Characterizing Rain Field Sub-pixel Variability in the Great Plains

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Why?

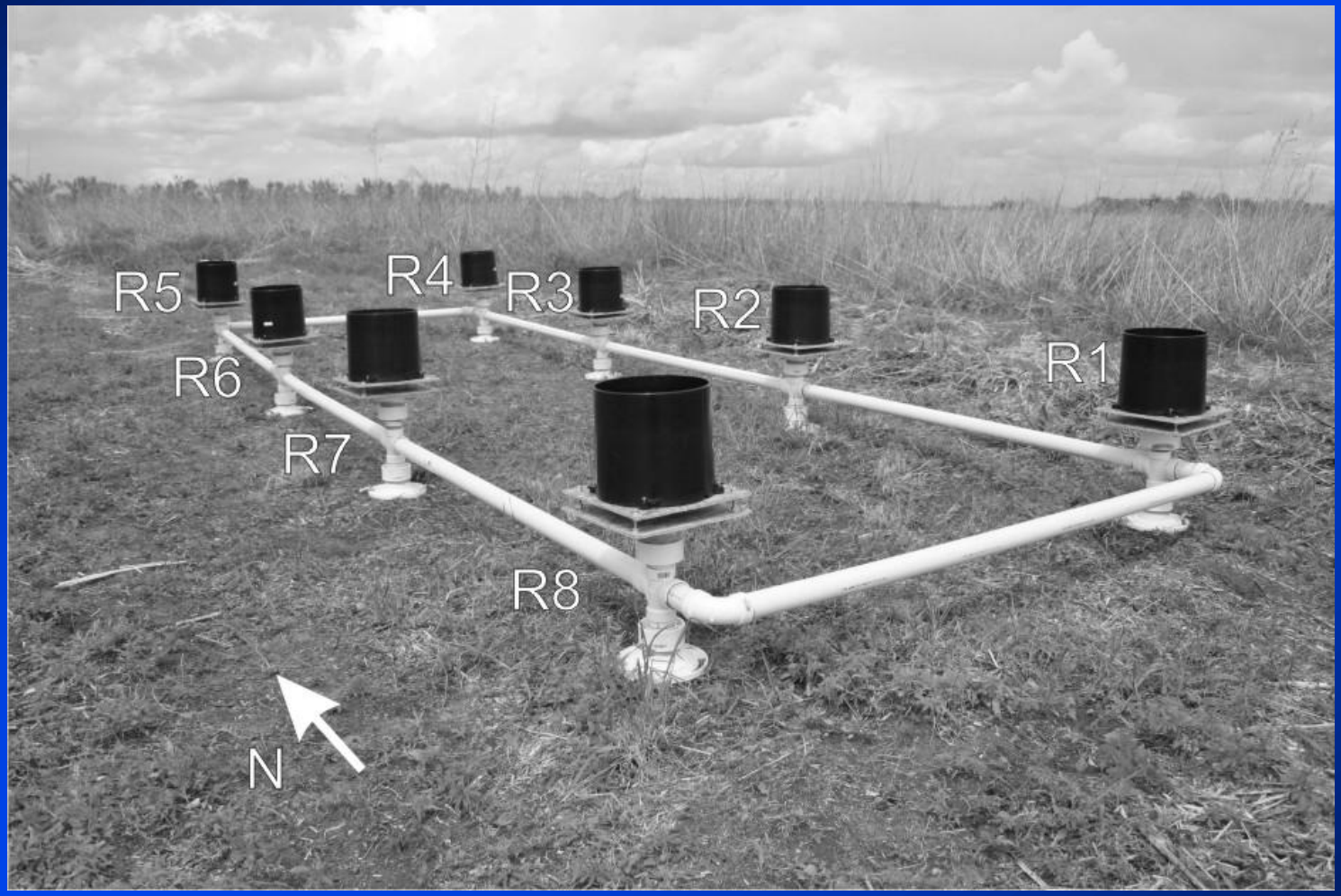
Rain fall variability on small scales remains largely un-quantified, but commonly witnessed to be substantial

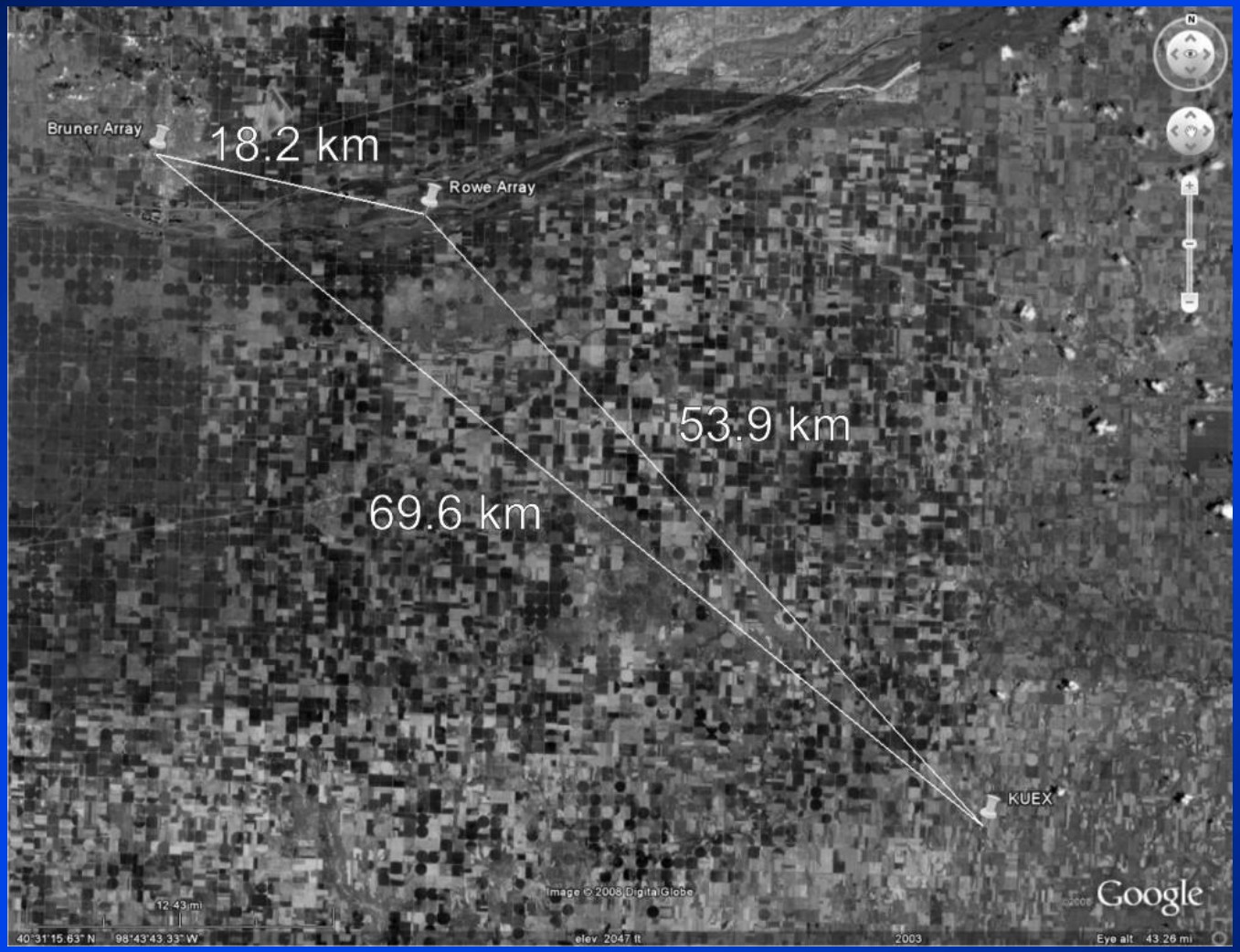
Radar is known to be inaccurate when estimating rain fall properties

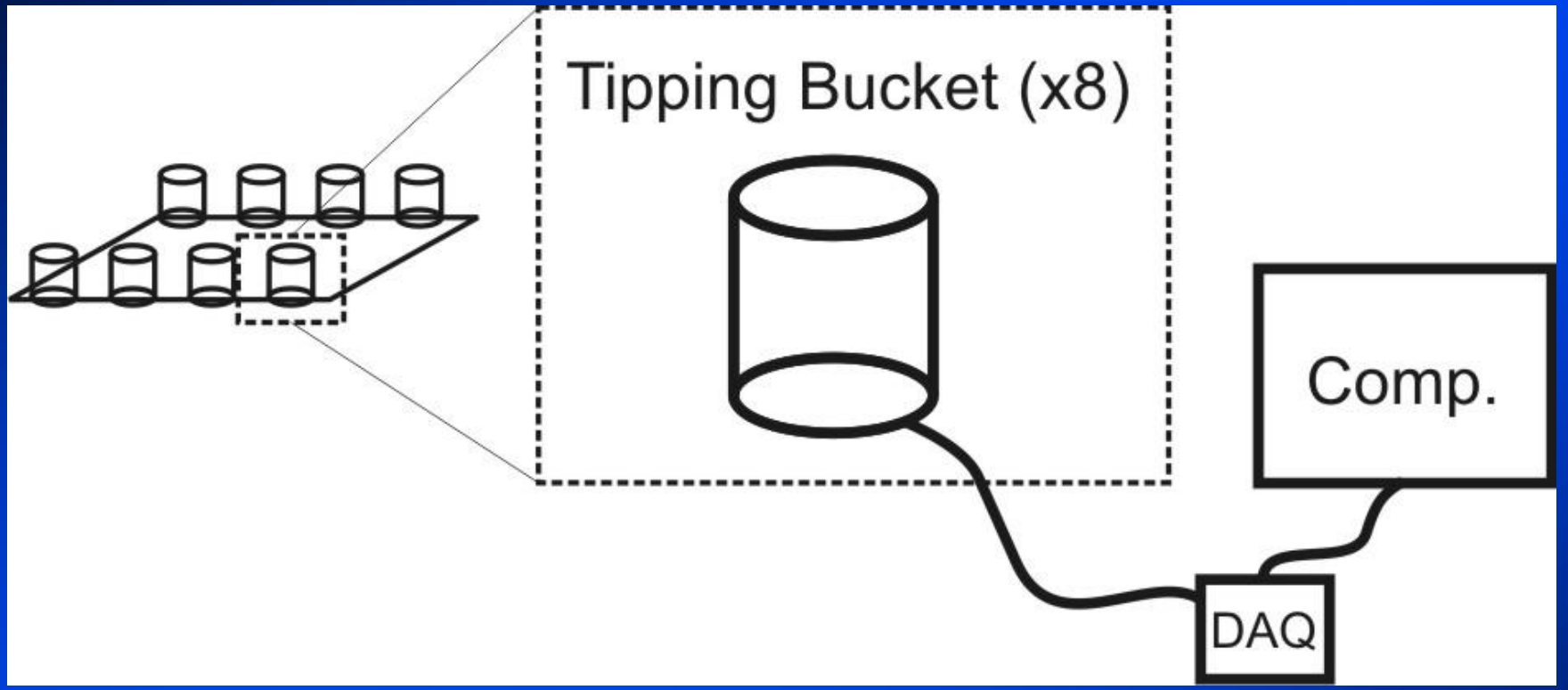
- Rates
- Accumulations

No one has ever addressed the issue on such a small spatial and time scale

Rowe Array

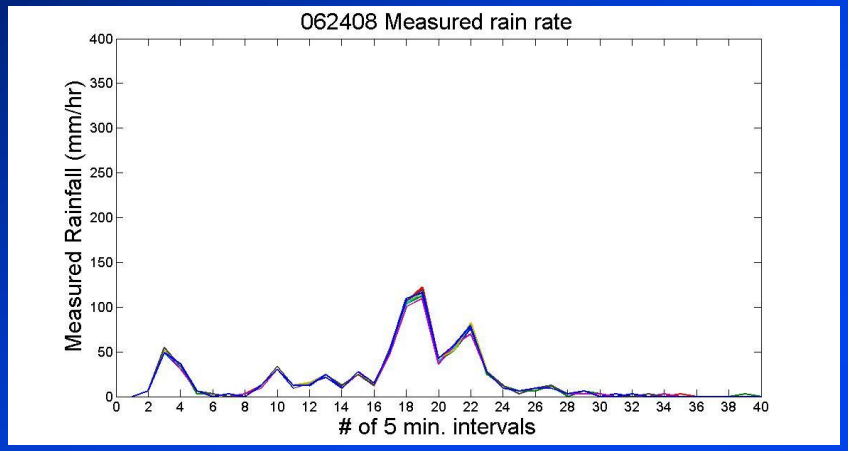


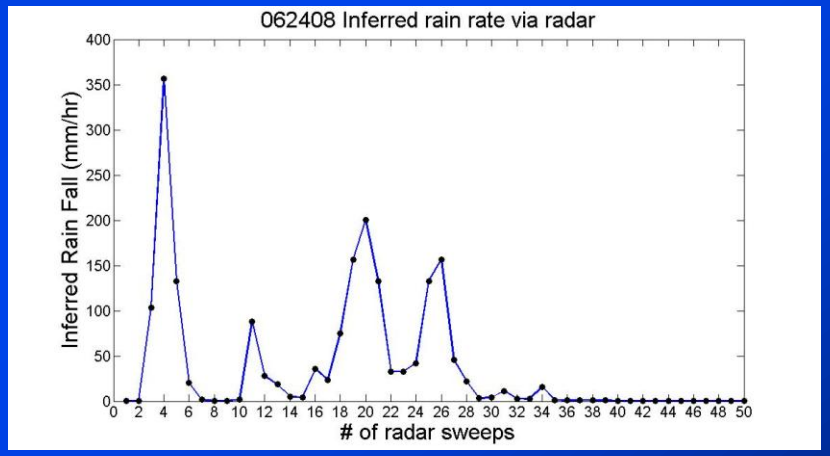

Bruner Array
18.2 km
Rowe Array
53.9 km
69.6 km
KUEX
Image © 2008 DigitalGlobe
Google
12.43 mi
40°31'15.63" N 98°43'43.33" W
elev 2047 ft
2003
Eye alt 43.26 mi

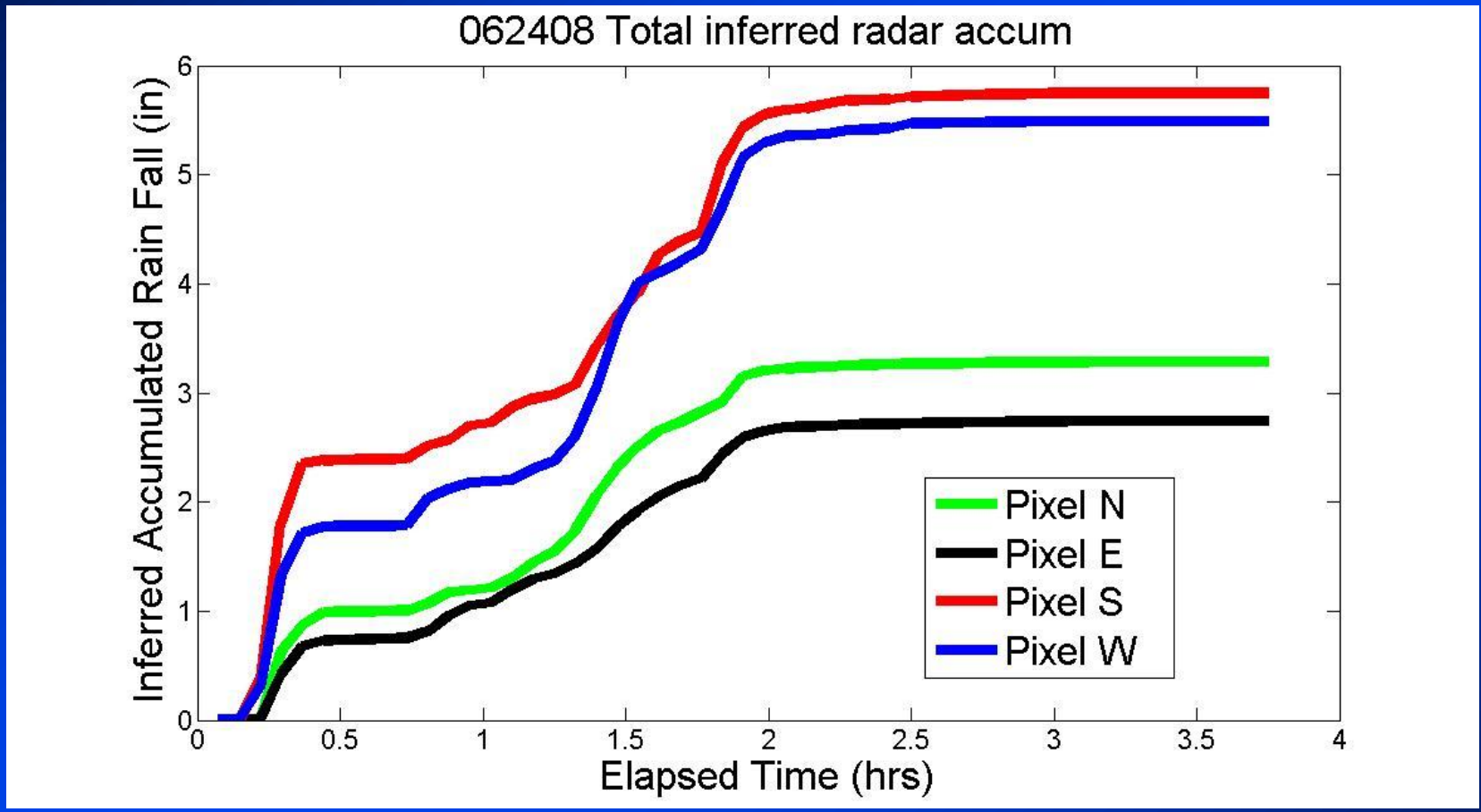

Tipping Bucket (x8)
Comp.
DAQ

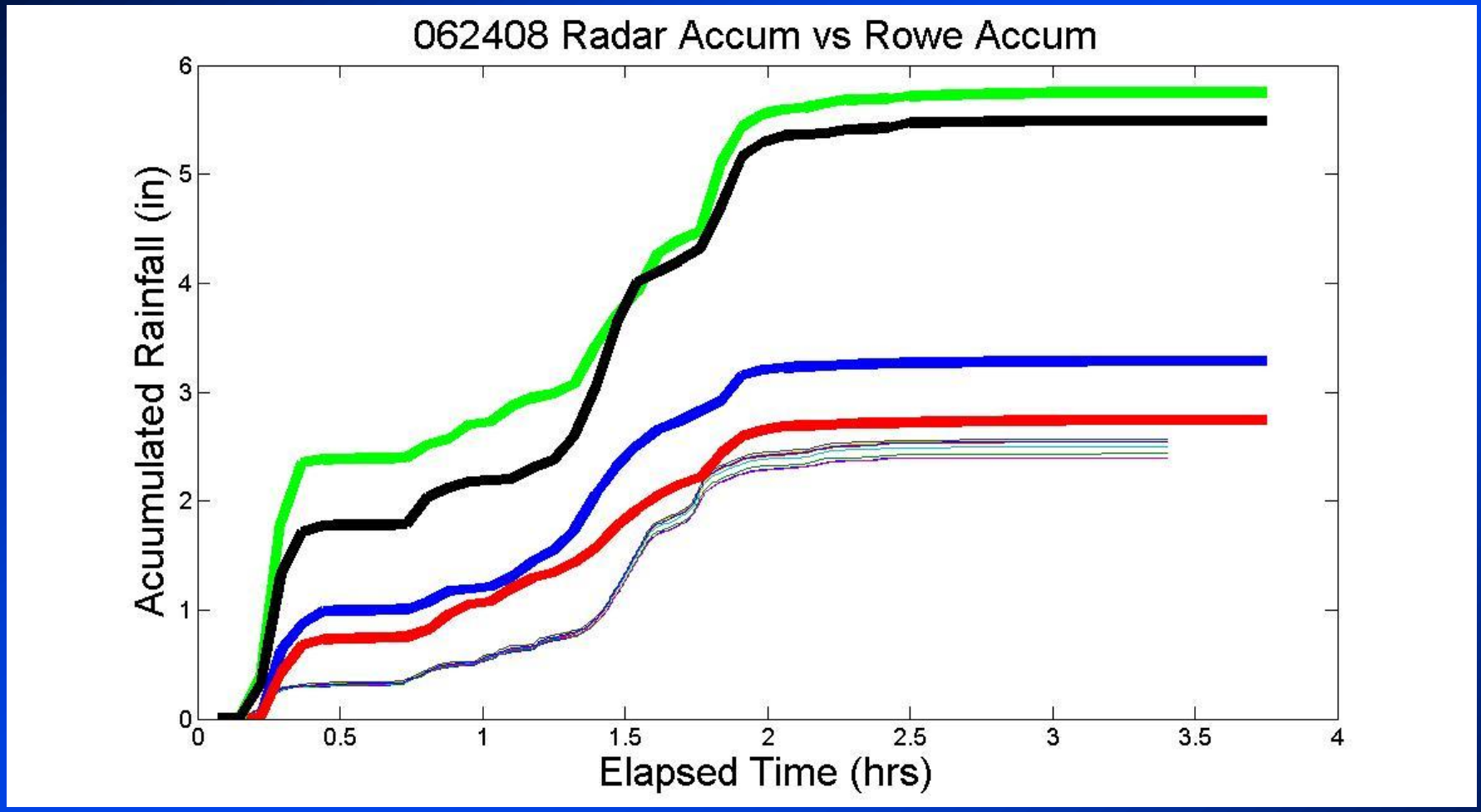
Radar overlay of Rowe Site

R-rate for 06/24/08






062408 Total inferred radar accum
Inferred Accumulated Rain Fall (in)
Elapsed Time (hrs)
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3
3.5
4
Pixel N
Pixel E
Pixel S
Pixel W


062408 Radar Accum vs Rowe Accum
Acuumulated Rainfall (in)
Elapsed Time (hrs)
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3
3.5
4

Possible reasons for error

Camera Effect
- Exposure time

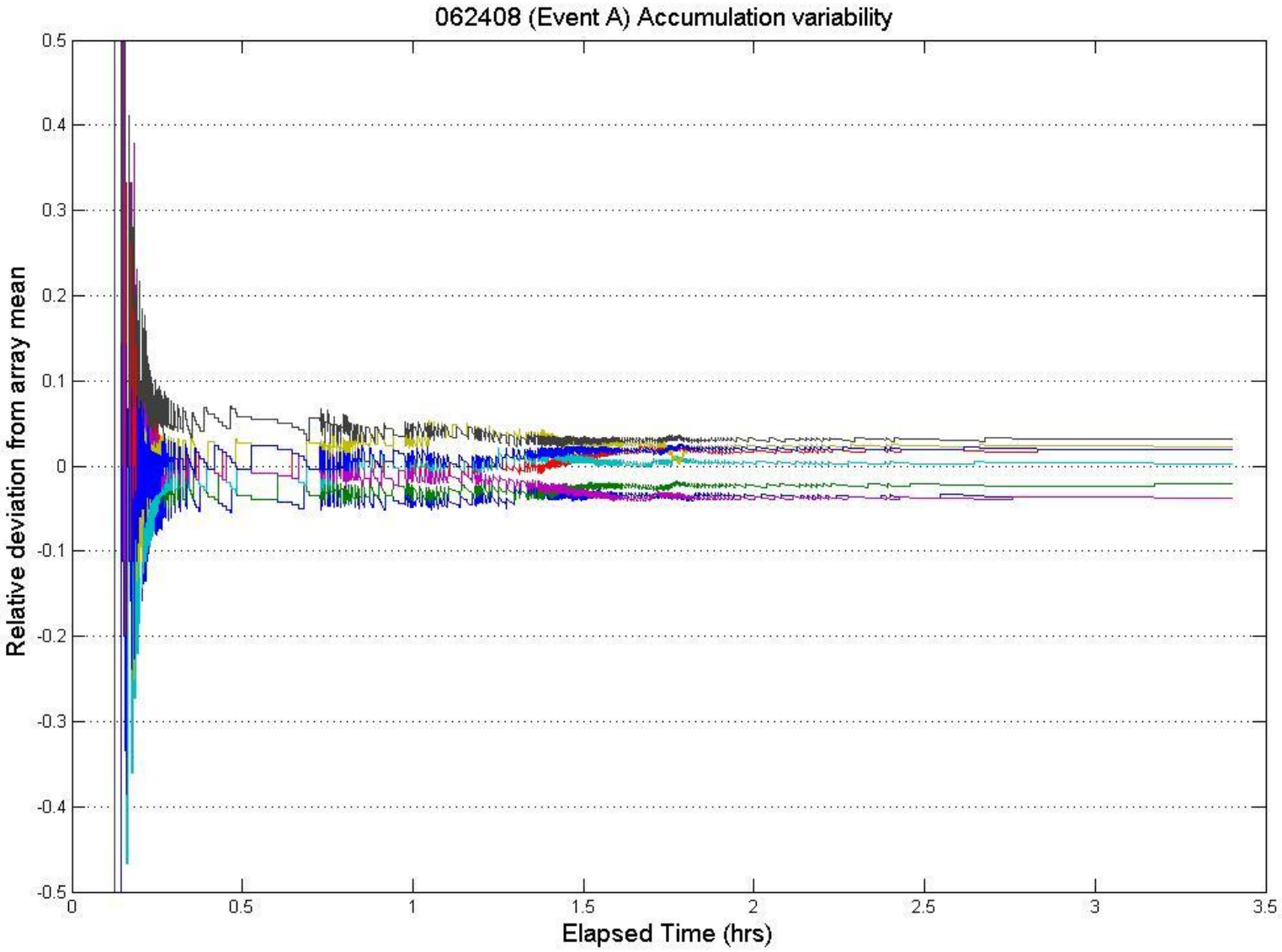
B.I.R.D.s
- Back-scatter Inducing Reflectivity Distorters

Gauge undercounting

Inversion Assumptions
- Ground truth (aloft and areal)

Imperfect Z-R relationship

And many others


062408 (Event A) Accumulation variability
Relative deviation from array mean
Elapsed Time (hrs)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
0.5
1
1.5
2
2.5
3
3.5

Accumulation Variance Comparison Based on Time Intervals for 06/24/08

	1 min	3 min	5 min	7 min	9 min	10 min	15 min	20 min
Largest variance (tips^2)	4.22	33.91	91.38	156.12	261.08	315.08	526.69	1128.5
Smallest variance (tips^2)	**3.53**	**28.88**	**78.05**	**133.21**	**225.42**	**264.21**	**449.77**	**942.0**
Mean variance (tips^2)	3.93	31.98	85.84	147.62	246.47	293.12	492.38	1050.8
Simulation variance (tips^2)	**4.66**	**29.47**	**95.94**	**123.52**	**208.29**	**259.78**	**415.09**	**825.07**
% difference b/t Mean var. and Simulation var.	15.84	7.79	10.53	16.32	15.49	11.38	15.69	21.49
Simulation var./Simulation mean	**3.93**	**8.28**	**13.16**	**14.80**	**18.94**	**21.47**	**22.29**	**34.09**
Array var./Mean accumulation	3.25	8.74	14.07	17.29	22.45	24.03	26.91	43.07

Conclusion

The acquisition design and techniques developed here have proven to be an accurate, affordable, scalable, and scientifically useful tool to study small scale properties of the rain field.

Vast differences have been found when comparing radar inferred rain rate and accumulations to that of measured data.

Large inferred accumulation differences can exist between adjacent pixels.

Sub-pixel variability has been shown to exist on a spatial scale of <10 meters, to an extent that cannot be easily explained or modeled using the simplest possible simulation

Directions for Future Work

Addition of gauges to Rowe Array

Analyzing more events

Additional Arrays and Sites

Addition of other scientific equipment

Suggestions for new Z-R methodology

Thank you for your time!

Acknowledgment is made to the Rowe Sanctuary for allowing the installment of the rain gauge array, computer housing, and assisting with site maintenance; Dr. Michael Larsen for his assistance and mentorship with the project; the Student Summer Research Program and the Administrative Staff at the University of Nebraska at Kearney; NWS Hastings for the consultation and assistance in radar data collection; the Department of Physics at the University of Nebraska at Kearney; and to Research Services Council for mini-grant funding.

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