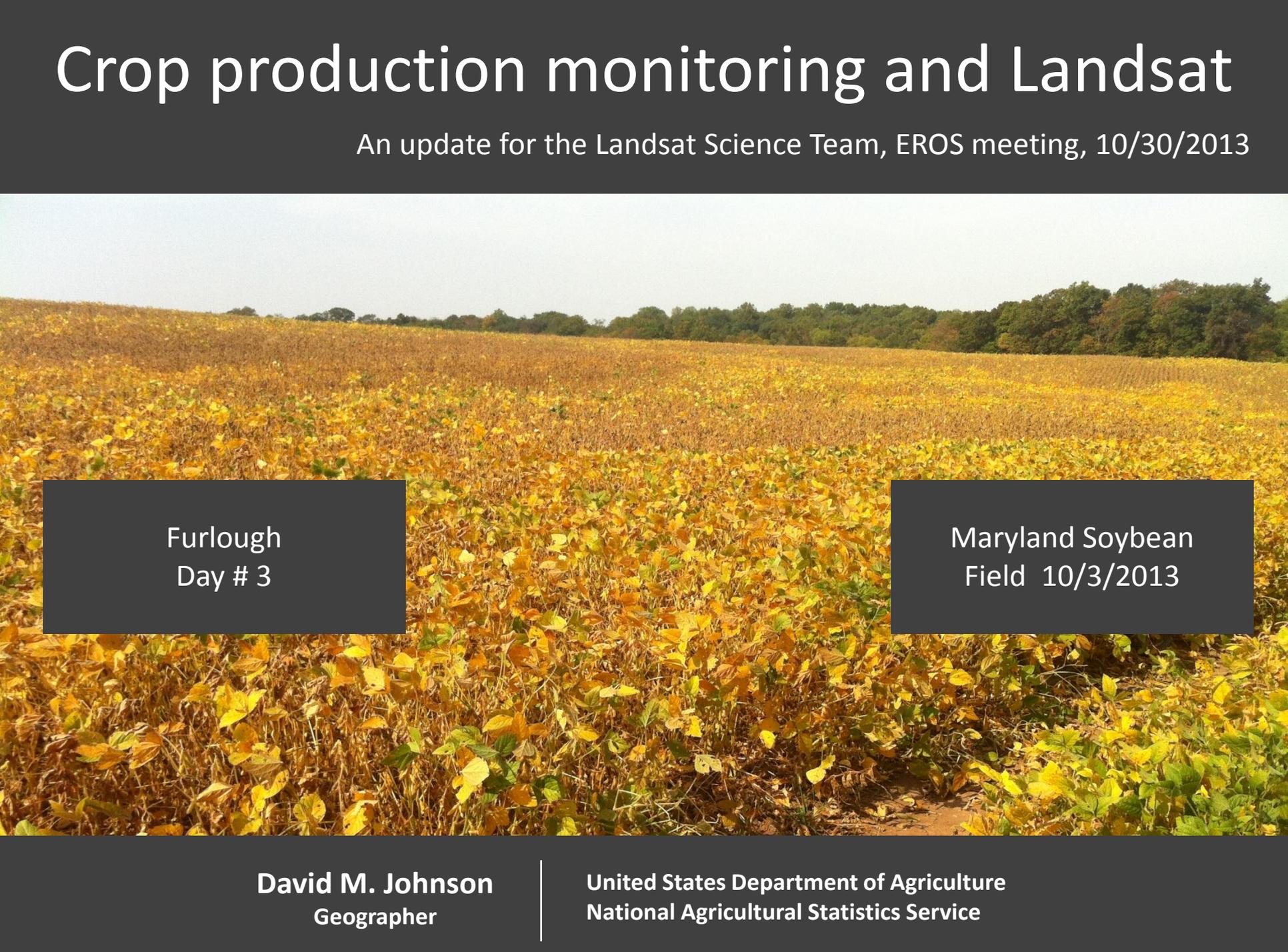


Crop production monitoring and Landsat

An update for the Landsat Science Team, EROS meeting, 10/30/2013



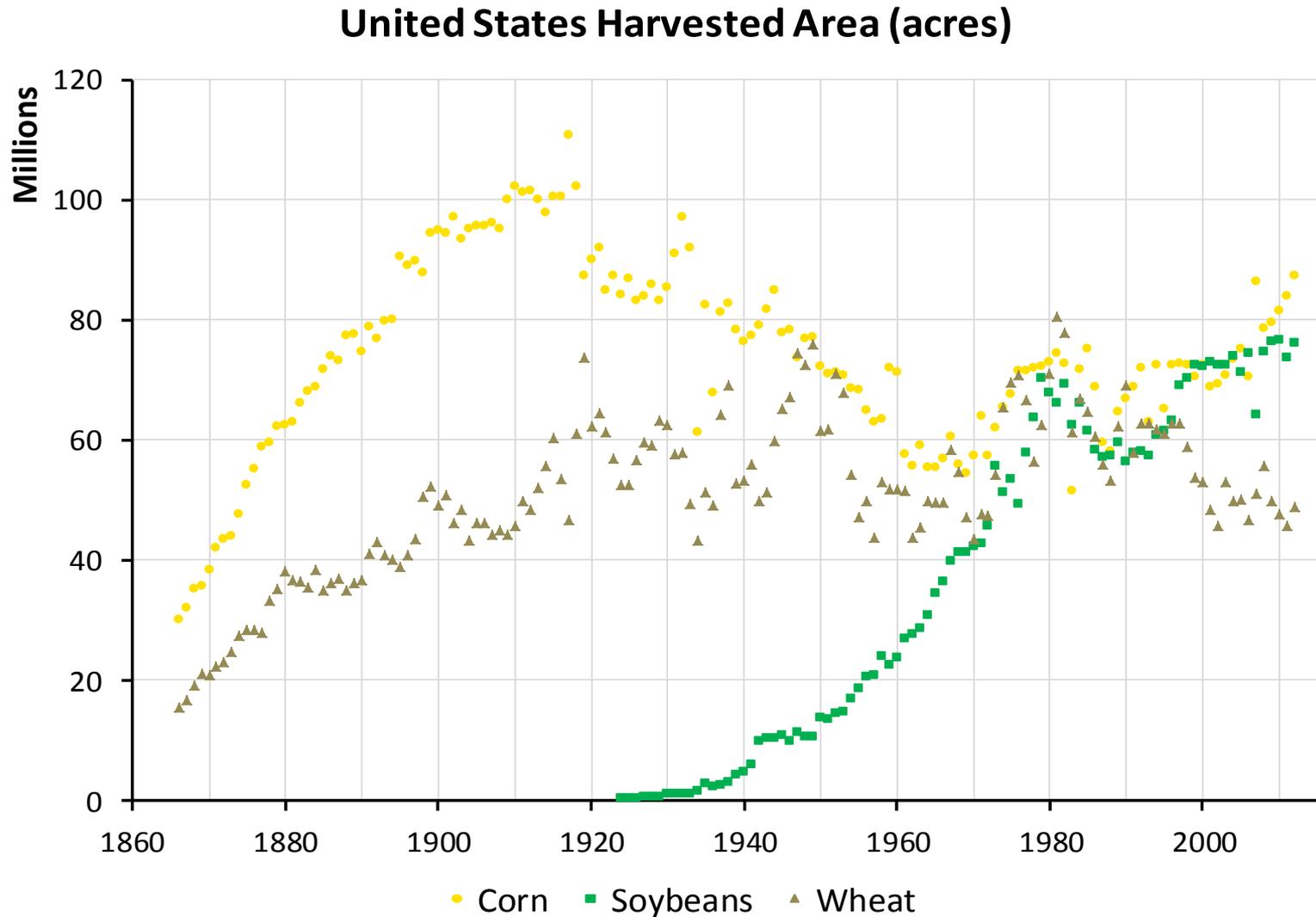
Furlough
Day # 3

Maryland Soybean
Field 10/3/2013

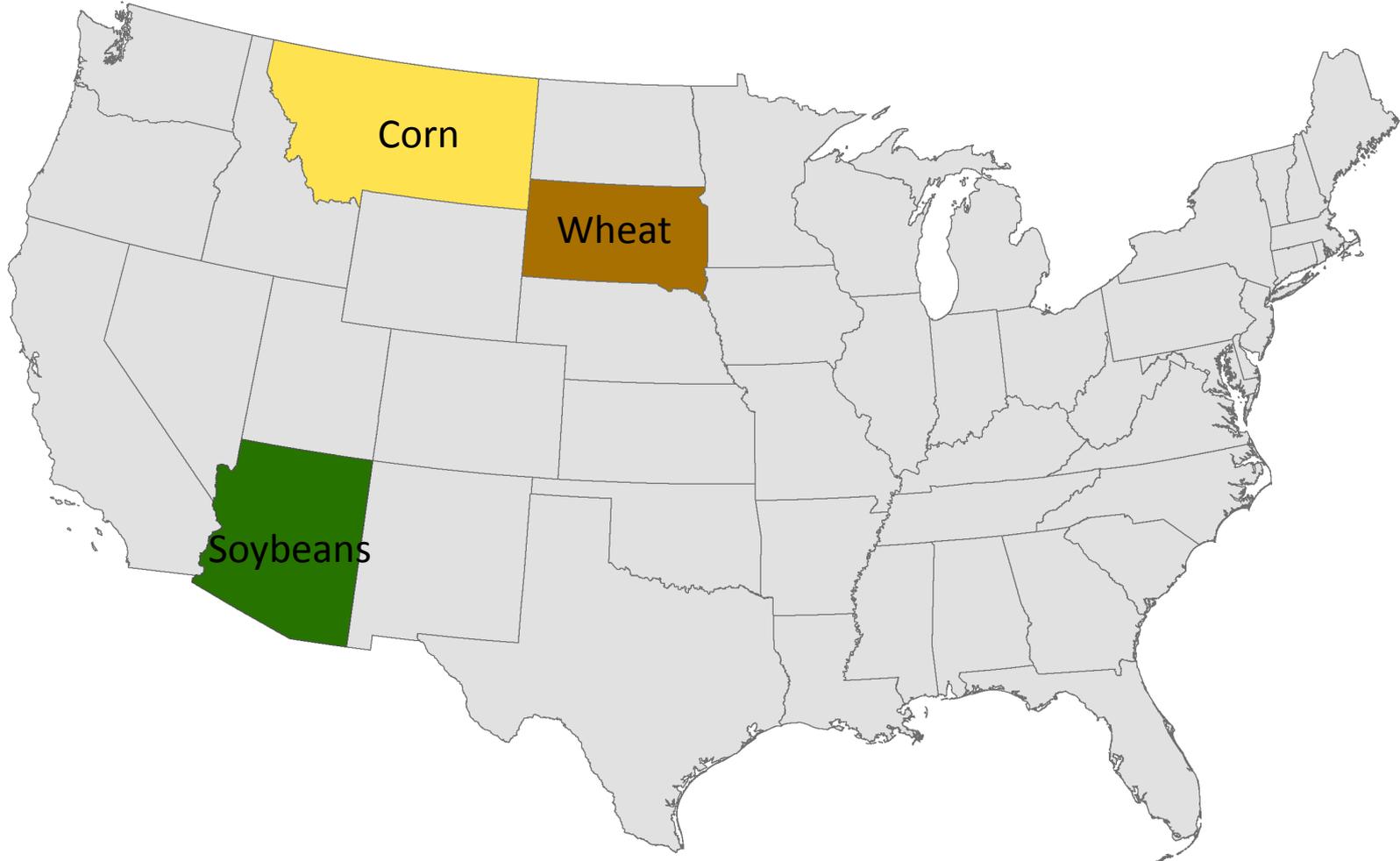
David M. Johnson
Geographer

United States Department of Agriculture
National Agricultural Statistics Service

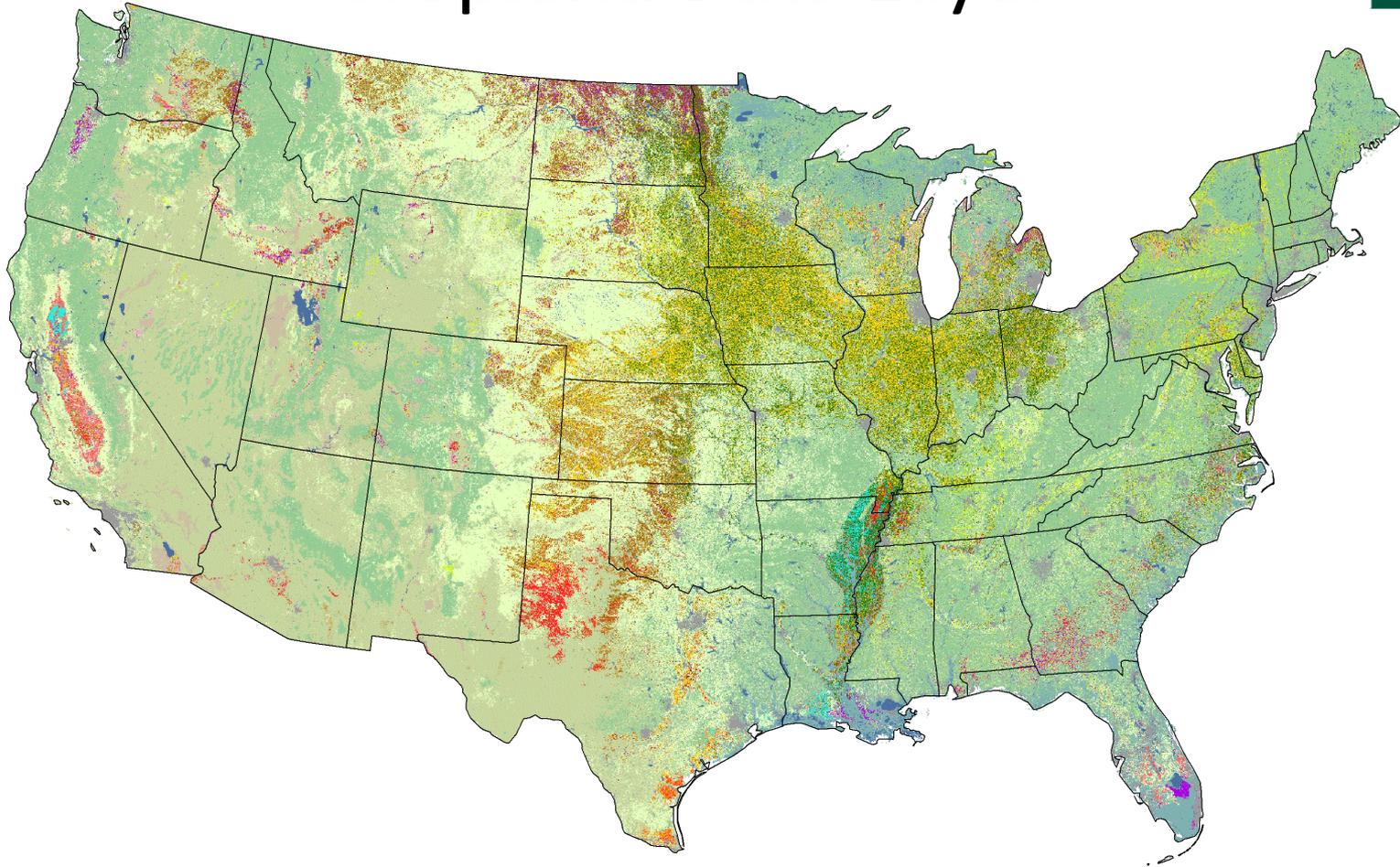
Why is agriculture important to the land cover community?



Collapsed harvested area of major US crops for 2013



Cropland Data Layer



Major Land Cover Categories

Agriculture

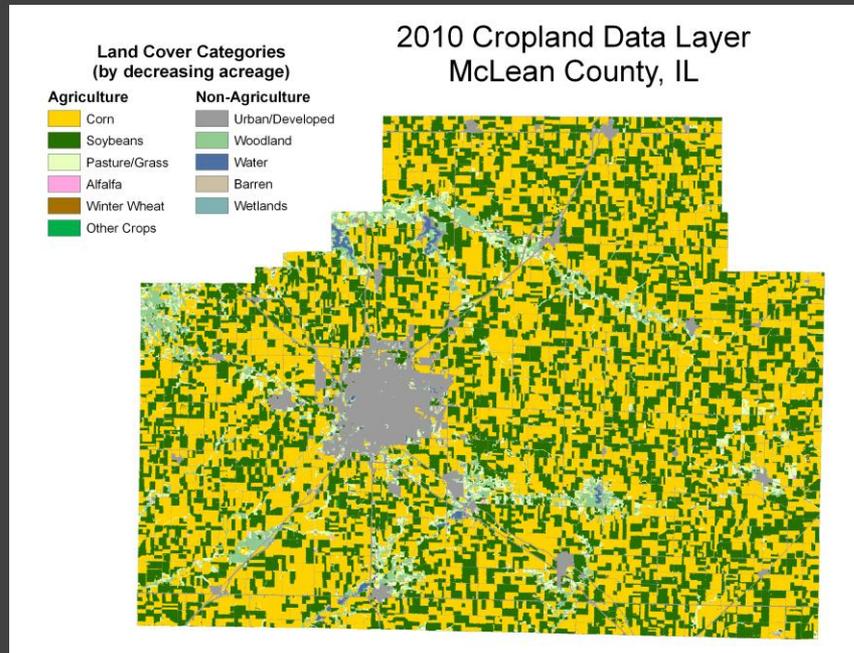
- | | | |
|---|--|--|
|  Pasture/Grass |  Fallow/Idle Cropland |  Sorghum |
|  Corn |  Alfalfa |  Other Small Grains |
|  Soybeans |  Cotton |  Rice |
|  All Wheat |  Other Crops | |
|  Other Hay |  Vegetables/Fruits/Nuts | |

Non-Agriculture

- | | |
|---|--|
|  Woodland |  Barren |
|  Shrubland |  Perennial Ice/Snow |
|  Urban/Developed | |
|  Wetlands | |
|  Water | |

CDL generalities

- Annual land cover classification targeted to identifying *circa* summer cultivated crops
- Encompasses all of conterminous USA (since 2008, some state prior)
- 56m or 30m resolution
 - Depending on year but now all 30m
- Built with a supervised boosted classification tree methodology
 - Implemented with See 5.0
- Utilizes ground/training data from USDA Farm Service data and ancillary data from National Land Cover Database
- Highly robust for dominant crop types
 - corn, soybeans, wheat, rice, cotton, etc.
- Used internally by NASS to estimate planted acreage amounts
- Derived primarily from
 - Resourcesat-1 AWiFS
 - Landsat-5 TM
 - DMC Deimos-1 and UK-2
 - Landsat-8 OLI and TIRS



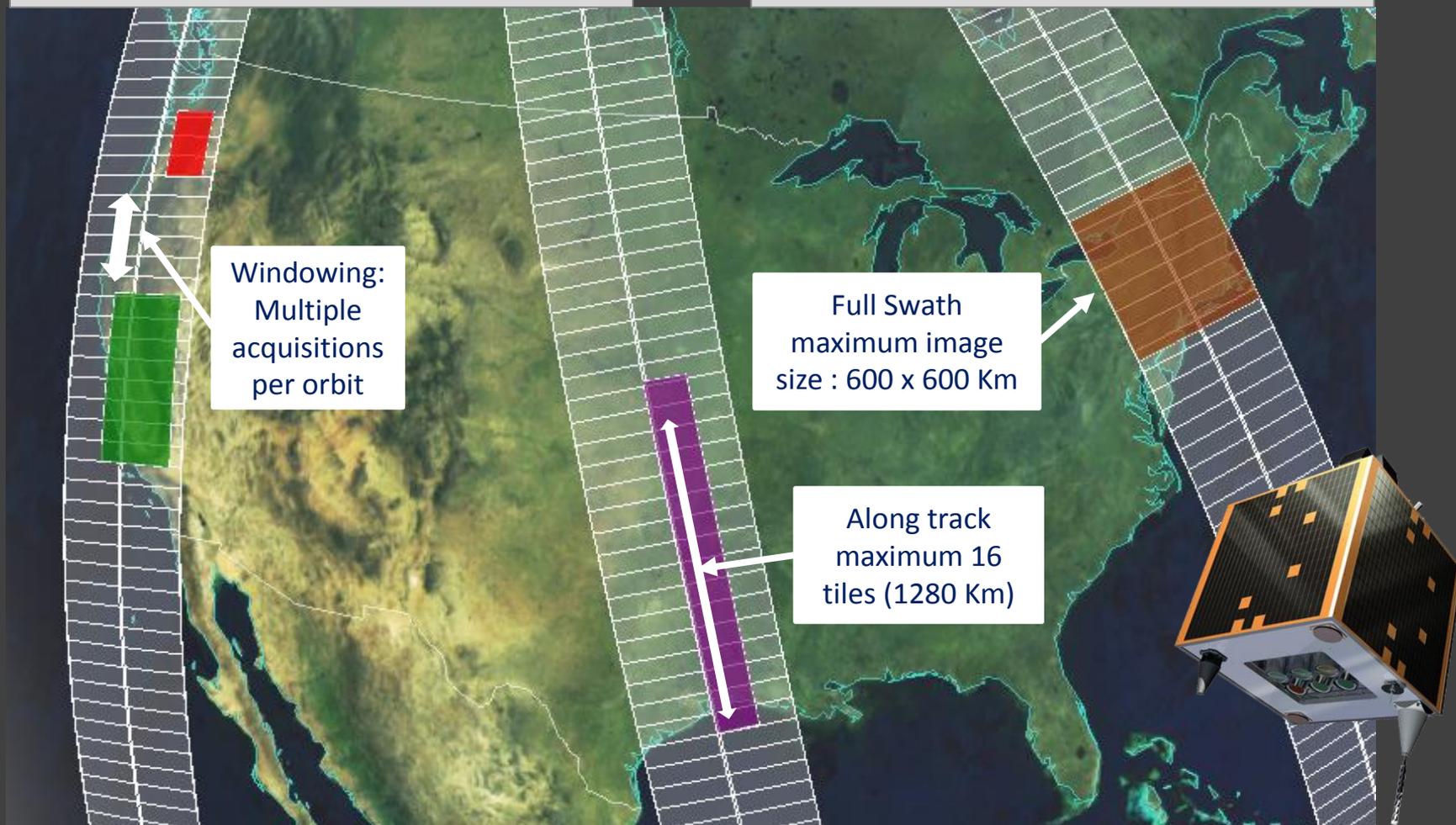
DMC Deimos-1/UK-2 Satellite Imagery

Default

*3 Bands – Green, Red, NIR
Resolution – 22 meters
CONUS coverage every 15 days*

2011 - 2013

*Bands for monitoring vegetation
Upscaled to 30 meters
Multi-temporal images May – Oct.*



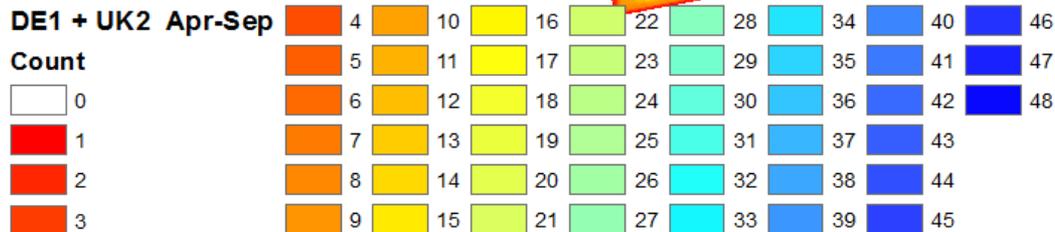
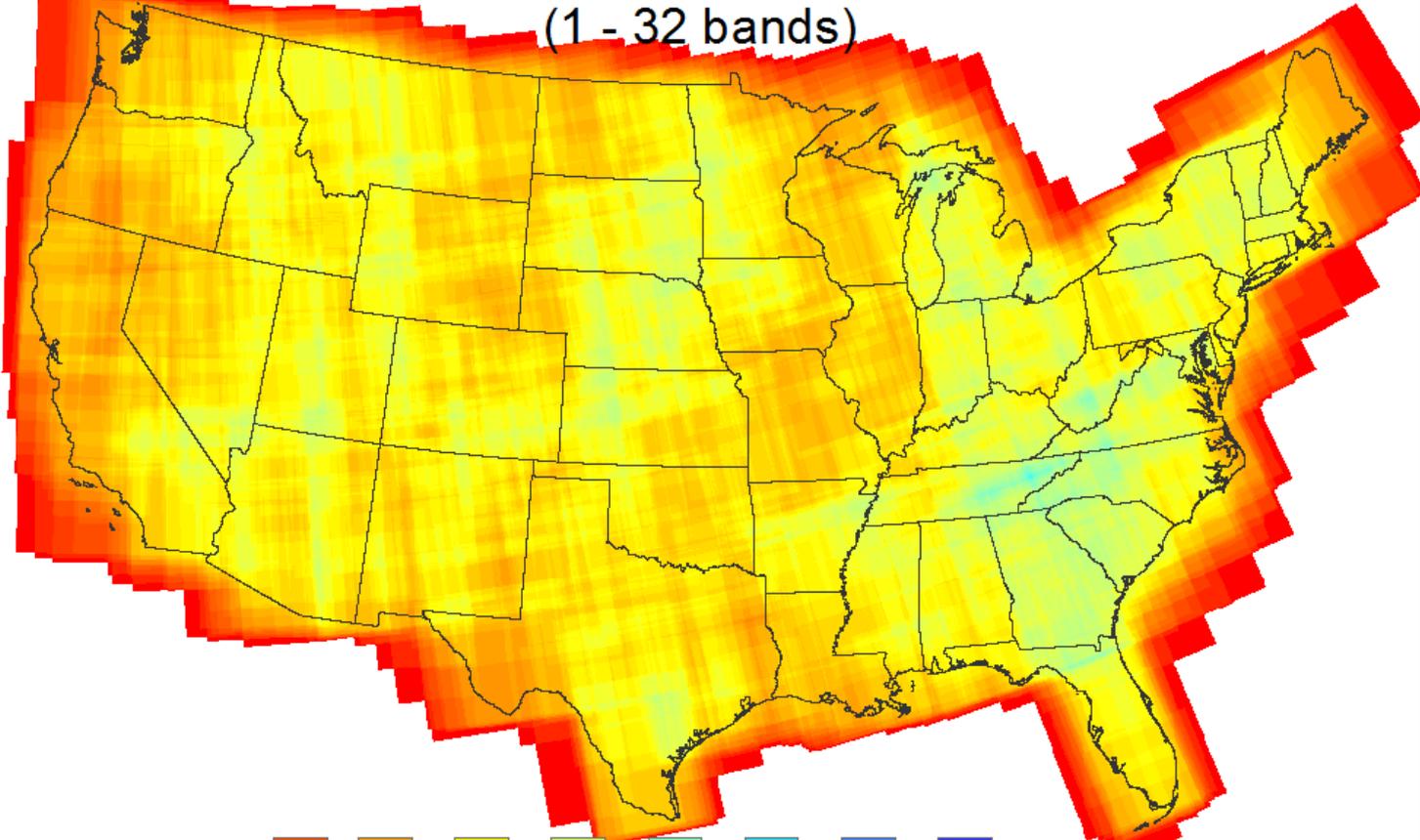
Deimos-1/UK2 Collections



June 27 – July 2, 2011

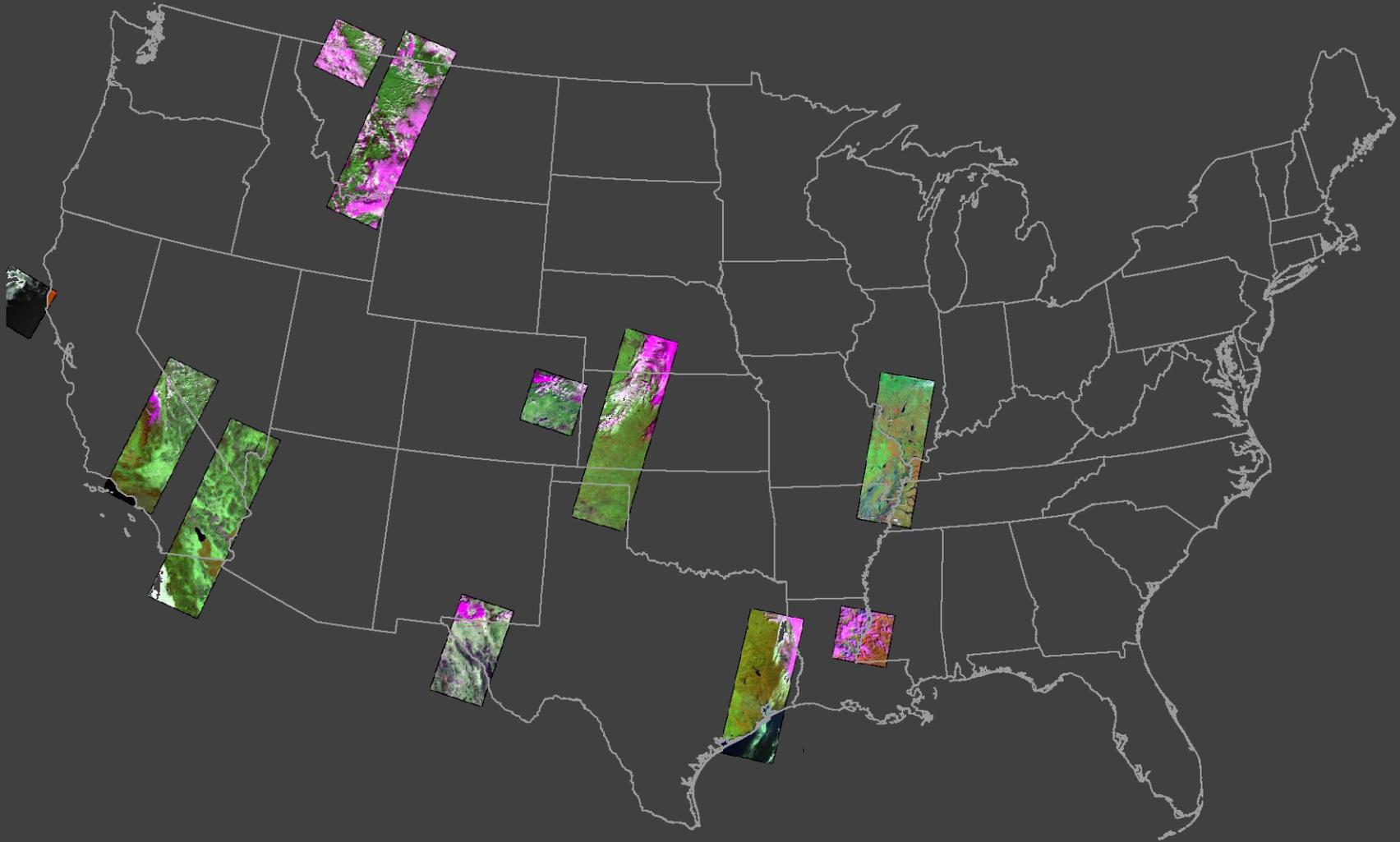
DMC "hit" map example

DE1 + UK2 : April through September, 2011
(1 - 32 bands)



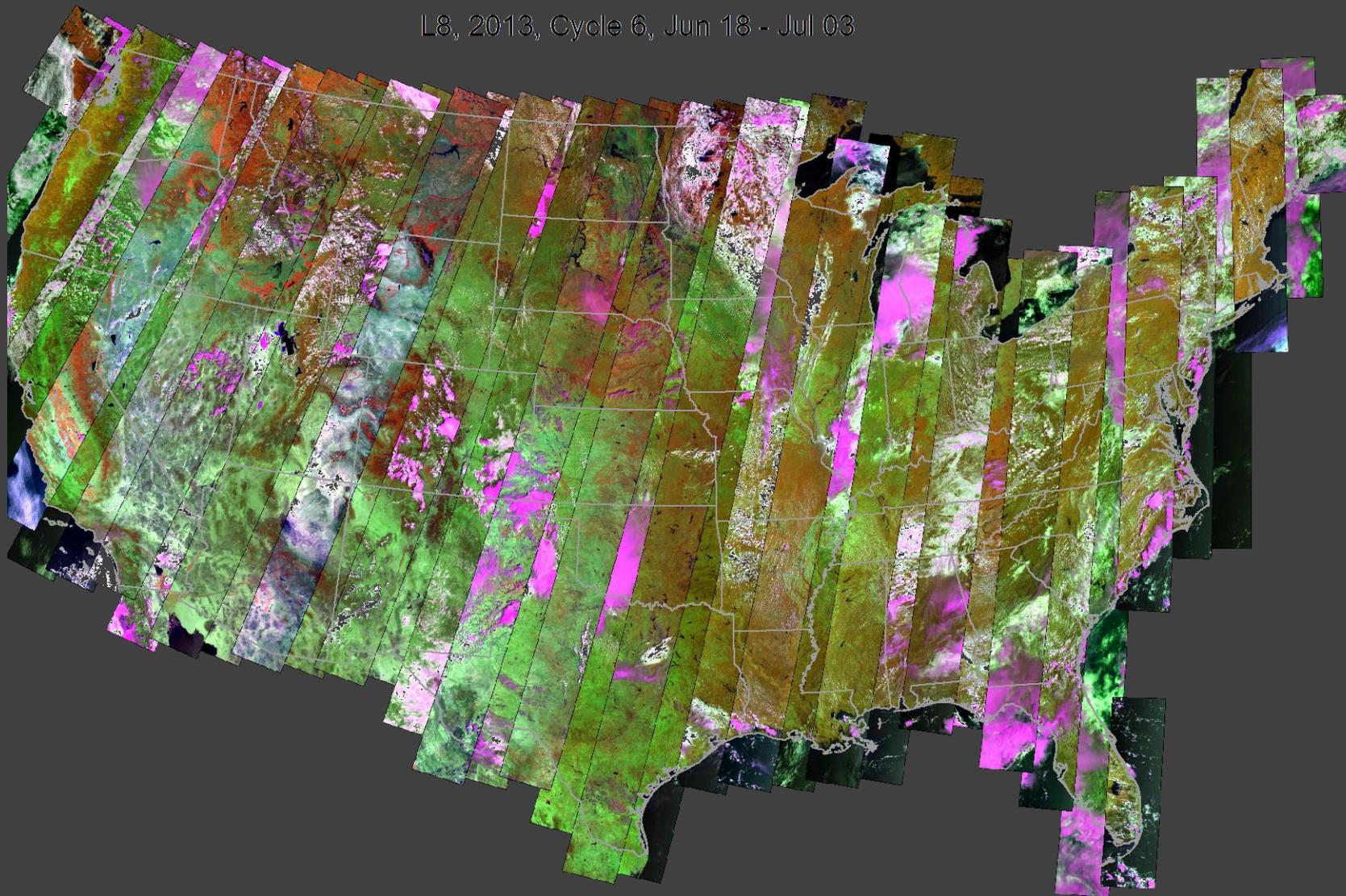
Landsat 8 Collections – mid April

L8, 2013, Cycle 1, Apr 11 - Apr 14



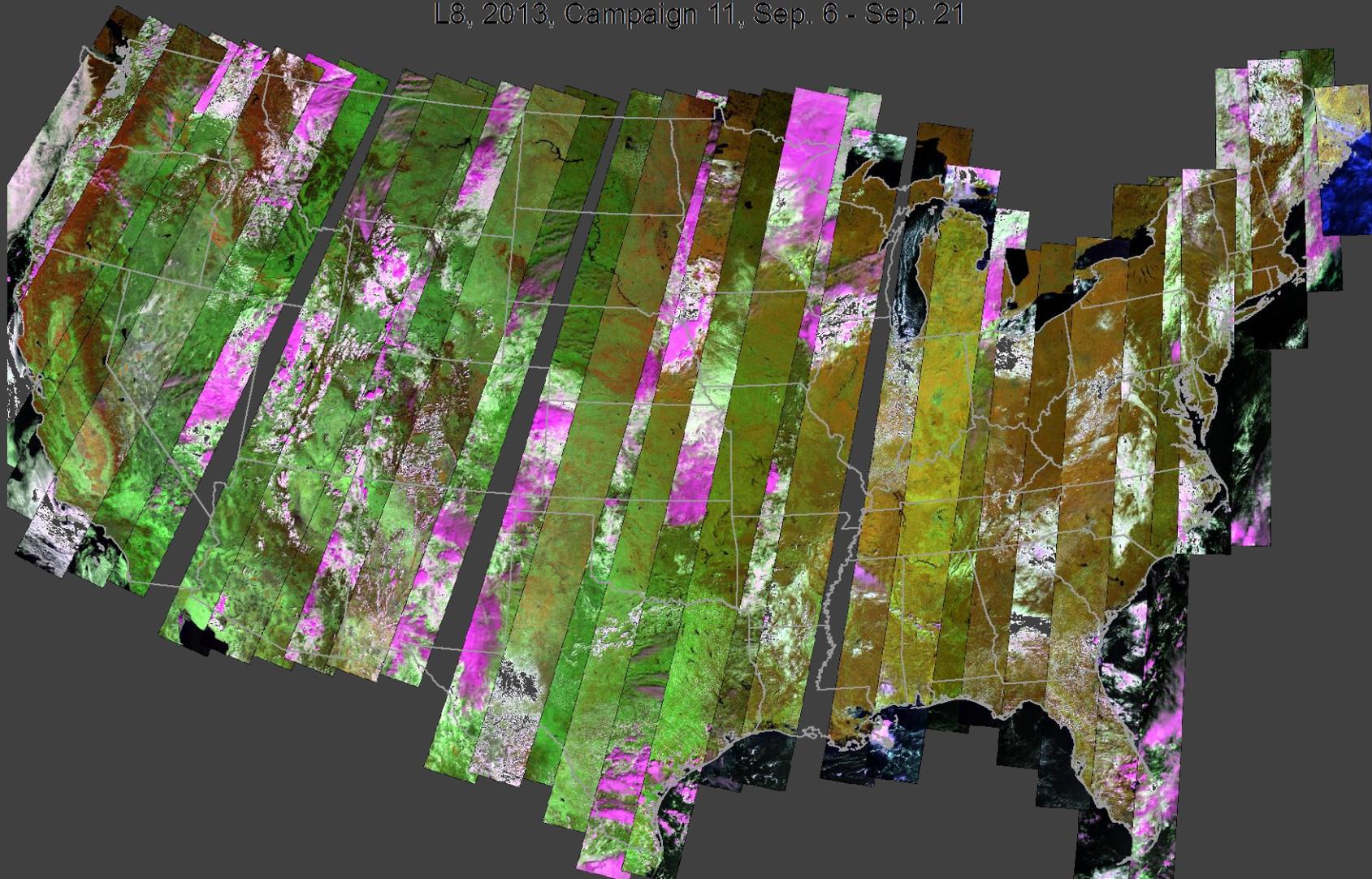
Landsat 8 Collections – late June

L8, 2013, Cycle 6, Jun 18 - Jul 03



Landsat 8 Collections – mid September

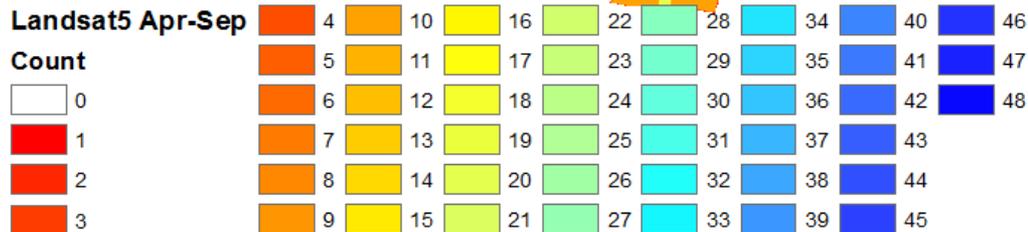
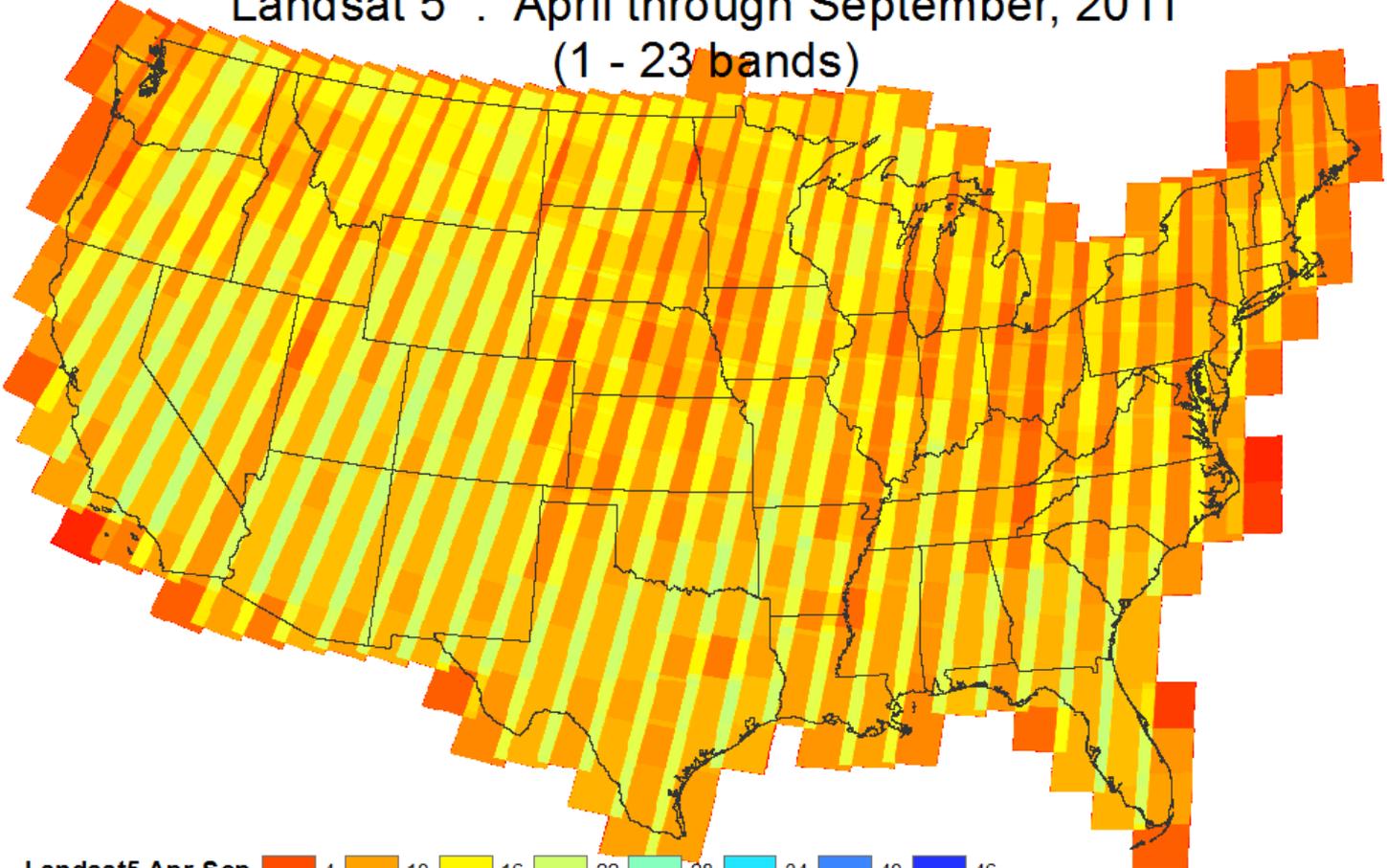
L8, 2013, Campaign 11, Sep. 6 - Sep. 21



Close to 5000 Landsat 8 scenes downloaded so far –
a lot of data for a non supercomputing group

Landsat "hit" map example

Landsat 5 : April through September, 2011
(1 - 23 bands)

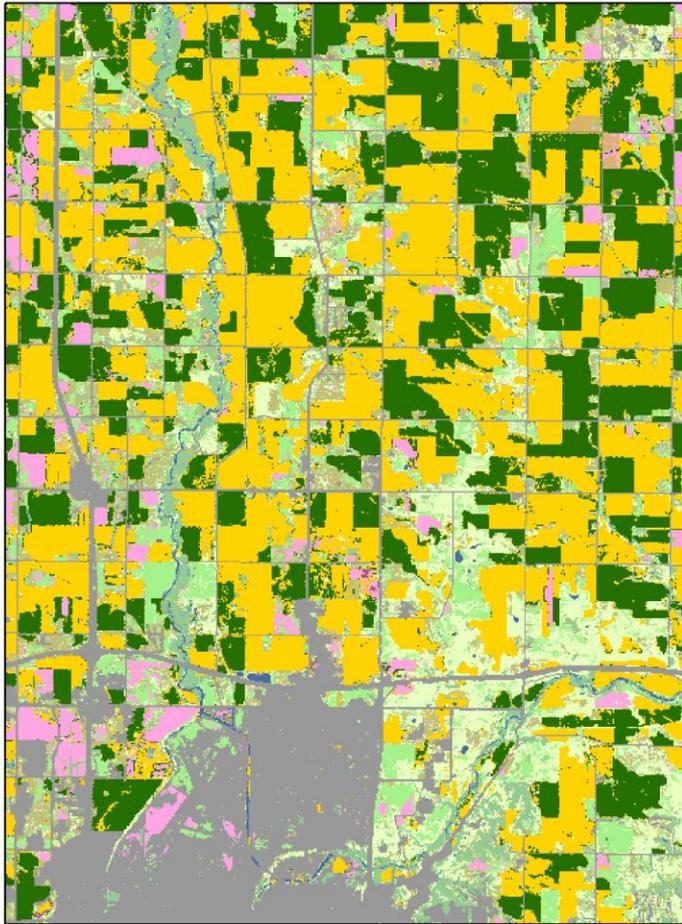


Landsat 8 usage

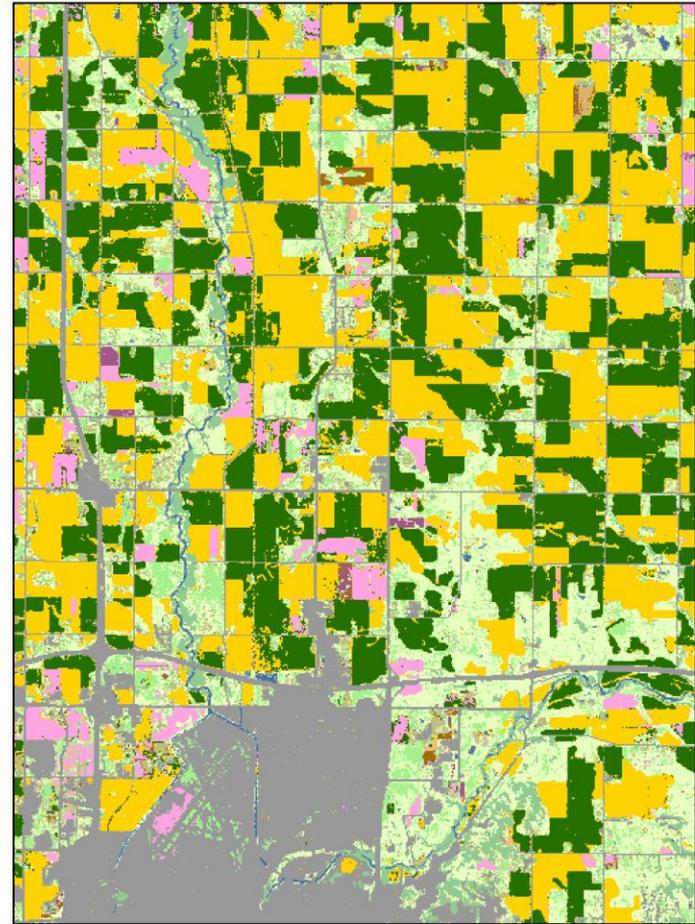
Month	Processed count	Used in CDL count
4	151	63
5	614	133
6	847	218
7	883	273
8	891	263
9	815	40
10	769	0
ALL	4970	990

Landsat 8 scene usage in the 2013 CDL, mid-season
The above results are as of 10/29/2013 for 25 states:

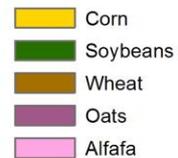
Sioux Falls CDL examples



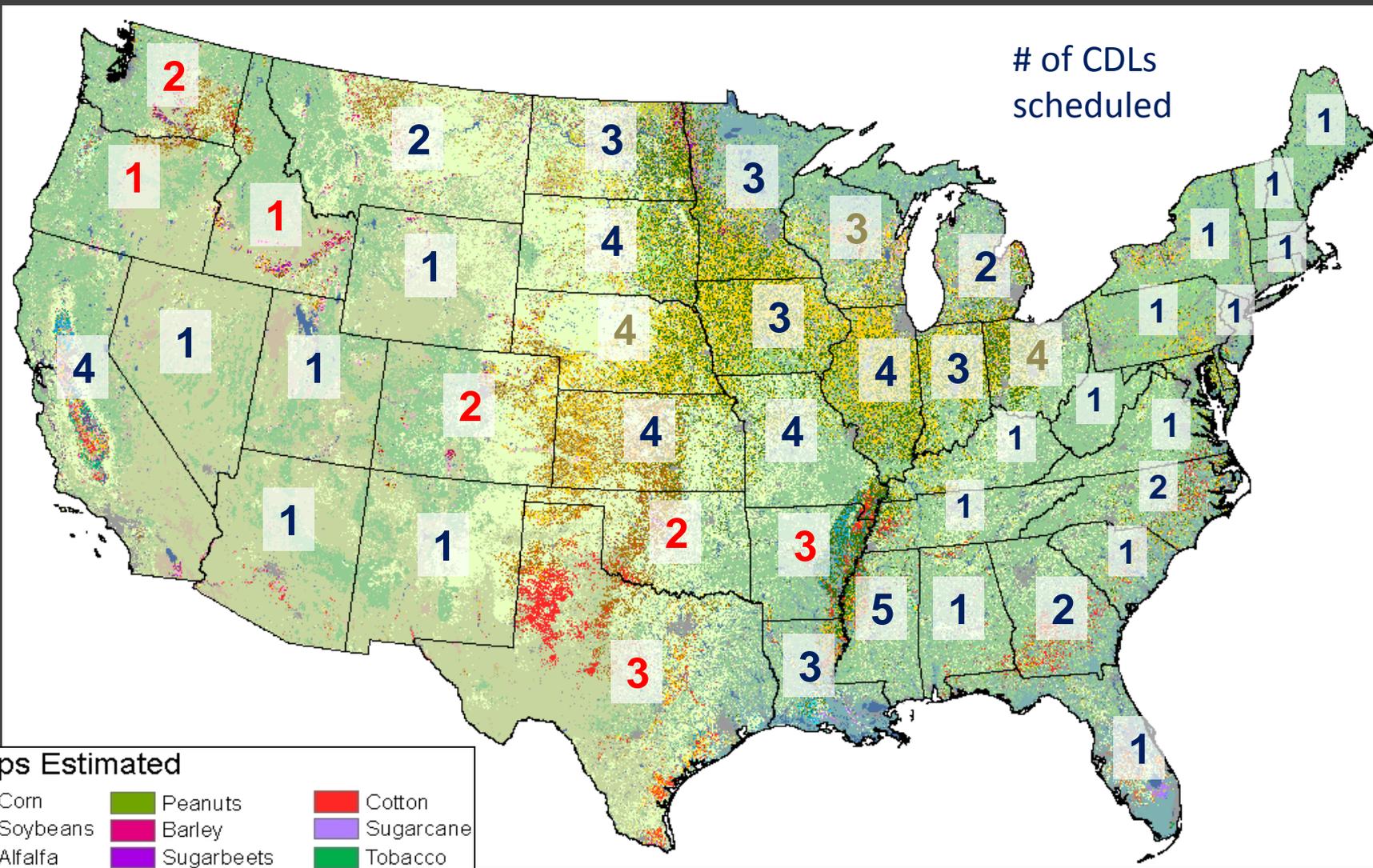
2012
Deimos-1 and UK-2 derived cropland classification



2013
Landsat 8 OLI derived cropland classification



In season CDL 2013 processing runs by state

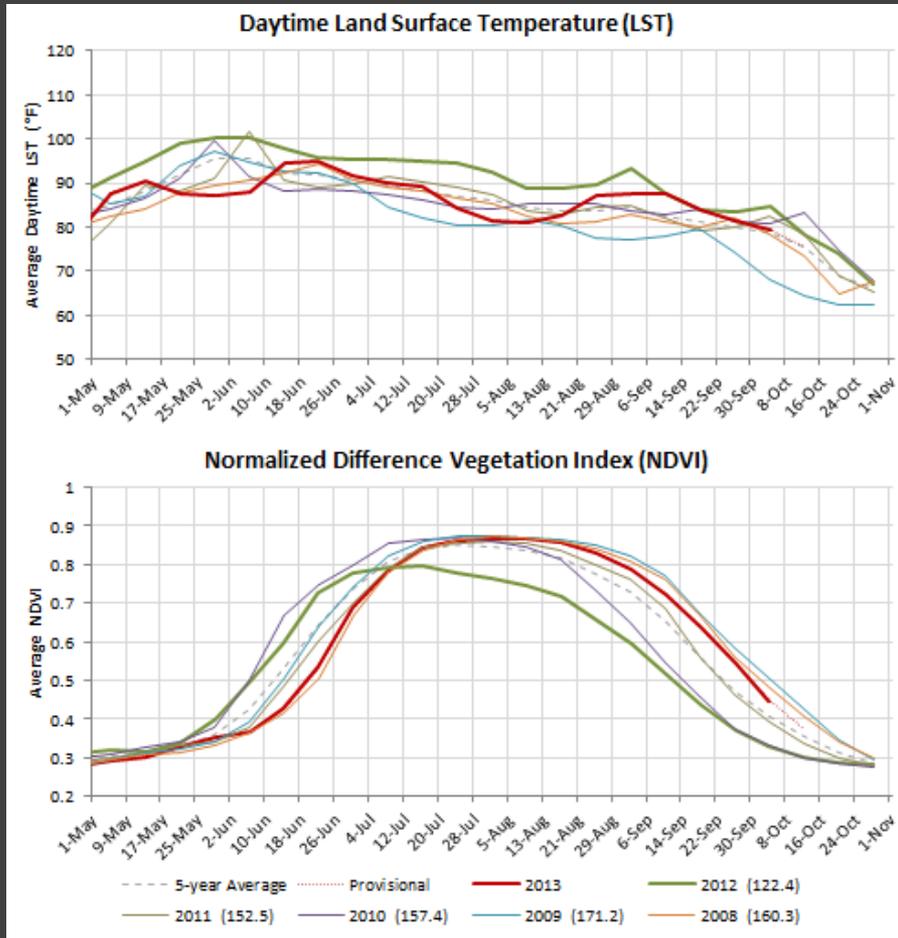


Crops Estimated

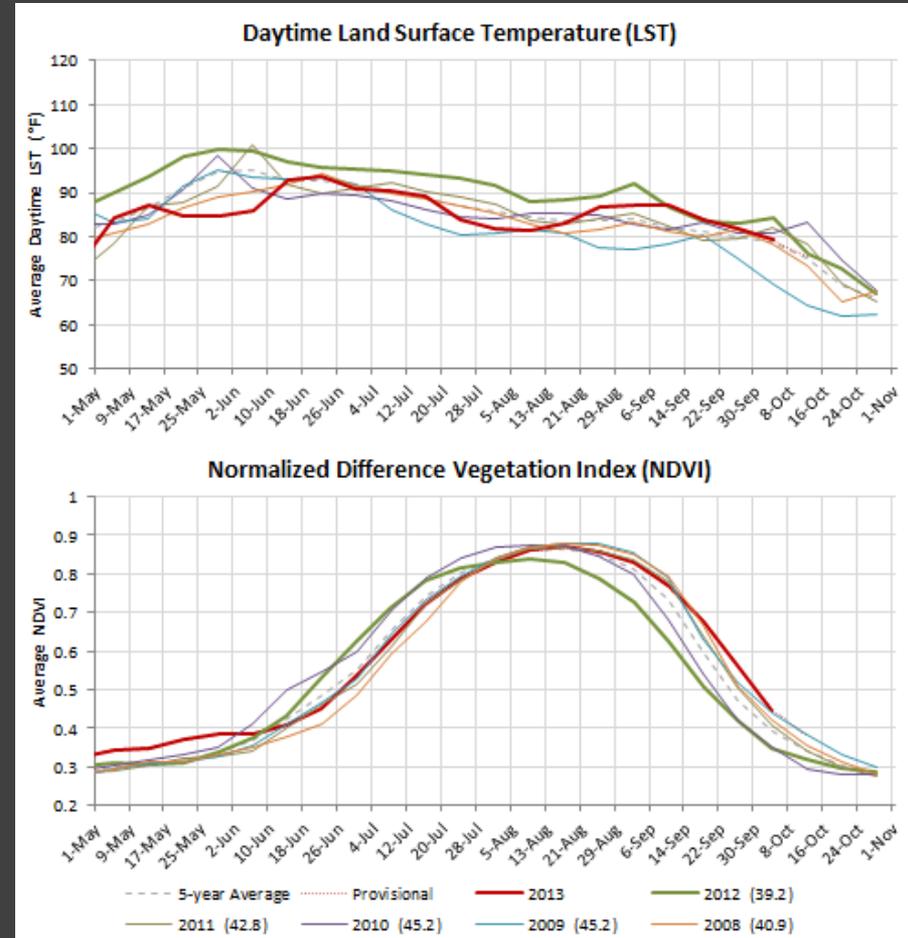
Corn	Peanuts	Cotton
Soybeans	Barley	Sugarcane
Alfalfa	Sugarbeets	Tobacco
Rice	Dry Beans	Sorghum
Canola	Spring Wheat	Potatoes
Flaxseed	Winter Wheat	
Sunflower	Durum Wheat	

Crop area "acreage" estimates derived for each

MODIS phenology using CDL as land cover masks



Corn



Soybeans

This type of information is directly related to crop yields

Had hoped to provide for this meeting

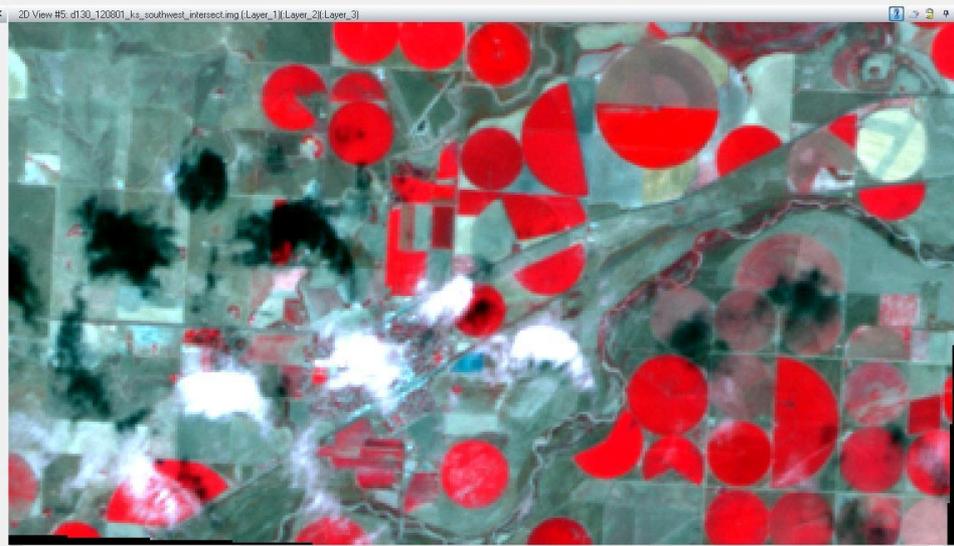
- An assessment of the usefulness of the individual OLI and TIRS bands on cropland cover classification
 - By summarizing the band usage metadata from all of the classifications
 - And by simplifying the classifications to certain bands to understand the utility of each
- Instead will discuss what might be useful for a future missions and how we can test now
 - Other spectral bands that might be useful for vegetation mapping
 - Implications of a wider swath on land cover classification

Southwest KS

Worldview 2 (NIR, RE, Red)



RapidEye (NIR, RE, Red)

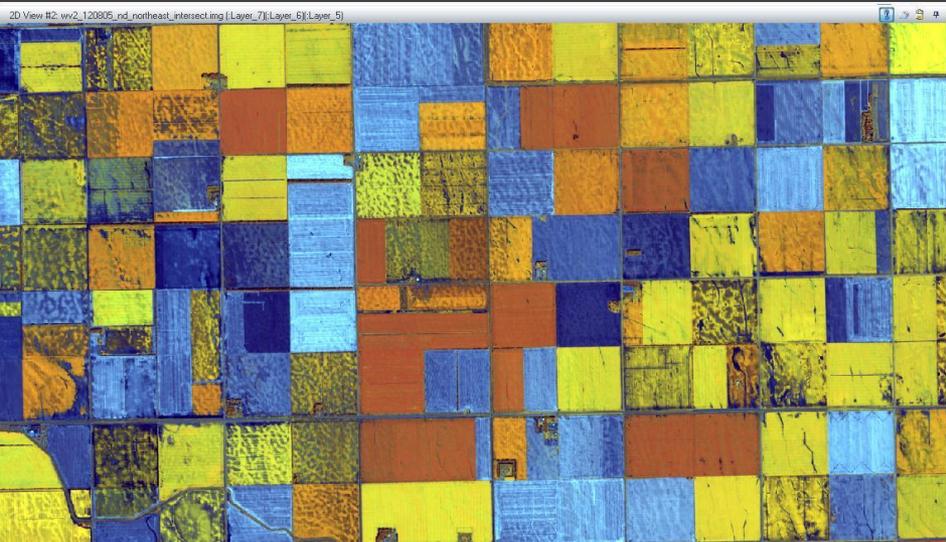


Known field types

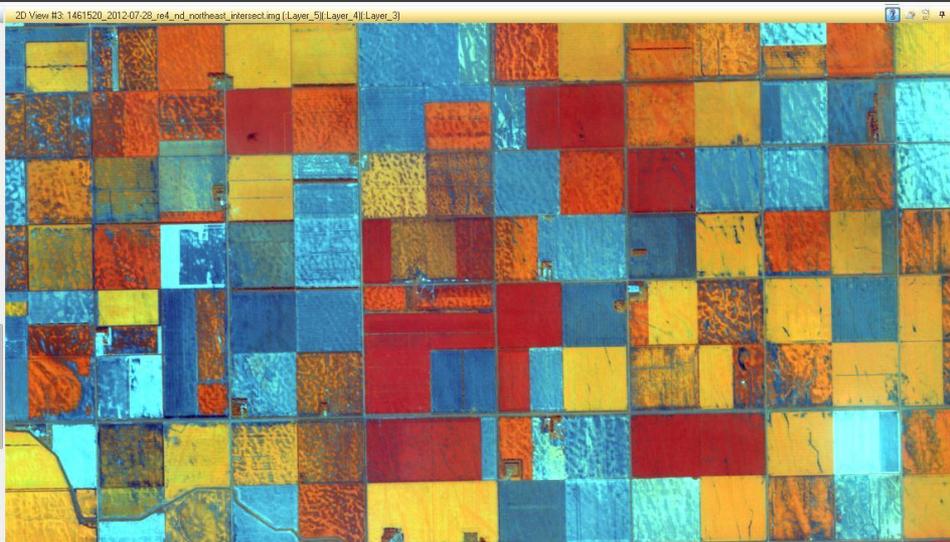
DMC (color-infrared)

Northeastern ND

Worldview 2 (NIR, RE, Red)



RapidEye (NIR, RE, Red)

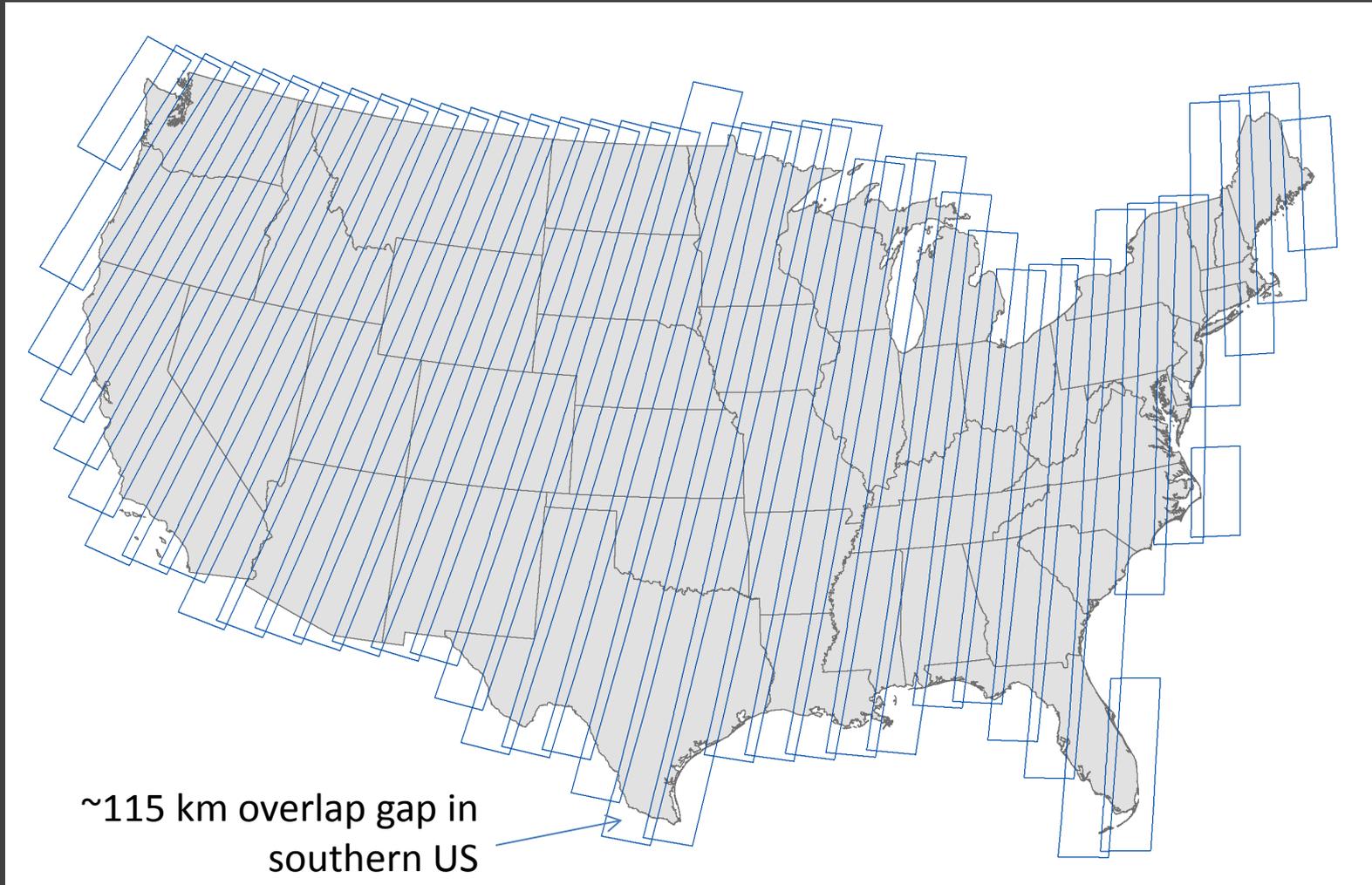


Known field types



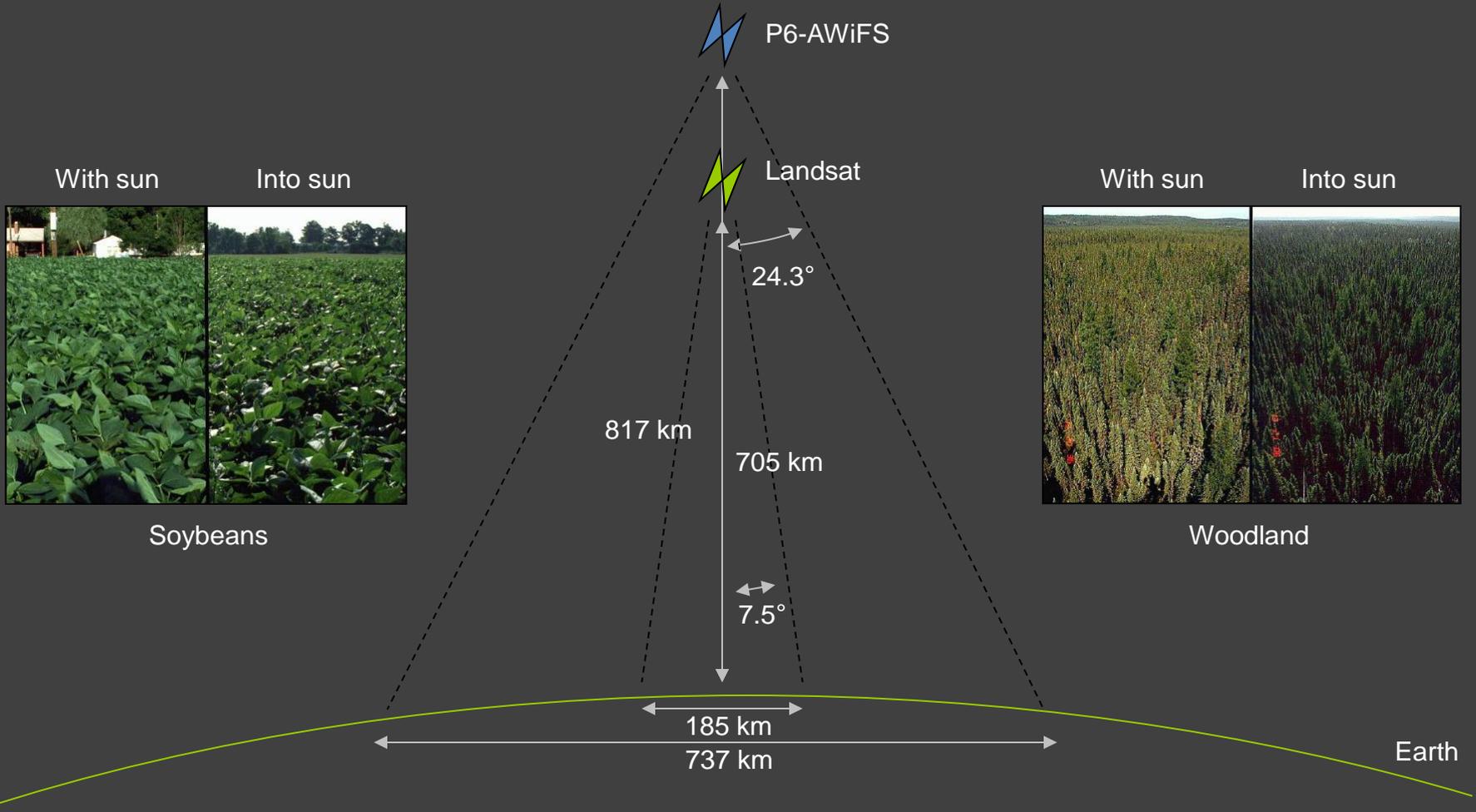
DMC (color-infrared)

Path geometry over US

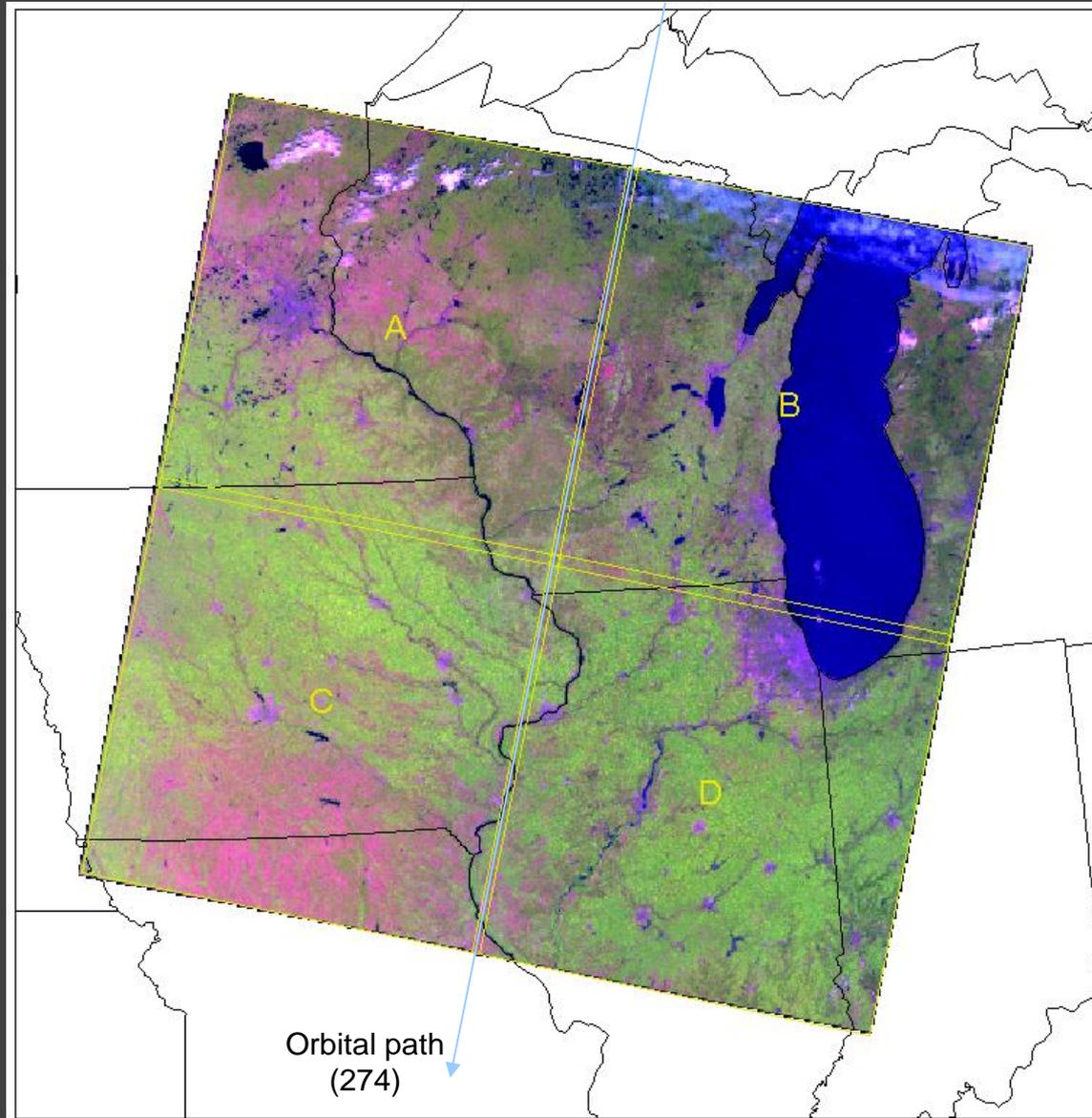


Don't need to massively widen field of view to give us 8-day data (~60%)

AWiFS viewing geometry



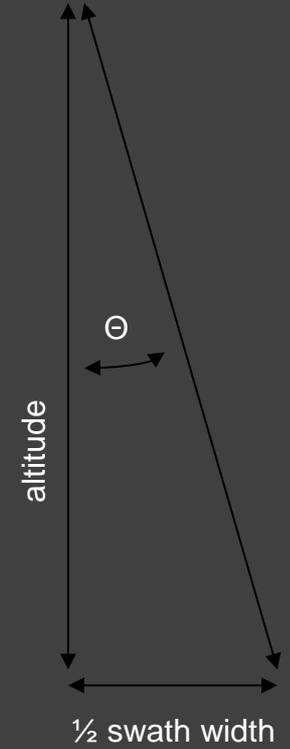
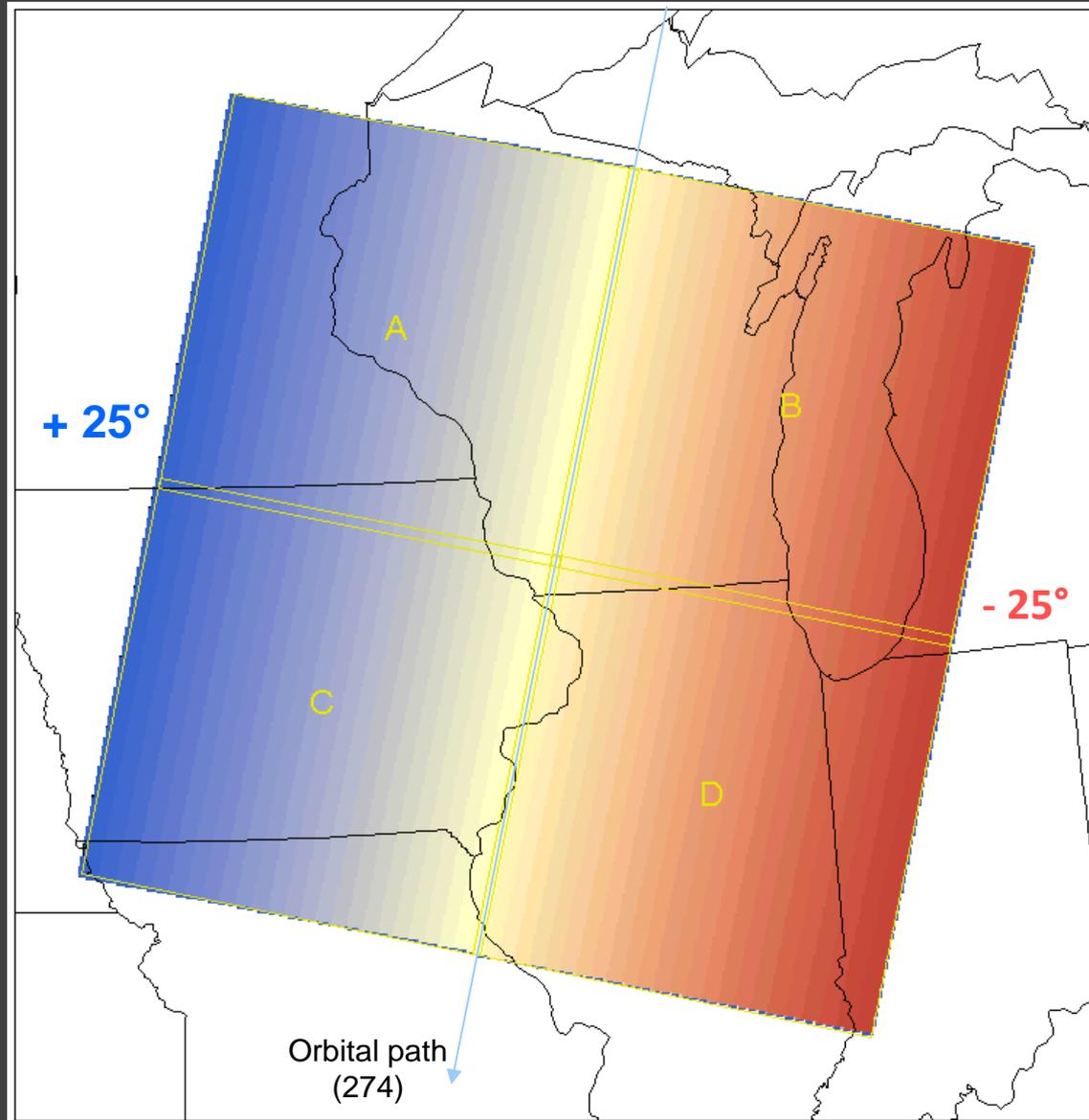
Example four quad, same date/path AWiFS collect



31 July 2006

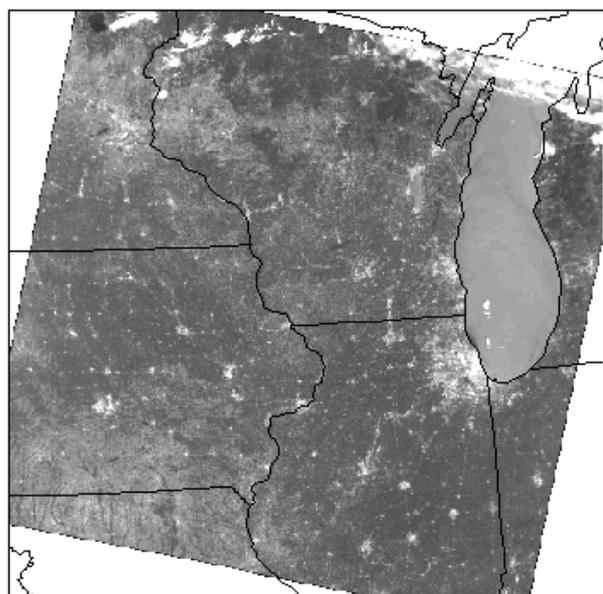
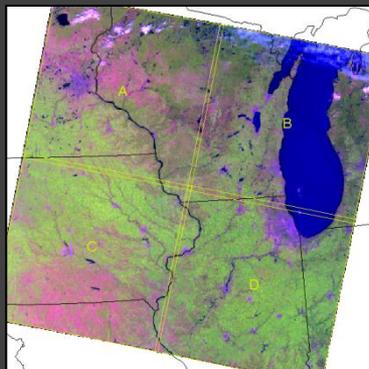
Angle from nadir calculation

Measured swath
Width: ~745 km

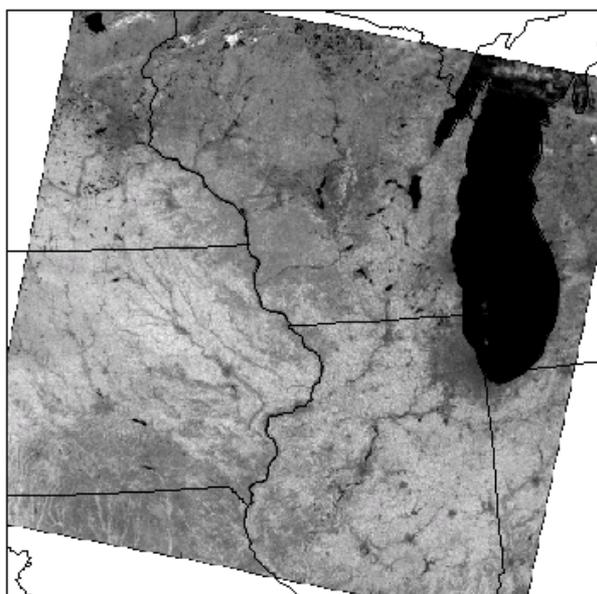


$$\Theta = \arctan(\text{opp./adj.})$$

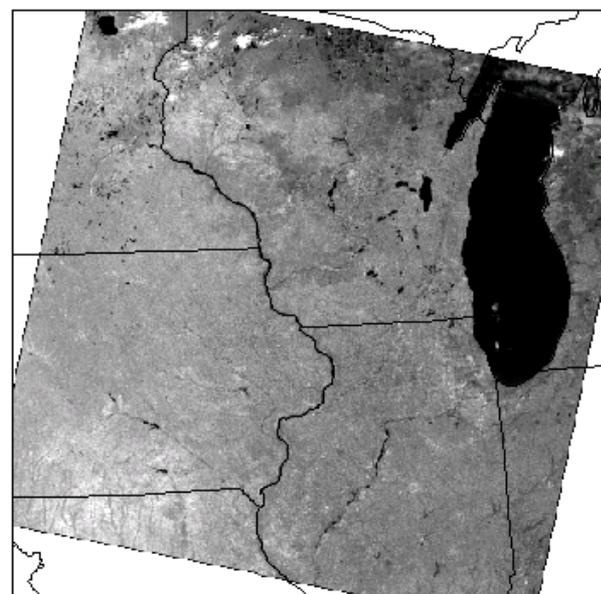
Inspection of across swath reflectance



Band 2 - Red

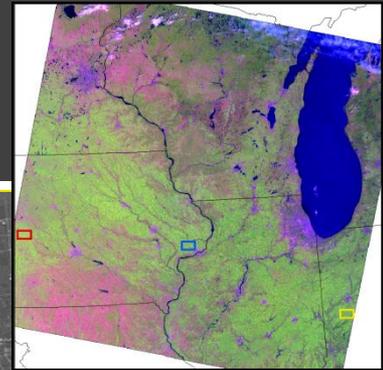


Band 3 - Near Infrared



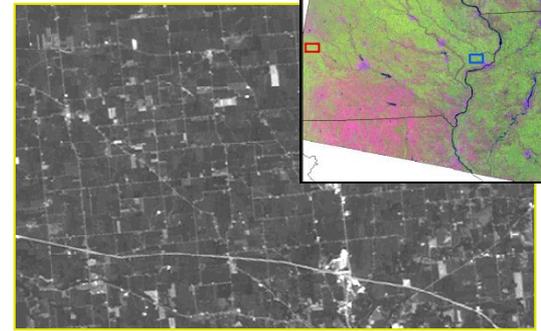
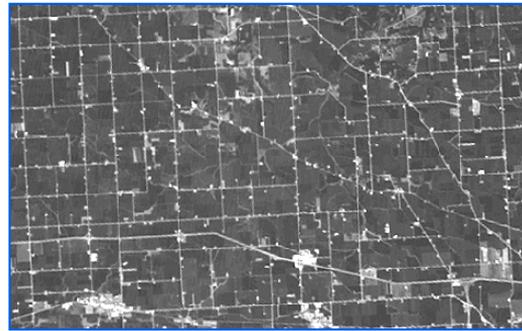
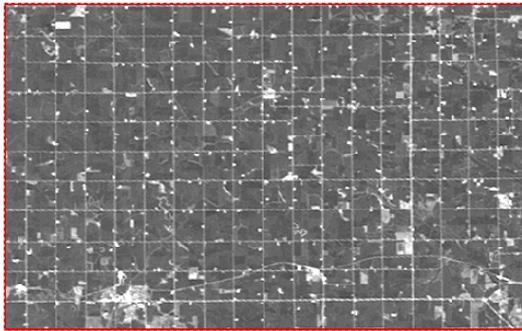
Band 4 - Shortwave Infrared

Across track reflectance



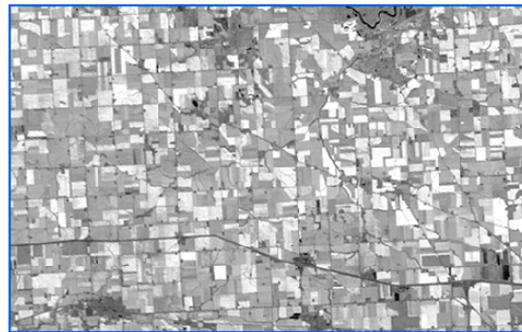
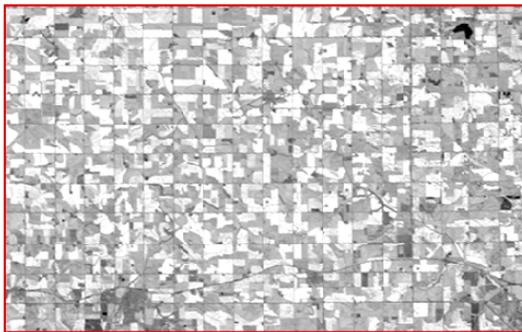
Band 2

Red



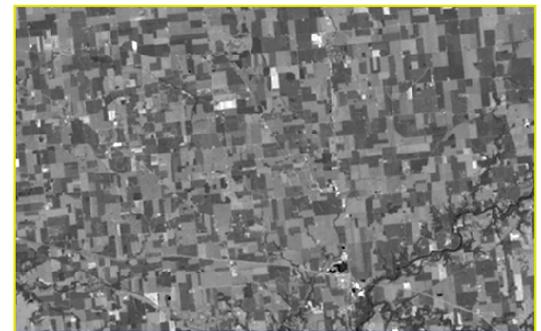
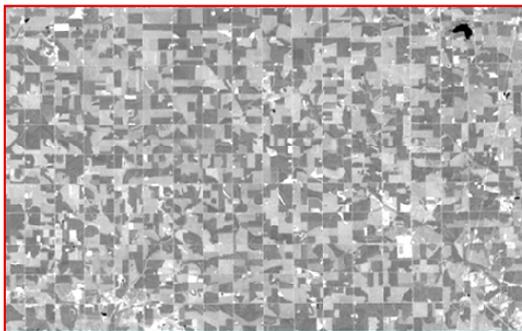
Band 3

NIR



Band 4

SWIR

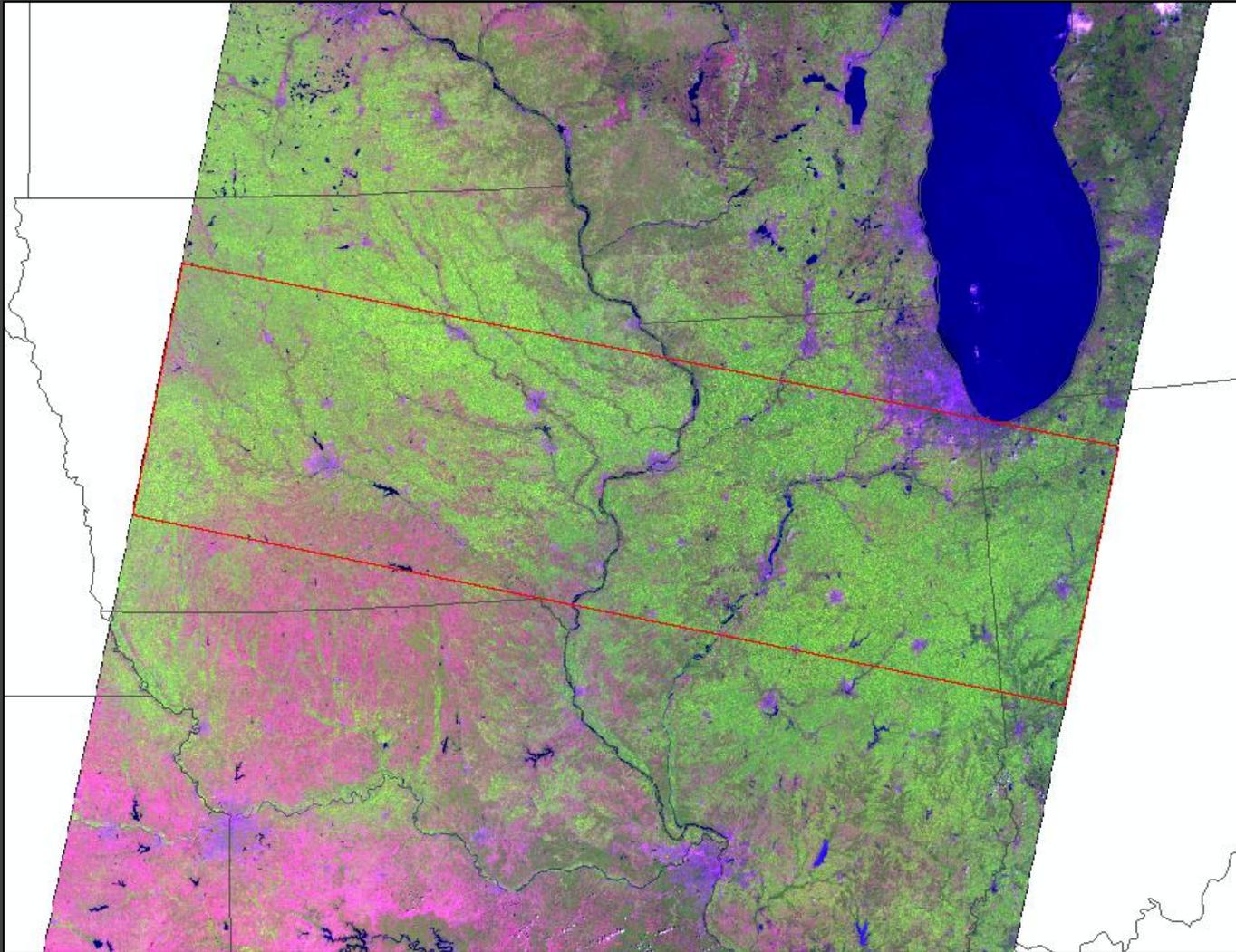


West

Nadir

East

Classification across track study area

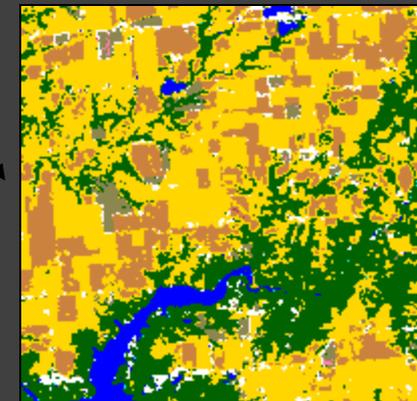
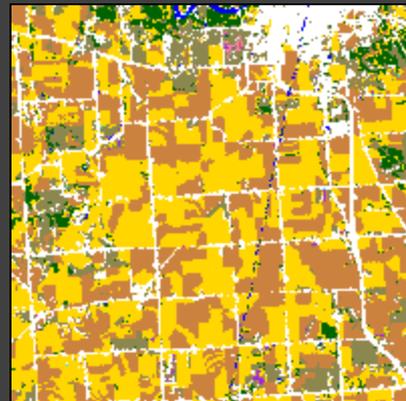
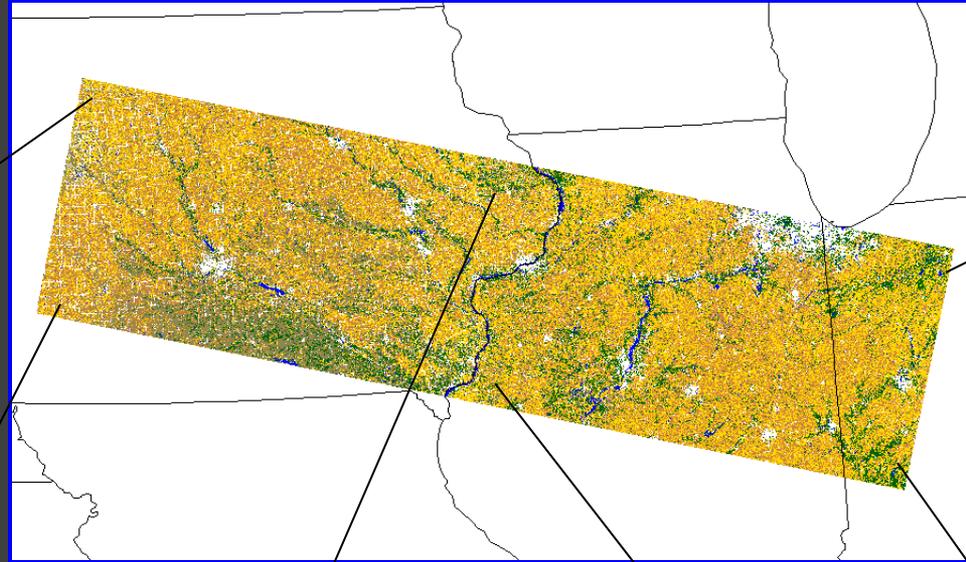
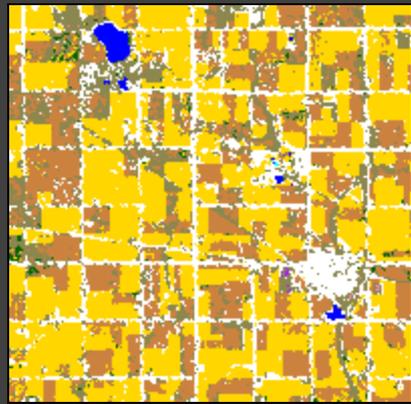


31 July 2006

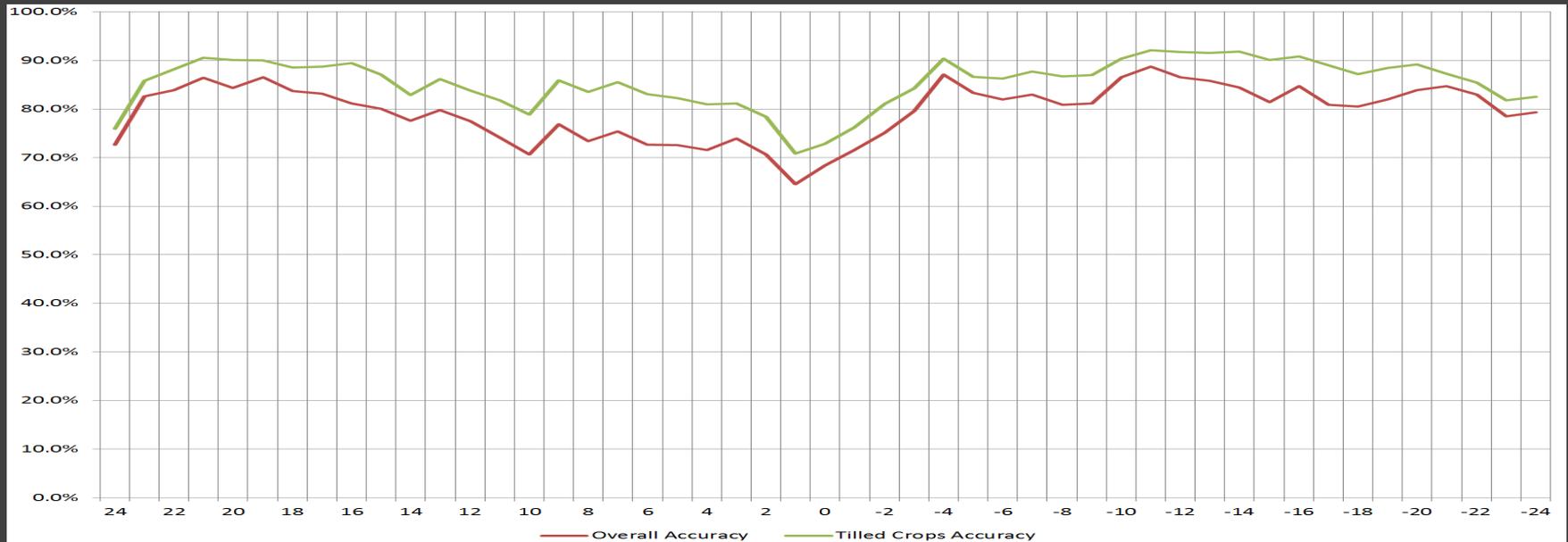
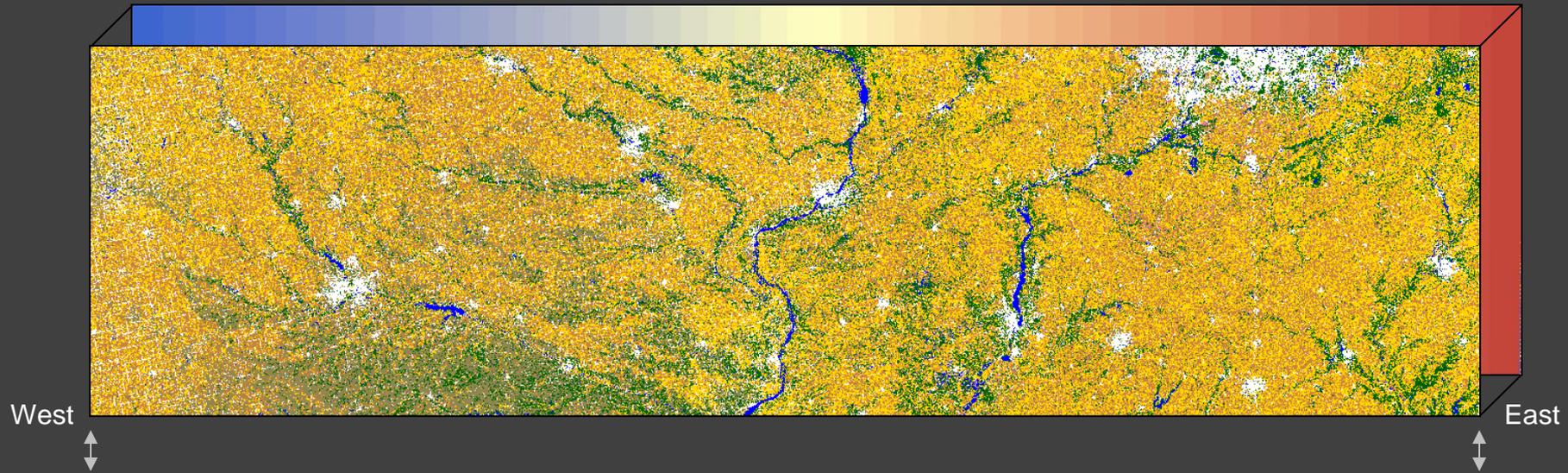
Full swath classification output

overall Accuracy = 82.5%

Kappa = 0.758

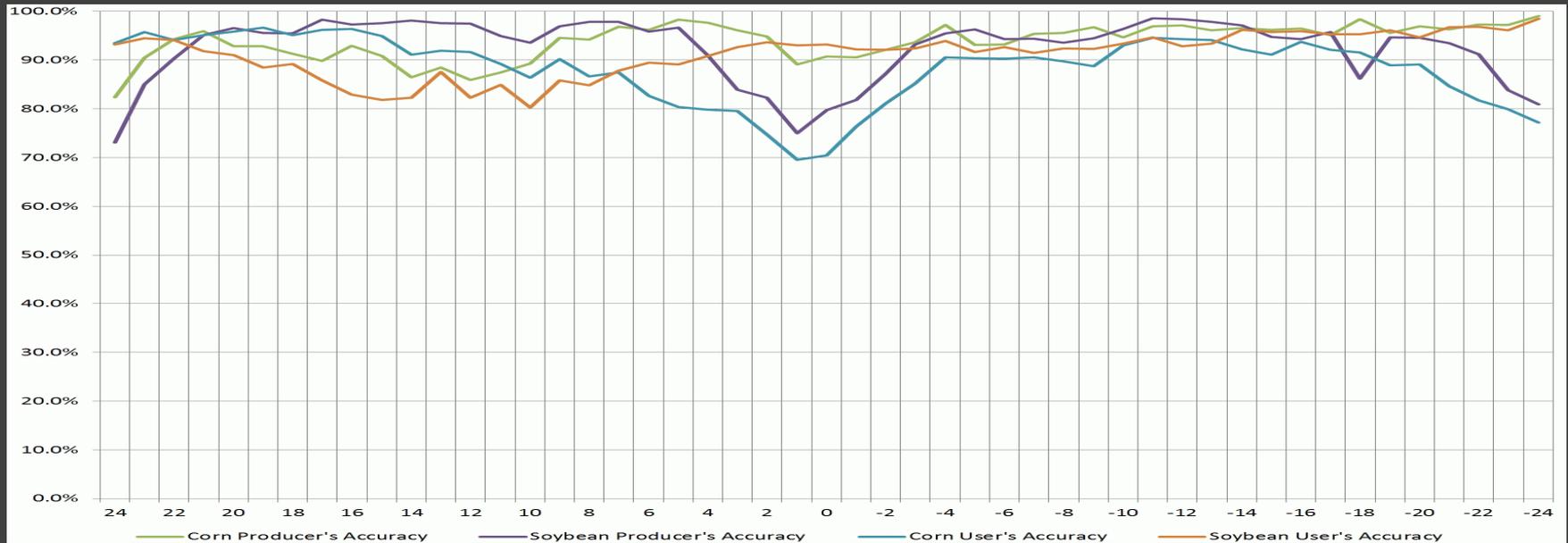
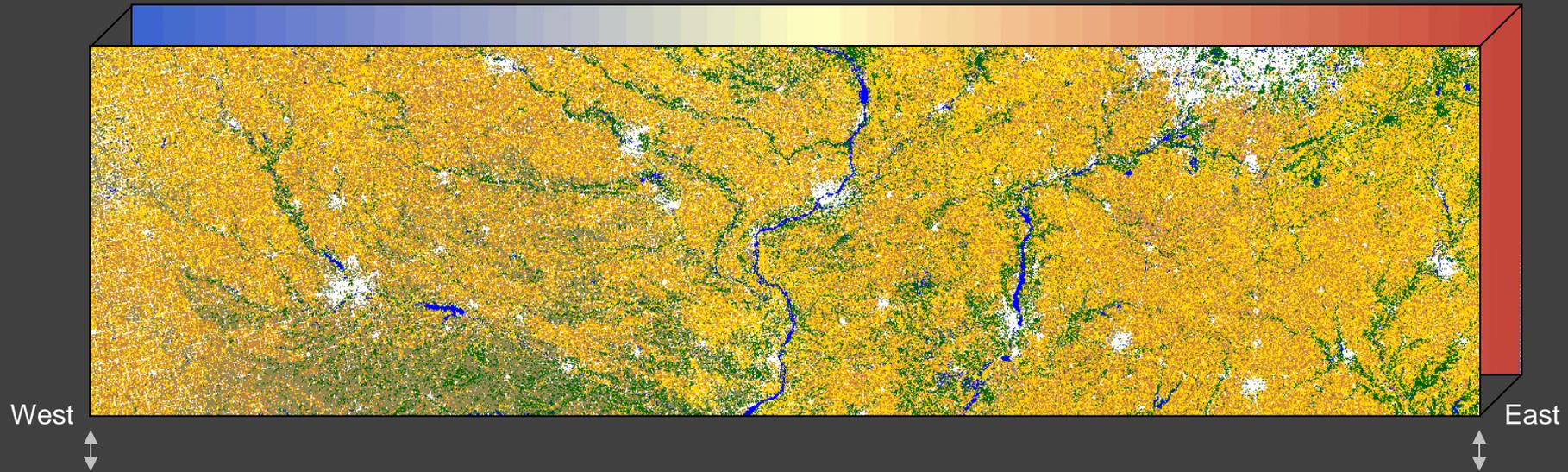


Overall accuracy as a function of viewing angle



Overall Accuracy Tilled Crops Accuracy

Crop accuracy as a function of viewing angle



Should we push for some off-nadir Landsat 8 collects?

- It is a direct way to assess what a wider swath Landsat will look like
 - I would argue yes.
- Will simply waiting for some serendipitous examples due to an disaster/emergency fill the need?
 - Maybe, but I'm not overly confident it will happen.
 - And even if it does it may not be over a relevant area or with decent atmospheric conditions.

Off-nadir L8 scene list

Landsat Scene Identifier	WRS Path	WRS Row	Target WRS Path	Target WRS Row	Nadir Off Nadir	Full or Partial Scene	Data Category	Roll Angle
LC81740502013105LGN01	174	50	175		50	OFFNADIR FULL	NOMINAL	-13.073
LC81740492013105LGN01	174	49	175		49	OFFNADIR FULL	NOMINAL	-13.073
LC81740512013105LGN01	174	51	175		51	OFFNADIR FULL	NOMINAL	-13.072
LC81740482013105LGN01	174	48	175		48	OFFNADIR FULL	NOMINAL	-13.074
LC80170372013109LGN01	17	37	18		37	OFFNADIR FULL	NOMINAL	-11.695
LC80170382013109LGN01	17	38	18		38	OFFNADIR FULL	NOMINAL	-11.694
LC80170392013109LGN01	17	39	18		39	OFFNADIR FULL	NOMINAL	-11.694
LC80170362013109LGN01	17	36	18		36	OFFNADIR FULL	NOMINAL	-11.695
LC81750852013112LGN01	175	85	174		85	OFFNADIR FULL	NOMINAL	10.723
LC81750822013112LGN01	175	82	174		82	OFFNADIR FULL	NOMINAL	10.721
LC81750832013112LGN01	175	83	174		83	OFFNADIR FULL	NOMINAL	10.722
LC81750842013112LGN01	175	84	174		84	OFFNADIR FULL	NOMINAL	10.722
LC81300332013117LGN01	130	33	131		33	OFFNADIR FULL	NOMINAL	-10.512
LC81300322013117LGN01	130	32	131		32	OFFNADIR FULL	NOMINAL	-10.513
LC81300302013117LGN01	130	30	131		30	OFFNADIR FULL	NOMINAL	-10.514
LC81300312013117LGN01	130	31	131		31	OFFNADIR FULL	NOMINAL	-10.513
LC81921242013119LGN01	192	124	228		118	OFFNADIR FULL	NOMINAL	-14.983
LC81921232013119LGN01	192	123	221		118	OFFNADIR FULL	NOMINAL	-14.983
LC81921222013119LGN01	192	122	215		118	OFFNADIR FULL	NOMINAL	-14.983
LC81921212013119LGN01	192	121	210		118	OFFNADIR FULL	NOMINAL	-14.983
LC81921172013119LGN01	192	117	200		116	OFFNADIR FULL	NOMINAL	-14.983
LC81921202013119LGN01	192	120	206		118	OFFNADIR FULL	NOMINAL	-14.983
LC81921192013119LGN01	192	119	204		117	OFFNADIR FULL	NOMINAL	-14.984
LC81921162013119LGN01	192	116	199		115	OFFNADIR FULL	NOMINAL	-14.983
LC81921182013119LGN01	192	118	202		116	OFFNADIR FULL	NOMINAL	-14.983
LC81921152013119LGN01	192	115	199		115	OFFNADIR FULL	NOMINAL	-14.983
LC81921142013119LGN01	192	114	198		114	OFFNADIR FULL	NOMINAL	-14.983
LC80190372013123LGN01	19	37	20		37	OFFNADIR FULL	NOMINAL	-11.033
LC80190382013123LGN01	19	38	20		38	OFFNADIR FULL	NOMINAL	-11.033
LC80190392013123LGN01	19	39	20		39	OFFNADIR FULL	NOMINAL	-11.032
LC80190362013123LGN01	19	36	20		36	OFFNADIR FULL	NOMINAL	-11.034
LC81320342013131LGN01	132	34	131		34	OFFNADIR FULL	NOMINAL	10.082
LC81320322013131LGN01	132	32	131		32	OFFNADIR FULL	NOMINAL	10.083
LC81320312013131LGN01	132	31	131		31	OFFNADIR FULL	NOMINAL	10.083
LC81320332013131LGN01	132	33	131		33	OFFNADIR FULL	NOMINAL	10.082
LC81300312013133LGN01	130	31	131		31	OFFNADIR FULL	NOMINAL	-10.262
LC81300302013133LGN01	130	30	131		30	OFFNADIR FULL	NOMINAL	-10.262
LC81300332013133LGN01	130	33	131		33	OFFNADIR FULL	NOMINAL	-10.261

LC81300322013133LGN01	130	32	131		32	OFFNADIR FULL	NOMINAL	-10.261
LC80372482013137LGN01	37	248	52		246	OFFNADIR FULL	NOMINAL	-11.707
LC80530042013137LGN01	53	4	99		241	OFFNADIR FULL	NOMINAL	-11.706
LC80530032013137LGN01	53	3	90		242	OFFNADIR FULL	NOMINAL	-11.707
LC80372452013137LGN01	37	245	37		880	OFFNADIR FULL	NOMINAL	-11.707
LC80530012013137LGN01	53	1	58		246	OFFNADIR FULL	NOMINAL	-11.707
LC80372472013137LGN01	37	247	37		882	OFFNADIR FULL	NOMINAL	-11.707
LC80530022013137LGN01	53	2	79		243	OFFNADIR FULL	NOMINAL	-11.707
LC80372432013137LGN01	37	243	16		246	OFFNADIR FULL	NOMINAL	-11.707
LC80372462013137LGN01	37	246	37		881	OFFNADIR FULL	NOMINAL	-11.707
LC80372442013137LGN01	37	244	22		246	OFFNADIR FULL	NOMINAL	-11.706
LC80440292013138LGN01	44	29	43		29	OFFNADIR FULL	NOMINAL	9.762
LC80440282013138LGN01	44	28	43		28	OFFNADIR FULL	NOMINAL	9.762
LC80440312013138LGN01	44	31	43		31	OFFNADIR FULL	NOMINAL	9.76
LC80440302013138LGN01	44	30	43		30	OFFNADIR FULL	NOMINAL	9.761
LC80190372013139LGN01	19	37	18		37	OFFNADIR FULL	NOMINAL	11.45
LC80190392013139LGN01	19	39	18		39	OFFNADIR FULL	NOMINAL	11.449
LC80190362013139LGN01	19	36	18		36	OFFNADIR FULL	NOMINAL	11.451
LC80190382013139LGN01	19	38	18		38	OFFNADIR FULL	NOMINAL	11.45
LC80170372013141LGN01	17	37	18		37	OFFNADIR FULL	NOMINAL	-11.318
LC80170362013141LGN01	17	36	18		36	OFFNADIR FULL	NOMINAL	-11.318
LC80170382013141LGN01	17	38	18		38	OFFNADIR FULL	NOMINAL	-11.316
LC80170392013141LGN01	17	39	18		39	OFFNADIR FULL	NOMINAL	-11.316
LC81911222013144LGN00	191	122	191		992	OFFNADIR FULL	NOMINAL	14.258
LC81911172013144LGN00	191	117	181		118	OFFNADIR FULL	NOMINAL	14.257
LC81911212013144LGN00	191	121	191		991	OFFNADIR FULL	NOMINAL	14.257
LC81911192013144LGN00	191	119	169		122	OFFNADIR FULL	NOMINAL	14.257
LC81911182013144LGN00	191	118	177		120	OFFNADIR FULL	NOMINAL	14.257
LC81911202013144LGN00	191	120	191		990	OFFNADIR FULL	NOMINAL	14.258
LC81911162013144LGN00	191	116	183		117	OFFNADIR FULL	NOMINAL	14.257
LC81911232013144LGN00	191	123	191		993	OFFNADIR FULL	NOMINAL	14.258
LC81911242013144LGN00	191	124	191		994	OFFNADIR FULL	NOMINAL	14.261
LC81730812013146LGN00	173	81	174		81	OFFNADIR FULL	NOMINAL	-10.875
LC81730842013146LGN00	173	84	174		84	OFFNADIR FULL	NOMINAL	-10.876
LC81730822013146LGN00	173	82	174		82	OFFNADIR FULL	NOMINAL	-10.875
LC81730832013146LGN00	173	83	174		83	OFFNADIR FULL	NOMINAL	-10.876
LC80320362013150LGN00	32	36	33		36	OFFNADIR FULL	NOMINAL	-11.179
LC80320372013150LGN00	32	37	33		37	OFFNADIR FULL	NOMINAL	-11.179
LC80320382013150LGN00	32	38	33		38	OFFNADIR FULL	NOMINAL	-11.179
LC80320352013150LGN00	32	35	33		35	OFFNADIR FULL	NOMINAL	-11.18



USGS/
EROS
→

South Dakota Corn
Field 10/29/2013

Thanks