ge03. \  
-single -cluster \  
-area_min 100
```

Output

Total mode lines read = 393

Total mode lines kept = 17

Fcst Valid Time	Area Matched	Area Unmatched	# Fcst Matched	# Fcst Unmatched	# Obs Matched	# Obs Unmatched
Apr 26, 2005 00:00:00	2685	0	1	0	1	0
May 13, 2005 00:00:00	3958	0	1	0	1	0
May 14, 2005 00:00:00	11695	0	2	0	2	0
May 18, 2005 00:00:00	4295	0	1	0	1	0
May 19, 2005 00:00:00	1206	0	1	0	1	0
May 25, 2005 00:00:00	4457	0	2	0	2	0
Jun 1, 2005 00:00:00	8256	0	3	0	3	0
Jun 3, 2005 00:00:00	5319	0	3	0	3	0
Jun 4, 2005 00:00:00	8365	0	3	0	3	0

Interpreting MODE

- MODE Input and Output
- Sample Verification Questions
- Mode Analysis Tool

