Integrating MODIS crop characterization capabilities with AWiFS and agricultural survey data in support of USDA NASS DSS

and

Advancing methods for global crop area estimation

NASA LCLUC, Applications, and Decision Support Systems Programs

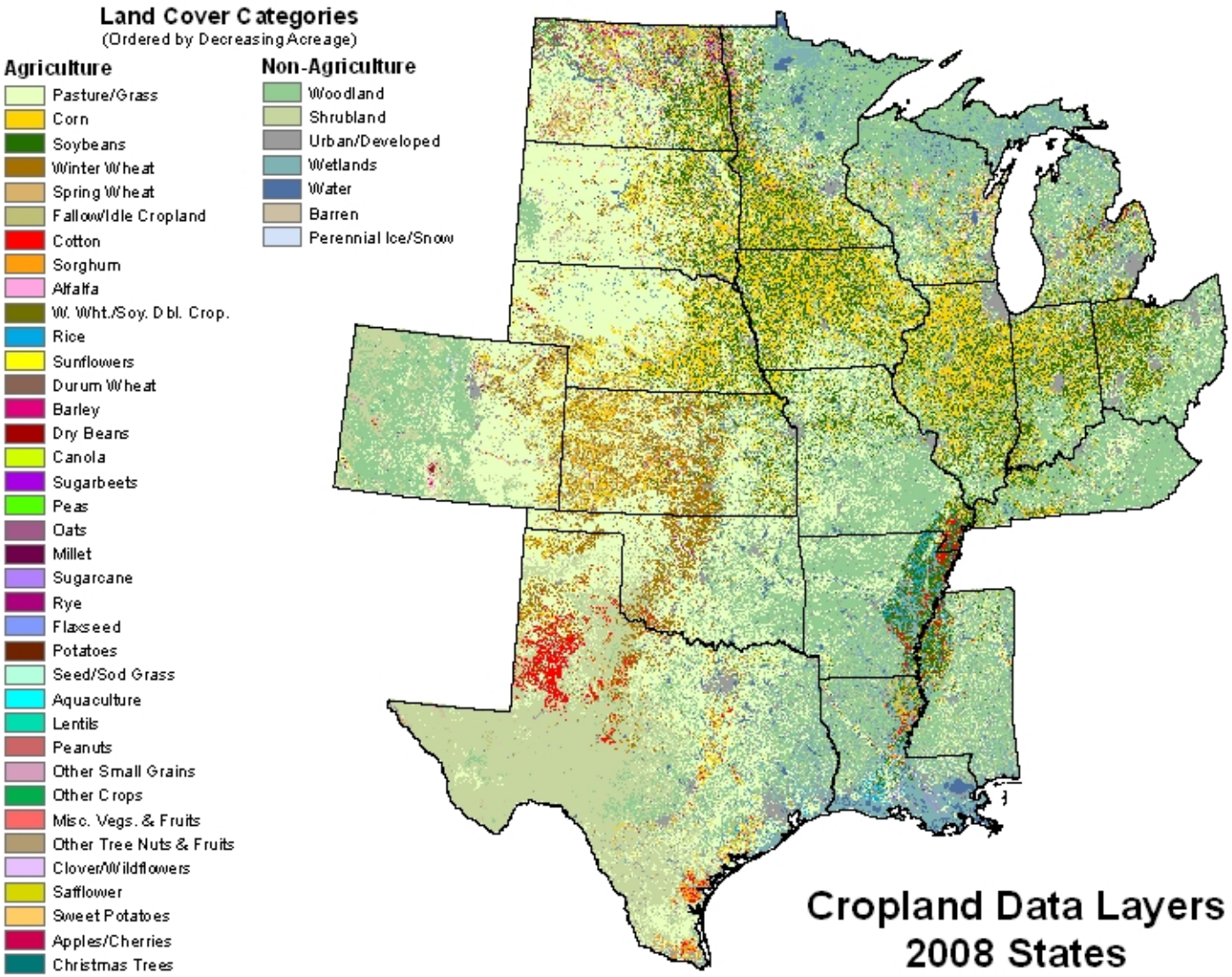
Matt Hansen - UMd, Rick Mueller – NASS, Tom Loveland – USGS,
Steve Stehman – SUNY-ESF, Inbal Becker-Reshef – UMd, Bernardo Rudorff – INPE,
Yosio Shimabukuro – INPE, Carlos Di Bella – INTA, Jessica McCarty - MTU

Objectives

- Develop, assess and incorporate products that employ MODIS data in support of the NASS Cropland Data Layer (CDL) product
  - Accurate, near-real time cropland cover characterization is critical for viable, timely USDS crop production estimation
  - We developed in-season MODIS models for estimation percent corn, soybean and winter wheat cover per 250m MODIS pixel
  - Results demonstrate that MODIS can be used as a back-up system to medium resolution data inputs that performs reasonably well in USDA NASS regression estimator procedures, but not in mapping applications

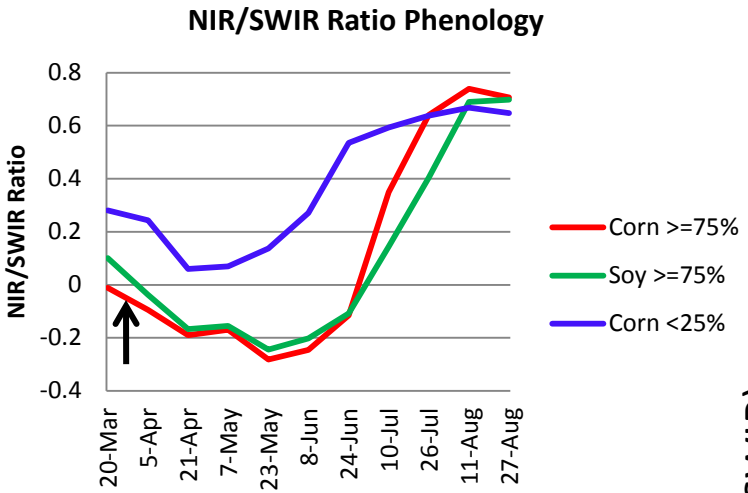
- Employ MODIS, Landsat, RapidEye and field data to estimate national-scale crop area by type
  - Probability-based sampling can be used to provide accurate estimation of cultivated area by crop type
  - Goal is to test a generic approach to estimate cultivated soybean area in the USA, Brazil, Argentina and China, which account for almost 90% of global soybean production)
  - Results will illustrate the viability of remote sensing-based global crop type area estimation

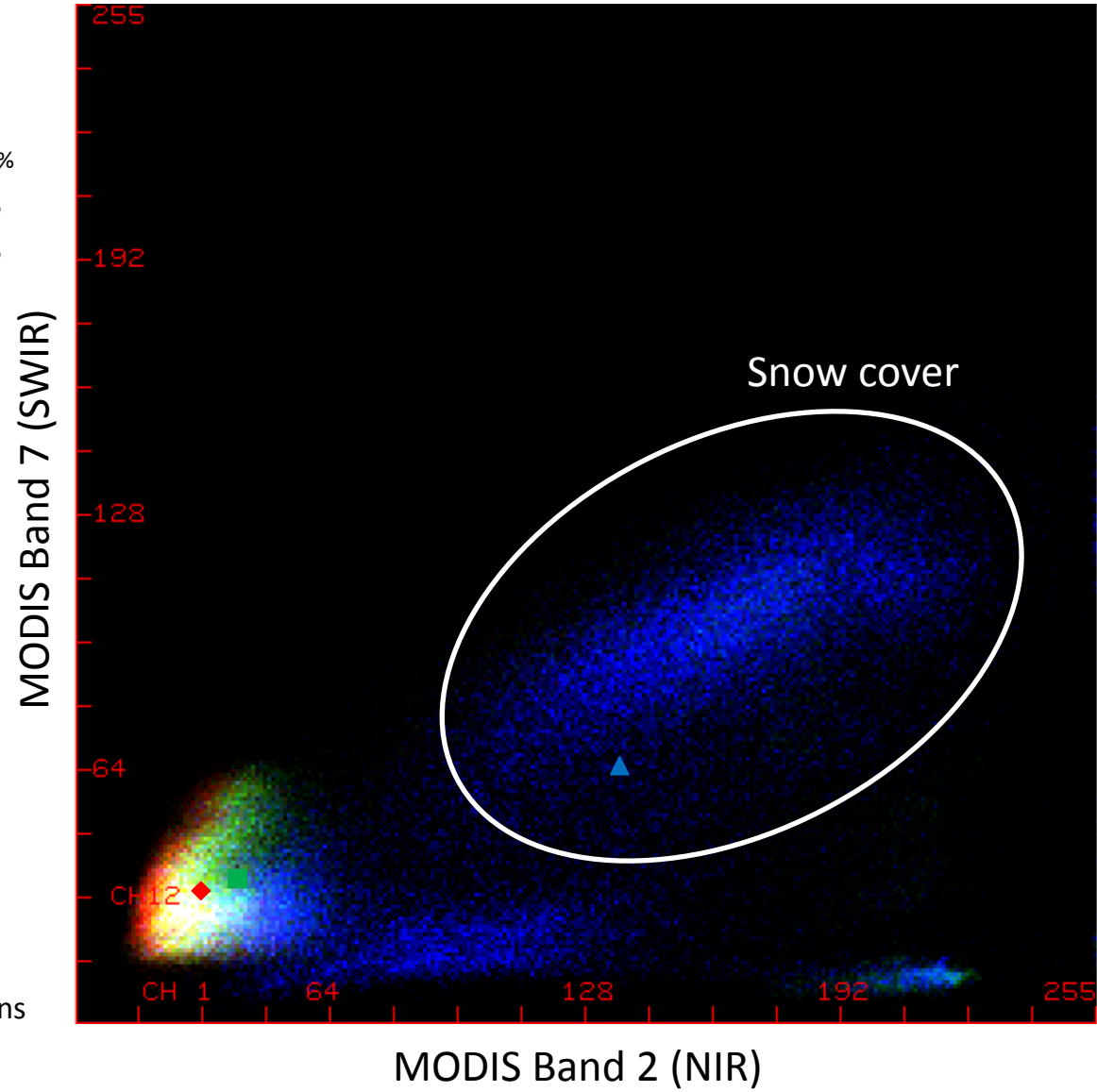
NASS Cropland Data Layer



Minnesota 2008

March 20





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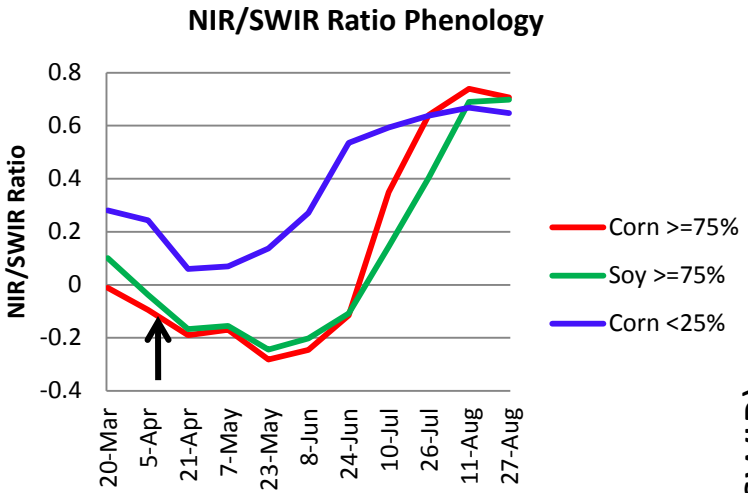
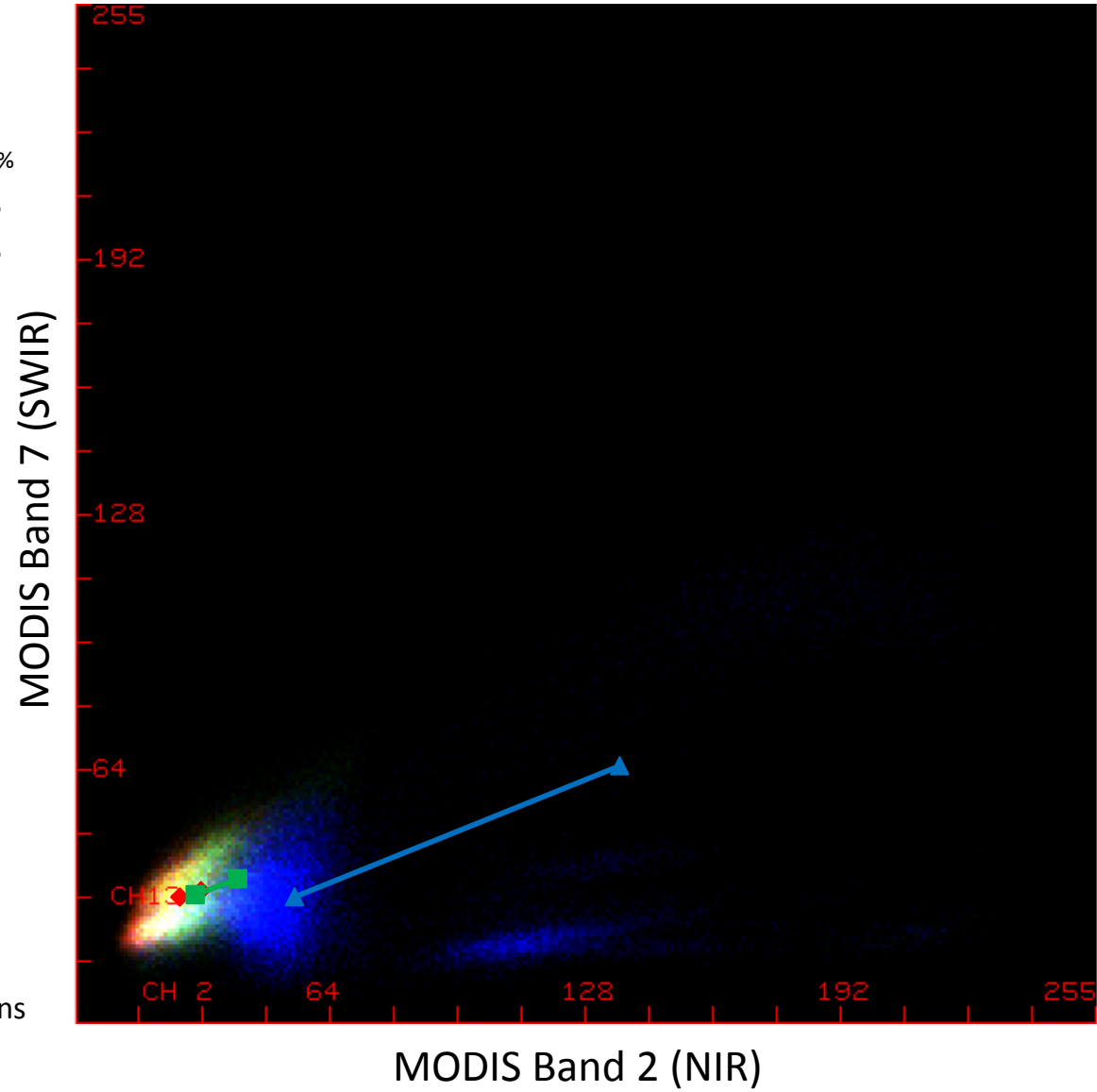
Blue: <25% Corn

Minnesota 2008

April 5





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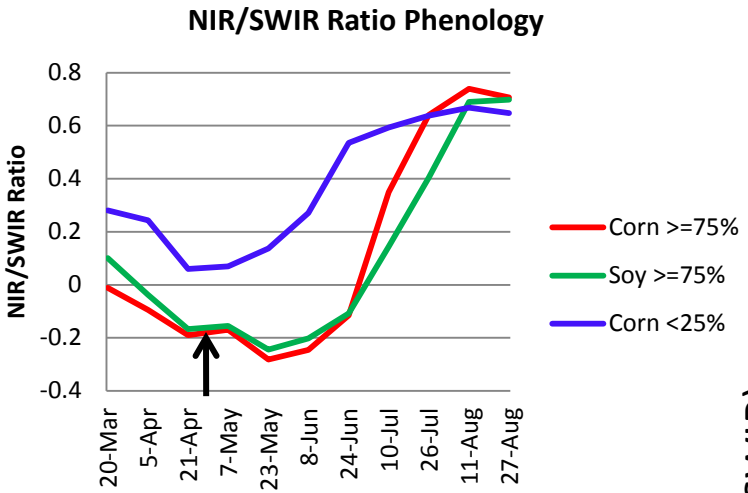
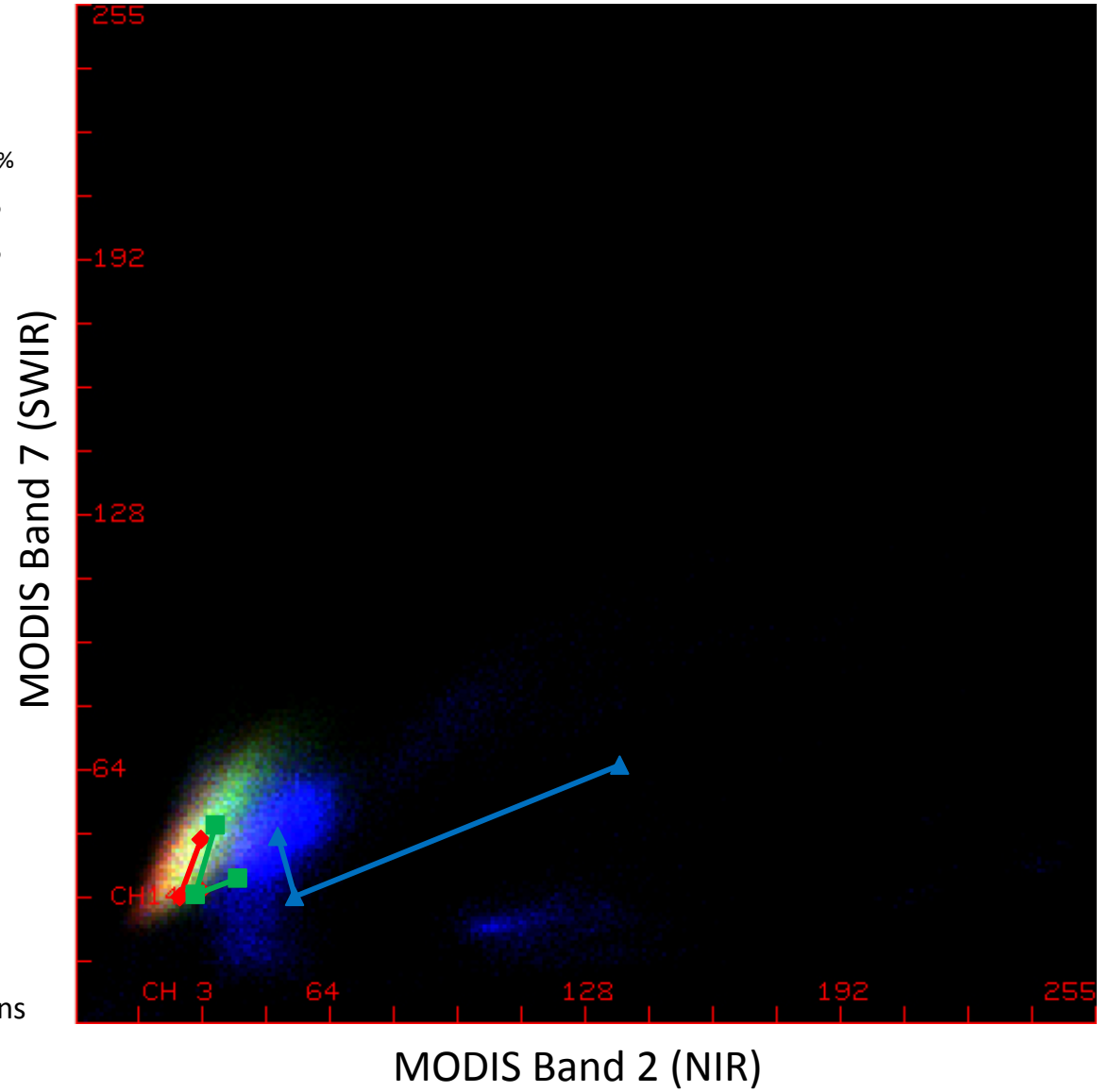
April 21





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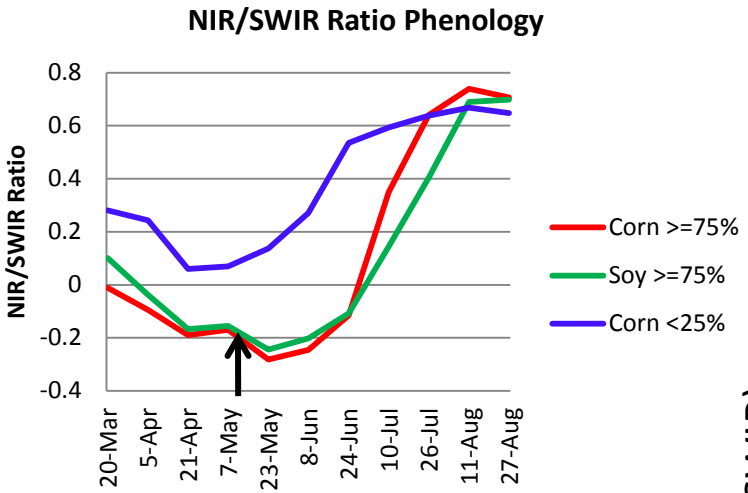
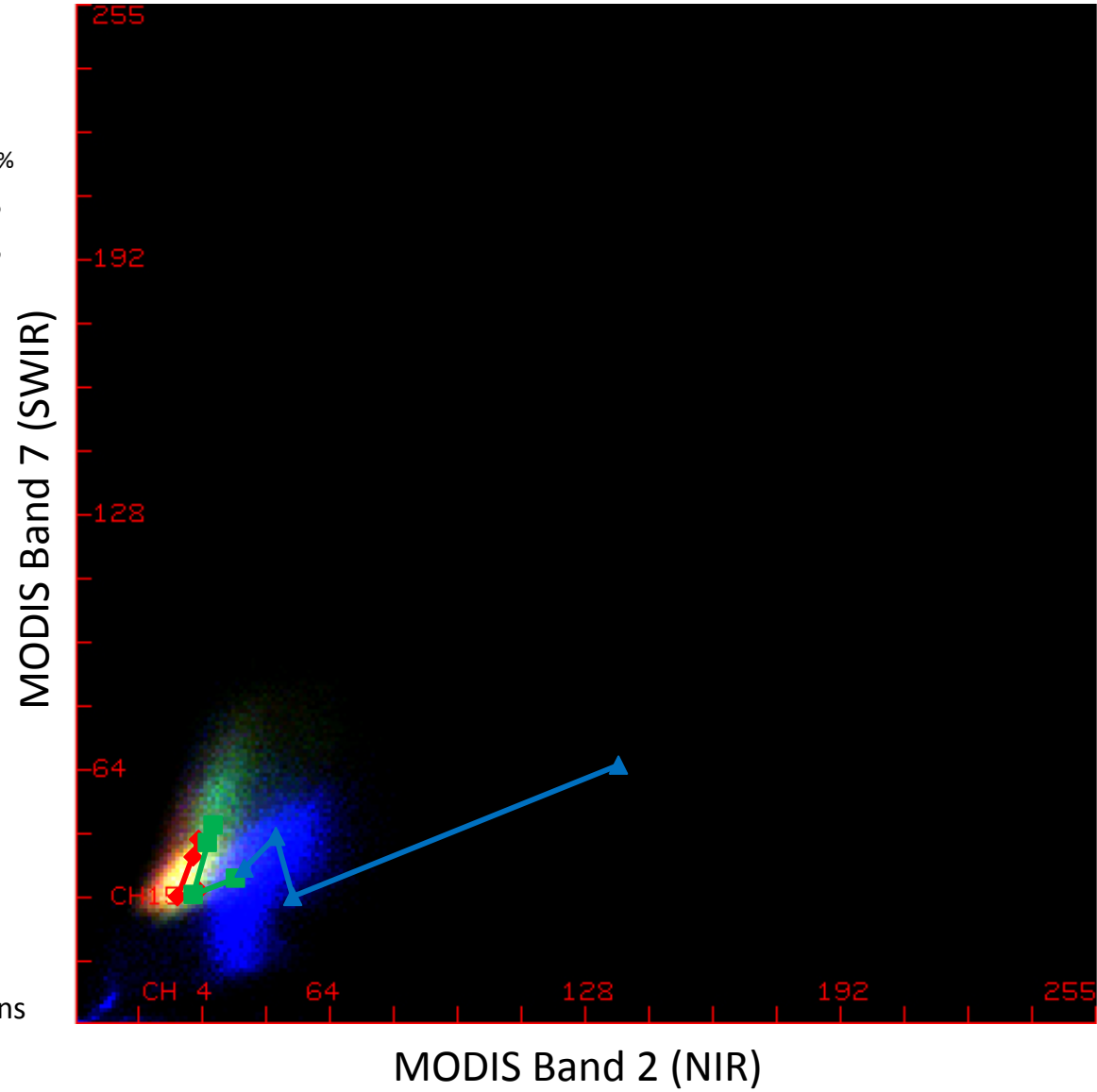
Minnesota 2008

May 7





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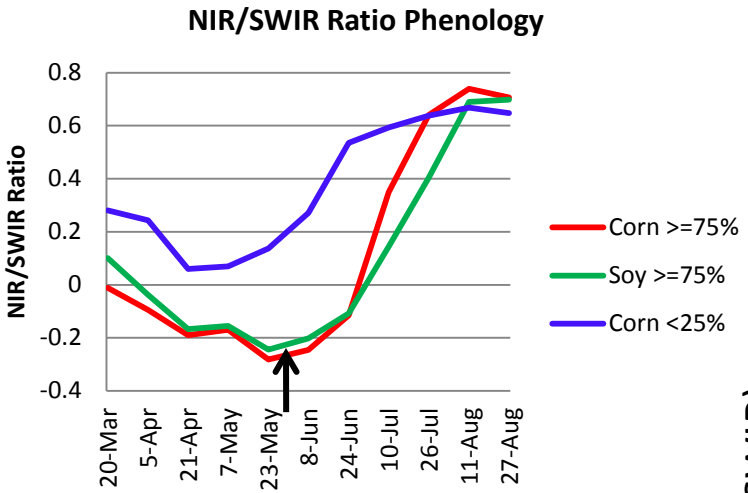

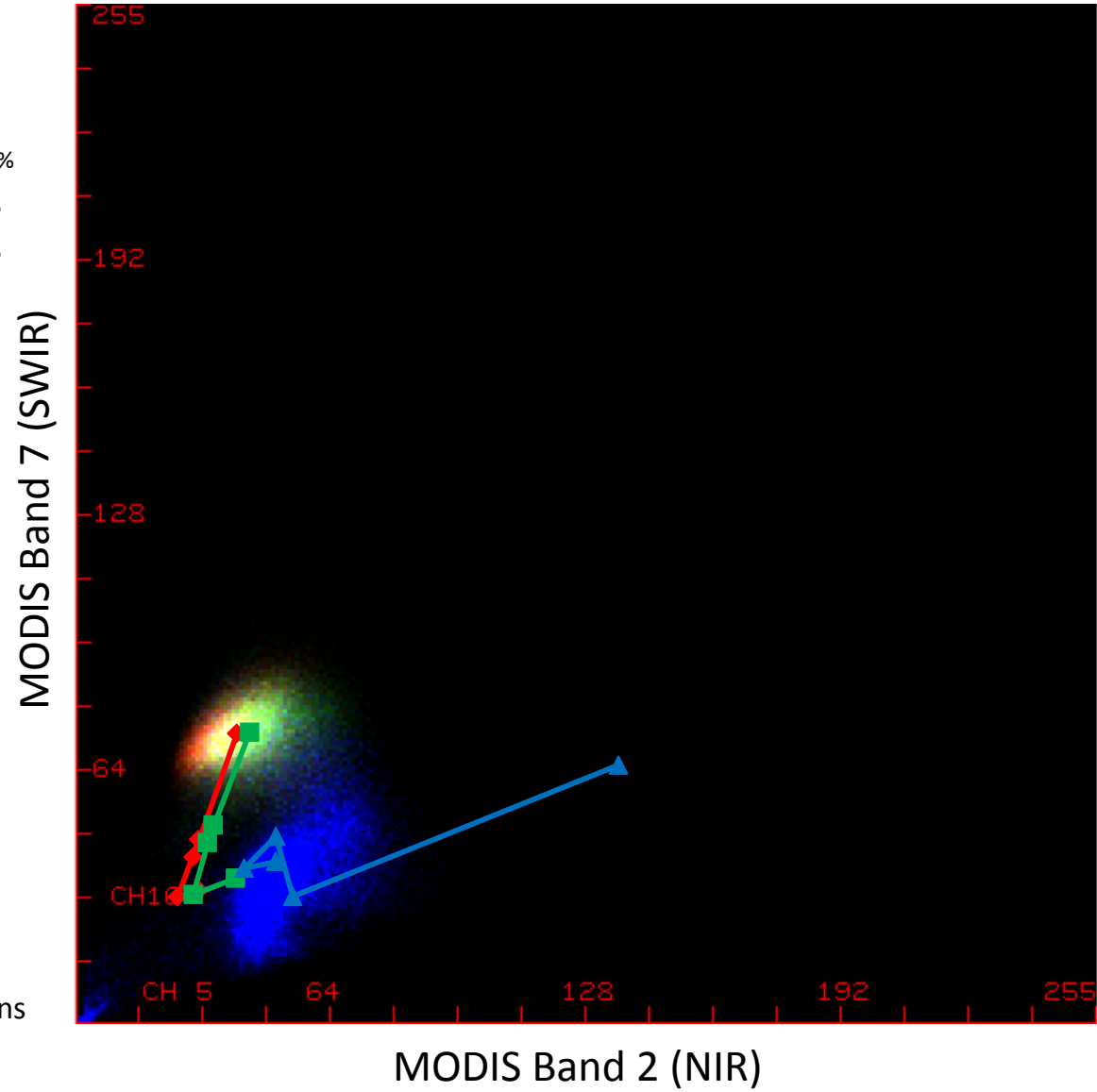

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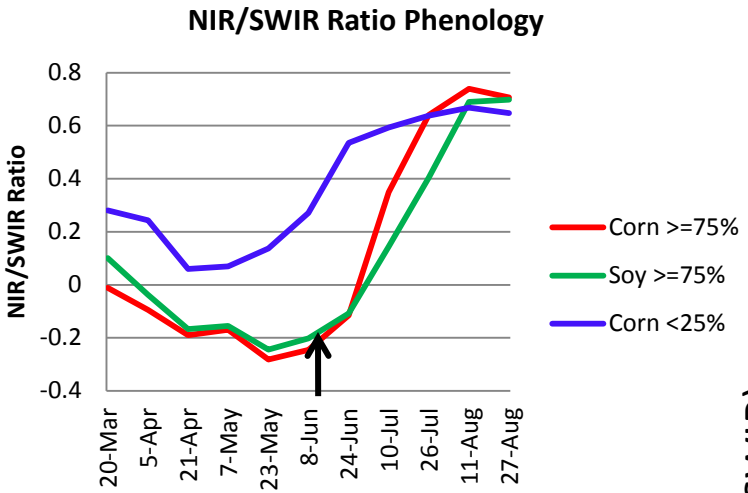
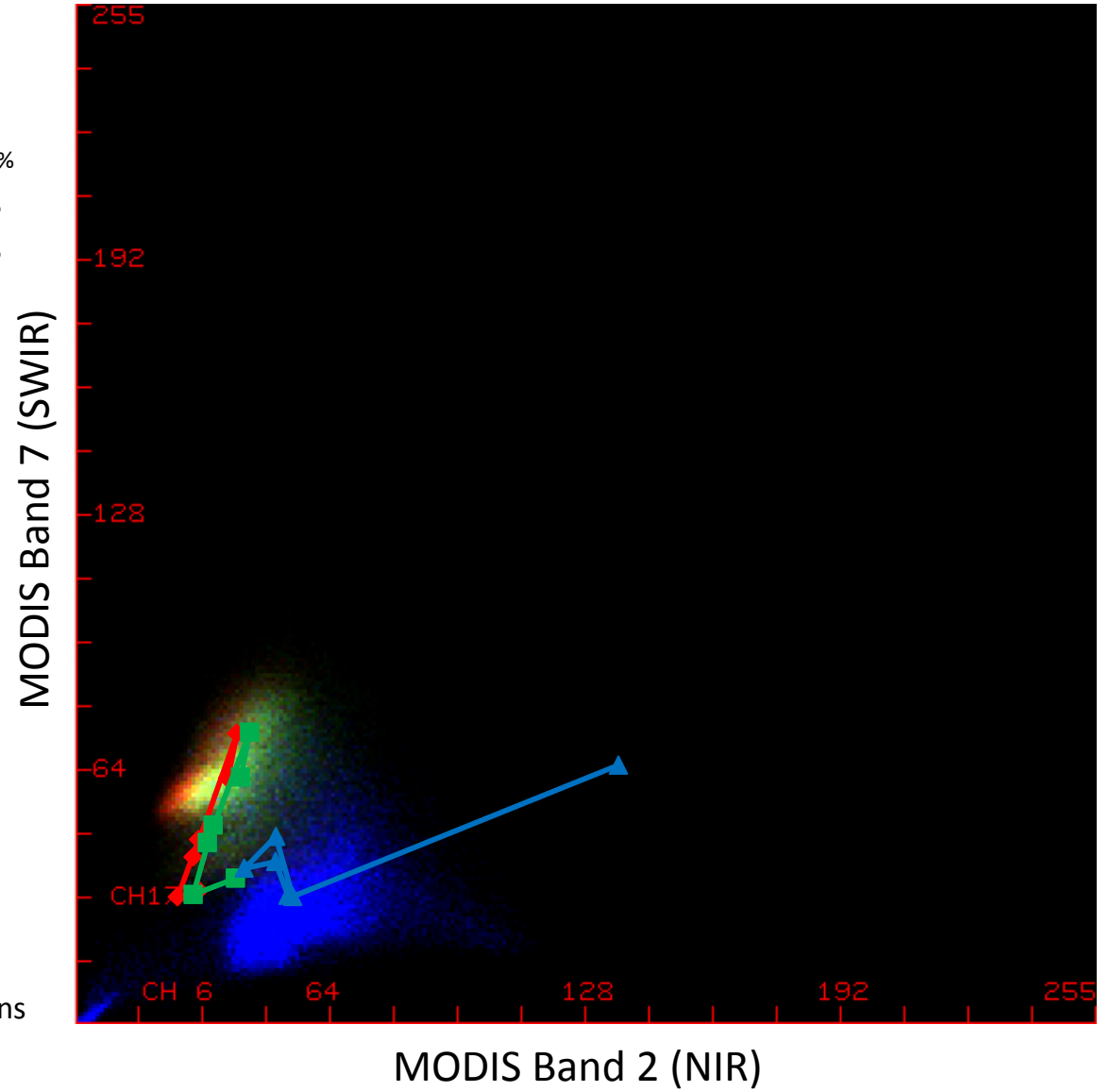
Minnesota 2008

June 8





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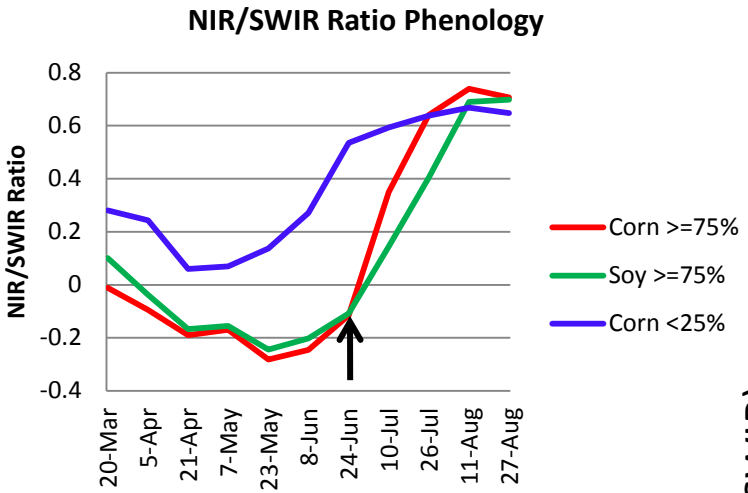
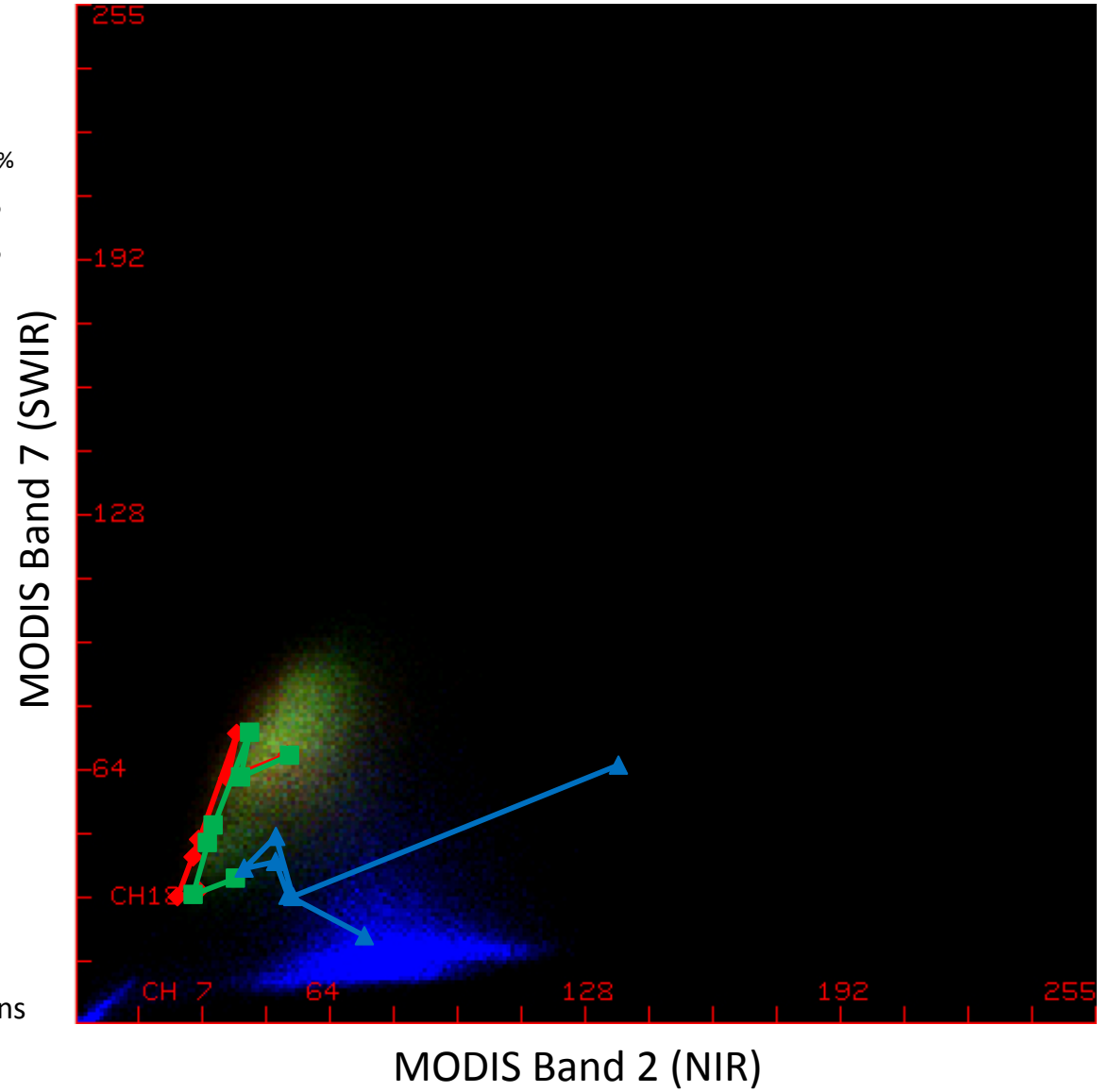
June 24





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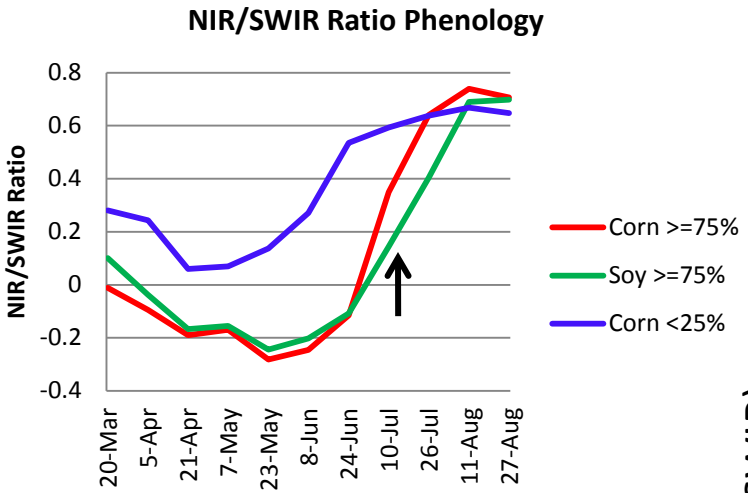
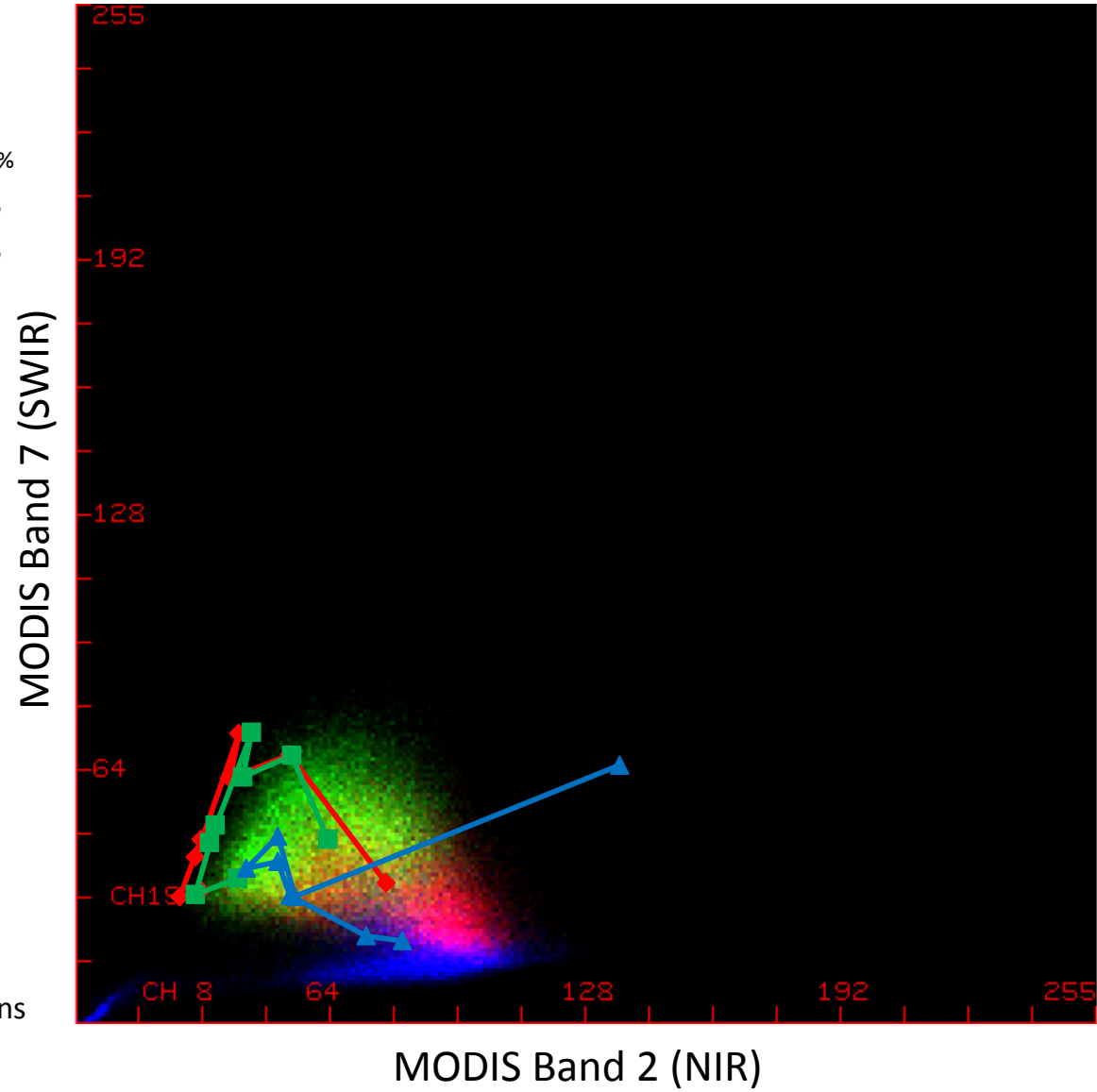
July 10





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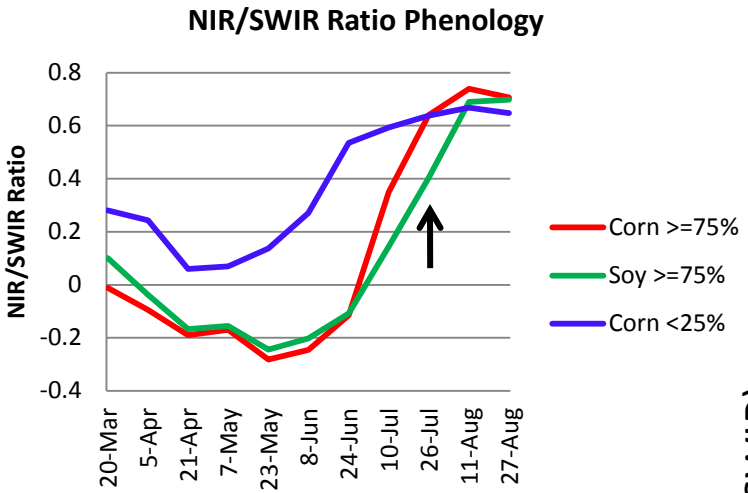
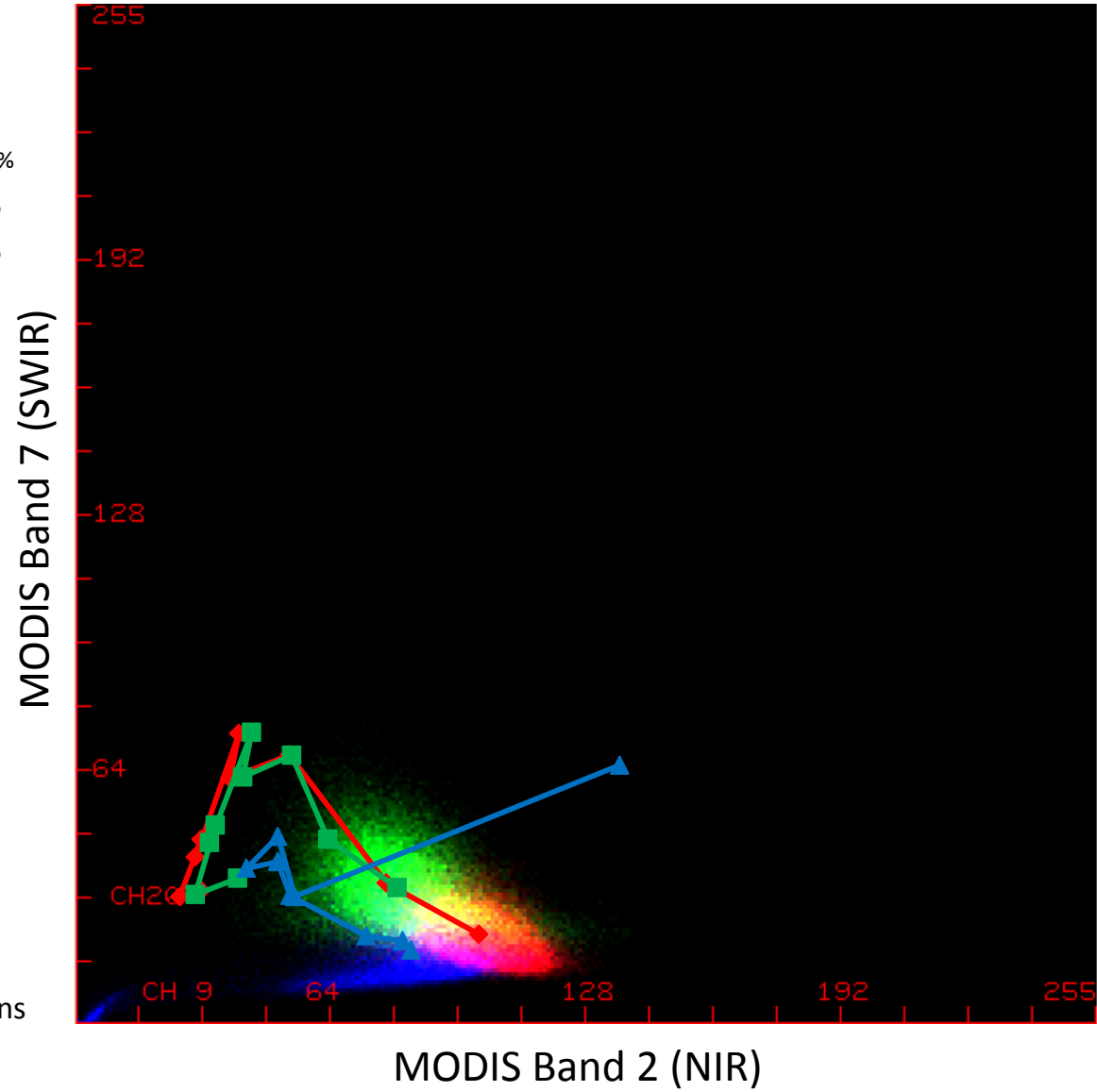
July 26





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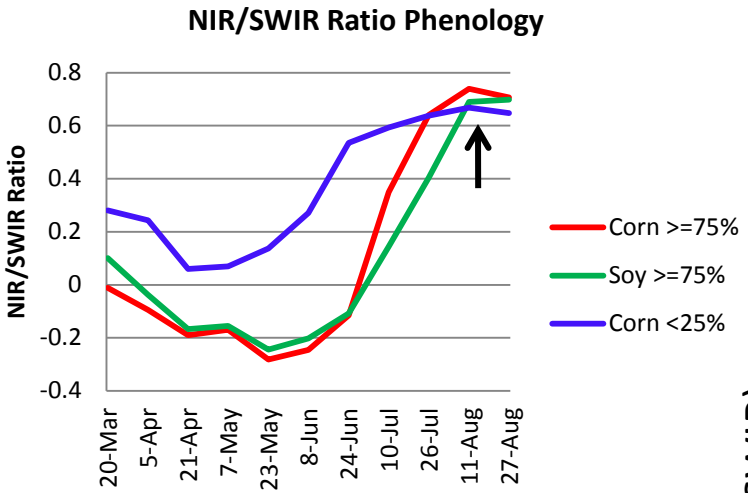
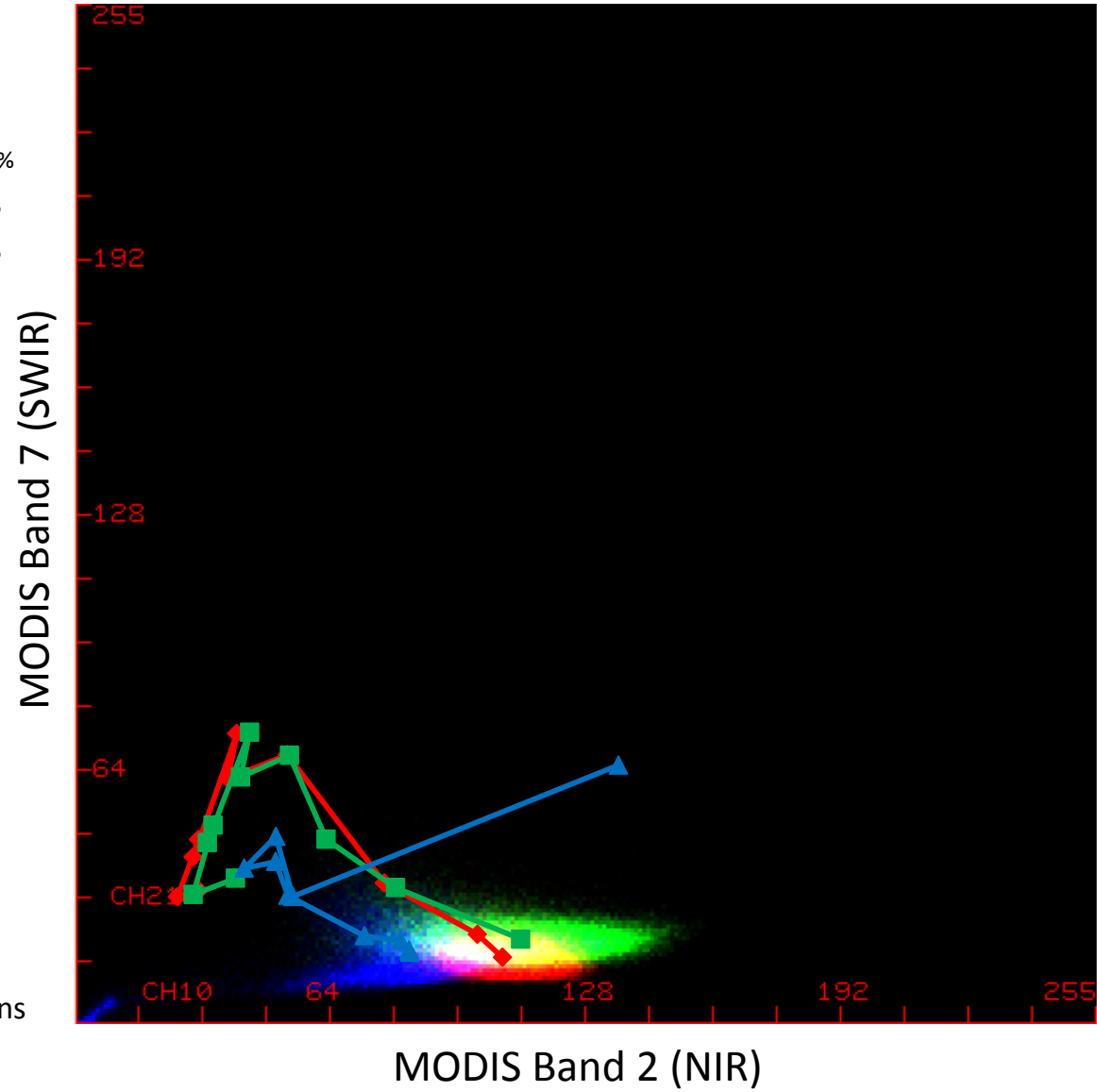
Minnesota 2008

August 11





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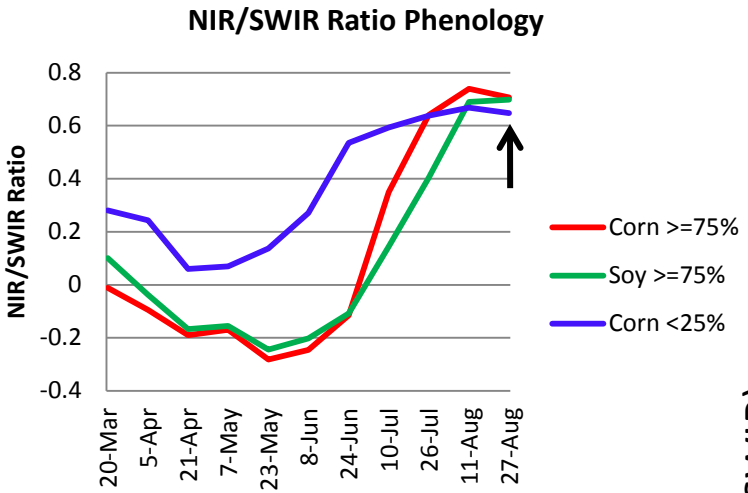
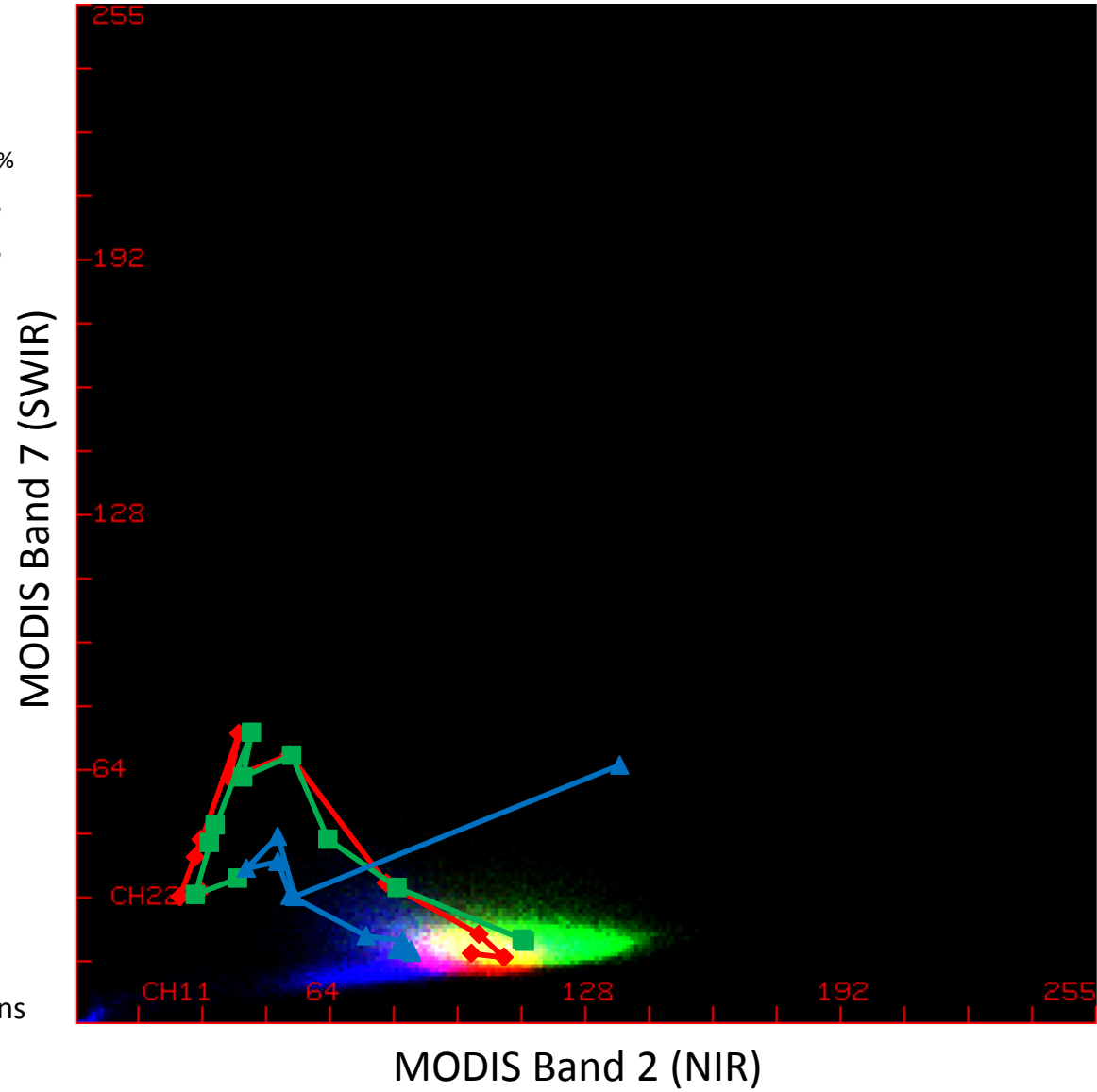
Minnesota 2008

August 27





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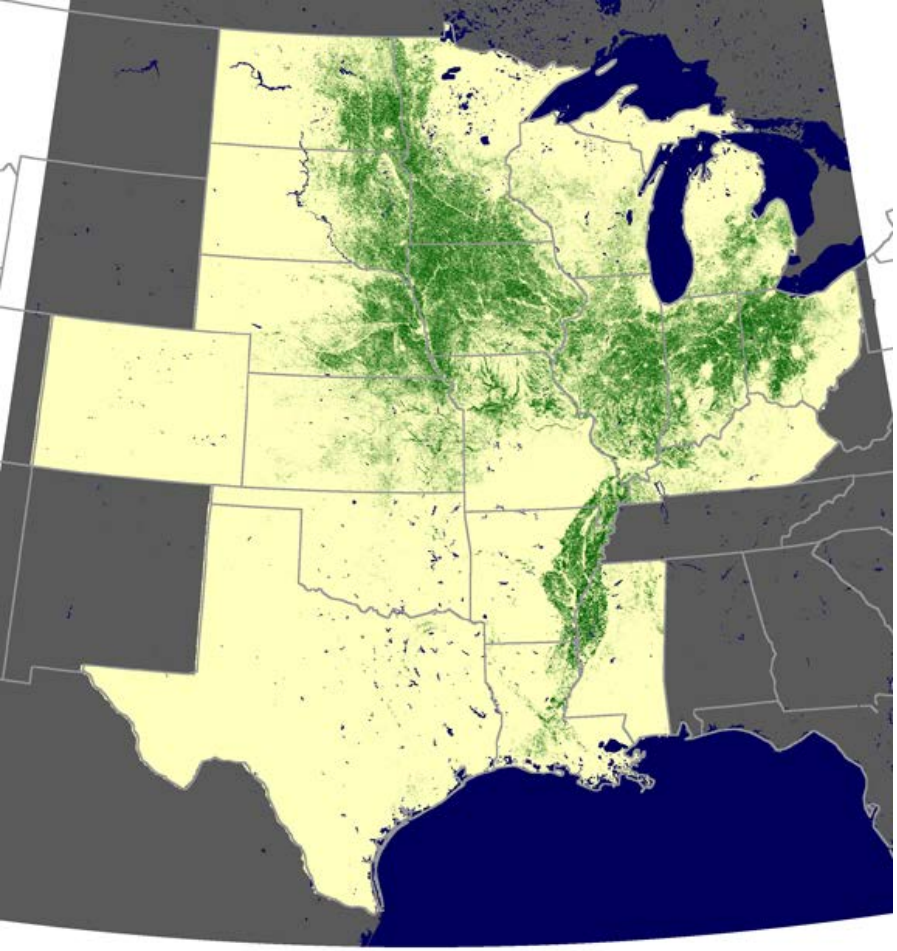
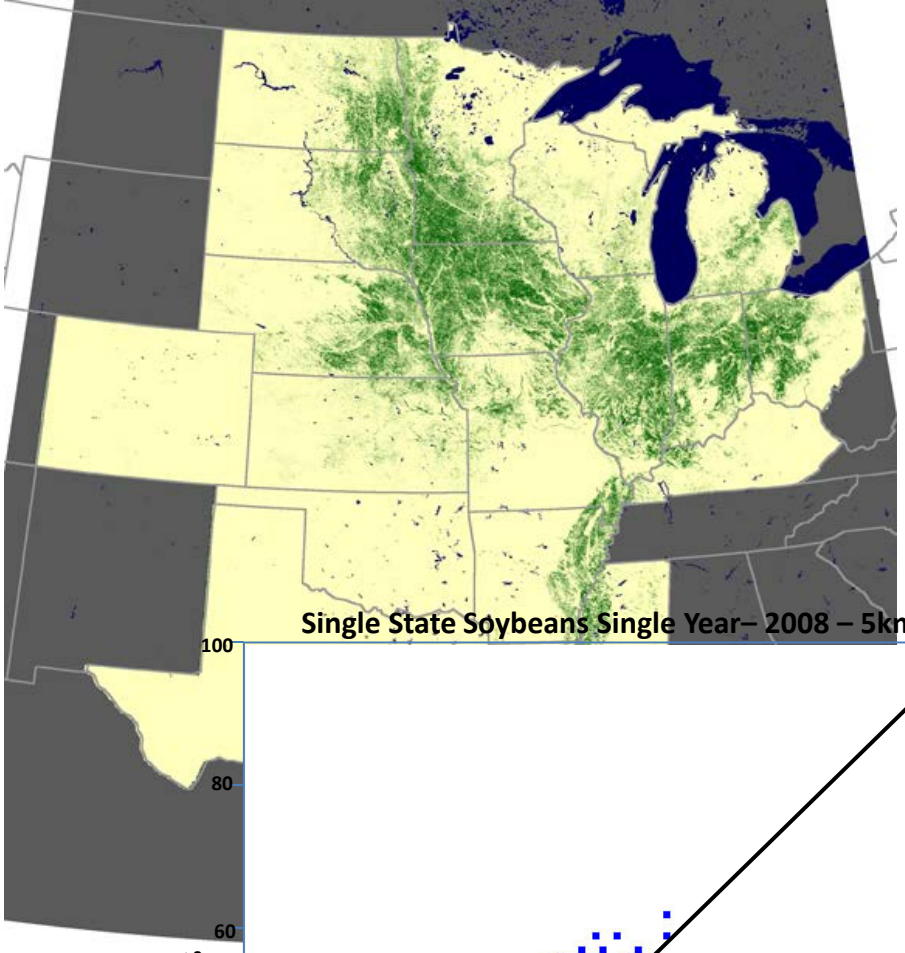
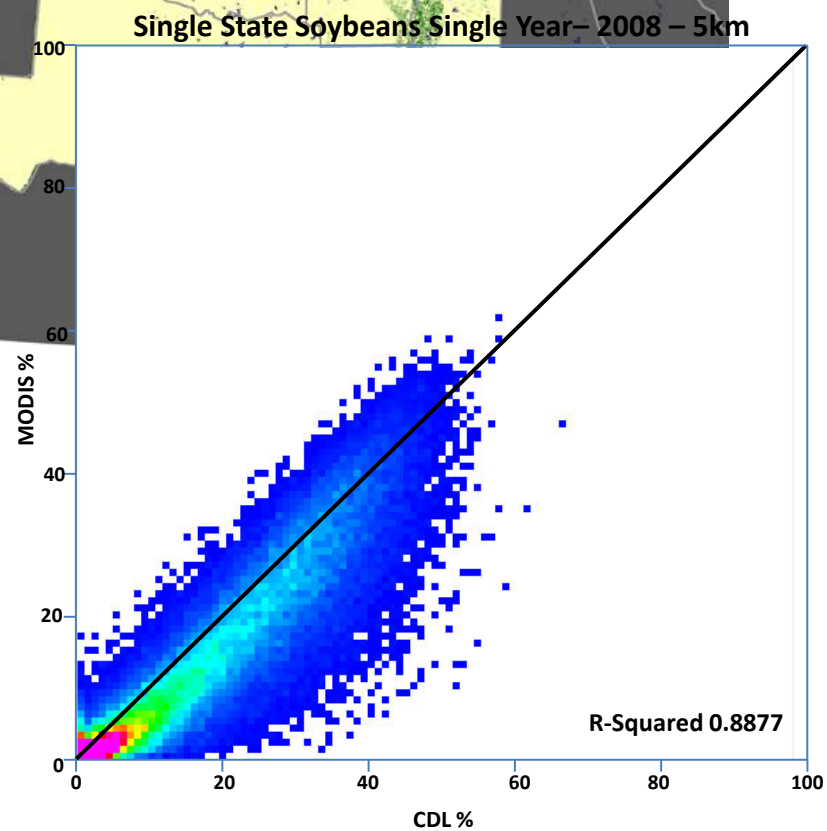


NASS AWiFS CDL 2008 soy



MODIS 2008 soy



MODIS data for soy indicator mapping – per state model

Example results for winter wheat

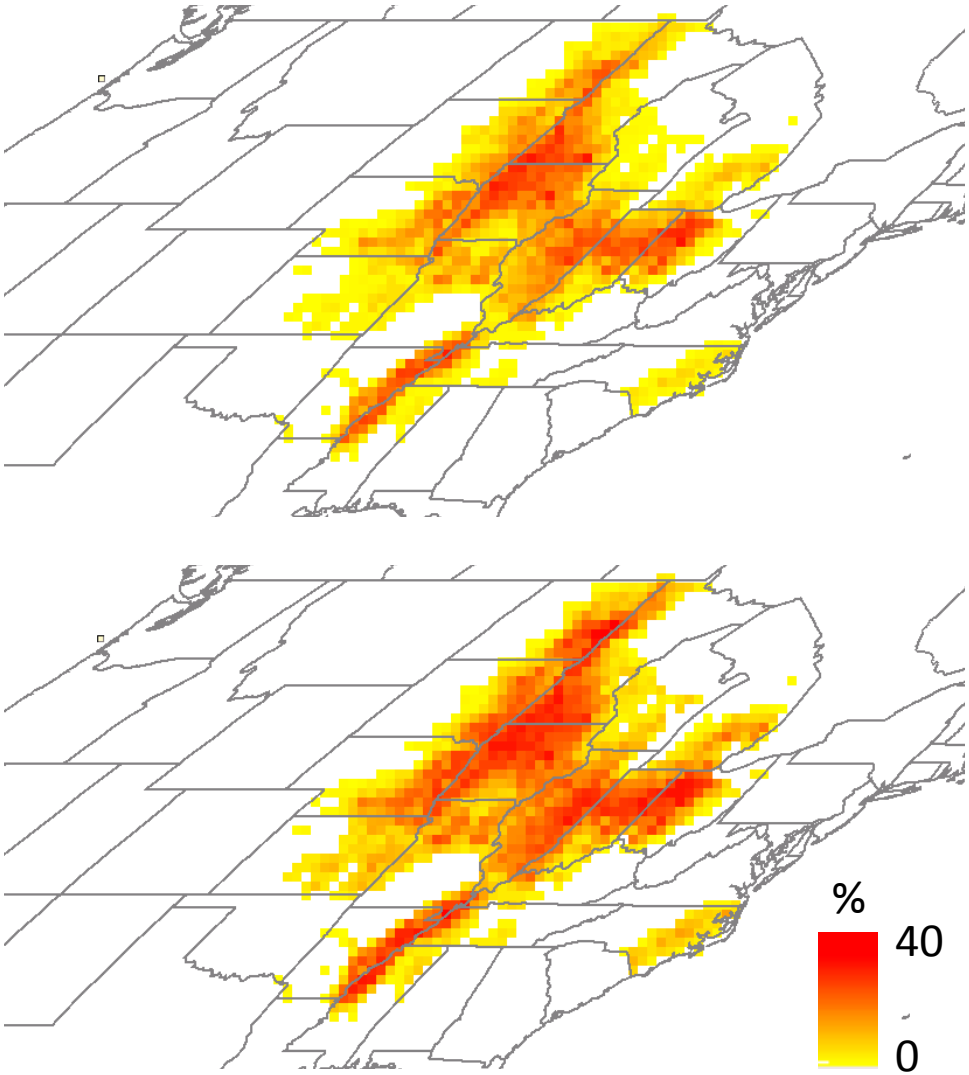
Regression estimator

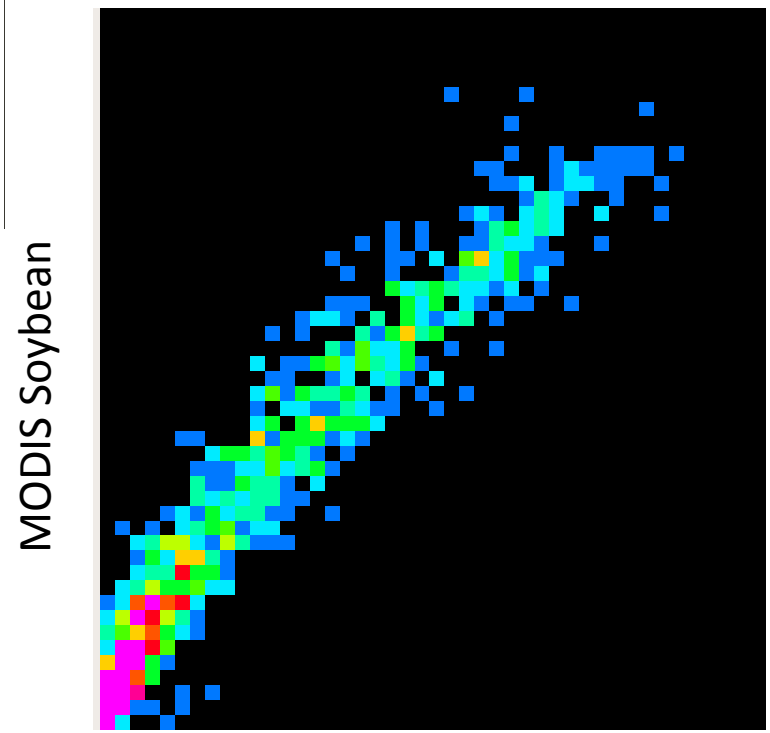
The following is an example test from NASS on incorporating in-season MODIS-derived percent wheat layers as well as select MODIS time-series metrics (all) in the regression estimator procedure for NASS crop area estimation.

r^2			
Kansas strata	CDL	MODIS (all)	CDL+MODIS
11	0.888	0.837	0.903
12	0.917	0.914	0.930
20	0.954	0.884	0.930
Oklahoma strata			
11	0.884	0.848	0.892
12	0.920	0.882	0.873
20	0.951	0.930	0.948
40	0.774	0.807	0.762

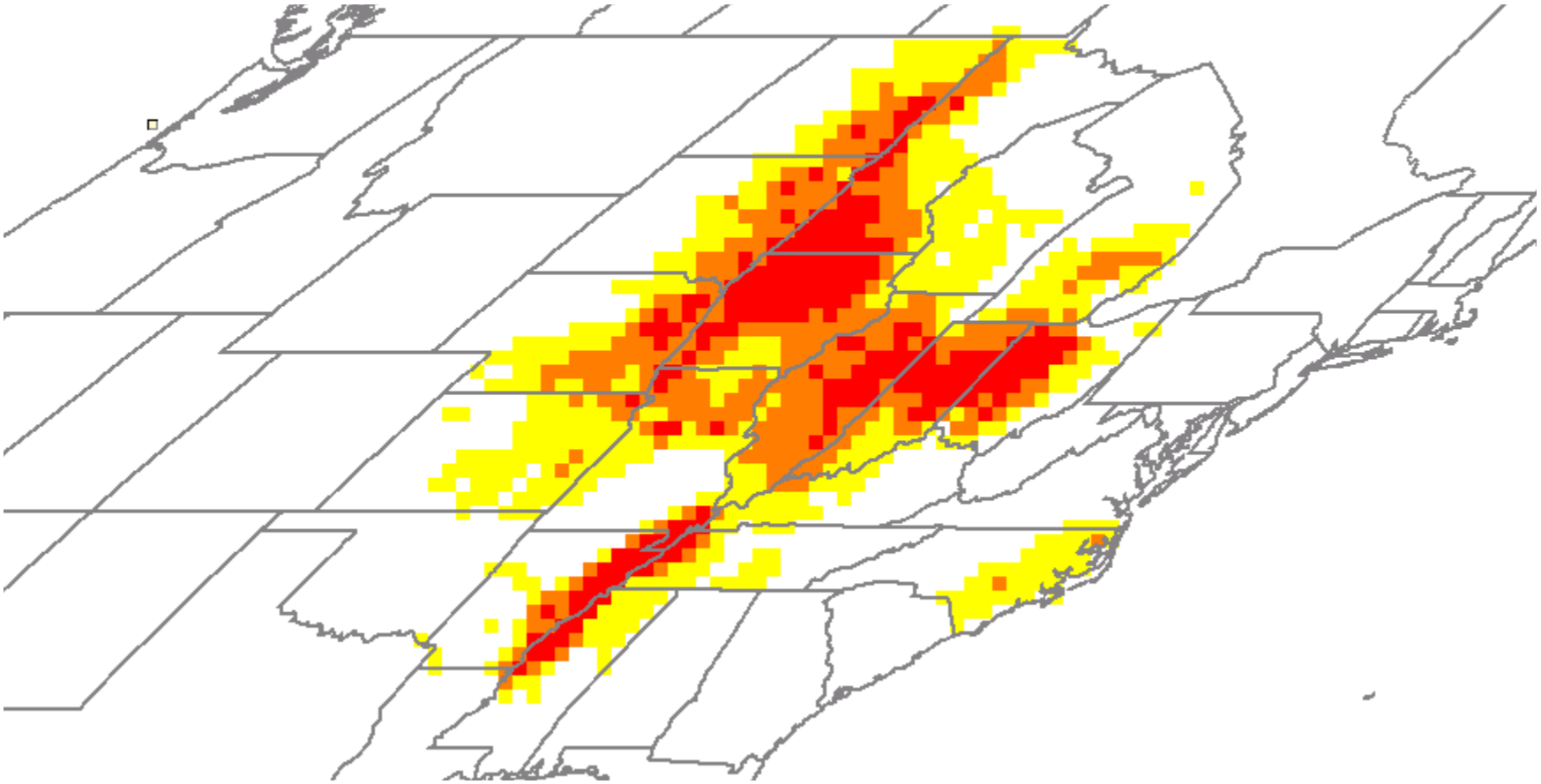
MODIS does better in the regression estimator procedure than per pixel mapping. However, results are not consistently better, bringing into question the generic value of adding MODIS metrics to the CDL processing stream.

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



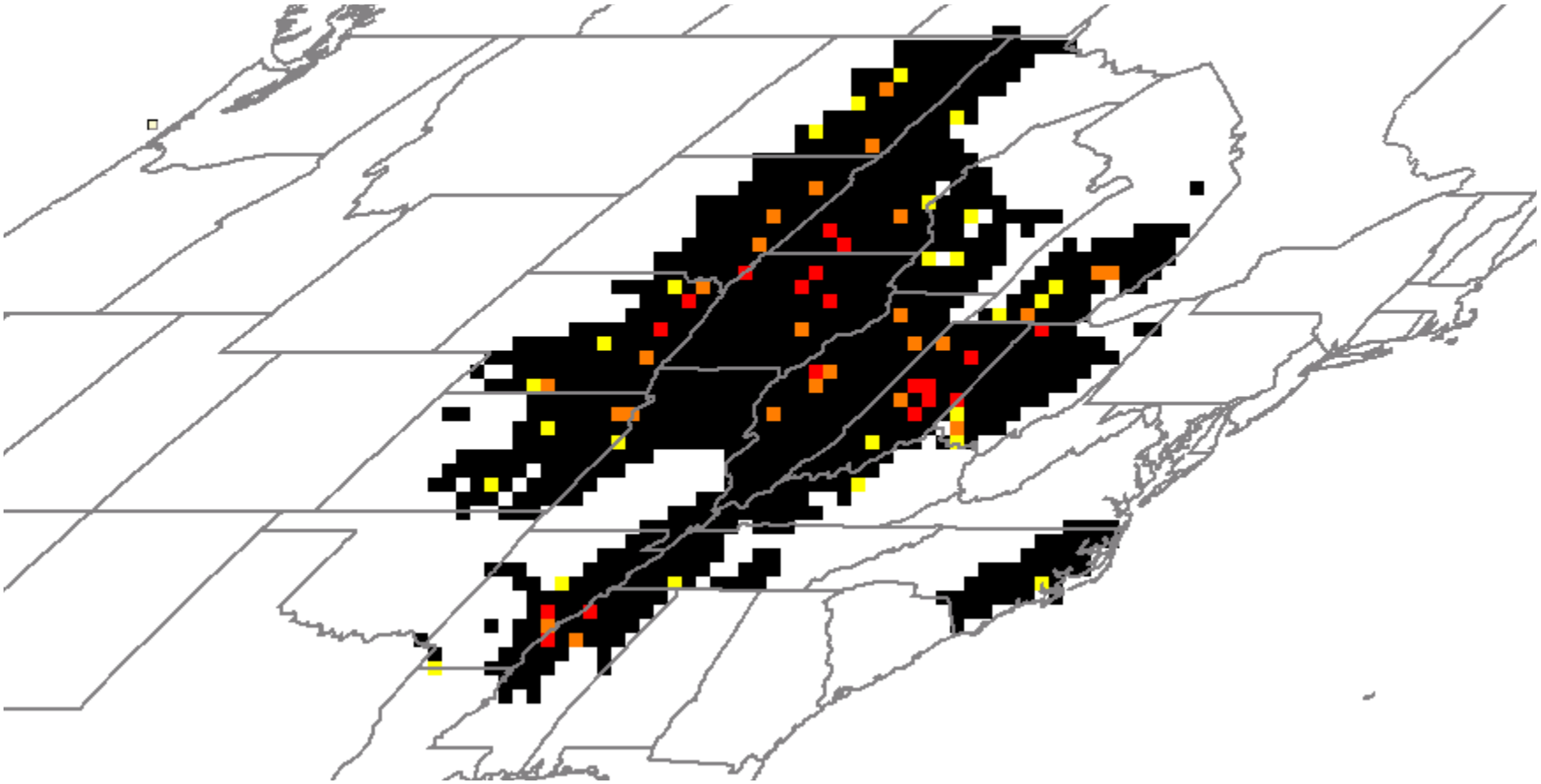


High, medium and low soybean strata



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

Landsat sample blocks



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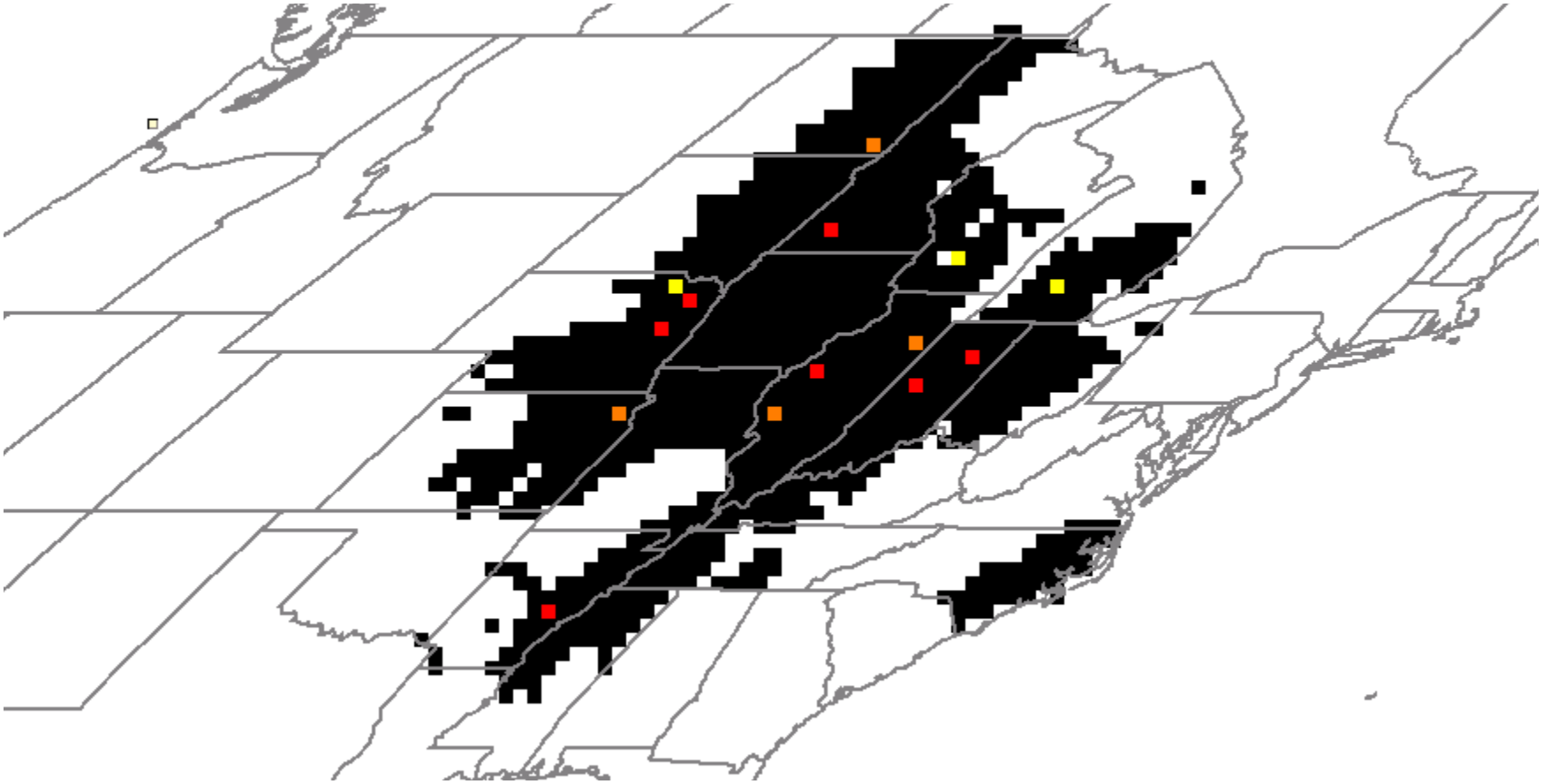
RapidEye locations



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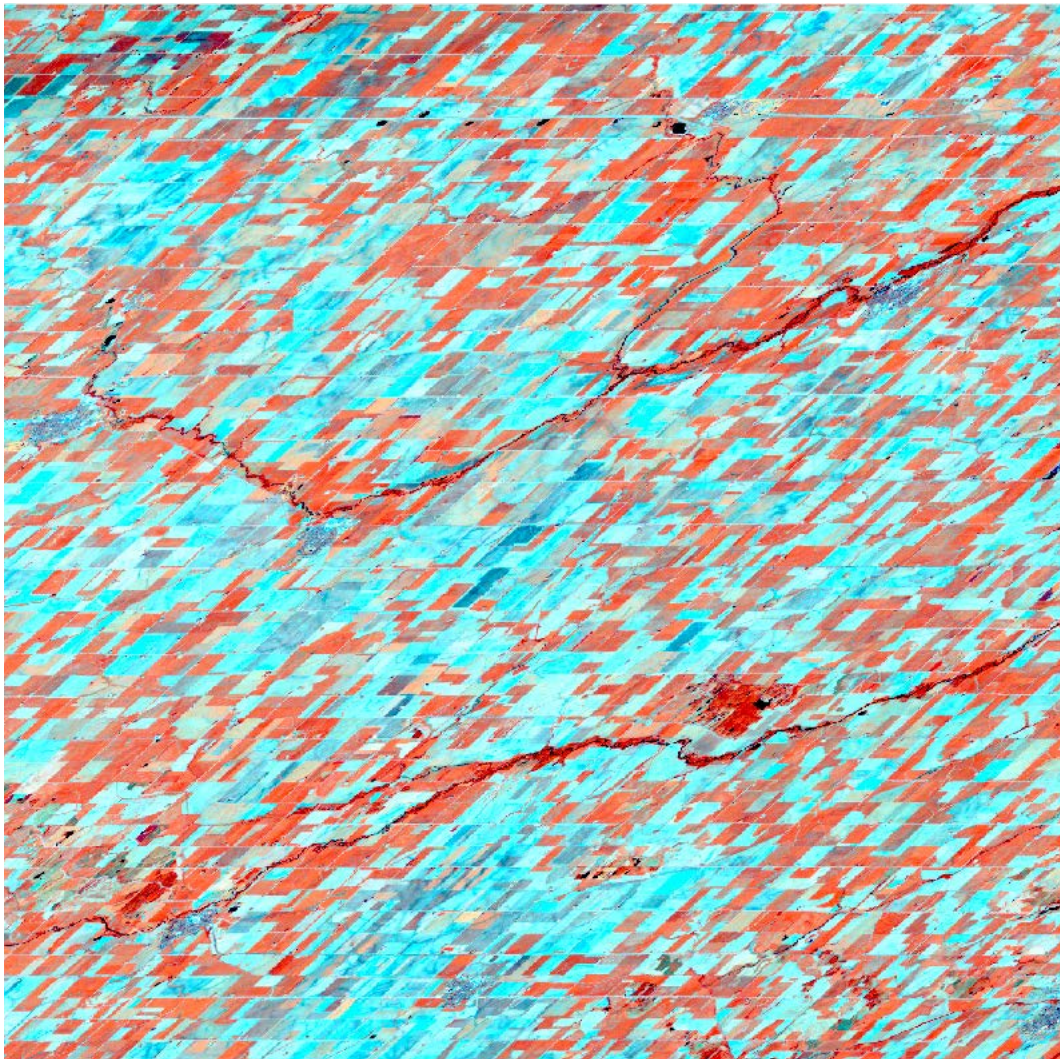
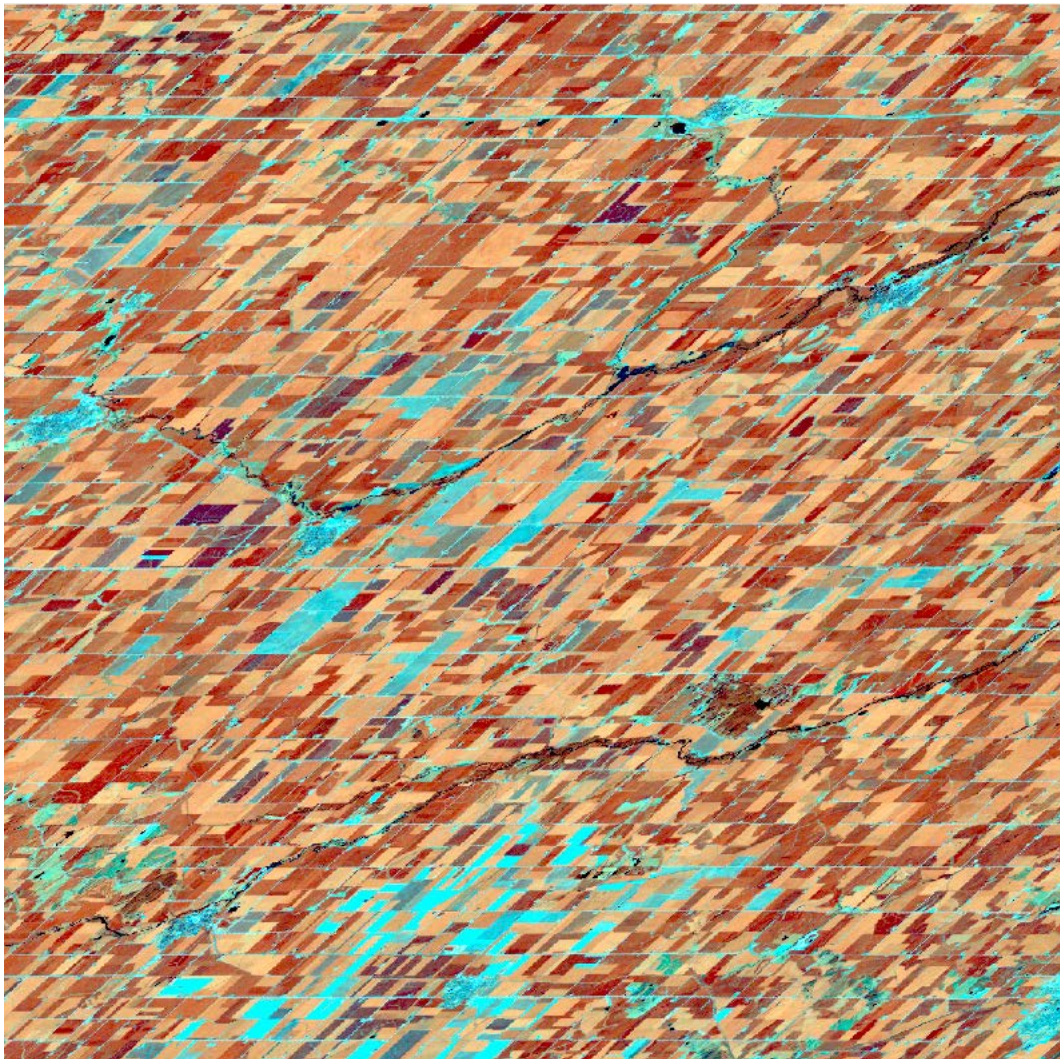
Iowa – Corn Belt



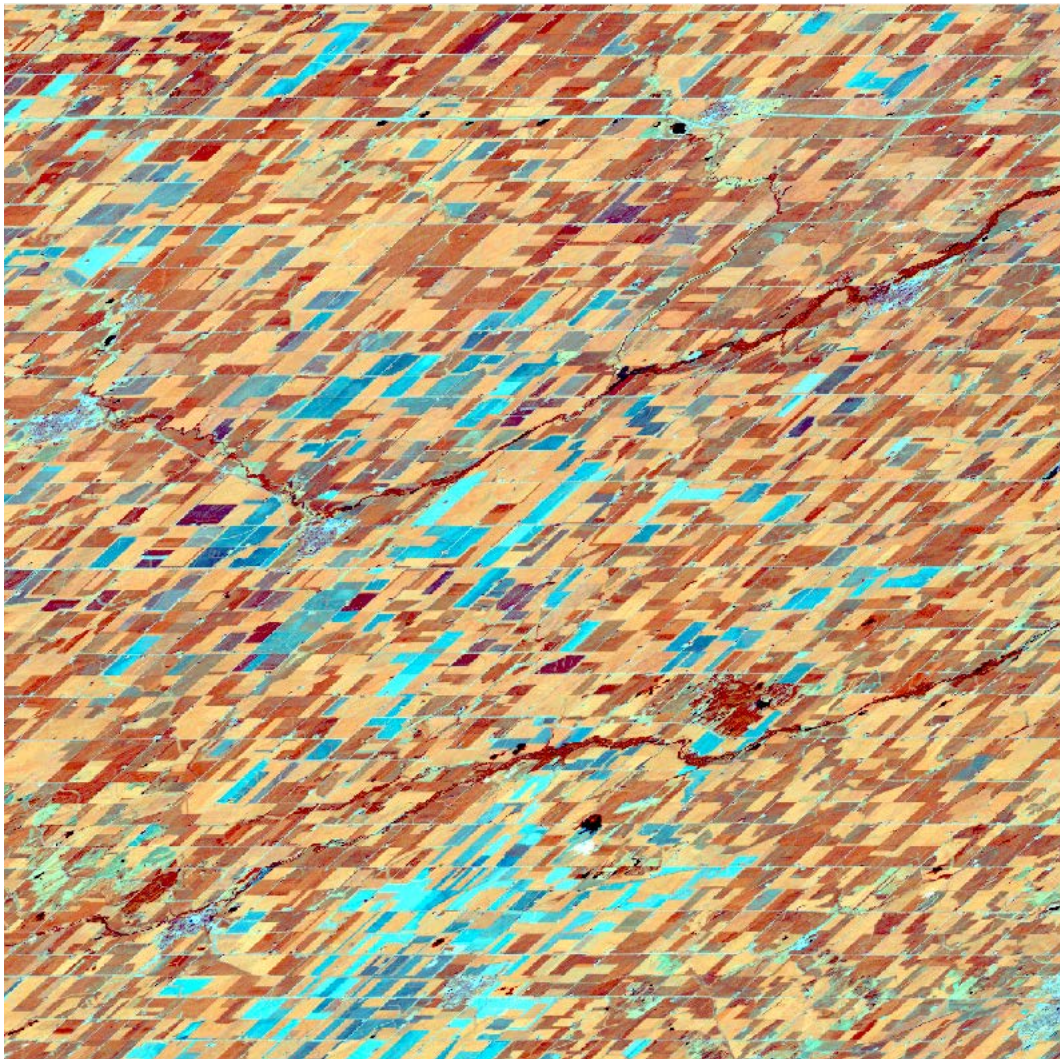
July 2, 2011 - LT50260312011183PAC01

Iowa – Corn Belt



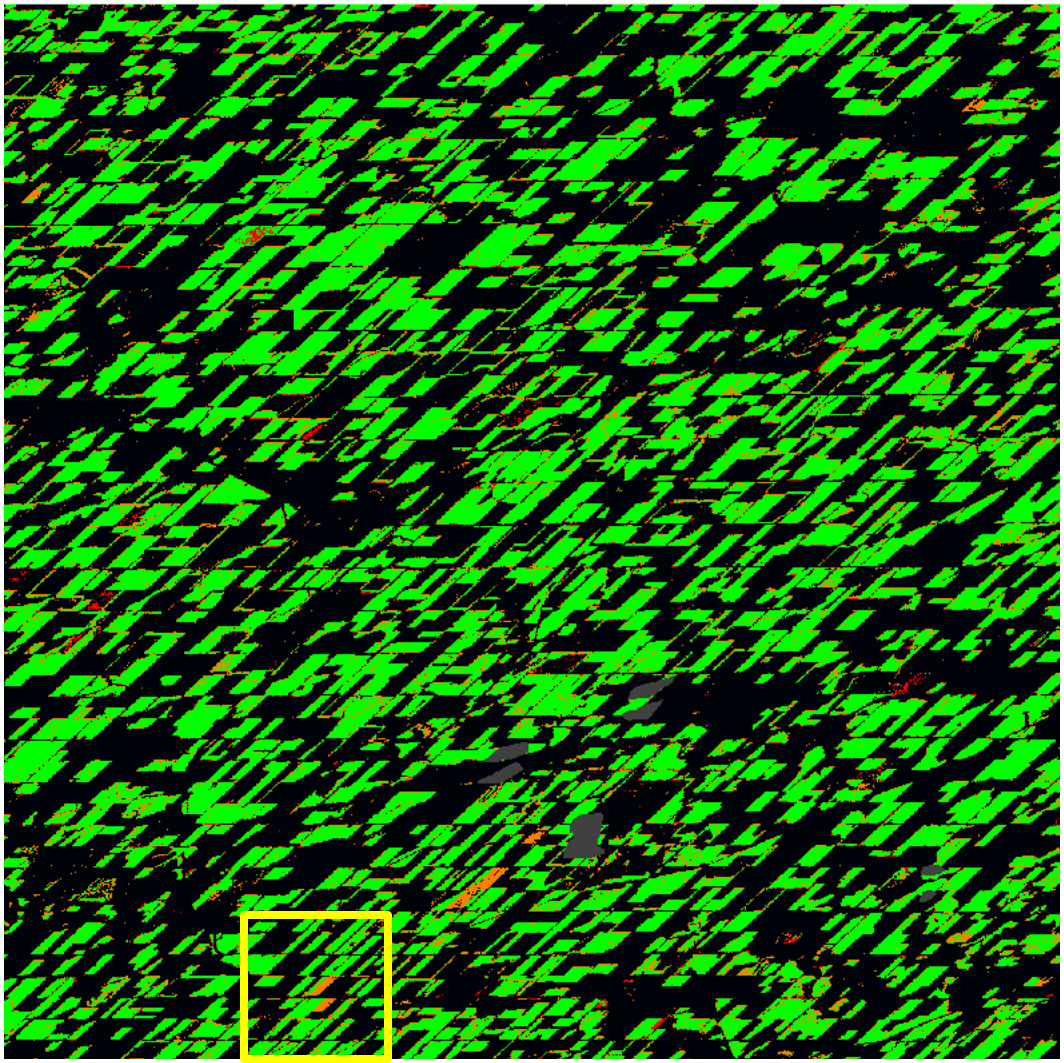
August 3, 2011 - LT50260312011215PAC01

Iowa – Corn Belt



Sept 4, 2011 - LT50260312011247PAC01

Iowa – Corn Belt



Soybean agreement

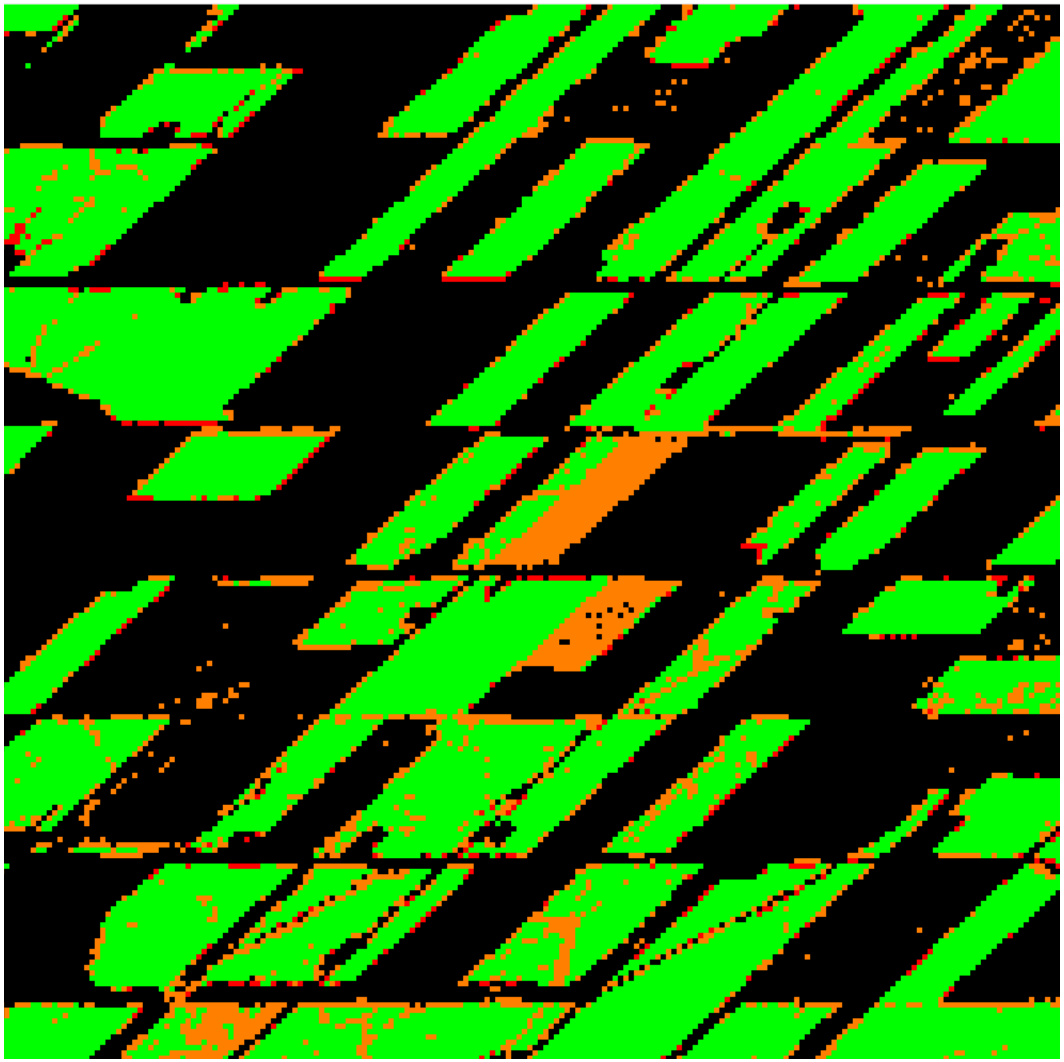
CDL no soybean / UMd soybean

CDL soybean / UMd no soybean

Soybean agreement –
CDL winter wheat double crop

CDL soybean / UMd no soybean
CDL winter wheat double crop

Iowa – Corn Belt



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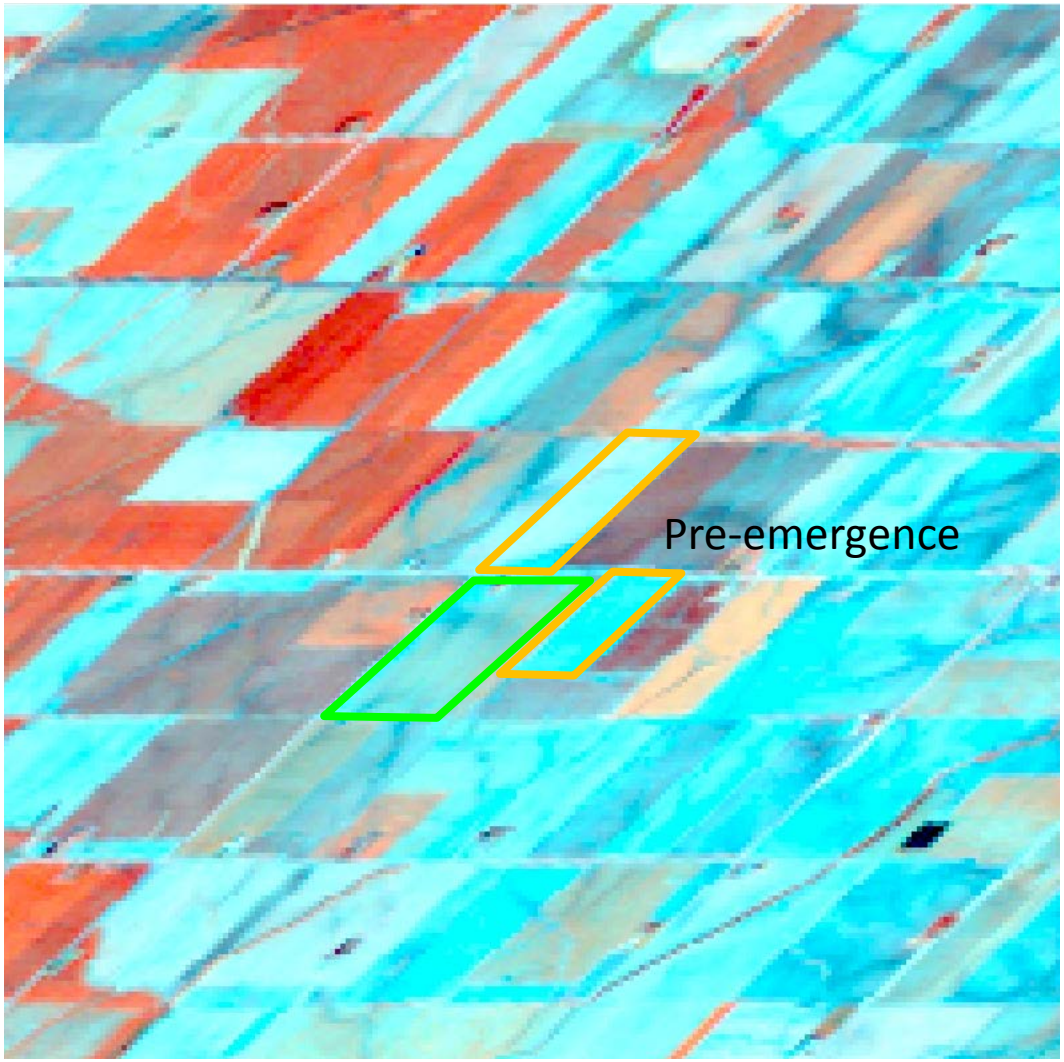

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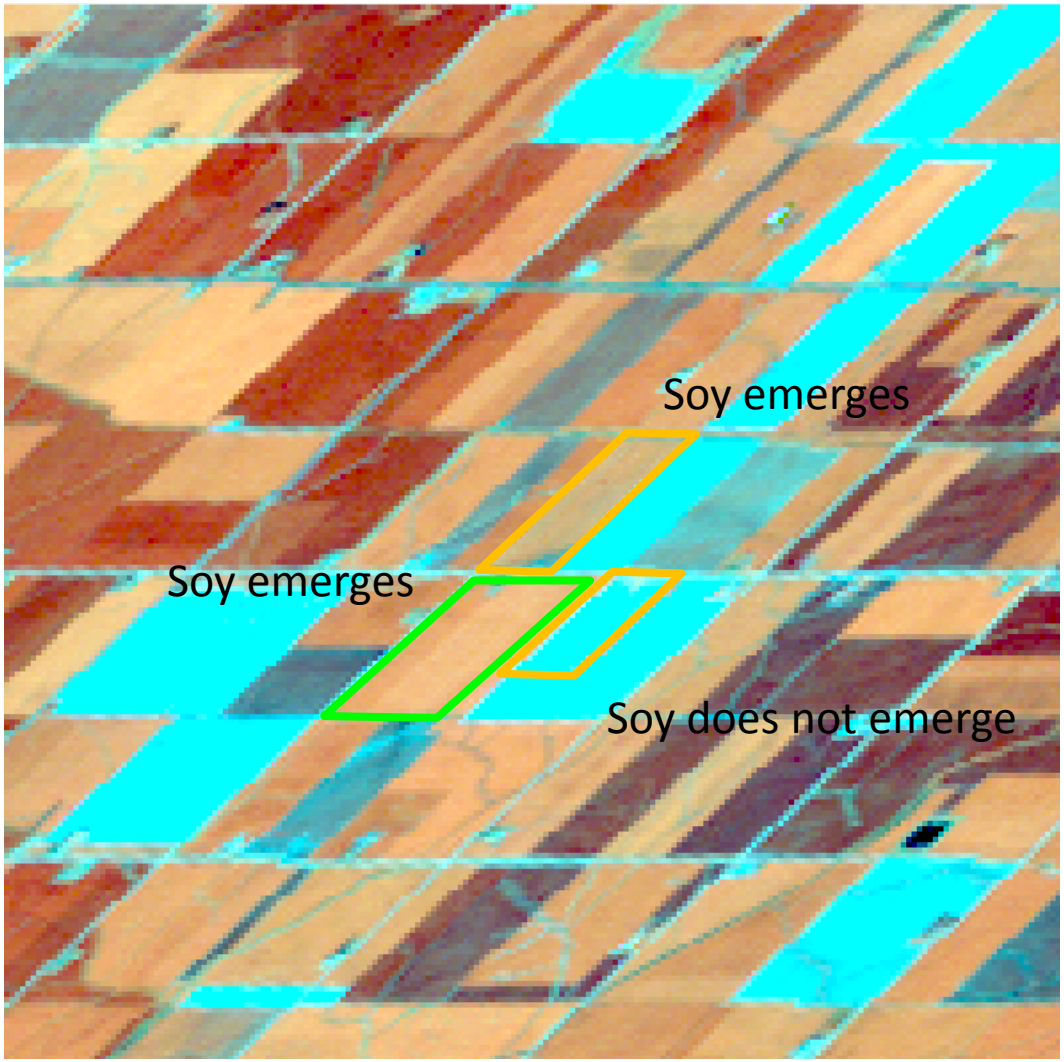

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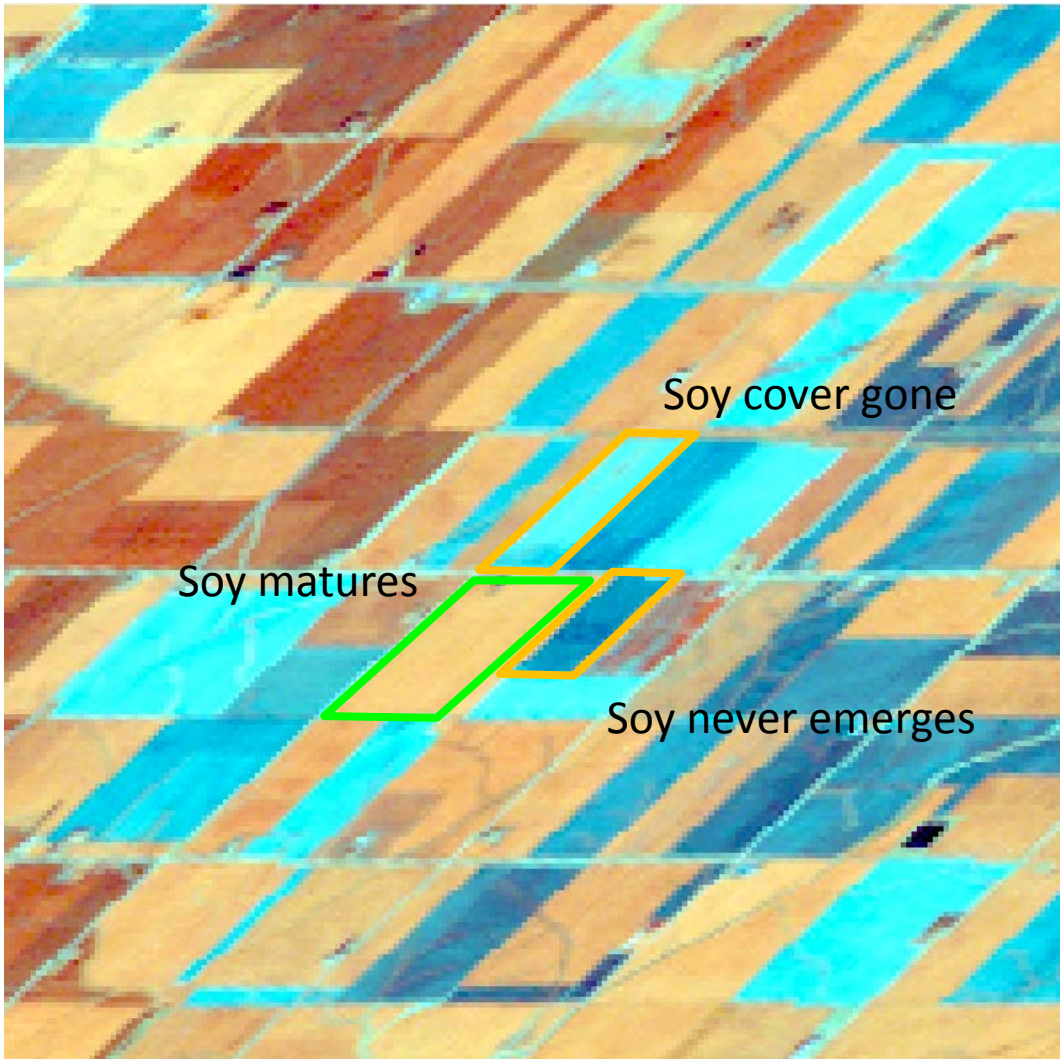

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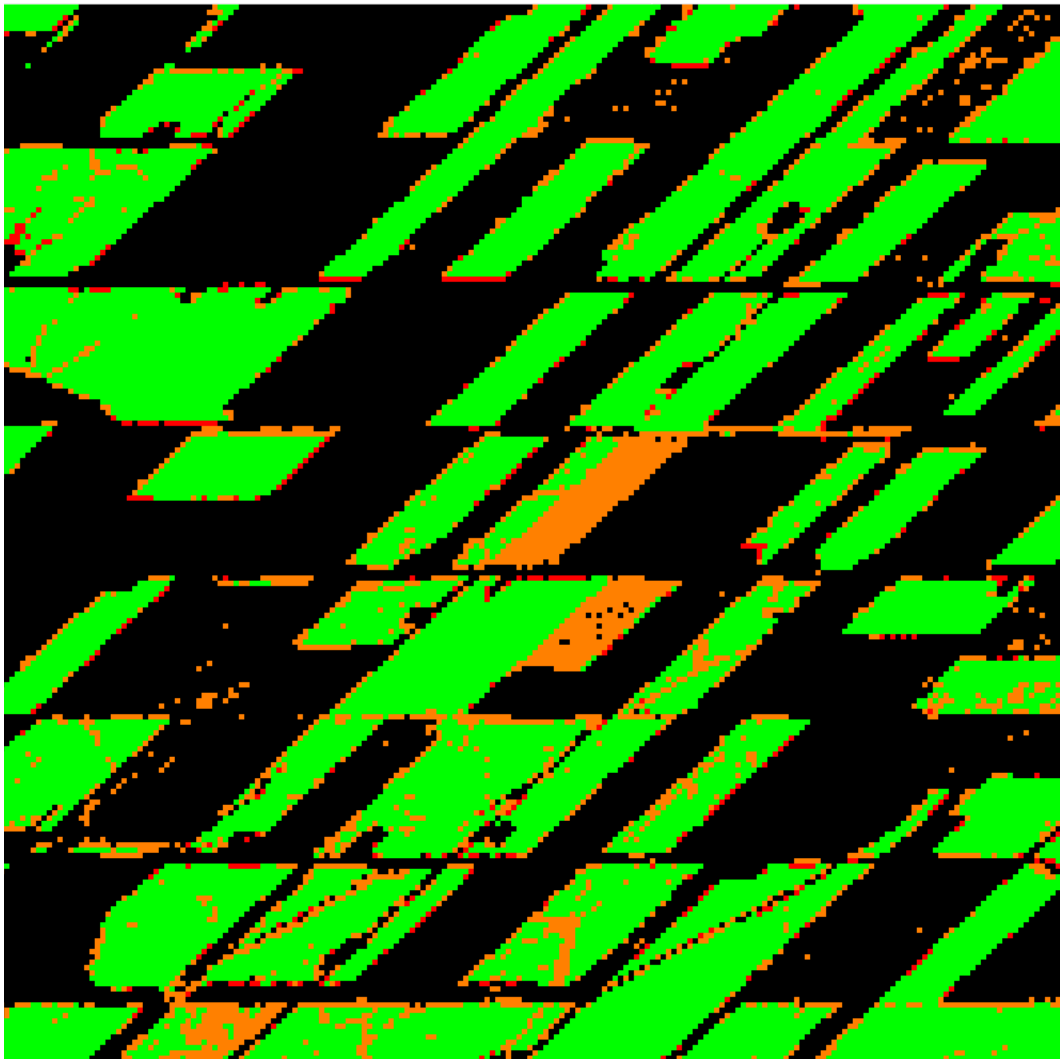

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Soybean agreement –
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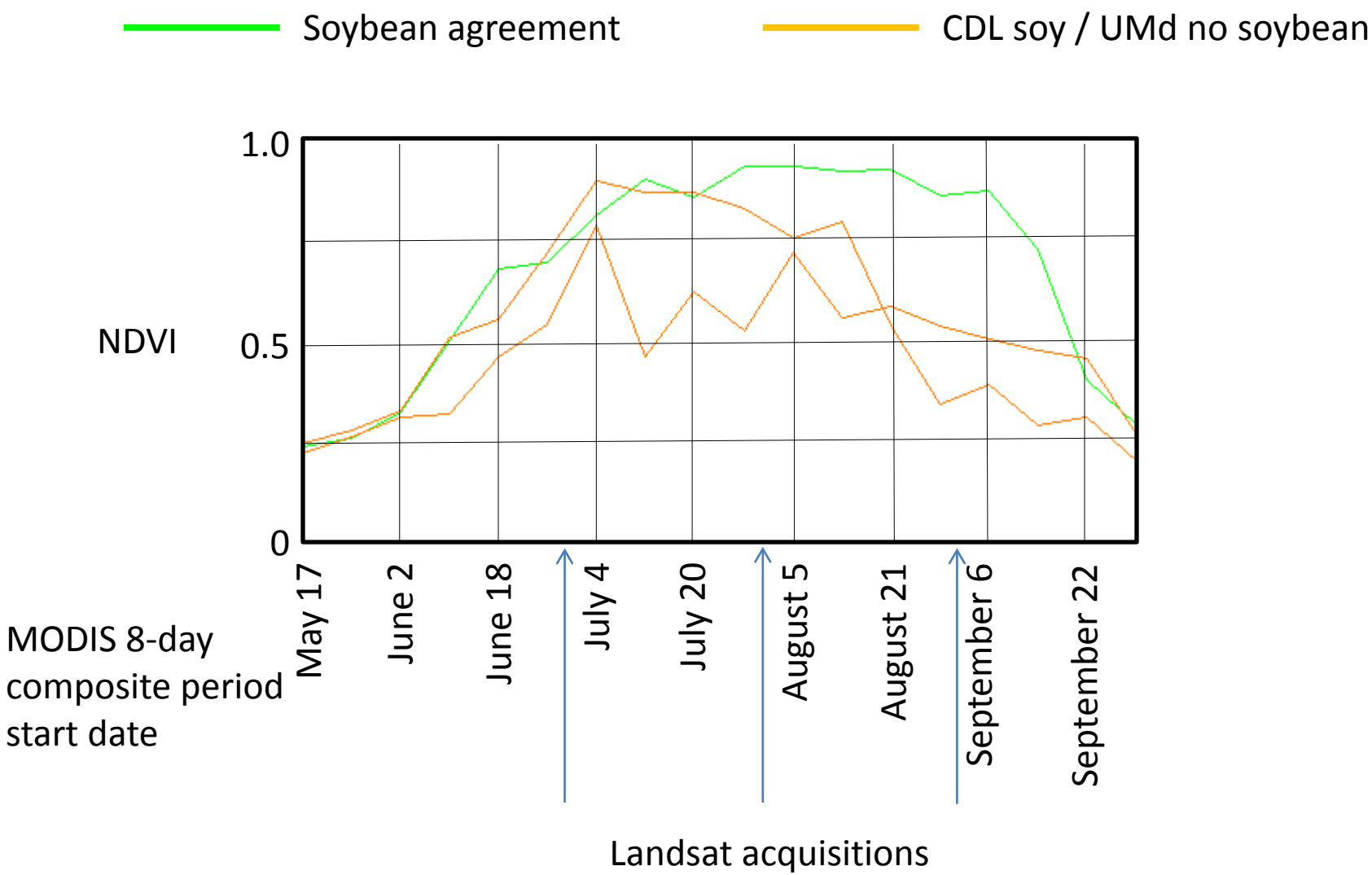
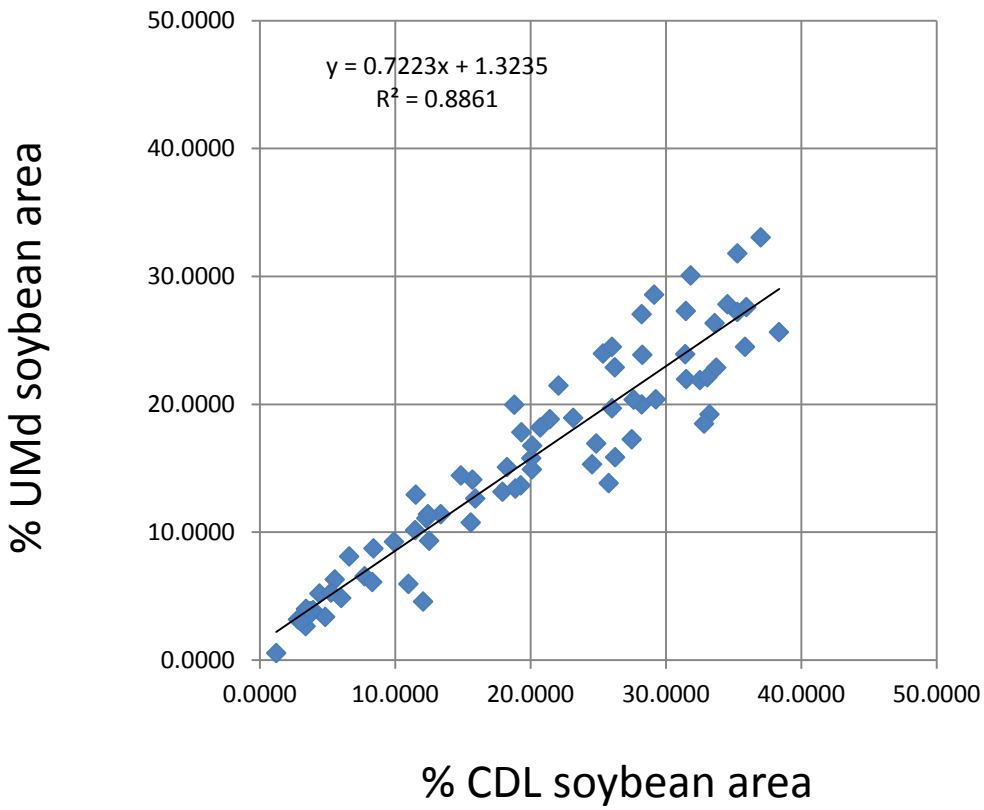
CDL winter wheat double crop

Comparison of 8-day MODIS over sample areas

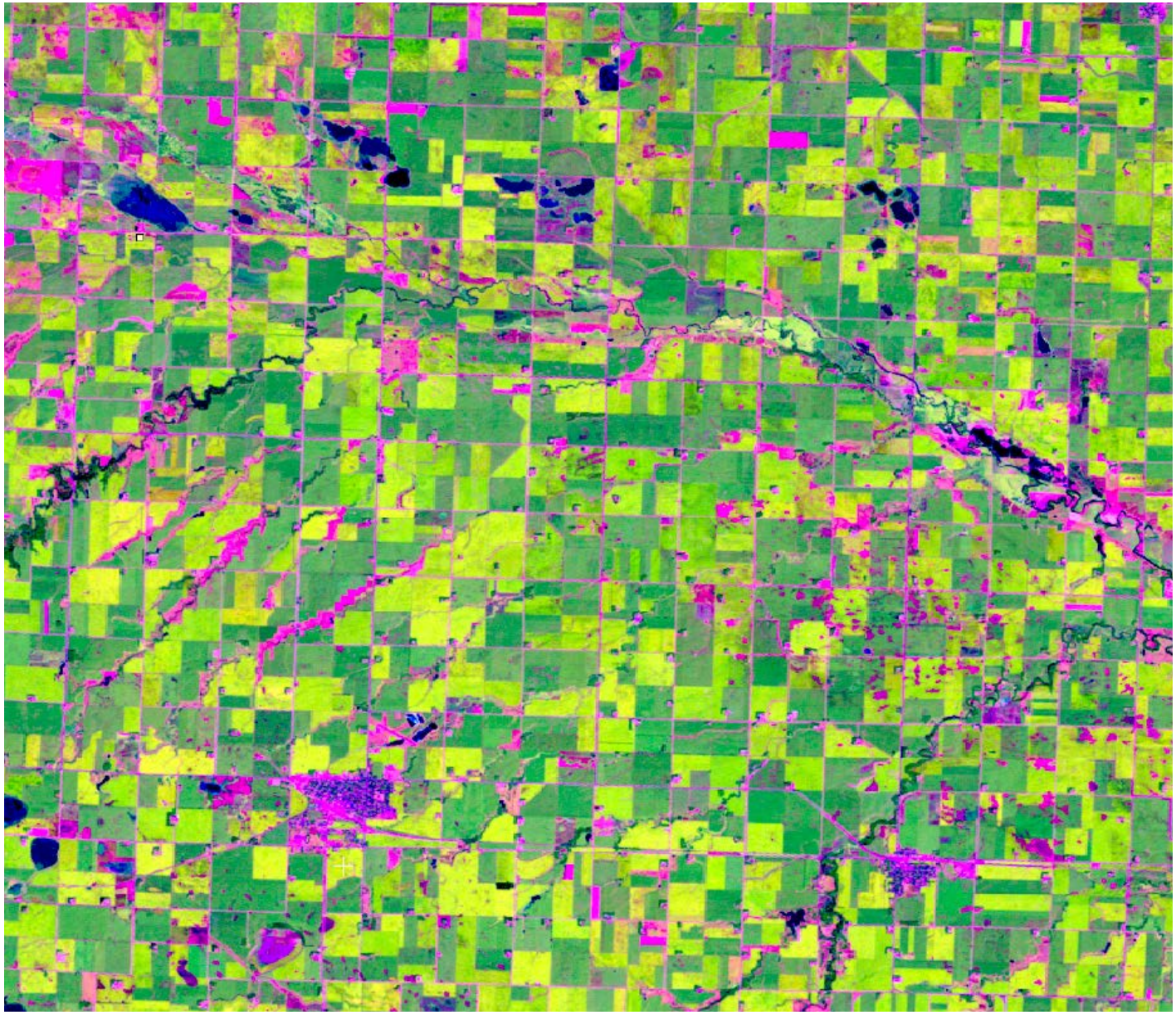


Preliminary block comparison – CDL vs. UMd



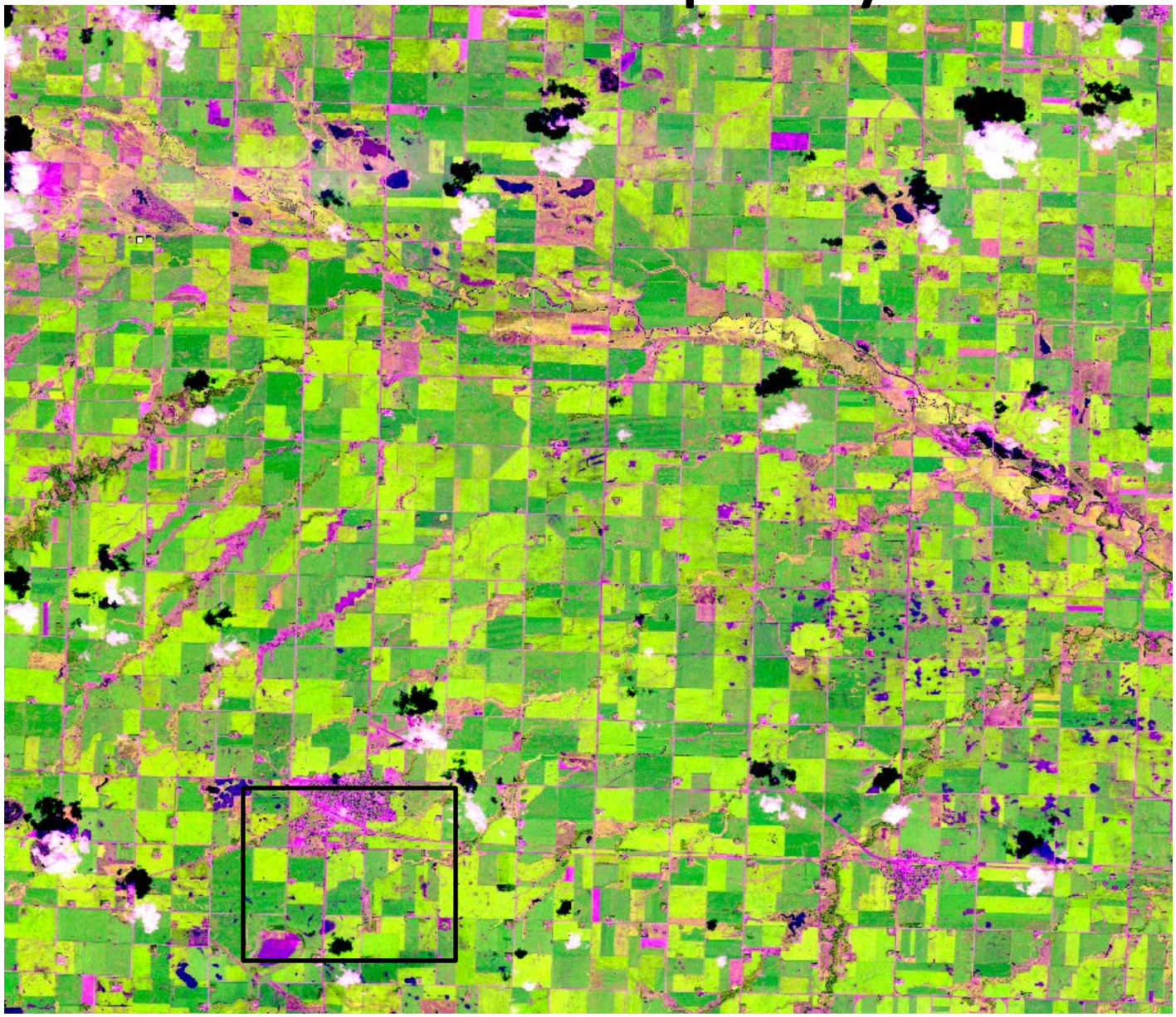
Comparison with single cropped soybean from CDL

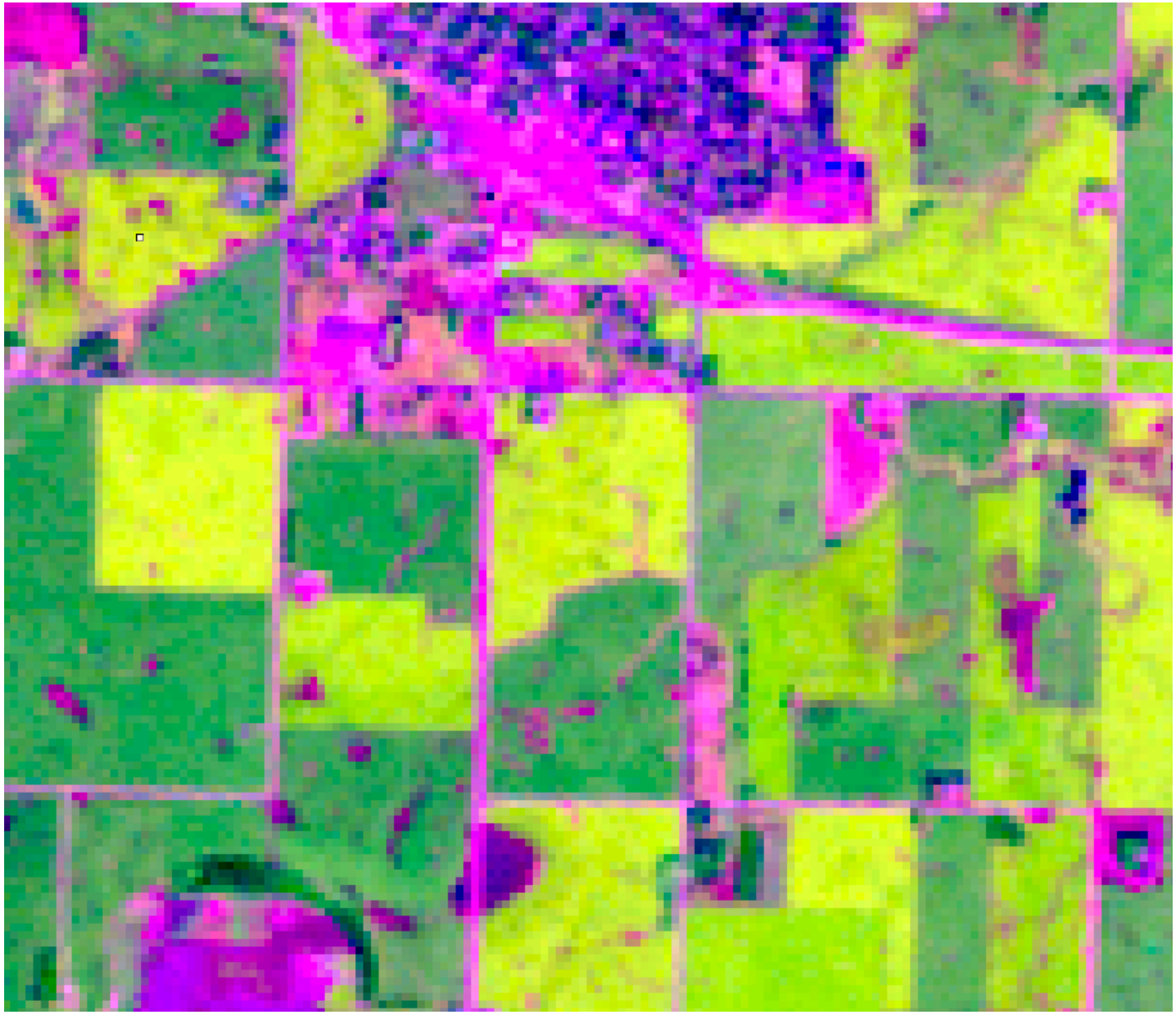
SW Minnesota Landsat 5-4-3

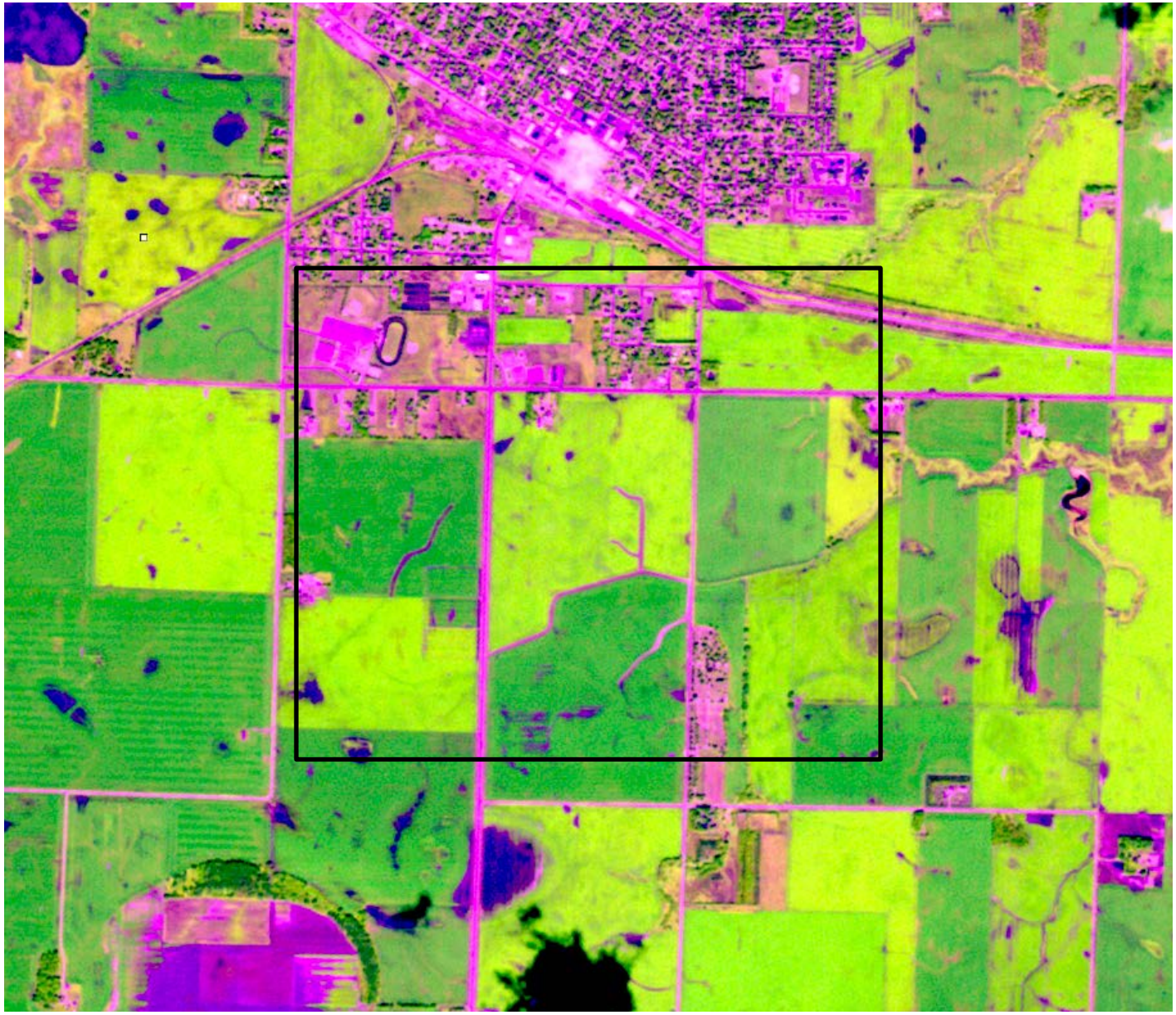


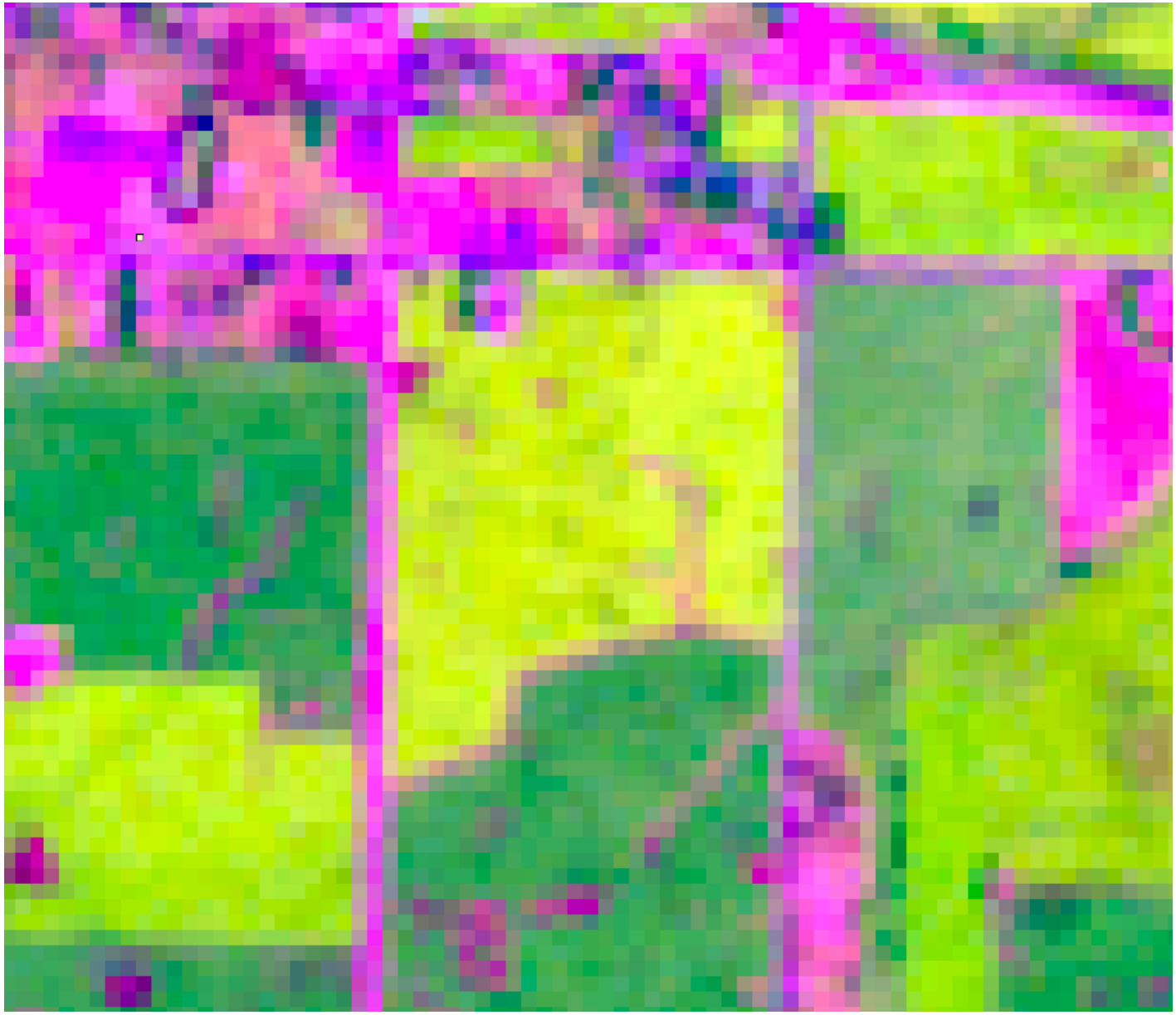
24km x 20km, centered on 95 35 24W, 44 19 38N

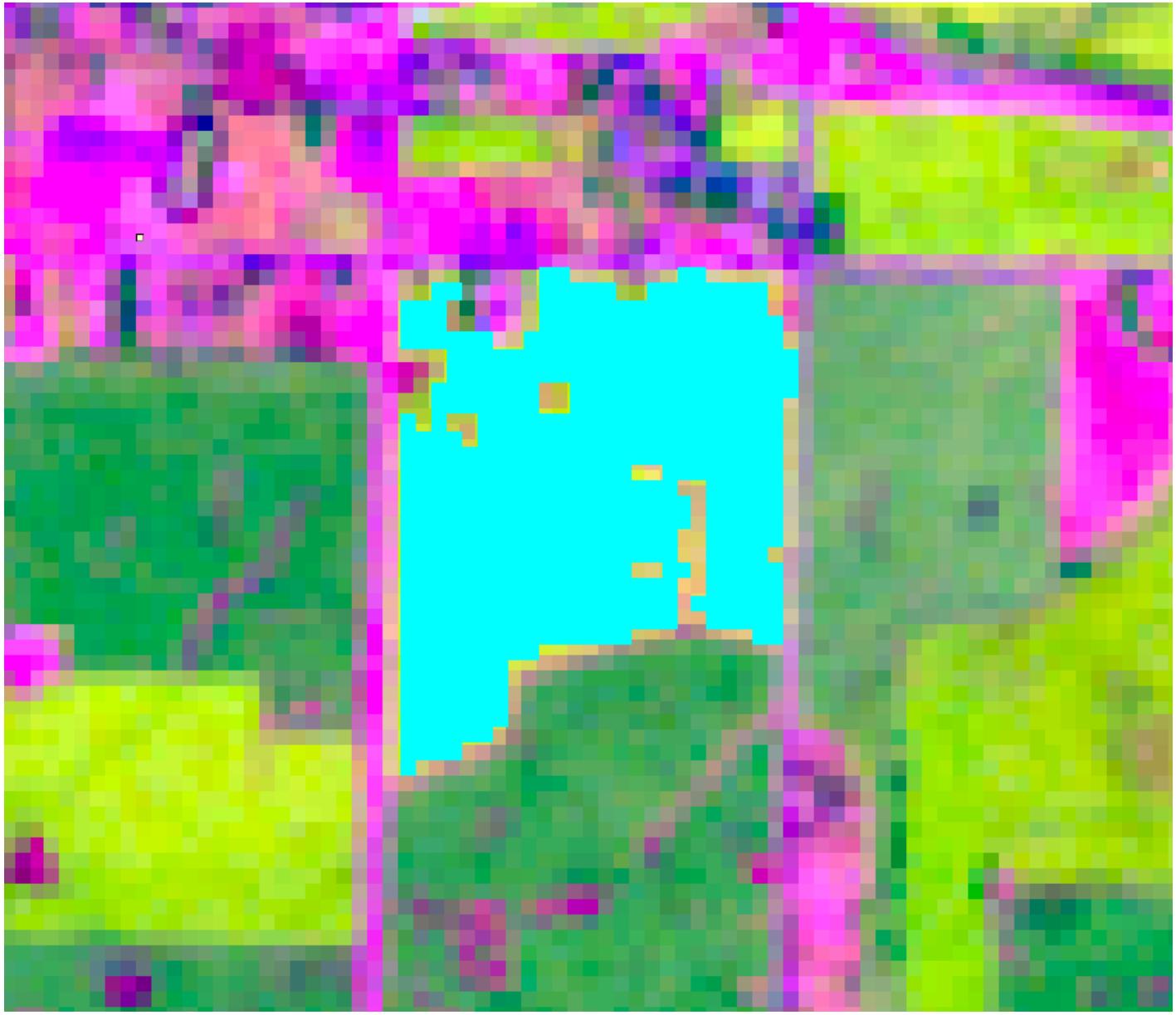
SW Minnesota RapidEye 4-5-3

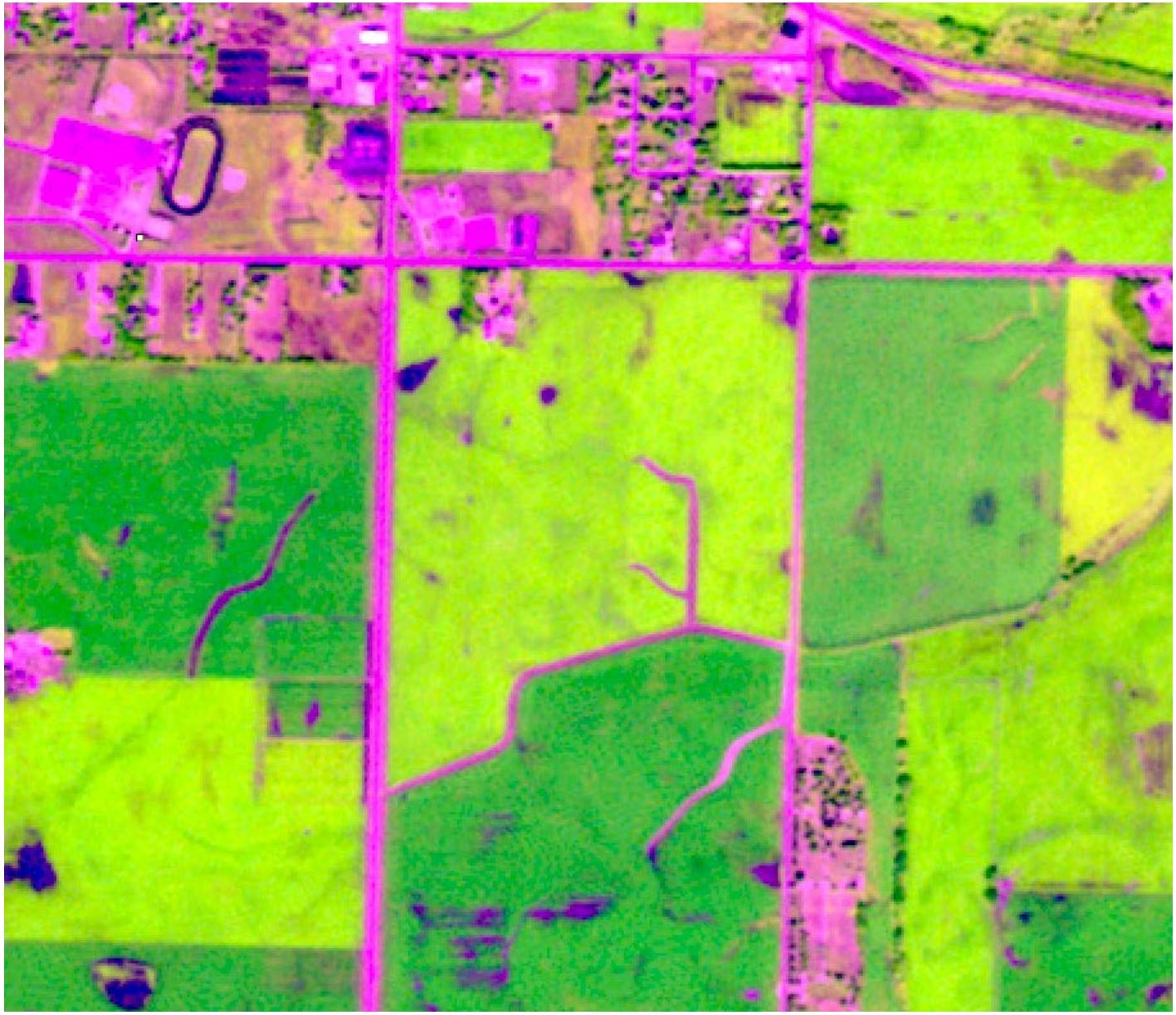


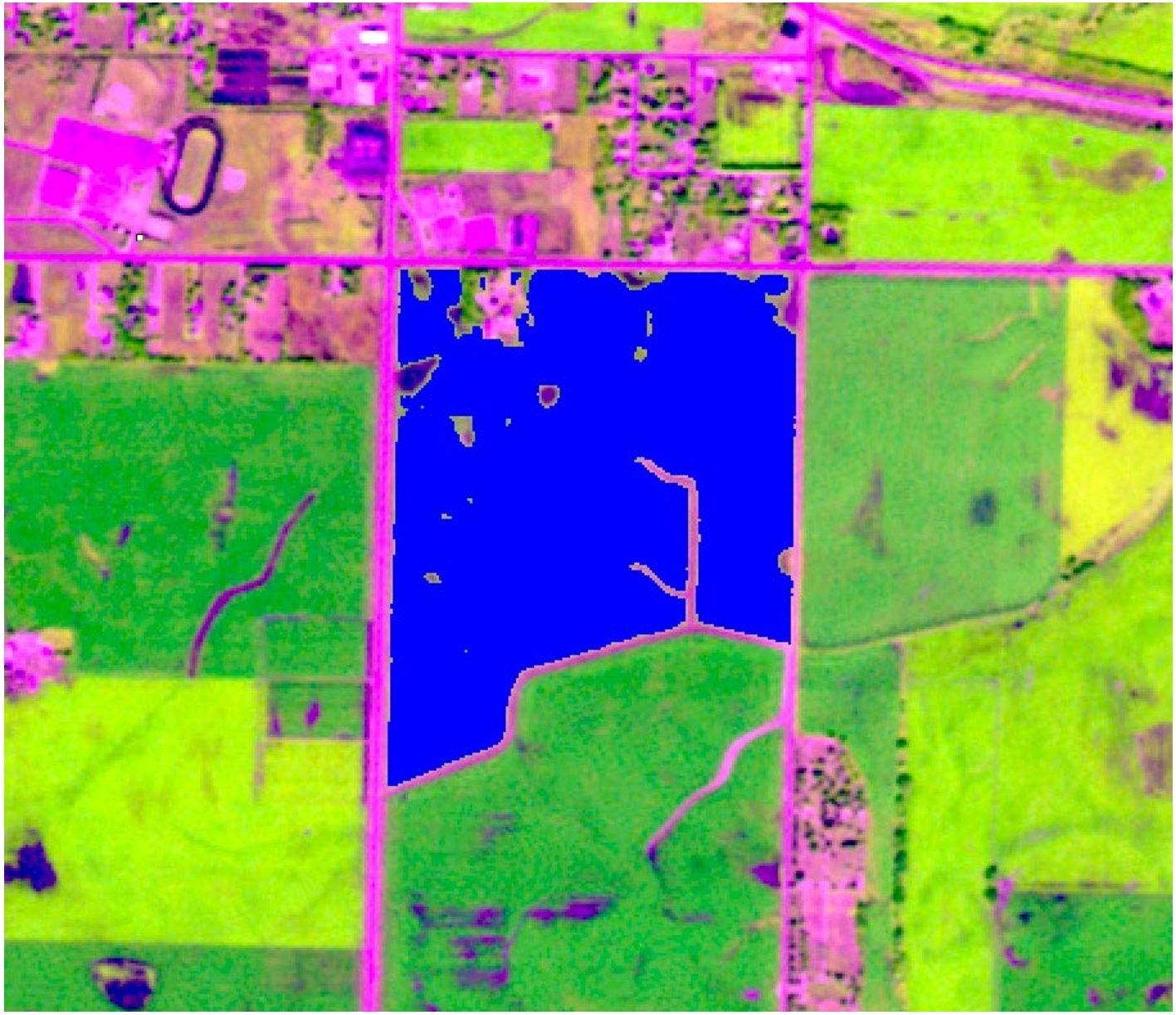






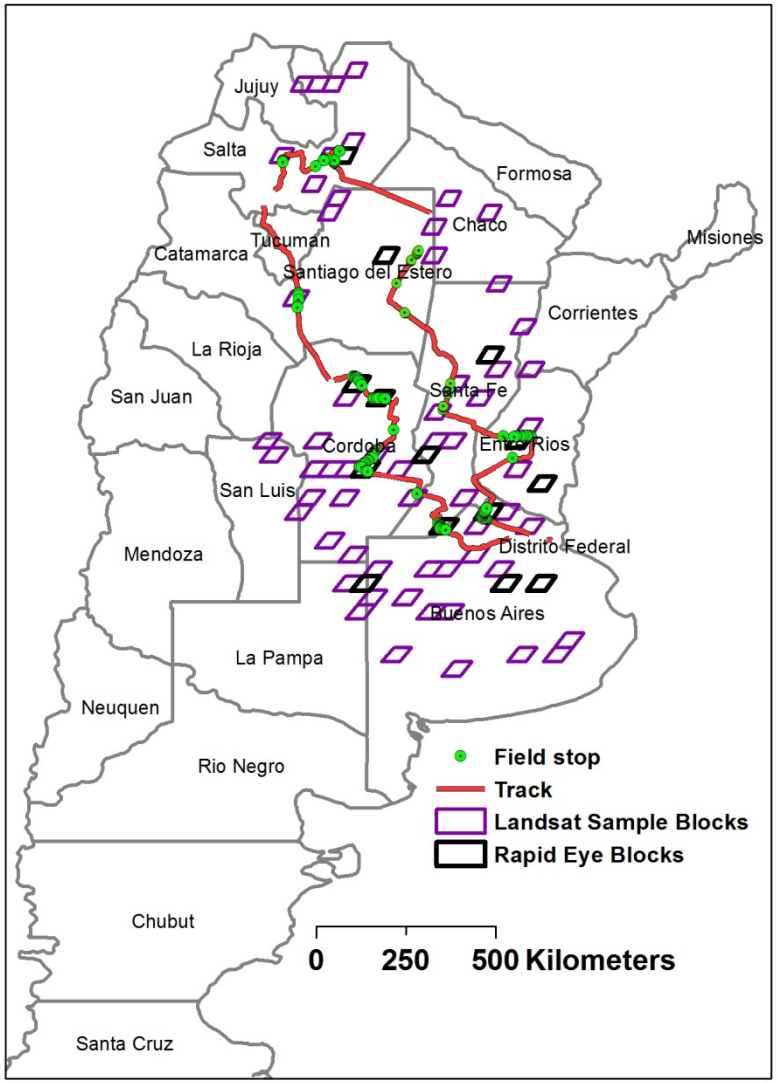






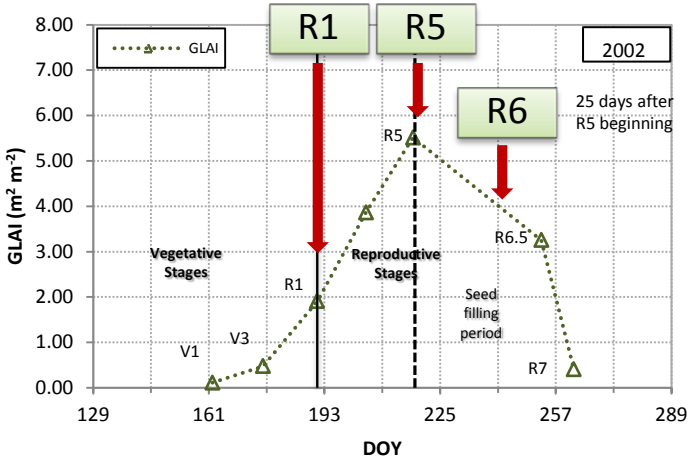
RapidEye – 140 acres, Landsat 126 acres

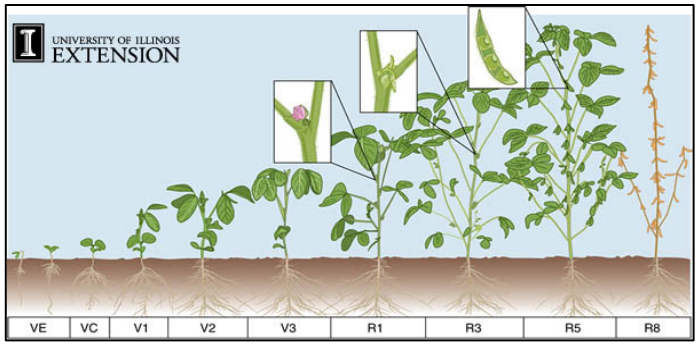
Argentina field data collection over selected sample blocks (Feb 2012)



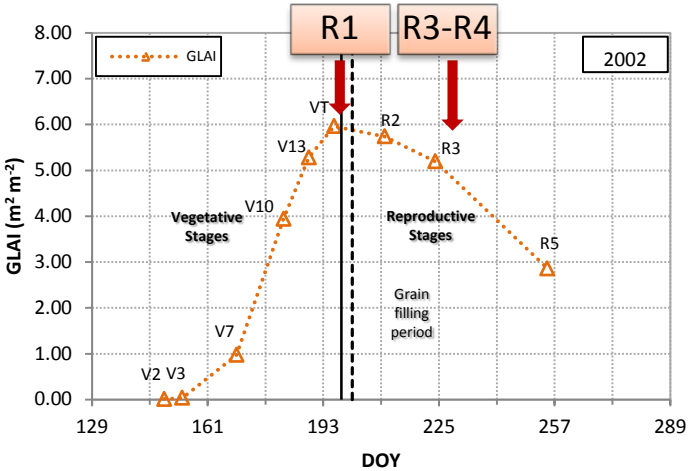
Soybean Yield Estimation

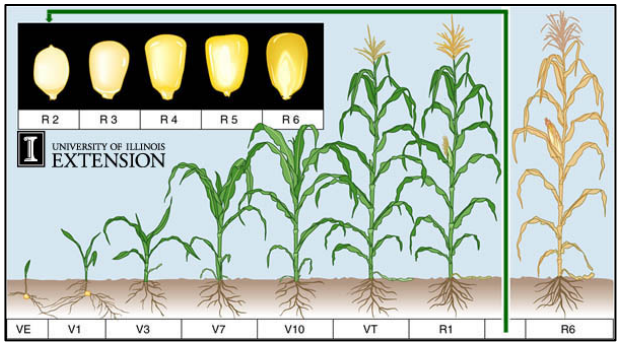
Soybean-Irrigated





Maize-Irrigated



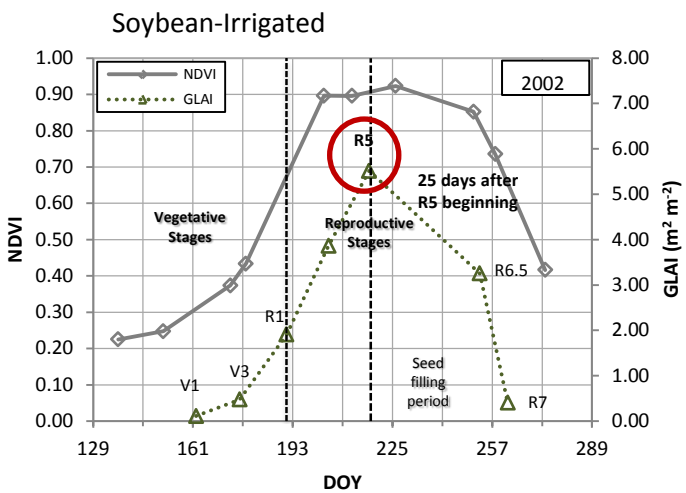


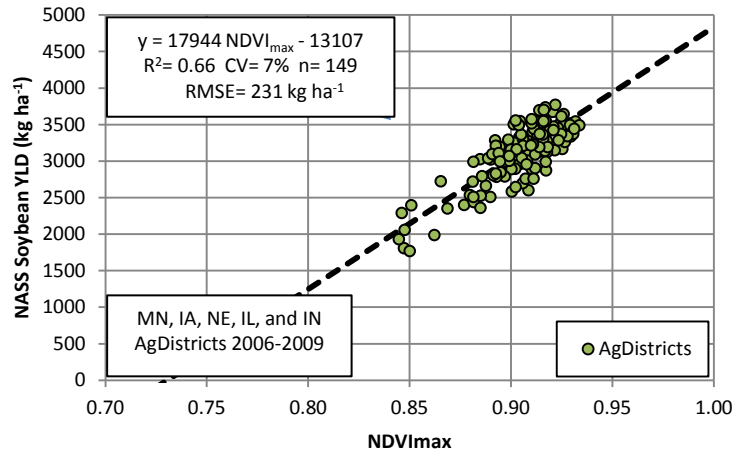
Data Source:

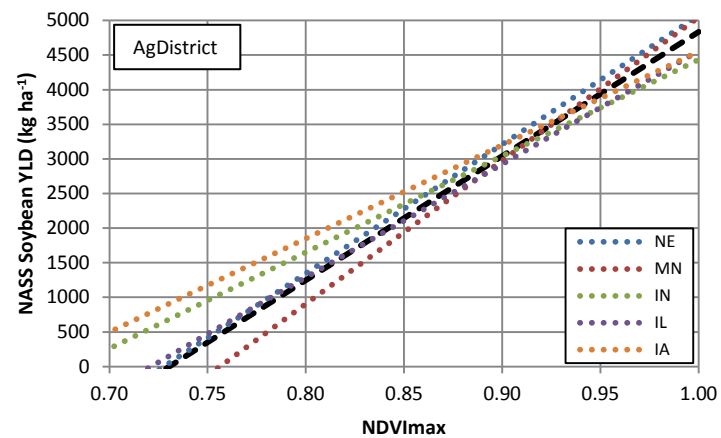
- Green Leaf Area Index (GLAI) and Phenology data collected by Dr. T.J. Arkebauer for the Carbon Sequestration Project at the University of Nebraska-Lincoln.

Preliminary Results

Soybean Yield Approach







- At the beginning of the seed filling period, or **R5**, soybean plants should have the maximum vegetative tissue present or a completely closed canopy.
- Based on field observations, the maximum values of NDVI (NDVImax) were obtained during the seed filling period.

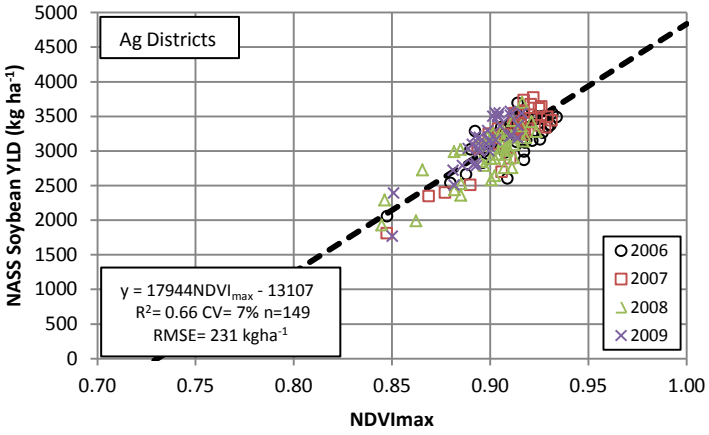
Data Source:

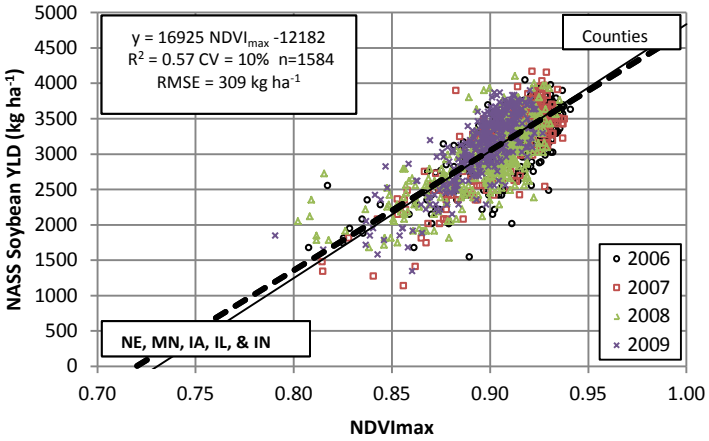
- NDVI: Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Index (MOD13Q1)
- Green Leaf Area Index and Phenology data from the Carbon Sequestration Project at University of Nebraska-Lincoln.

Preliminary Results

Soybean Yield Approach

- Relationship between maximum value NDVI (NDVImax) and reported soybean yields.





Results to date

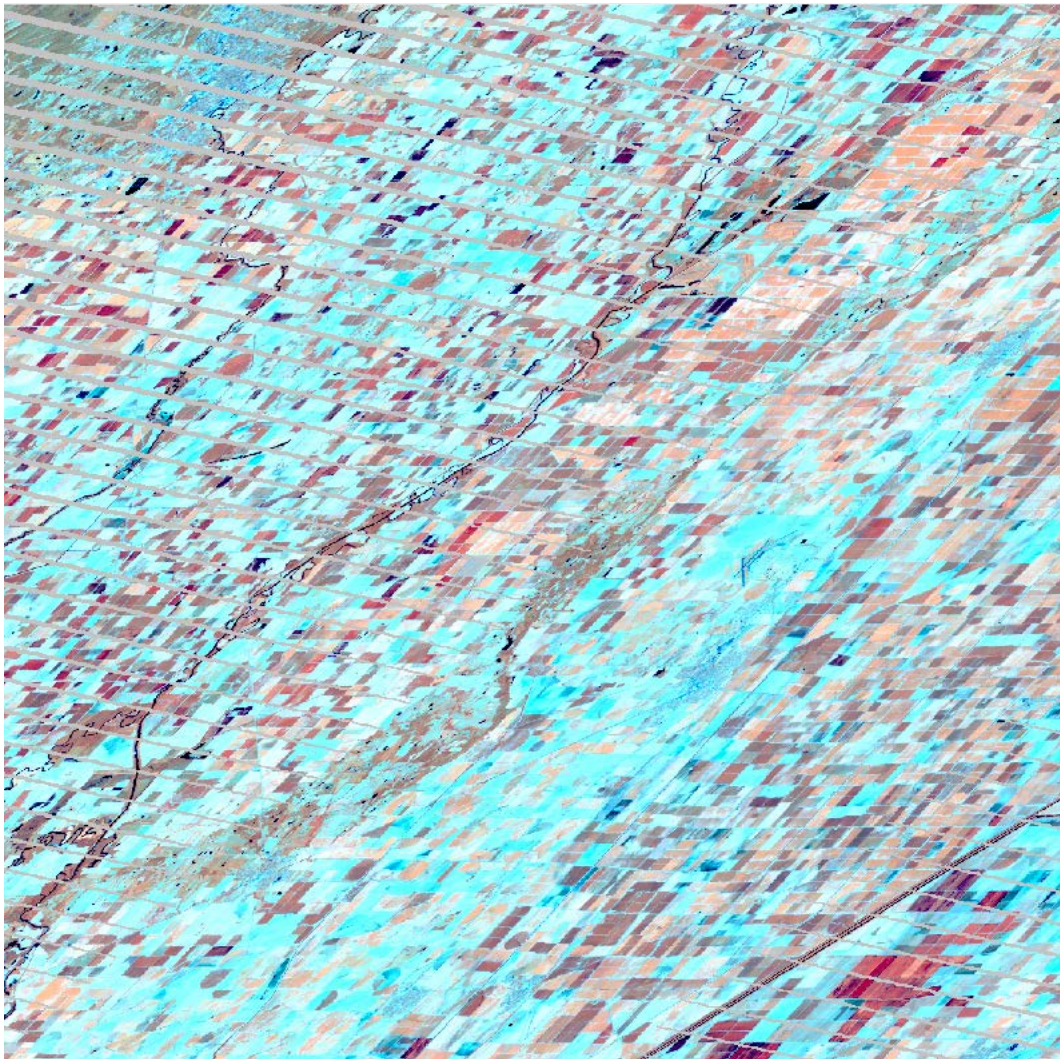
- We have developed and applied MODIS soybean models to the 2011 USA and 2011-12 Brazil and Argentina growing seasons
  - We have stratified each country into low/medium/high strata
  - Landsat data have been collected for all samples in each country
  - RapidEye data have been collected for a subset of samples in each country
  - Field visita have been made to a subset of samples in each country

- Our objective is to map all soybean that is clearly identifiable
  - Other crops can confound this (cotton, for example)
  - Scale can confound this for certain landscapes (if most soybean occurs as mixed pixels, for example)
  - Regardless, we want to capture a conservative and repeatable soybean signature

- For the U.S., our preliminary results are reducing soybean acreage compared to the CDL
  - RapidEye could further reduce estimates

- Given a sample-based Landsat-scale soybean estimate, we will apply a MODIS-driven model over pure soybean targets to estimate yield at national scales
  - This can be coupled with our area estimate to generate a production number

Missouri - Mississippi Delta



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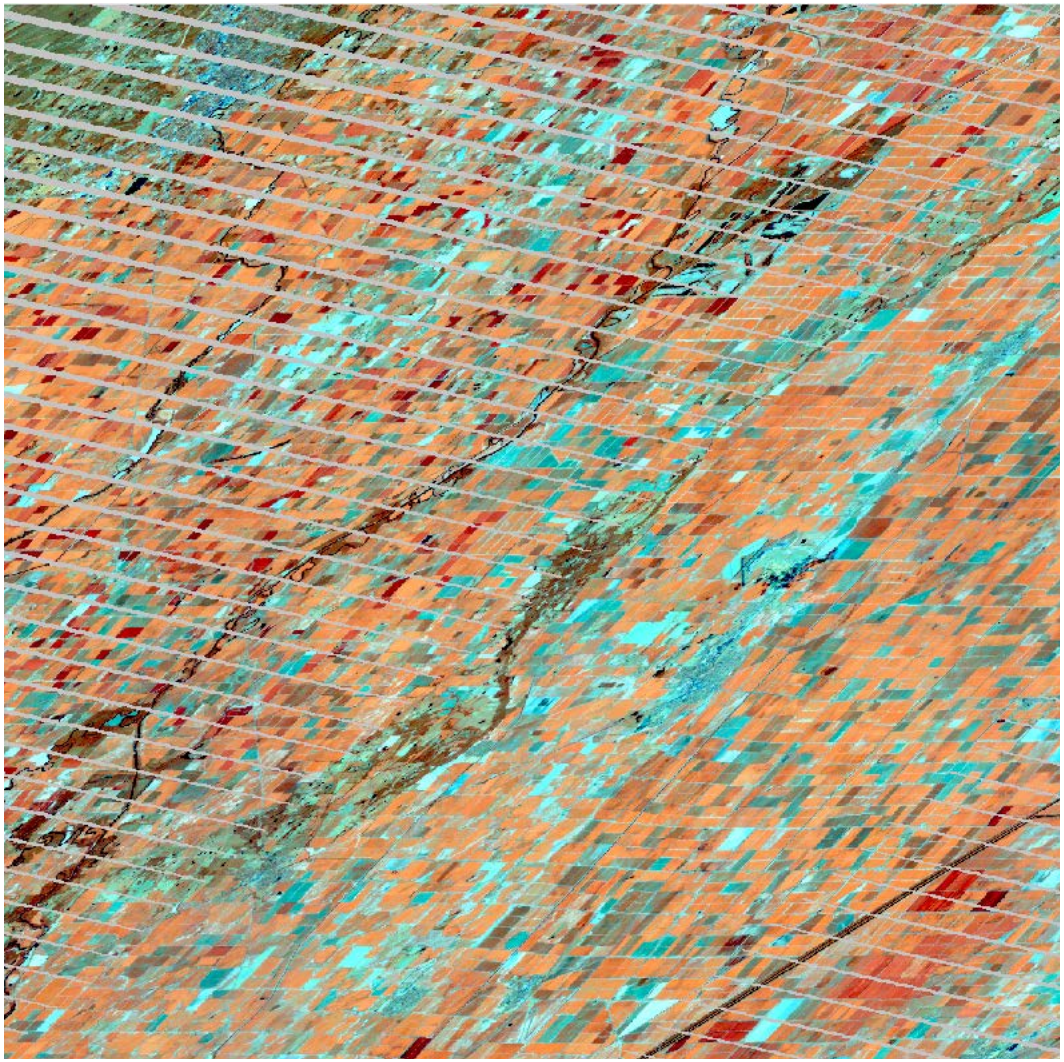
Missouri - Mississippi Delta



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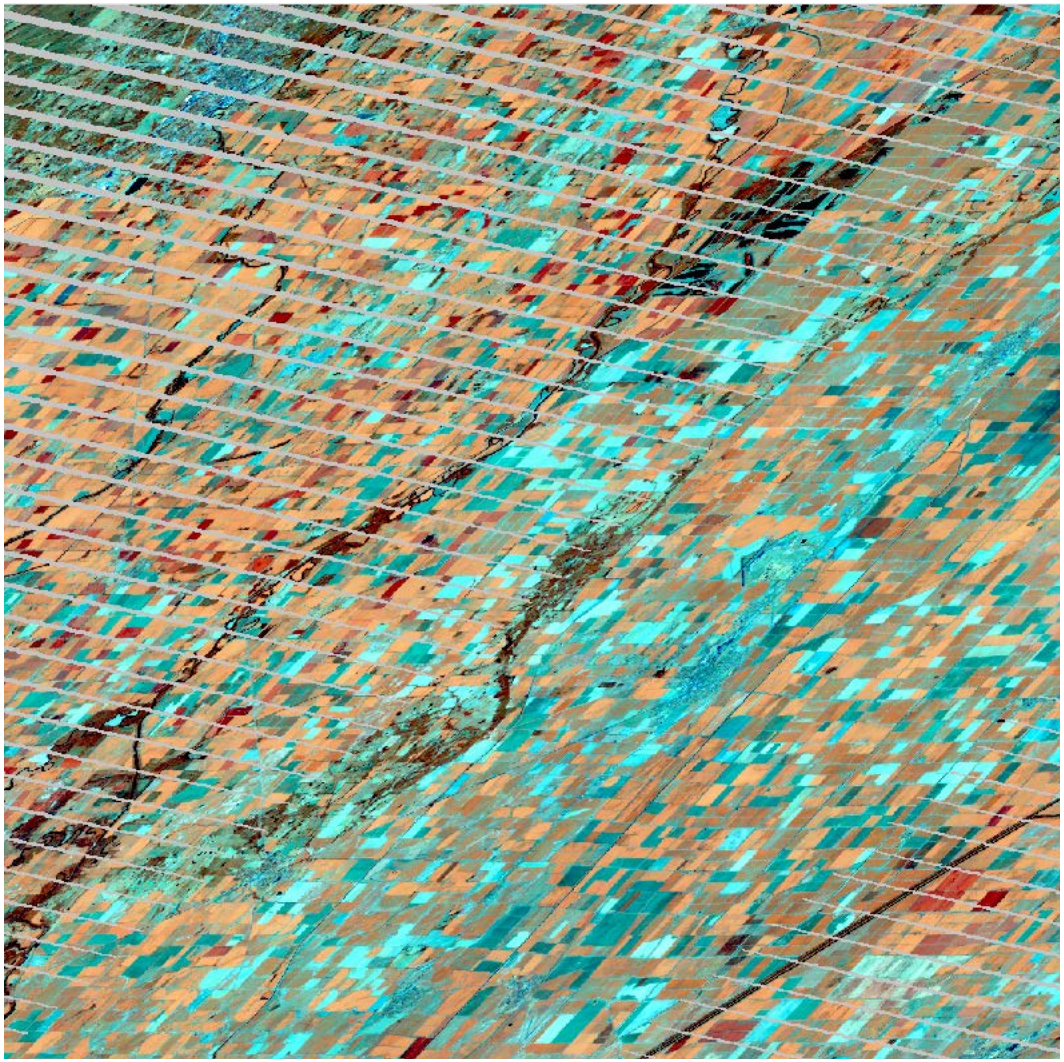
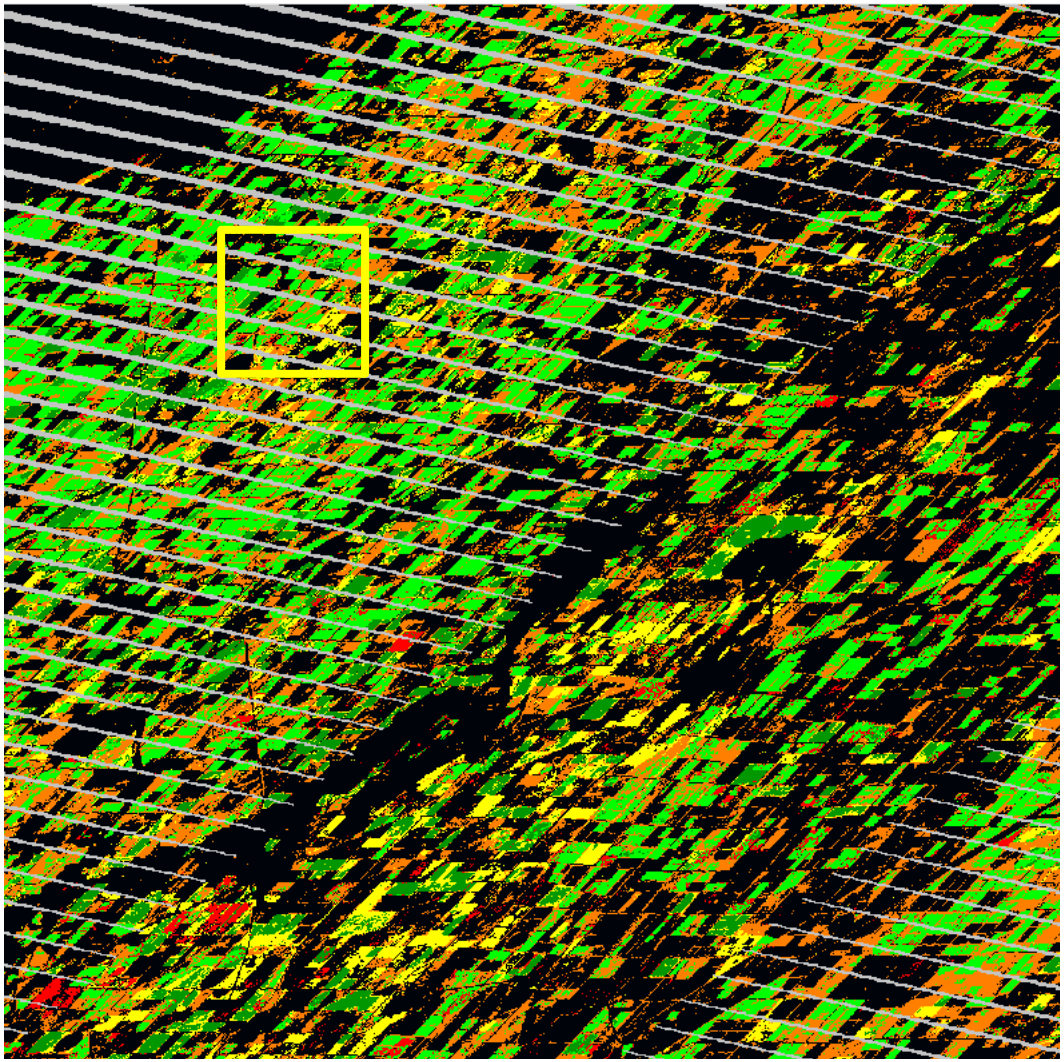
Missouri - Mississippi Delta



Sept 15, 2011 - LT50230352011258PAC01

Missouri - Mississippi Delta



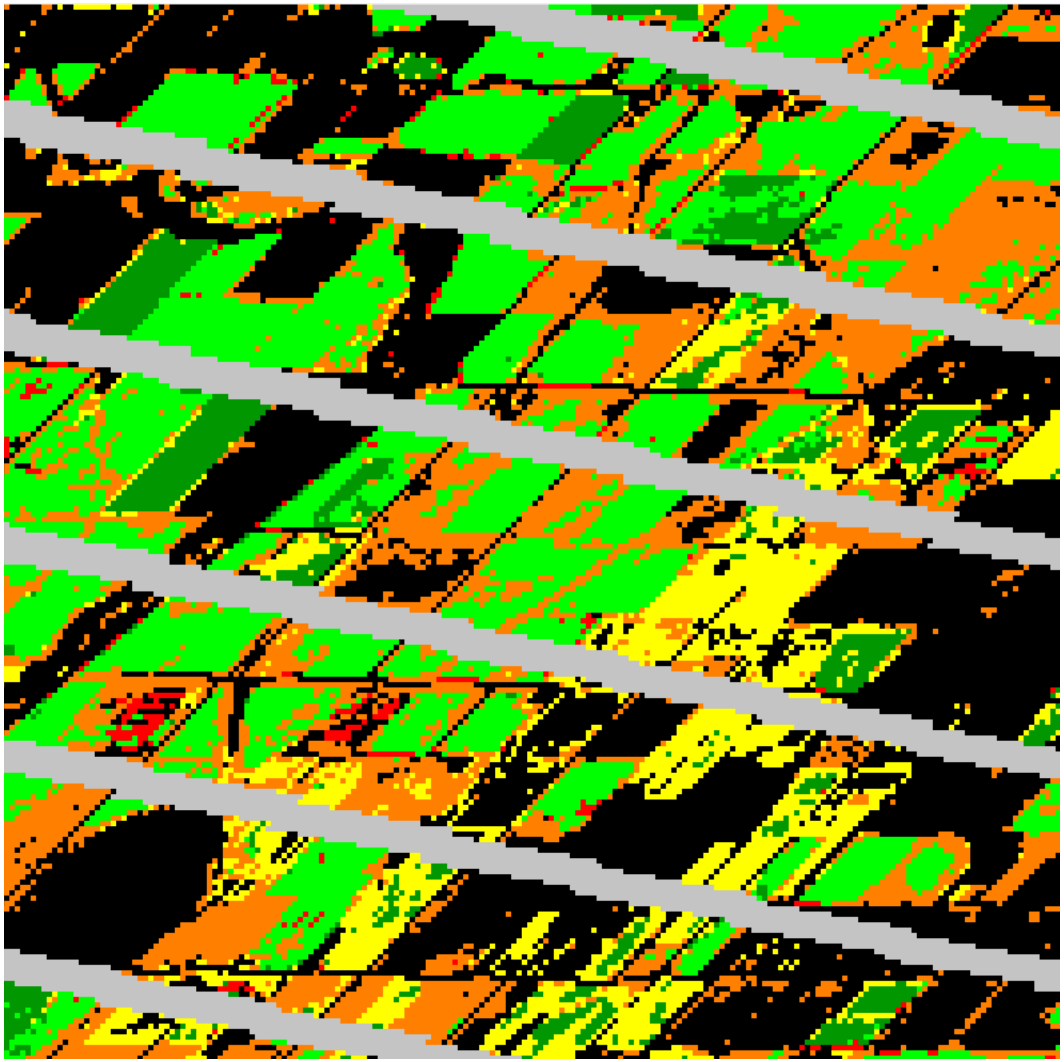
Soybean agreement

CDL no soybean / UMd soybean

CDL soybean / UMd no soybean

Soybean agreement –
CDL winter wheat double crop

CDL soybean / UMd no soybean
CDL winter wheat double crop



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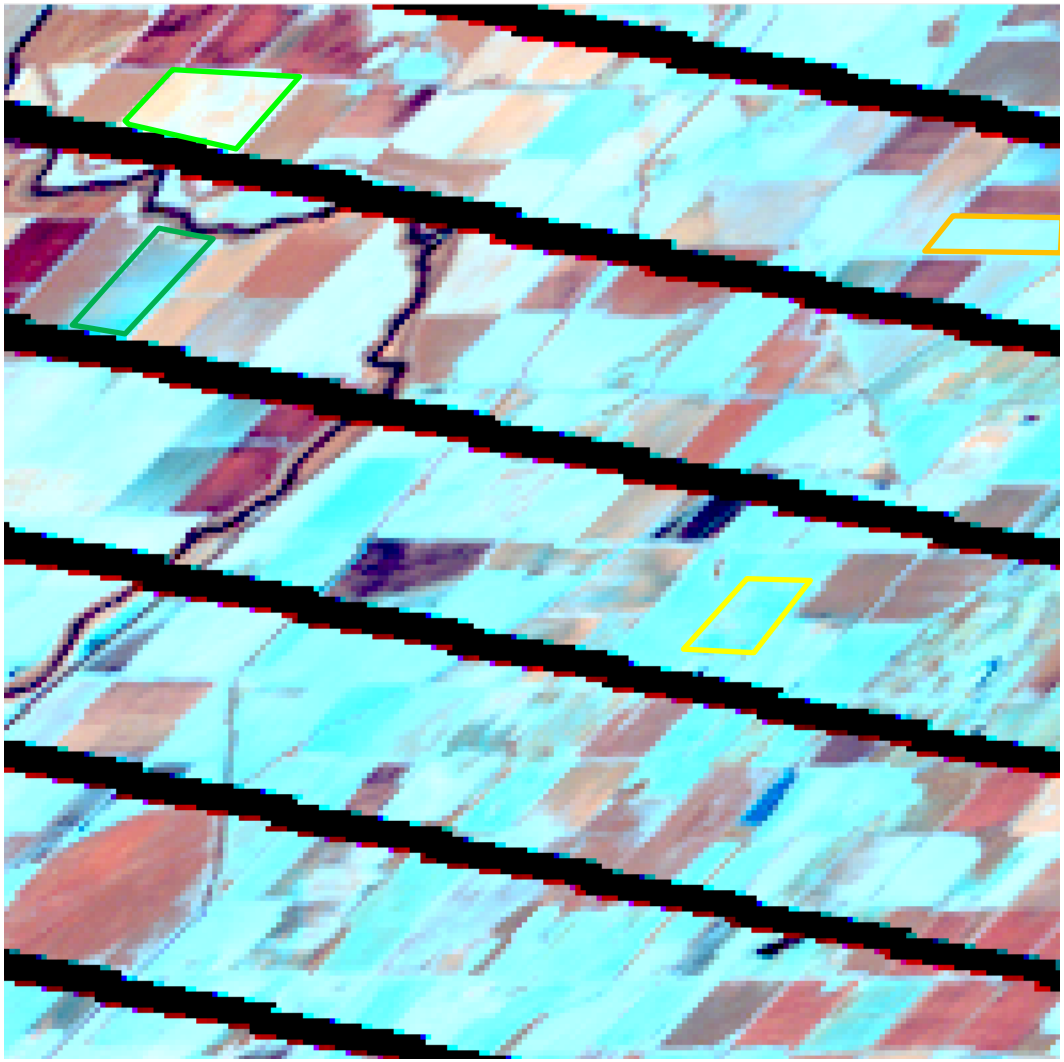

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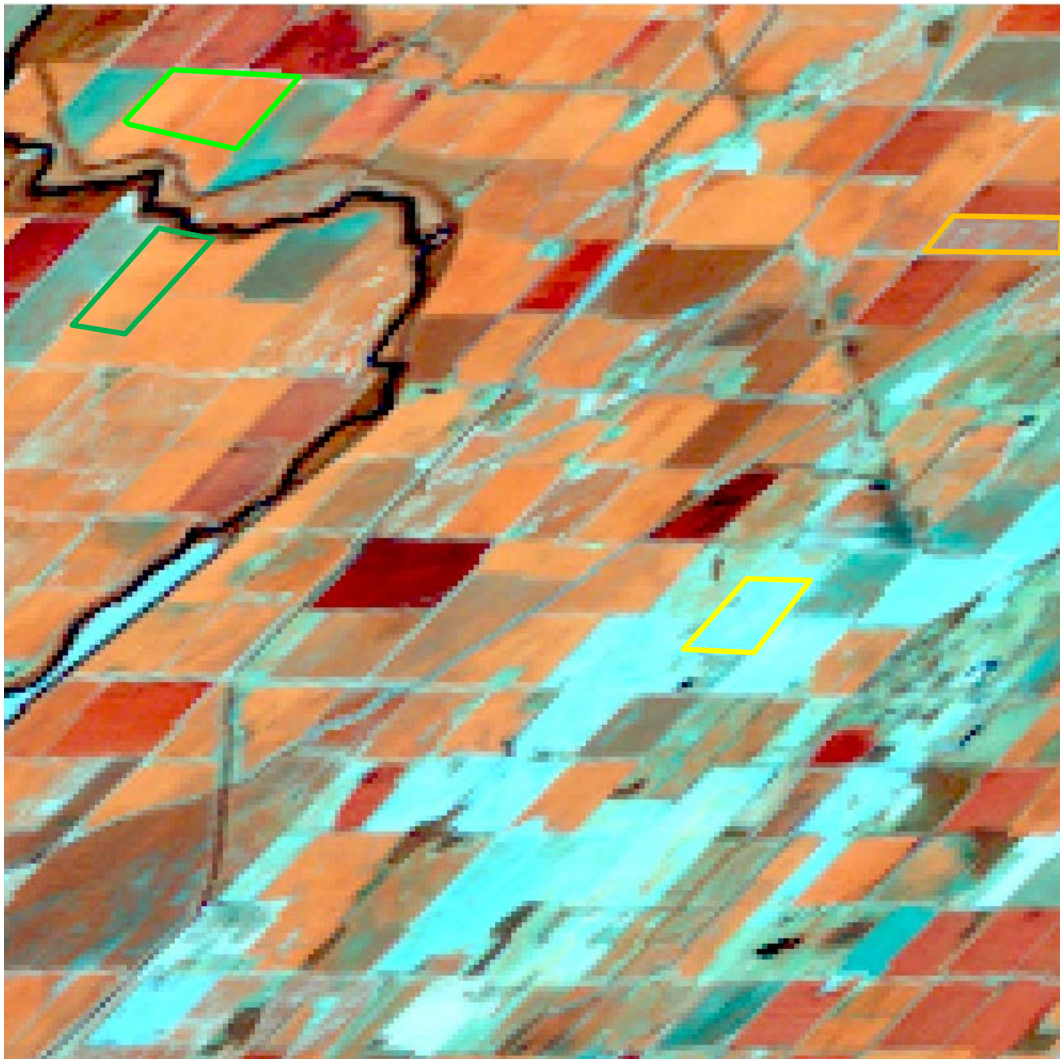

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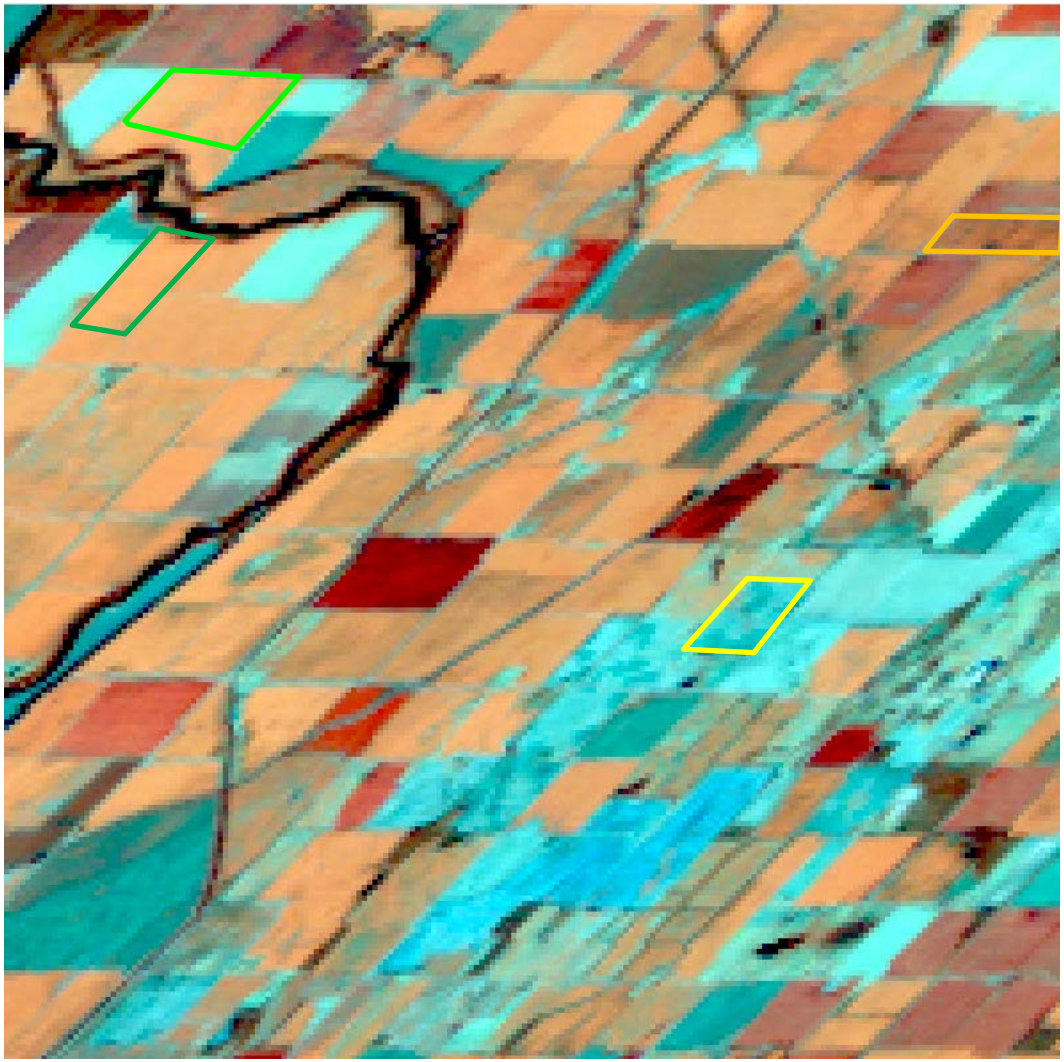

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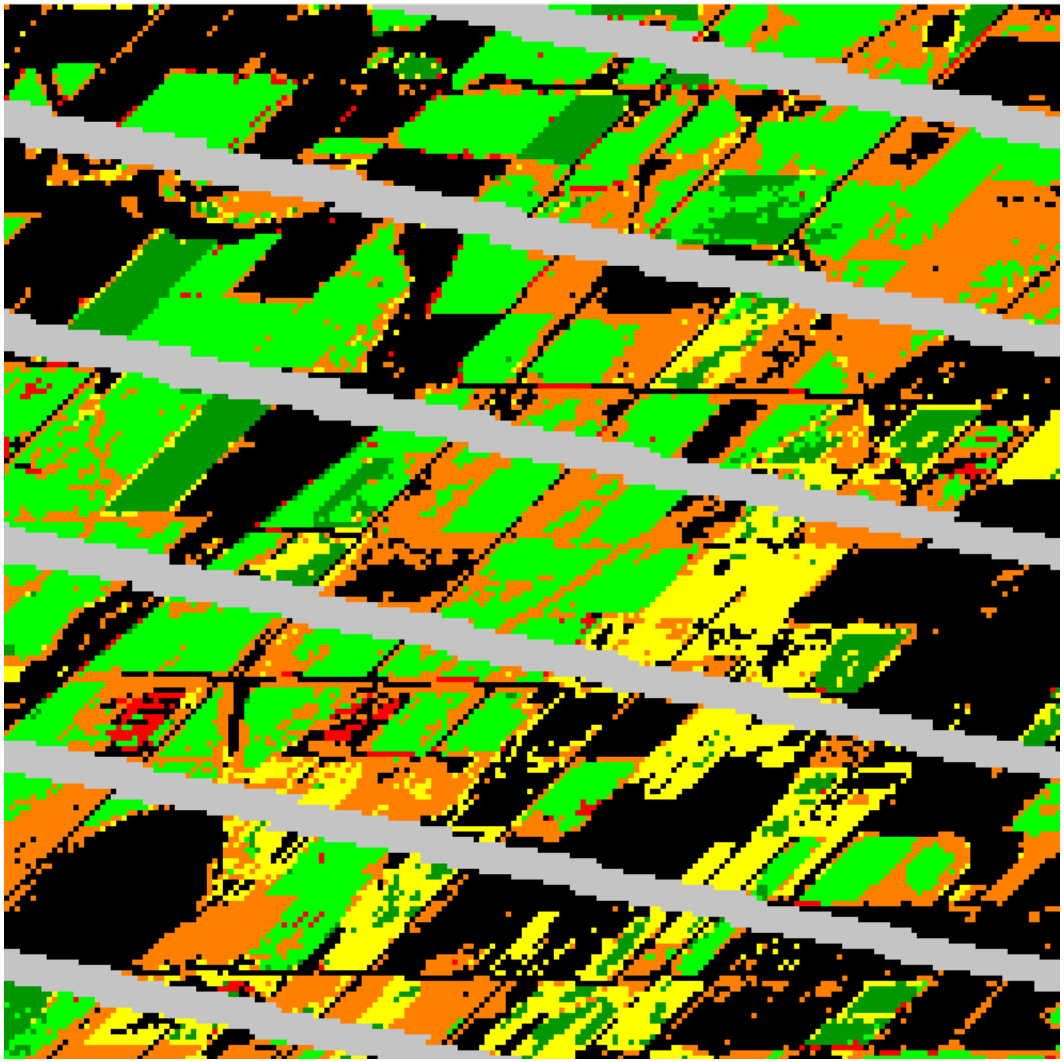

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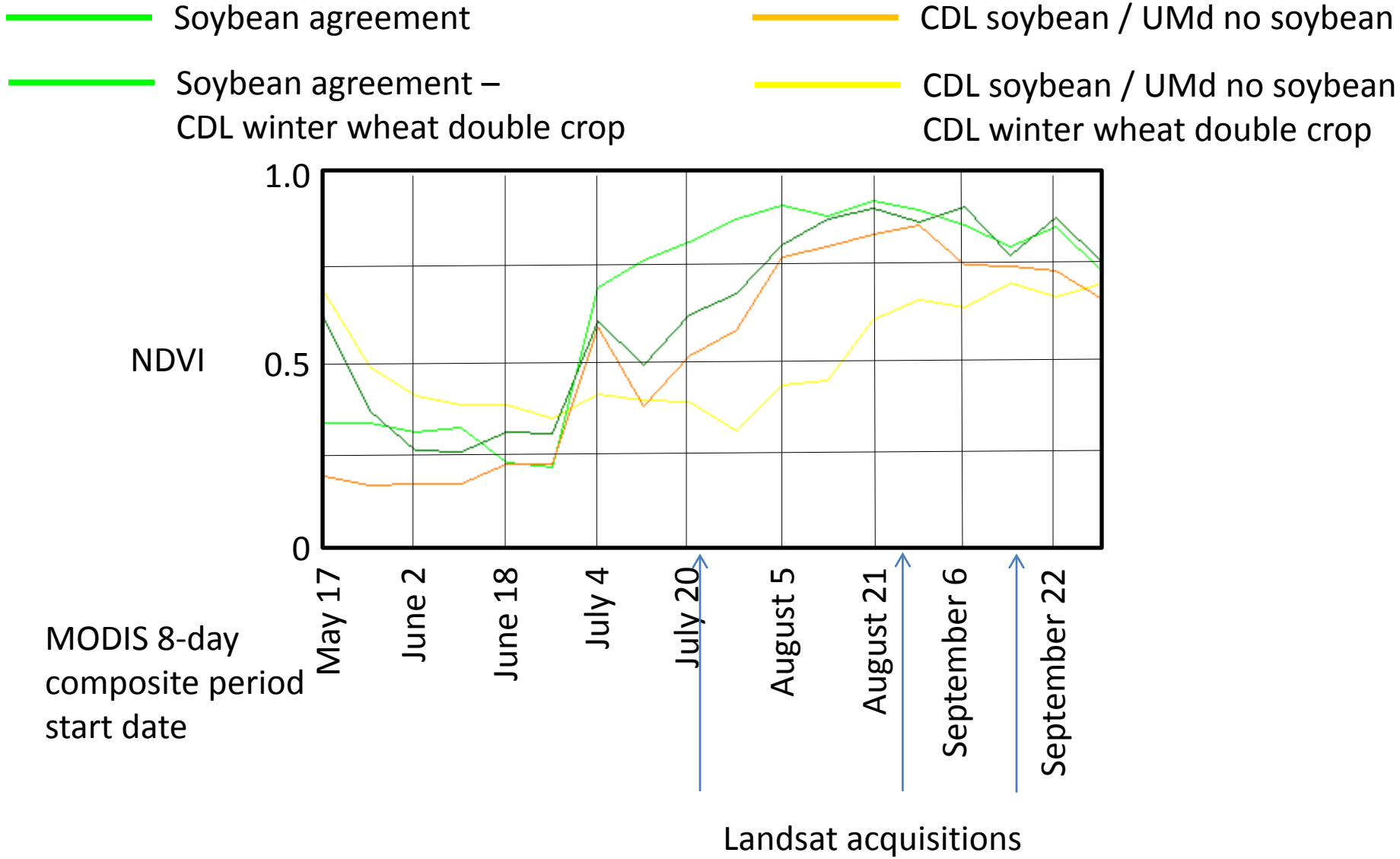
Comparison of 8-day MODIS over sample areas