Integrating MODIS and P-6 AWiFS Data for Operational Crop Type Mapping

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NASS CDL

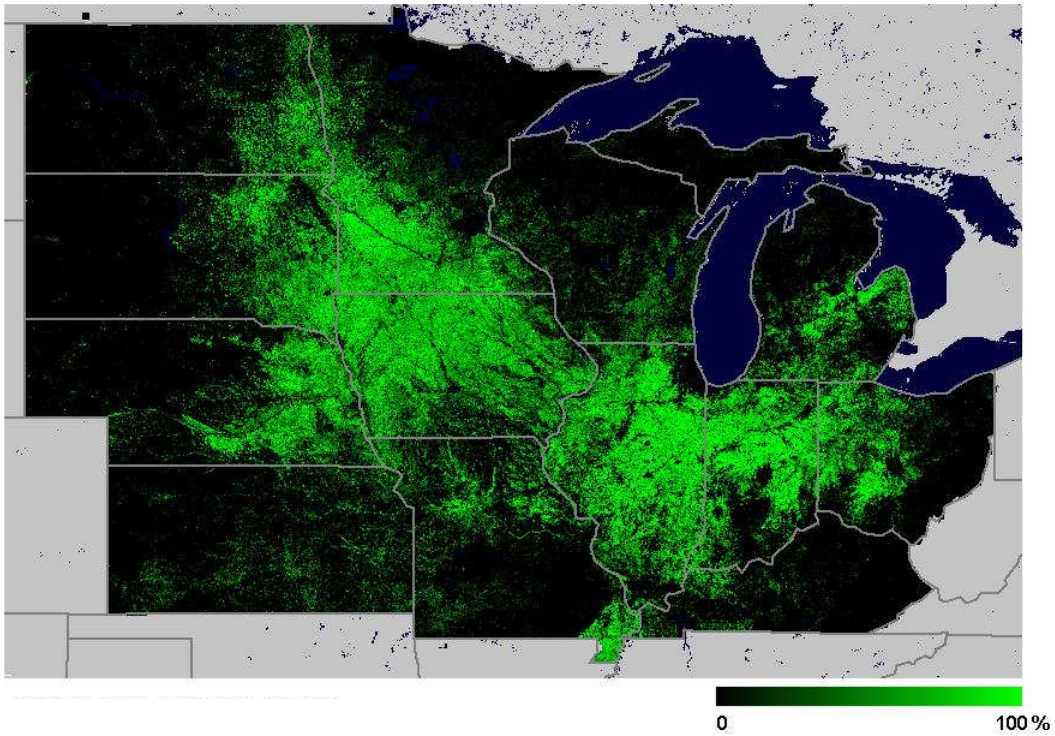
- NASS Cropland Data Layer (CDL) made using FSA Common Land Unit (CLU) labels
- CLU is a rich database that is explicitly labeled each growing season for crop type
- CLU Labels are used with AWiFS in a classification tree algorithm to map crop type
- Goal is to produce timely national maps of crop type

CLU Limitations

- CLU crop type labels are confidential-limited access
- Have to wait for ground information to be collected in order to label fields
- Most regions do not have such a rich, comprehensive database of field-level crop type information

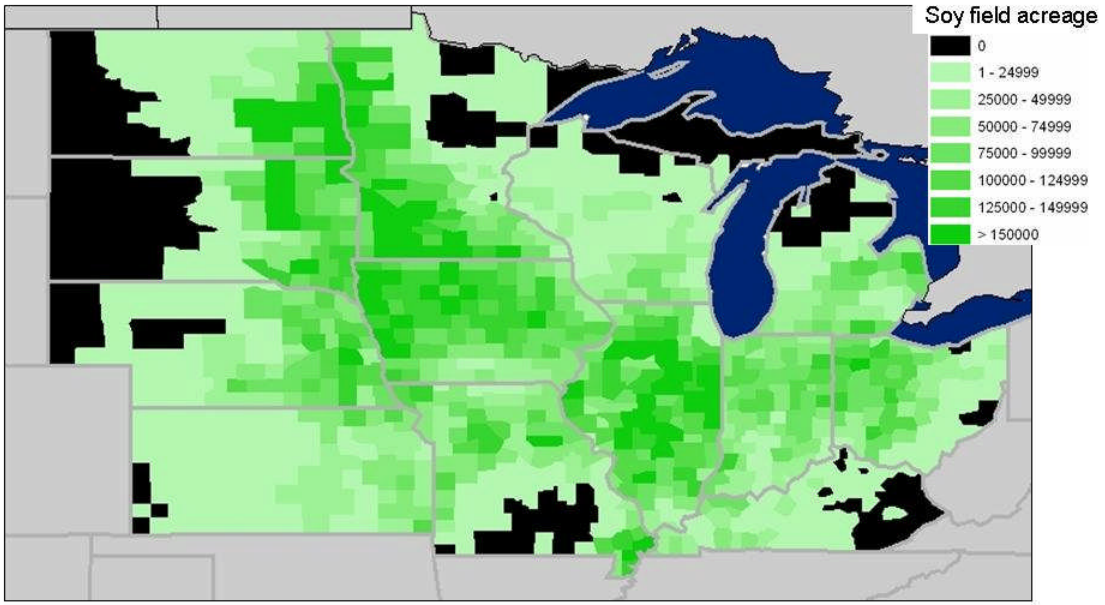
What if CLU training data is not available?

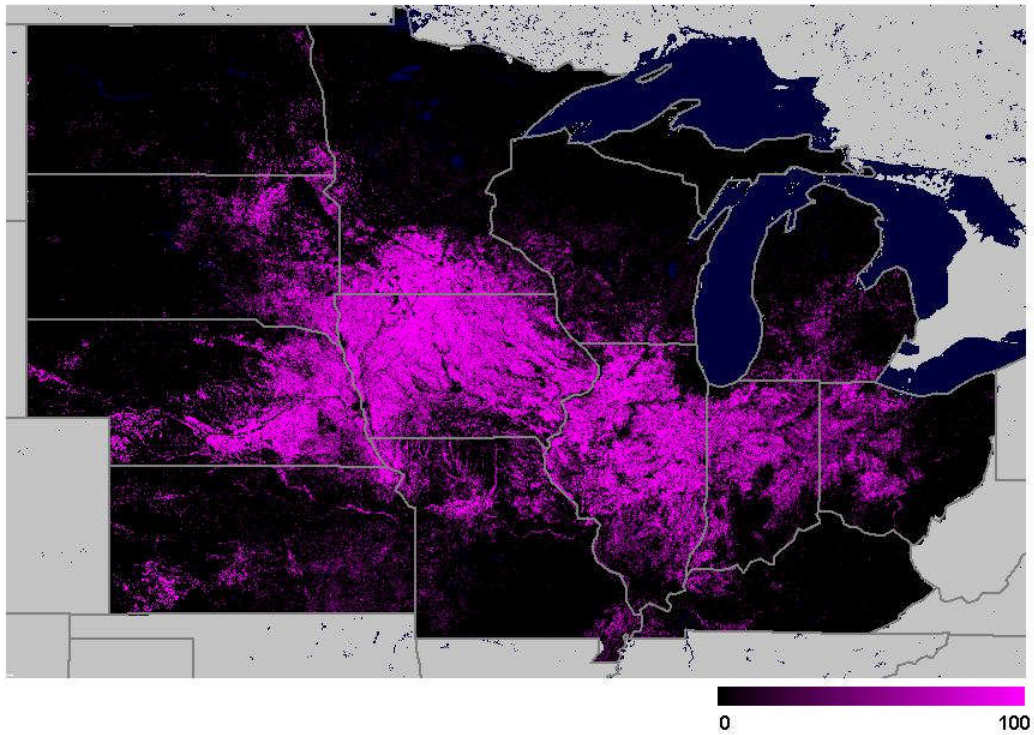
- Historic crop type maps can be used to calibrate an operational model using MODIS and AWiFS inputs
- MODIS crop type maps allow for a timely robust state and county level product
- MODIS crop type maps can be used to operationally pre-process and train an AWiFS crop type model



Percent soy cover, 2002 from MODIS time-series

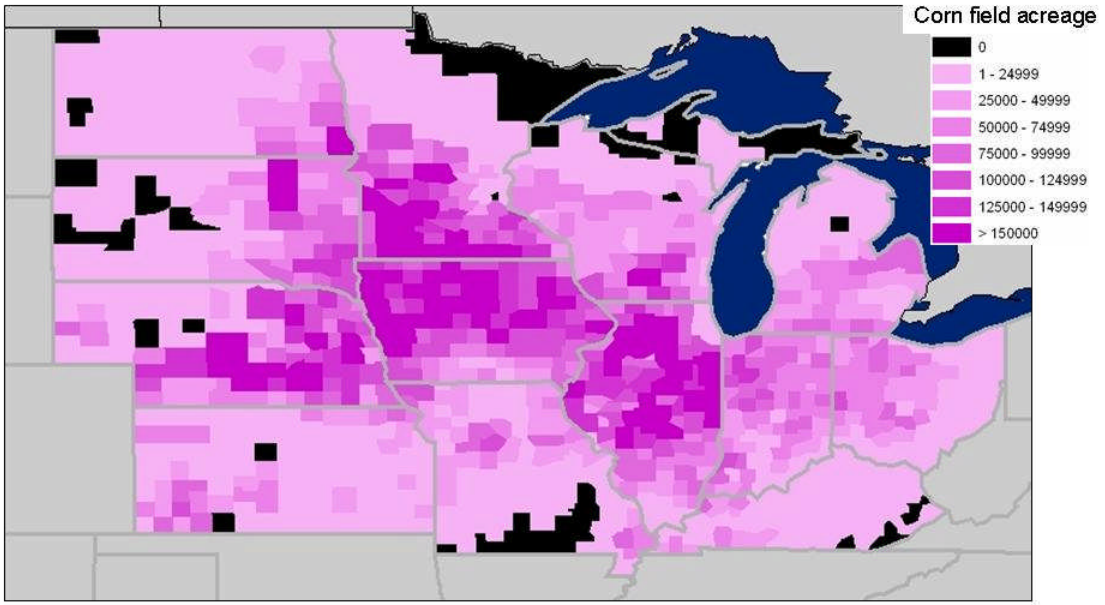
Soy acreage, 2002 from NASS data

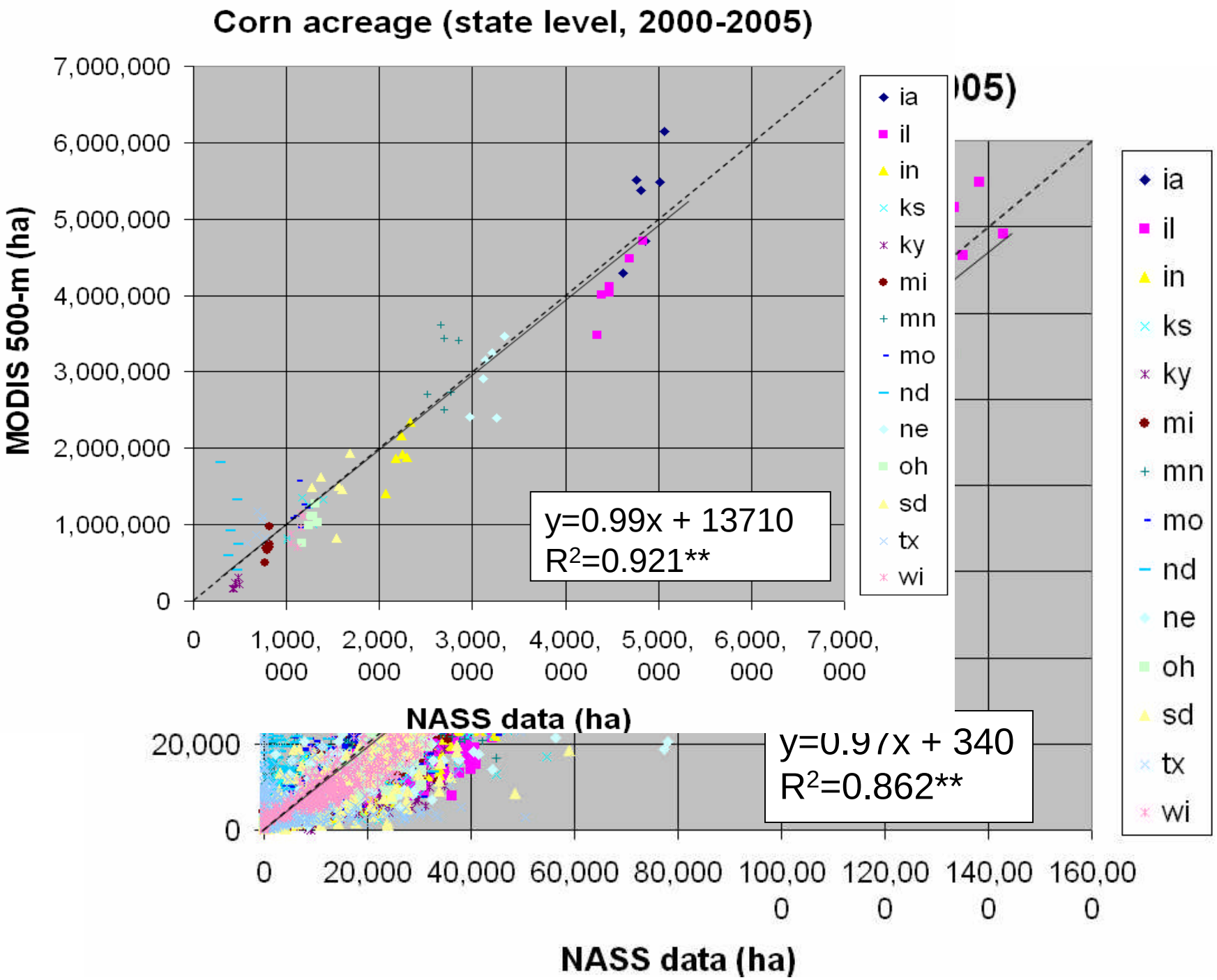


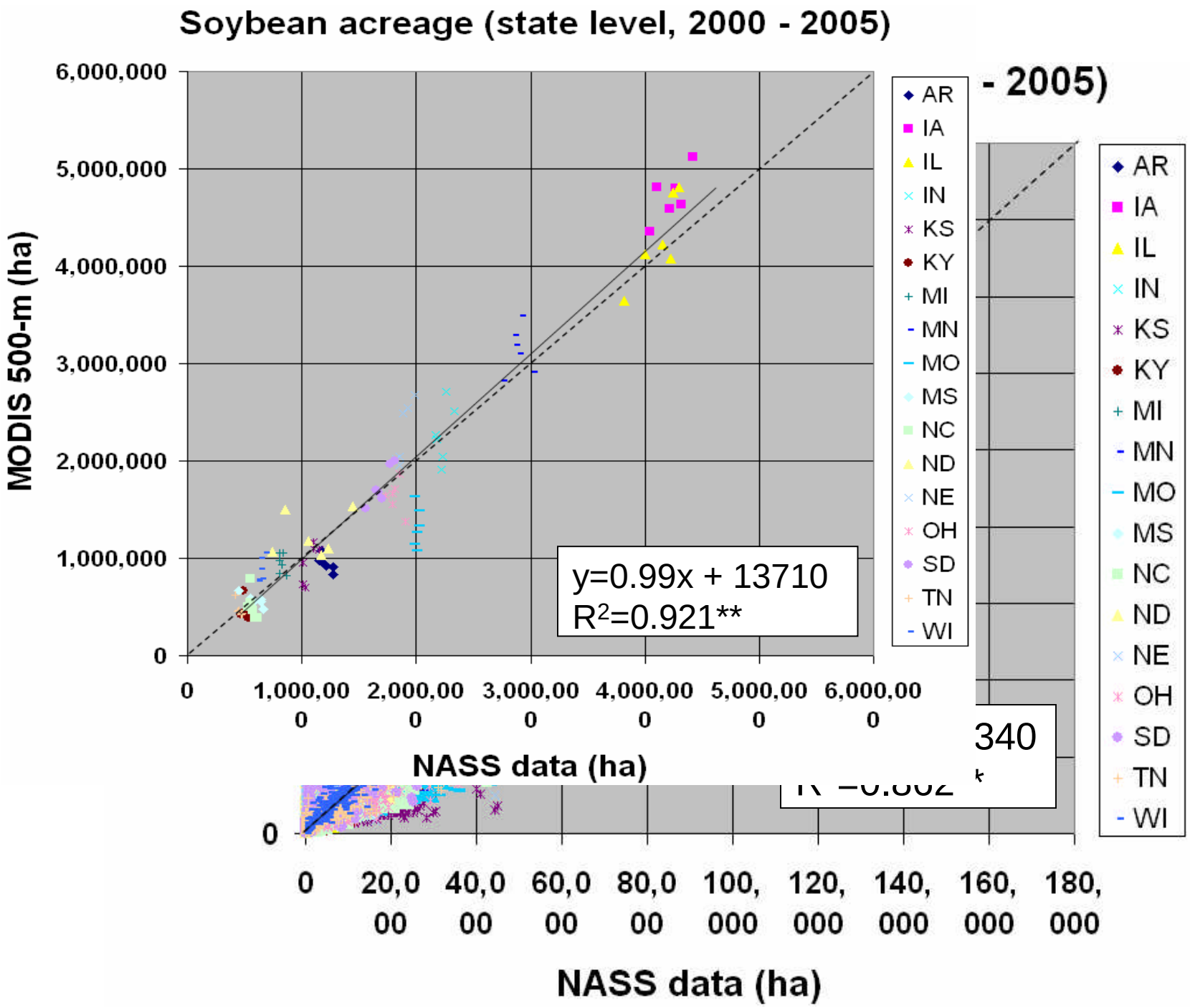


Percent corn cover, 2002 from MODIS time-series

Corn acreage, 2002 from NASS data



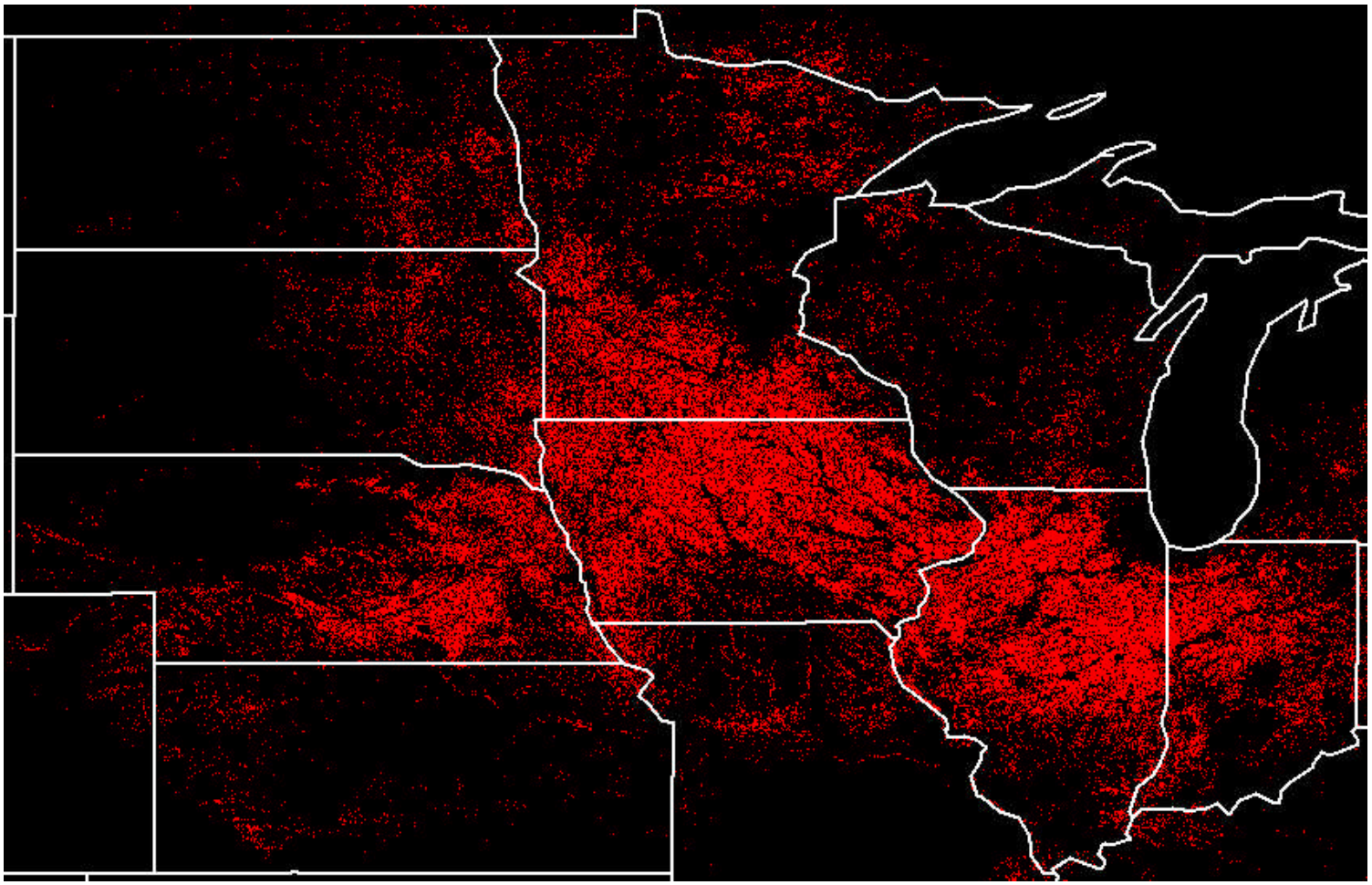

Corn acreage (state level, 2000-2005)
MODIS 500-m (ha)
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
0
1,000,000
2,000,000
3,000,000
4,000,000
5,000,000
6,000,000
7,000,000
NASS data (ha)
y=0.99x + 13710
R2=0.921**
ia
il
in
ks
ky
mi
mn
mo
nd
ne
oh
sd
tx
wi
20,000
0
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
NASS data (ha)
y=0.97x + 340
R2=0.862**


Soybean acreage (state level, 2000 - 2005)
MODIS 500-m (ha)
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
0
1,000,000
2,000,000
3,000,000
4,000,000
5,000,000
6,000,000
NASS data (ha)
y=0.99x + 13710
R2=0.921**
AR
IA
IL
IN
KS
KY
MI
MN
MO
MS
NC
ND
NE
OH
SD
TN
WI
- 2005)
340
0
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
180,000
NASS data (ha)

250m MODIS processing – current state

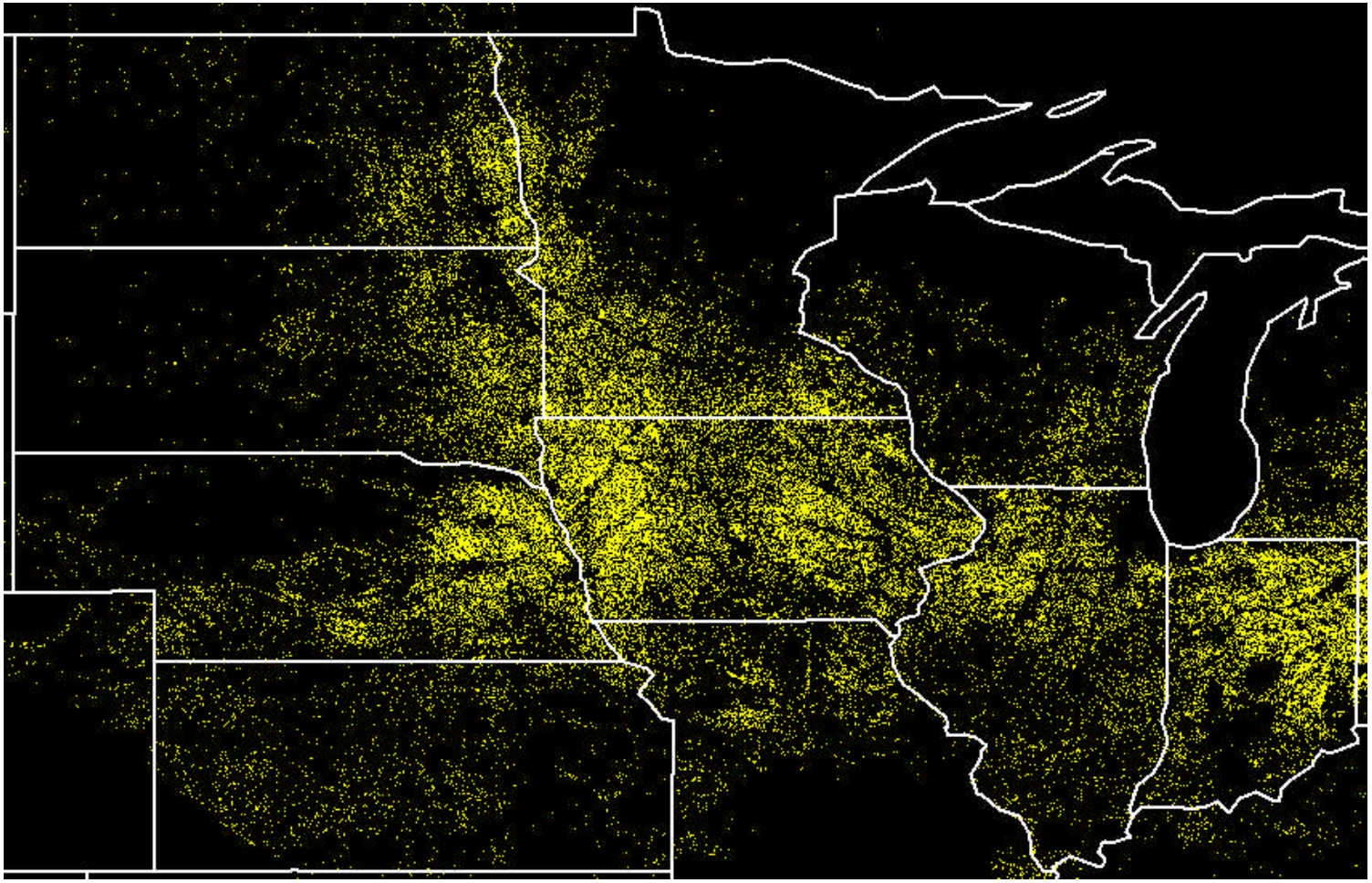
- Use historical CDL maps to calibrate generic soy, corn, other models
  - Examining possibility for stratifying to improve ND, TX and other less robust results
- Produce June, July, August, September versions of each model
- Threshold high-confidence MODIS pixels to use as training data for AWiFS characterization

MODIS 2007 Corn



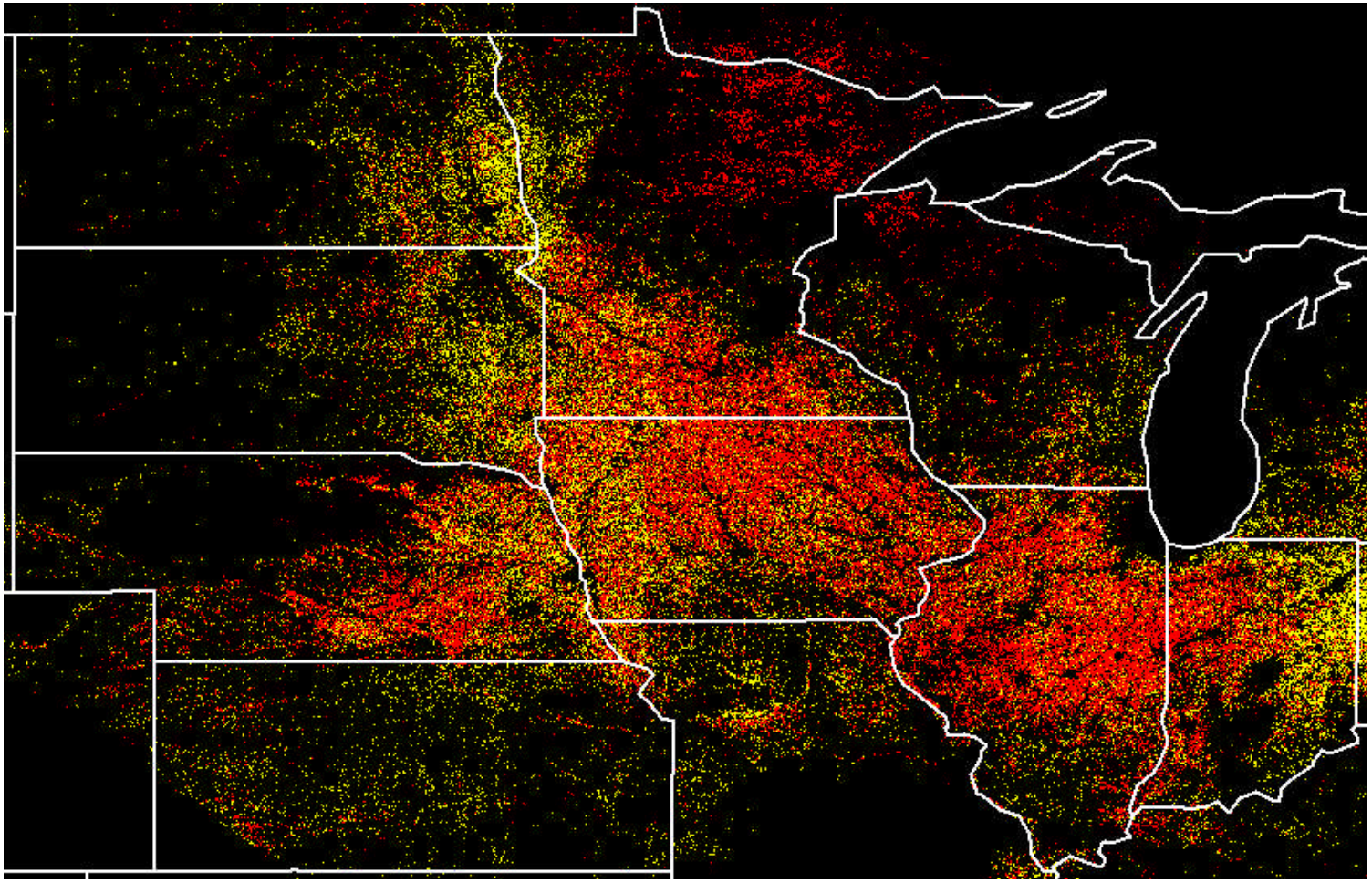
>40% Corn Cover Per Pixel

MODIS 2007 Soybeans

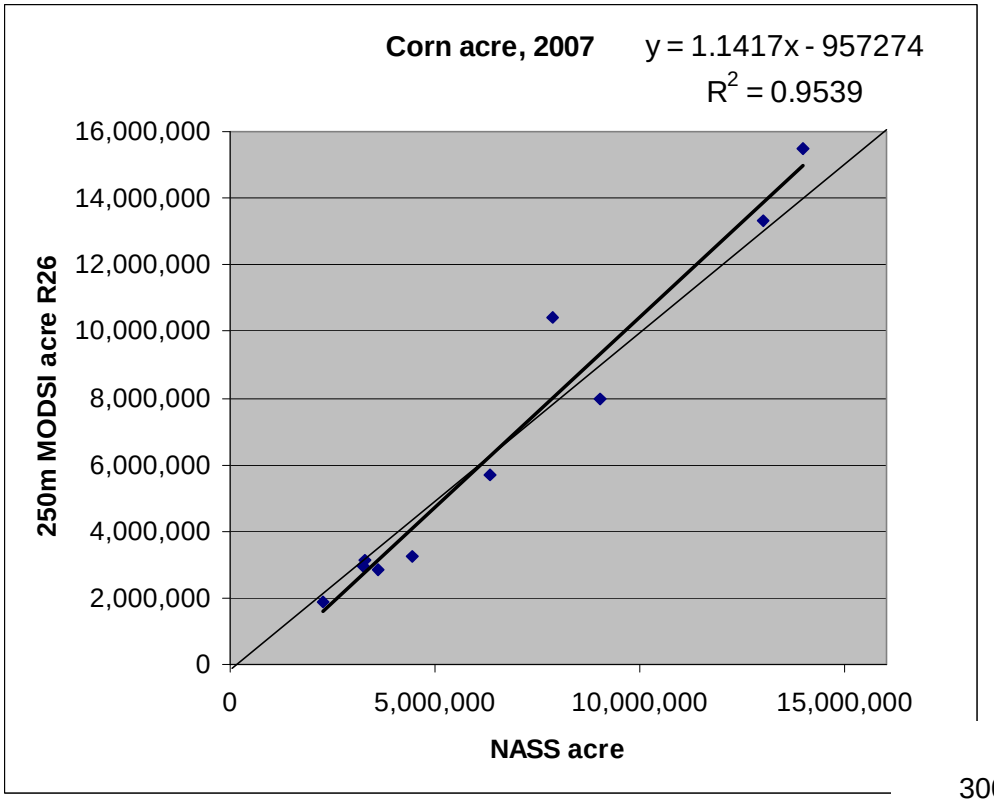


>35% Soybean Cover Per Pixel

MODIS 2007 Corn and Soybeans

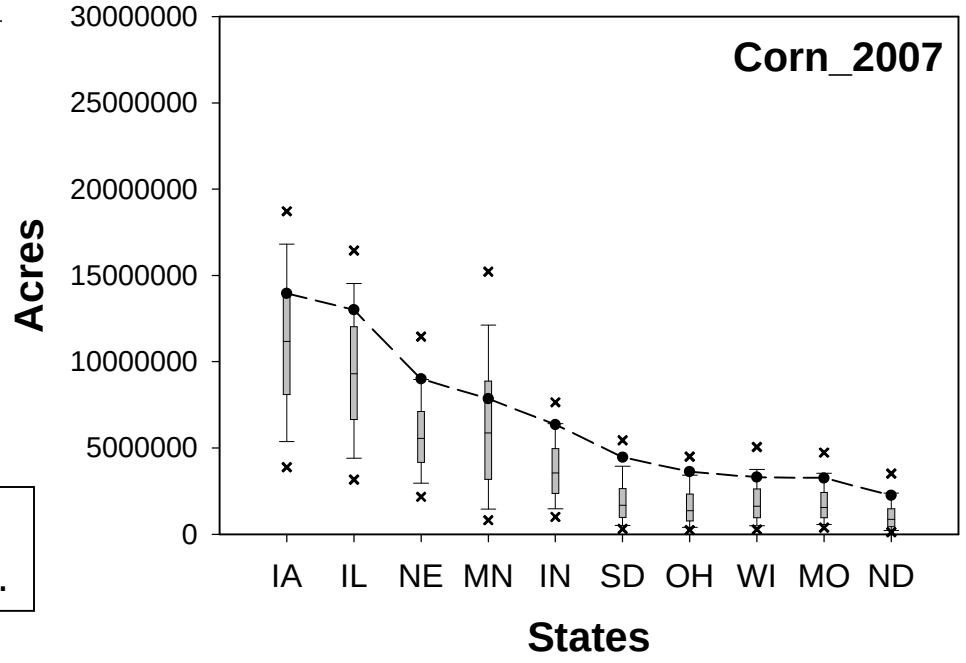


>40% Corn or >35% Soybean Cover Per Pixel



State	corn_acre	MODIS_acre_26
IA	13,950,000	15,491,338
IL	13,000,000	13,302,074
NE	9,000,000	7,970,956
MN	7,850,000	10,443,609
IN	6,350,000	5,667,413
SD	4,450,000	3,236,673
OH	3,610,000	2,849,956
WI	3,300,000	3,152,376
MO	3,250,000	2,938,219
ND	2,250,000	1,881,118
sum	**67,010,000**	**66,933,732**

250-m MODIS Corn 2007



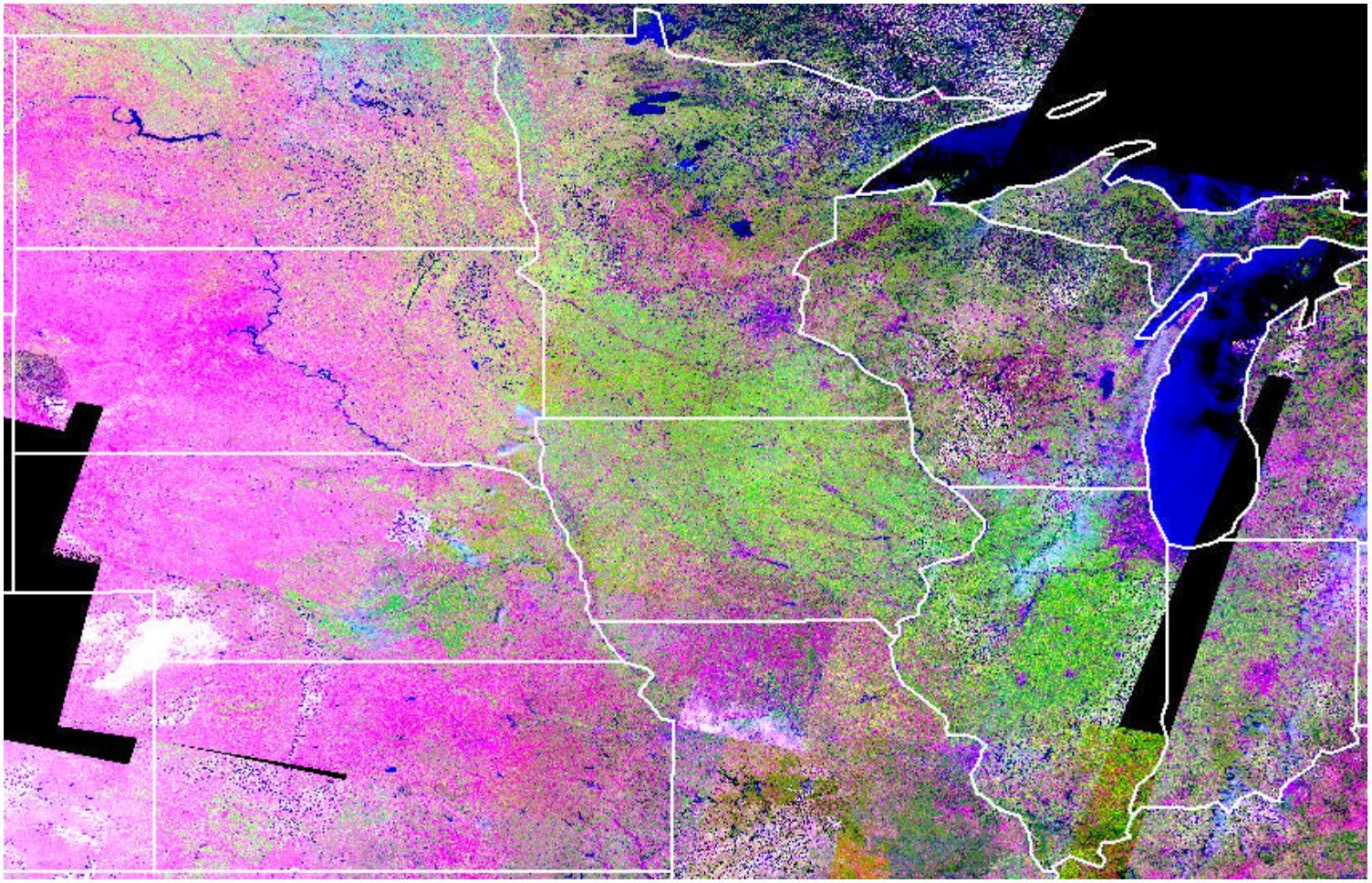
Bagging 30 results. Dot-lines are NASS acreage.

AWiFS compositing – 2007 example

- Compositing done for 3 16-d time periods
  - 7-12-07 to 7-27-07
  - 7-28-07 to 8-12-07
  - 8-13-07 to 8-28-07
- Testing various methods, current one is to use cloud/shadow QA and date to produce most recent composite unaffected by atmosphere
- To fill gaps, composite periods expanded to include other dates
- Could use fusion with MODIS to fill in missing, cloudy or shadow-affected pixels

AWiFS Composite

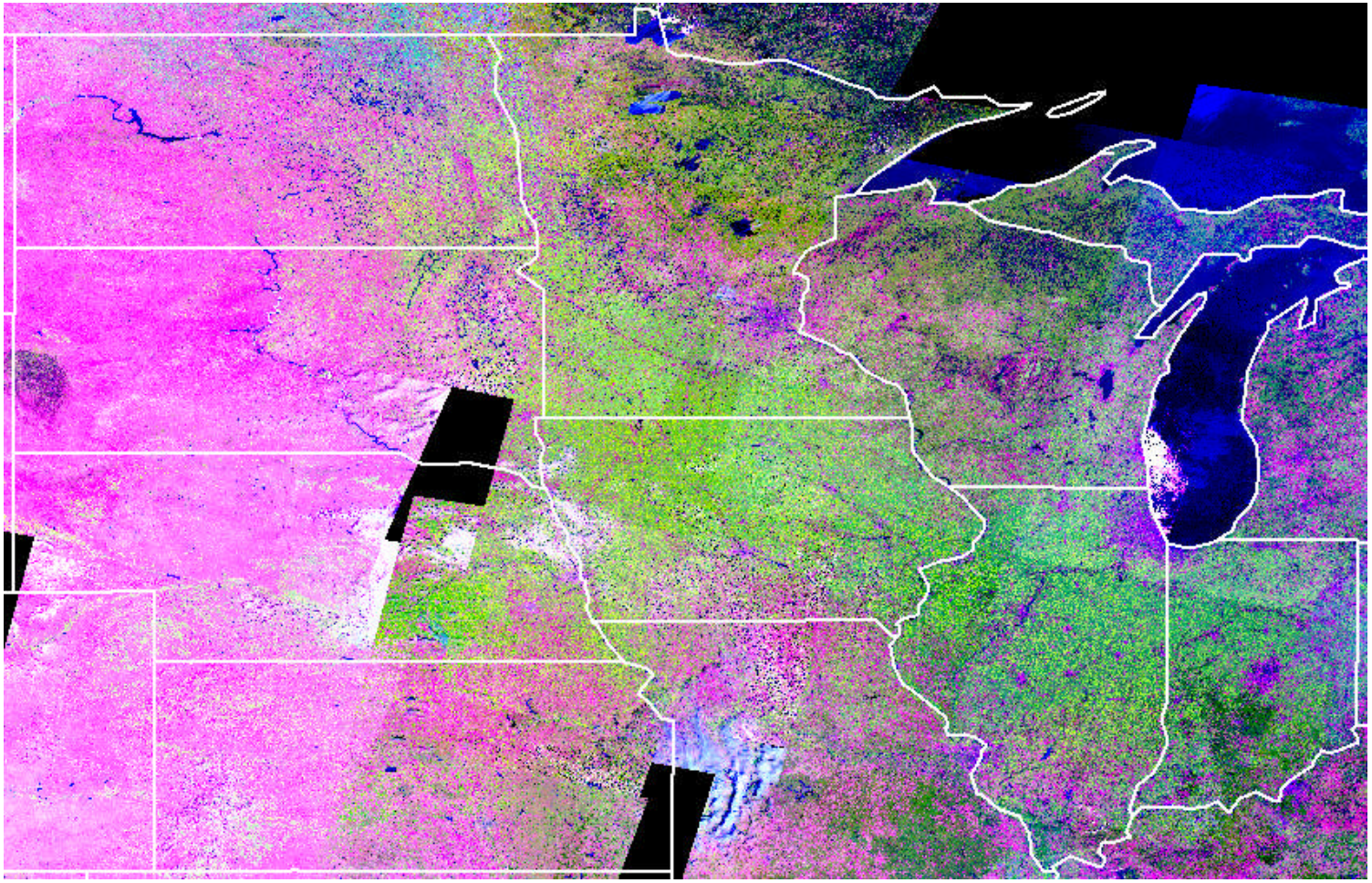
7-12-07 to 7-27-07



Red: AWiFS band 5, Green: AWiFS band 4, Blue: AWiFS band 3

AWiFS Composite

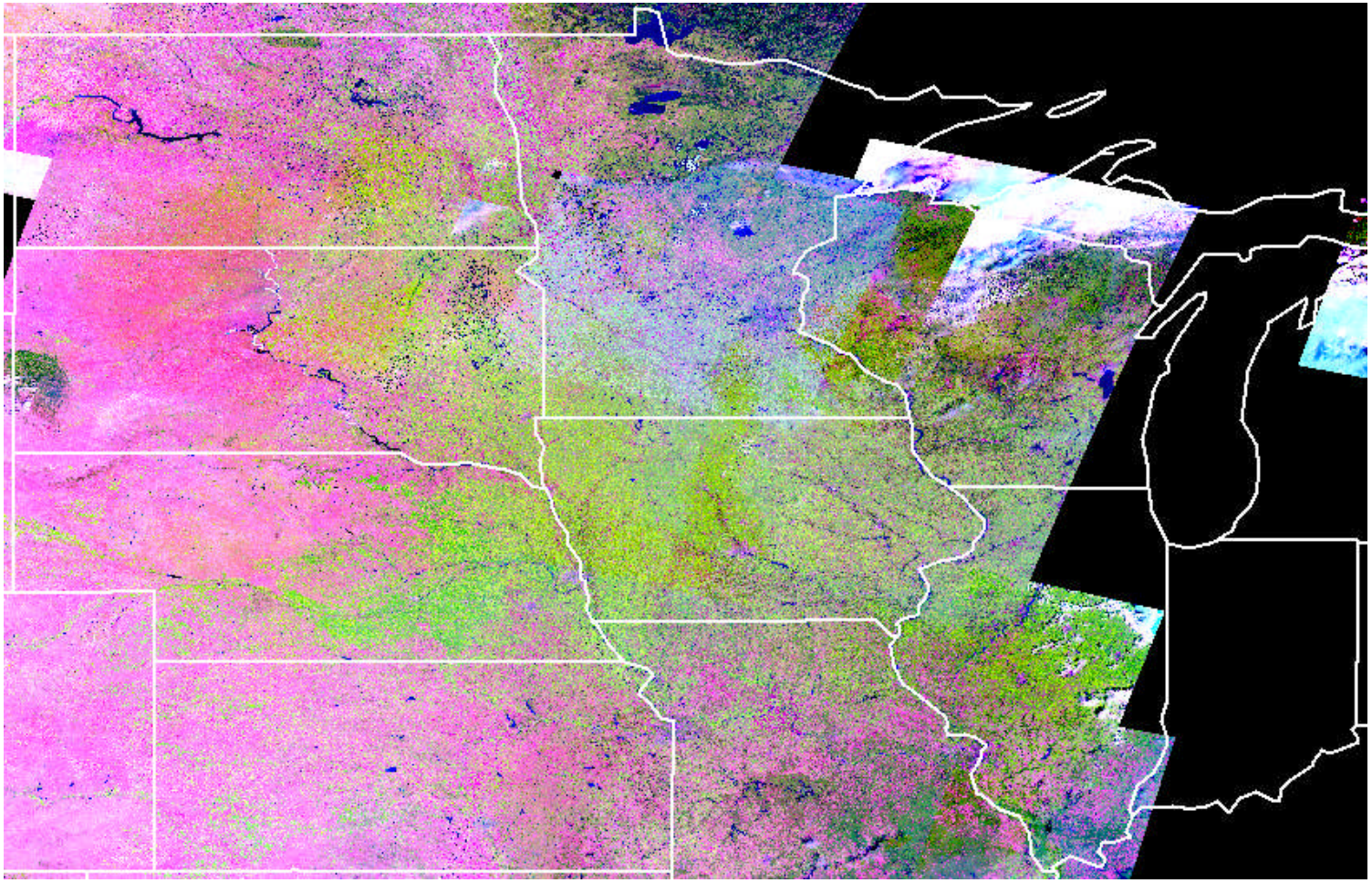
7-28-07 to 8-12-07



Red: AWiFS band 5, Green: AWiFS band 4, Blue: AWiFS band 3

AWiFS Composite

8-13-07 to 8-28-07



Red: AWiFS band 5, Green: AWiFS band 4, Blue: AWiFS band 3

Training an AWiFS Tree-Model

- Areas in MODIS falling within both corn and soybean thresholds were removed from training
- An 8 x 5 grid was created covering the entire region and a 0.25% sample was taken from each grid cell to ensure even sampling distribution (~2.3 million training pixels per sample)
- 30 corn and 30 soybean sample datasets were created for each composite period
- Input data for each composite period was 4 AWiFS bands plus ratio of each band to each other band (10 total input channels)

AWiFS Tree Analysis- Corn

Corn: Mid-Late July		
Metric	**Deviance**	**Average**
root	1466933.333	NA
ratio34	365537.4329	24.92
ratio13	72604.39657	4.95
band3	25990.7664	1.77
band1	20502.98803	1.40
ratio12	10446.74523	0.71
ratio14	9385.3519	0.64
band2	8306.723167	0.57
band4	6607.896133	0.45
ratio24	3743.994	0.26
ratio23	1639.287267	0.11
	Total Reduced:	**35.77**

Corn: Early August		
Metric	**Deviance**	**Average**
root	1466766.667	NA
ratio34	401875.6393	27.40
band3	31753.43027	2.16
ratio24	31300.4989	2.13
ratio14	24031.73923	1.64
band2	21886.8626	1.49
ratio13	12228.19383	0.83
band1	11435.82893	0.78
ratio12	11204.00263	0.76
ratio23	6696.458767	0.46
band4	6479.722367	0.44
	Total Reduced:	**38.10**

Corn: Mid-Late August		
Metric	**Deviance**	**Average**
root	1466766.667	NA
ratio34	177889.6425	12.13
band4	113428.508	7.73
band3	76438.68257	5.21
ratio23	13328.74383	0.91
ratio24	12138.0672	0.83
ratio13	7112.6251	0.48
ratio12	6715.014833	0.46
band2	5631.9612	0.38
ratio14	5463.960667	0.37
band1	4916.836433	0.34
	Total Reduced:	**28.84**

Ratio of band 3 (NIR) to band 4 (SWIR) is consistently best

Amount of deviance reduced drops significantly in Mid-Late August (due to tasseling?)

In Mid-Late August, band 4 (SWIR) becomes much more significant

AWiFS Tree Analysis- Soybeans

Soybeans: Mid-Late July		
Metric	**Deviance**	**Average**
root	920673.3333	NA
ratio24	64157.16003	6.97
band3	56414.24677	6.13
band4	20814.24323	2.26
band2	14485.22523	1.57
ratio14	10574.00613	1.15
ratio13	8951.480467	0.97
band1	7567.307267	0.82
ratio34	5547.369	0.60
ratio12	5154.0339	0.56
ratio23	2563.4739	0.28
	Total Reduced:	**21.31**

Soybeans: Early August		
Metric	**Deviance**	**Average**
root	920673.3333	NA
band3	179747.6162	19.52
ratio13	48620.14043	5.28
ratio23	25874.9685	2.81
ratio24	12339.0589	1.34
ratio14	12003.90433	1.30
band2	11380.3024	1.24
ratio12	5528.239067	0.60
ratio34	5239.8496	0.57
band4	4506.723533	0.49
band1	3000.5571	0.33
	Total Reduced:	**33.48**

Soybeans: Mid-Late August		
Metric	**Deviance**	**Average**
root	920673.3333	NA
band3	150597.4918	16.36
ratio23	102985.5239	11.19
band4	18872.3815	2.05
ratio34	13214.97393	1.44
ratio24	4299.4258	0.47
band1	3616.977833	0.39
ratio13	3213.4275	0.35
ratio12	2593.834767	0.28
band2	1866.7742	0.20
ratio14	1728.876233	0.19
	Total Reduced:	**32.91**

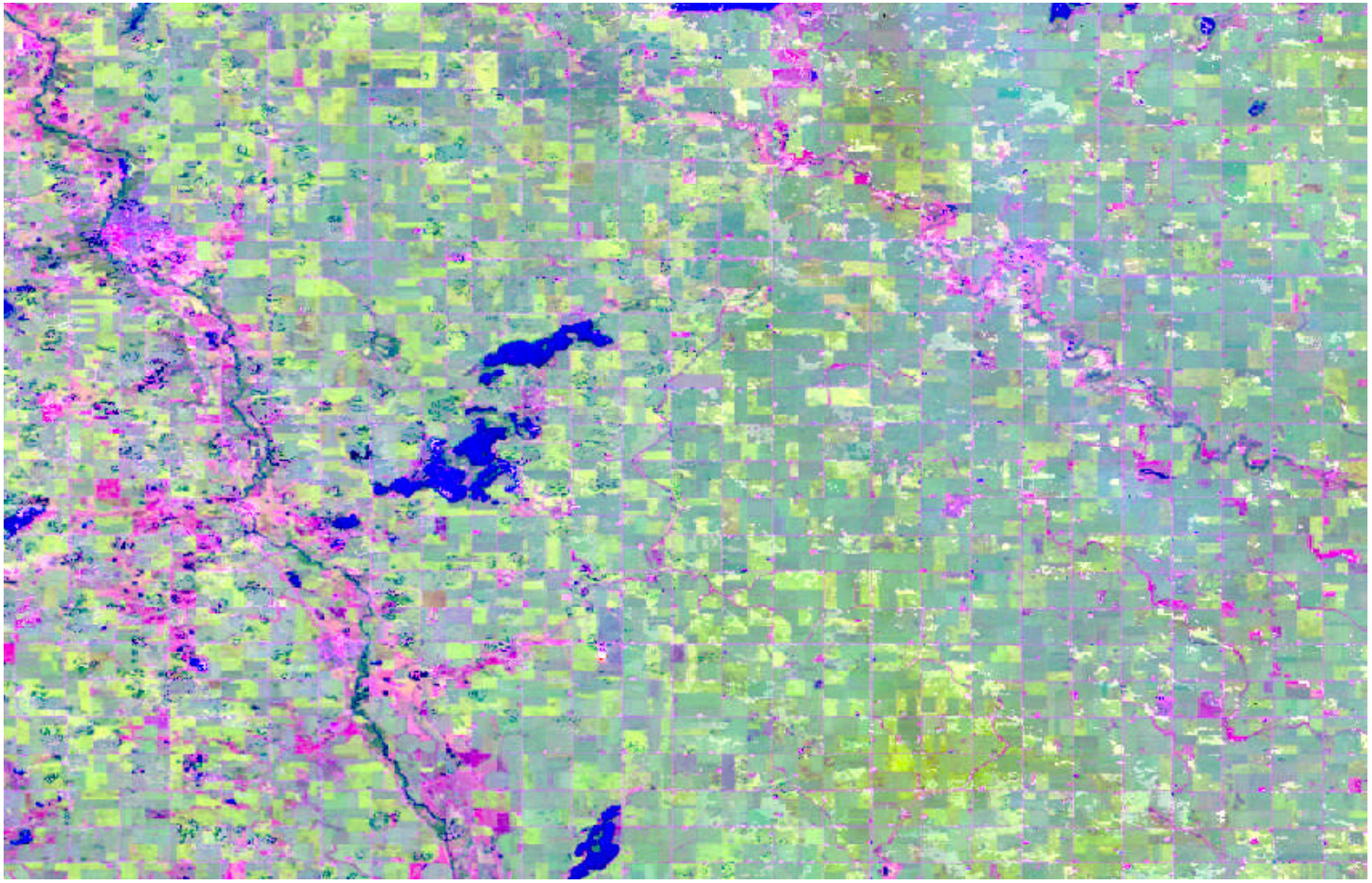
Band 3 (NIR) is most important

Deviance reduced in Mid-Late July far lower than other two composite periods

Ratio of band 2 (Red) to band 4 (SWIR) is very important in Mid-Late July and drops off significantly afterwards

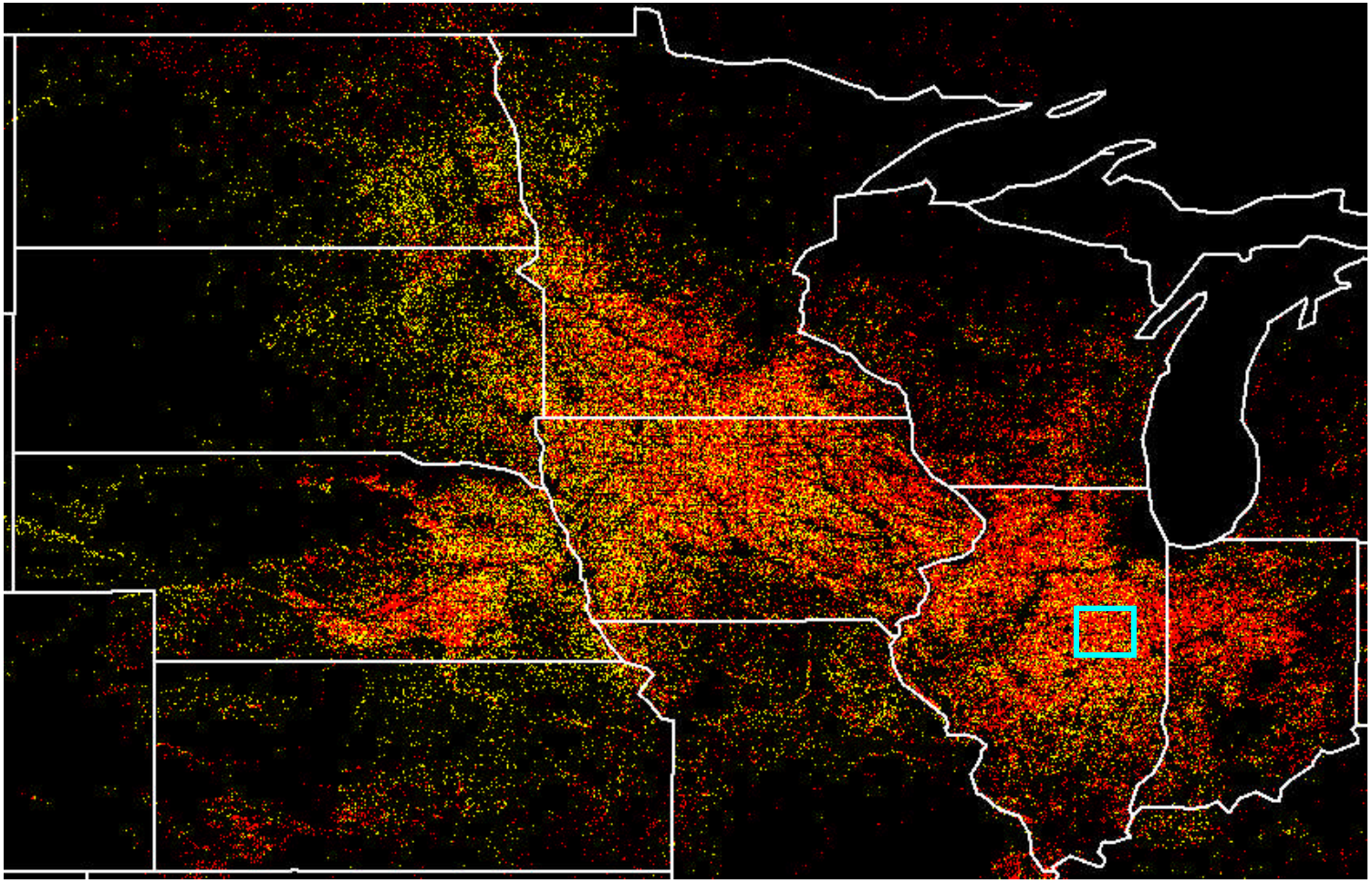
Soybean Fields

Mid-July vs. Mid-August



North-Central Iowa

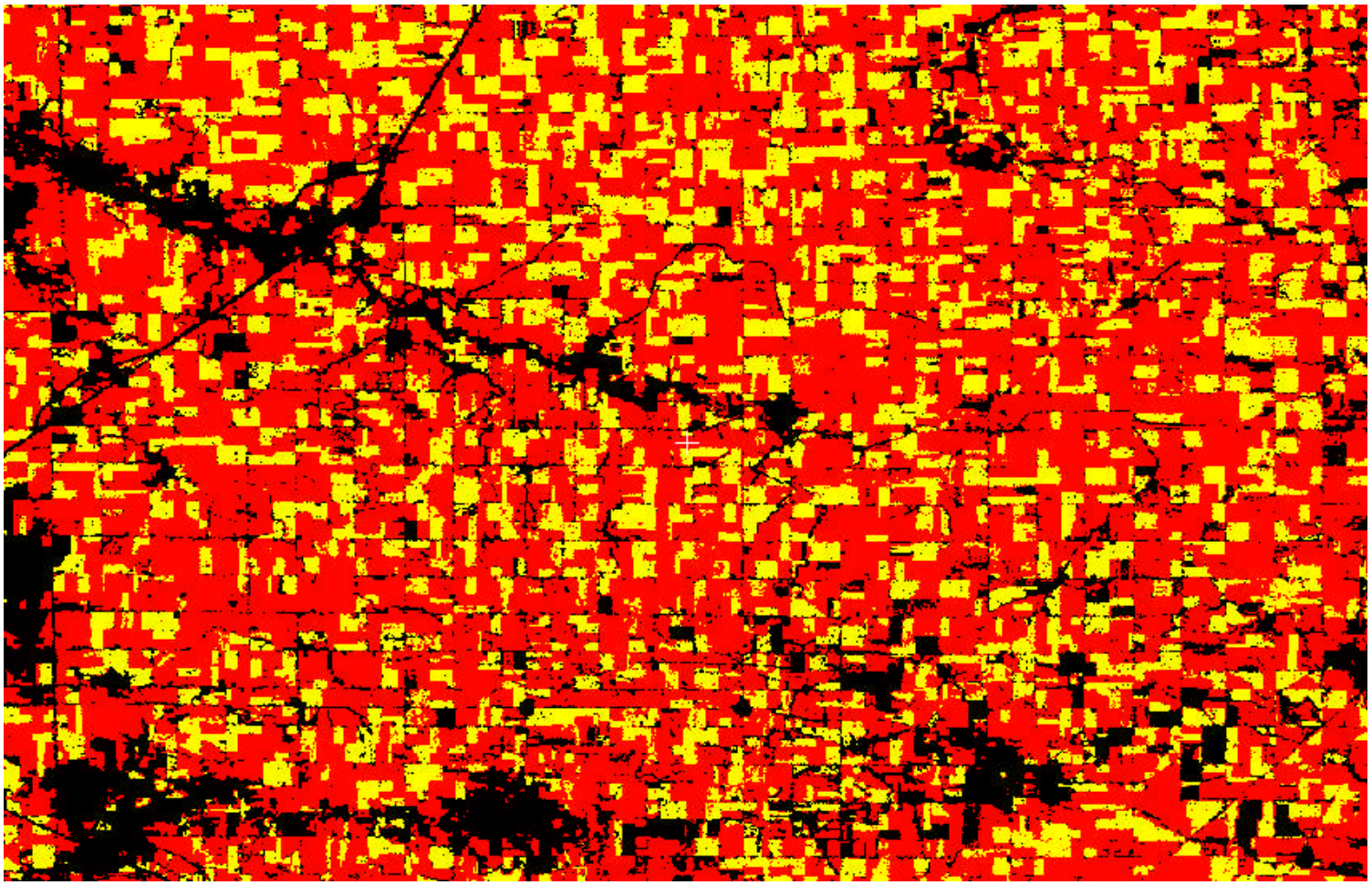
Preliminary AWiFS Result



Early August; Red: AWiFS band 5, Green: AWiFS band 4, Blue: AWiFS band 3

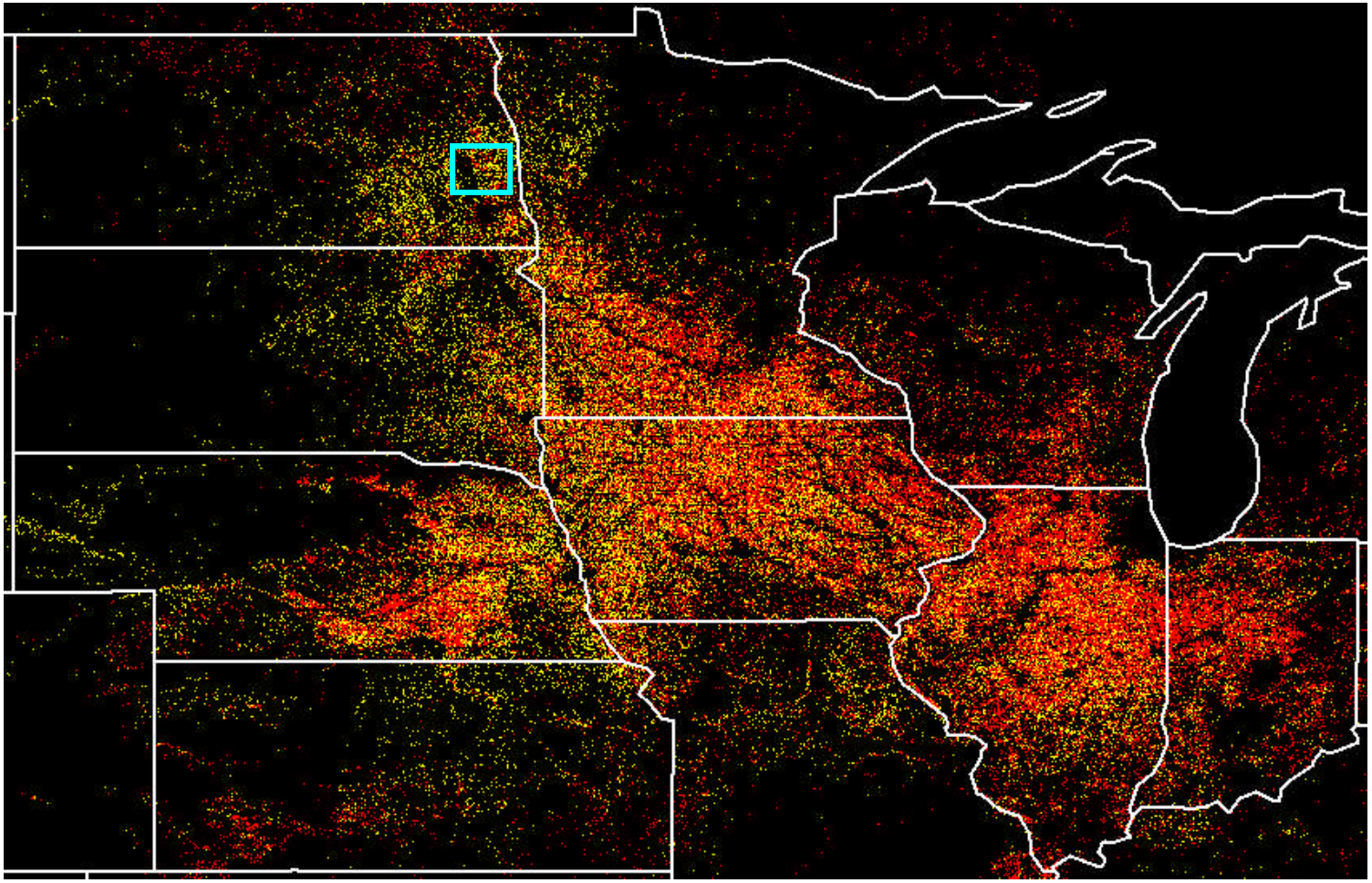
Soybean Soybean

AWiFS Zoom: Illinois



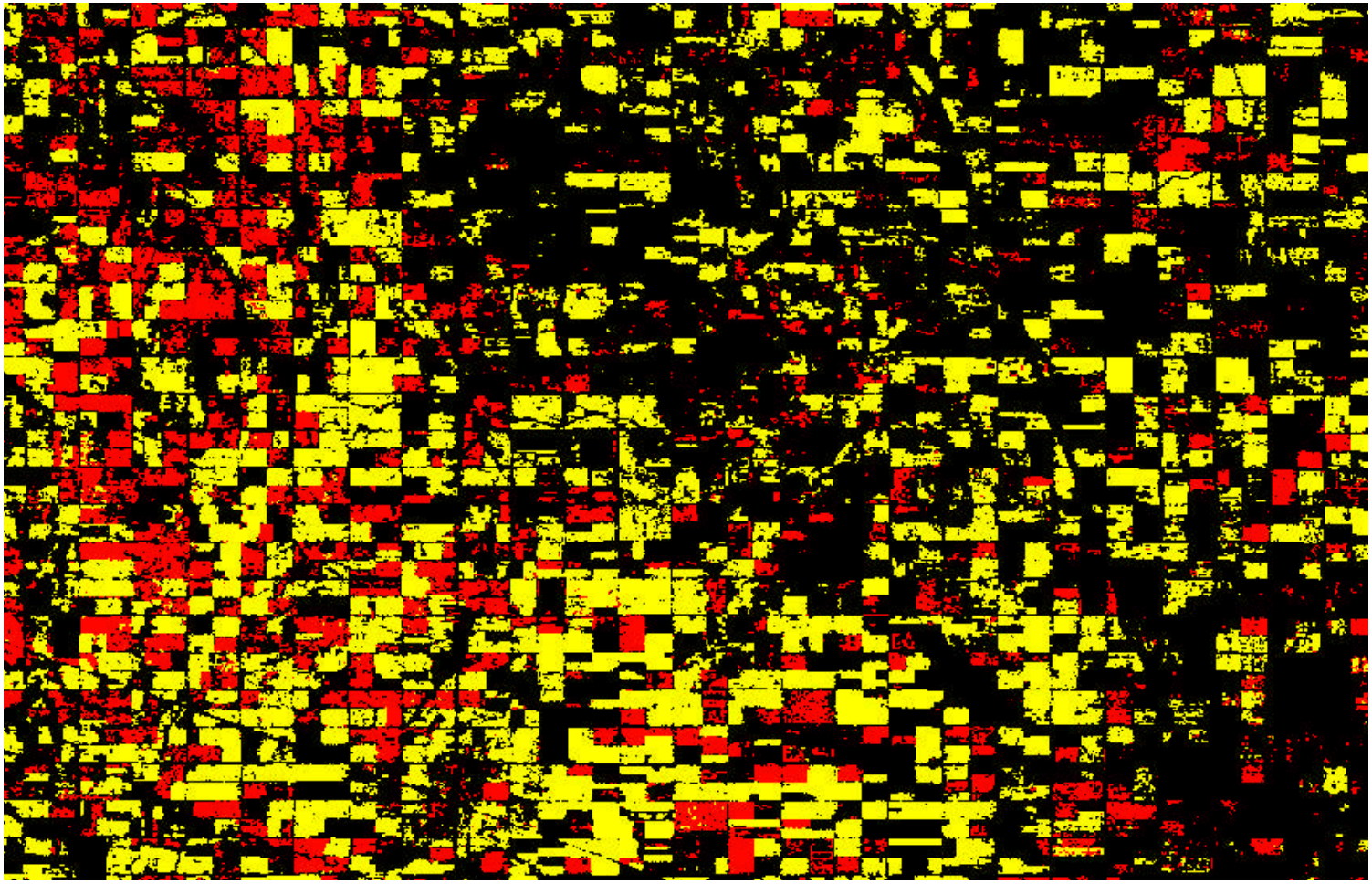
Corn: Red Soybeans: Yellow

Preliminary AWiFS Result



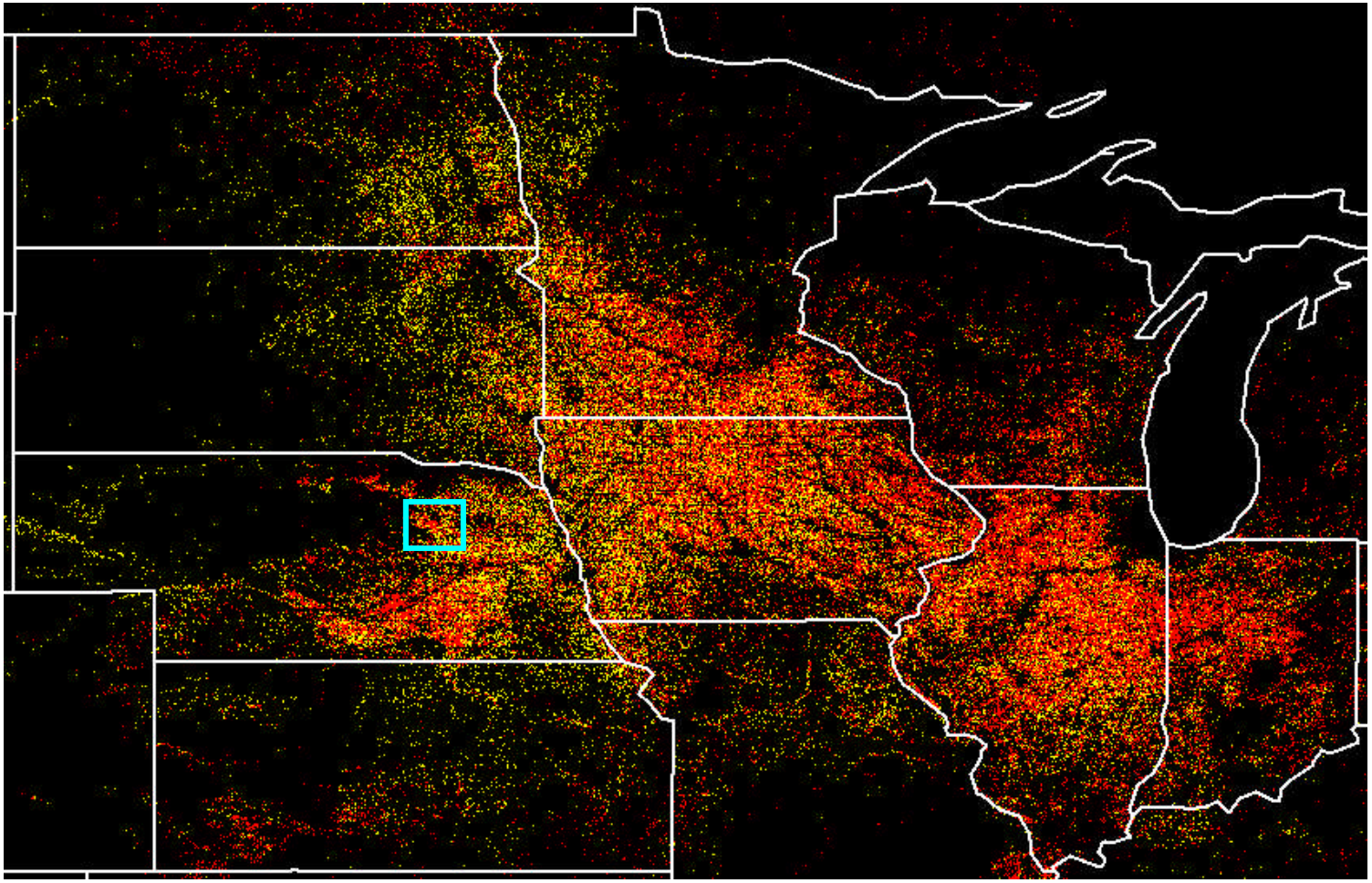
Corn: Red Soybeans: Yellow

AWiFS Zoom: North Dakota



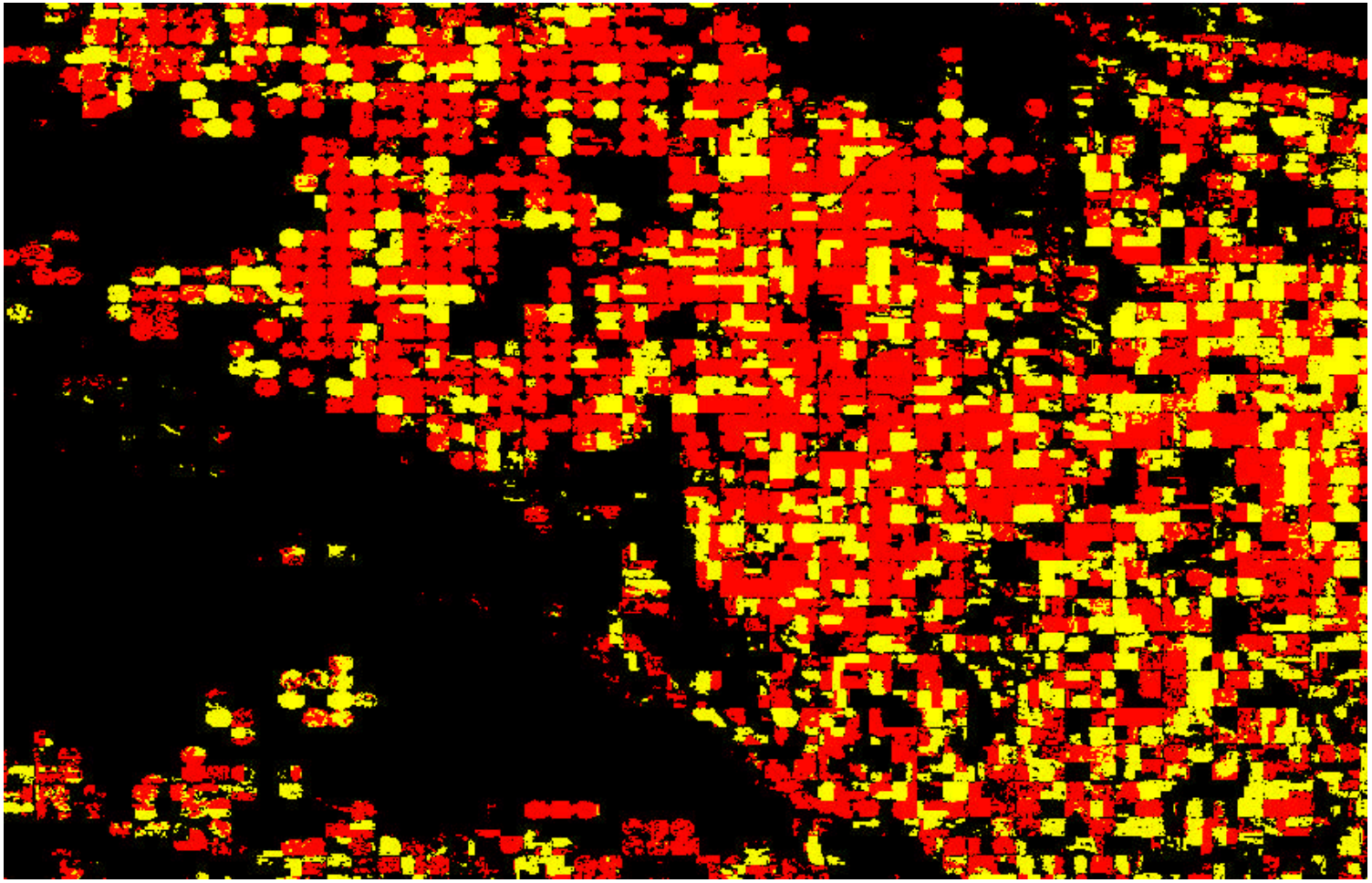
Corn: Red Soybeans: Yellow

Preliminary AWiFS Result



Corn: Red Soybeans: Yellow

AWiFS Zoom: Nebraska

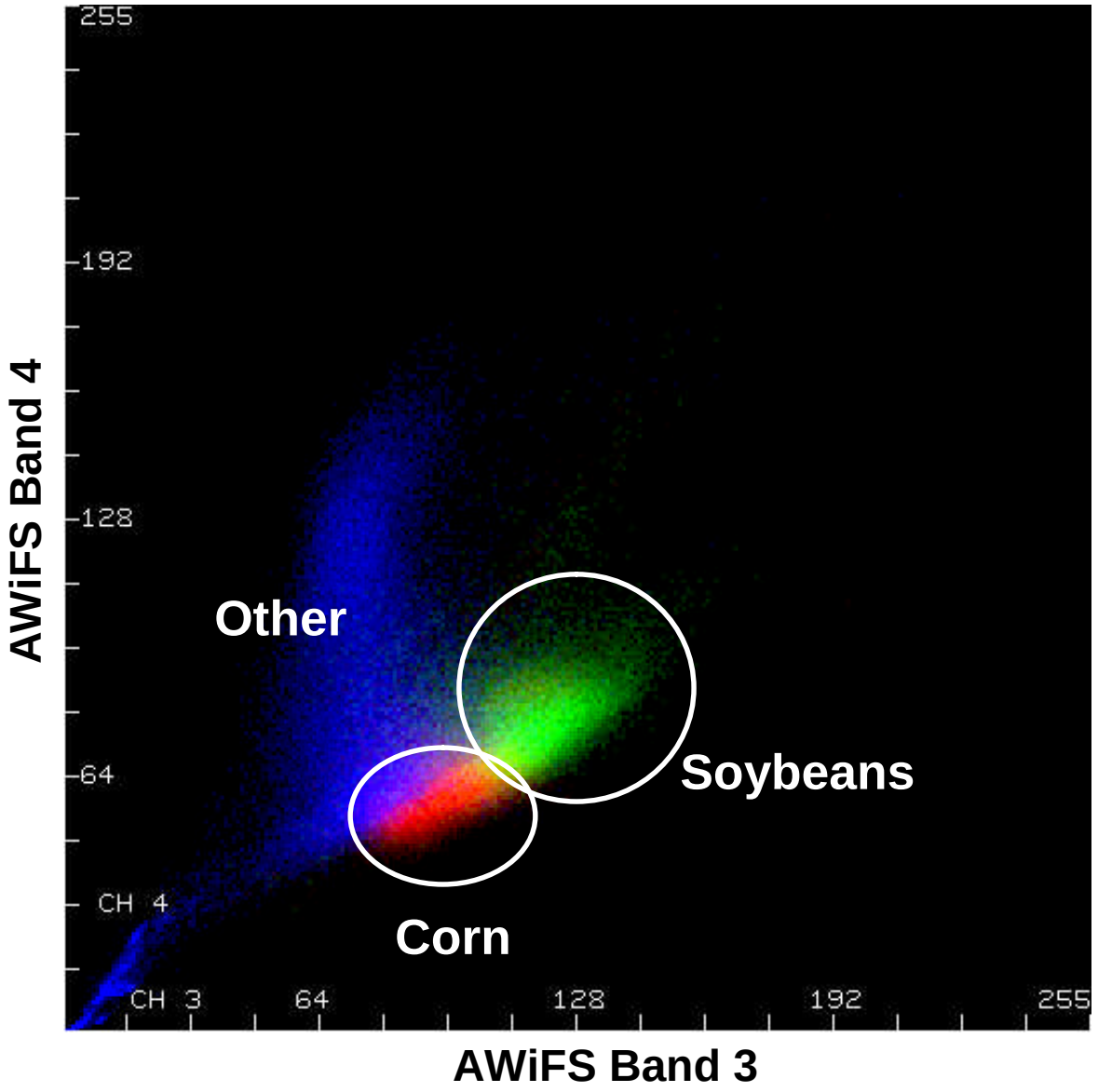


Corn: Red Soybeans: Yellow

Class separability for AWiFS

Scatterplot showing separability of corn (red), soybeans (green) and all other cover types (blue) using AWiFS bands 3 and 4 across the entire region

Color intensity indicates point density

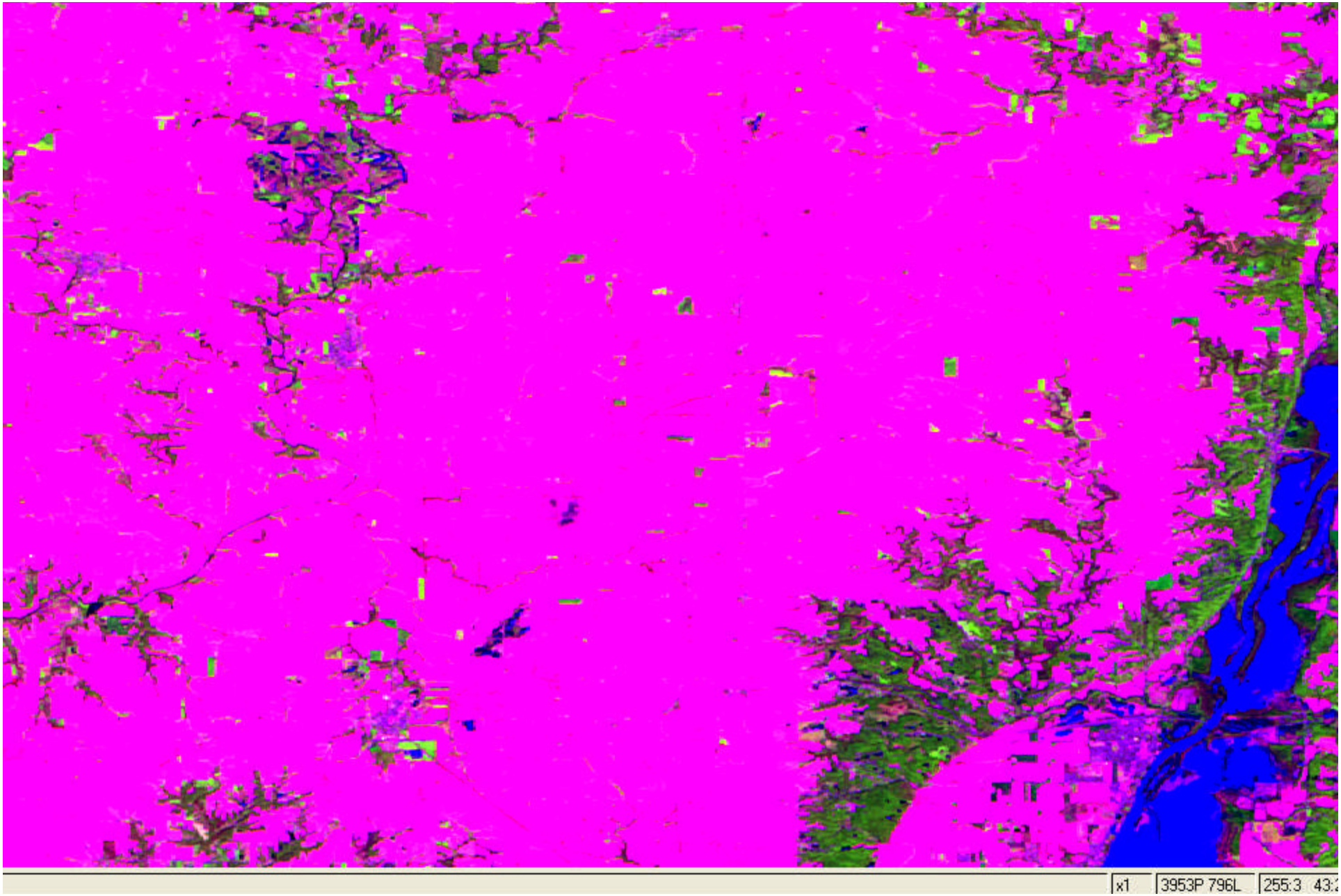


Compositing example from 2008

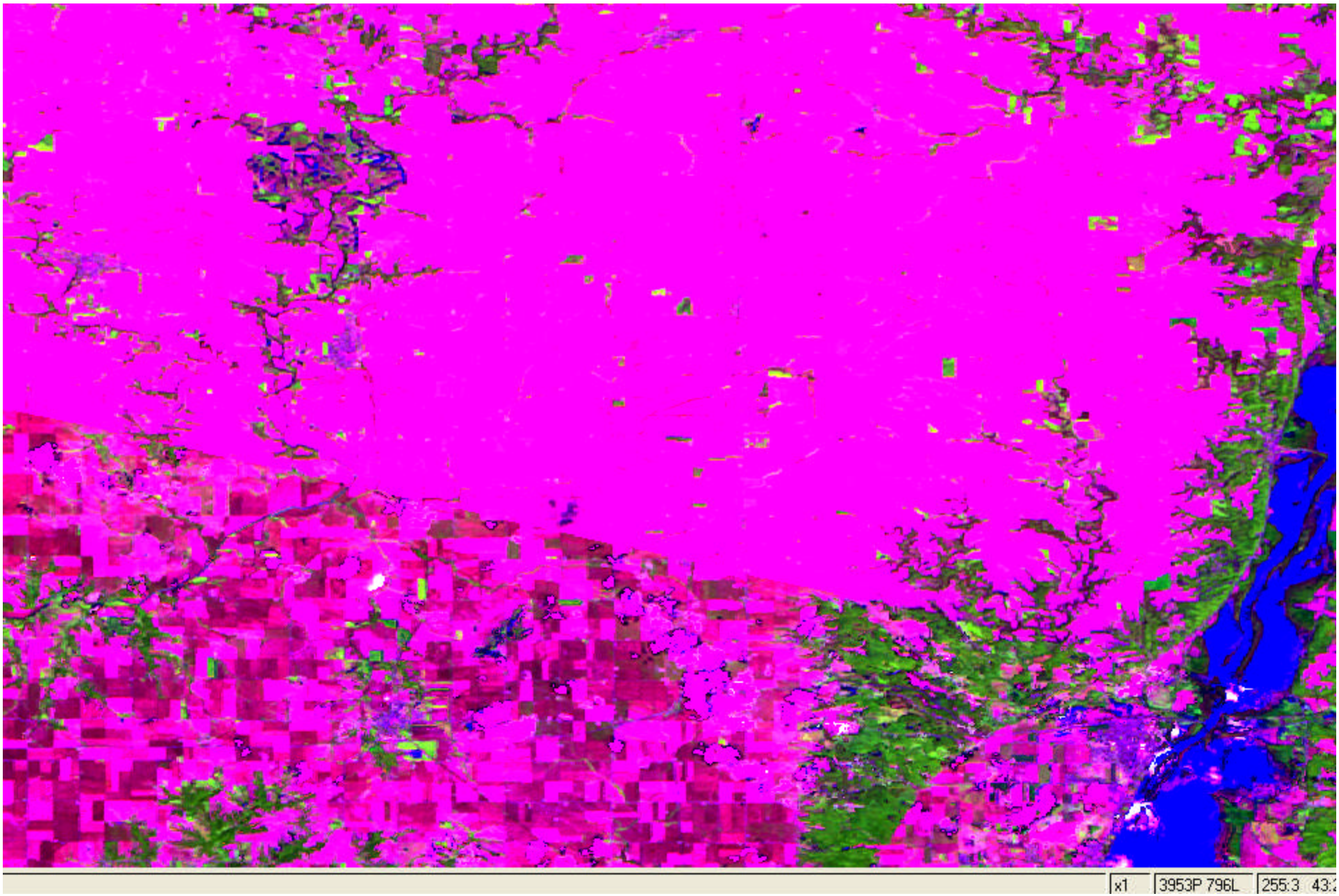
- AWiFS collections currently not adequate to capture MODIS-like phenology
- Extend the composite period to create more comprehensive regional composites
  - mixes phenologies
- A solution could be to use data fusion with MODIS in creating virtual AWiFS
- Could also employ variable composite periods based on amount of AWiFS being acquired
  - May/June composite
  - July composite
  - August bi-weekly composites

89.6W, 41.1N
North of Peoria, IL

May 5, 2008



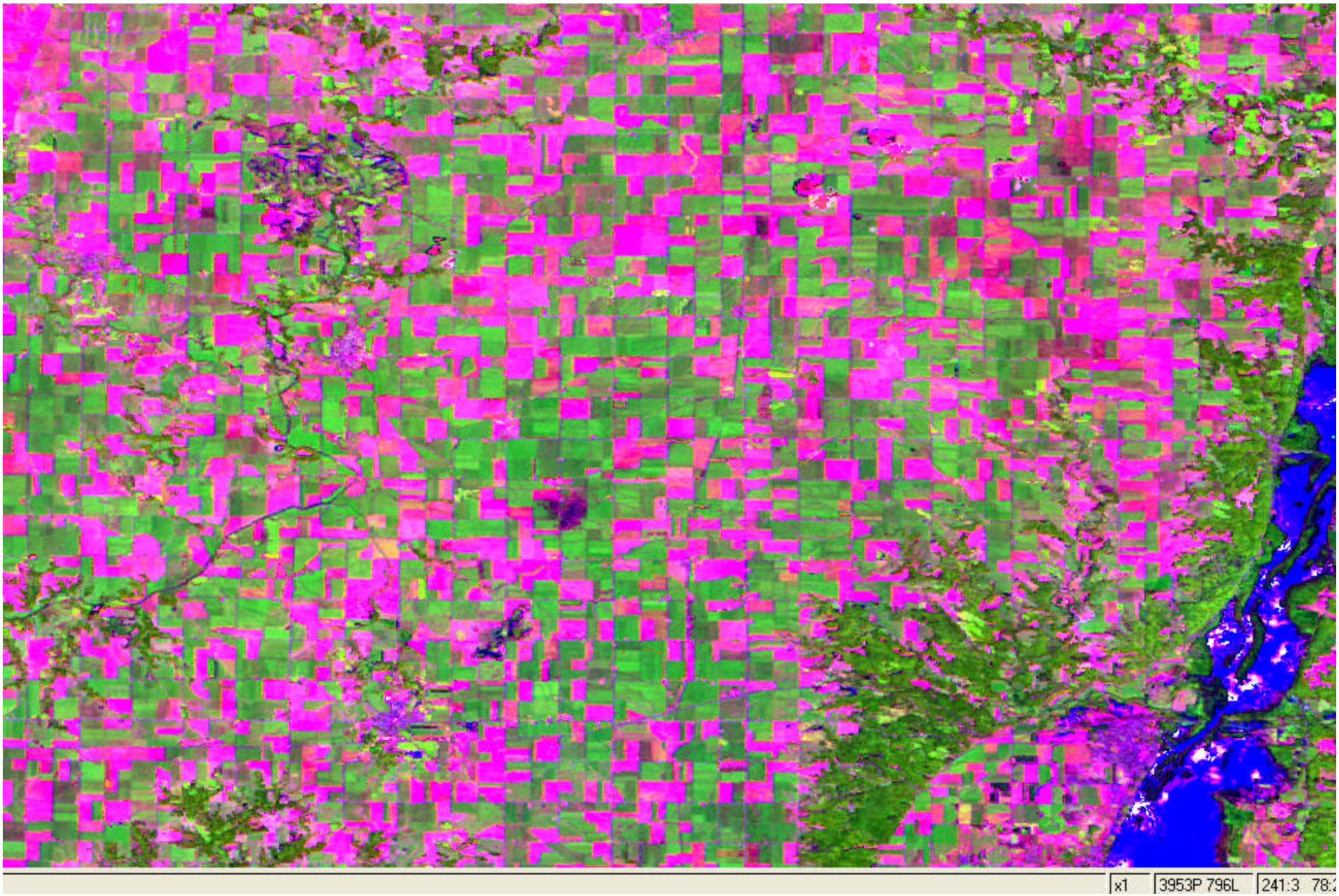
June 12, 2008



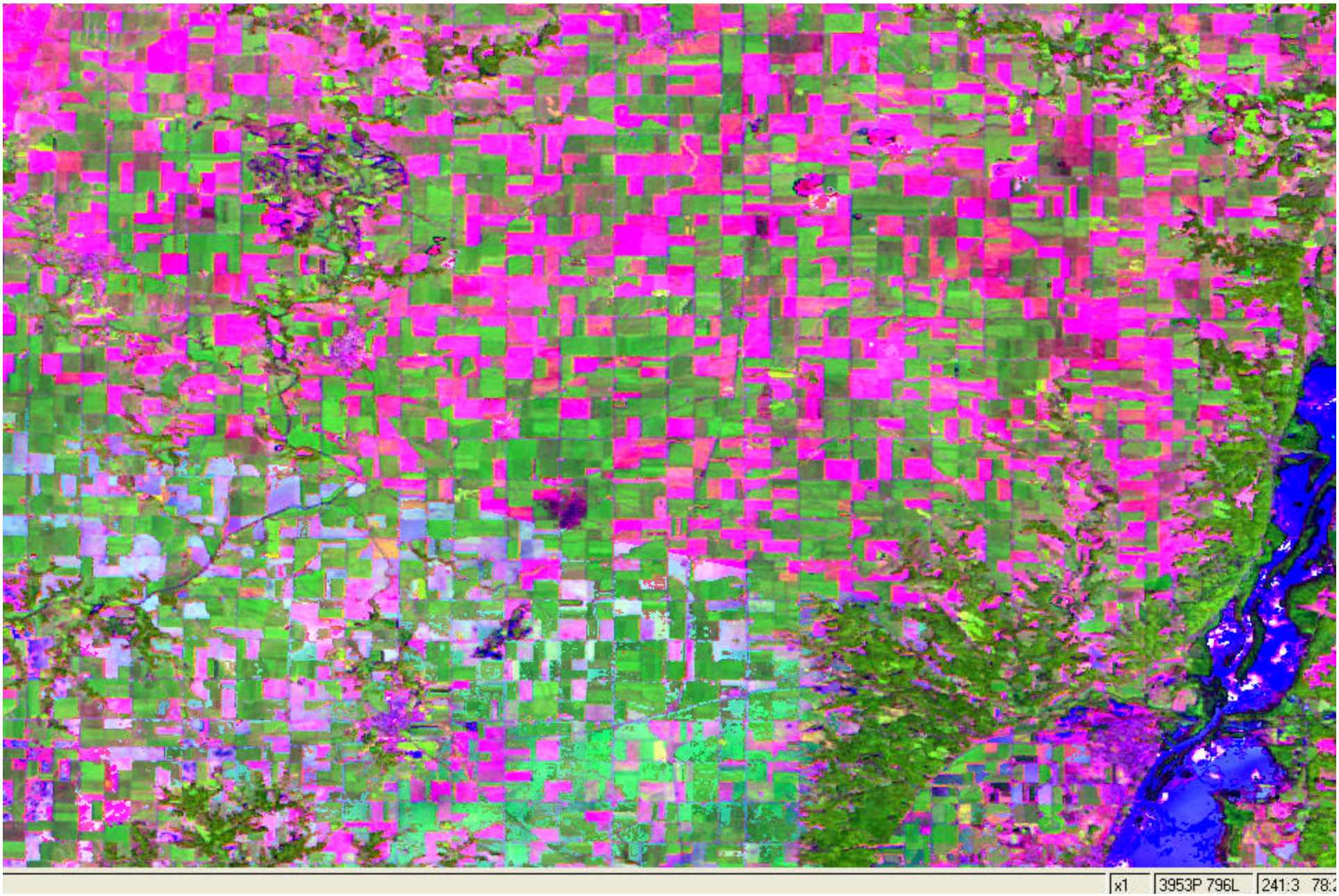
June 16, 2008

June 21, 2008

July 1, 2008

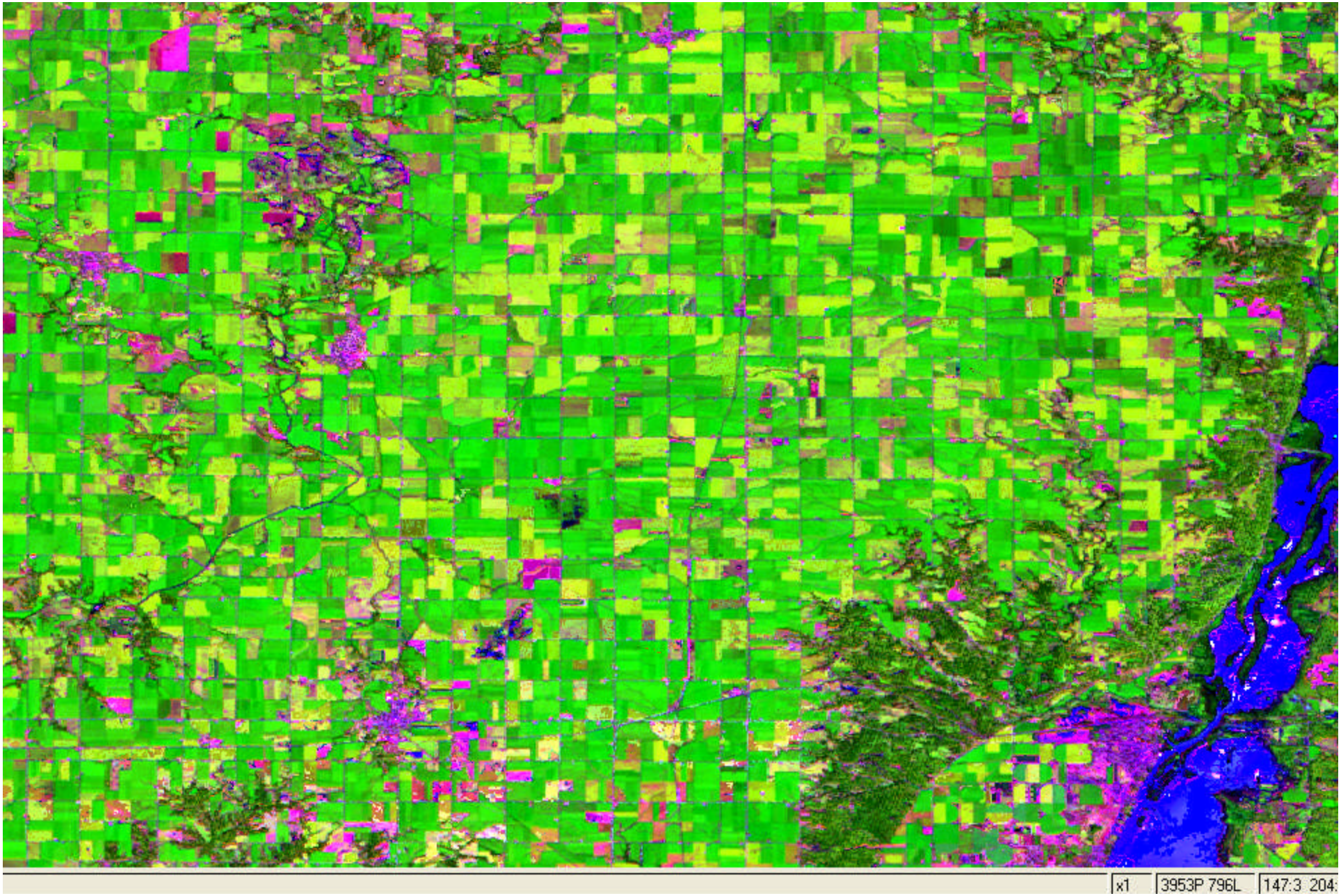


July 6, 2008

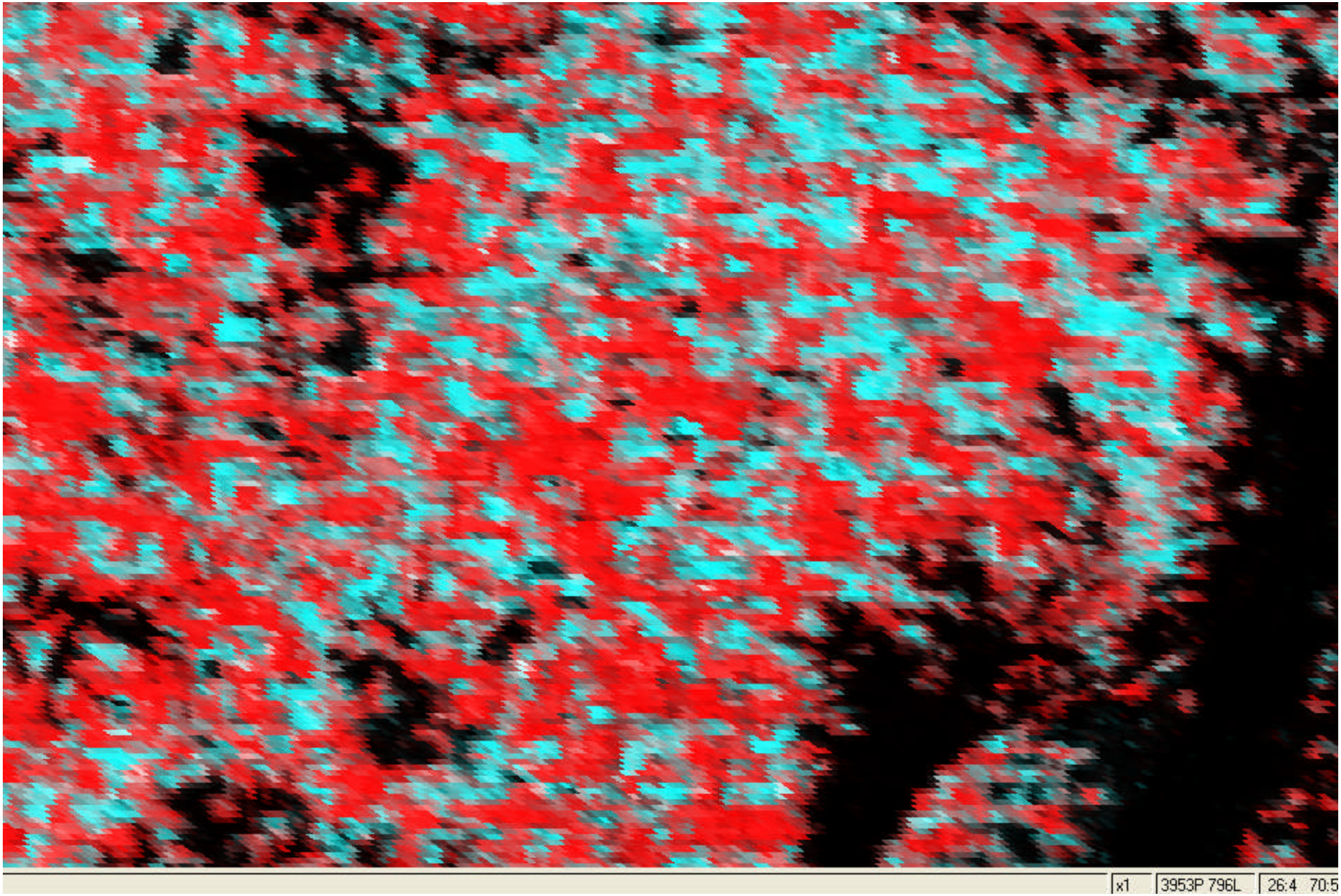


July 10, 2005

July 15, 2008

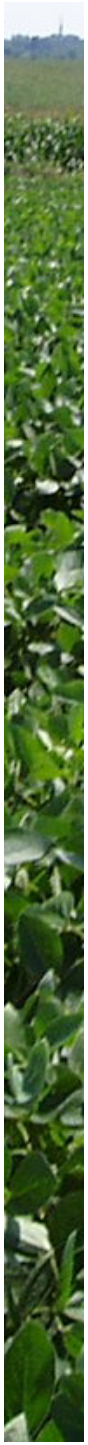


MODIS July model, %corn in red, %soy in cyan



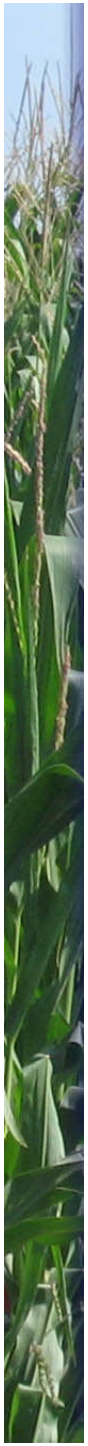
Next steps for MODIS/AWiFS processing

- Complete June/July/August corn/soy models for 2008 MODIS
- Finalize AWiFS compositing scheme
- Run an AWiFS classification using the MODIS classification for training



Summary

- Generic, unified multi-year MODIS crop type model shows promising results
- MODIS crop type maps can be used to train an AWiFS crop type map
  - Taking advantage of MODIS temporal resolution and AWiFS spatial resolution
- More AWiFS acquisitions required for phenologicaly coherent composites



Future Directions

- Develop a unified multi-year based AWiFS model to produce crop type indicator maps as season develops without training data such as the CLU

- Such a model can potentially be calibrated and transferred to other, less data rich regions to produce timely crop type maps

Thank You!

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