Testing Competing High-Resolution Precipitation Forecasts

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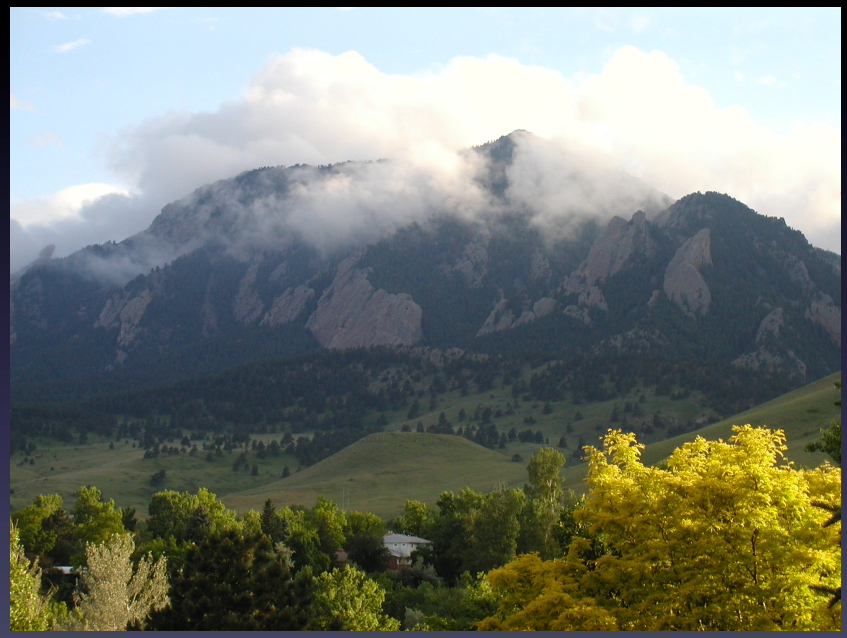
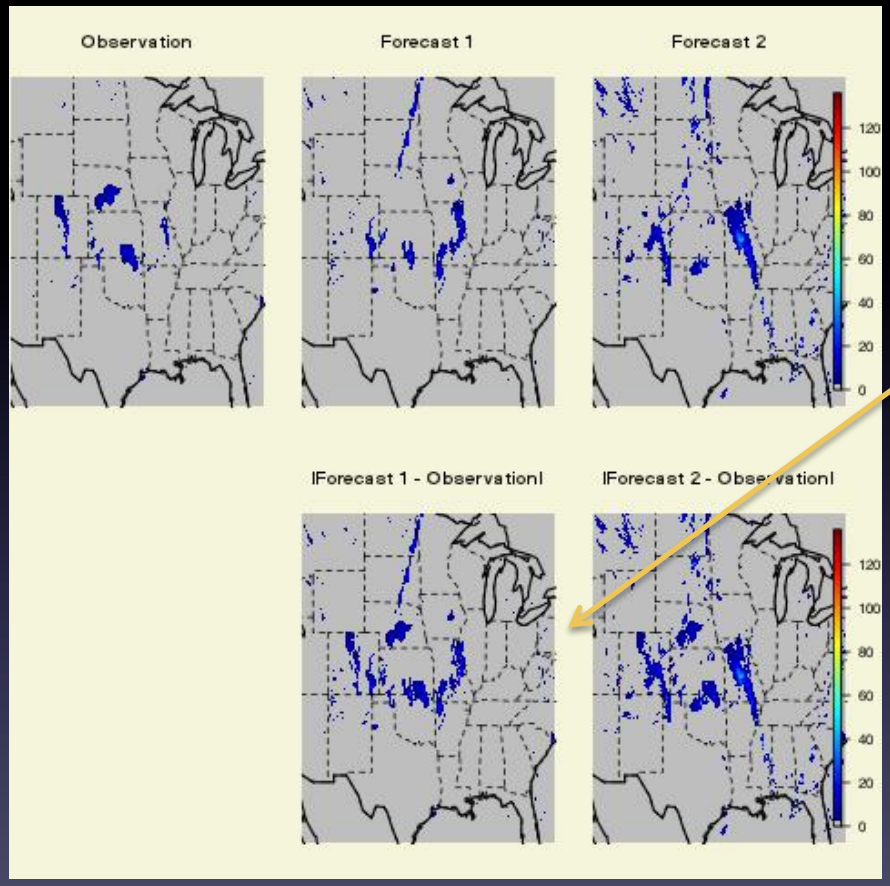


Photo by Everett Nychka

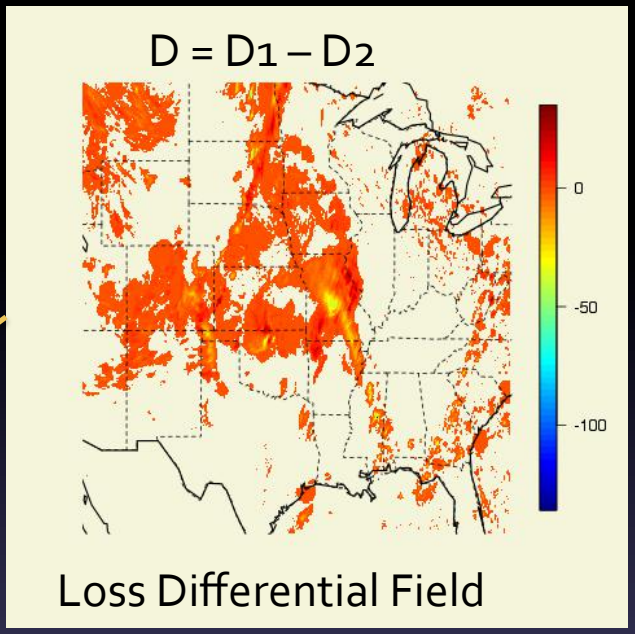
13th European Meteorological Society (EMS) and
11th European Conference on Applied Meteorology (ECAM)
9 – 13 September 2013
Reading, U.K.

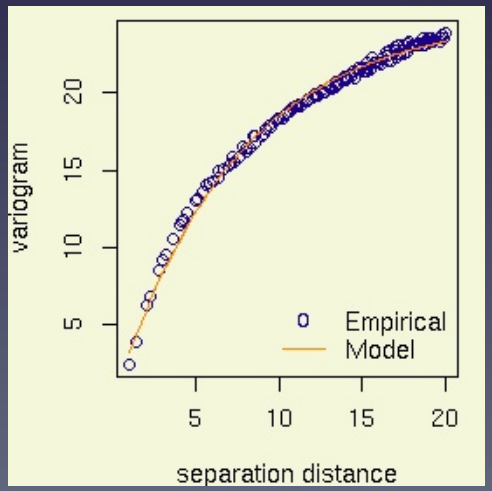
NCAR

Spatial Prediction Comparison Test



D1 D2

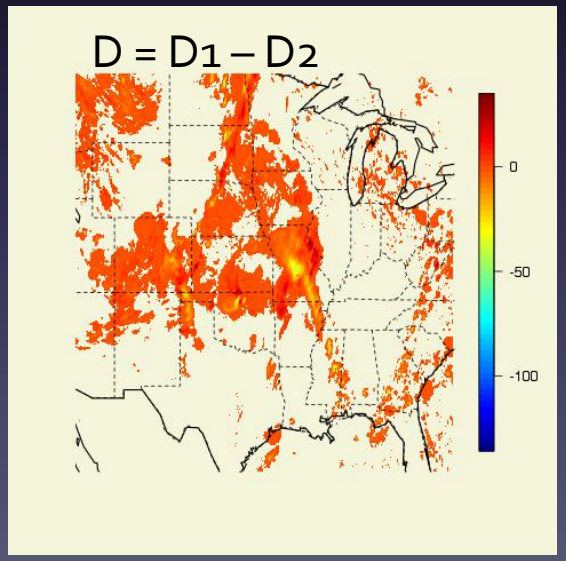




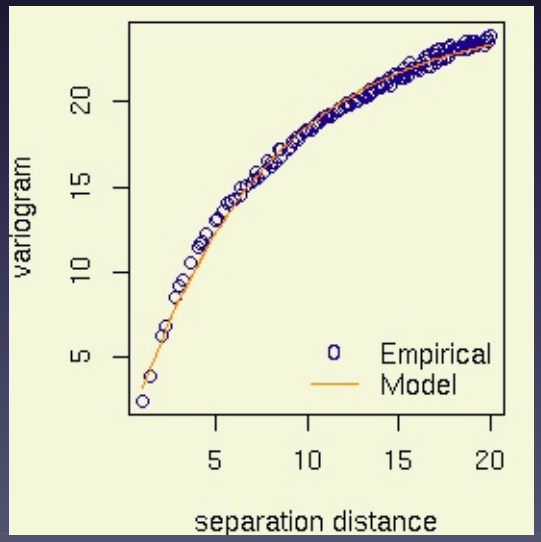
Spatial Prediction Comparison Test

Introduced by Hering and Genton (2011, *Technometrics*, **53**, 414 – 425)

Extension of the time series version introduced by Diebold and Mariano (1995, *J. Business and Economic Statistics*, **13**, 253 – 263).

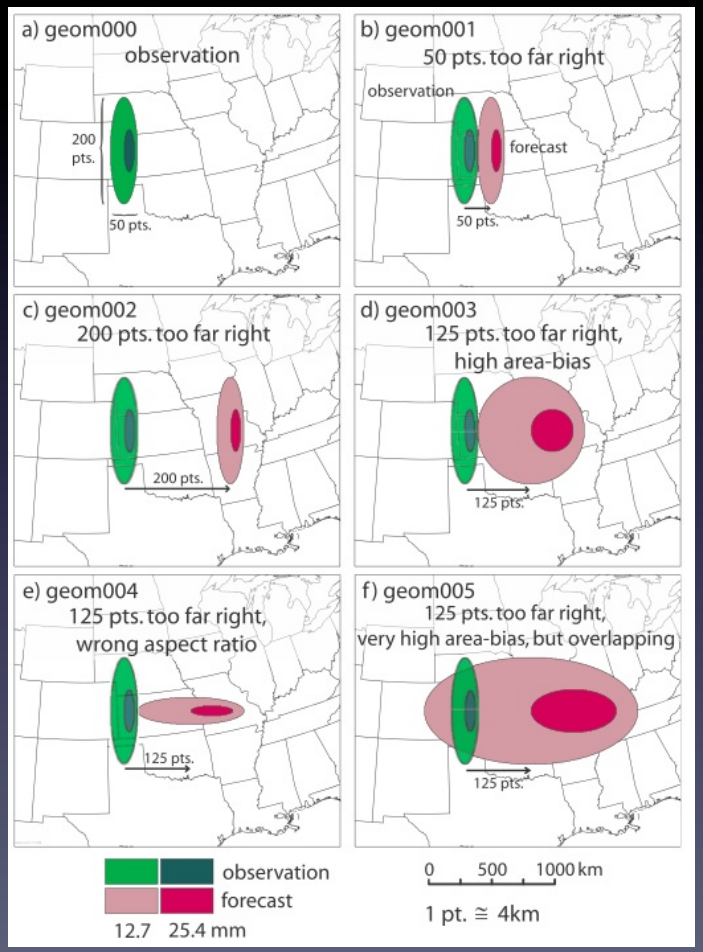


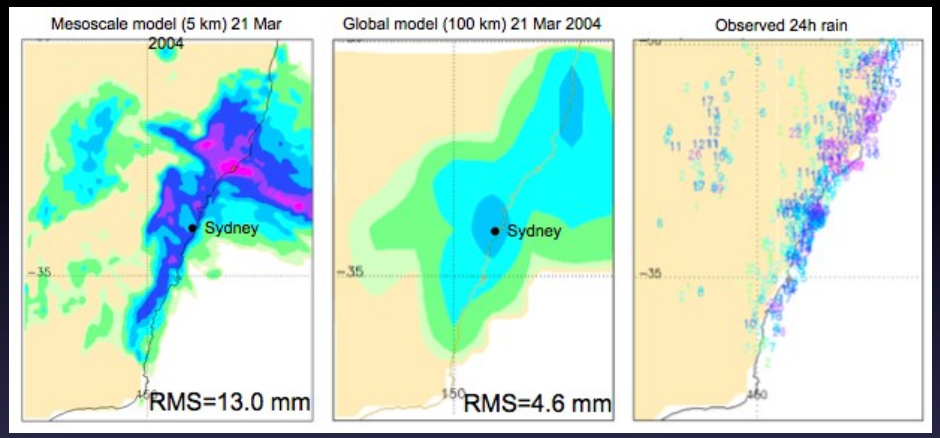
$$S = \frac{\bar{D}}{\sqrt{\mathrm{var}(\bar{D})}}$$



Spatial Prediction Comparison Test

Accounting for Location Errors and Reducing Effects of Small Scale Errors





Traditional score	geom001/002/004	geom003	geom005
Accuracy	0.95	0.87	0.81
Frequency bias	1.00	4.02	8.03
Multiplicative intensity bias	1.00	4.02	8.04
RMSE (mm)	3.5	5.6	6.9
Bias-corrected RMSE (mm)	3.5	5.5	6.3
Correlation coefficient	−0.02	−0.05	0.20
Probability of detection	0.00	0.00	0.88
Probability of false detection	0.03	0.11	0.19
False alarm ratio	1.00	1.00	0.89
Hanssen–Kuipers discriminant (H-K)	−0.03	−0.11	0.69
Threat score or CSI	0.00	0.00	0.11
Equitable threat score or GSS	−0.01	−0.02	0.08
HSS	−0.03	−0.04	0.16

Above Figure from Beth Ebert

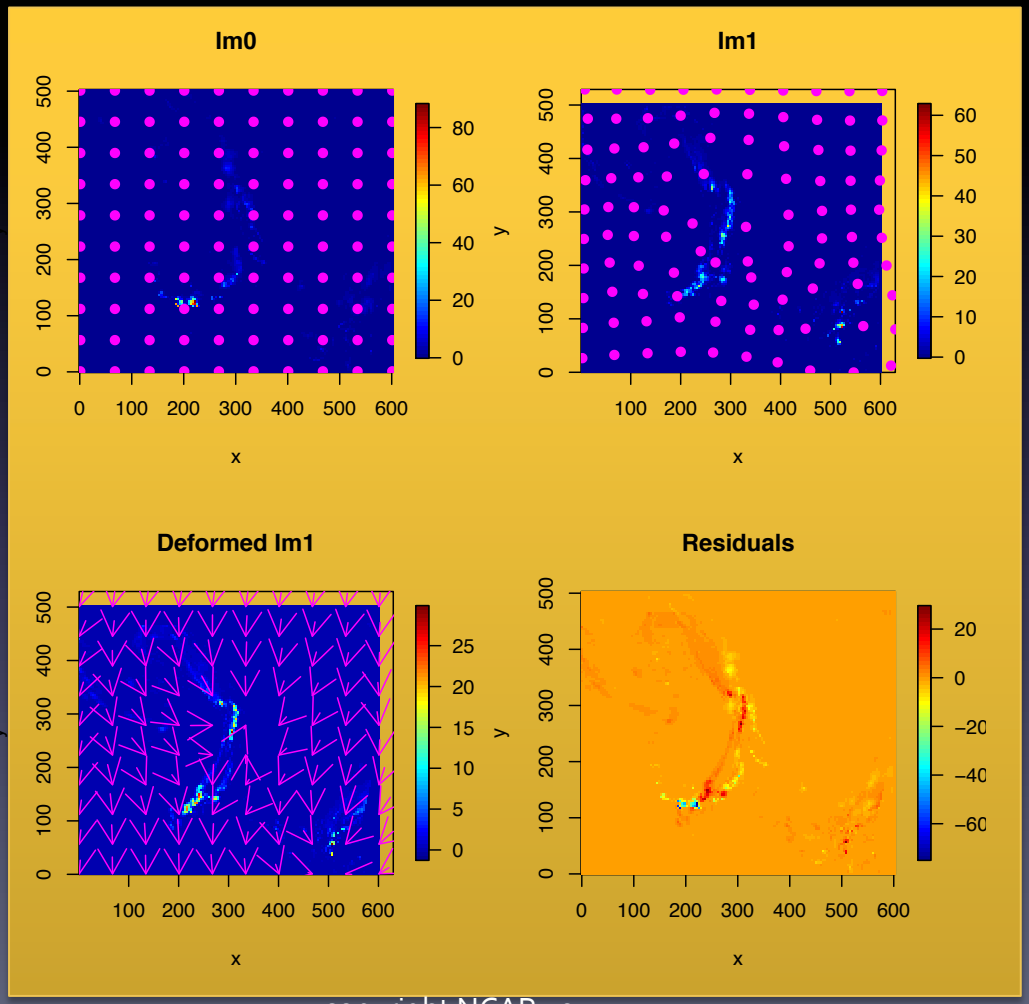
Spatial Prediction Comparison Test

Accounting for Location Errors and Reducing Effects of Small Scale Errors

Above Figure from Johan Lindström

Spatial Prediction Comparison Test

Accounting for Location Errors and Reducing Effects of Small Scale Errors



Spatial Prediction Comparison Test

Accounting for Location Errors and Reducing Effects of Small Scale Errors

Loss at each point =

Distance from original location of each point to warped location

Loss at each point between observation value and warped value

G. (2013, *MWR*, **141** (1), 340 – 355)

Spatial Prediction Comparison Test

Accounting for Location Errors and Reducing Effects of Small Scale Errors

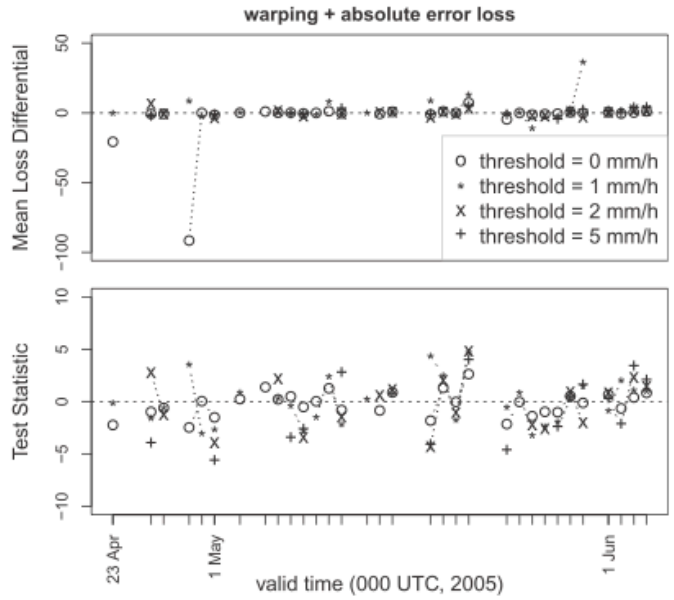


FIG. 3. Results for (top) mean differential $\overline{D}$ based on warping plus AE loss, and (bottom) the associated test statistic. Dotted lines indicate contiguously available scores. Negative (positive) values imply that ARW-WRF (NMM) is better on average in terms of warping loss.

TABLE 2. Warping plus AE loss results for the 32 test cases. A dash (—) indicates that a good fitting variogram model to $D(\mathbf{s})$ was not found, thus no test was performed. Negative (positive) values imply ARW-WRF performs better (worse) than NMM. Note that there is no stage II precipitation ≥5 mm h^{-1} on 29 Apr 2005.

Valid date (0000 UTC 2005)	$\overline{D}$ Threshold (mm h^{-1}) 0	1	2	5
23 Apr	13.35[a]	−9.83[b]	17.67[c]	−34.73[c]
26 Apr	—	—	21.83[c]	−20.81[c]
27 Apr	7.80	−69.97[b]	9.63[a]	8.05[a]
29 Apr	3.42	31.92[c]	—	—
30 Apr	—	−145.51[c]	—	—
1 May	−36.82[a]	−42.87[b]	−36.92[c]	−100.93[c]
3 May	—	24.59[a]	—	—
5 May	2.69	—	—	—
6 May	1.92	0.48	—	—
7 May	—	−54.48[b]	—	−19.65[c]
8 May	−6.64	−25.21[c]	−26.78[c]	−10.55[b]
9 May	—	−18.40[a]	—	—
10 May	—	20.52[c]	8.31[a]	—
11 May	—	−17.98[c]	−19.32[c]	26.23[b]
13 May	—	12.27[a]	−9.14[a]	9.74[b]
14 May	−3.70	—	−2.07	—
15 May	7.97	25.18[a]	8.69	−10.02[a]
18 May	−12.42[a]	−26.24[c]	−50.74[c]	−28.66[c]
19 May	14.58[a]	109.14[c]	10.15[c]	21.83[c]
20 May	—	−41.91[c]	—	—
21 May	13.73[a]	−34.54[c]	−43.12[c]	−1.76
24 May	−10.43[a]	56.70[c]	−7.30[c]	−30.66[c]
25 May	−1.51	—	—	—
26 May	−7.82[a]	—	−36.10[b]	−12.60[c]
27 May	−15.03	−23.77[c]	0.71	3.62
28 May	−14.09	−30.33[a]	3.16	2.60[a]
29 May	—	−9.29[a]	0.75	—
30 May	−2.06	8.76	−59.34[a]	−3.99
1 Jun	−1.47	20.27	—	—
2 Jun	—	1.91	−11.37[b]	−46.96[c]
3 Jun	3.30	3.43	5.27[a]	—
4 Jun	5.81	—	10.05	12.10*

[a] Significance at the 5% level.
[b] Significance at the 1% level.
[c] Significance at the <1% level.

G. (2013, *MWR*, **141** (1), 340 – 355)

The Spatial Prediction Comparison Test (SPCT)

Summary and Conclusions

- Applying image warping first results in a test that accounts for location errors as well as spatial correlation.
- Optimizing the warp function takes time, but is not terribly inefficient either.
- Can be applied to non-gridded fields, but perhaps trickier.

Future Work

Additional uncertainty introduced because of uncertainty associated with fitting the warp function to the fields. Can this be incorporated into the test?

It is possible to extend this to a test for spatio-temporal fields, but how exactly?

The Spatial Prediction Comparison Test (SPCT)

Other Remarks

- ICP2: Spatial Forecast Verification Inter-Comparison Project Part 2 is about to begin.

  http://www.ral.ucar.edu/projects/icp

- R (http://www.r-project.org) package, SpatialVx , in the works to do most spatial verification techniques.
- R image warping package on its way.

Questions?