

The displacement-based forecast quality measure FQM applied in the vx-intercomparison project

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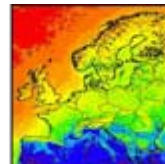
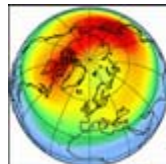
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Reference:

Keil, C. and G. C. Craig, 2007: A Displacement-based Error Measure applied in a Regional Ensemble Forecasting System, *Mon. Wea. Rev.*, accepted.



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What kind of data does the method use?

- gridded as well as point data
- data is mapped with IDL onto same domain
- Displacement-based method has been applied so far on
 - ▶ satellite imagery (e.g. infrared Meteosat-8 (SEVIRI))
 - ▶ radar reflectivities
 - ▶ daily rainfall accumulations
 - ▶ ...

Method: Pyramidal Matching Algorithm (Mannstein et al., 2002)

1. **Project** observed and simulated images to same grid
2. **Coarse-grain** both images by averaging of 2^F pixels onto one pixel element
3. **Compute a displacement vector field** that minimizes the squared difference within the range of +/- 2 pixel elements
4. **Repeat** step 2 at successively **finer scales**
5. Displacement vector for every pixel results from the **sum** over all scales

Forecast Quality Measure

$$FQM = \frac{1}{A} \sum_A \max(c_1 \cdot DIS, c_2 \cdot LSE)$$

$$c_1 = DIS_{\max}^{-1}$$

$$c_2 = (\psi_{\max} - \psi_{\min})^{-2}$$

If forecast and observed features can be matched, the magnitude of the displacement vector (DIS) characterises forecast quality (averaged over forecast feature), whereas when matching features cannot be found within the search distance, the local squared error LSE between both fields ($\psi_{i,j}$) is used. The FQM of a perfect forecast equals zero.

What kind of verification information does the method give?

- FQM is based on a
 - ▶ displacement error (of observed and forecast imagery) and an
 - ▶ amplitude error (of observed and morphed forecast imagery)
- A useful forecast is one with structure that is more accurate than a random arrangement of the observations.

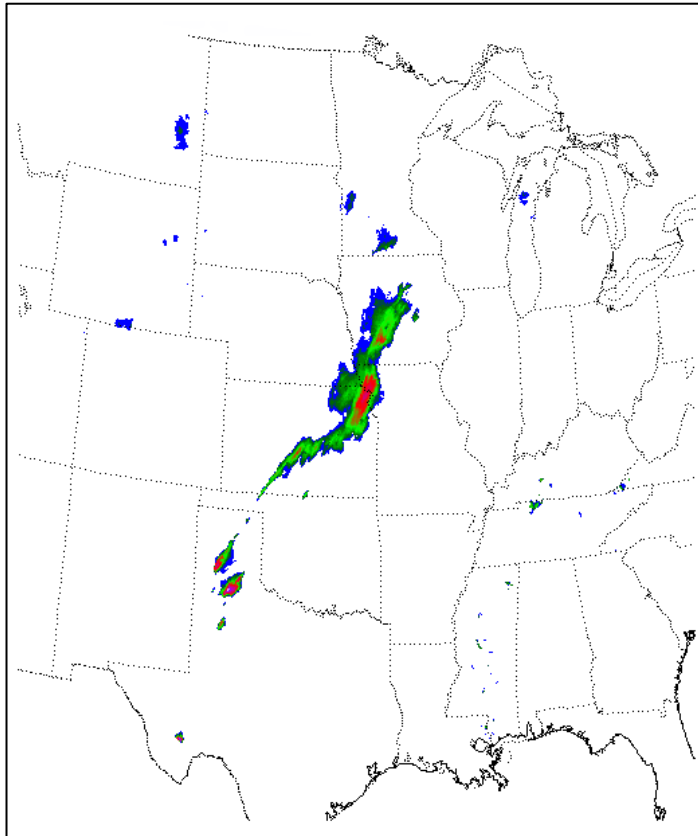
Strengths of the approach:

- computation of displacement vector field

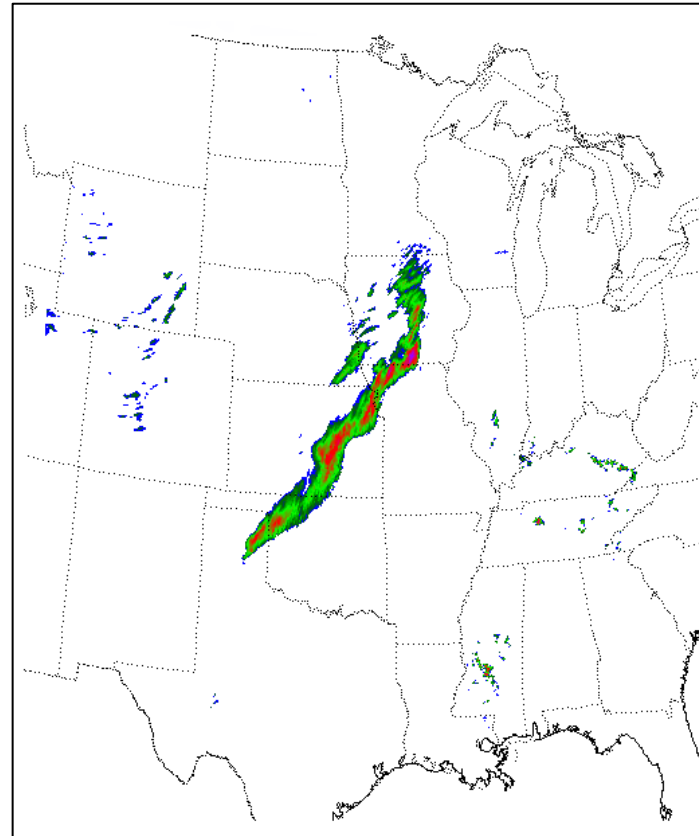
Weaknesses of the approach:

- only one parameter is verified at a time
- works best for isolated features in subdomain
- some arbitrariness in combination of DIS and LSE components
- a boundary zone needs to be excluded

Demonstration on 13 May 2005 case



observation



forecast (wrf2caps)

Setting of free parameters in matching algorithm: max displ.:

$$DIS_{\max} = 360km$$

precip threshold:

$$\psi_{\min} = 1mm$$

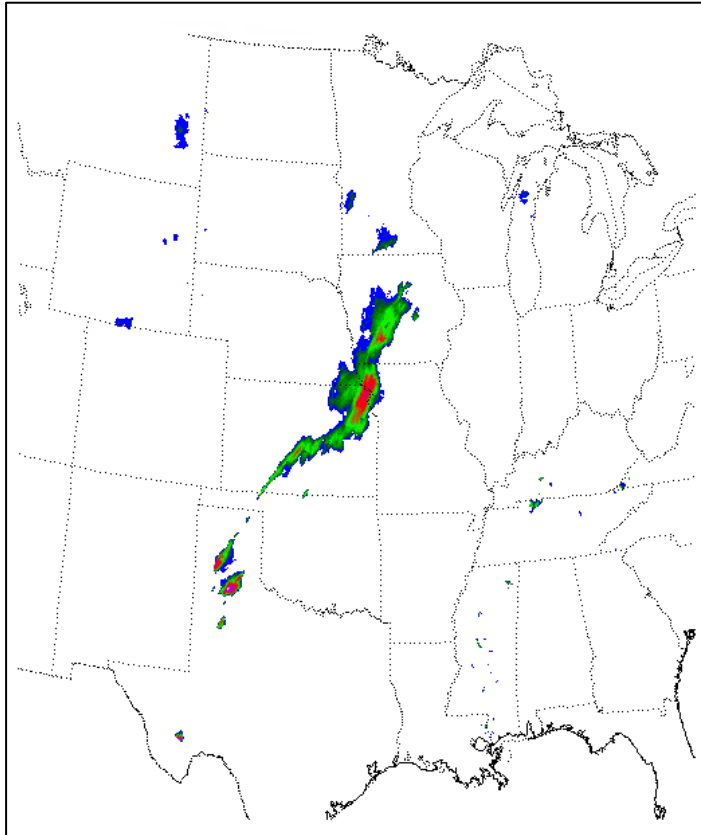


DLR

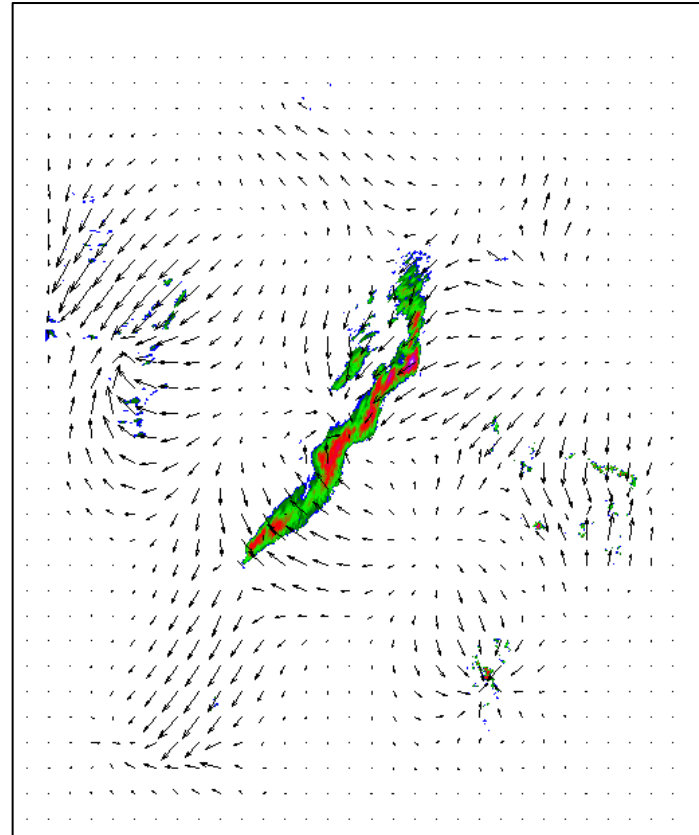
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Demonstration on 13 May 2005 case



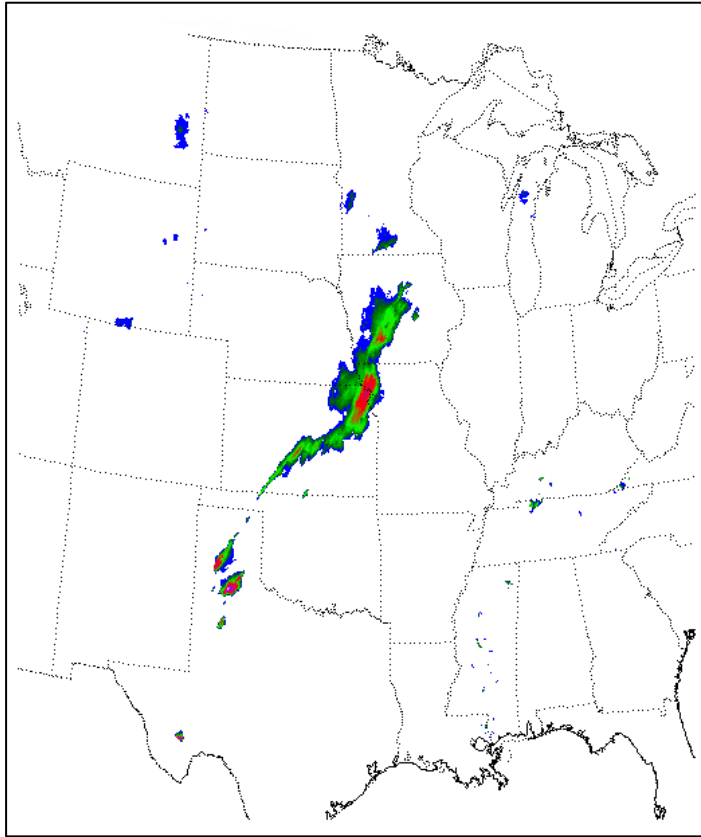
observation



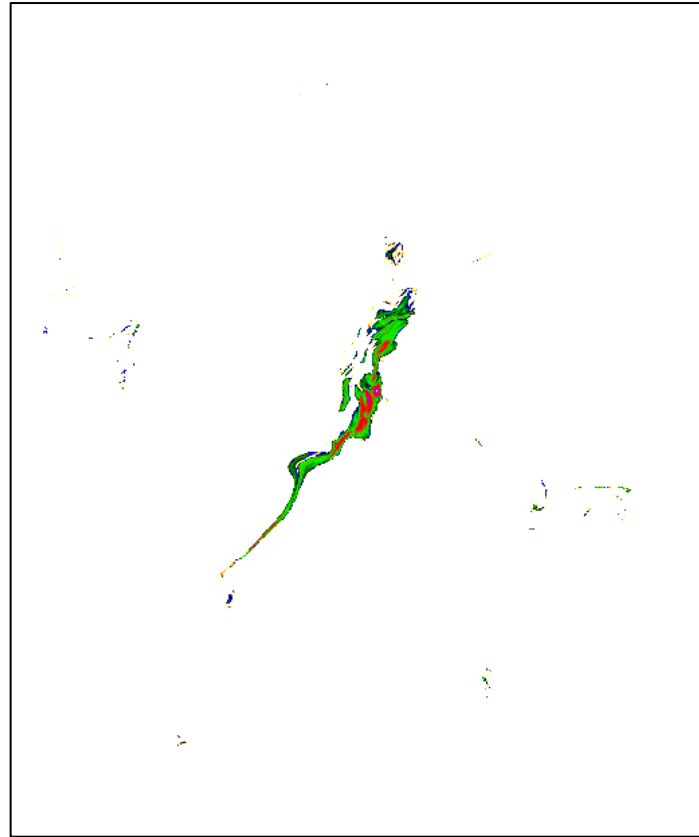
forecast with displ vectors

displacement vector field encompasses region of observed and forecast precipitation

Demonstration on 13 May 2005 case



observation



morphed forecast

Demonstration on 13 May 2005 case

Results:

max displacement: $DIS_{\max} = 360km$

precip threshold: $\psi_{\min} = 1mm$

exp	rank	fqm	obs _{max} /mm	fc _{max} /mm	bias	threat	eqth	far
wrf2caps	2	0.0086	93.73	78.49	0.76	0.18	0.16	0.73
wrf4ncar	1	0.0061	93.73	48.26	0.87	0.26	0.25	0.61
wrf4ncep	3	0.0127	93.73	98.30	0.60	0.10	0.08	0.86