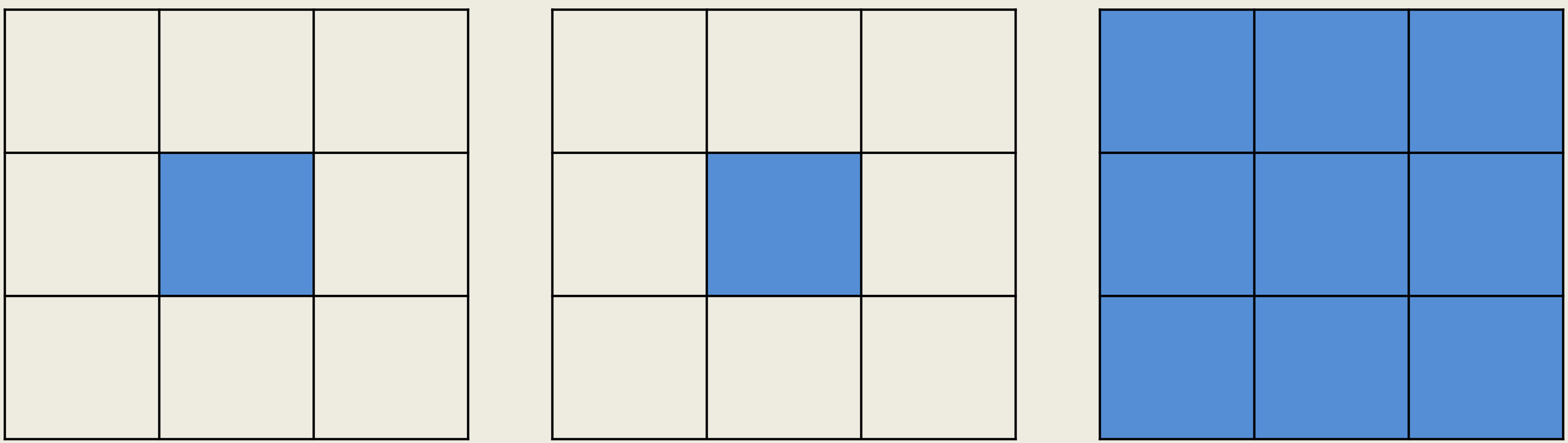
Forecasting Probabilities of Precipitation for the Goodland Area using a Neighborhood Approach

Chris Schaffer

August 6, 2011

A neighborhood approach to forecasting

- Considers an area of grid points in a forecast, instead of an individual point



Observation

Corresponding traditional forecast

Corresponding neighborhood forecast

Figure adapted from Ebert (2009)

Derive probabilistic forecasts from deterministic forecasts

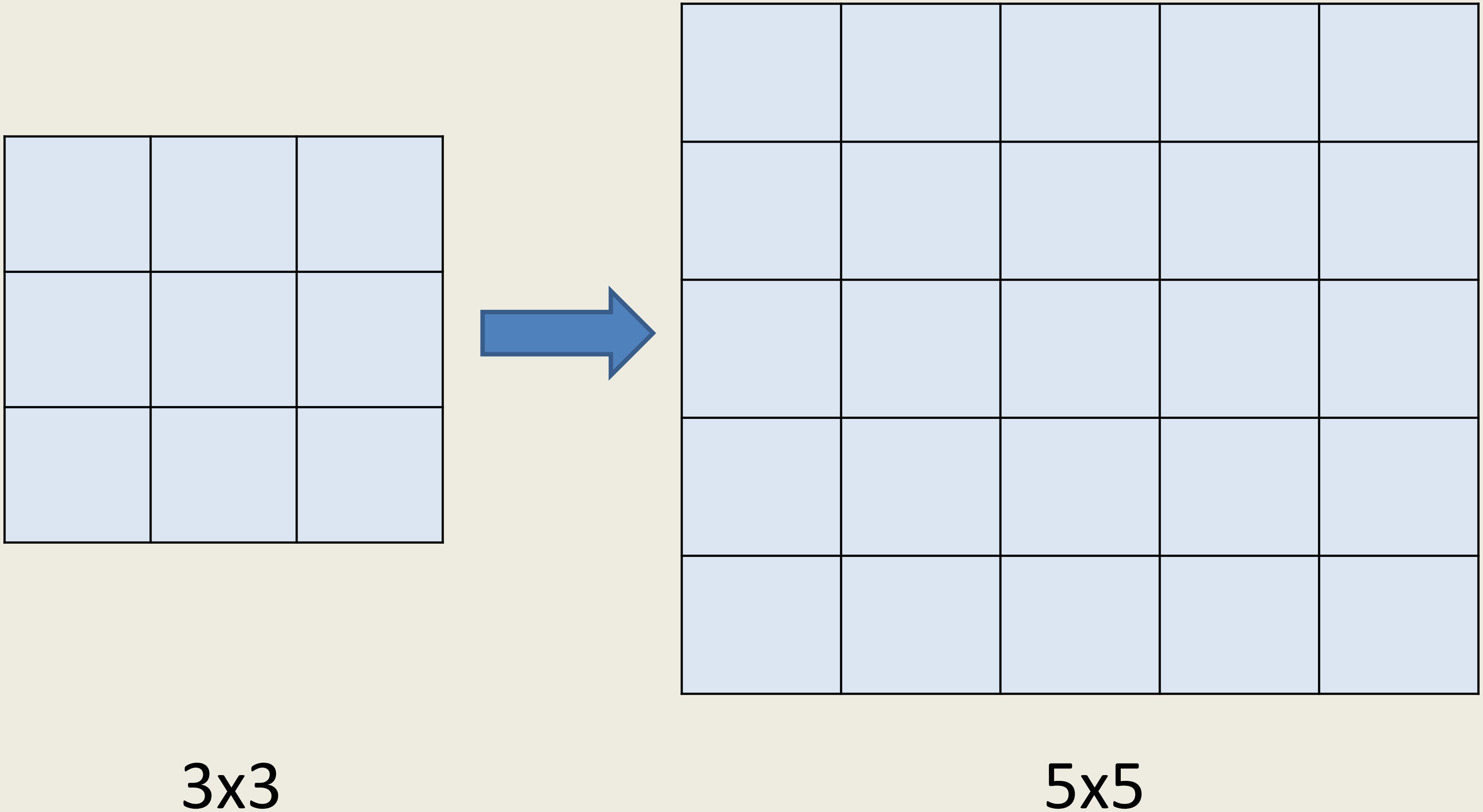
0.01	0.04	0.09
0.05	0.14	0.16
0.11	0.18	0.28

Uncalibrated:
5 of 9 points > 0.10 inch
5/9= 56%

Calibrated:
5 of 9 > 0.10 inch
Maximum: 0.28 inch
Average: 0.12 inch

- Spatial ensemble
- Allows for slight displacements in forecast fields

Adaptable framework



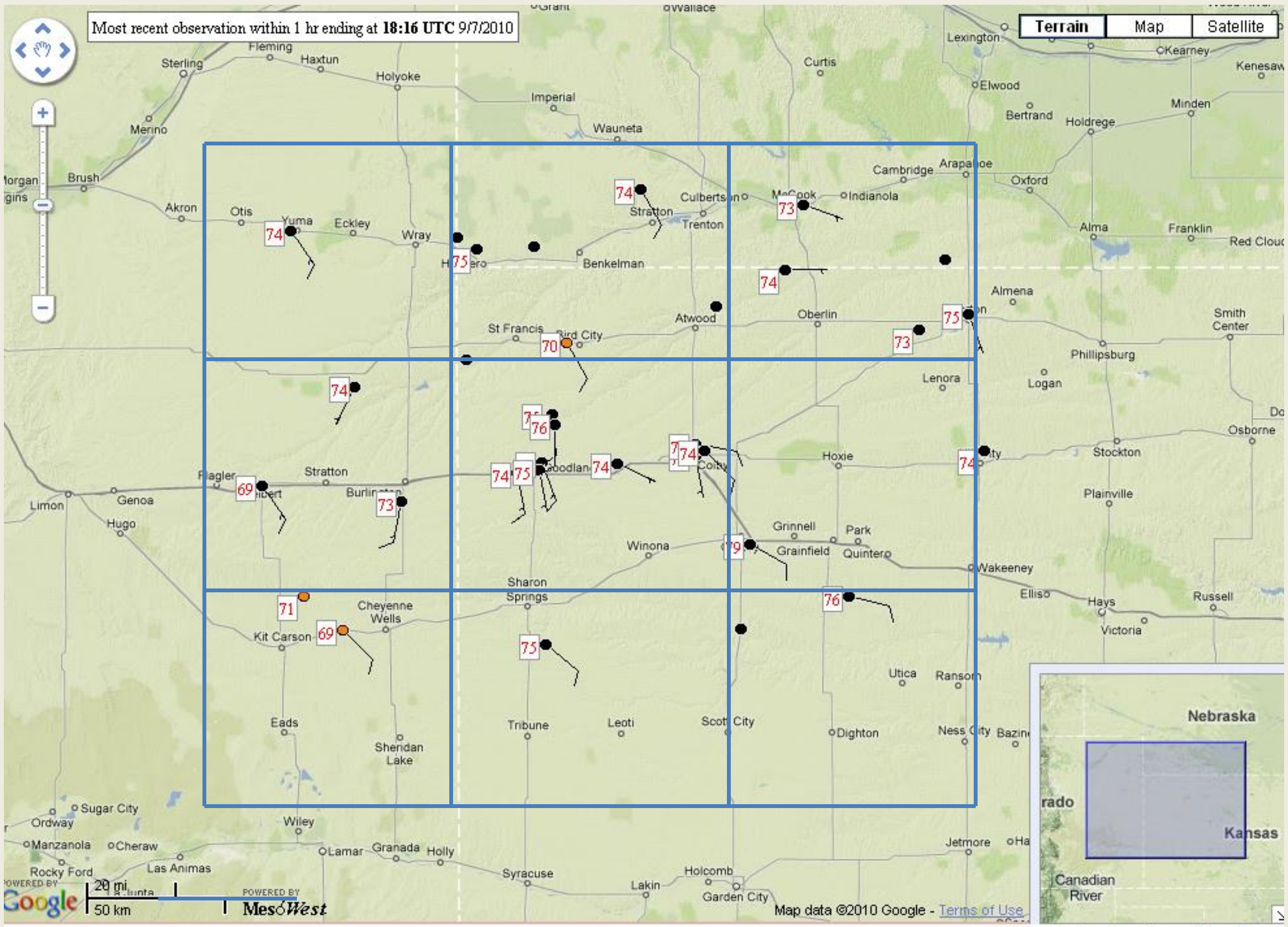
Produces new forecasts from the data we already have

"Only by making tough choices to both **cut spending** and deficits and invest in what we need to win the future can we out-educate, out-build, and **out-innovate** the rest of the world."

Office of Management and Budget

Jack Lew

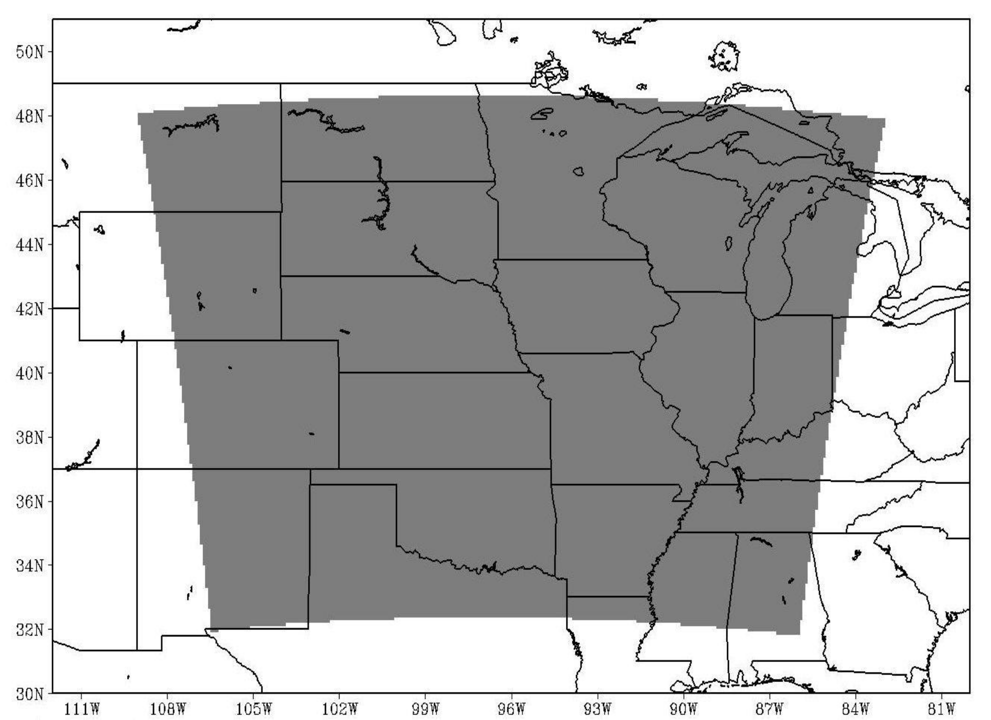
Methodology



A 3x3 neighborhood is the simplest neighborhood, and uses average QPFs. Previous research indicated the forecasts could be improved by increasing the neighborhood size.

- **How many of the 9 neighborhood points have precipitation >= a threshold? (0.01, 0.10, or 0.25 inch)**
- **What is the average precipitation amount within the 9 points?**

<0.01	0.01-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.00	>1.00



Hazardous Weather Testbed Spring Experiment

5 of 9 points >= 0.01 in
Ave precip: 0.05-0.10 in → 5643 cases

of the 5643 cases where the 12 hr accumulated precip was >= 0.01 → 1673 cases

$$\frac{1673 \text{ cases}}{5643 \text{ cases}} = 29.647\%$$

POP table for 0.01 inch threshold

	<0.01	0.01-0.05	0.05-0.10	0.10-0.25	0.25-0.50	0.50-1.00	>1.00
0	8.626	-	-	-	-	-	-
1	27.332	29.147	12.5	-	-	-	-
2	29.647	34.509	40	37.5	-	-	-
3	30.361	37.894	37.617	37.705	57.143	100	-
4	28.34	38.481	43.004	47.687	58.621	50	-
5	21.875	39.618	45.294	47.66	41.667	28.571	100
6	26.923	41.007	48.454	50.653	55.022	41.176	66.667
7	-	43.003	52.198	54.148	63.21	64.516	57.143
8	-	42.972	54.806	58.207	63.424	71.648	45.161
9	-	41.281	57.63	69.185	82.385	88.61	91.082

Testing for the Goodland CWA

- MOSguidance QPFs considered (BOIVerify)
- Goodland ASOS used for verification
- Tested against MOSguidance and SREF POPs
- Two statistics
  - Brier scores (Ideal value of 0.0)
  - Bias values (Ideal value of 1.0)

Statistics for Goodland Area

Brier score	Official	MOSguidance	SREF
0.01 inch	0.057	0.062	0.088

Bias	Official	MOSguidance	SREF
0.01 inch	1.302	1.171	1.949

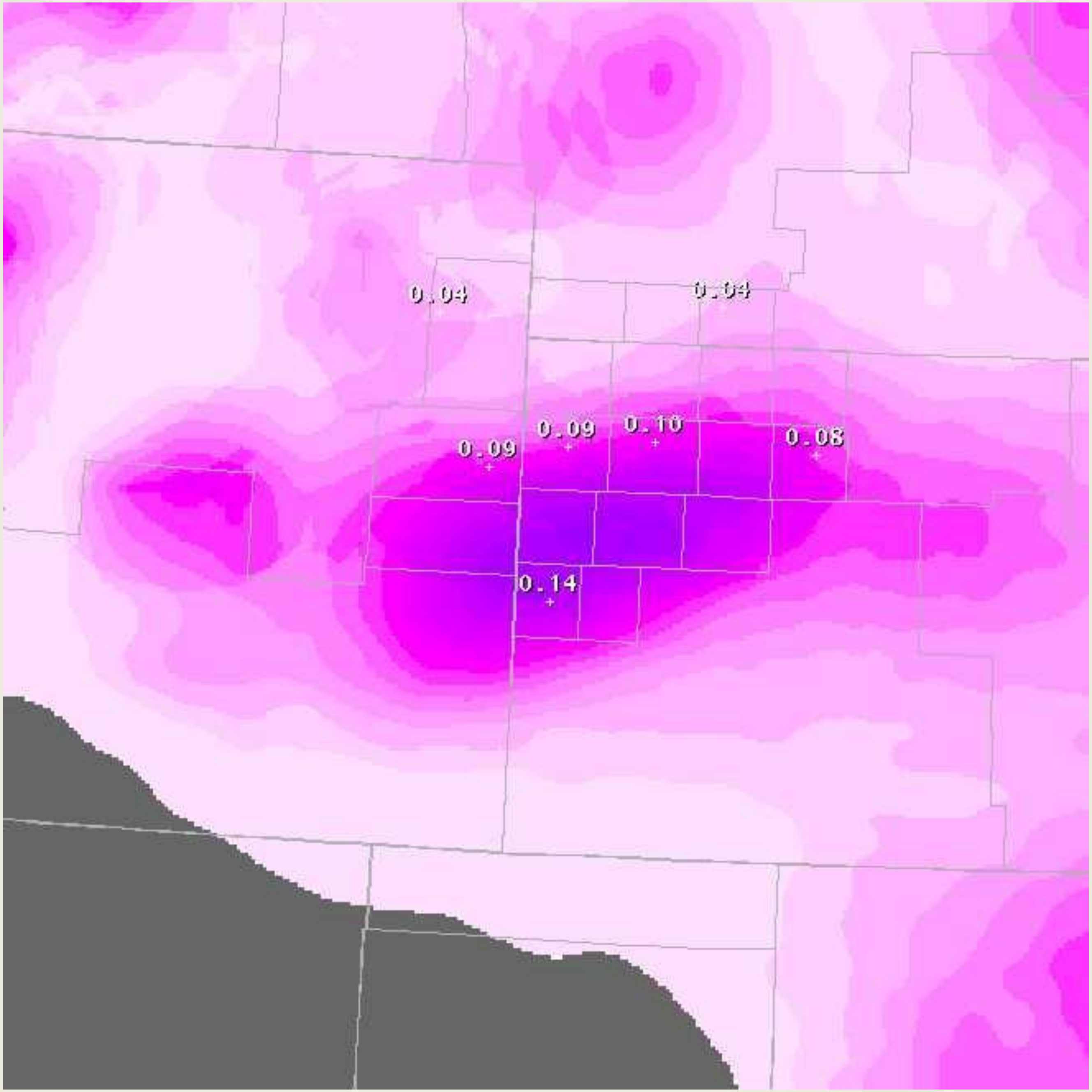
Statistics for Goodland Area

Brier score	Official	Nbh	MOSguidance	SREF
0.01 inch	0.057	0.071	0.062	0.088
0.10 inch	-	0.028	-	-
0.25 inch	-	0.013	-	-

Bias	Official	Nbh	MOSguidance	SREF
0.01 inch	1.302	1.228	1.171	1.949
0.10 inch	-	1.317	-	-
0.25 inch	-	1.227	-	-

Results

- Brier scores show that forecasts for Nbh are competitive with MOSguidance and SREF forecasts
- Brier scores for Nbh improve further as the threshold increases
  - More diverse QFP fields/gradients at higher thresholds


0.04
0.04
0.09
0.09
0.10
0.08
0.14

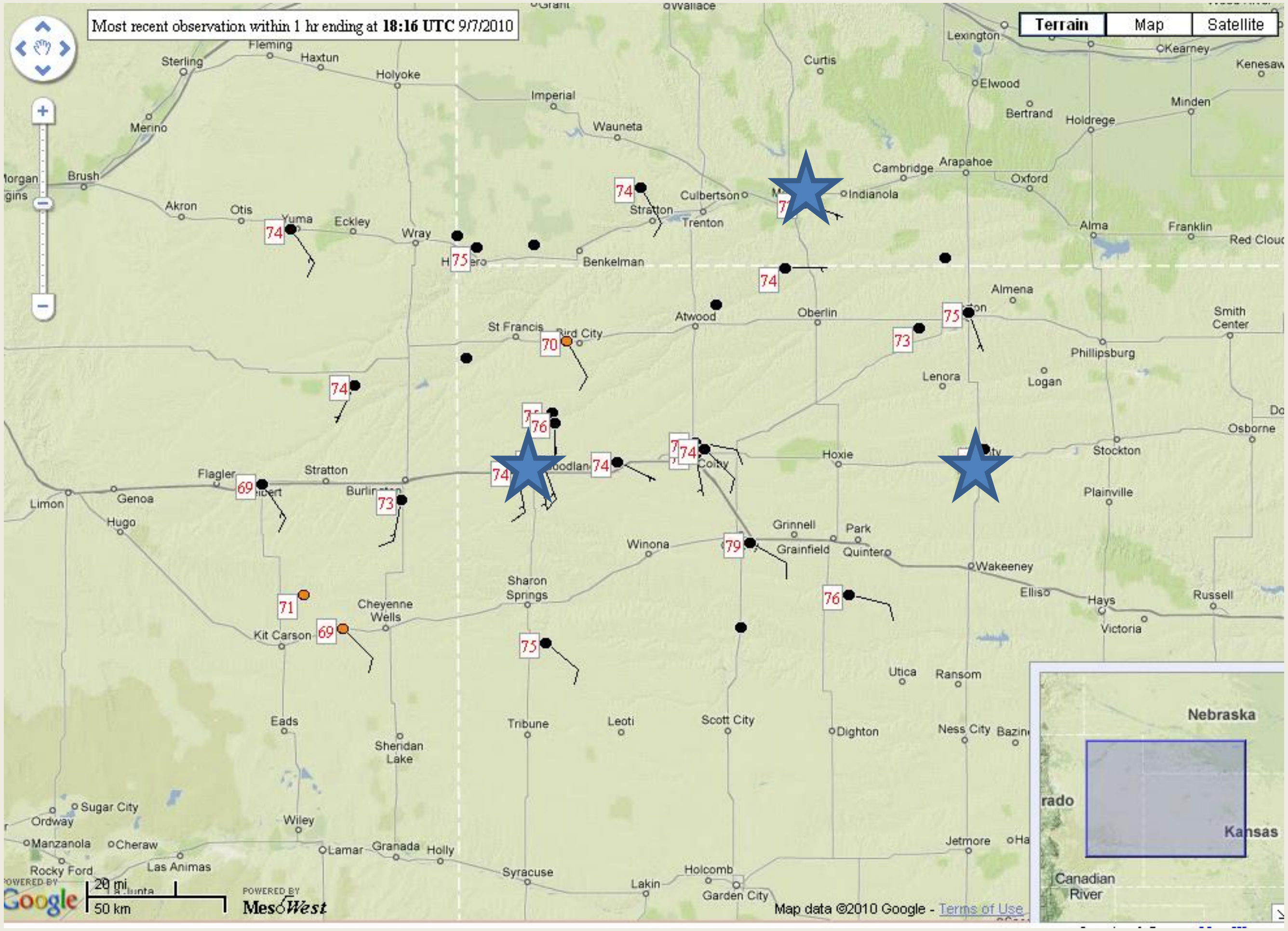
Results

- When only considering days with precip (cases with only “Yes” Observations)
  - SREF has better Brier score than MOSguidance
  - Nbh still has a Brier score between the two
    - For a data set in between drought conditions and persistently rainy, Nbh may do best

Results

- Nbh has bias value between MOSguidance and SREF
  – Again suggests that Nbh may do best when the "no precip" days aren't dominating (when we exit drought)
  – Larger SREF Bias value supports claim that SREF tends to forecast higher POPs than Nbh and MOSguidance

- Similar results when the study was repeated for Hill City, KS and McCook, NE
  - Consistent performance/trends between MOSguidance, Nbh, and SREF at each site



The Take-Home Message

- This neighborhood approach creates POP forecasts competitive with MOS Guidance and SREF forecasts, using QPF data we already have.
- It accounts for uncertainty by considering forecasts over a CWA, and provides calibrated POPs at the three thresholds (0.01, 0.10, and 0.25 inch) using a spatial ensemble.

From here…

- Smart tool to make this approach operational
- Comparison to NAM and GFS POPs
- Once we have a new BOIVerify dataset (hopefully without drought), reevaluate
- Test the approach over a larger neighborhood, both in physical size and dimension (5x5?)

Thanks to…

- Jeremy Martin, for his assistance in getting the BOIVerify data
- Al Pietrycha, for helpful discussions regarding the results and presentation
- You, for your time!

Obligatory Equation Slide

$$BS = \frac{1}{n}\sum_{k=1}^{n} (p_k - o_k)^2$$

$$BS = \frac{1}{n}\sum_{i=1}^{I} N_i(p_i - \bar{o}_i)^2 - \frac{1}{n}\sum_{i=1}^{I} N_i(\bar{o}_i - \bar{o})^2 + \bar{o}(1 - \bar{o})$$

$$\bar{o}_i = \frac{1}{N_i}\sum_{k \in N_i} o_k \qquad \bar{o} = \frac{1}{n}\sum_{i=1}^{I} N_i\,\bar{o}_i$$

$$bias = \frac{\sum_{k=1}^{n} p_k}{\sum_{k=1}^{n} o_k}$$

Statistics for Hill City Area

Brier score	Official	Nbh	MOSguidance	SREF
0.01 inch	0.075	0.077	0.073	0.115
0.10 inch	-	0.018	-	-
0.25 inch	-	0.010	-	-

Bias	Official	Nbh	MOSguidance	SREF
0.01 inch	1.421	1.255	1.253	2.015
0.10 inch	-	2.959	-	-
0.25 inch	-	2.406	-	-

Statistics for McCook Area

Brier score	Official	Nbh	MOSguidance	SREF
0.01 inch	0.070	0.076	0.069	0.103
0.10 inch	-	0.030	-	-
0.25 inch	-	0.012	-	-

Bias	Official	Nbh	MOSguidance	SREF
0.01 inch	1.405	1.230	1.224	2.046
0.10 inch	-	1.417	-	-
0.25 inch	-	1.652	-	-