



NCAR

Object-based Verification of Quantitative Precipitation Forecasts

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Overall goal

Objective verification approaches for spatial forecasts that measure the quality of the forecasts in a meaningful way

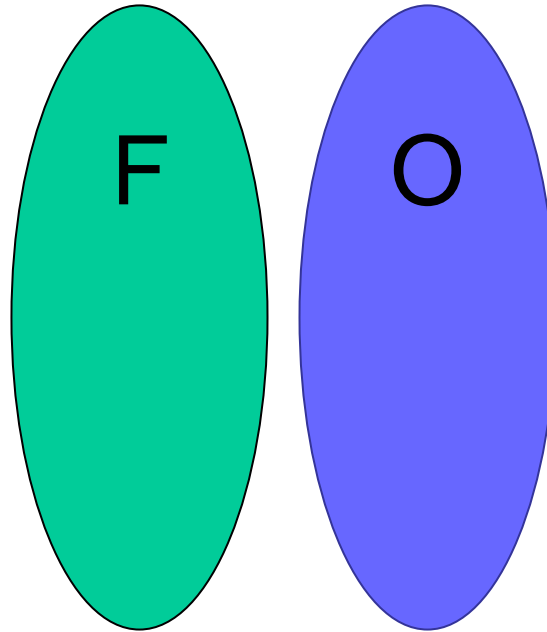
- *Diagnostic and operationally meaningful (mimic what a human would do)*
- *Improve forecasts*
- *Aid in forecast interpretation and use (decision making)*

Motivation

Why now?

- ***Finer-resolution models/forecasts:***
more detail that is penalized by the standard verification measures/approach
- ***Forecast developers*** *require performance information that can help improve forecasts*
- ***Users*** *are demanding more useful/relevant information*

Good forecast or Bad forecast?



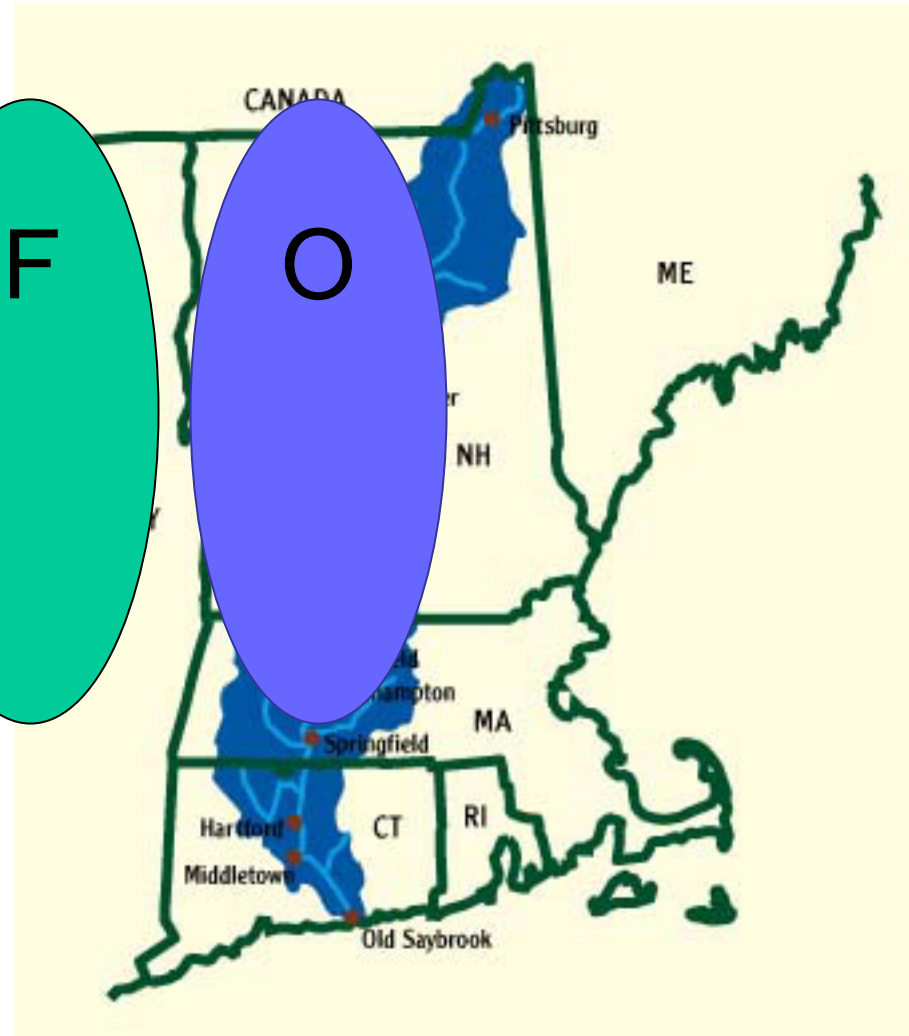
POD = 0; FAR = 1; CSI = 0; RMSE is large

Good forecast or Bad forecast?

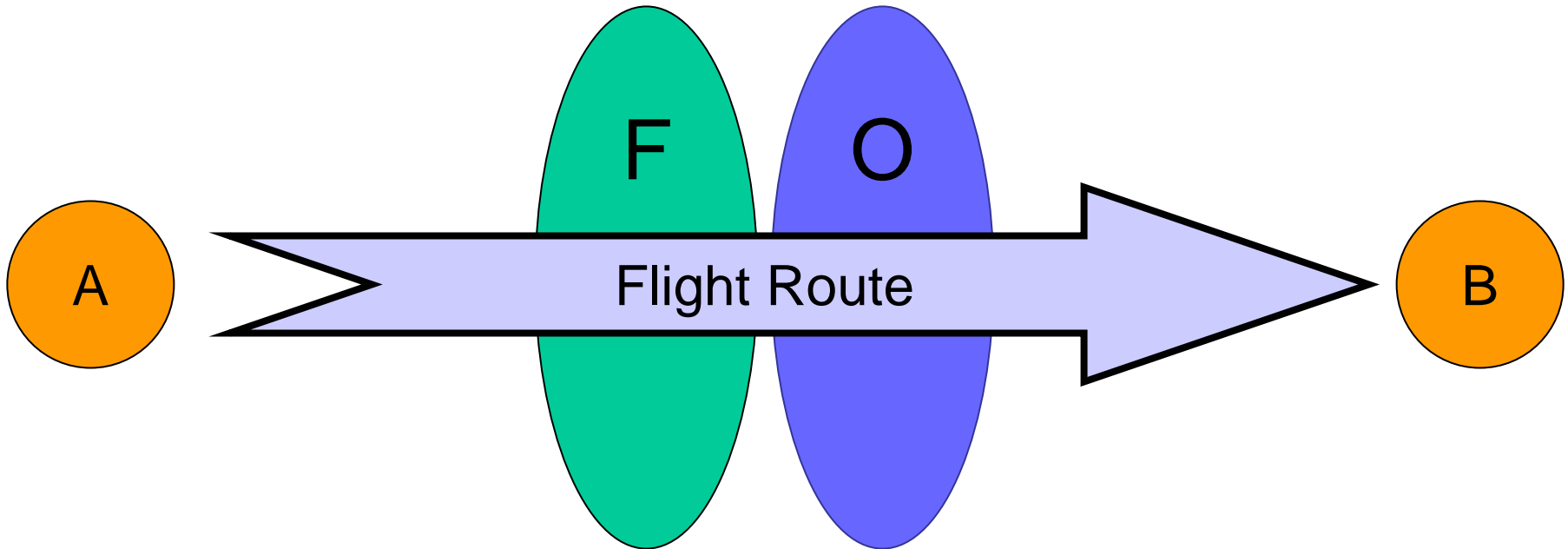
If I'm a water manager for this watershed, it's a pretty bad forecast!

F

O



Good forecast or Bad forecast?



If I'm an aviation traffic strategic planner...

It might be a pretty good forecast

Different users have different ideas
about what makes a good forecast

Focus

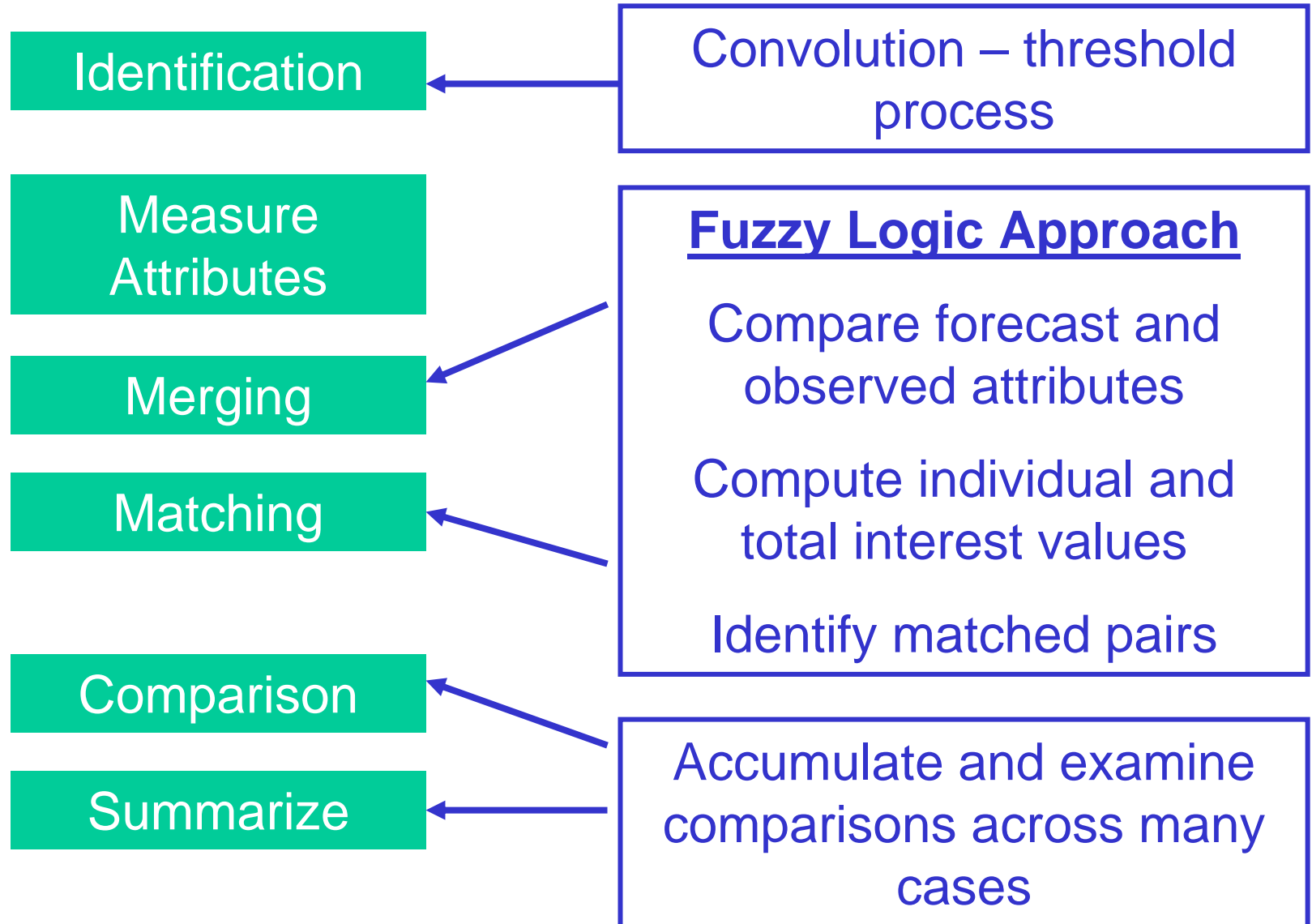
Spatial forecasts

- *Precipitation*
- *Convection*
- *Assume forecast and observations can be represented on a grid*

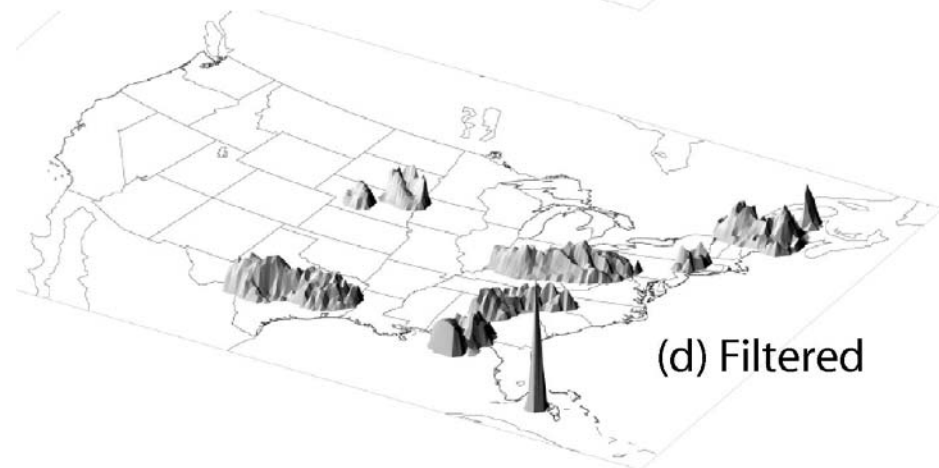
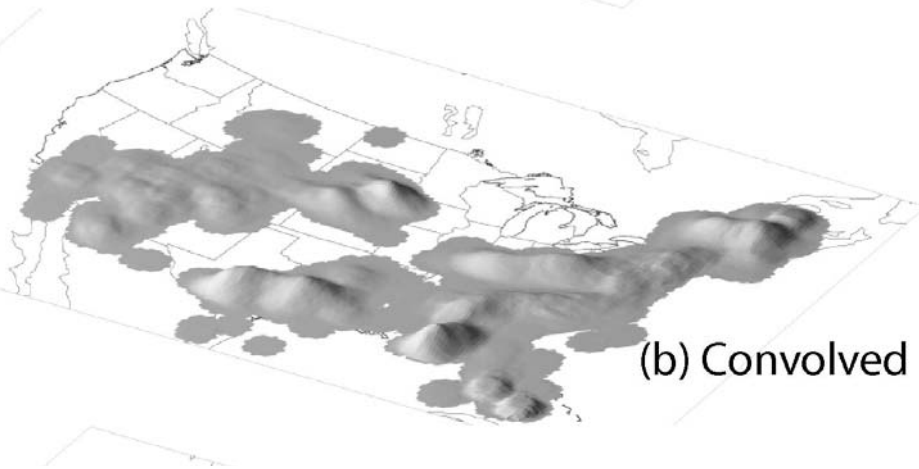
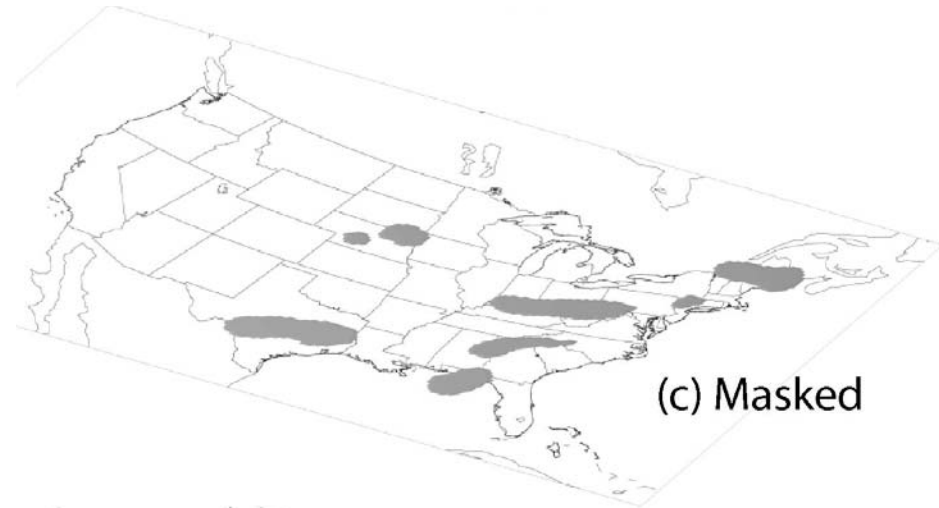
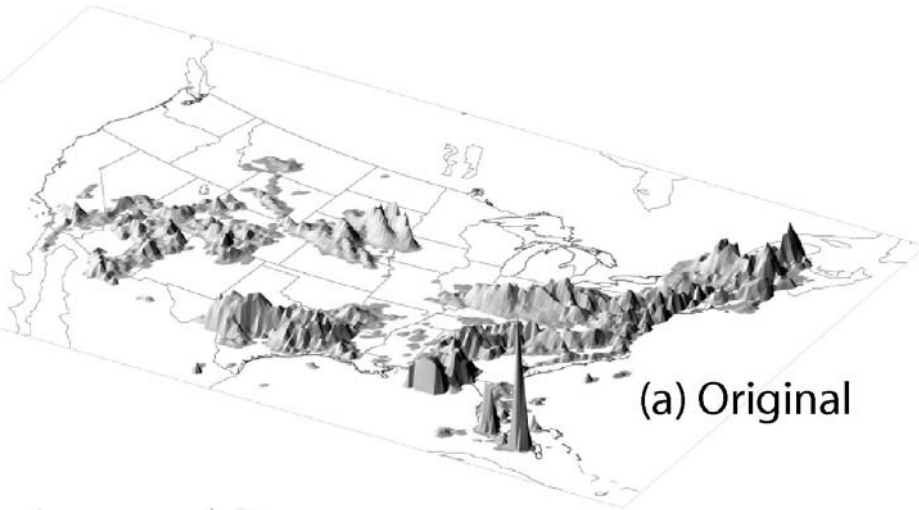
Evaluate forecast attributes that are of interest to forecast users (including forecast developers)

- *Displacement and timing errors*
- *Density of weather*
- *Intensity*
- *Total storm rainfall*
- *Etc.*

Object-based approach



Object identification



Parameters:

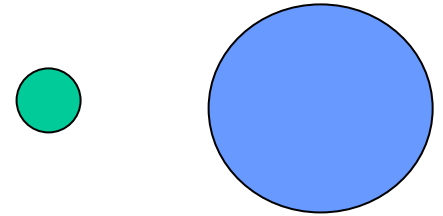
(i) Convolution radius (Step b);

(b) Threshold (Step c)

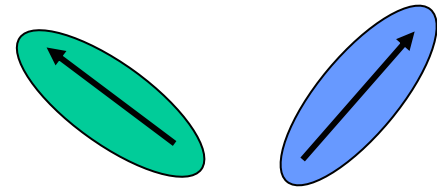
Merging and Matching: Fuzzy logic

Compare attributes for pairs of forecast and observed objects

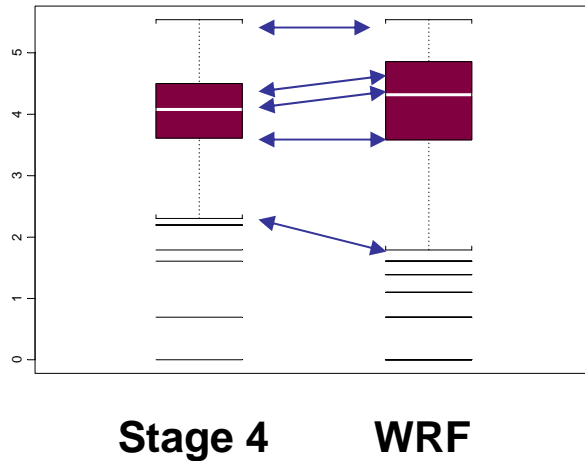
Size



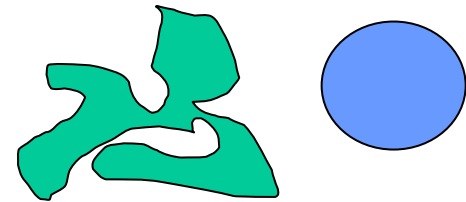
Orientation



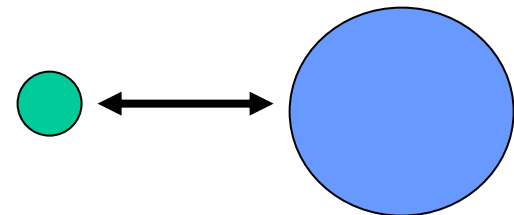
Intensity



“Ugliness”

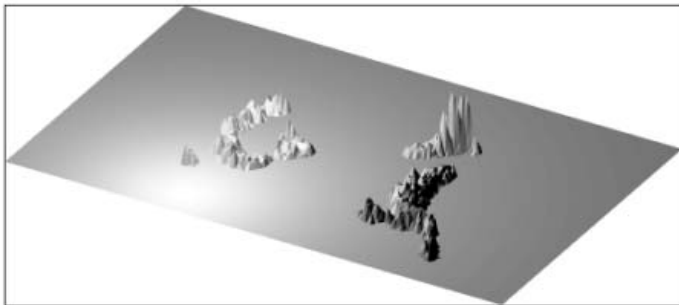
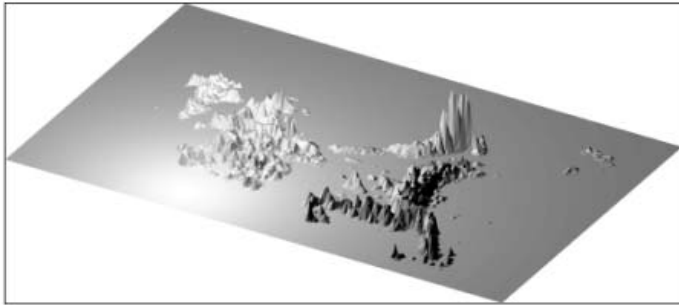
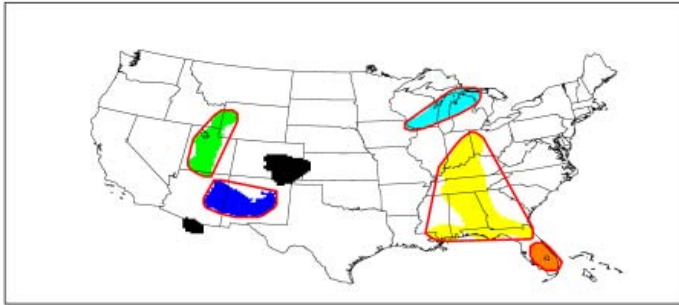


Displacement

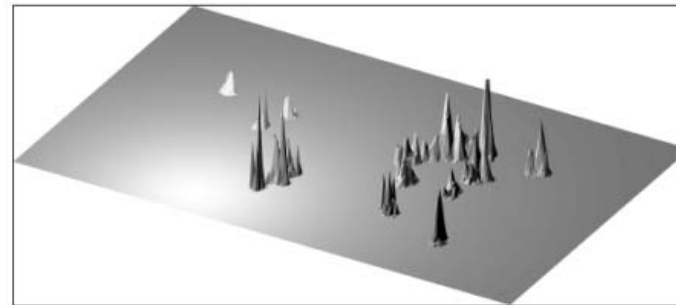
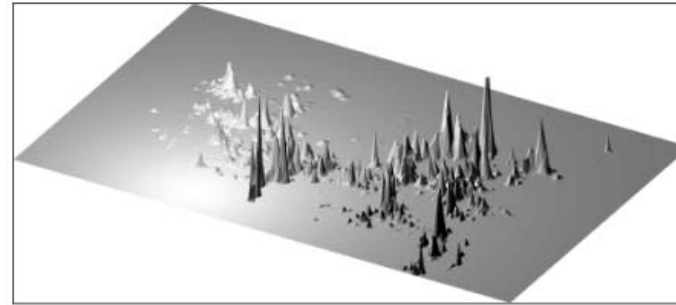
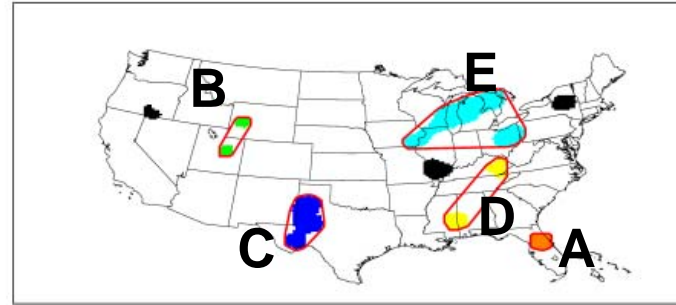


WRF precipitation example

Wrf



Stage 4



10Aug01

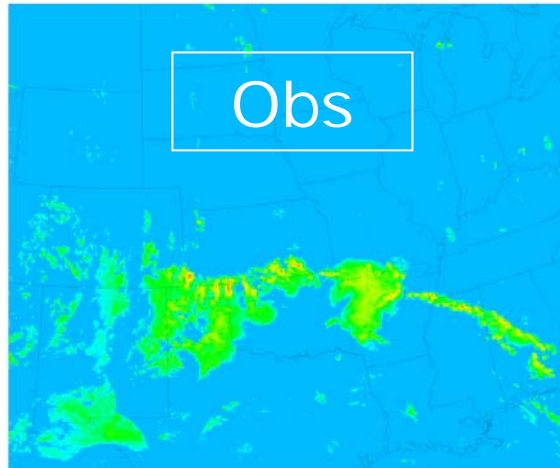
Wrf File: wrf.V_2001081000.L_48.22b.field
Stage4 File: mul.2001081000.grb.22.field
Threshold: 3000
Radius: 5
Area Min: 20

Project to Compare Verification Methods

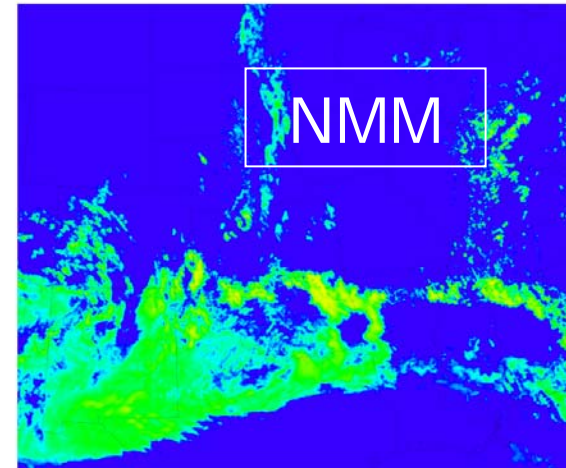
- Purposes
 - *Compare information obtained from different spatial verification approaches*
 - *Identify positive and negative aspects of each*
 - *Identify ways to*
 - Improve each approach
 - Possibly combine approaches?
- Examples of methods
 - *Object (Baldwin, Brown/Davis)*
 - *Entity (e.g., Ebert)*
 - *Spatial scale decomposition (Casati)*
 - *Fuzzy verification (Ebert)*
 - *Clustering approach (Marzban)*
 - *Etc.*
- Data
 - *U.S. Storm Prediction Center Spring Program 2005 (18 April – 4 June)*
 - *3 versions of WRF (NMM, ARW4, ARW2)*
 - *Reflectivity and Precipitation*
 - *Stage IV precipitation*
 - *4-km horizontal resolution*
 - *Courtesy of **Mike Baldwin***
- Contact bgb@ucar.edu to participate!

12May05, 00UTC, 24-h reflectivity forecasts

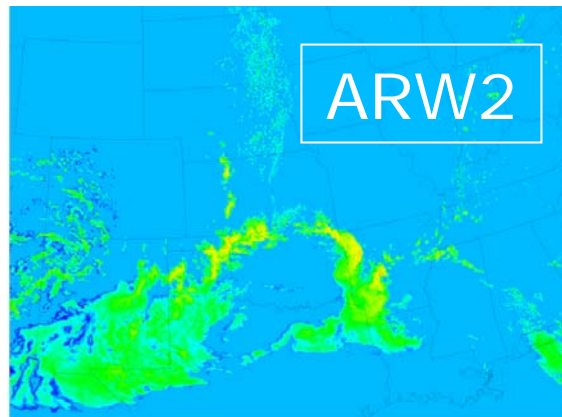
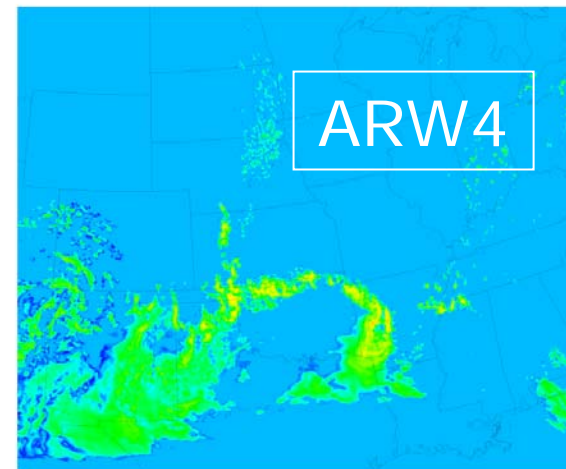
bref_2005051200.g240.txt



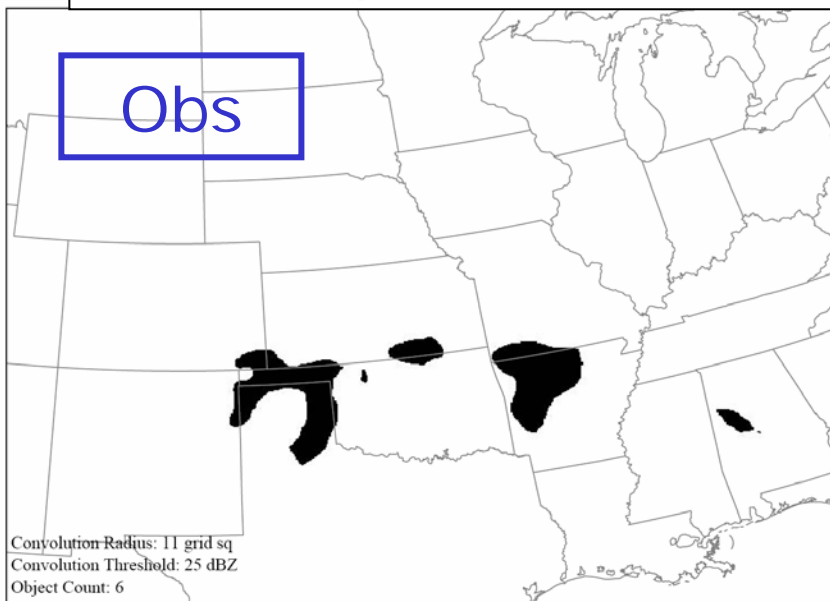
nmm4_2005051100.g240.f24.txt



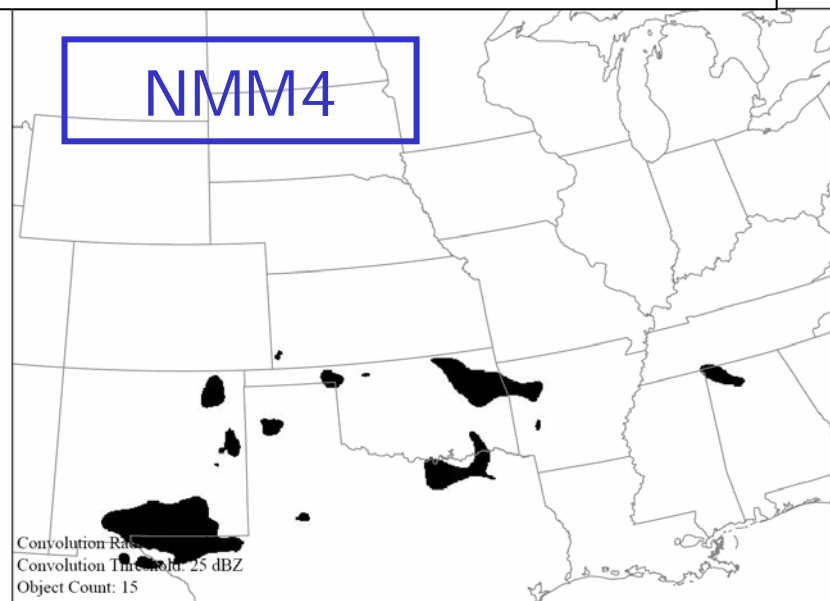
arw4_2005051100.g240.f24.txt



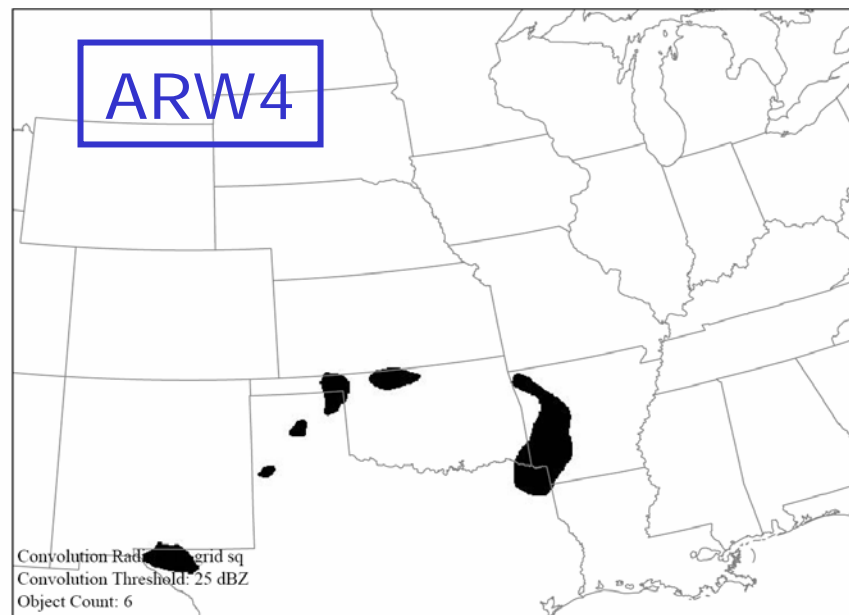
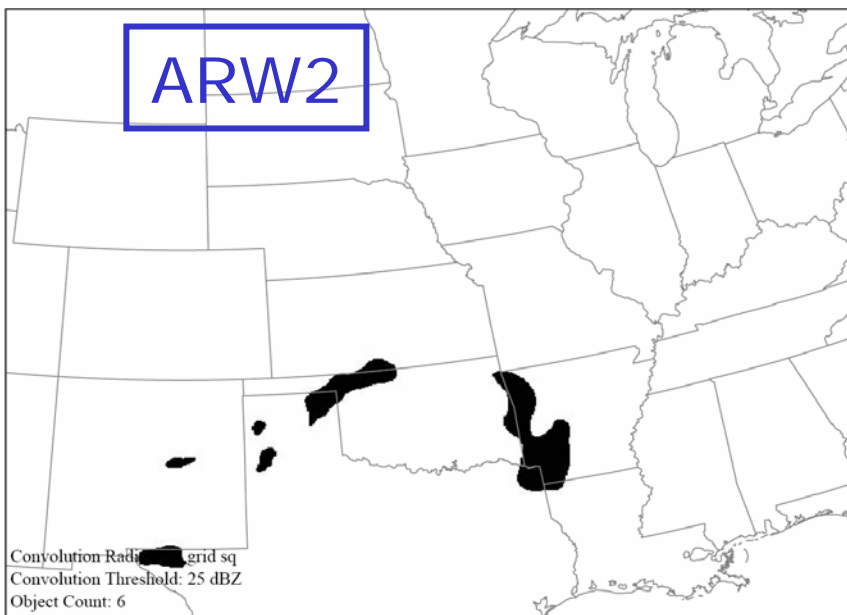
Example: Radius=11 Threshold = 25 dBZ



arw2: R_11_20050512_00V_24L_spc



arw4: R_11_20050512_00V_24L_spc

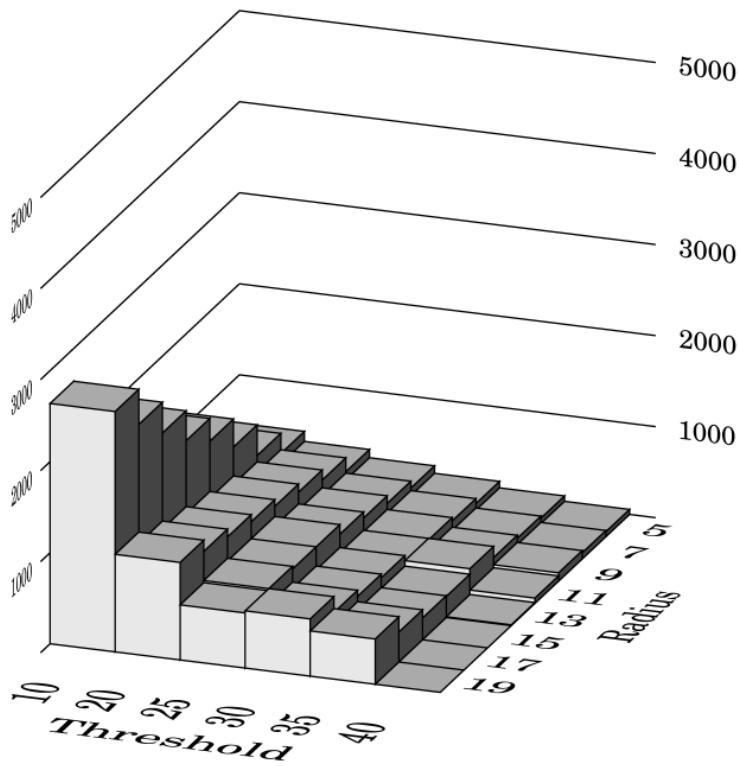


12May05, 00UTC, 24-h reflectivity forecasts

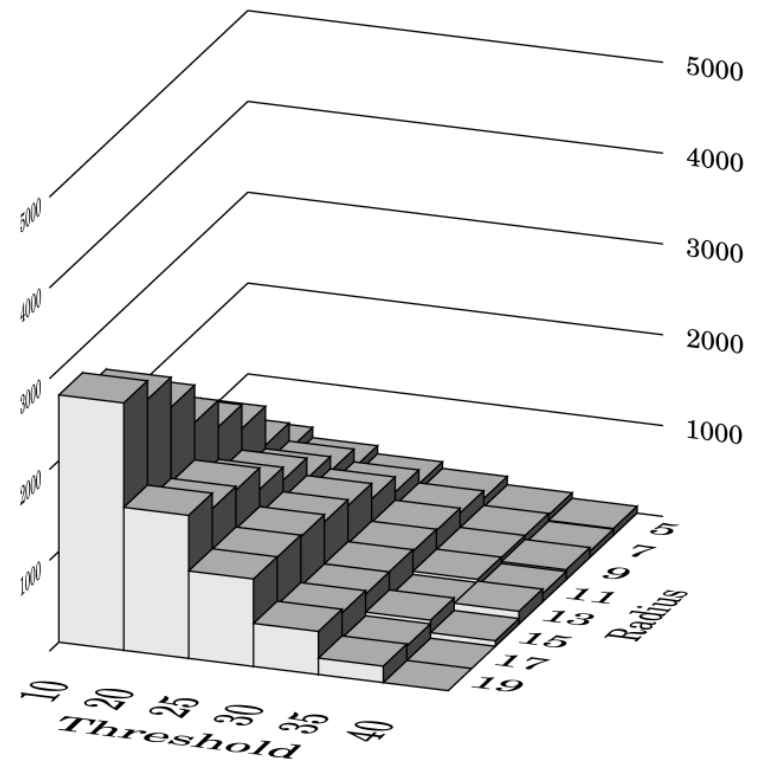
	# objects	Total area (grid squares)	Ave median intensity	Max median intensity	Ave 90 th intensity	Max 90 th intensity
Obs	6	8,094	34.7	41	44.5	50
ARW2	6	5,318	33.8	40	40.7	49
ARW4	6	4,889	34.5	40	42.5	48
NMM	15	8,260	33.3	45	37.1	46

Variation of Average Object Area with Convolution Radius and Threshold

Observed

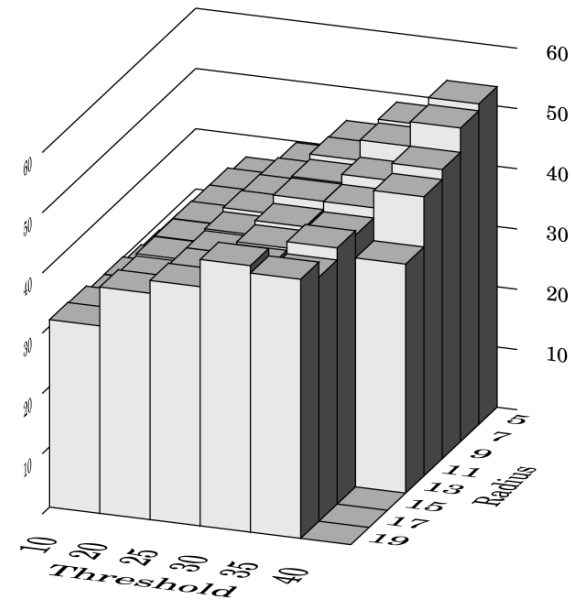


ARW2 24-h forecasts

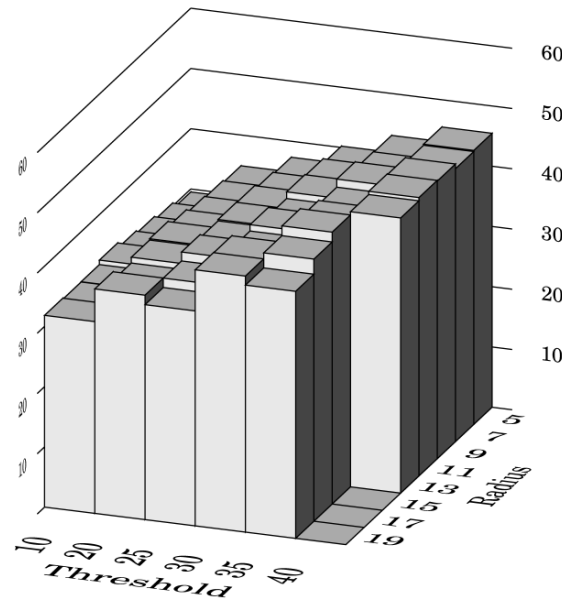


Average 90th percentile of intensity as a function of convolution radius and threshold

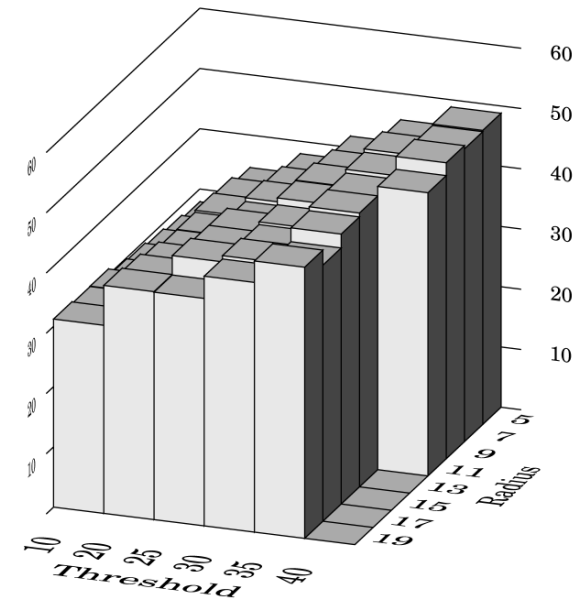
Observed



NMM4



ARW4



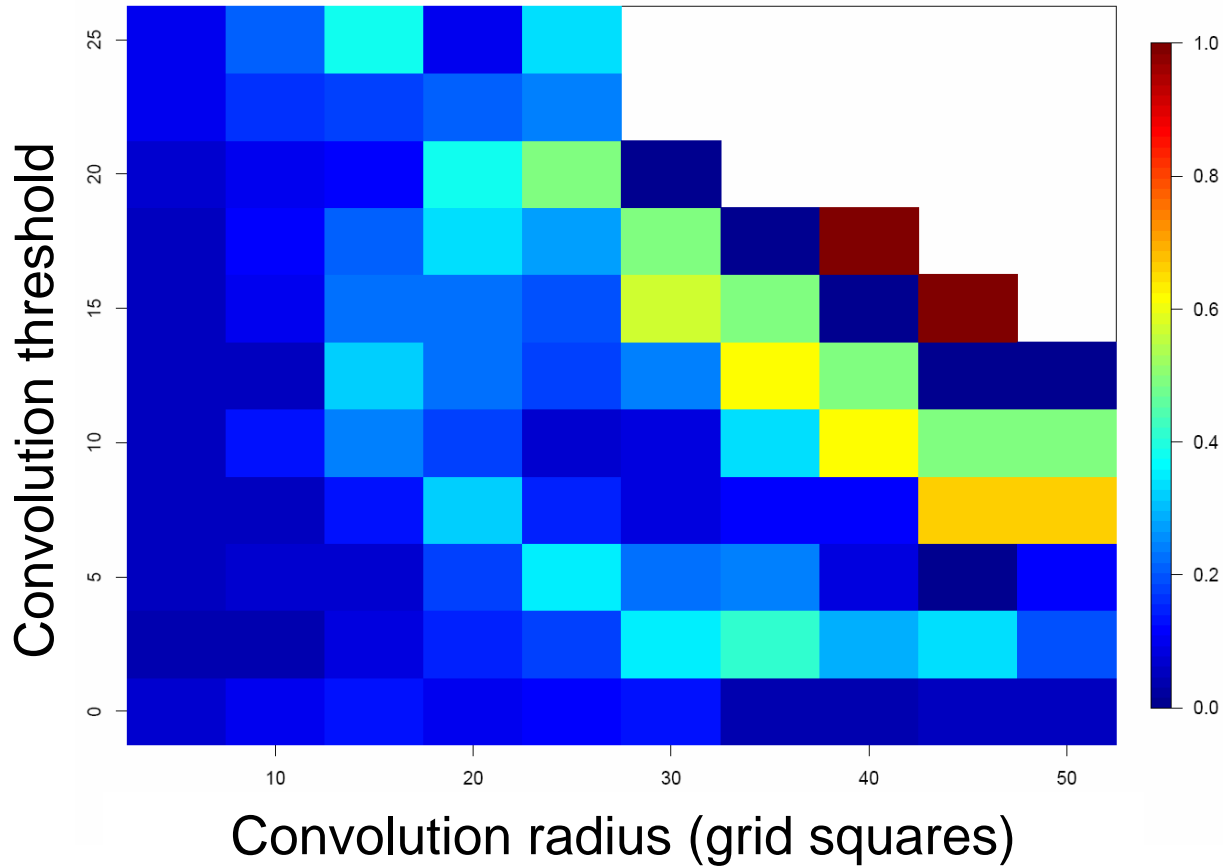
Future work

- Identify sets of convolution radius and threshold to apply to all the models
- Examine characteristics of matched objects and compare among models
 - *Create an “error” (or “fitting”) surface for matched objects*
- Intercomparison of methods

Future development:

- Include time dimension
- Application to ensemble forecasts

Proportion of Unmatched Objects



Example:

National
Convective
Weather
Forecast

% of
unmatched
objects as a
function of
convolution
and threshold
parameters

Future work

- Identify sets of convolution radius and threshold to apply to all the models
- Examine characteristics of matched objects and compare among models
 - *Create an “error” (or “fitting”) surface for matched objects (NCWF2 example)*
- Intercomparison of methods

Future development:

- Include time dimension
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