

EQUITABLE THREAT SCORE APPLIED TO MCS RAINFALL:

- SCALE DEPENDENCE**
- DISAGREEMENT WITH SUBJECTIVE
EVALUATIONS AND**
- IMPACT OF PHASE-SHIFTING**

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Warm Season QPF Issues

- Many studies have shown that QPF skill is much lower for the warm season (e.g. Olson et al. 1995)
- Numerous reasons exist for this – small scale forcing, large variability and fine-scale structure
- Some specific problems in Equitable Threat Score are very apparent in our own work

Scale Dependence

- NCEP on-line statistics clearly show that ETSs are higher for 24-hr verifications than for 6-hr or 3-hr, as timing errors result in less penalty
- Tustison et al. (2001) show that verifying method will determine the relationship of representativeness error to horizontal resolution at which verification is performed.

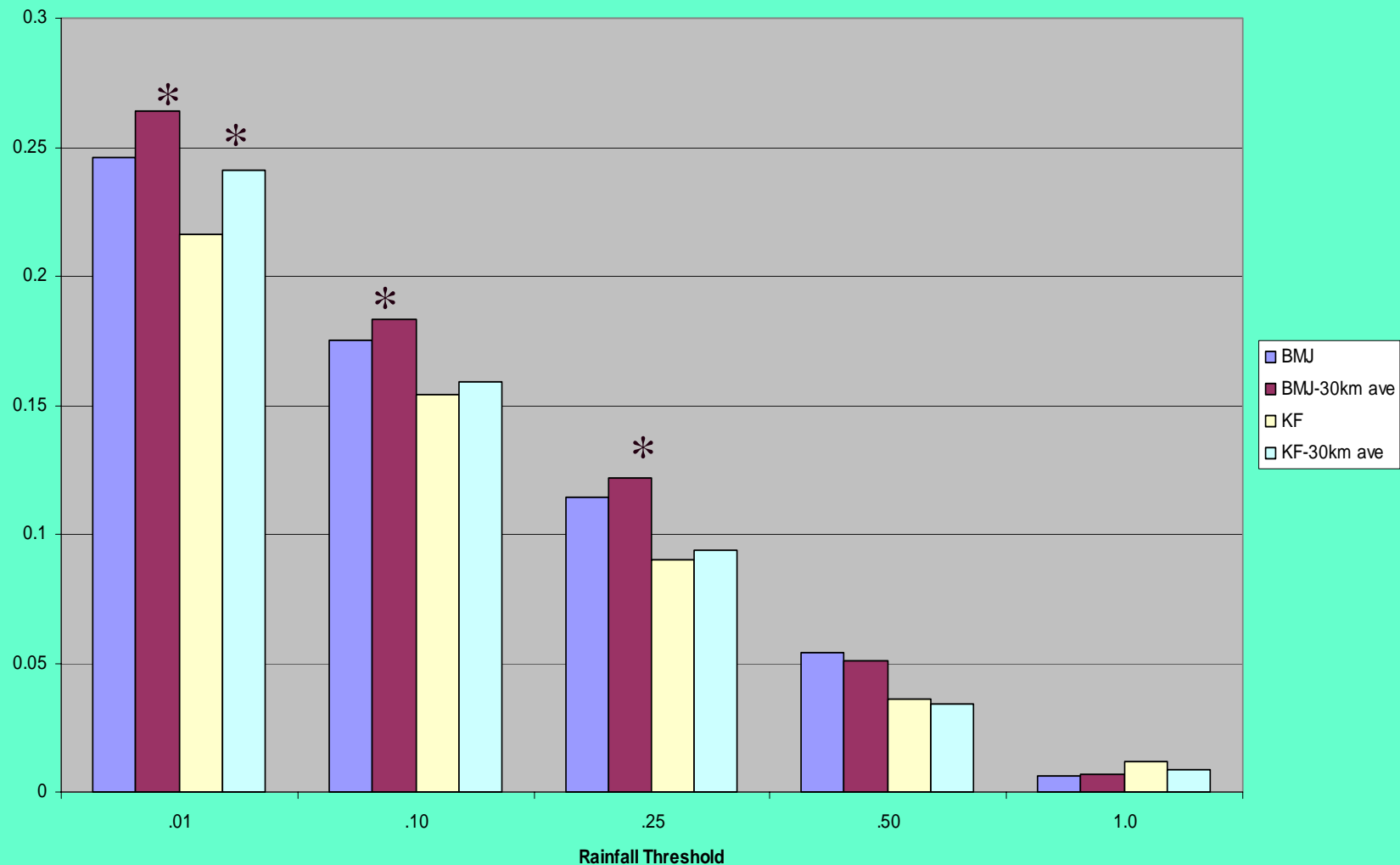
Spatial scale dependence

- For area-to-point interpolation/averaging, finer resolution reduces representativeness error – so some perceived model improvement doesn't necessarily reflect a better model
- For point-to-area techniques (NCEP standard procedure), representativeness error worsens as resolution is refined

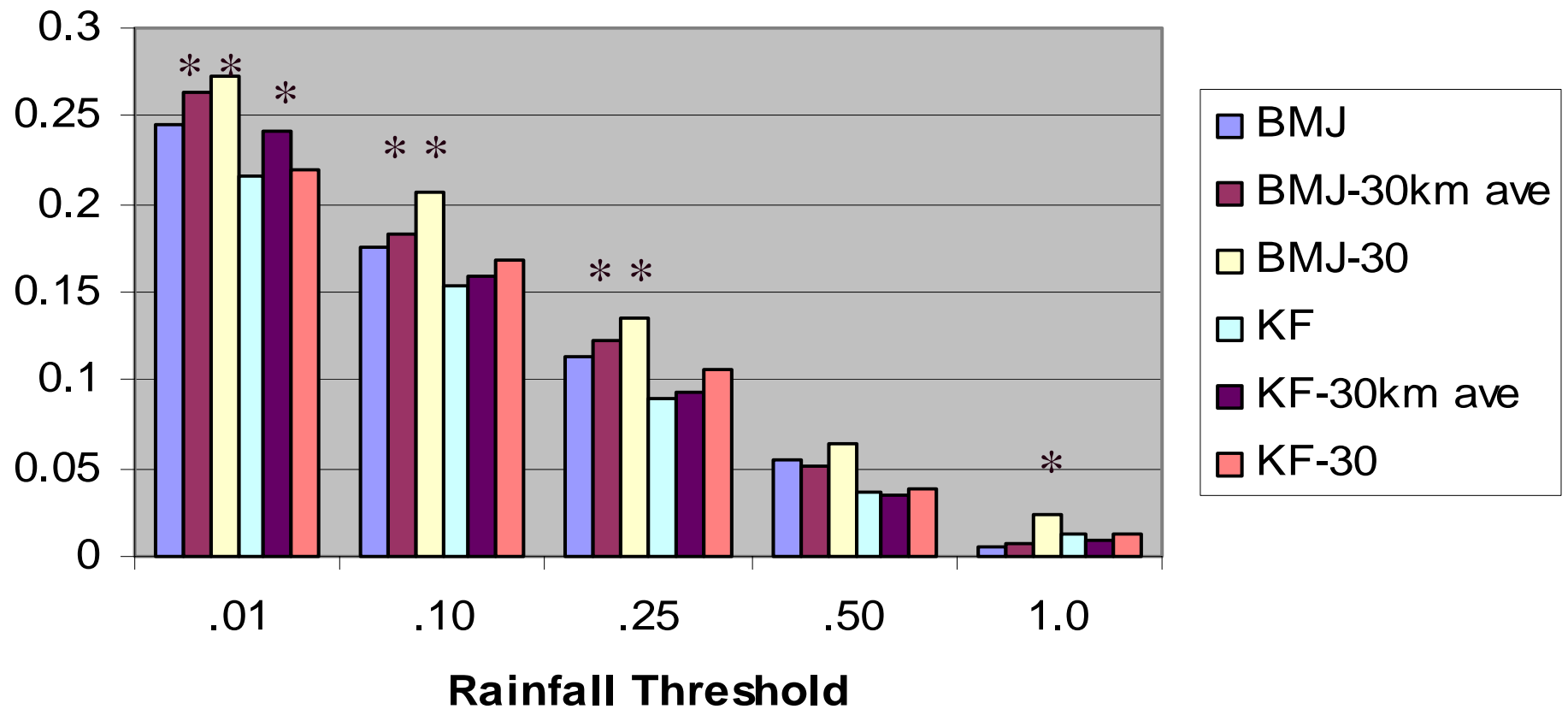
Using 11 of the 23 warm season cases we've identified in the summers of 1998-2000 where significant Midwest convective systems occurred, we have computed ETSs for Eta simulations using point-to-area conversion on:

- ✓ the model's own 10 km grid
- ✓ the 10 km model output averaged on to a 30 km grid and verified on the 30 km grid
- ✓ 30 km version of model's own grid (matching the grid in item 2)

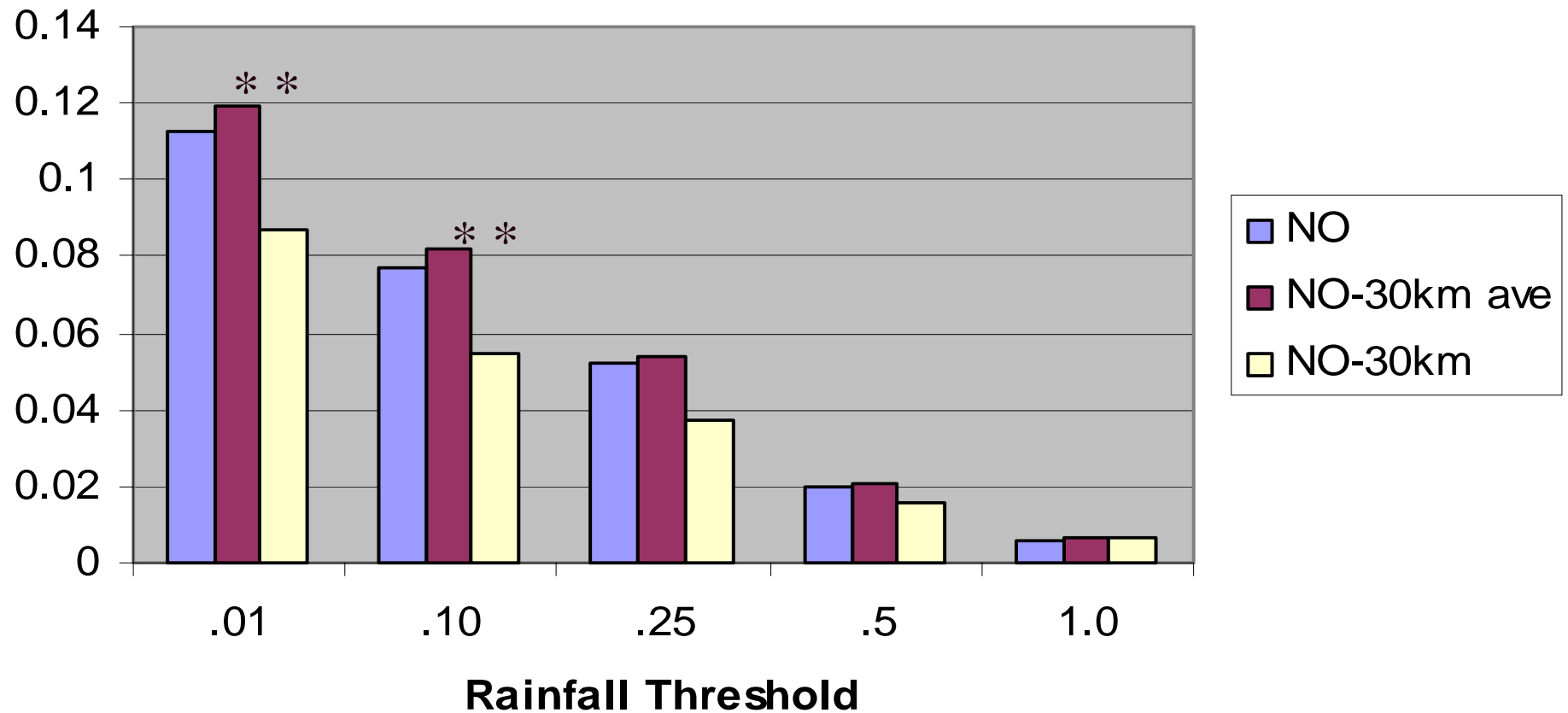
ETTs increase, often in a statistically significant sense (95% confidence shown with *) when the 10 km output is averaged onto and verified on a 30 km grid



Bigger surprise is that ETSs generally improve even more when model is run with 30 km grid spacing



Out of many model variants, the only one not showing improvement was one using NO convective scheme (as would be expected)



Possible Reasons for “better” 30 km Eta performance

- **Spurious small-scale features simulated at 10 km might degrade larger-scale regions of forecasted rainfall**
- **The use of the KF and BMJ convective schemes at 10km may cause a problem that is not present at 30 km**
- **The use of ETS to evaluate performance may simply be misleading**

SUMMARY

- Caution must be used when comparing model skill scores among runs verified at different spatial scales
- For point-to-area conversion, it may be increasingly difficult to show that ETSs are improving with increasingly fine resolution

Subjective Verification

- Larger sample of 20 cases (including previous 11) was evaluated subjectively with emphasis on comparison between BMJ and KF runs
- Area/location, initiation timing, and general system-wide rain amount were examined
- Further evidence of problems in use of ETS to determine “better” forecast

Gallus and Segal (2001) computed ETSs for all events and a range of model variants:

Run	.01	.10	.25	.50	1.0
BMJ	.204	.155	.092	.043	.005
KF	.171	.120	.077	.040	.014

The results suggest better performance by the BMJ scheme, though BIAS scores show high BIAS for BMJ except at 1.0 threshold, and low bias for KF below 0.5 threshold. KF has much better bias at .1, .25 and .5 thresholds.

Criteria used for subjective analysis:

Location/Areal Coverage of predicted precipitation area

Shifted, Overpredicted, Underpredicted and Missed part of a system

Timing of precipitation system initiation

Late and Early

Amount of general system-wide predicted precipitation

Overpredicted, for more than 2 mm, and Underpredicted, for more than 2mm than observed

Results considering all MCS simulations

Location	Shifted (%)	Overpredicted (%)	Underpredicted (%)	Missed system (%)
BMJ	63	47	5	31
KF	42	10	16	26

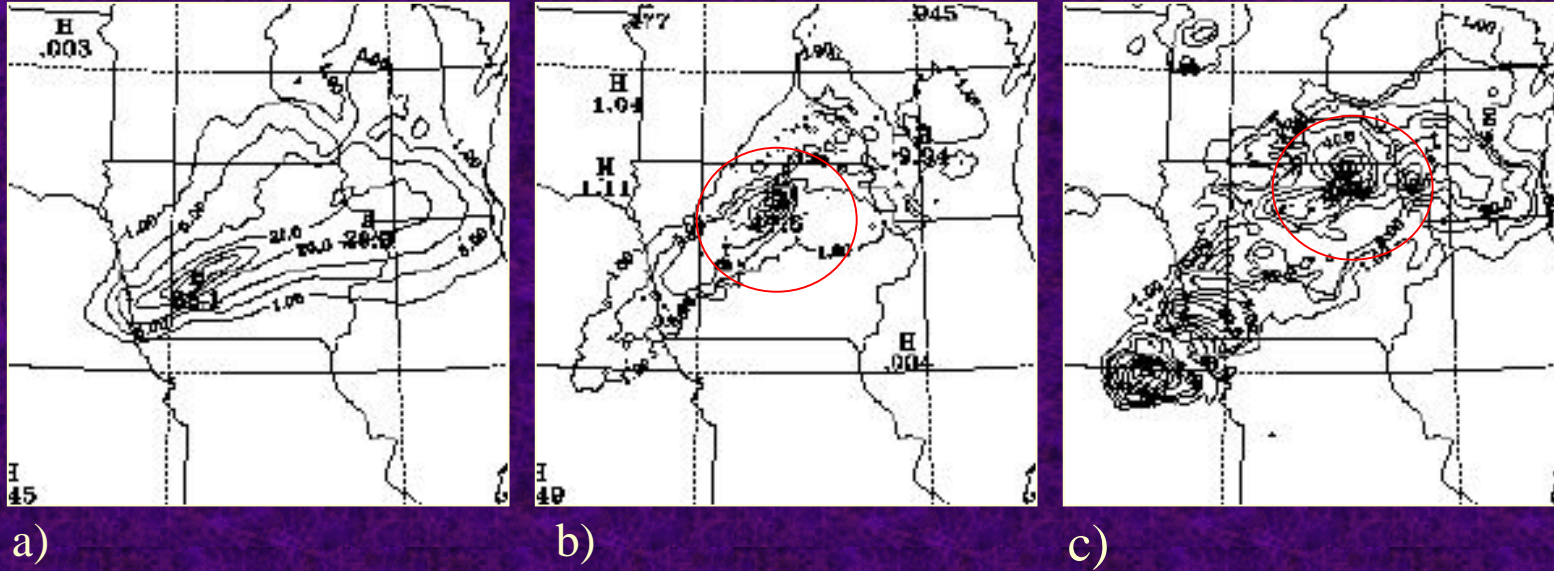
Time	Late (%)	Early (%)
BMJ	16	0
KF	47	5

Amount	Overpredicted (%)	Underpredicted (%)
BMJ	21	68
KF	26	21

Example: June 28, 1998, 00z initialization

Threshold (mm)	ETS (BMJ)	ETS (KF)	BIAS (BMJ)	BIAS (KF)
0.254	0.460	0.334	0.966	0.605
1.270	0.512	0.323	0.914	0.517
2.540	0.509	0.249	0.918	0.376
6.350	0.418	0.132	0.780	0.183
12.70	0.289	0.068	0.690	0.123

ETS and BIAS values during the 00-06 UTC period for both convective schemes, 06/28/98.

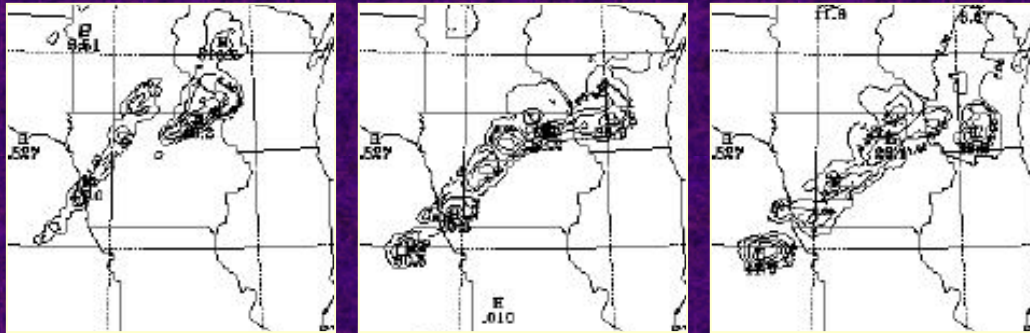


a) Accumulated precipitation during 06/28/98, 00-06 UTC from a) the BMJ simulation, b) the KF simulation, and c) observations.

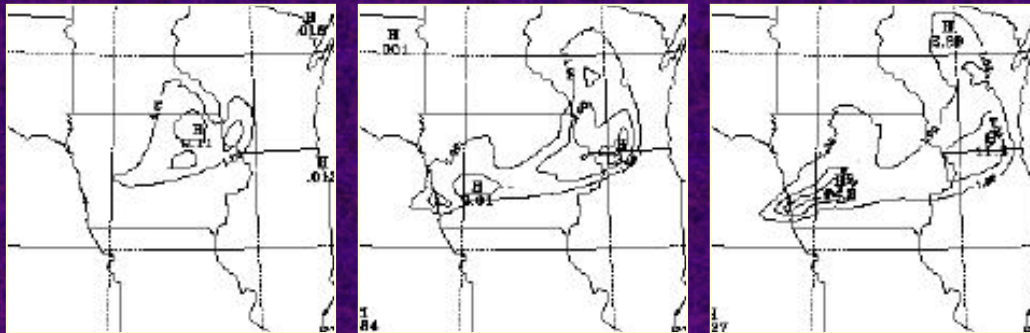
Subjective impressions:

- Areal coverage better simulated by BMJ.
- Orientation of rain area was slightly better simulated by KF (precipitation axis more sloped in SW-NE direction like observations).
- KF better located heavier precipitation over the northeastern corner of IA.

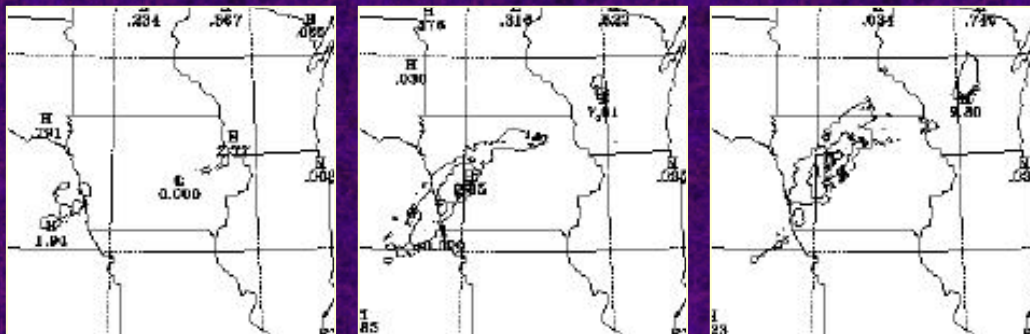
Evaluation at finer time scales also disagrees with 6hr ETSs



Observed accum.precipitation
(NCEP Stage IV analysis),
06/28/98 at 00 UTC +02, 04
and 05h, respectively.



BMJ, accum. Precipitation
06/28/98 at 00 UTC +02, 04
and 05h, respectively.



KF, accum. Precipitation
06/28/98 at 00 UTC +02, 04
and 05h, respectively.

❖ **Note:** Contouring every five millimeters with one-millimeter contour included.

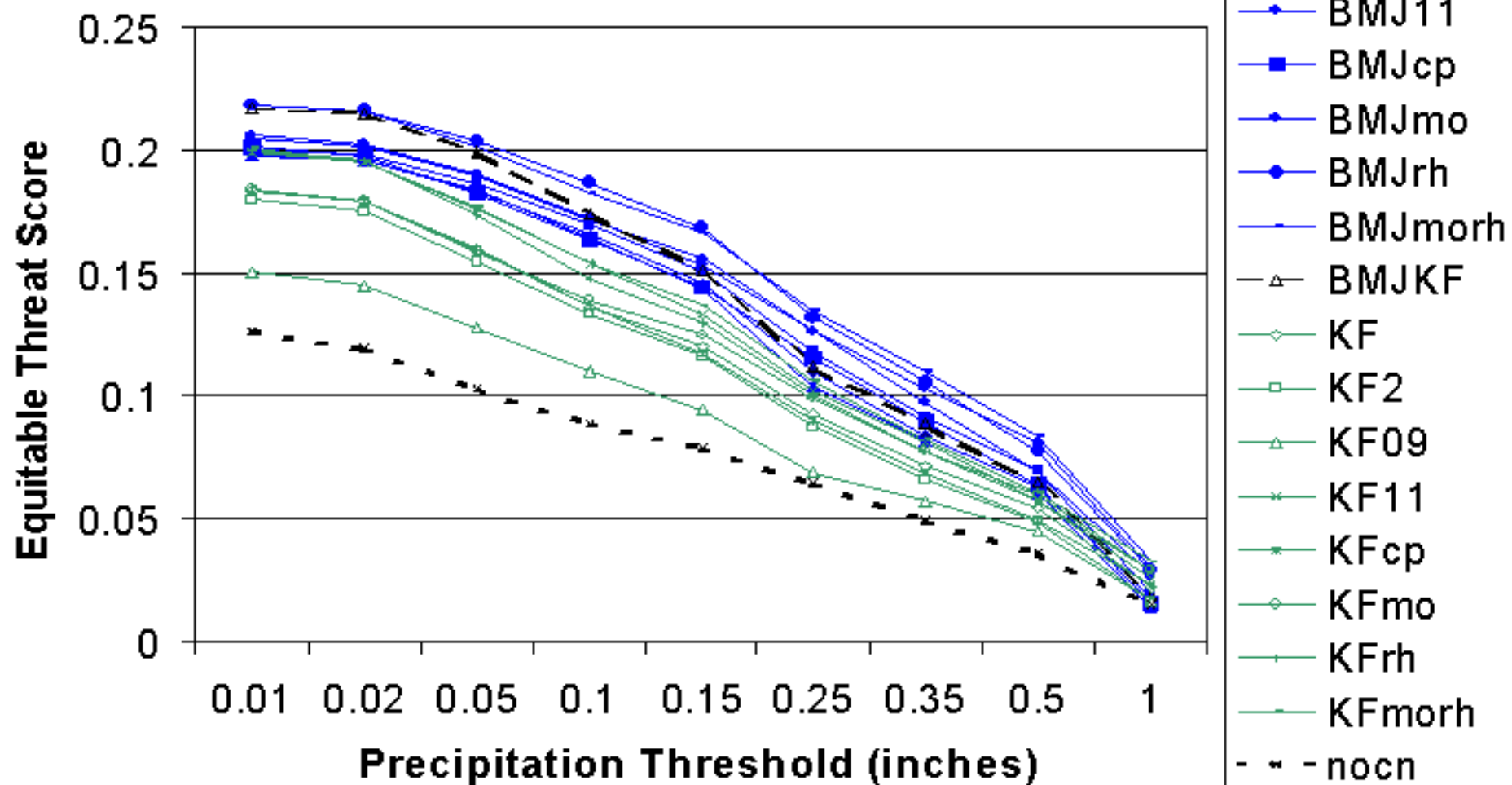
SUMMARY

- Though BMJ scheme has pretty big advantage over KF in ETSs, subjective analysis favors KF scheme for 20 MCS events
- Warm-season MCS events with fine-scale precipitation structure can serve as rigorous test bed for design of new “objective” evaluation techniques that would better reflect subjective impressions

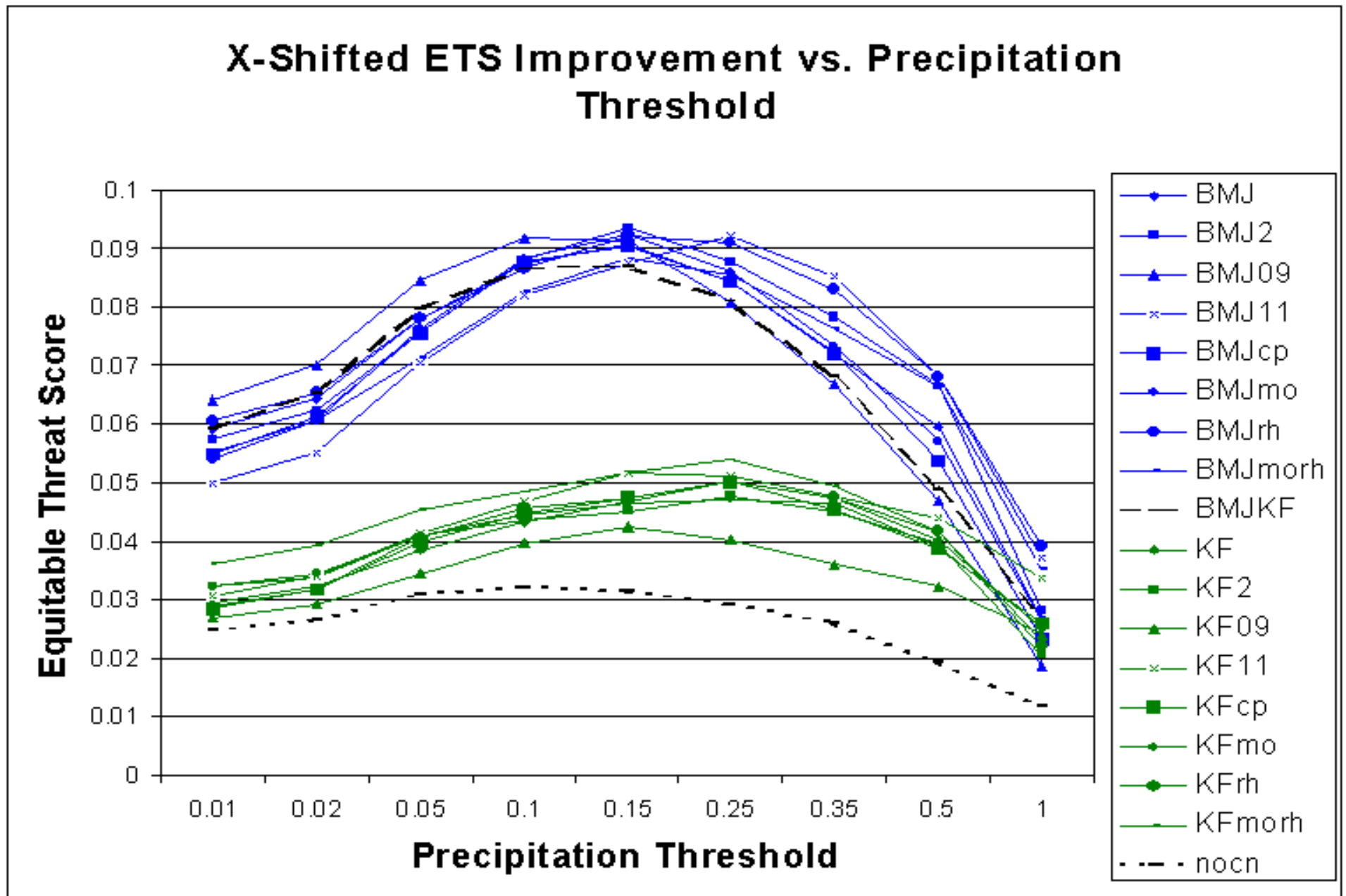
Can use of ETS be improved?

- Kalnay and Miller explored phase-shifting approach
- We extended to 2 directions and applied to all MCS events
- Simulated rainfall in rows permitted to shift up to 8 grid points to maximize ETS
- Does this change findings of Gallus and Segal (2001)?

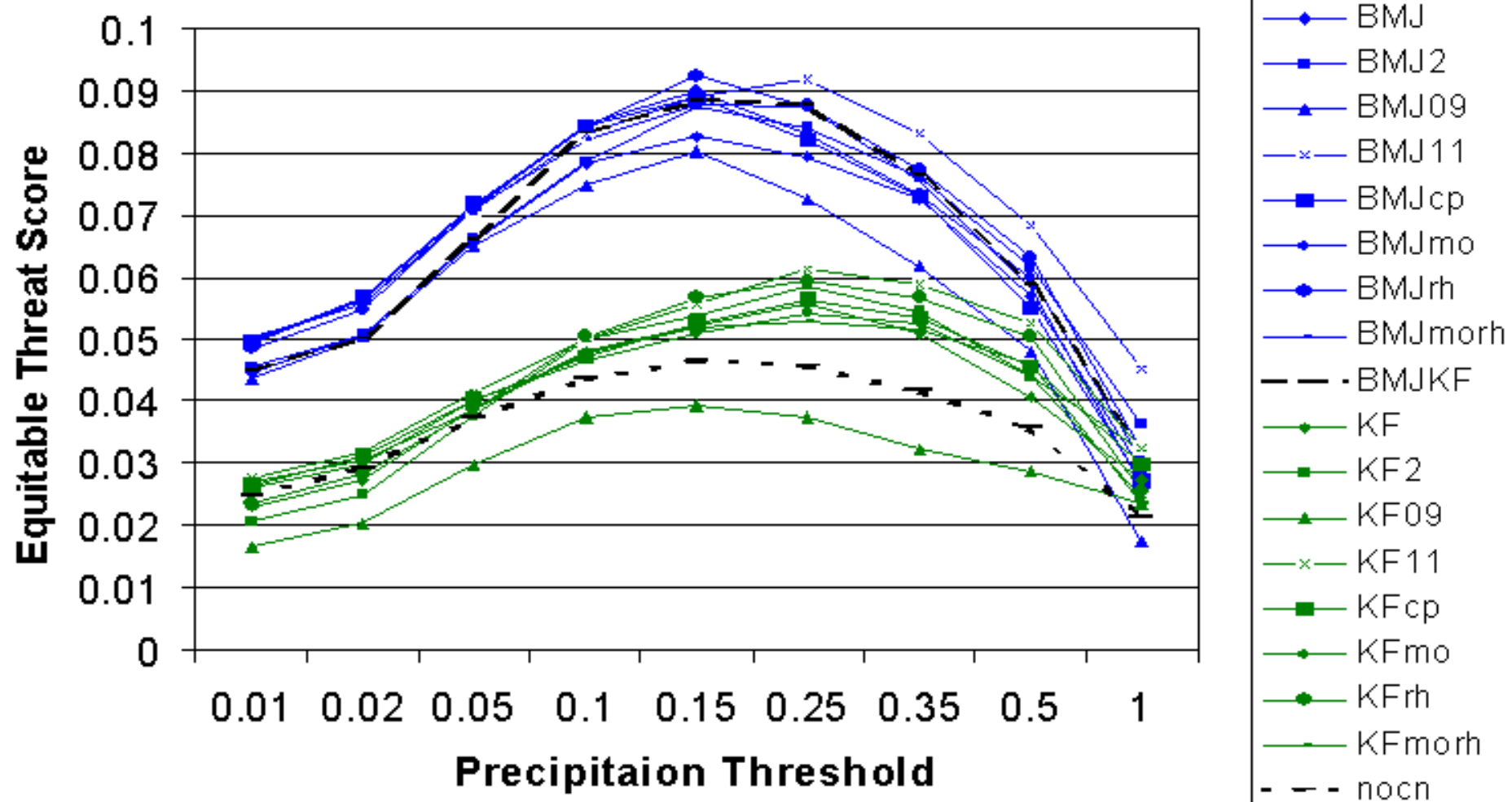
ETS vs. Precipitation Threshold for All Ensemble Members



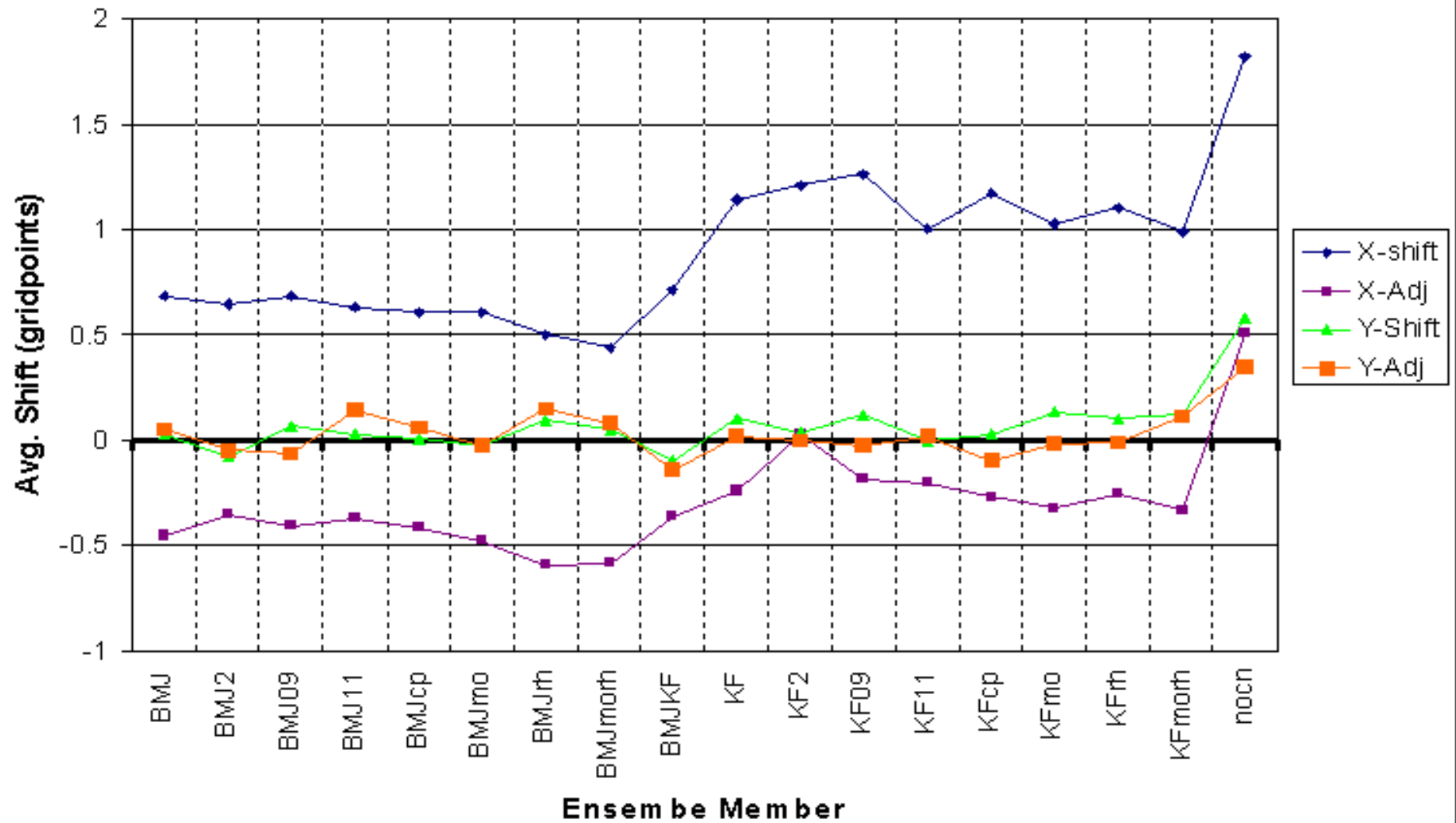
In both X and Y directions, BMJ runs benefitted more from shift



Y-Shifted ETS Improvement vs. Precipitation Threshold



Average Shift for All Ensemble Members



Conclusions

- Phase shifting may help provide more insight into model comparisons, but did not markedly affect our results
- Our impression is that more fundamentally different techniques need to be developed and applied to warm season QPF evaluation

Acknowledgments

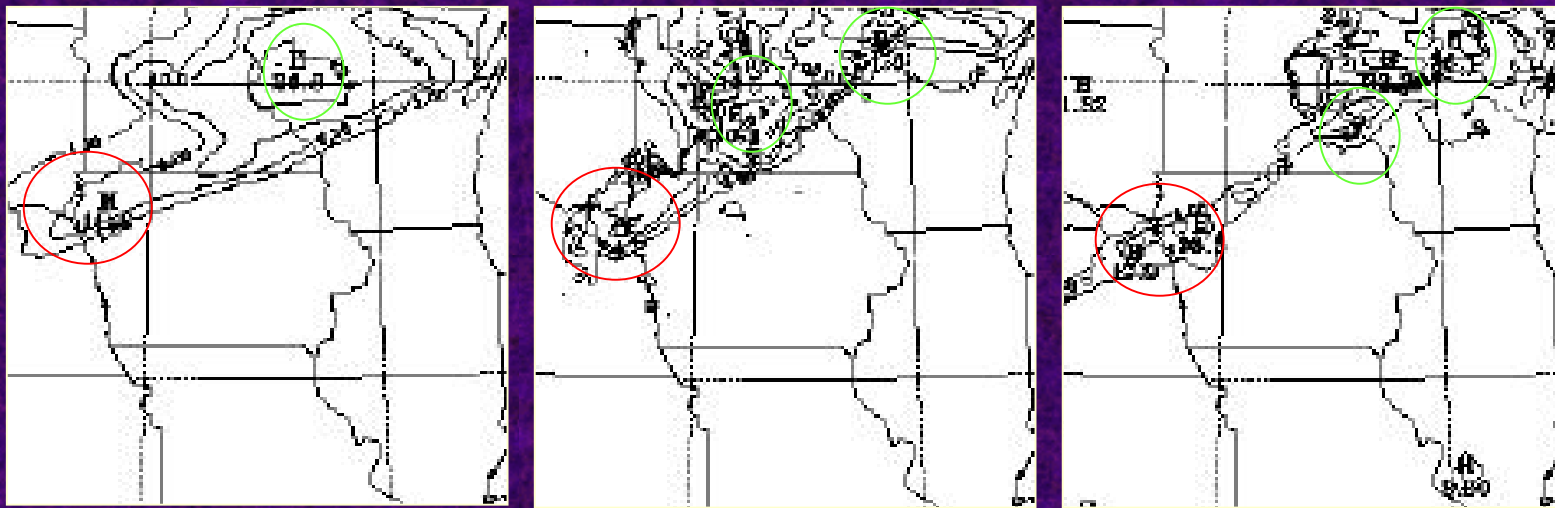
Mike Baldwin, Jack Kain, Dave Stensrud

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Example 1: July 8, 1999, 12z initialization

Threshold (mm)	ETS (BMJ)	ETS (KF)	BIAS (BMJ)	BIAS (KF)
0.254	0.337	0.295	1.125	0.990
1.270	0.312	0.283	1.340	1.135
2.540	0.293	0.273	1.513	1.274
6.350	0.262	0.238	1.511	1.393
12.70	0.181	0.181	1.182	1.477

Table 1. ETS and BIAS values during the 06-12 UTC period for both convective schemes, 07/08/99.



a) b) c)
 Accumulated precipitation during 07/08/99, 06-12UTC from a) The BMJ simulation, b) the KF simulation, and c) observations

Subjective impressions:

- Slightly narrower precipitation area with KF scheme seemed better
- Precipitation amount overpredicted by KF but underpredicted by BMJ
- Main advantage of KF compared to BMJ was in the fine-scale details. KF distinguished between the peak over N. WI and NE. MN, while BMJ had just one over W. WI.