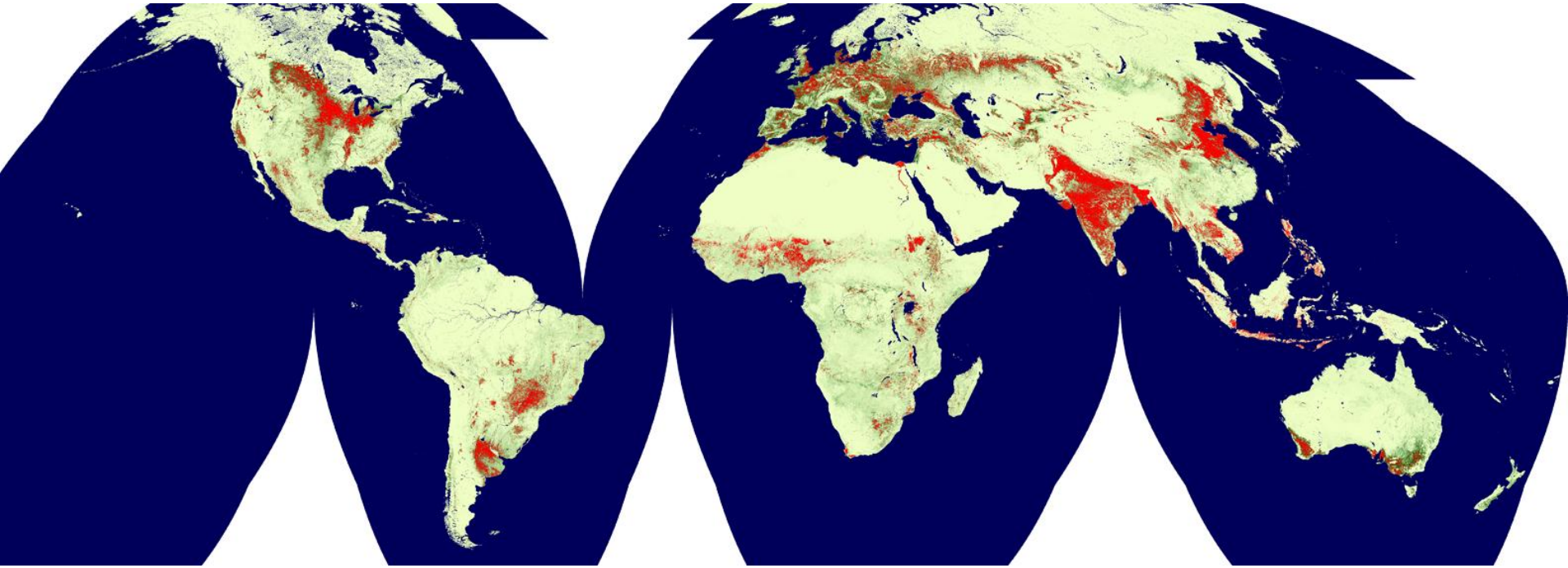
Global crop type assessment – soybean area estimation



NASA LCLUC and Applications Programs

Matt Hansen – UMd, Tom Loveland – USGS, Steve Stehman – SUNY-ESF, Inbal Becker-Reshef – UMd, Wu Bingfang – IRSA, Pei Zhiyuan – CAAE, Rick Mueller – NASS, Bernardo Rudorff – INPE, Yosio Shimabukuro – INPE, Carlos Di Bella – INTA, Diego De Abelleyra – INTA, Bernard Adusei - SDSU

Global cropland

- Cropland is one of the most challenging land cover themes
  - What is cropland – herbaceous/shrub/tree crops?
  - Crop type
  - Varieties
  - Intensification
  - Field size
  - Dryland/irrigated
  - Single/double/triple cropping

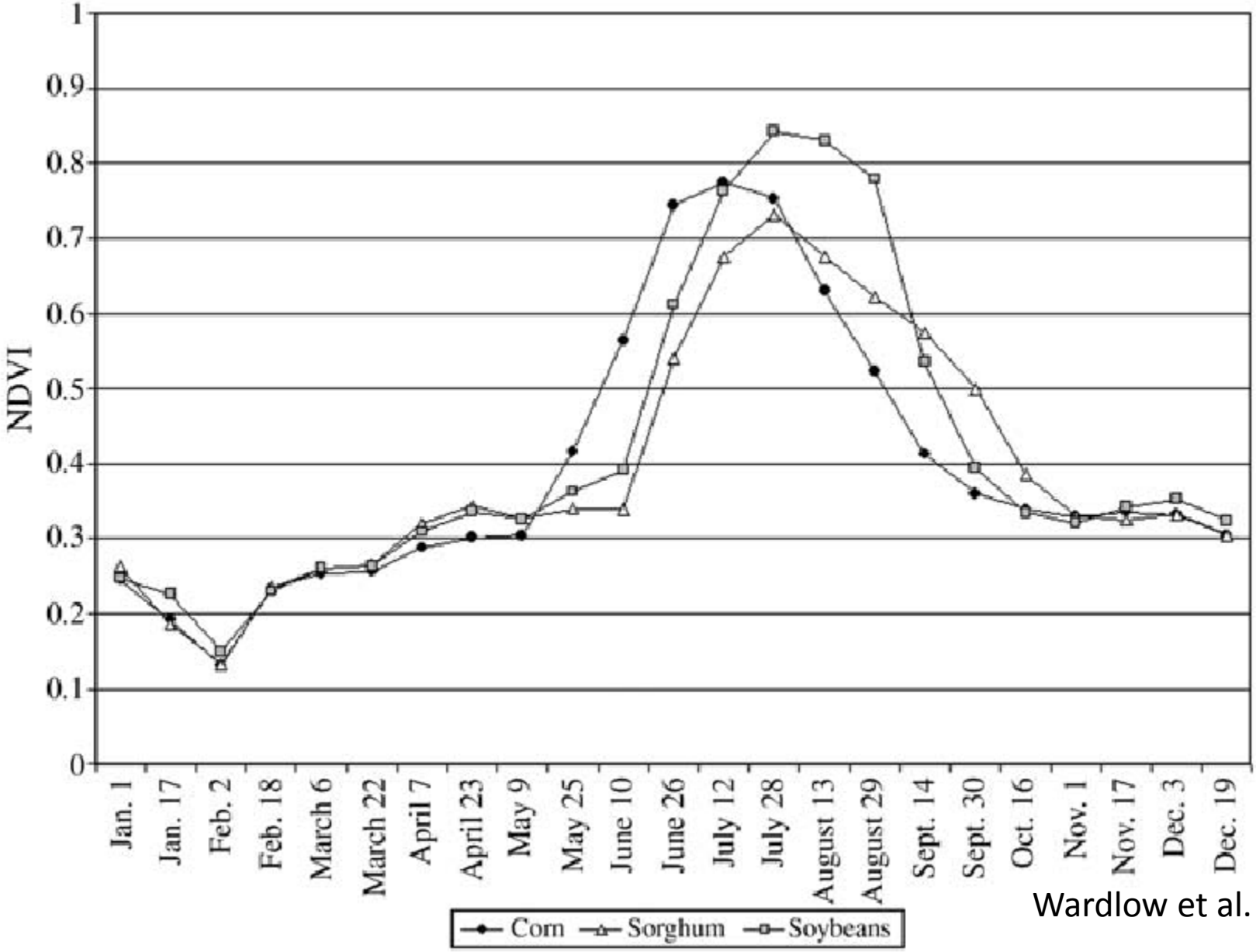
Soybean world supply and production

in thousand metric tons (USDA FAS)

	2007/08	2008/09	2009/10	2010/11	Aug 2011/12	Sep 2011/12
Production						
United States	72,859	80,749	91,417	90,610	83,168	83,969
Brazil	61,000	57,800	69,000	75,500	73,500	73,500
Argentina	46,200	32,000	54,500	49,000	53,000	53,000
China	13,400	15,540	14,980	15,100	14,000	14,000
India	9,470	9,100	9,700	9,800	9,800	10,500
Paraguay	6,900	4,000	7,200	8,300	7,500	7,500
Canada	2,696	3,336	3,507	4,345	4,000	4,000
Other	7,944	9,435	10,534	11,465	12,503	12,523
Total	220,469	211,960	260,838	264,120	257,471	258,992

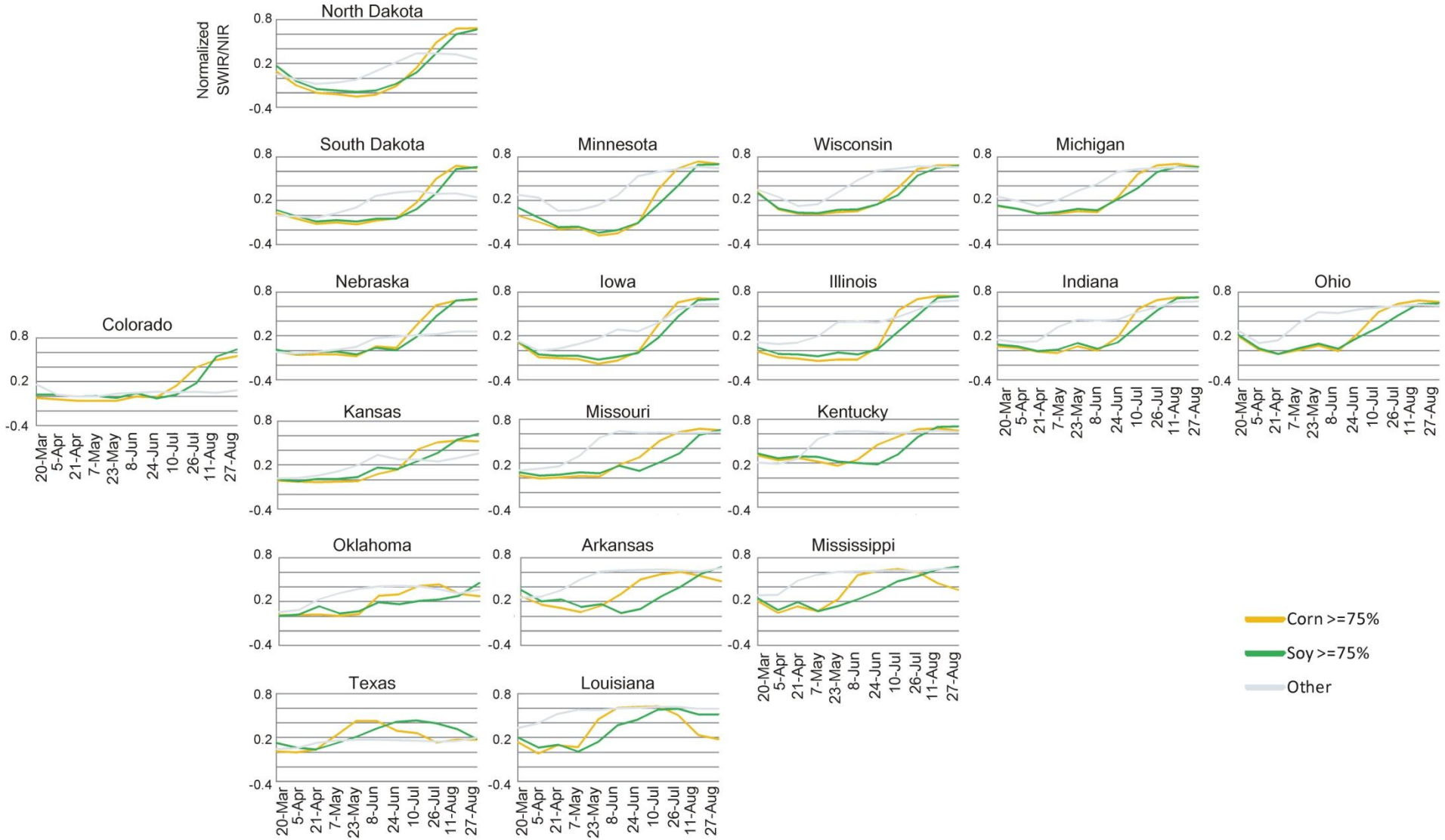
U.S., Brazil, Argentina and China account for ~90% of global soybean production

MODIS for crop type identification



Wardlow et al. 2007

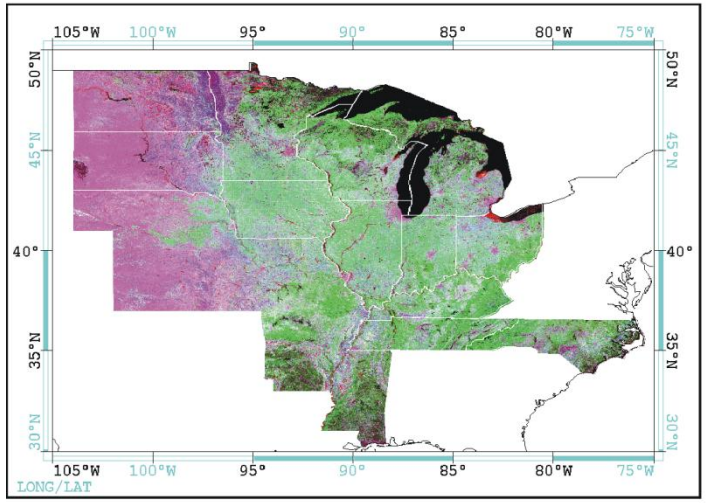
MODIS per U.S state soybean and corn phenologies

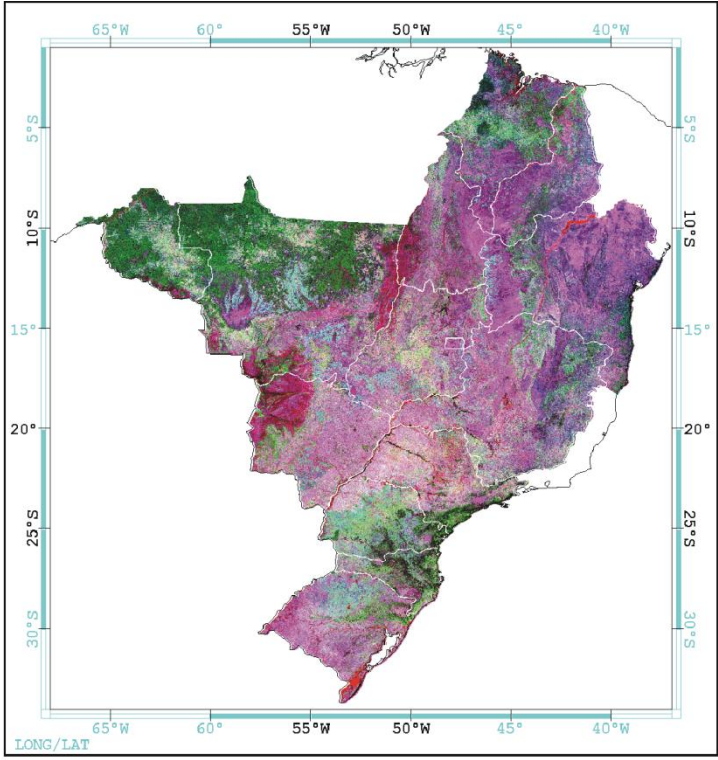


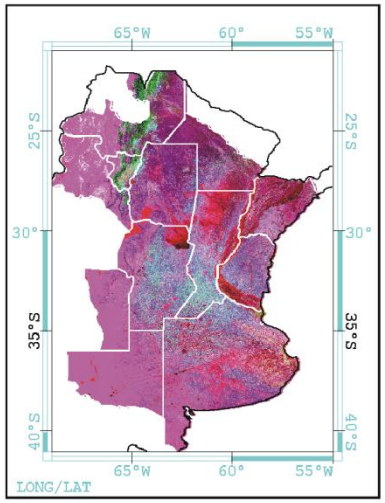
Method

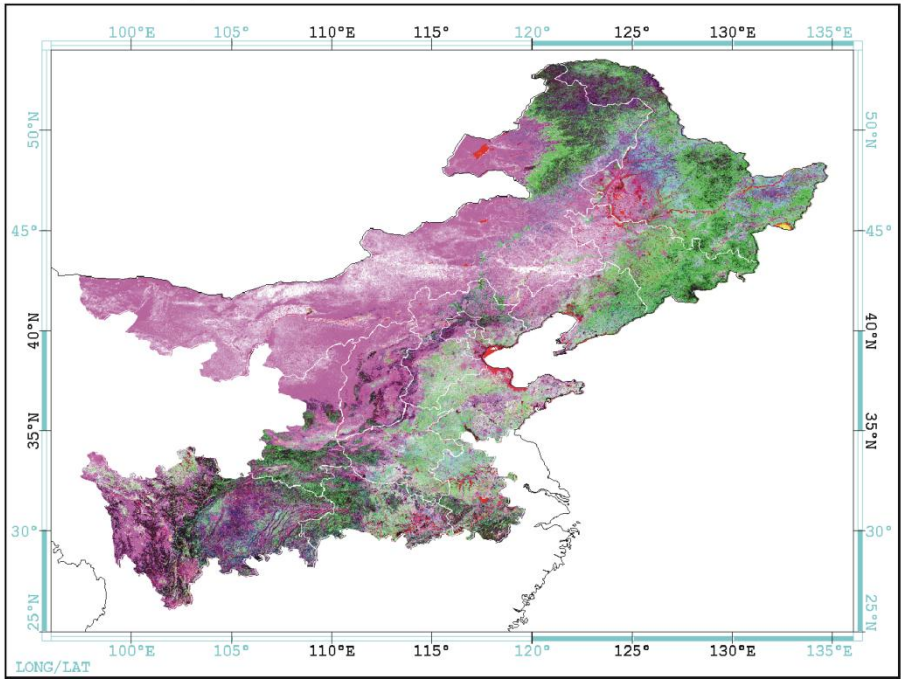
- MODIS for turn-key models per nation/sub-region to indicate within growing season soybean cultivation based on sub-pixel percent cover training data
- Landsat samples based on MODIS soybean indicator maps to map per sample block soybean cultivated area
- RapidEye will allow for per country/region calibration of Landsat area estimates

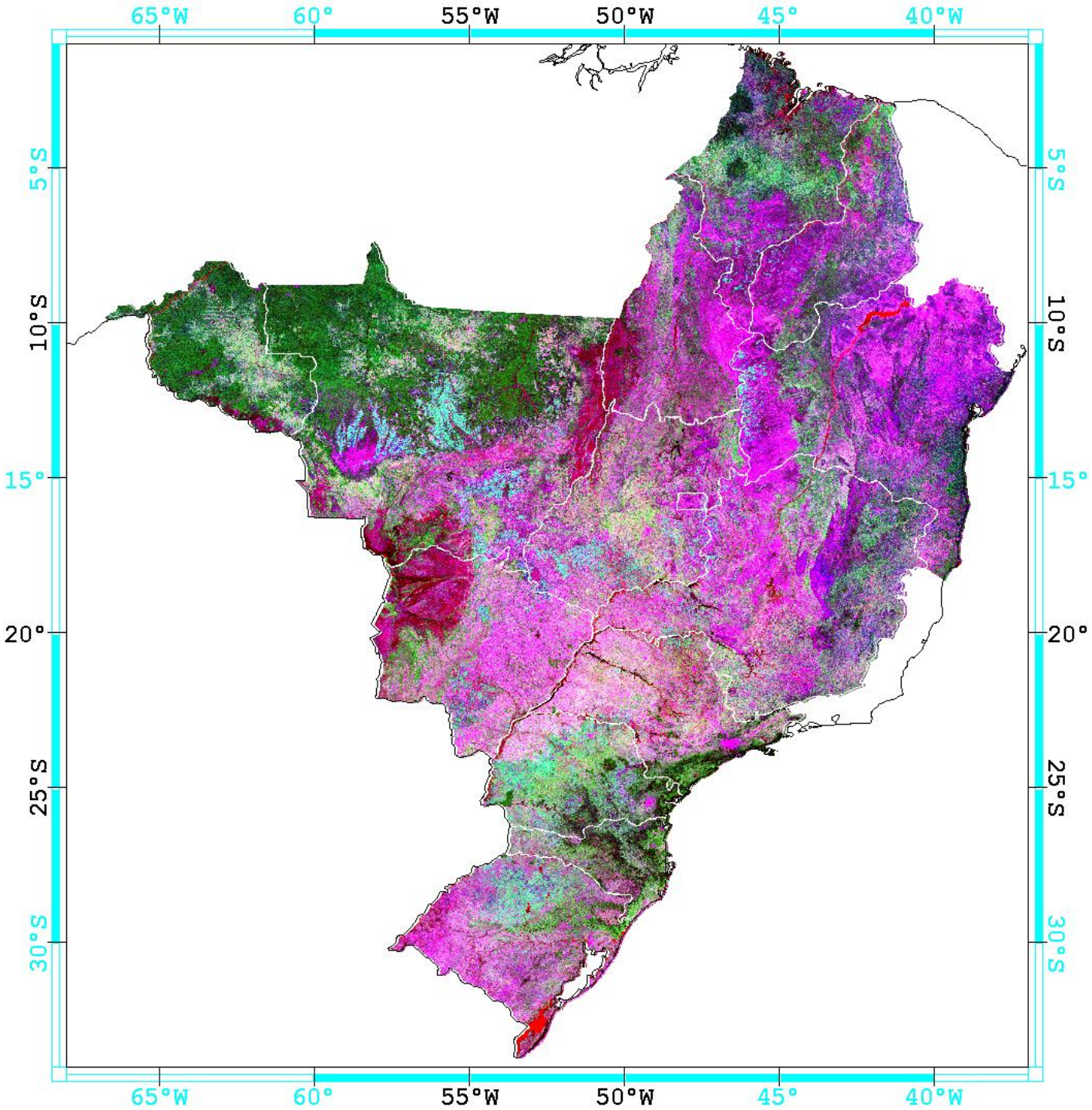
Study area, consisting of the top four soybean production countries, nearly 90% of global soybean production. Top left, United States; top right, Brazil; lower left, Argentina; lower right, China. For each country, the administrative subset shown accounts for over 95% of national soybean acreage, except for China, where the subset shown represents 88% of national soybean acreage. Images, with a globally applied enhancement, are from MODIS median 9-year growing season metrics for red=visible red, green=nearinfrared, and blue=shortwave infrared (band 7).







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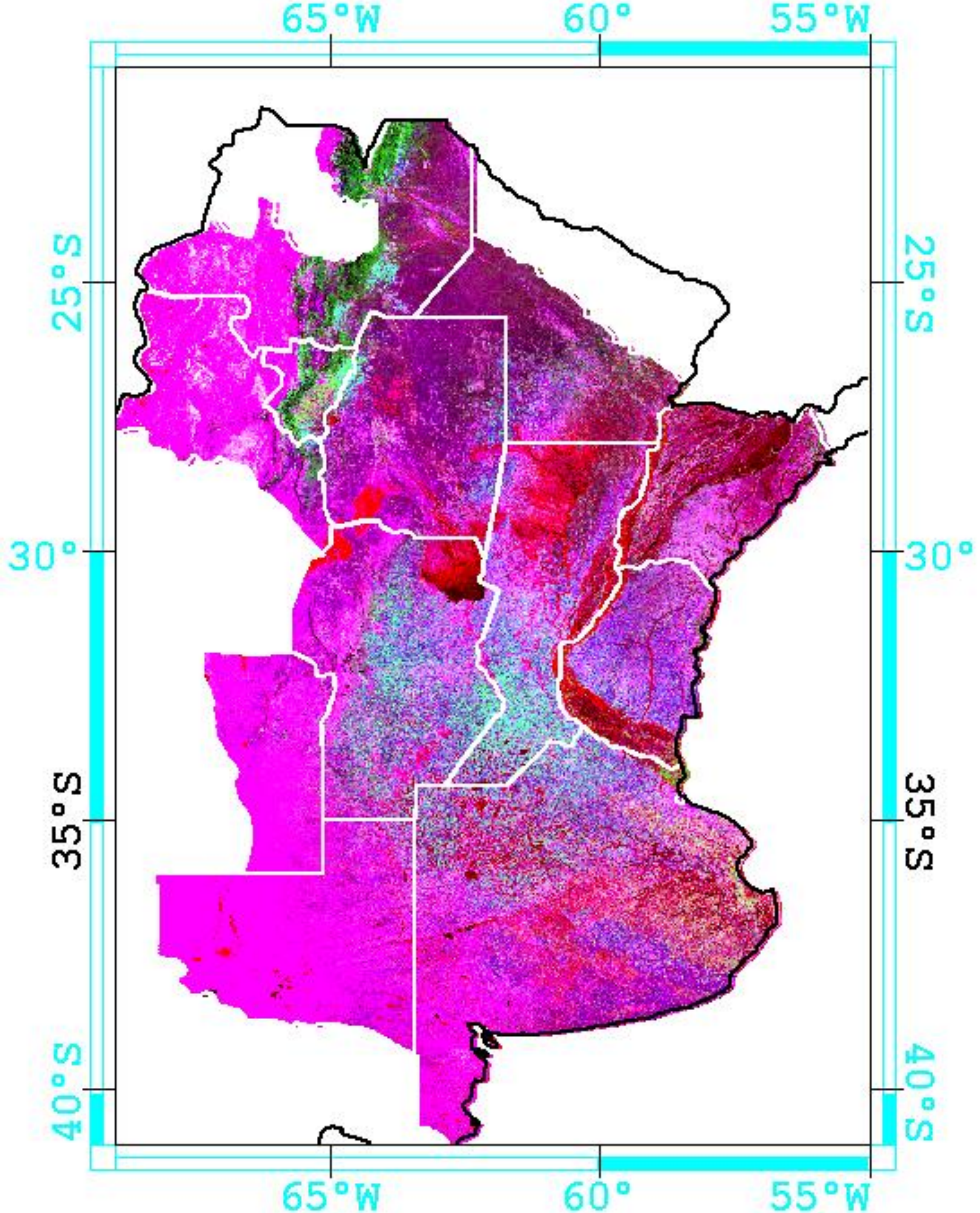

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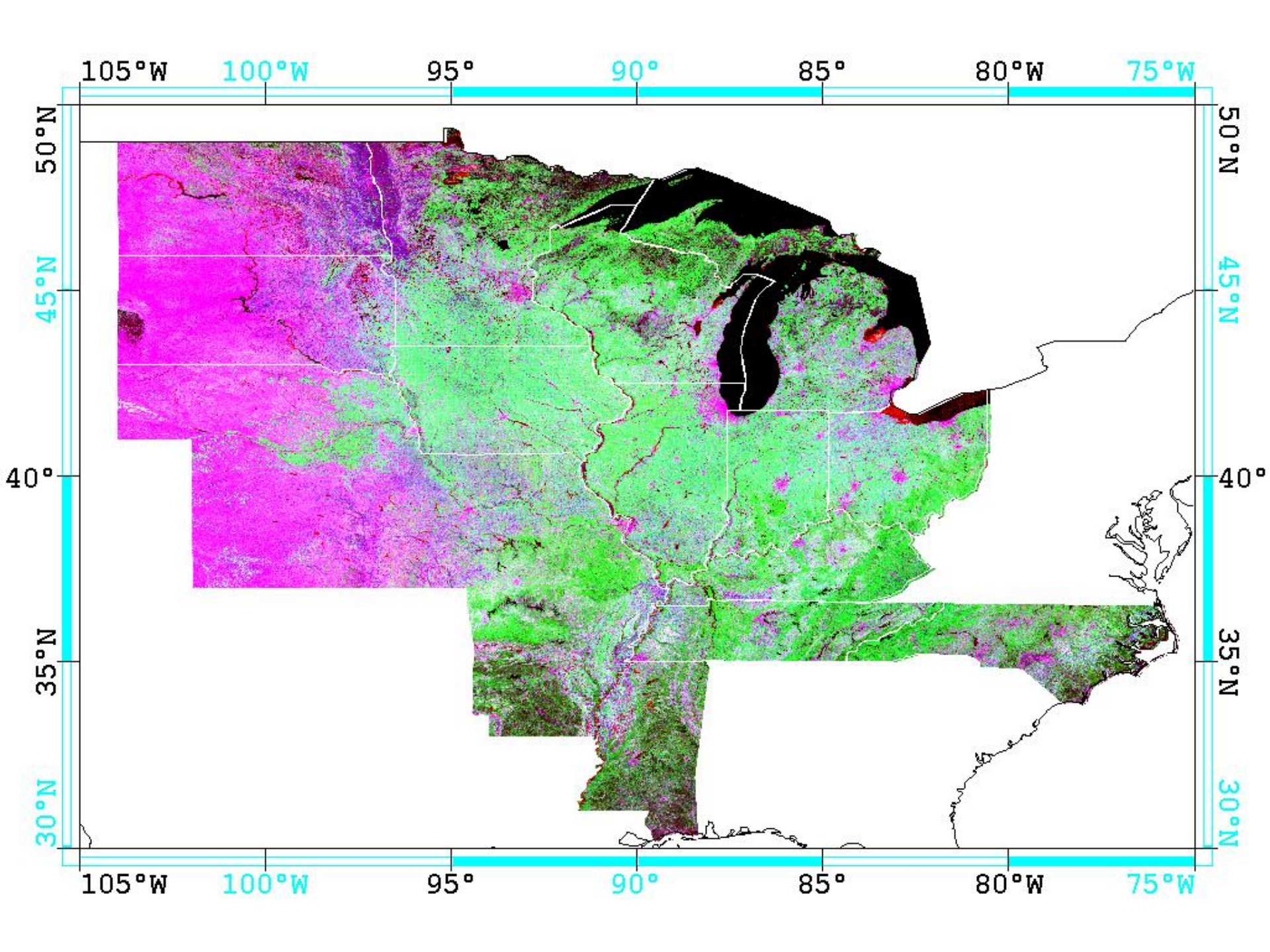
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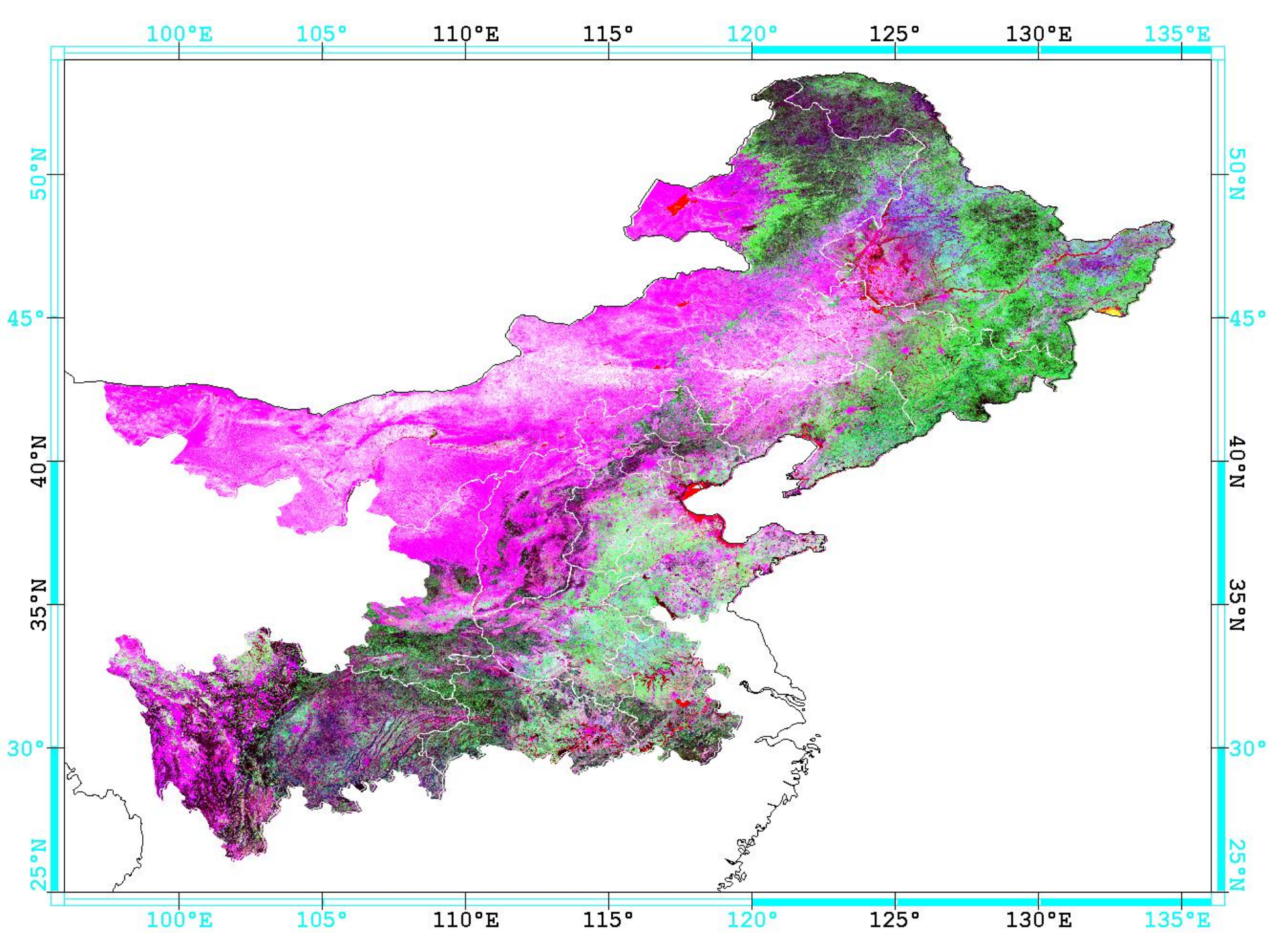
40°
35°N
30°N

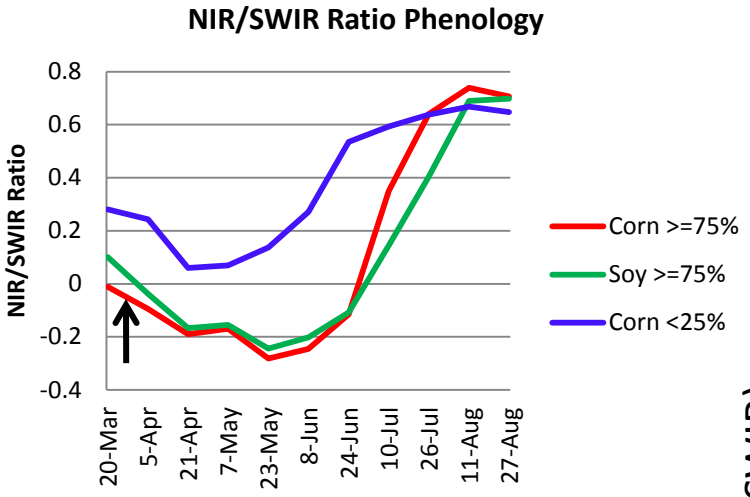

100°E
105°
110°E
115°
120°
125°
130°E
135°E
50°N
45°
40°N
35°N
30°
25°N

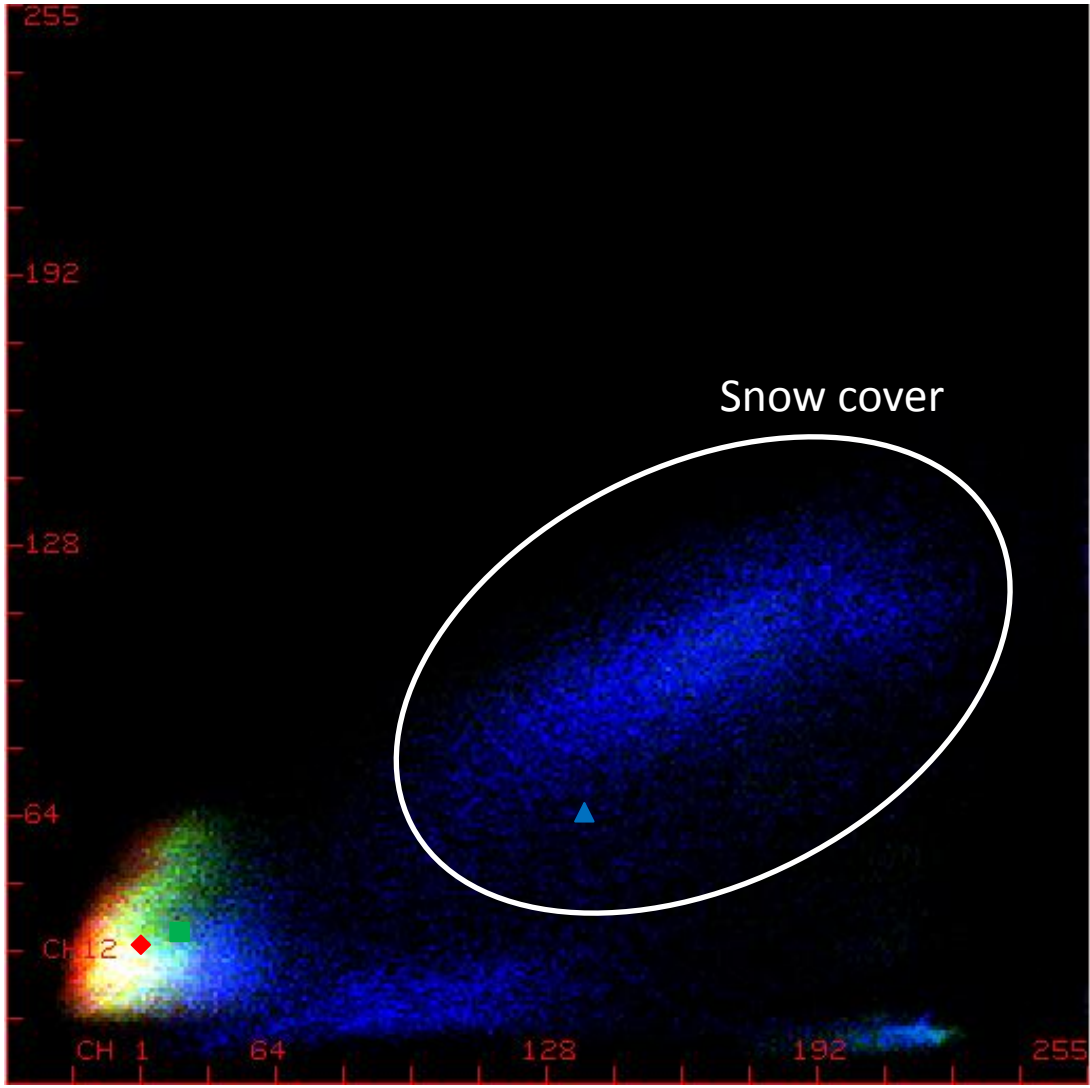
Statistics of Soybean area,2008			
	Hectare	%	sum
Heilongjiang	4036500	44.2	44.2
Anhui	988400	10.8	55.1
Inner Mongolia	668000	7.3	62.4
Henan	486100	5.3	67.7
Jilin	457100	5.0	72.7
Jiangsu	232800	2.6	75.3
Sichuan	208600	2.3	77.5
Shanxi	204700	2.2	79.8
Shanxi	189500	2.1	81.9
Hebei	187600	2.1	83.9
Liaoning	181000	2.0	85.9
Shandong	167000	1.8	87.7
Yunnan	128900	1.4	89.1
Guizhou	125700	1.4	90.5
Hubei	112300	1.2	91.8
Jiangxi	102600	1.1	92.9
Gansu	99800	1.1	94.0
Guangxi	89300	1.0	94.9
Hunan	88200	1.0	95.9
Chonqing	81700	0.9	96.8
Xinjiang	70500	0.8	97.6
Guangdong	62000	0.7	98.3
Fujian	55800	0.6	98.9
Zhejiang	54400	0.6	99.5
Ningxia	21000	0.2	99.7
Tianjin	9500	0.1	99.8
Beijing	9400	0.1	99.9
Shanghai	5000	0.1	100.0
Hainan	3200	0.0	100.0
Tibet	300	0.0	100.0
Qinghai	0	0.0	100.0

China has a more diffuse / complicated soybean distribution

Minnesota 2008

March 20



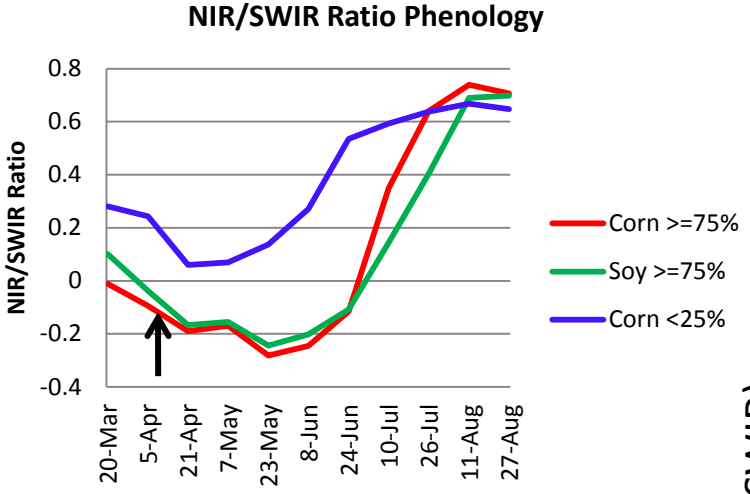


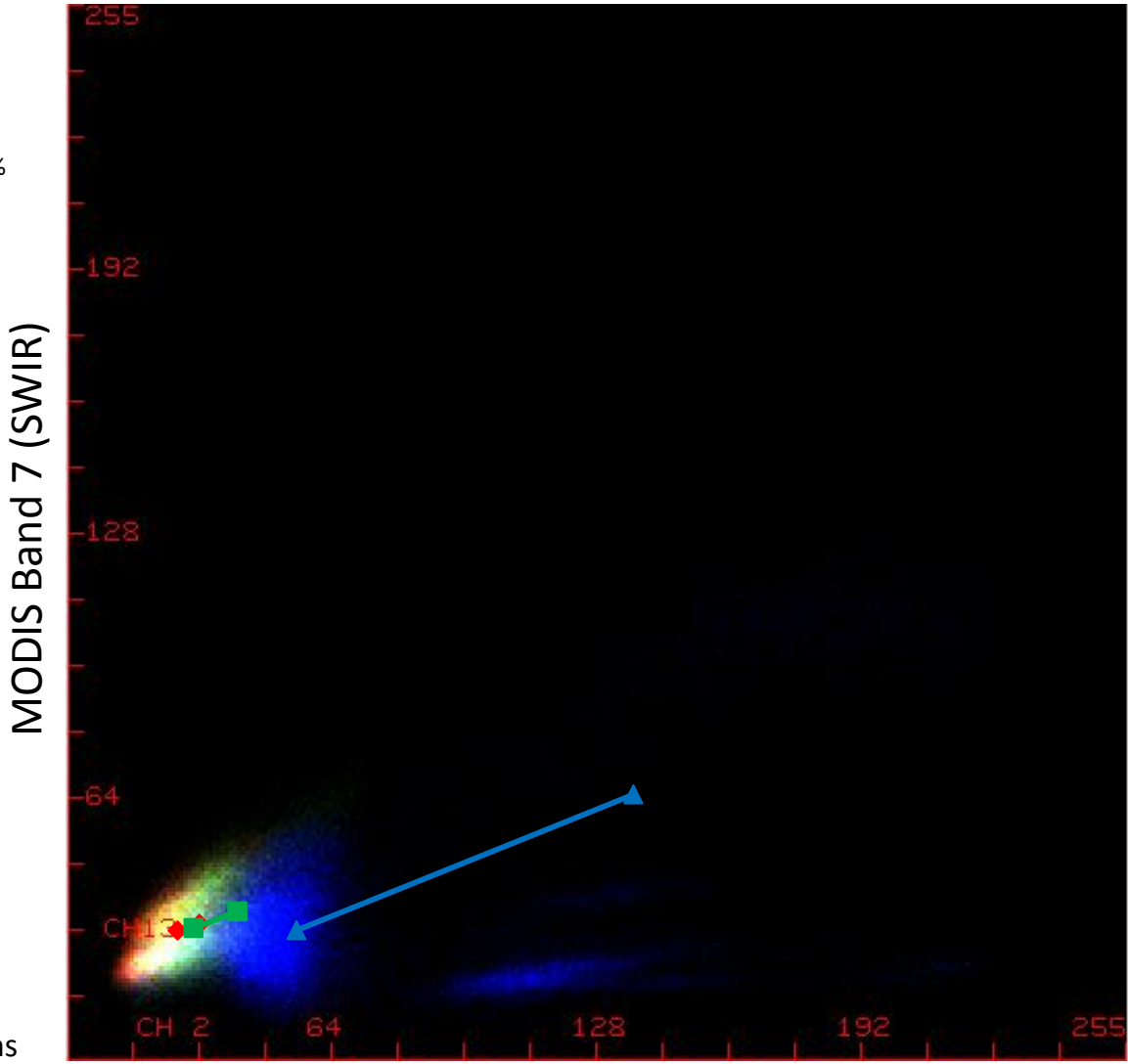
Red: >=75% Corn
Green: >=75% Soybeans
Blue: <25% Corn

SDSU

Minnesota 2008

April 5





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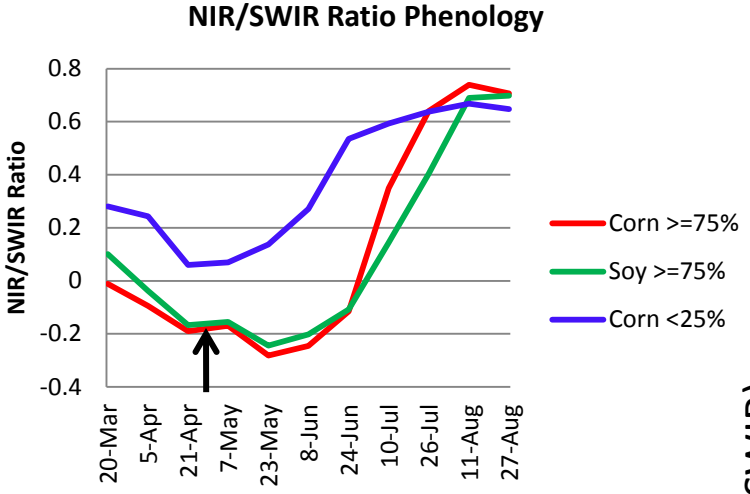
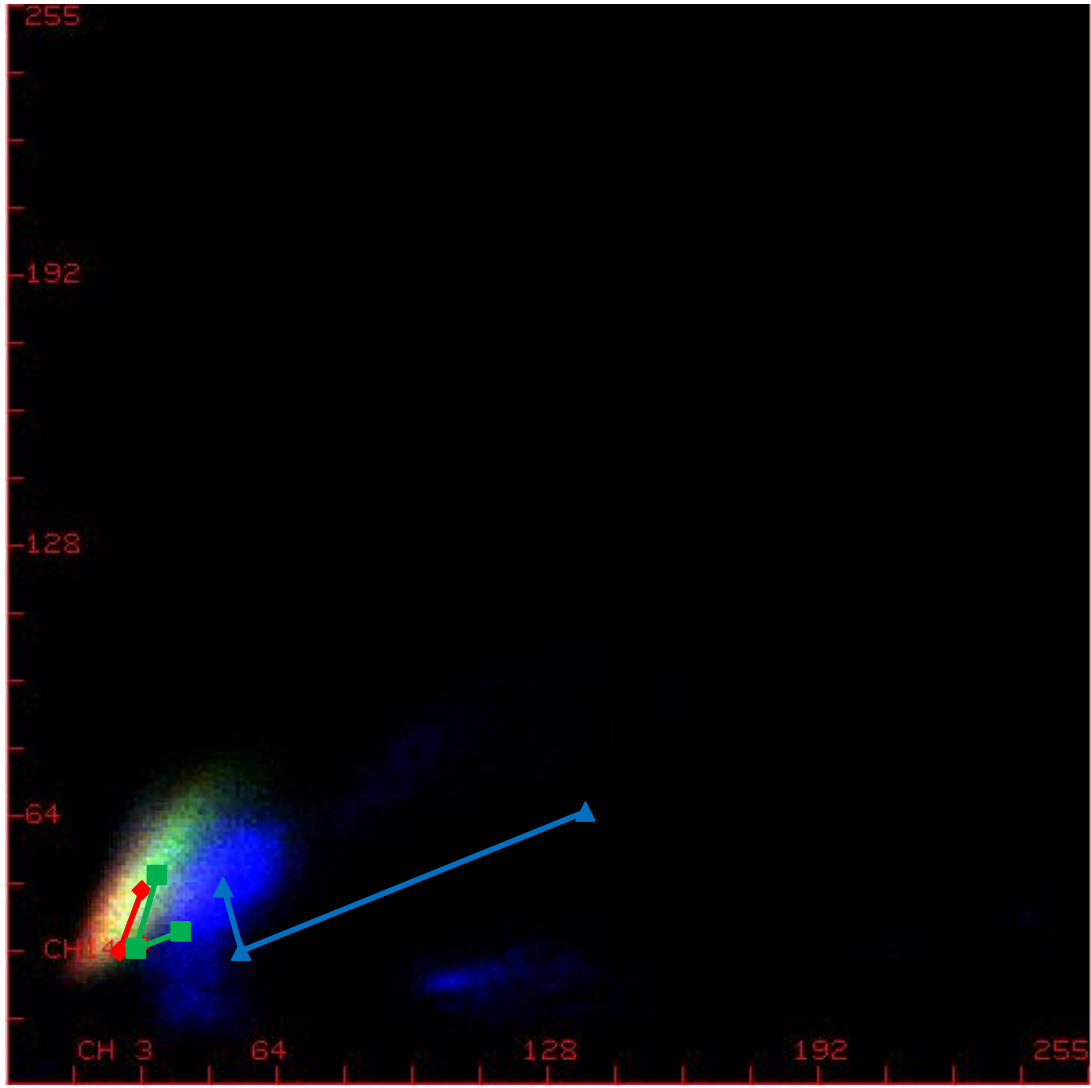
SDSU

Minnesota 2008

April 21





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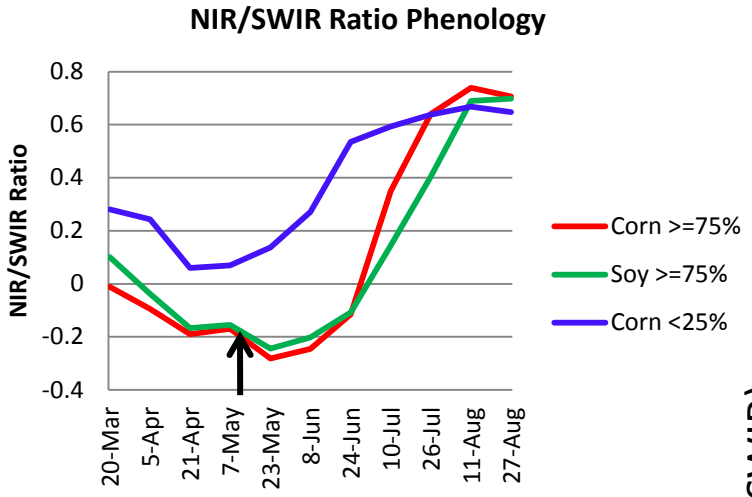
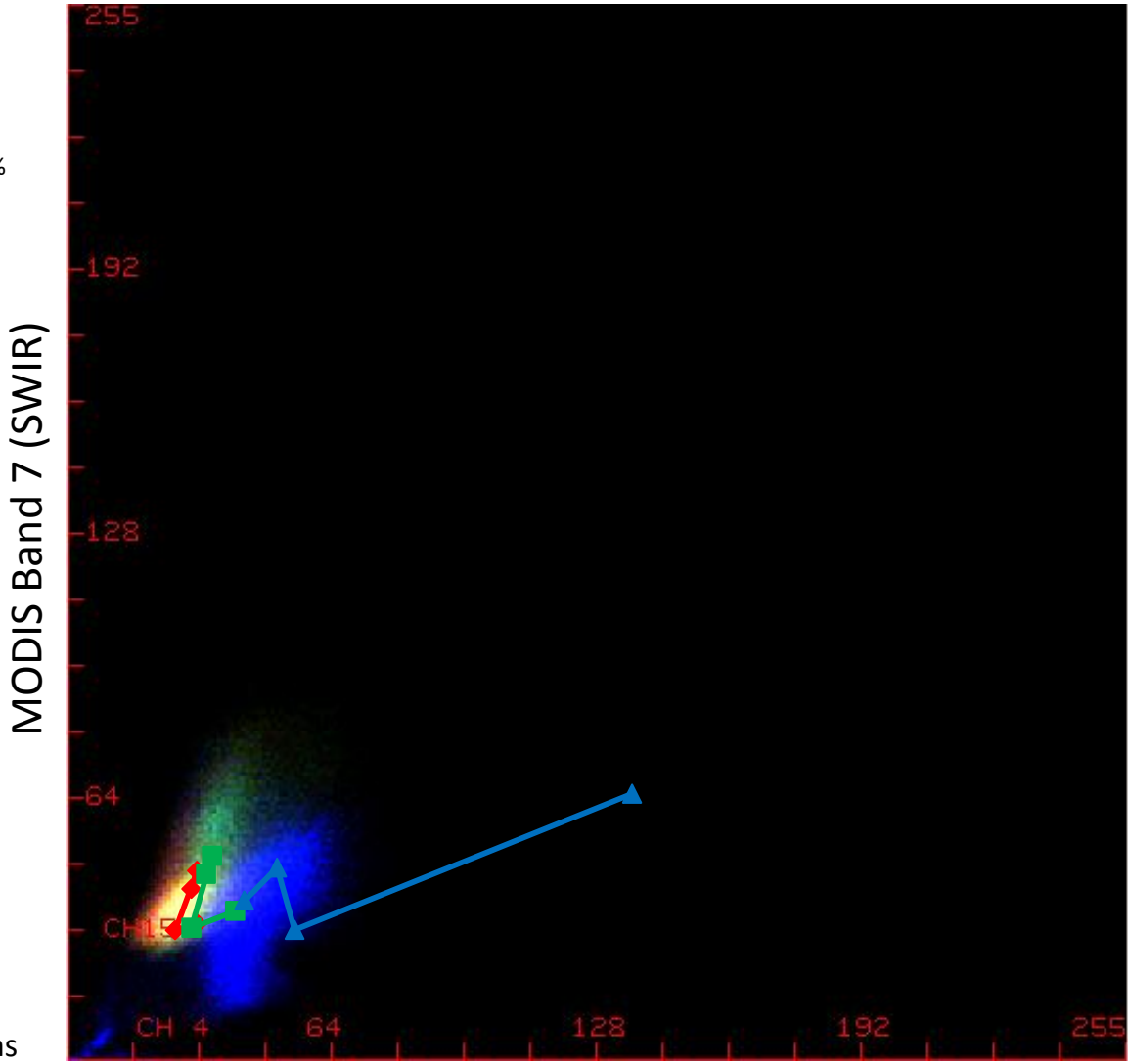
SDSU

Minnesota 2008

May 7





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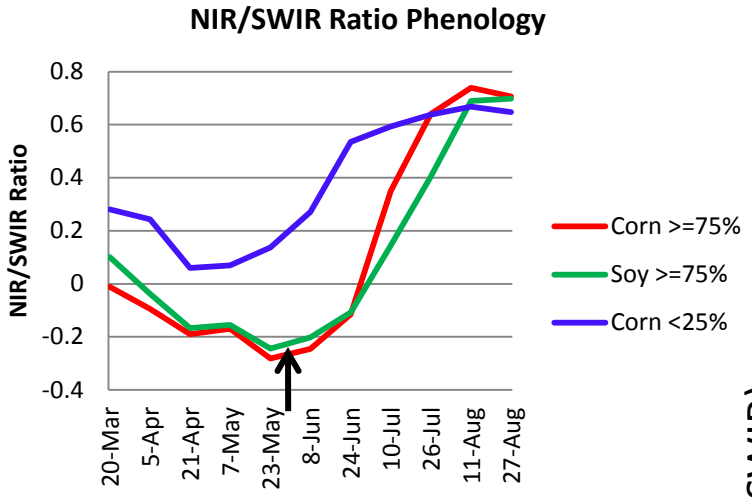
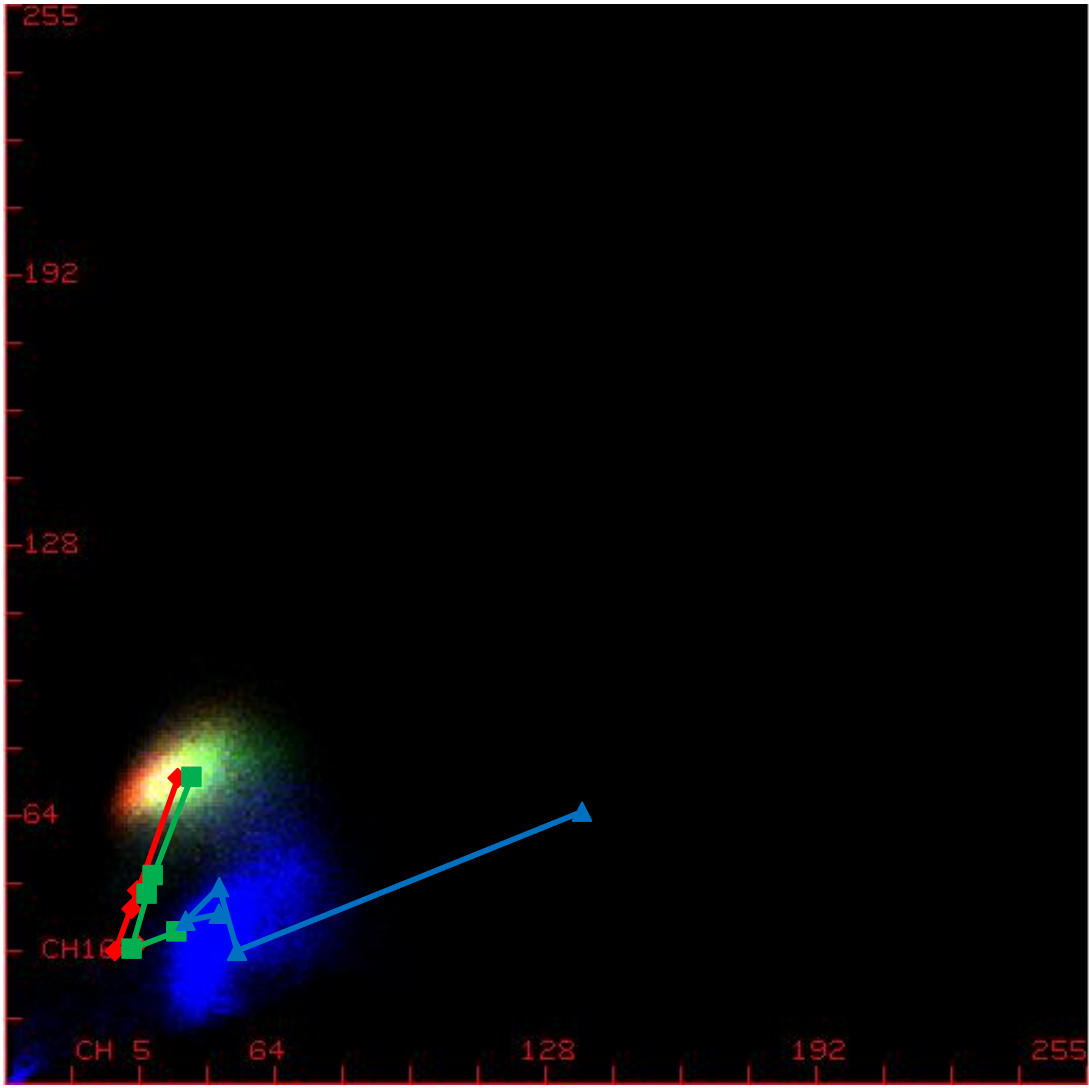
SDSU

Minnesota 2008

May 23





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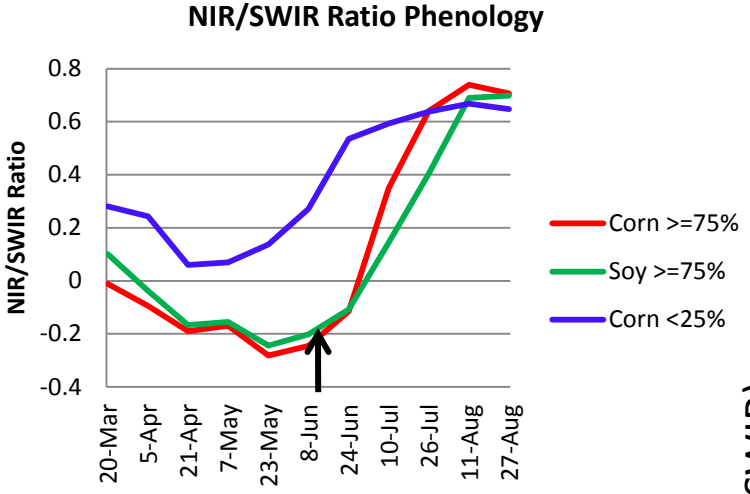
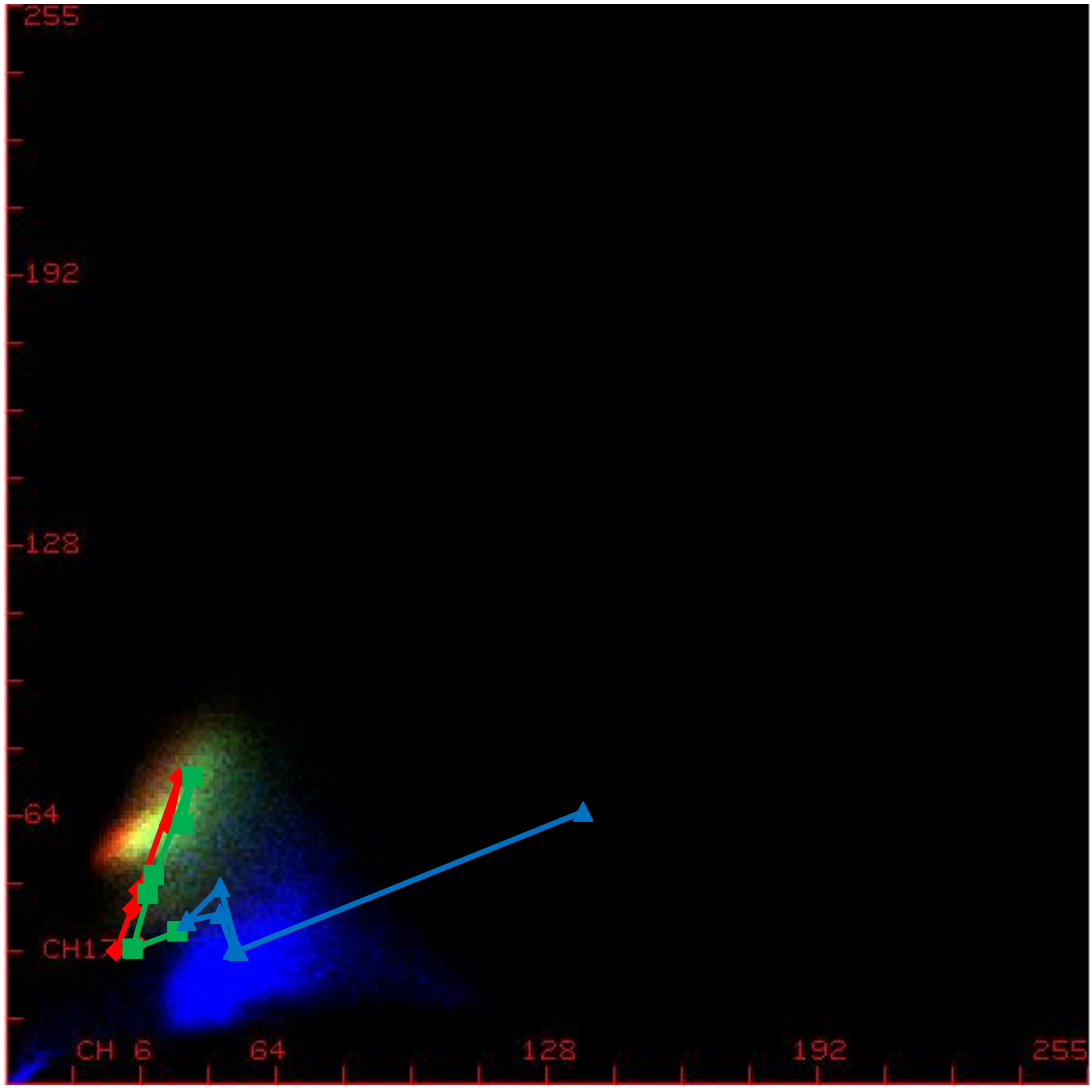
SDSU

Minnesota 2008

June 8





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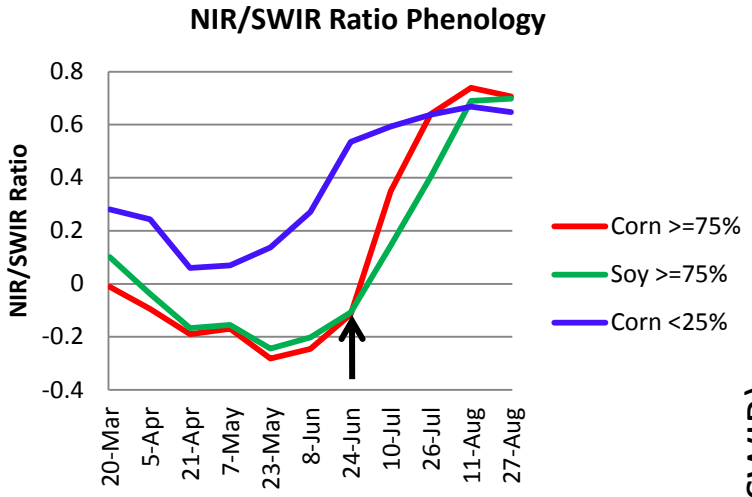
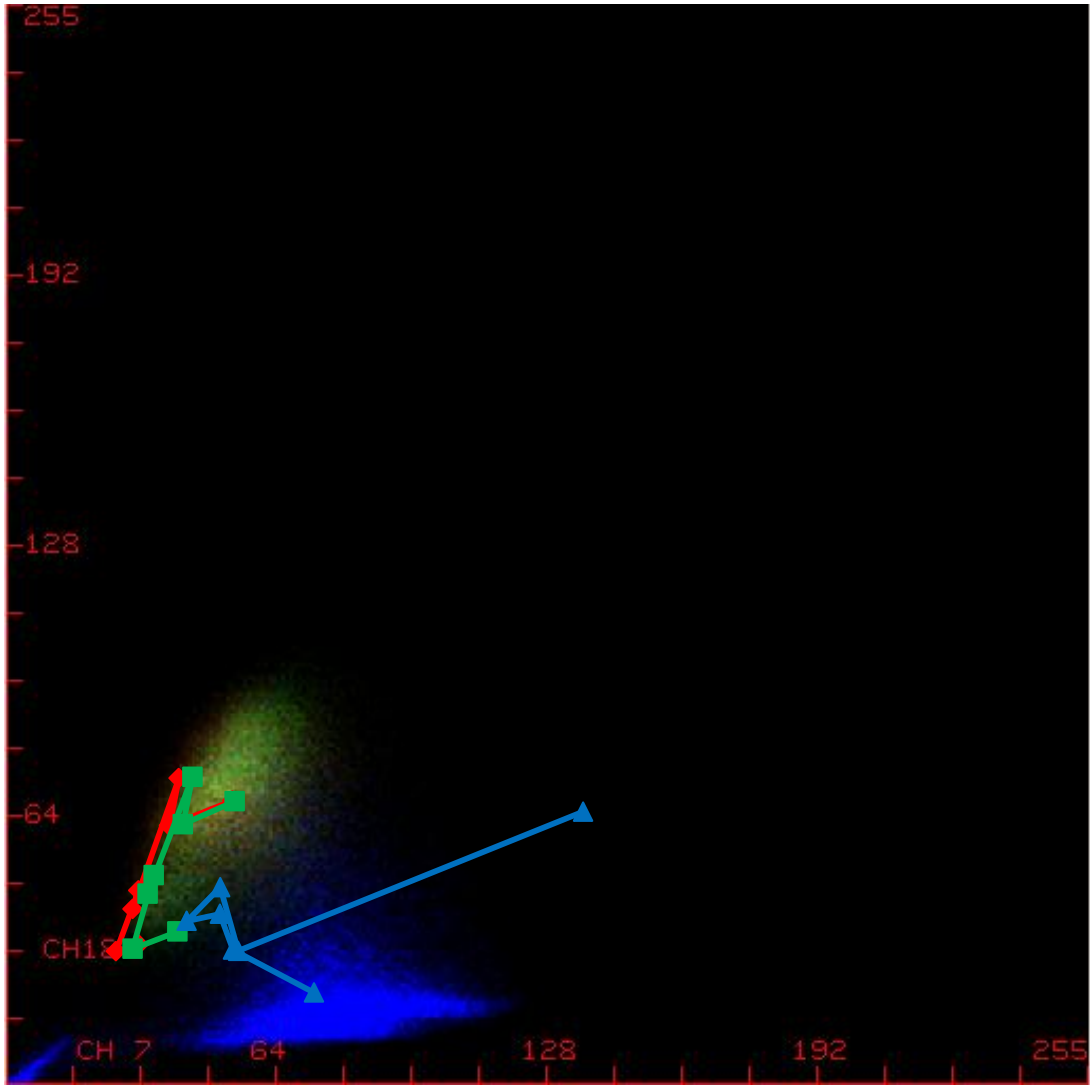
SDSU

Minnesota 2008

June 24





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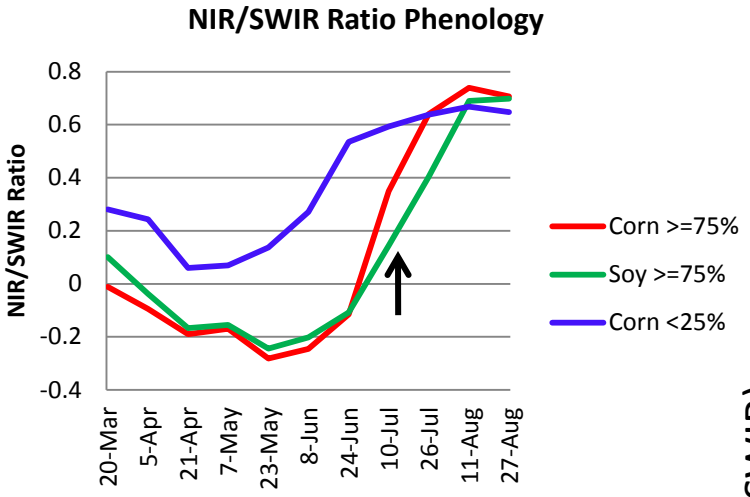
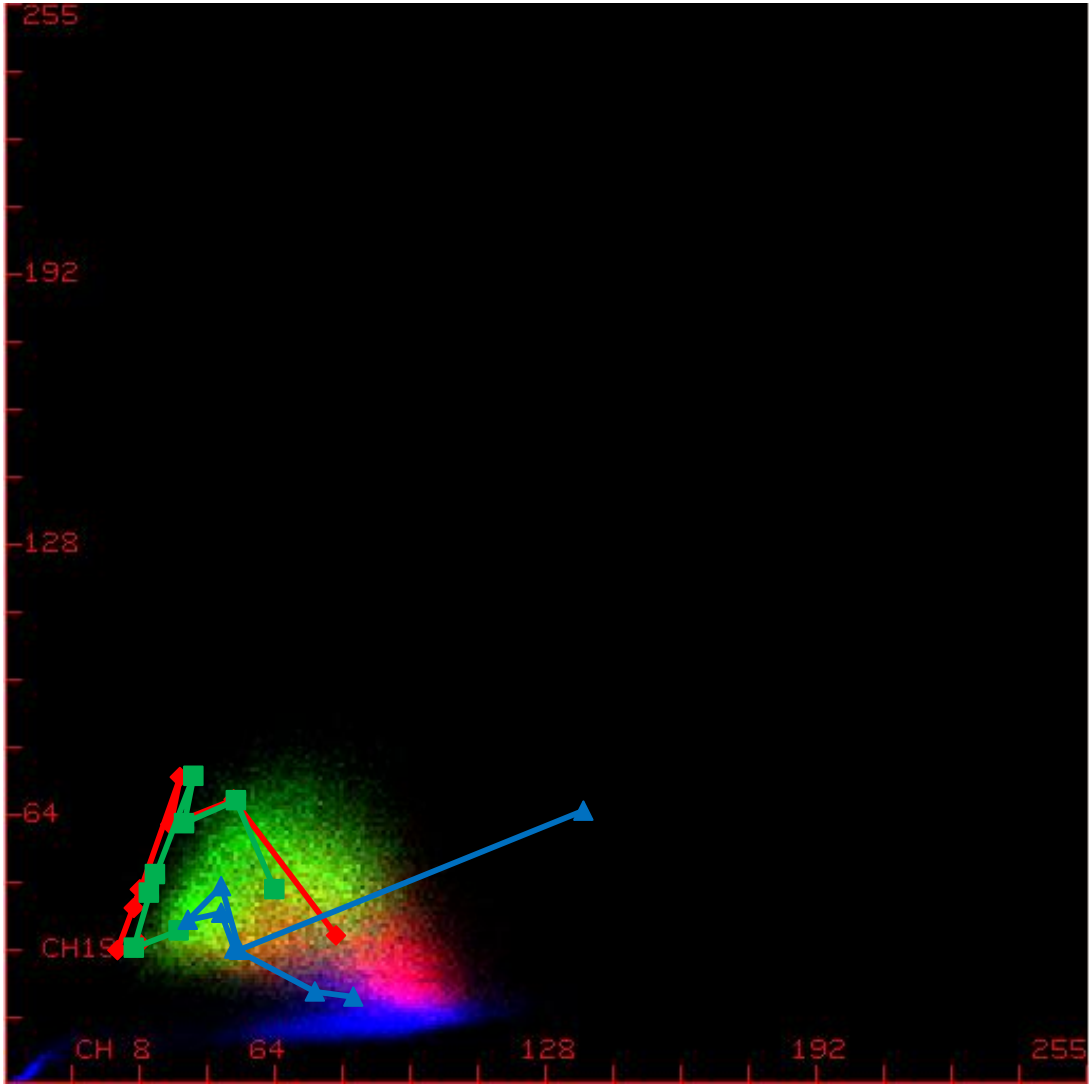
SDSU

Minnesota 2008

July 10





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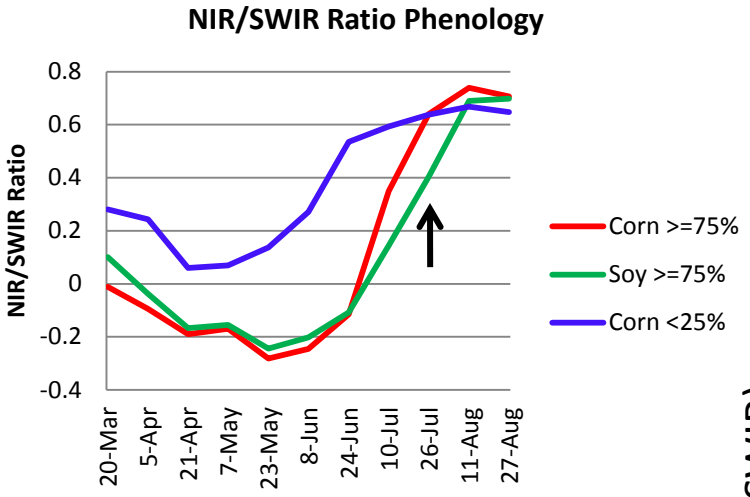
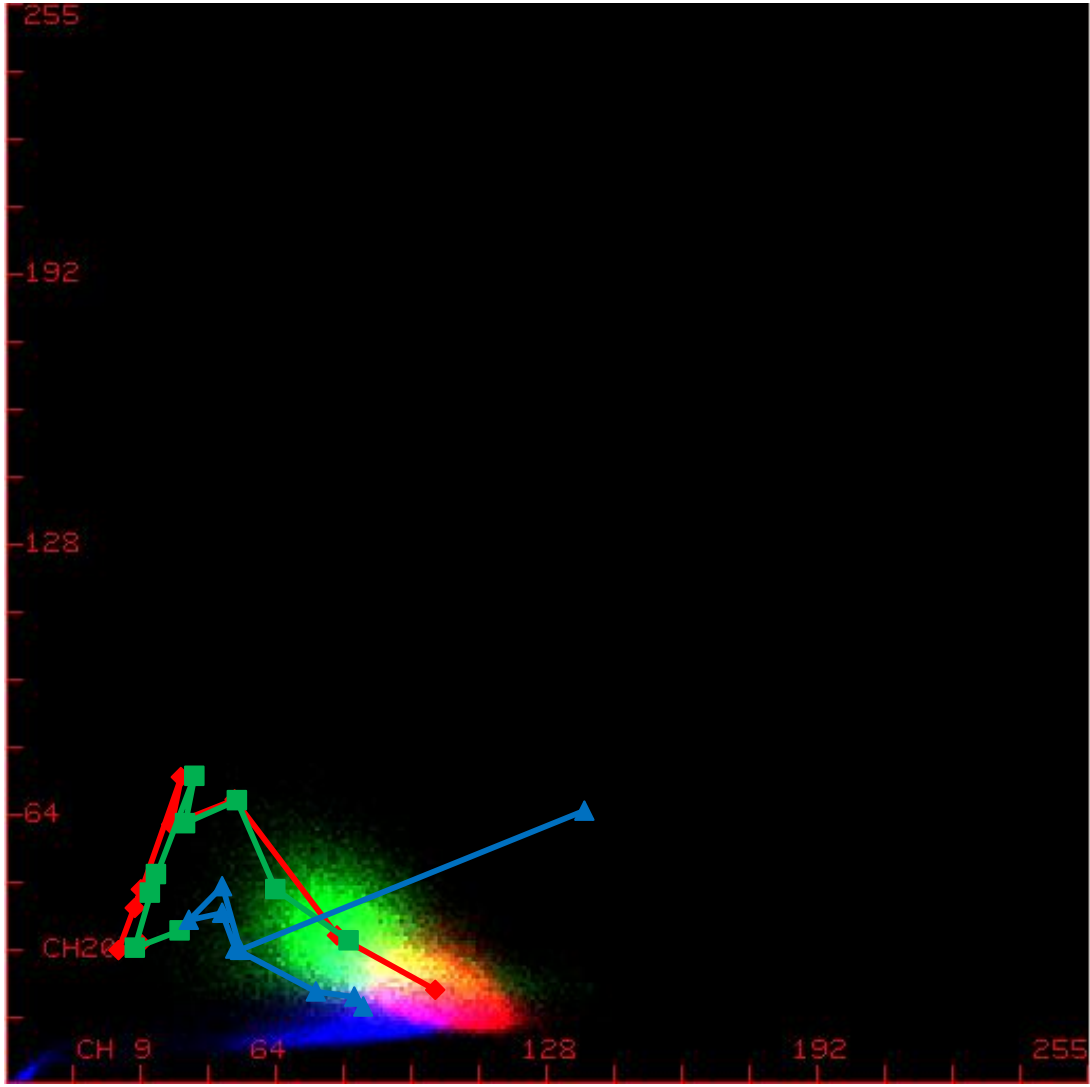
SDSU

Minnesota 2008

July 26





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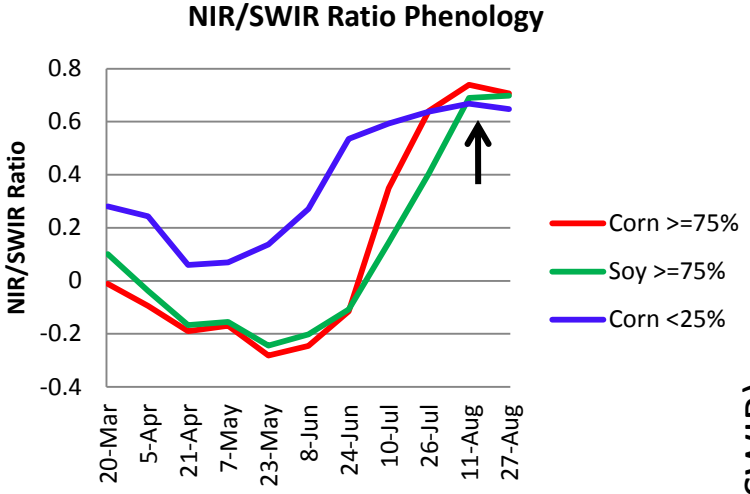
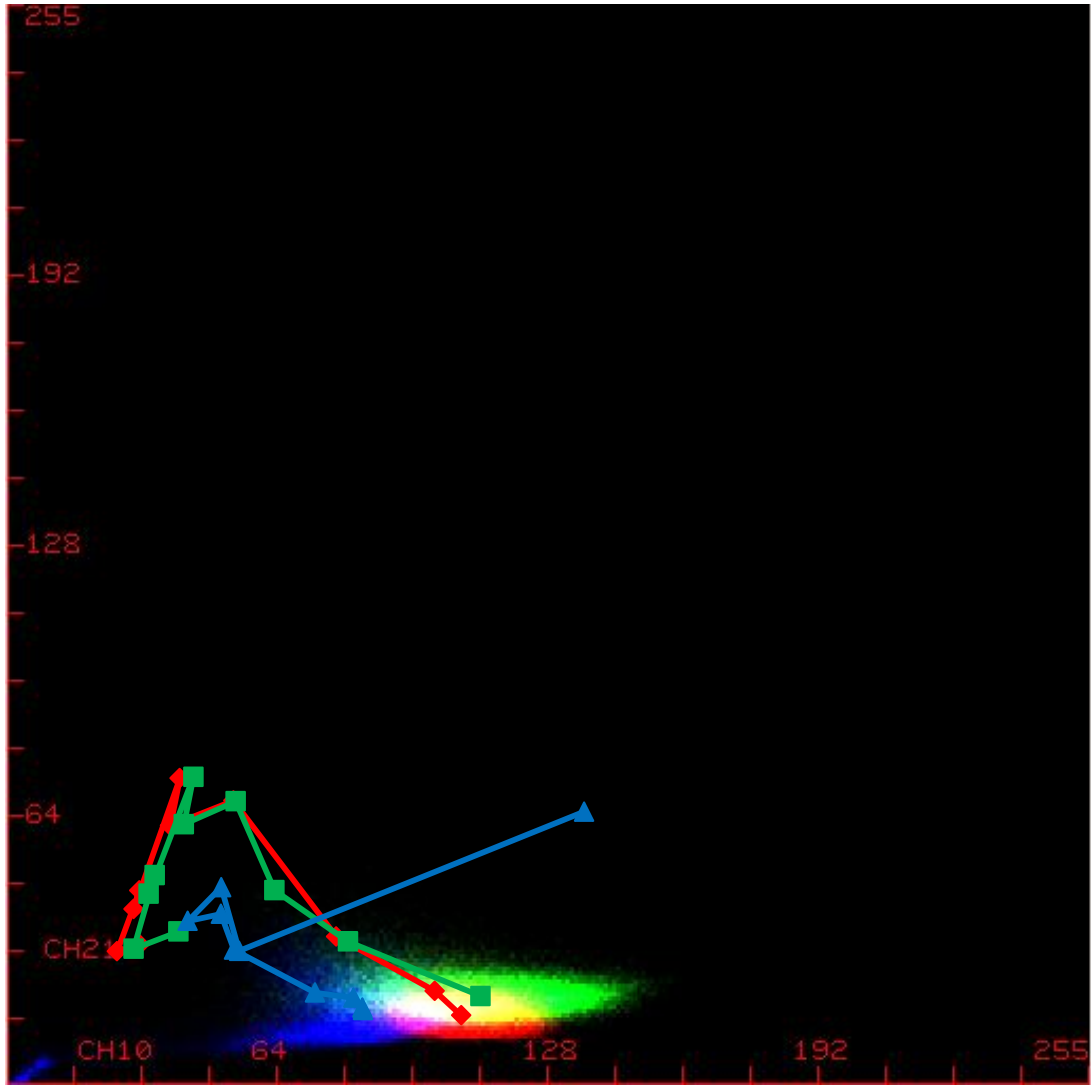
SDSU

Minnesota 2008

August 11





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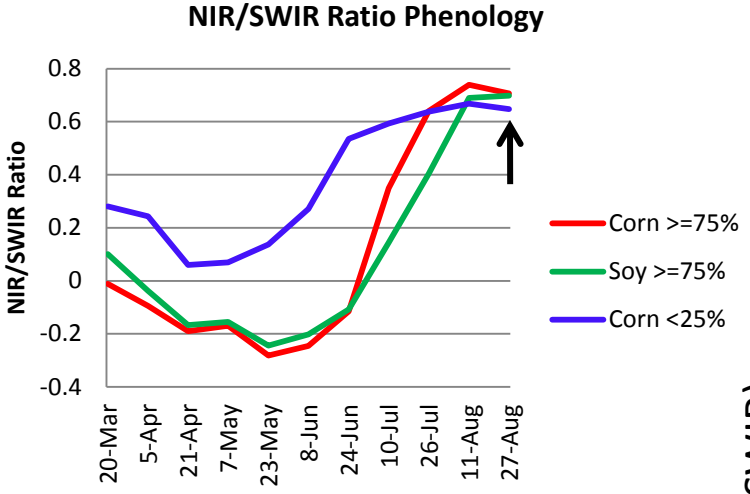
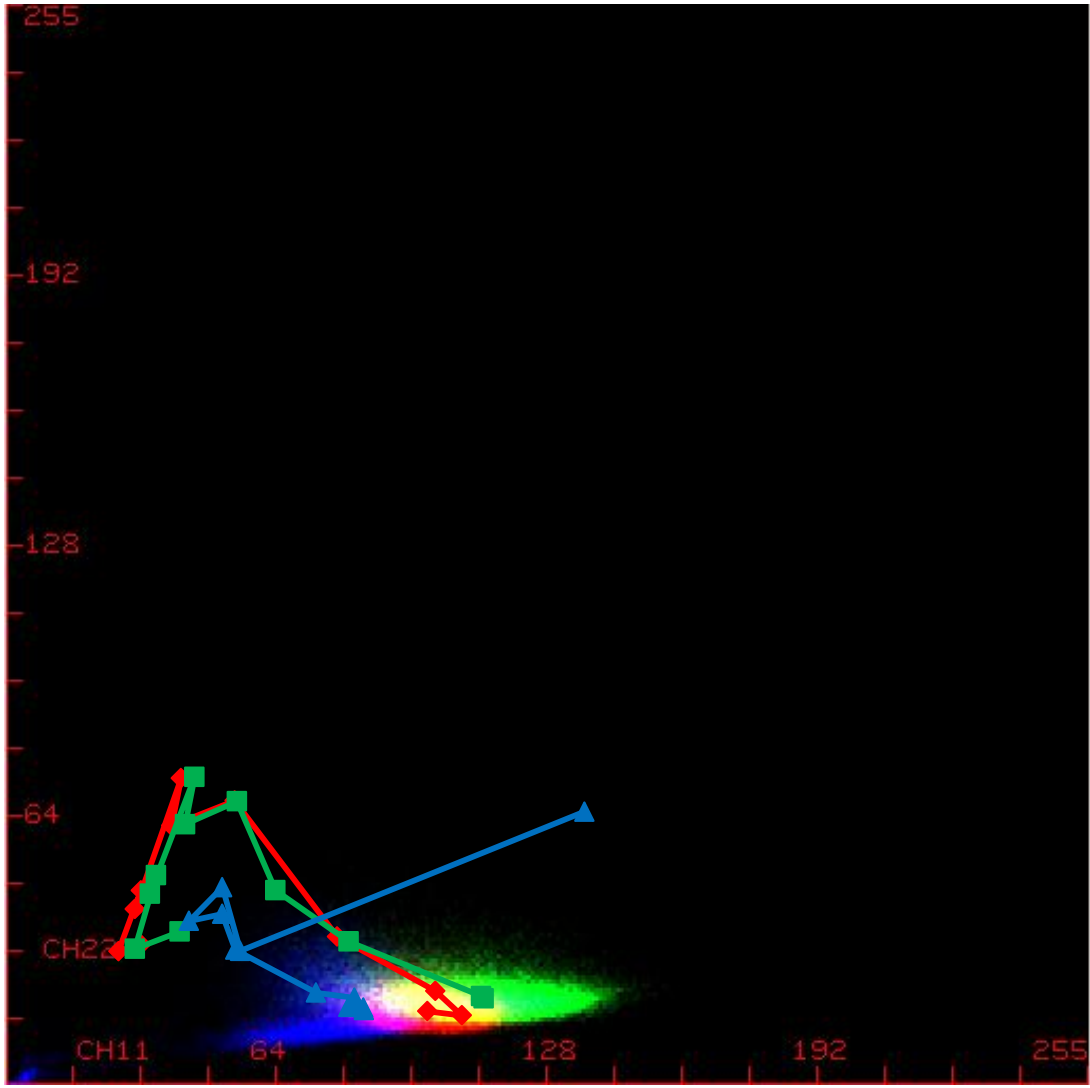
SDSU

Minnesota 2008

August 27





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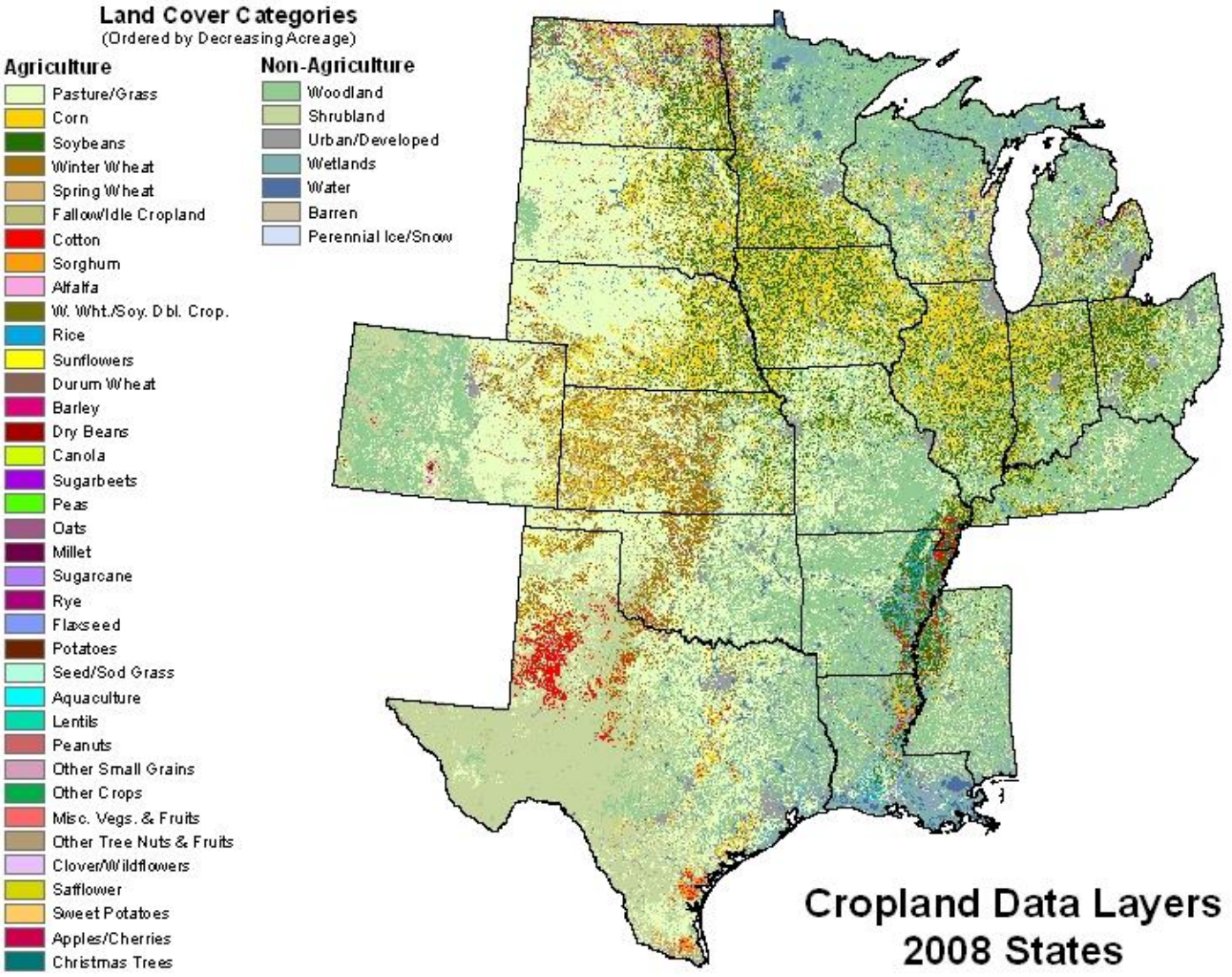
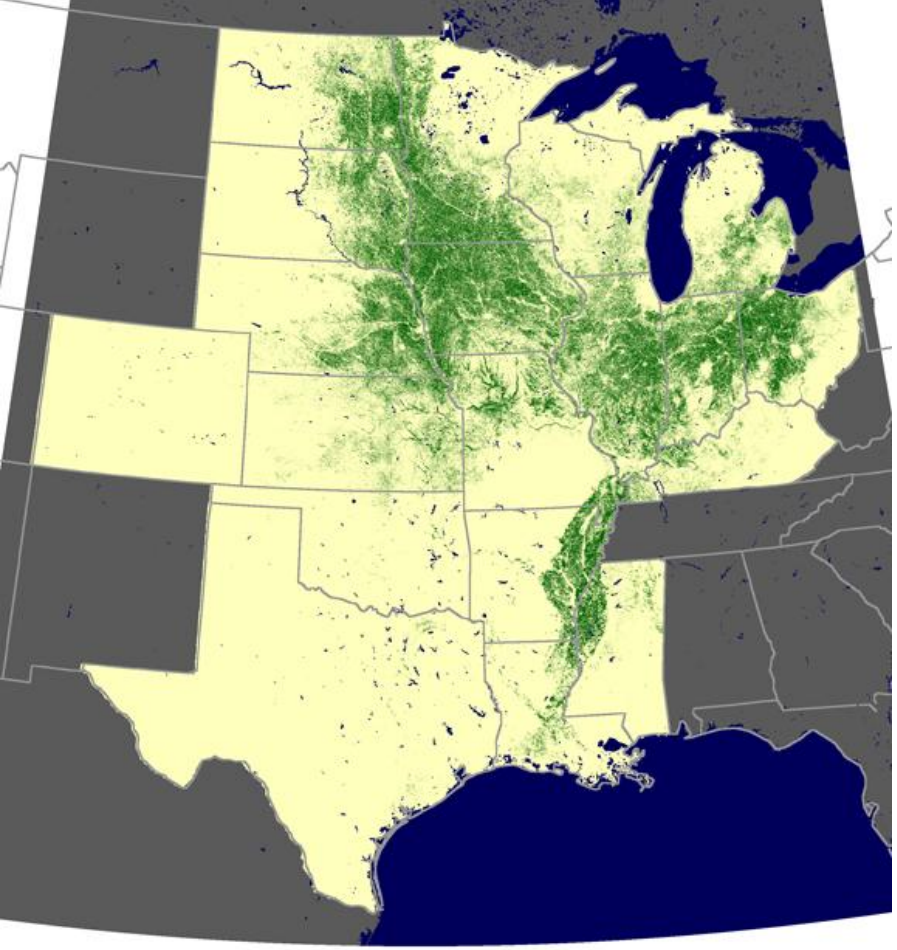
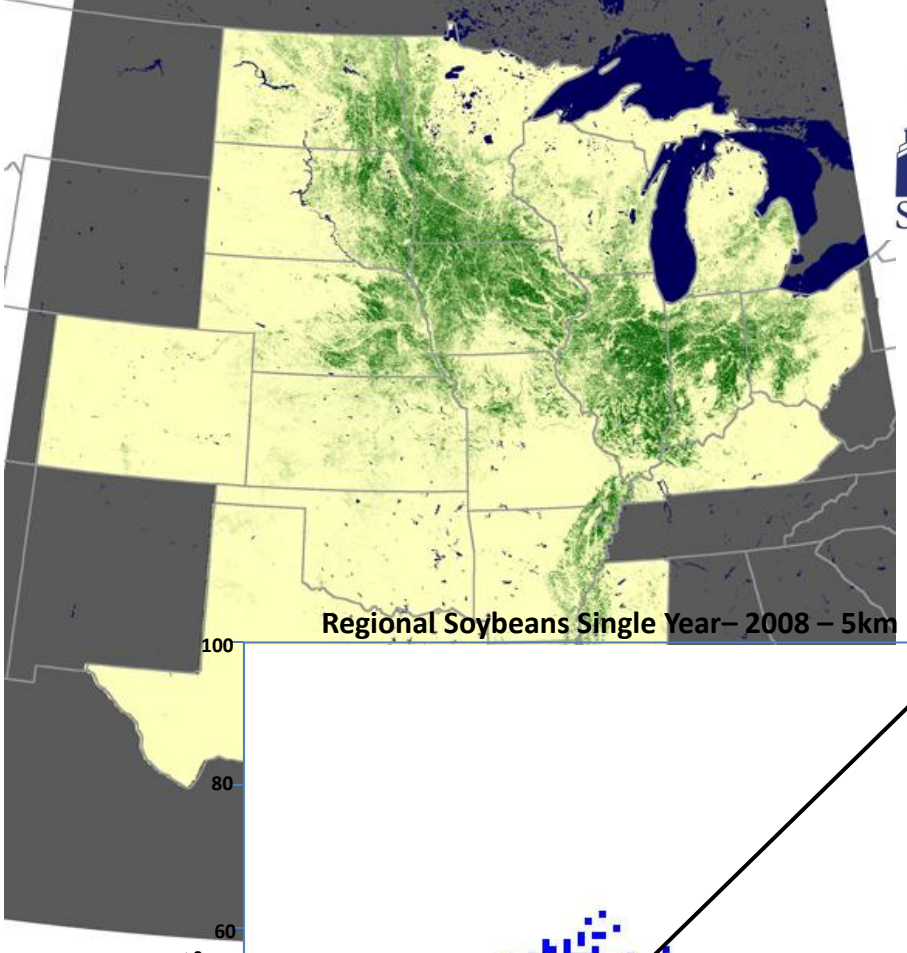
SDSU

NASS Cropland Data Layer

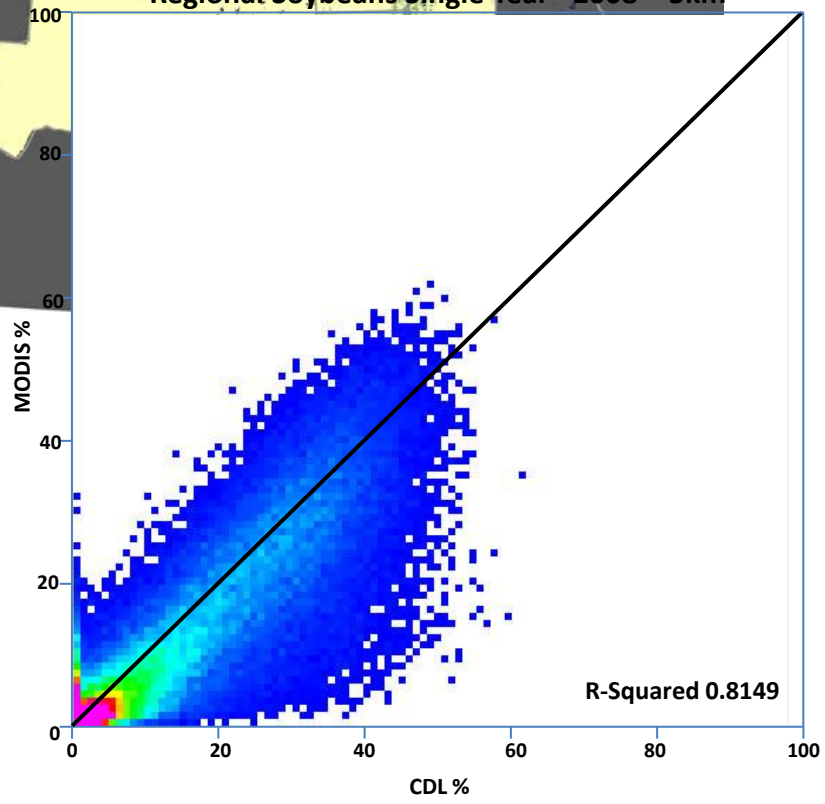




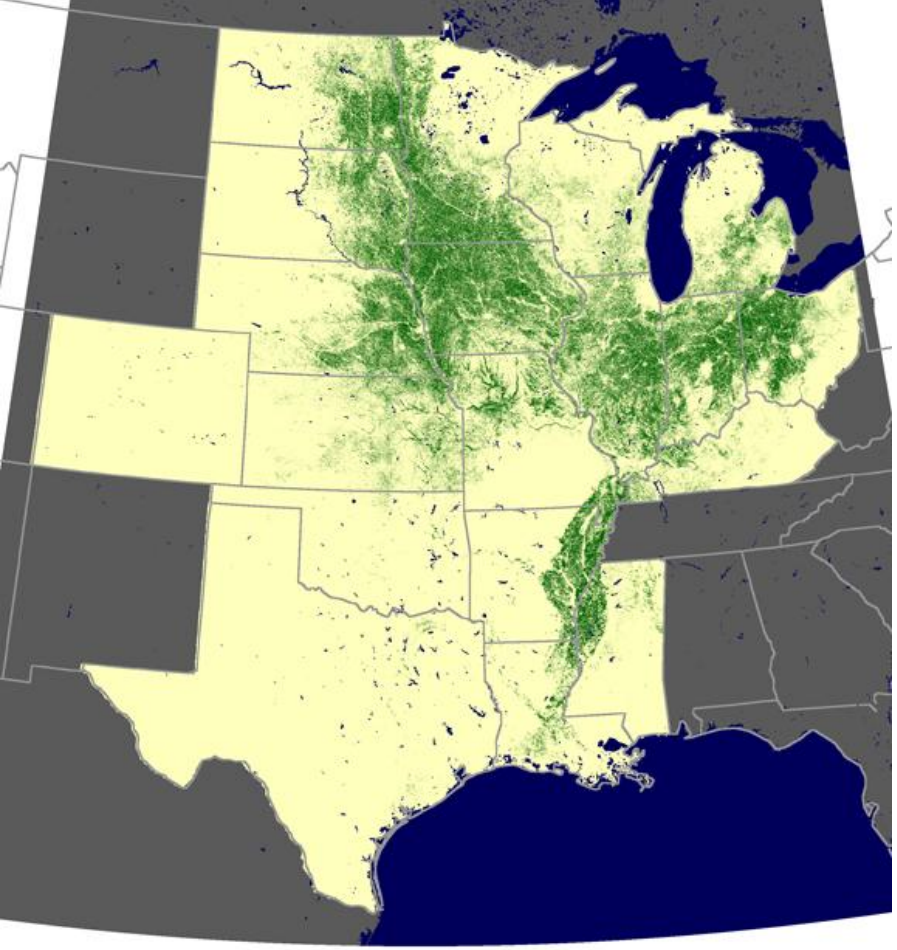
NASS AWiFS CDL 2008 soy



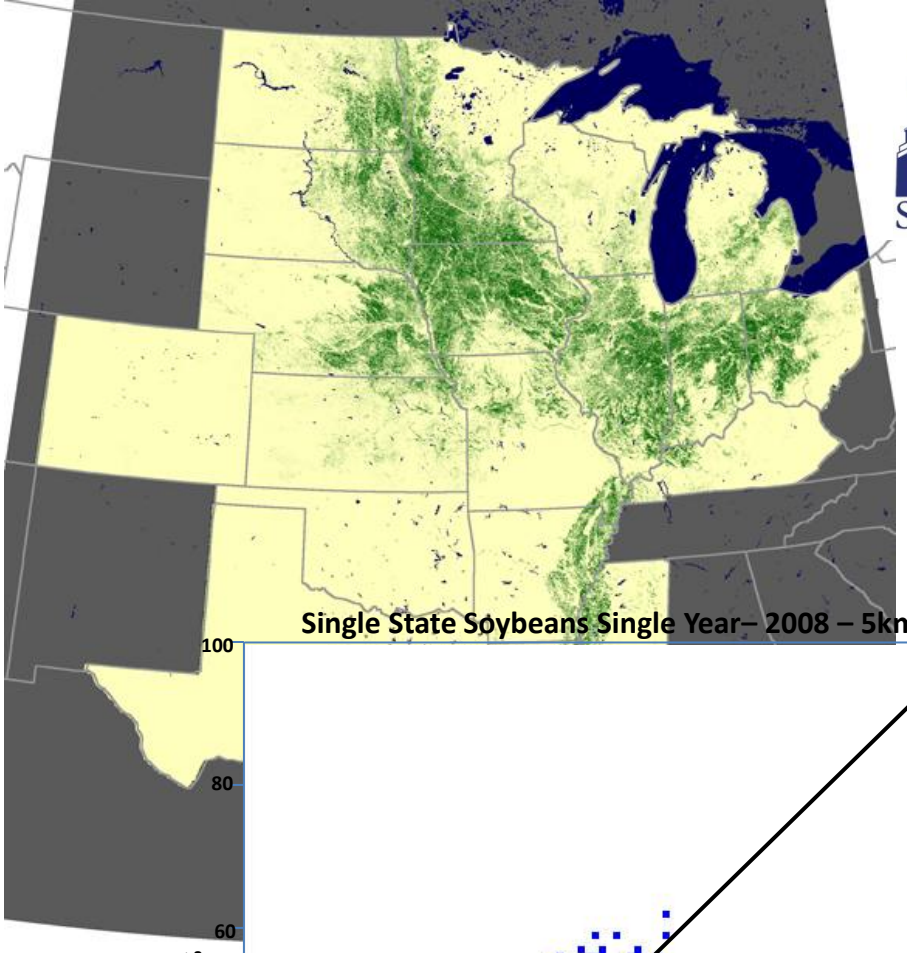
MODIS 2008 soy



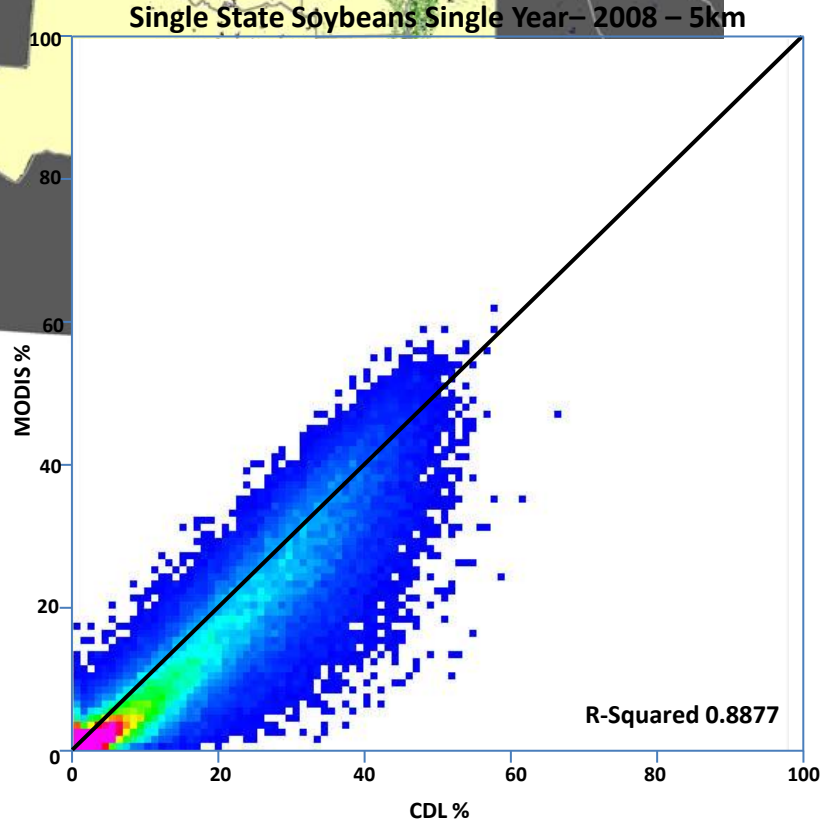
MODIS data for soy indicator mapping – regional model



NASS AWiFS CDL 2008 soy

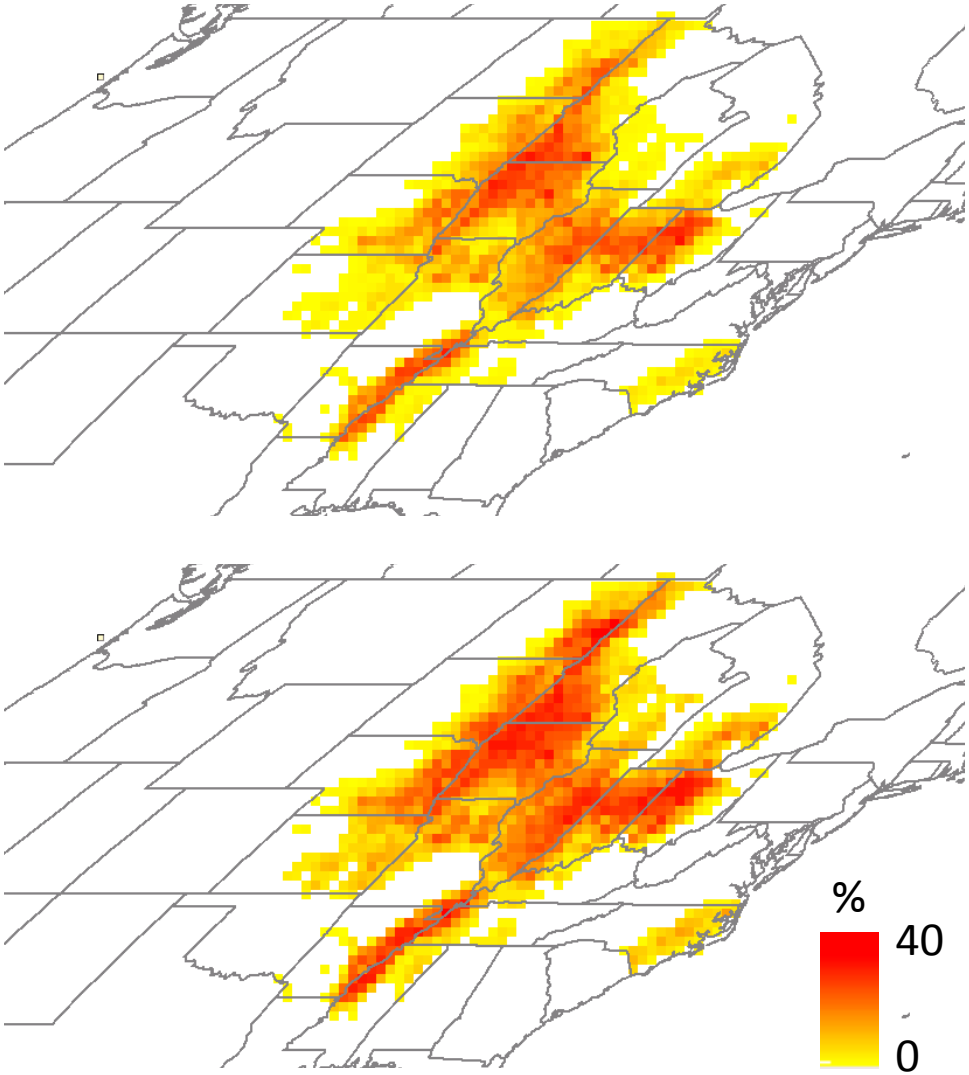


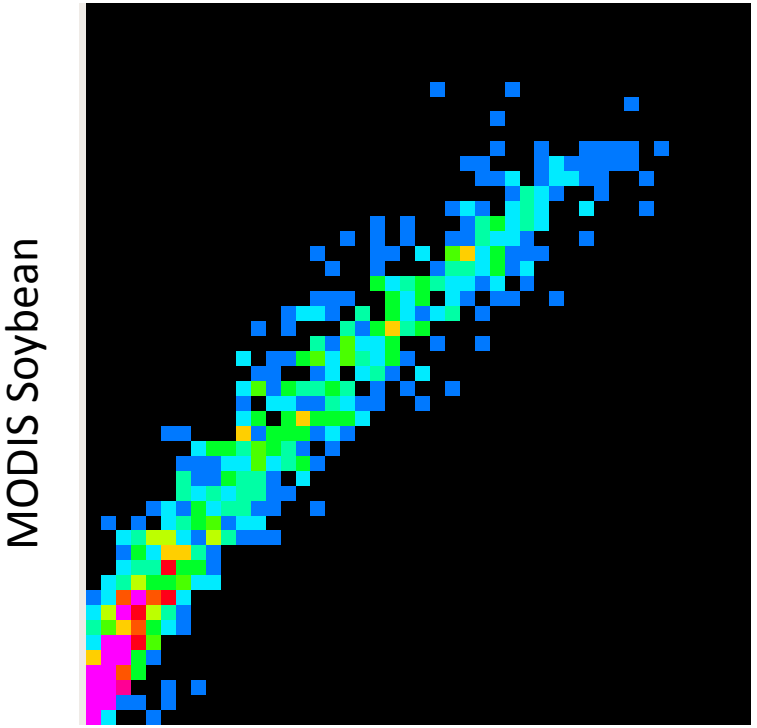
MODIS 2008 soy



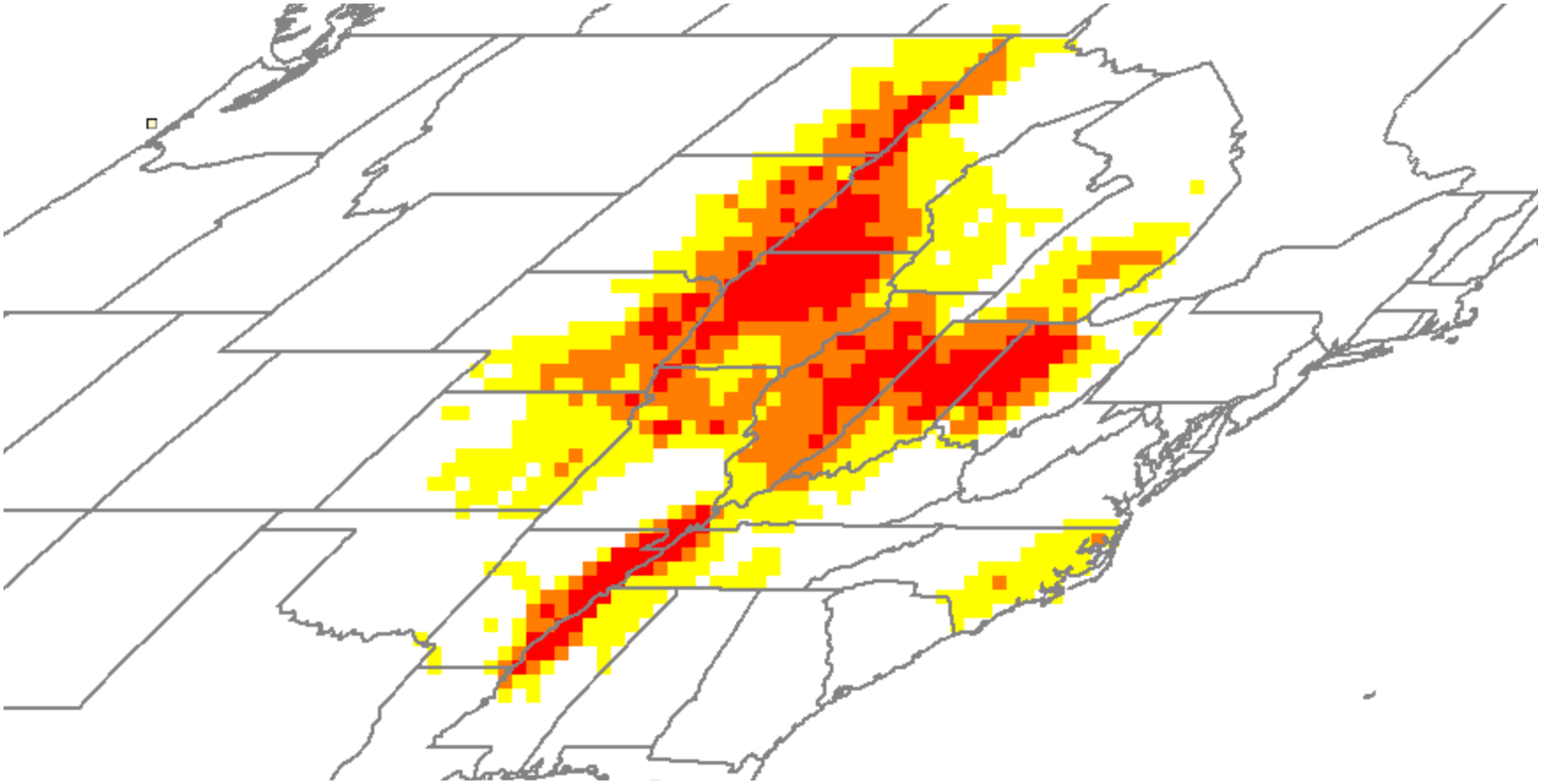
MODIS data for soy indicator mapping – per state model

MODIS versus CDL – average soybean estimated per 40km block, 2007 to 2010



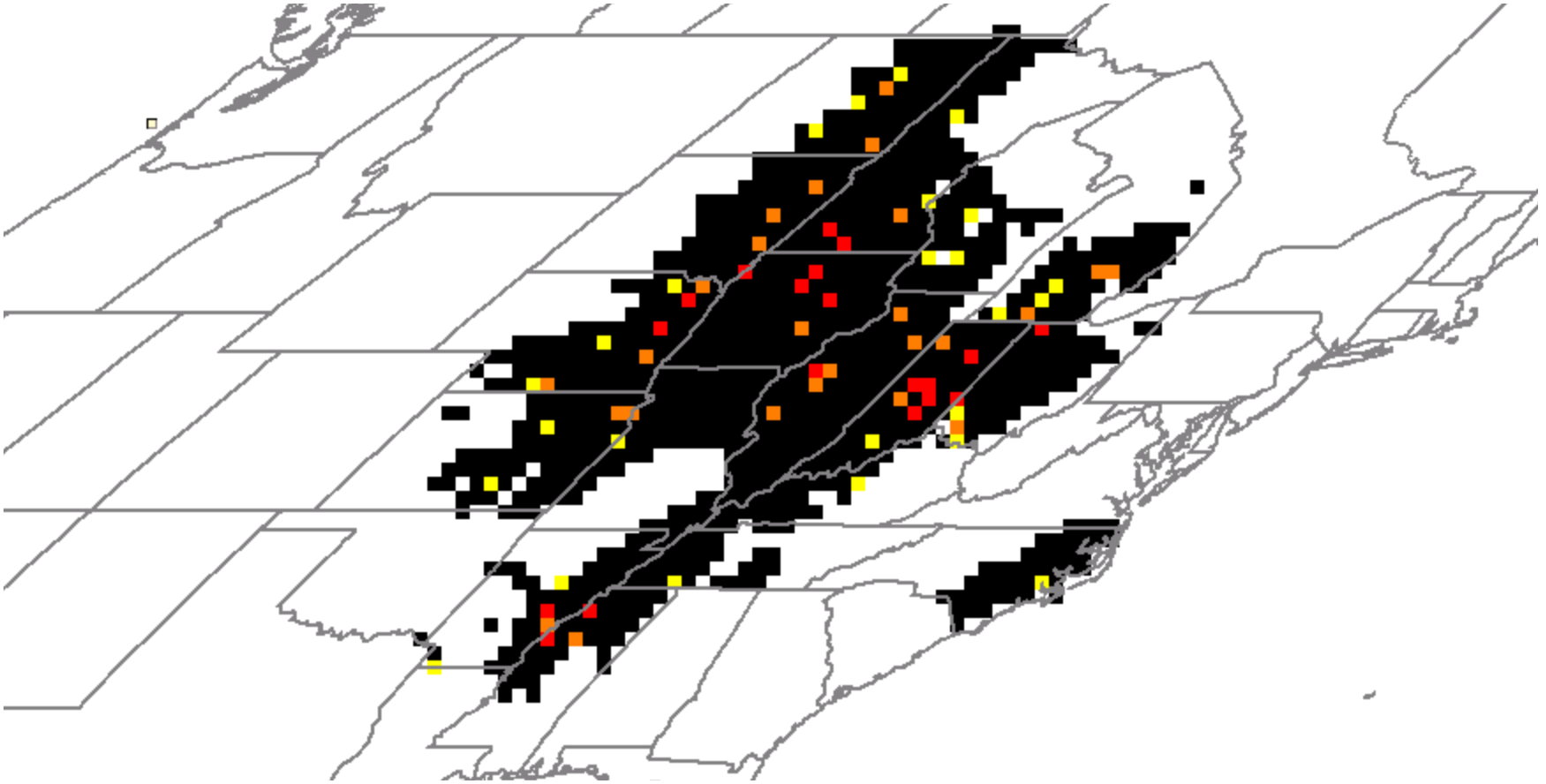


High, medium and low soybean strata



Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

Sample blocks



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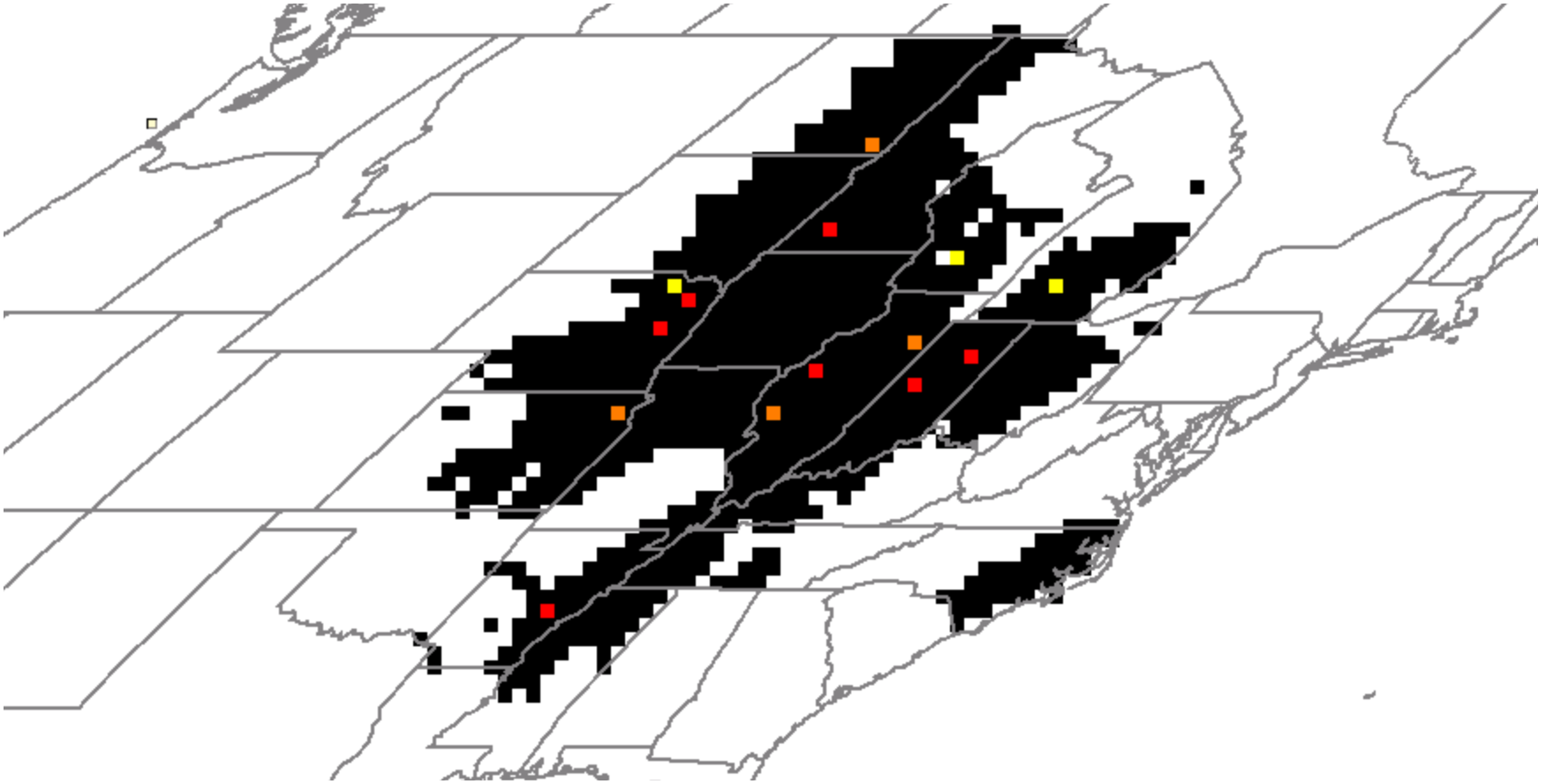
RapidEye locations



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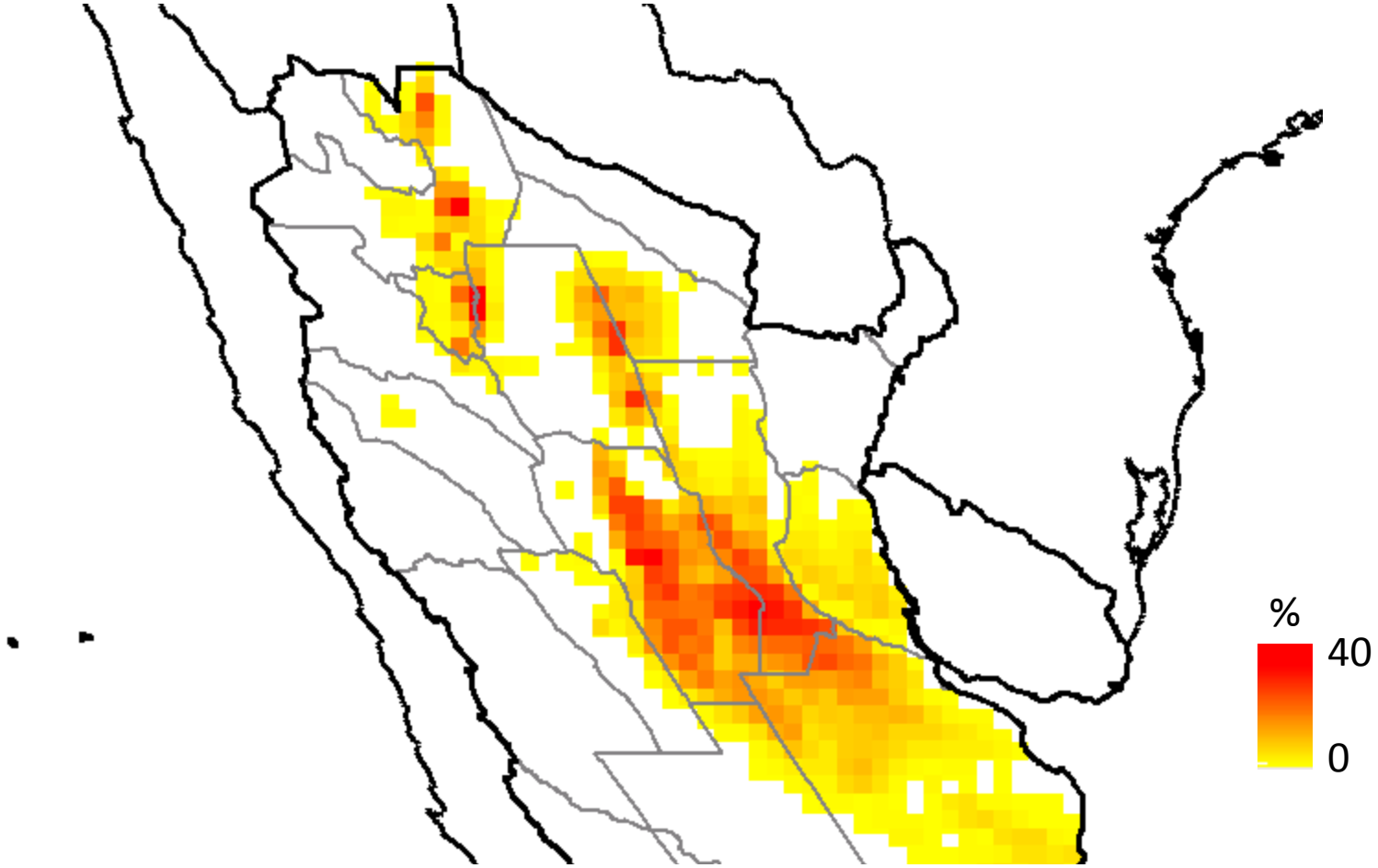
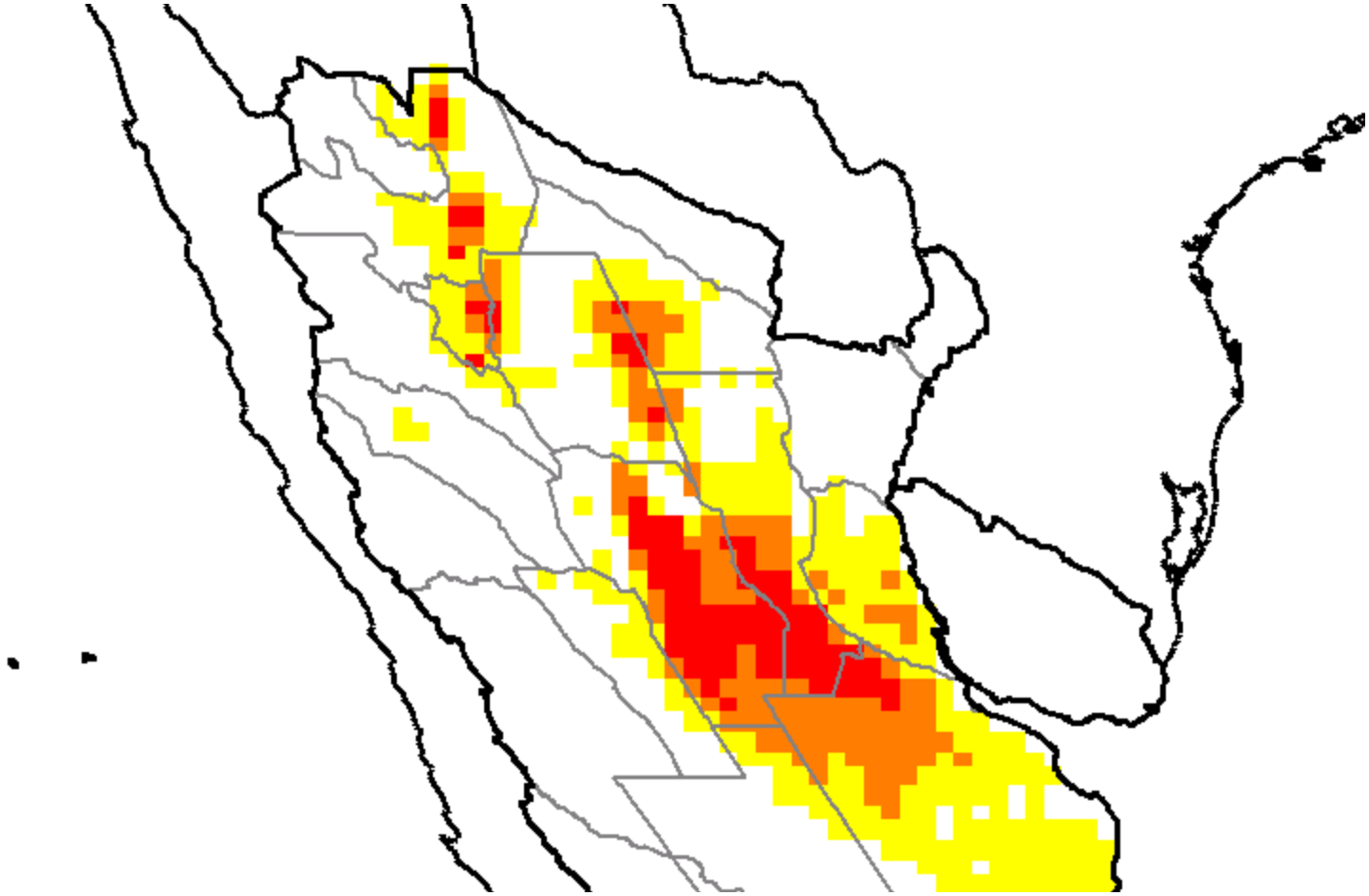
Argentina soybean indicator

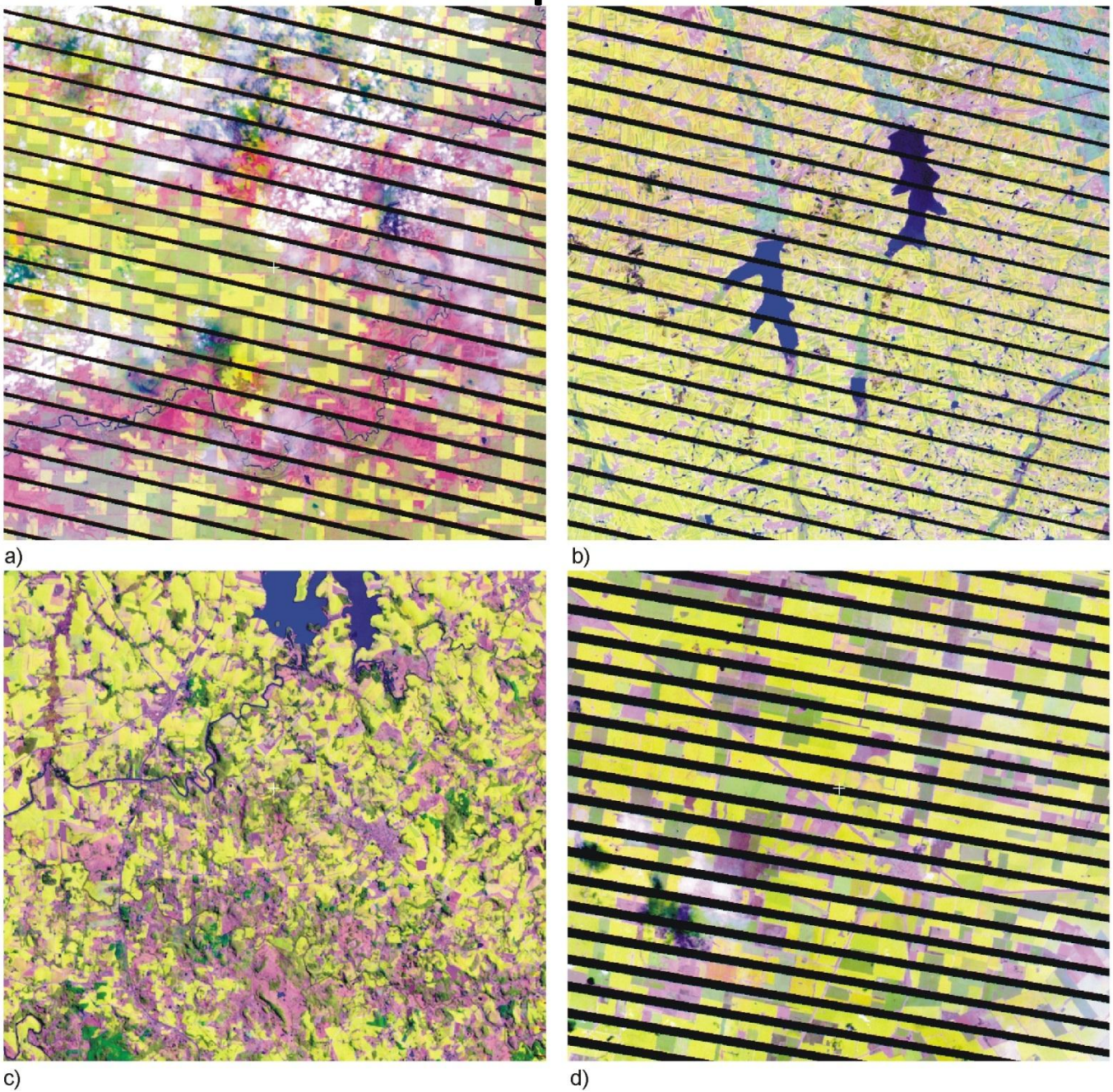


Argentina strata



Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

Landsat sample block data



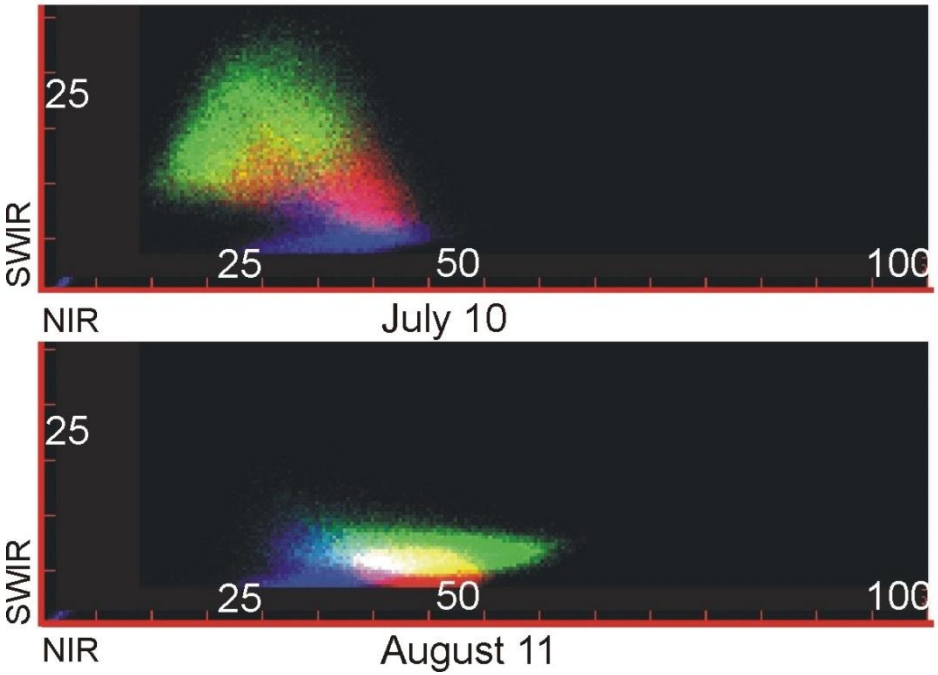
USA

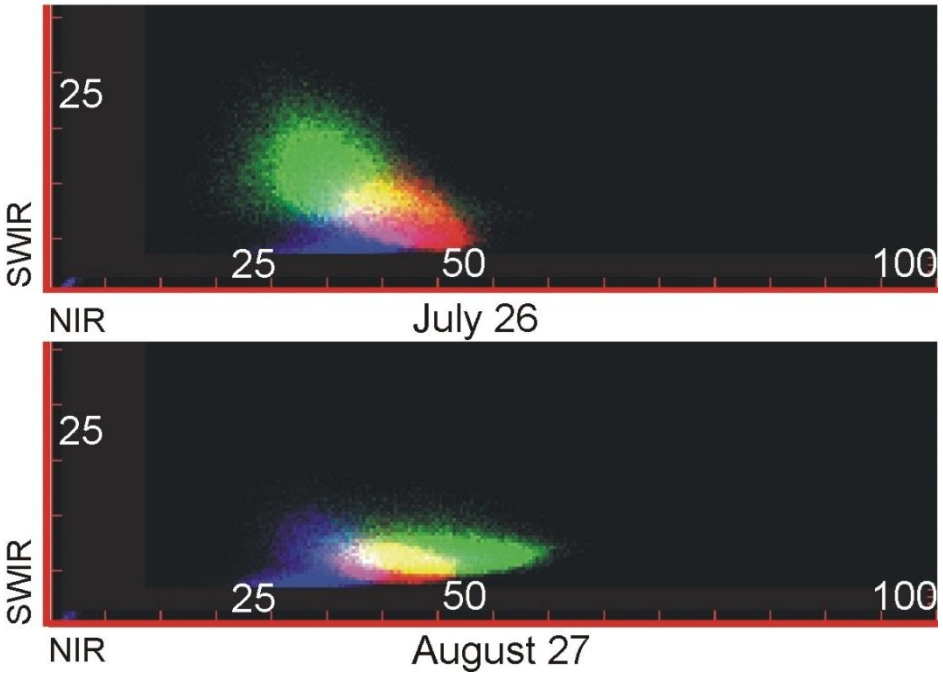
China

Brazil

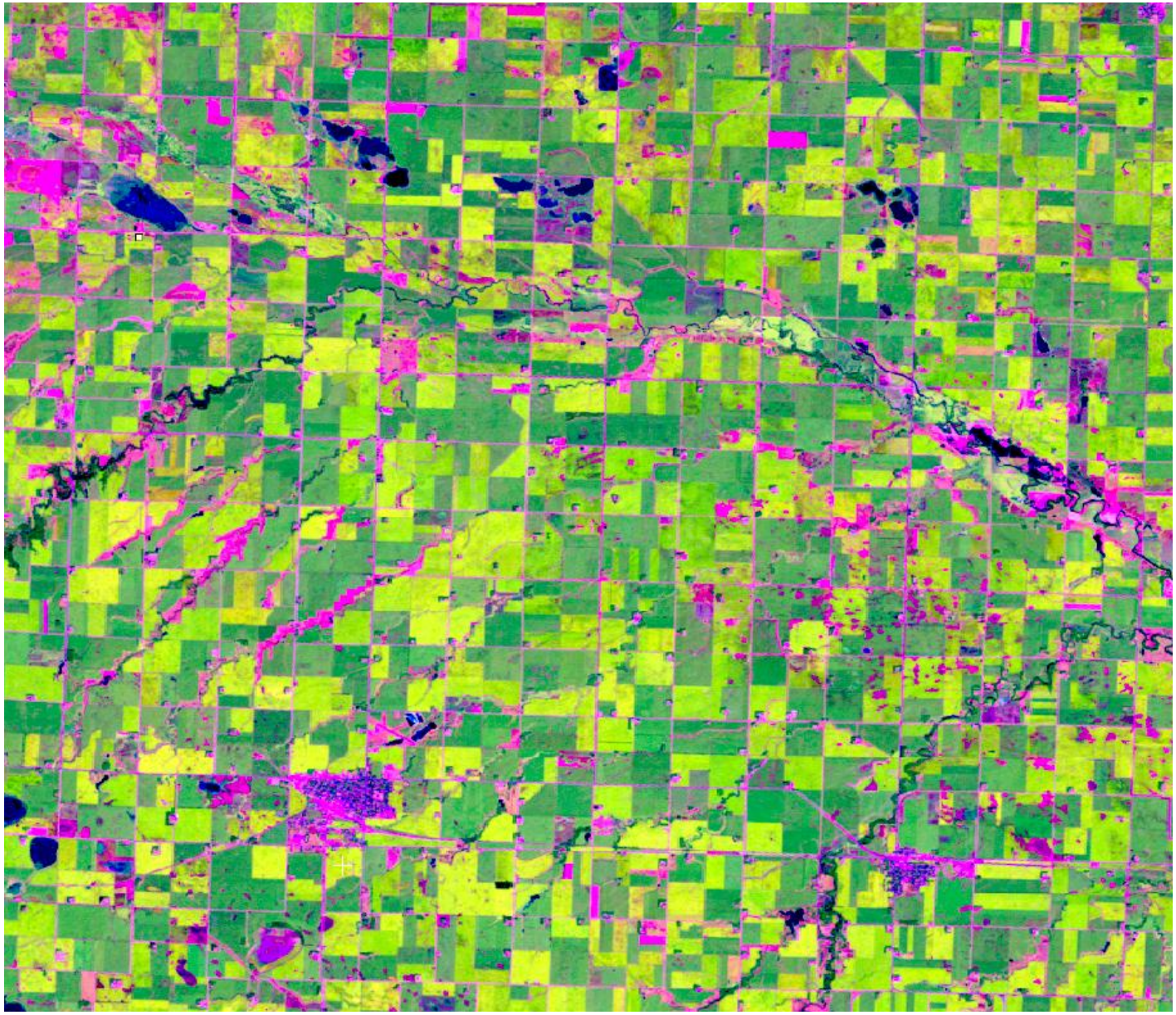
Argentina

Multi-temporal Landsat to assure correct characterization



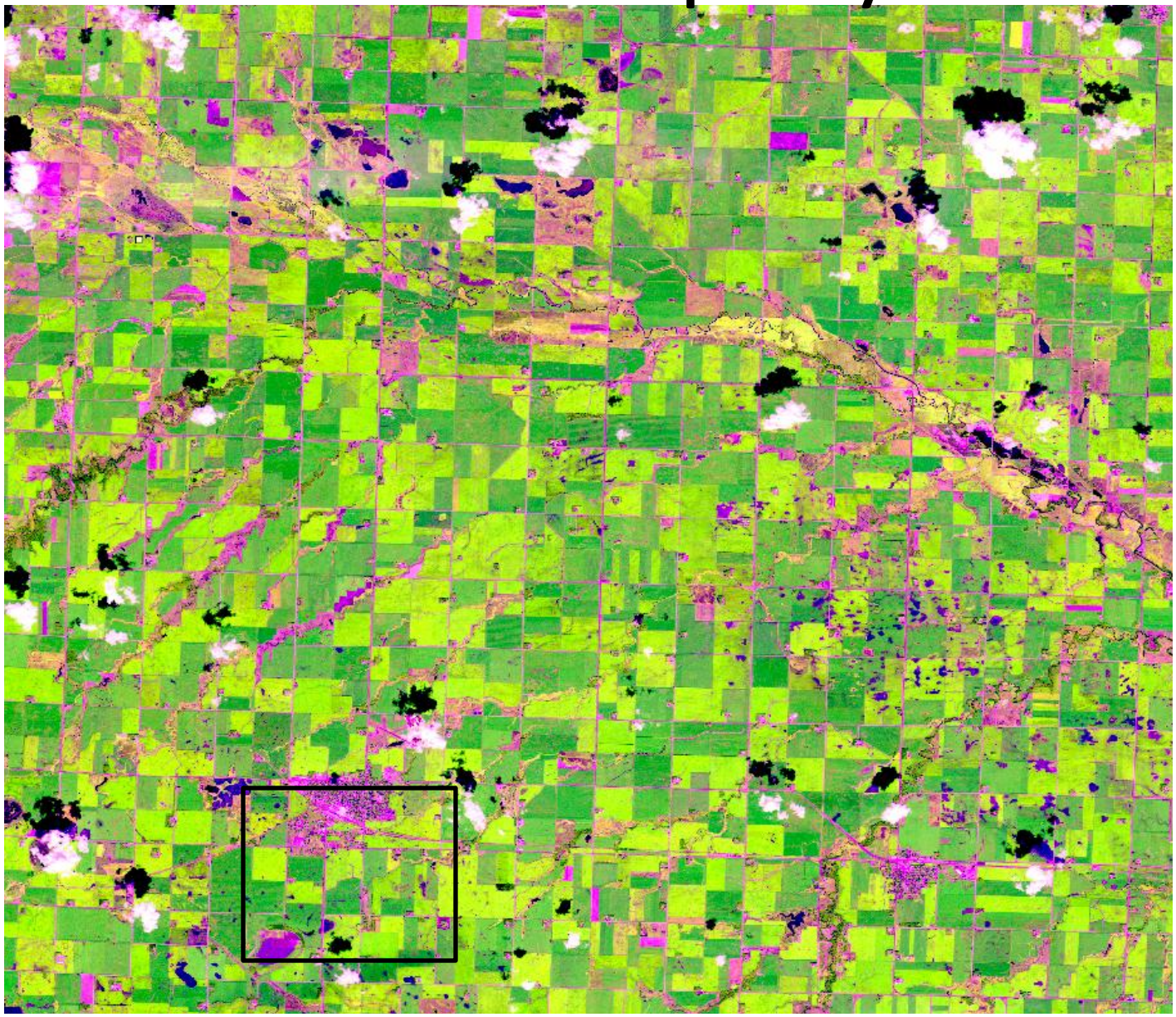


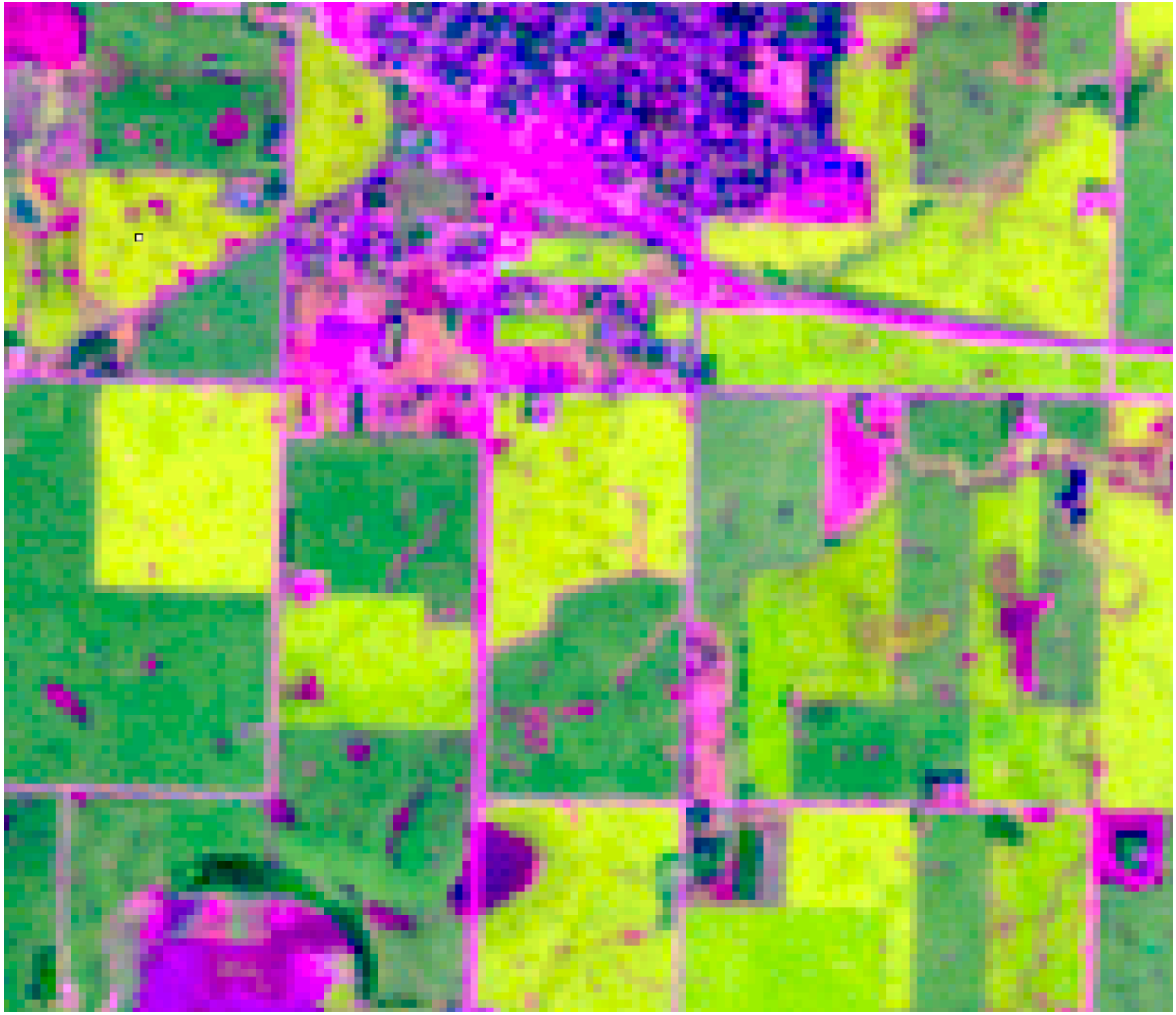
SW Minnesota Landsat 5-4-3

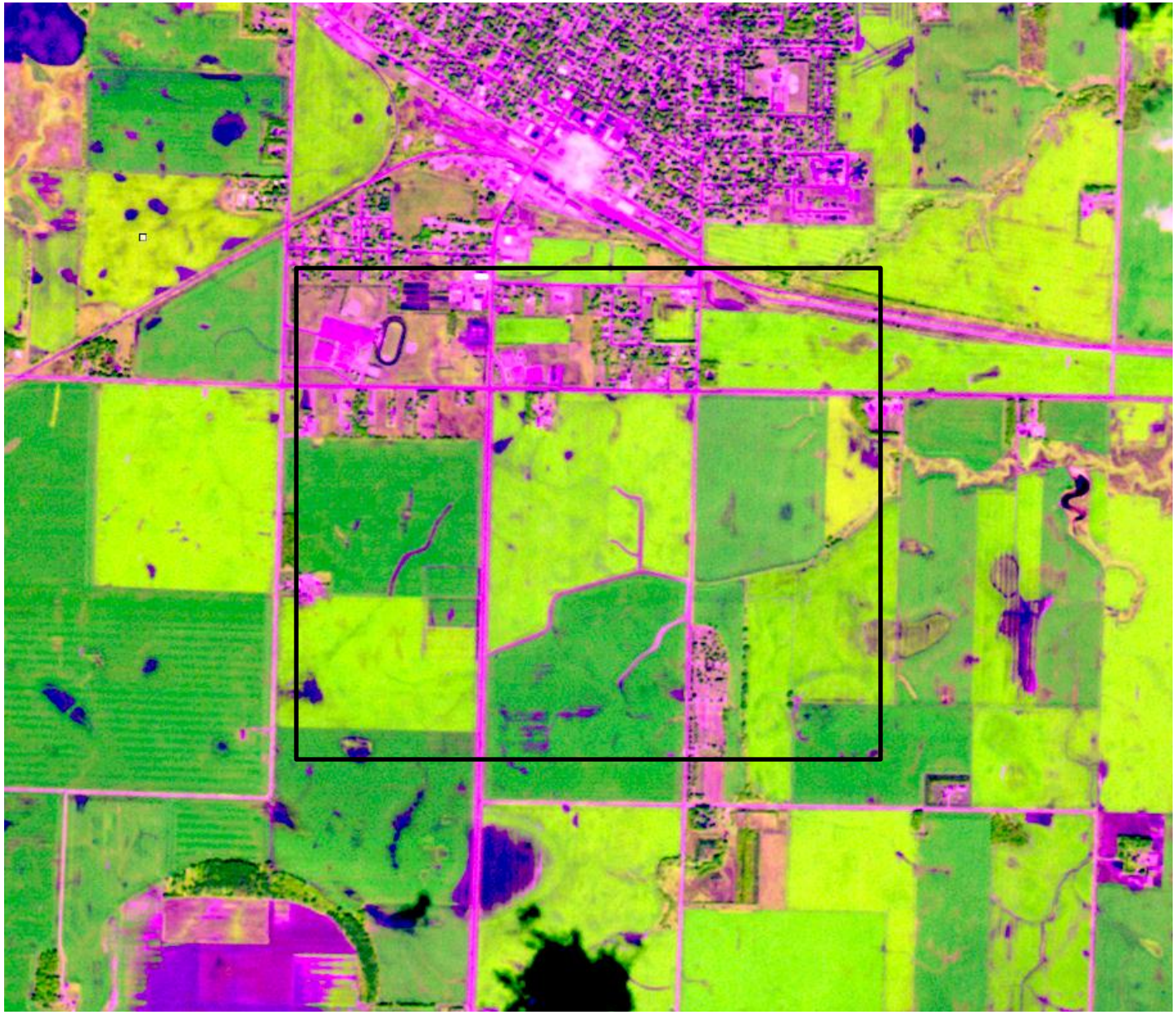


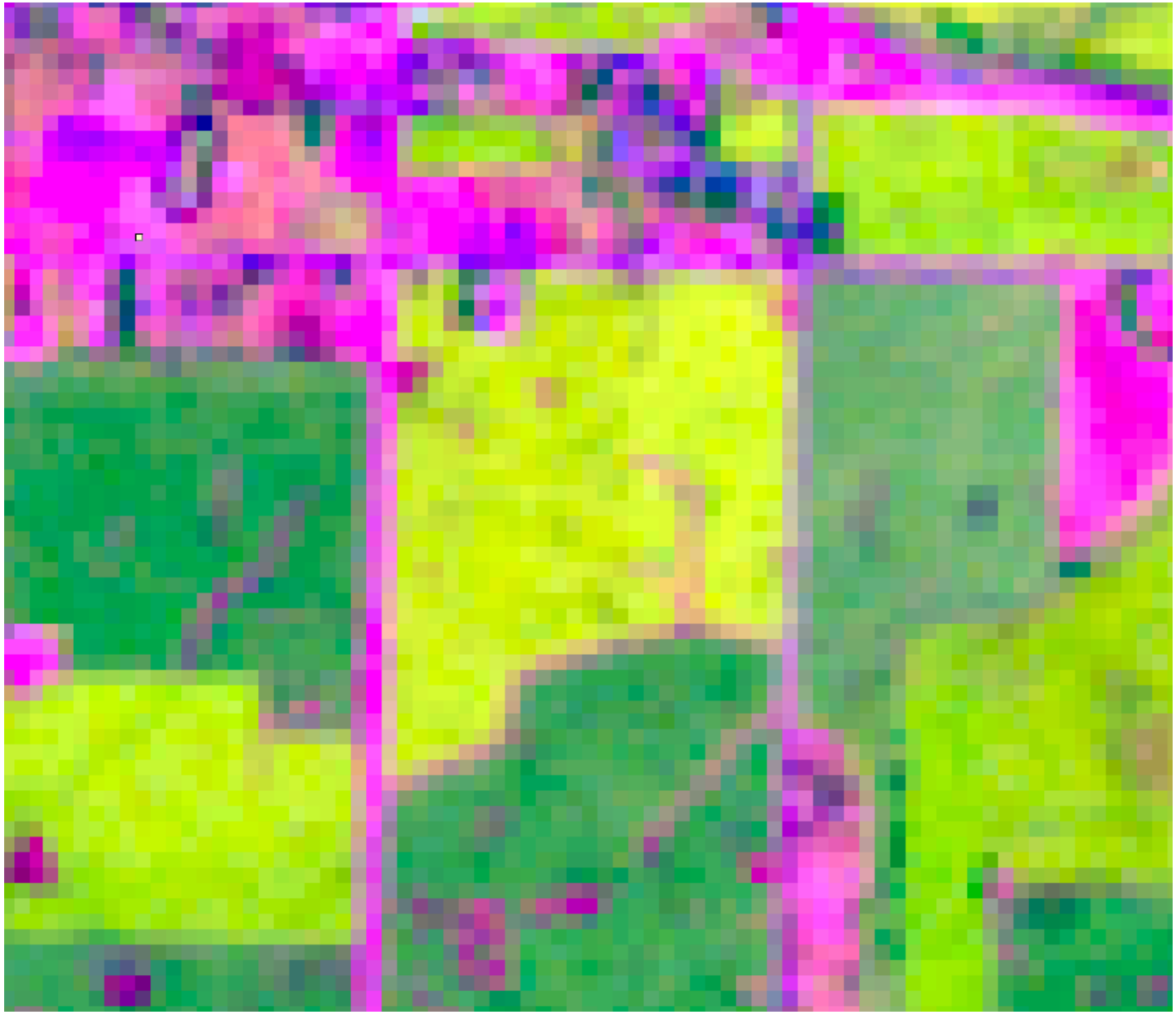
24km x 20km, centered on 95 35 24W, 44 19 38N

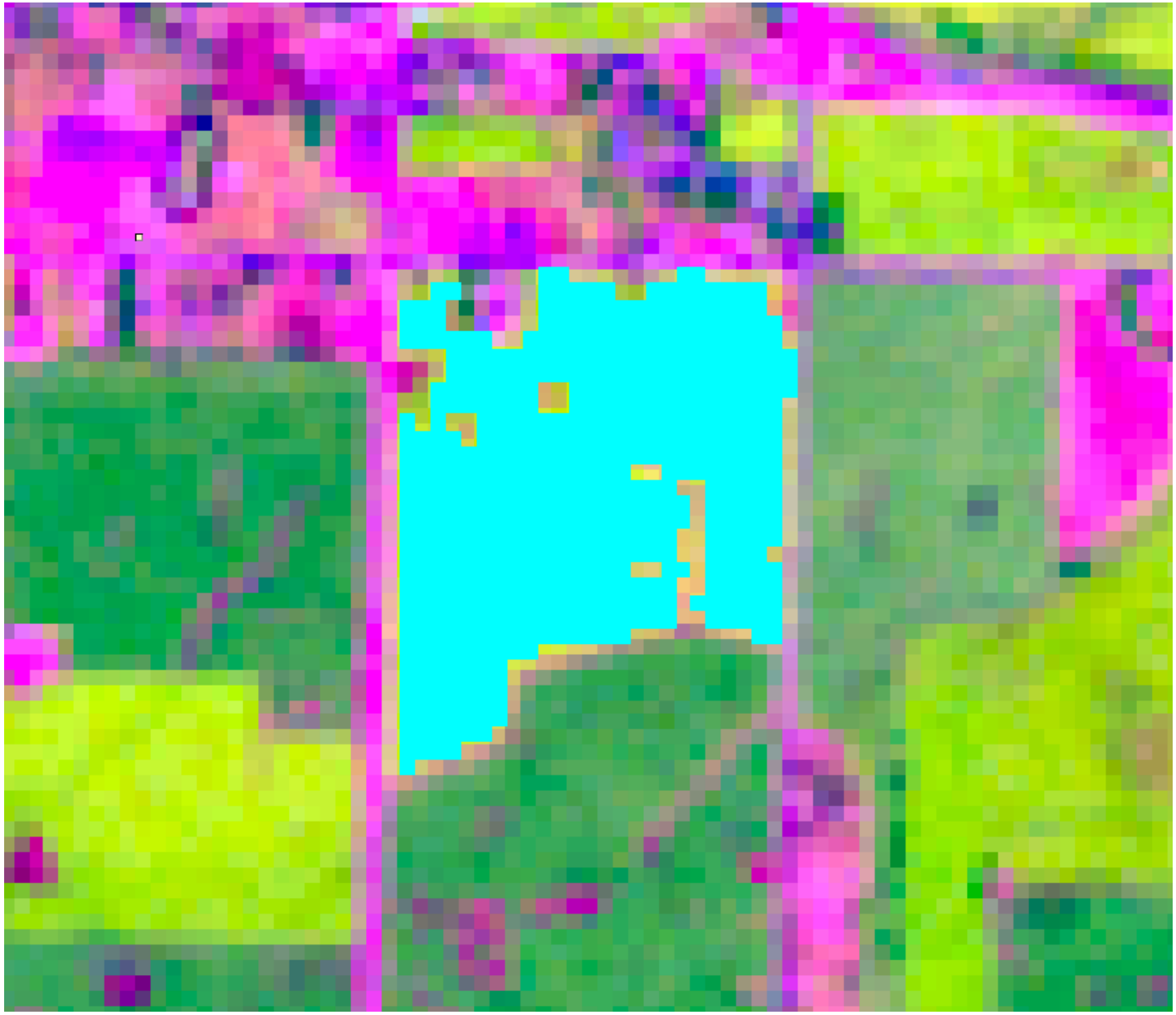
SW Minnesota RapidEye 4-5-3

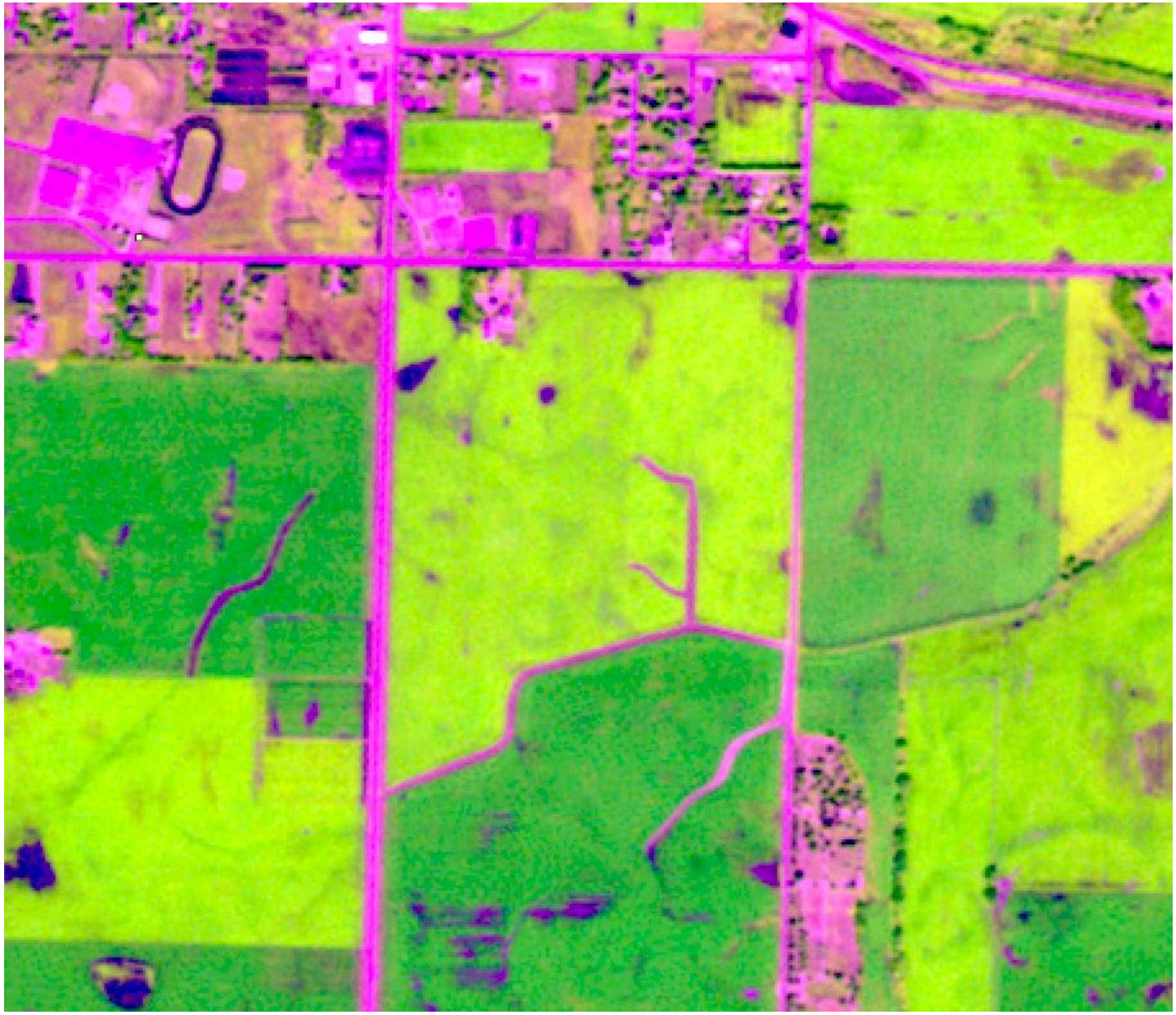


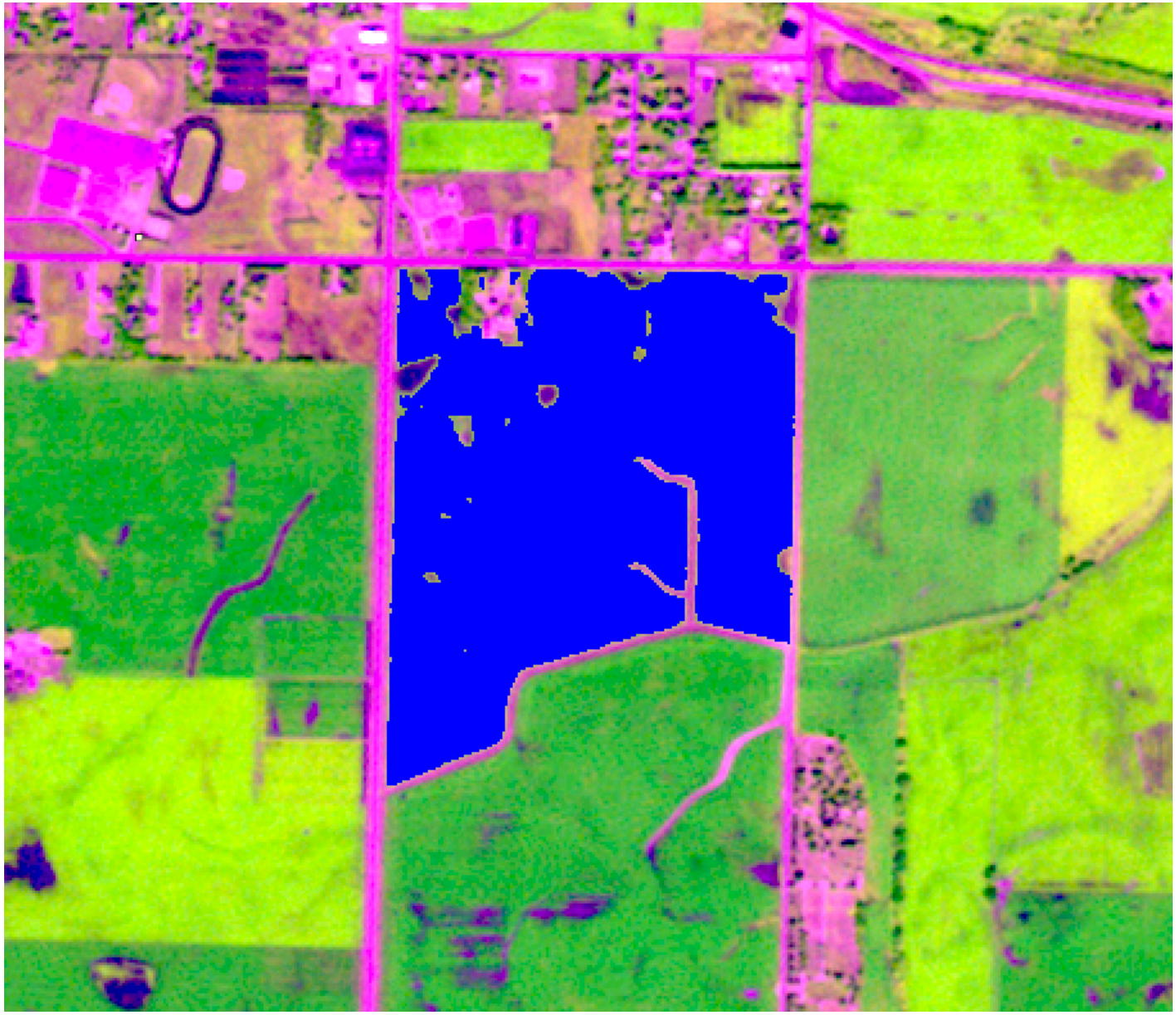






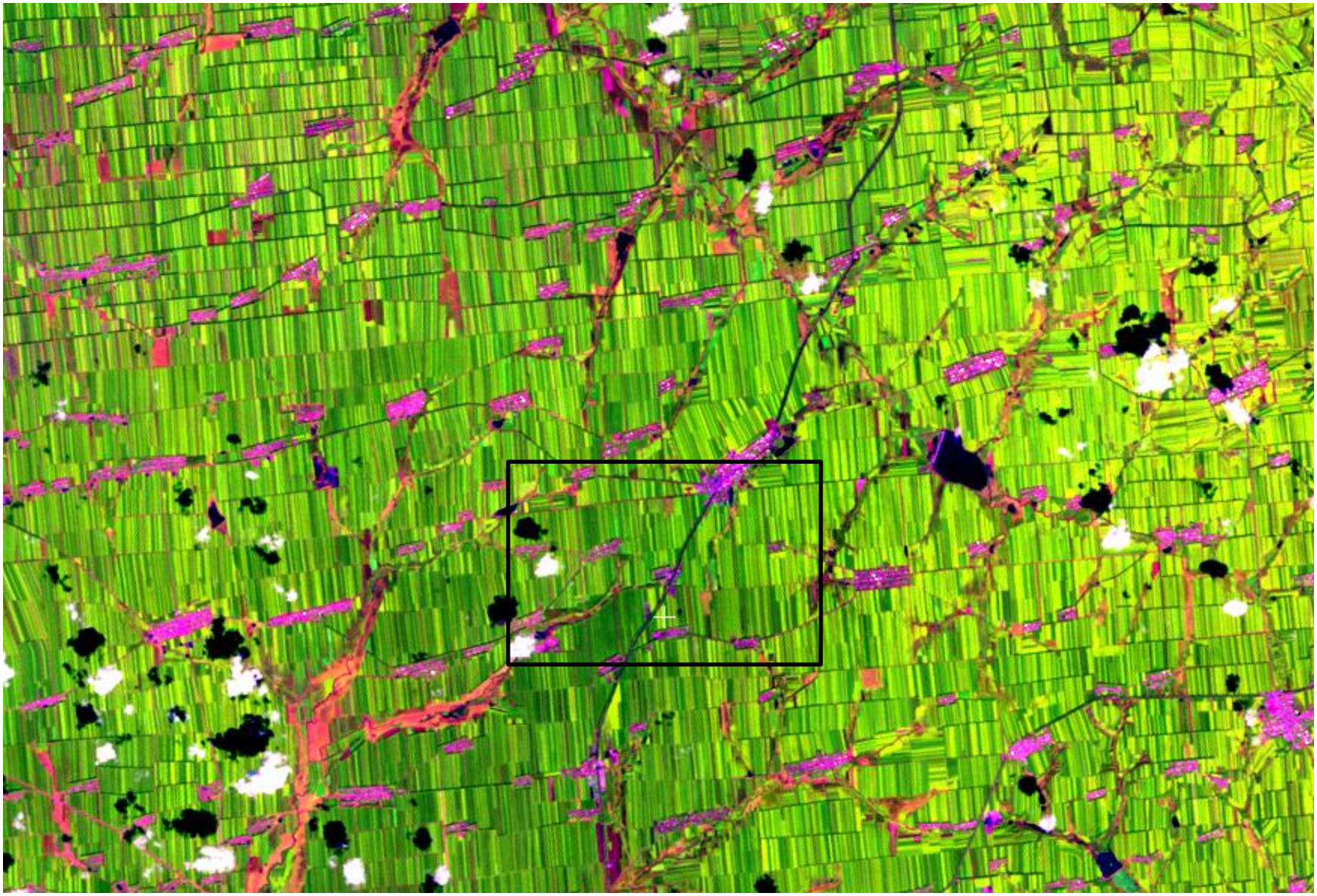


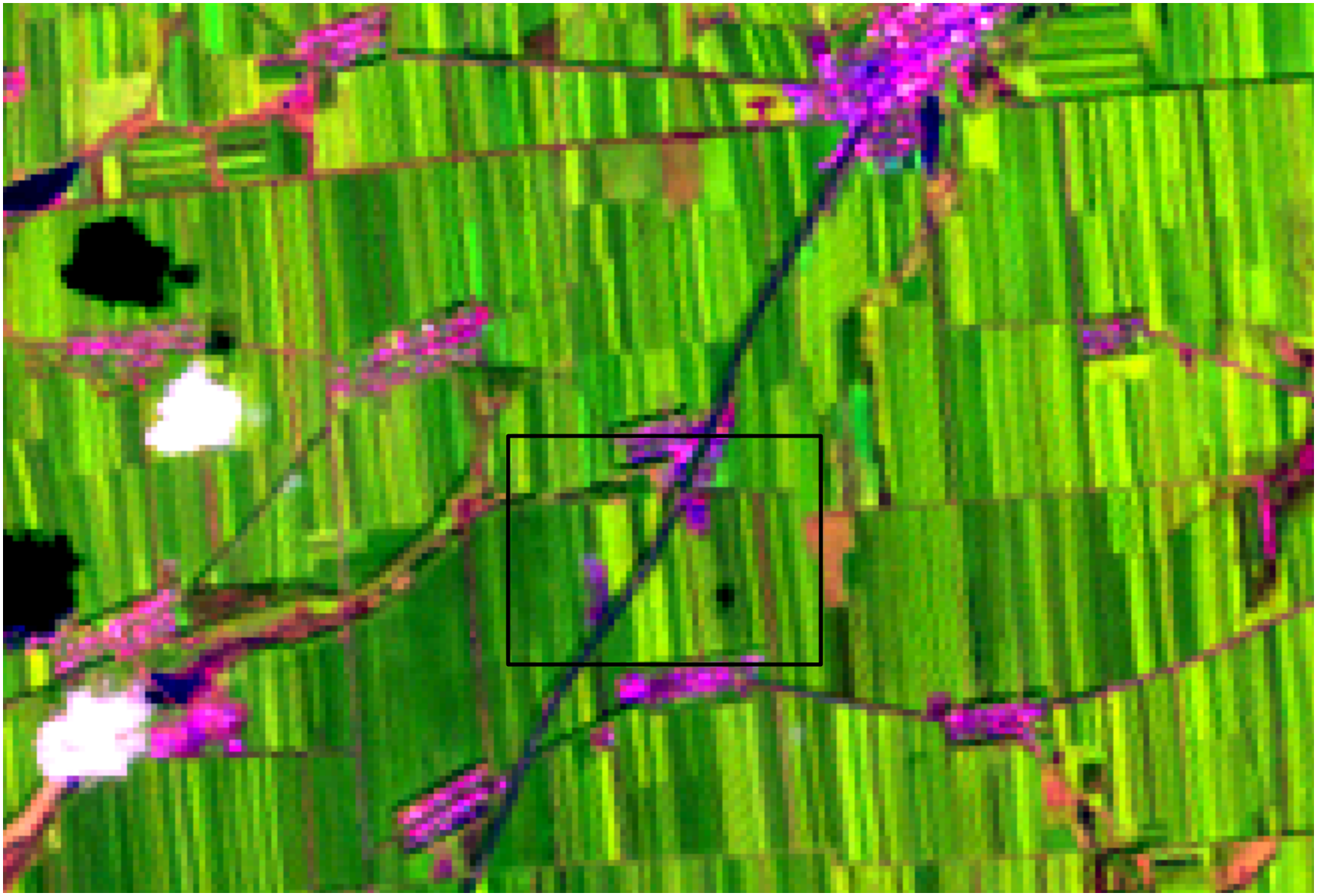


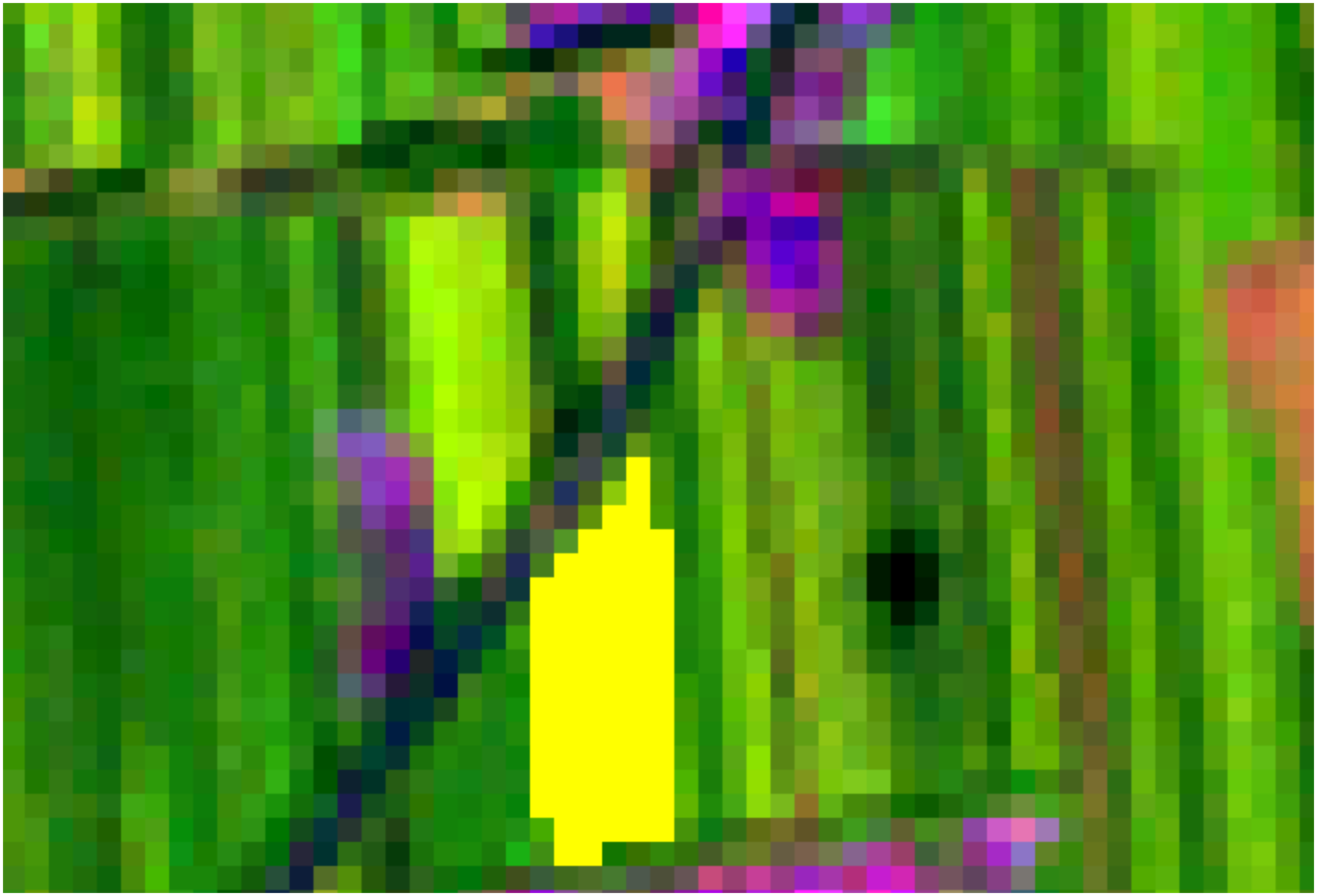


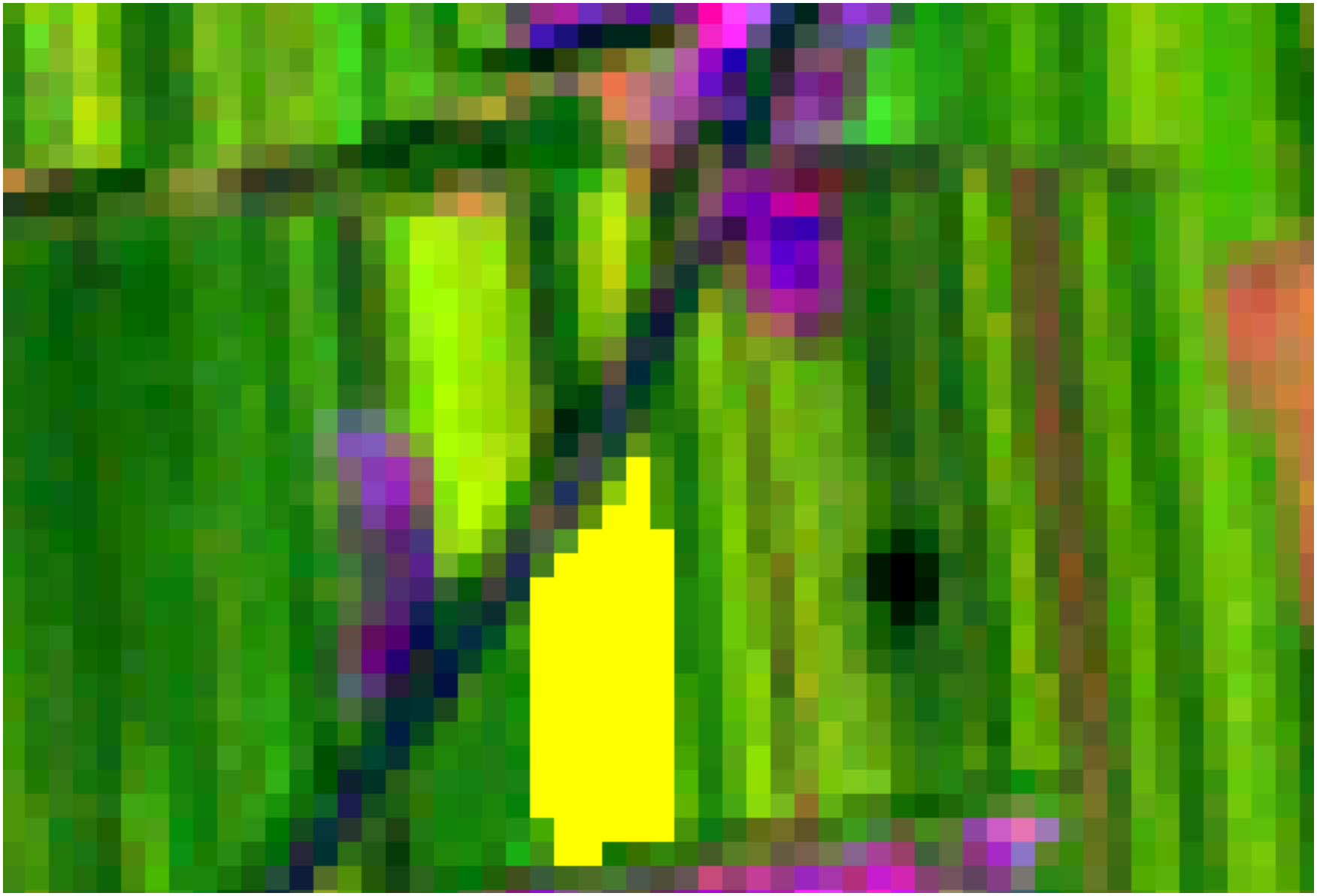
RapidEye – 140 acres, Landsat 126 acres

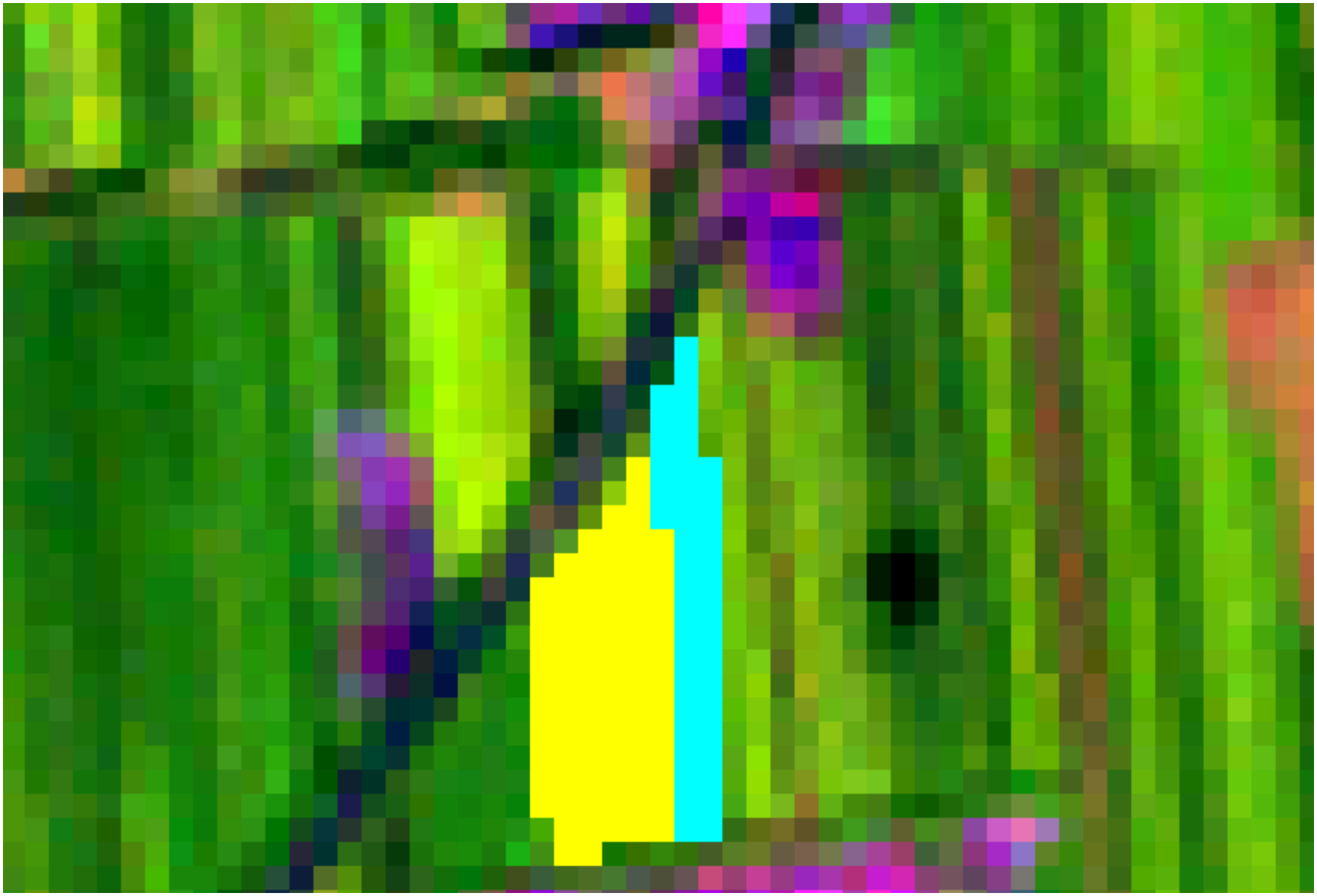
Landsat -Heilongjiang, China (26km x 20km)

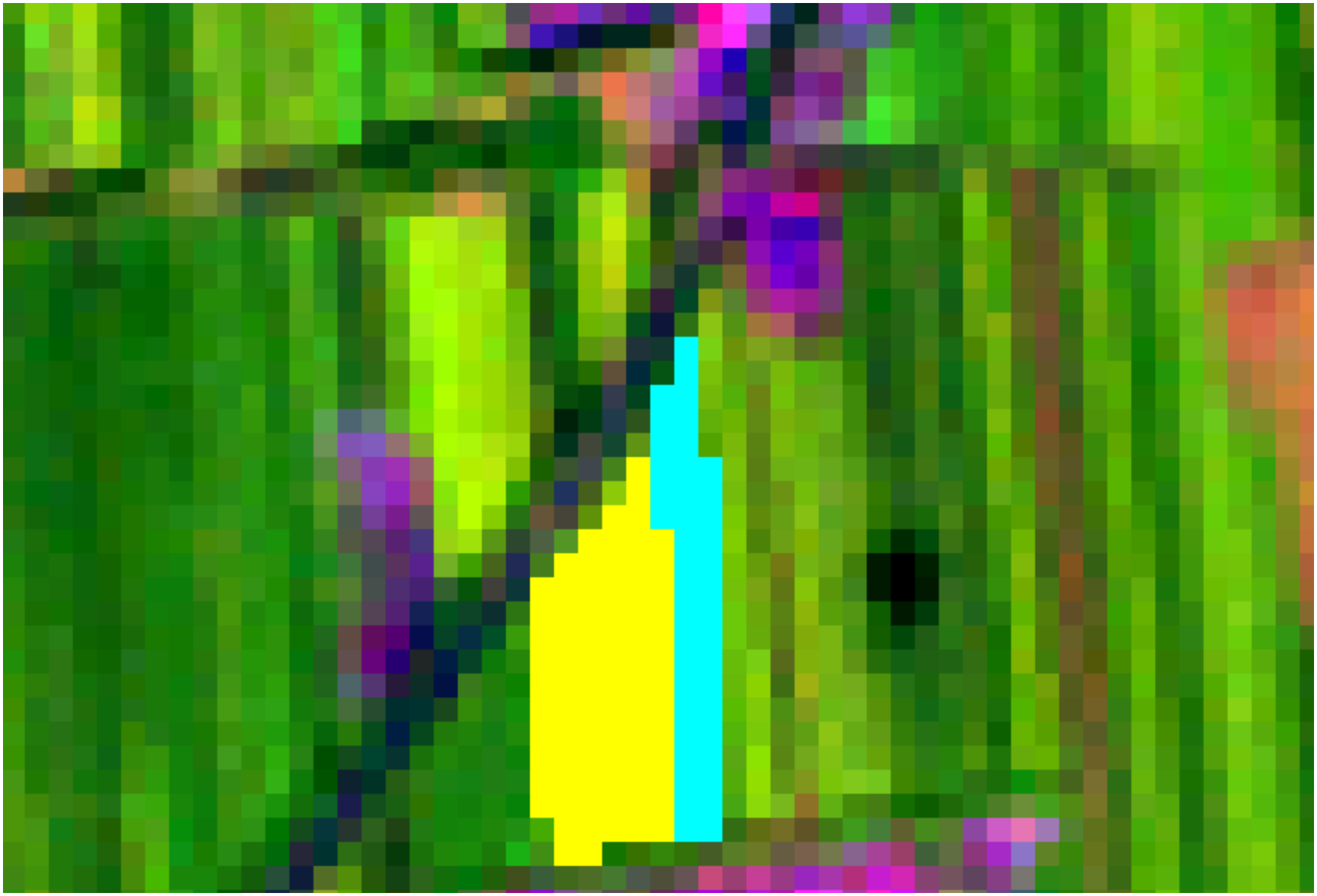


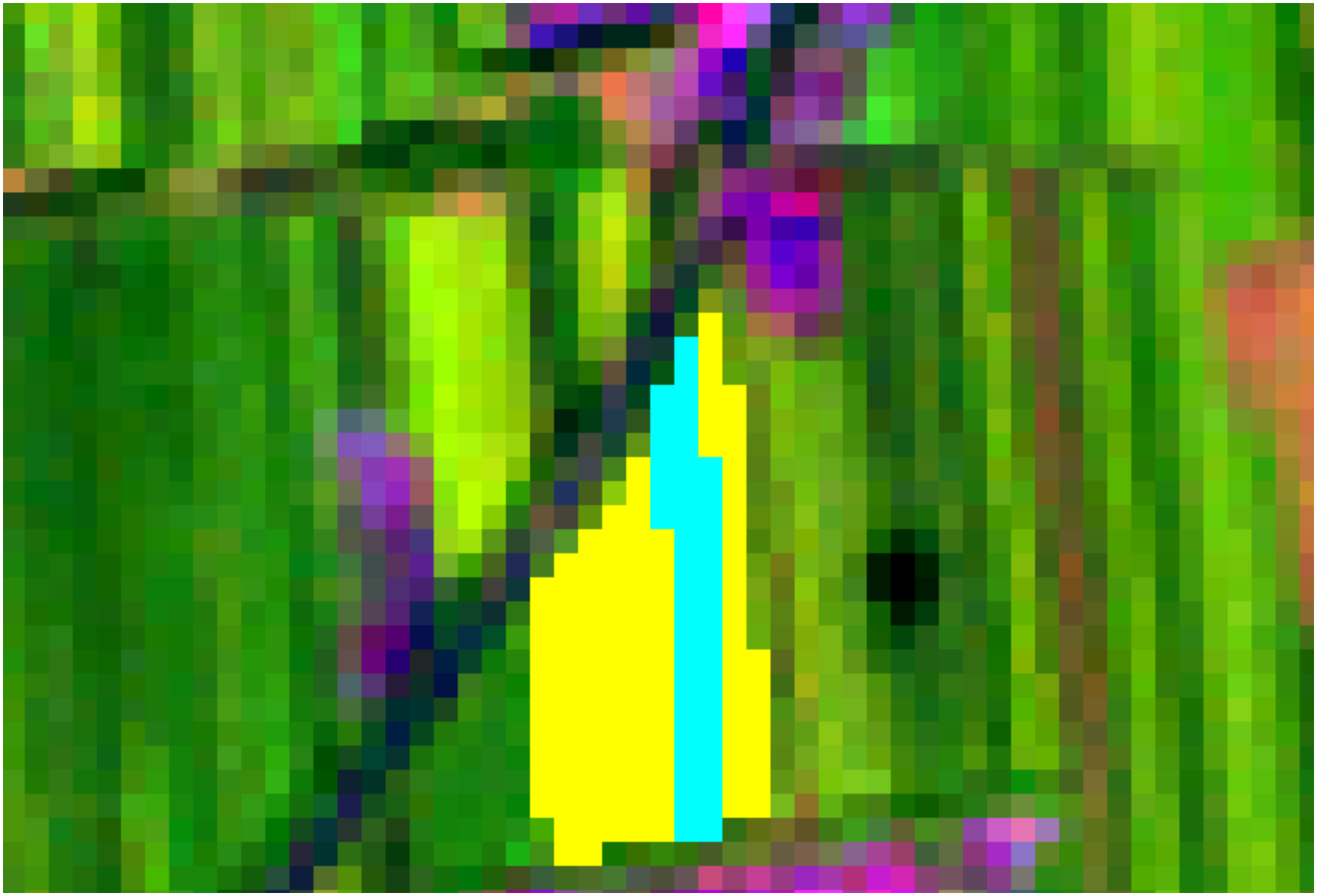


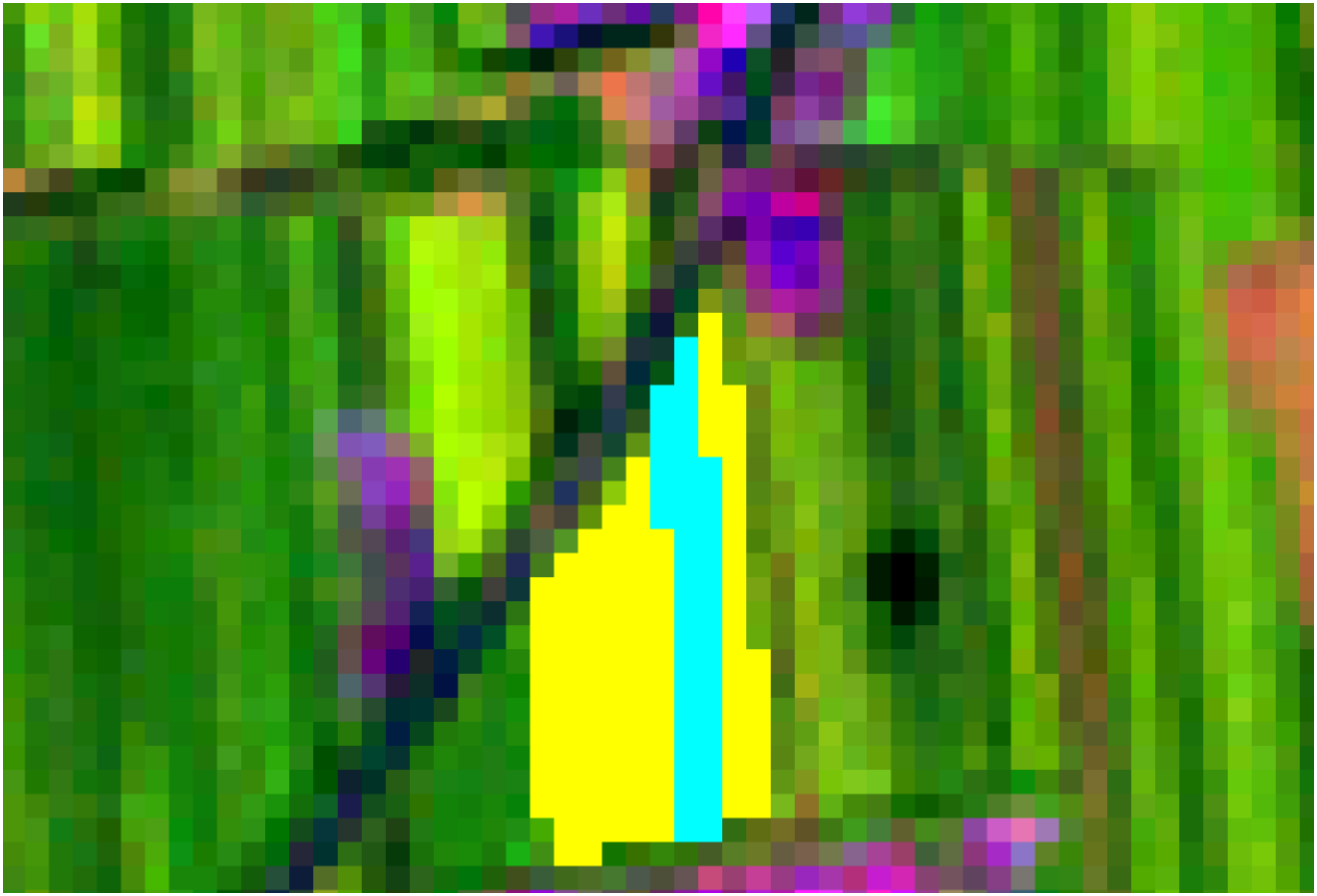












Sample block analysis / validation

- We will have two to three analysts to examine blocks and map soy / no soy / no data
- We will include field visits or other ancillary data for some / all blocks to verify interpretations
- What challenges are we going to face in analyzing block data
  - Poor or inadequate timing
  - Confusion between soy and another cover type
  - Landscape heterogeneity
- What is the protocol for block replacement
  - Cloud/shadow/no data threshold (a minimum of 25% good data coverage)
  - Inability to interpret due to aforementioned challenges (if this introduces geographic biases, this is a big problem)
  - Secondary issue - what if RapidEye is acquired for areas where we end up with no useable Landsat imagery?

Timeline

- USA August 2011
- Argentina and Brazil February 2012
- China August 2012

Yield estimation with and without crop masks

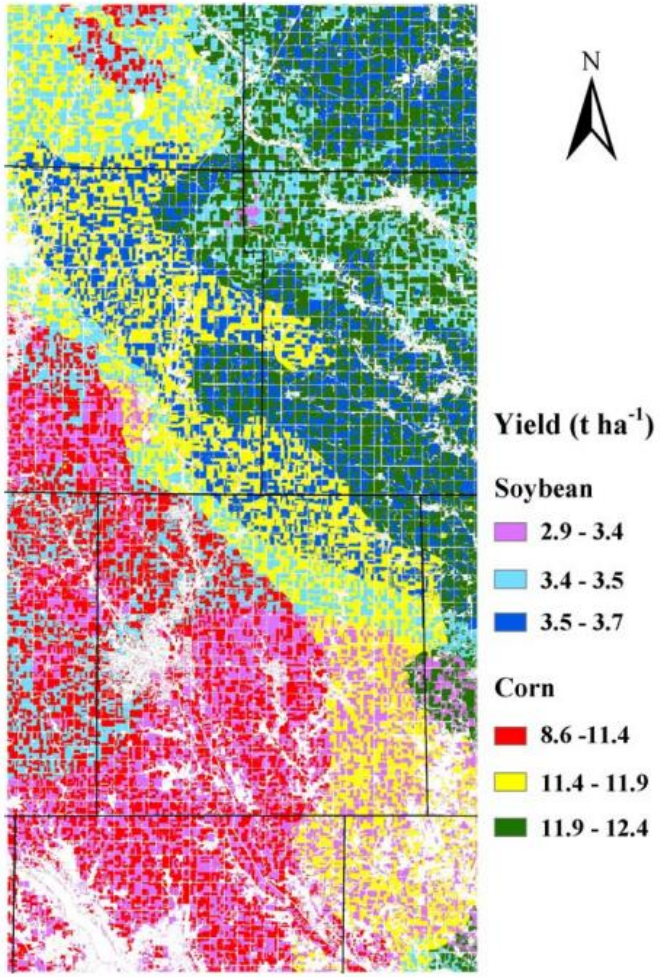


Fig. 11. Model simulation of corn and soybean crop yields (tones per hectare) at 1.6 km^2-grid resolution for the study area.

Doraiswamy et al. 2004

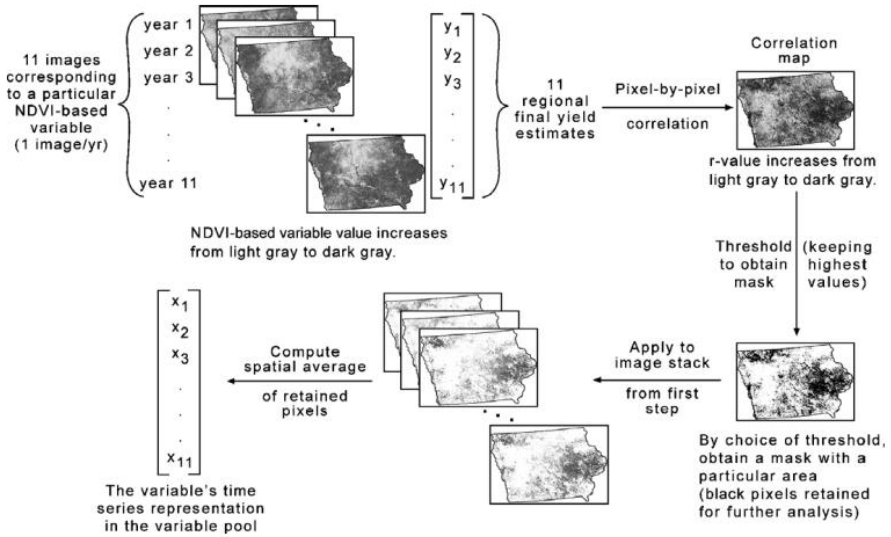
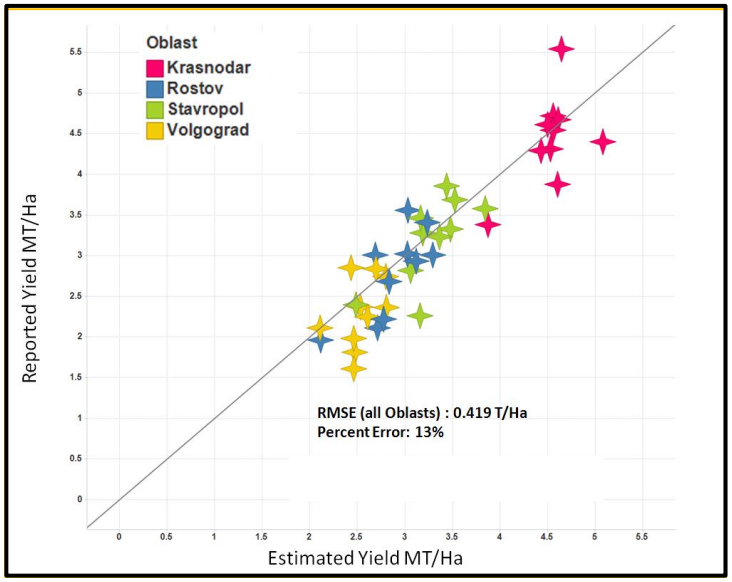


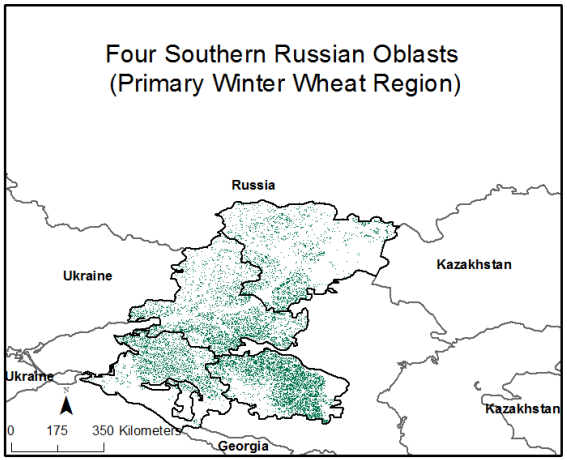
Fig. 3. Flowchart for a single-variable application of the yield-correlation masking technique for a single choice of mask size. Example shown is for Iowa corn using the NDVI variable obtained by accumulating values across periods 3 and 4 during the 11-year span 1989–1999 (and thus would have been used for the prediction of Iowa corn yields when 2000 was the 'out year'). A different variable vector will be obtained for each unique mask size choice.

Kastens et al. 2005

Crop type productivity

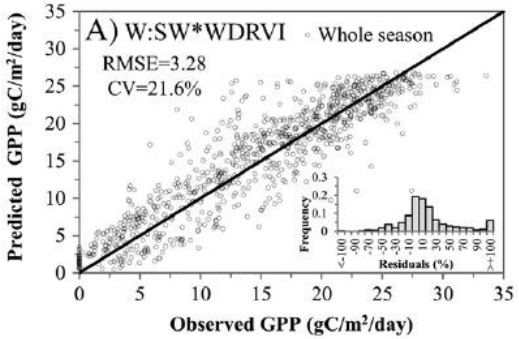
Wheat yield from MODIS

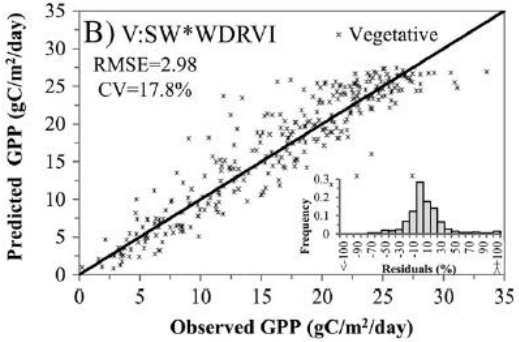


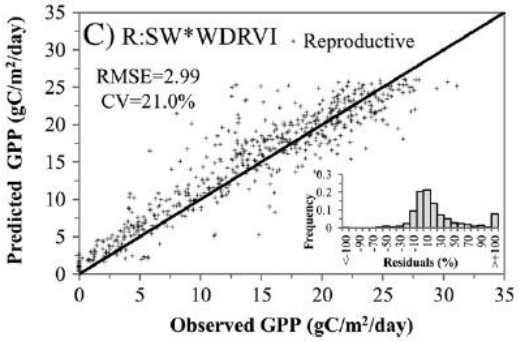


Becker-Reshef et al. 2010

Maize GPP from MODIS

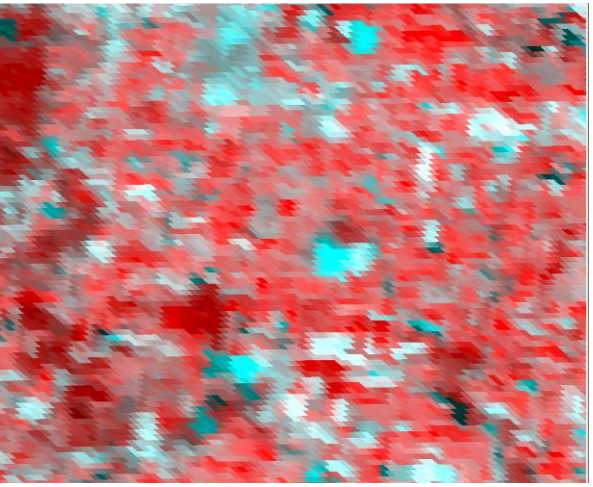
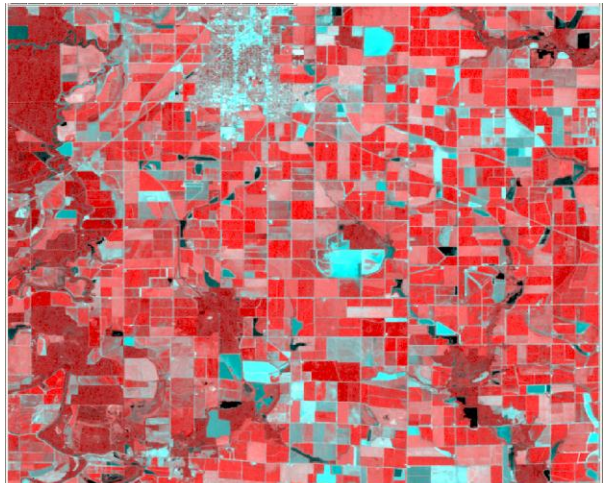
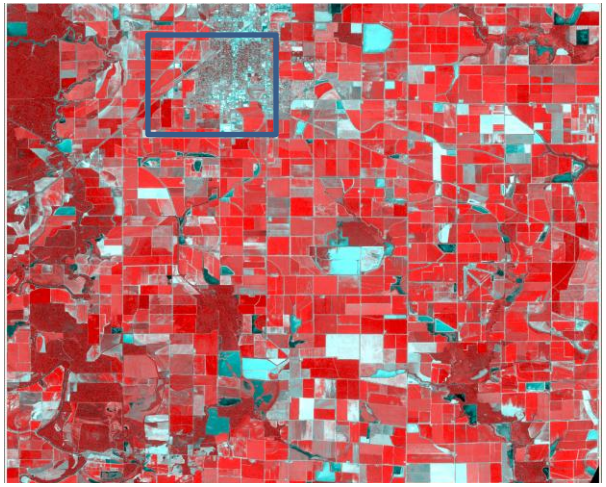






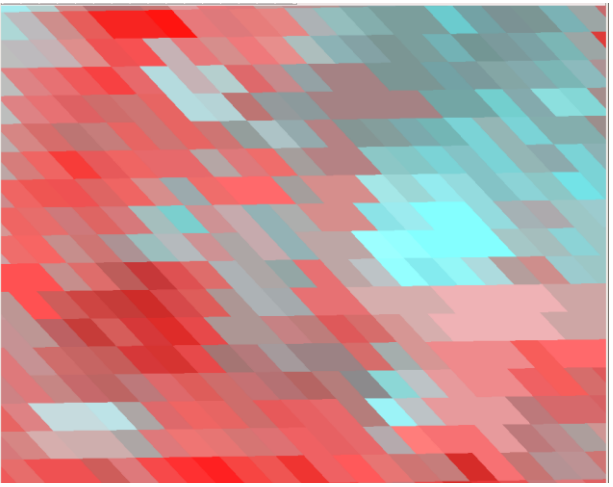
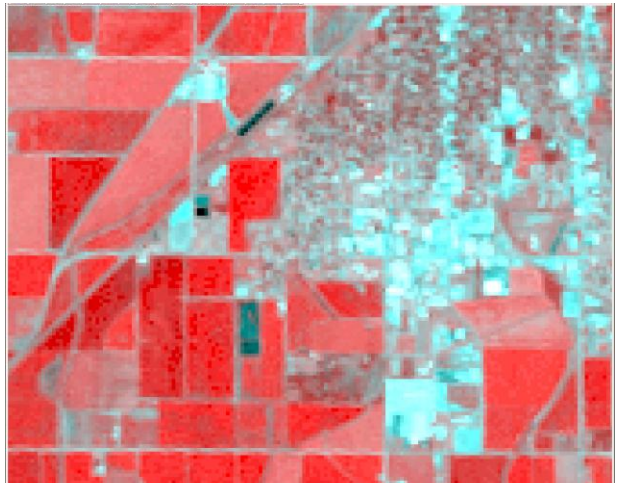
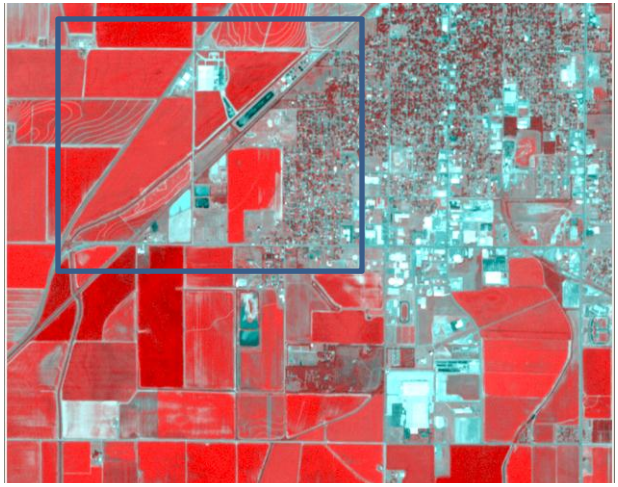
Sakamoto et al. in press

MODIS – Landsat – RapidEye

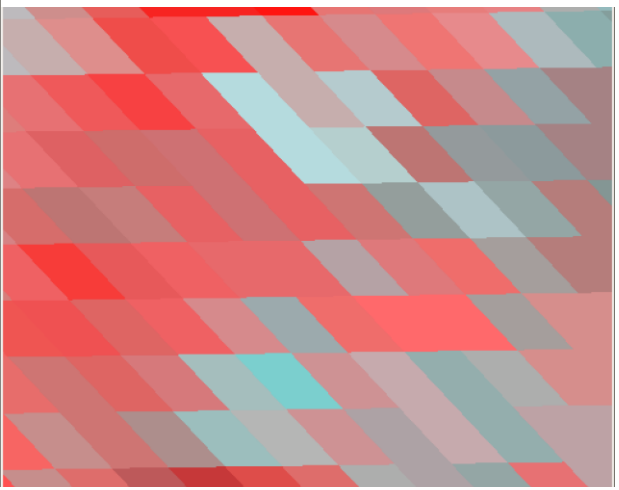
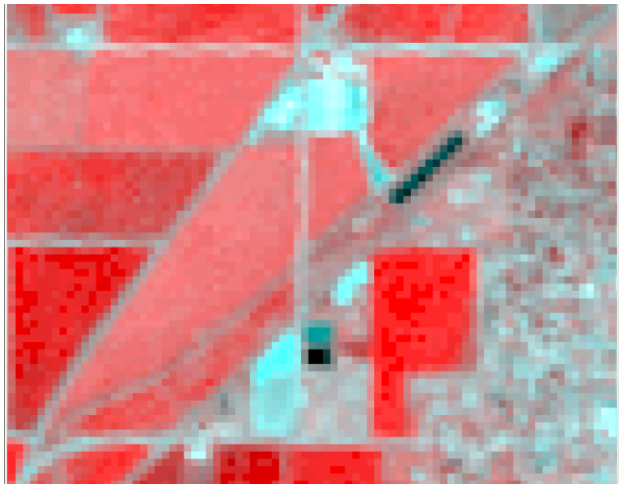
20.5km x 19.5km near Stuttgart, Arkansas

MODIS – Landsat – RapidEye

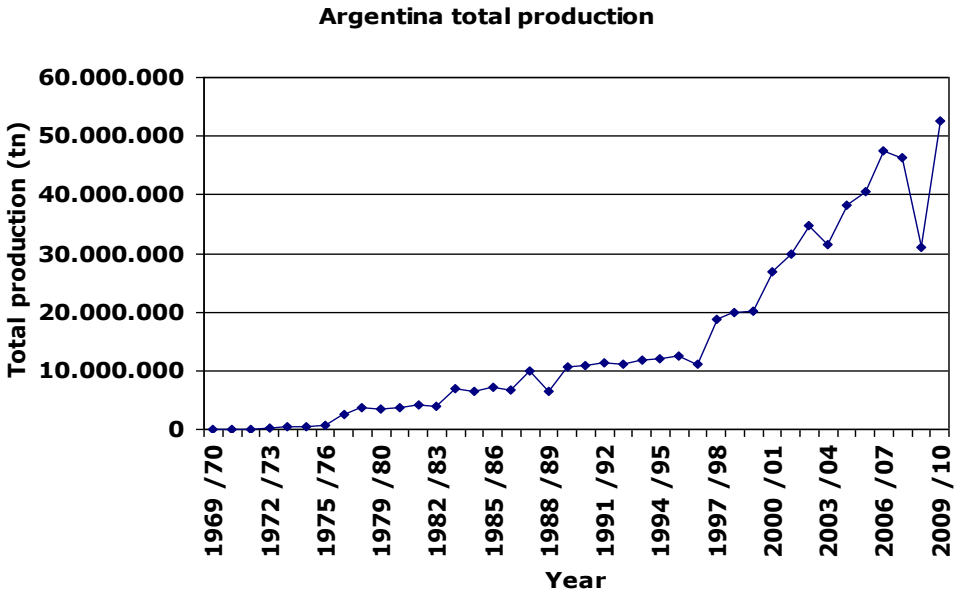
5km x 4.7km near Stuttgart, Arkansas

MODIS – Landsat – RapidEye

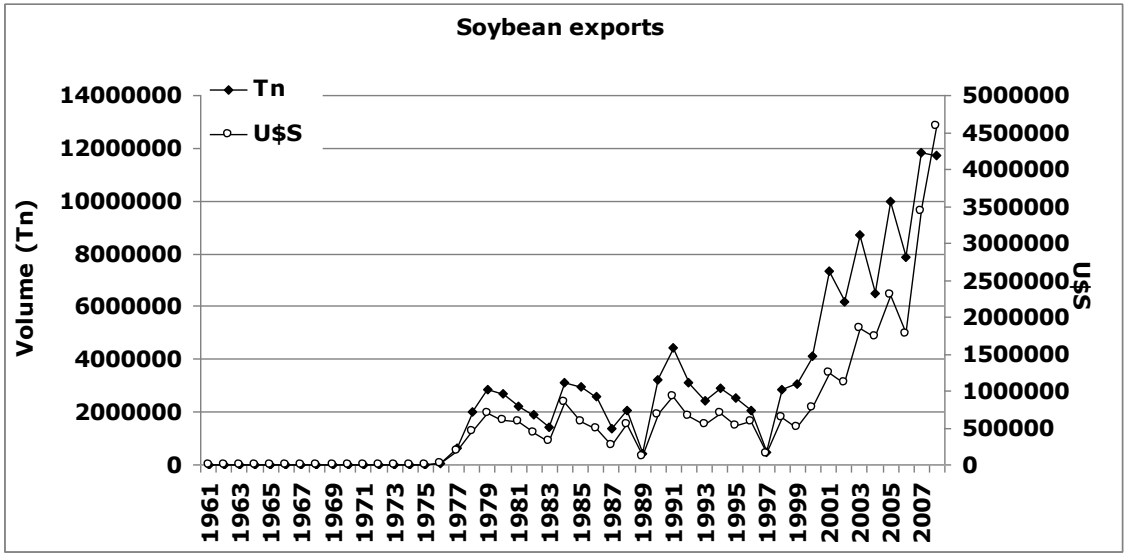

5km x 4.7km near Stuttgart, Arkansas

Soybeans in Argentina's Economy



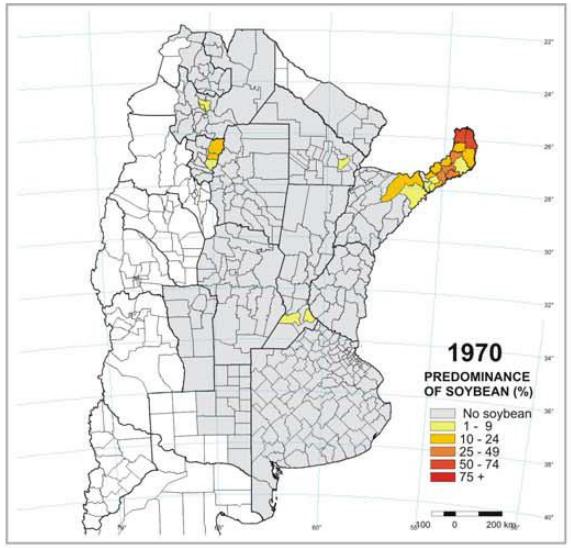
3rd Global Soybean Producer

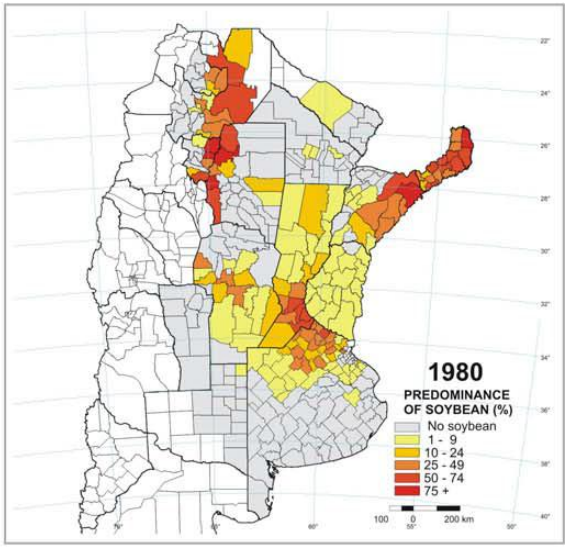
20% Gross National Product

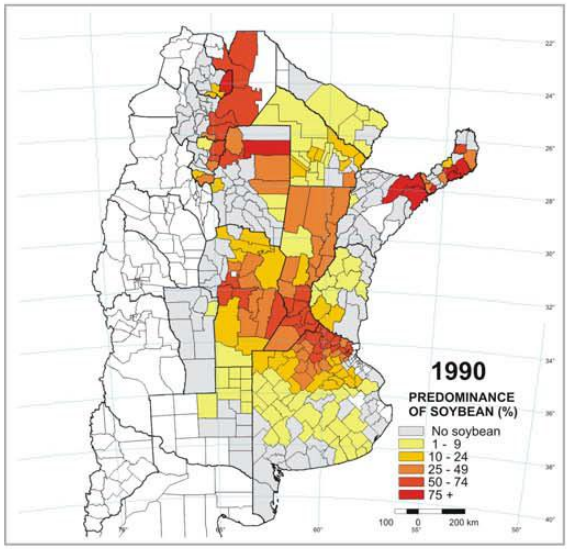


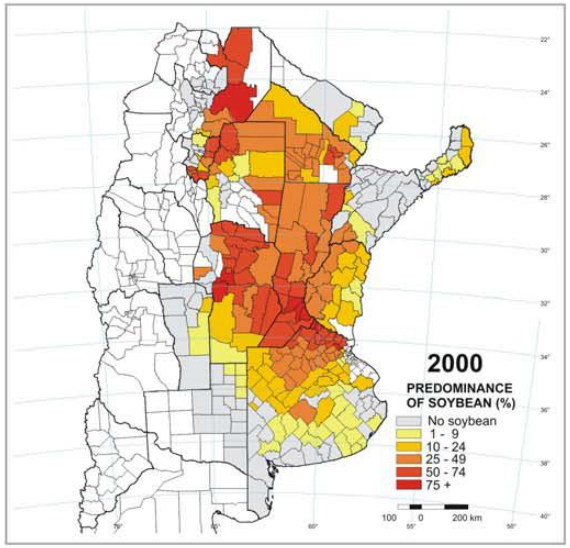
Mapping efforts- Statistics

Agricultural Estimates by Ministry of Agriculture: Informants

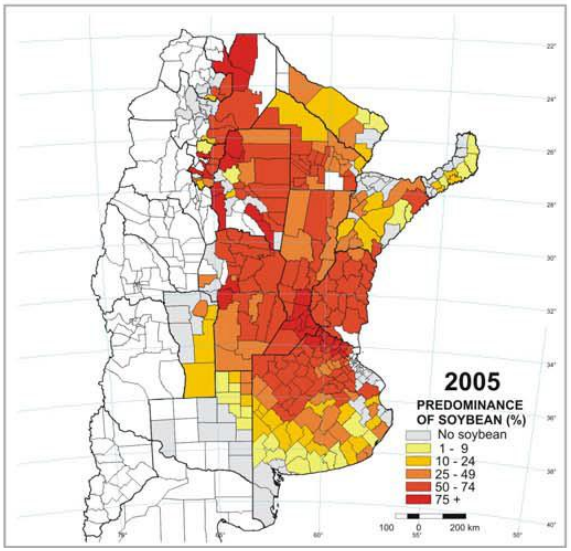




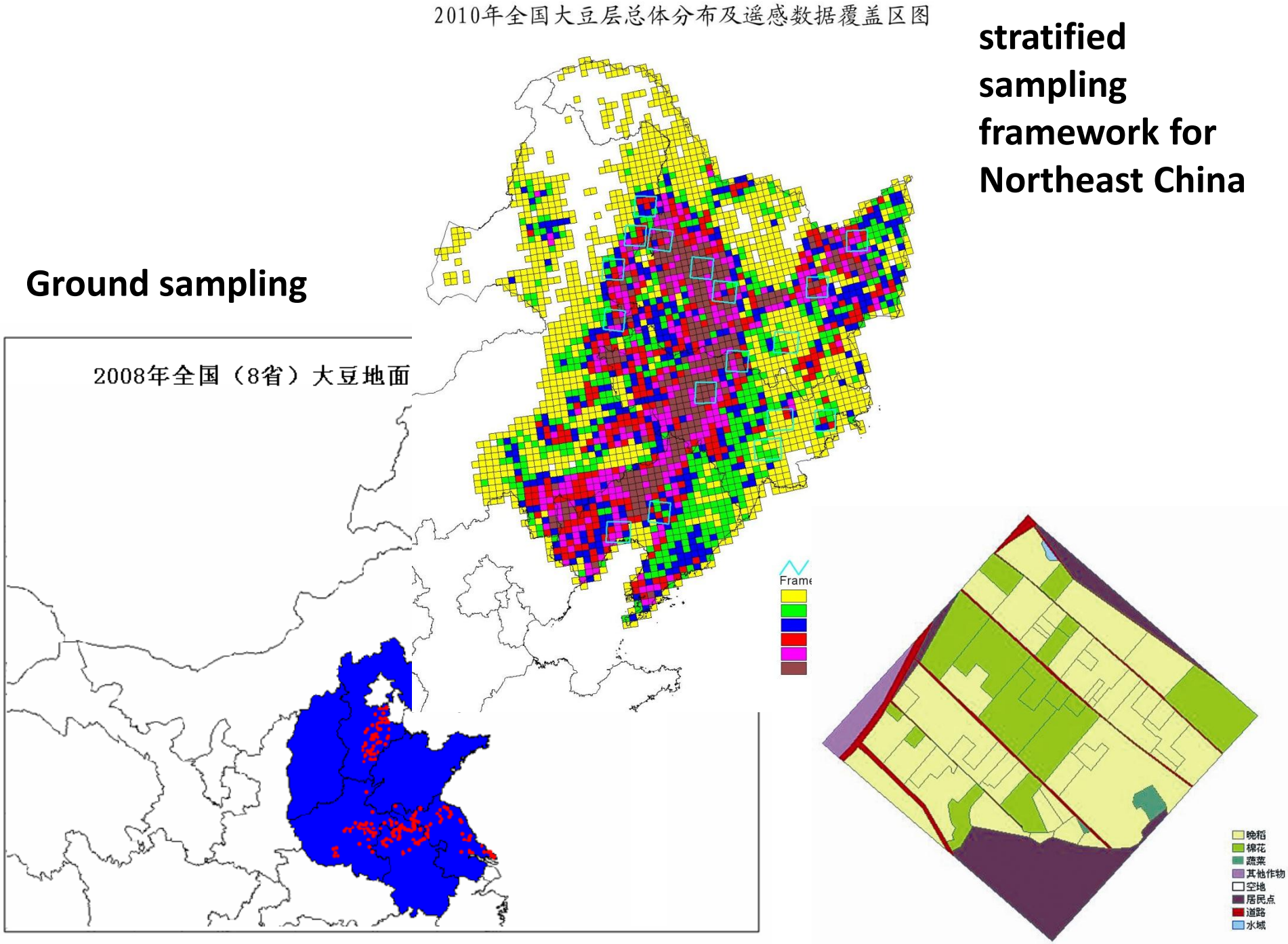




100.000 ha – 15.000.000 ha



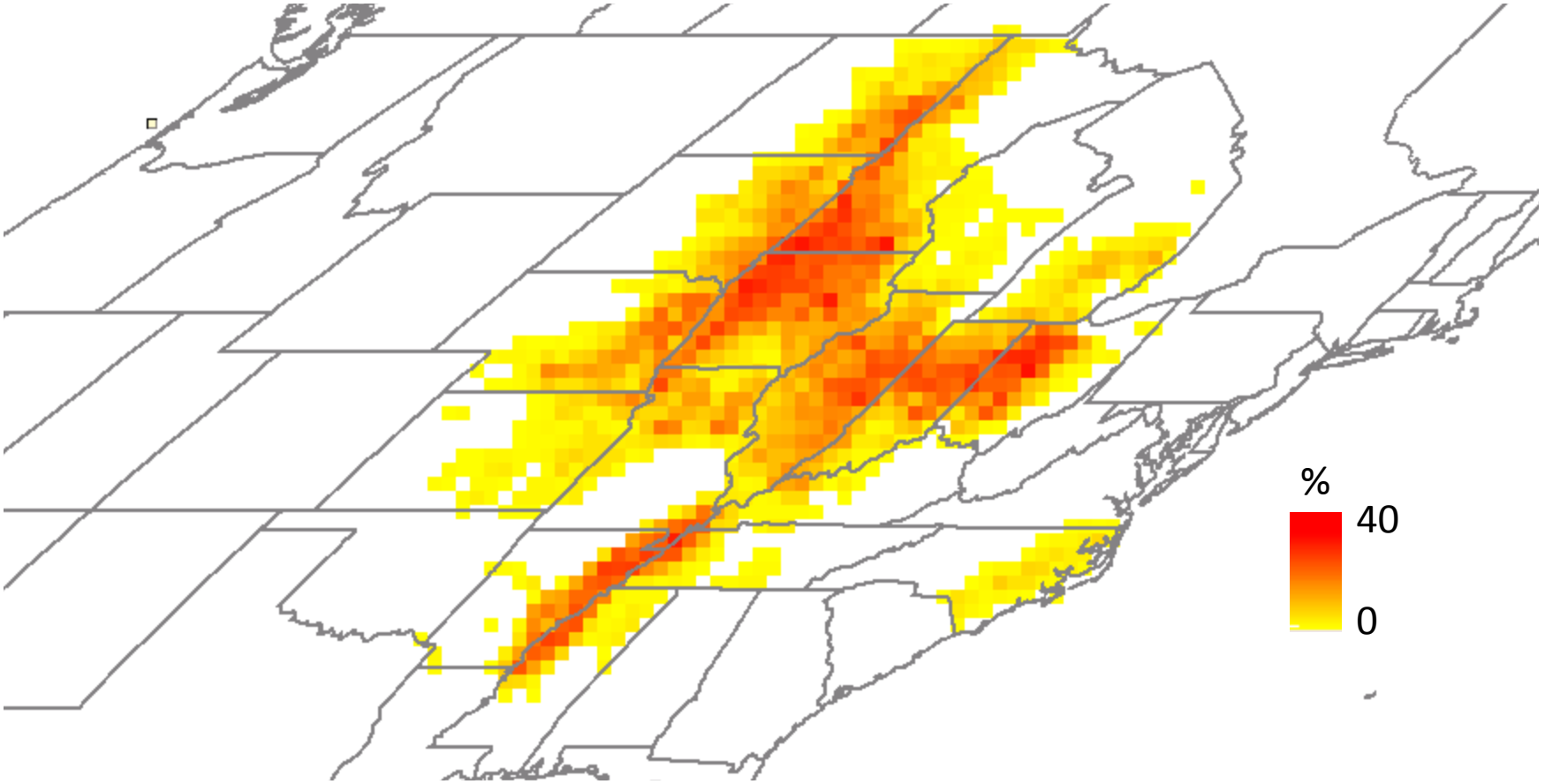
2010: 18.000.000 ha



stratified sampling framework for Northeast China

Ground sampling

NASS CDL soybean indicator at 40km block scale



MODIS soybean indicator at 40km block scale