Developing a Sampling Strategy: Examples from Phase 1 using multi-source remotely sensed data

Matt Hansen, Carlos Di Bella, Inbal Becker-Reshef, Ian Jarvis, Alyssa Whitcraft

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Current Status

- Initial piloting leveraging existing projects- demonstrating feasibility
  - Argentina
  - US
  - Canada
  - Australia
- Need discussion on next steps
  - Currently IP states a global sampling approach for main producer countries

Generic multi-source approach

Wall to wall is not always feasible, however sampling frames may provide statistically viable data at a fraction of the cost and effort

- Philosophy – integrate time-series multi-spectral, multi-resolution remote sensing data streams to improve cropland characterization for area estimation
- National-scale indicator mapping with coarse res MODIS data by crop type for targeted stratification, calibrated by Landsat cover characterizations
- Samples of Landsat and RapidEye to derive cultivated area estimation
- Incorporation of national-scale indicator maps in a regression estimator procedure

Sampling Strategy

A nested stratified, multi-resolution sampling approach is a complementary approach which allows for more frequent acquisitions over selected sites that are statistically representative of entire area, often at higher resolution

Nested Scales:

- **S1: Moderate res sample blocks**
  - Number of sample blocks depends primarily on variability of crop types, of crop rotations, size of region, desired standard error
  - Blocks should be quite small (~20km)

- **Frequency of acquisition, will depend on the complexity of the cropping** system- approximately 5 scenes per growing season; 1-2 out of season

- **S2: Fine res sample blocks**
  - Smaller Subset of sample blocks requested for fine res with same acquisition frequency as S1 blocks

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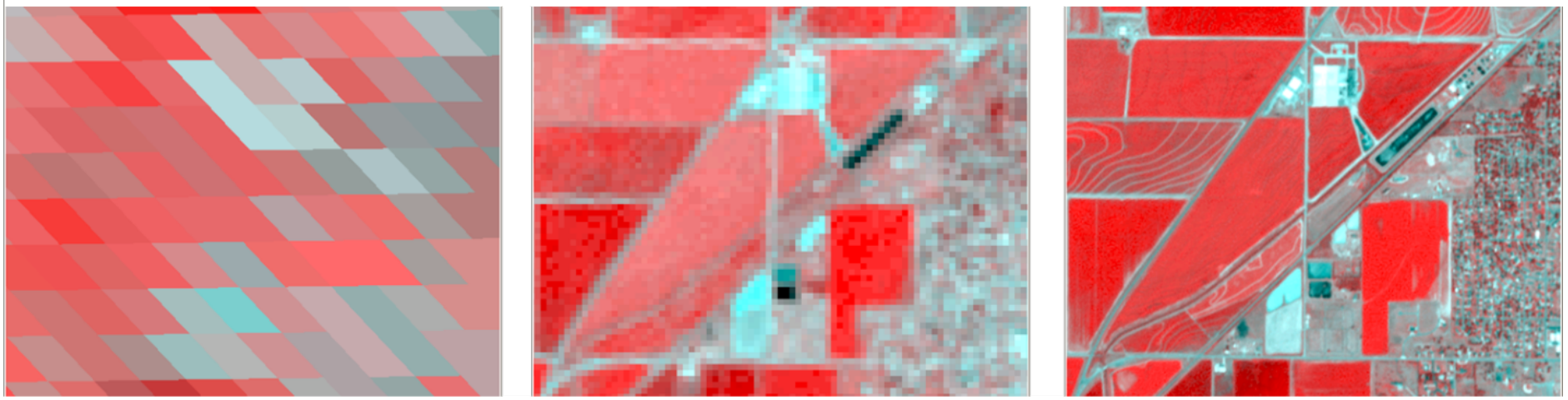
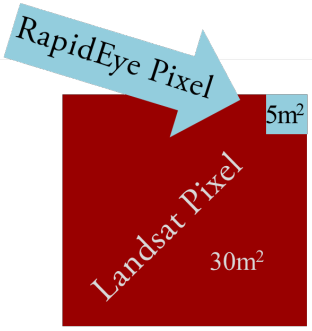
Multi-Resolution Data for developing a generic approach to crop type area estimation

MODIS – Landsat – RapidEye



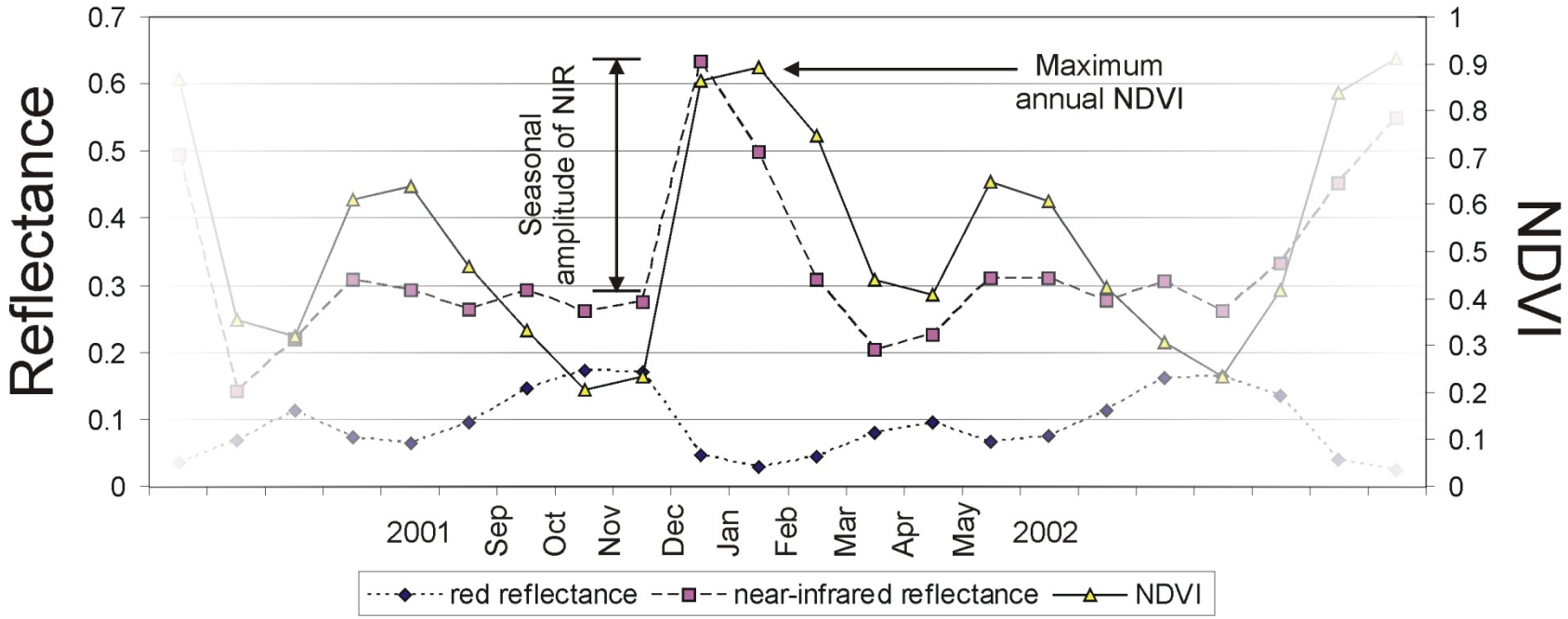
5km x 4.7km near Stuttgart, Arkansas



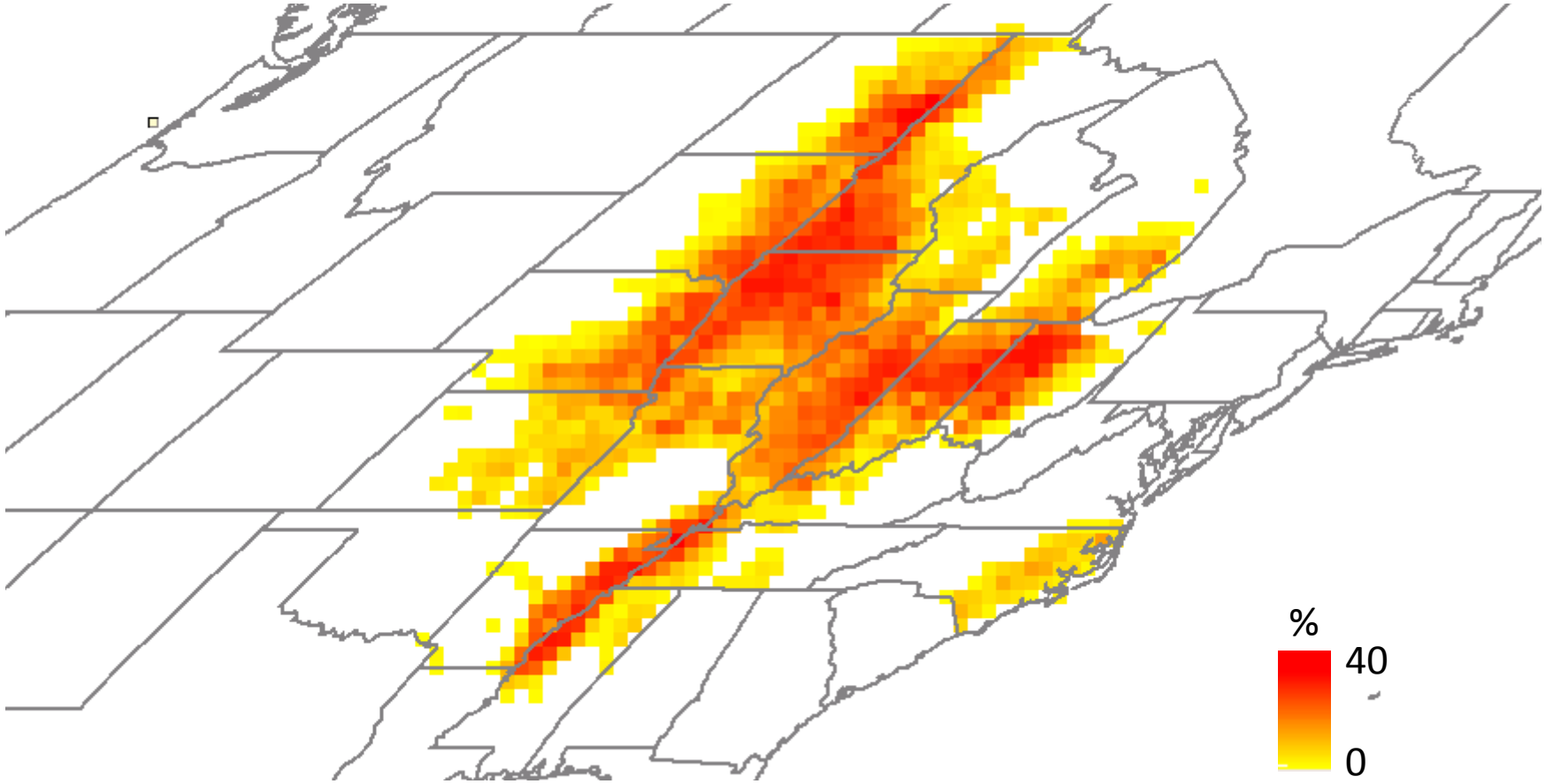
Pixel Size Ratio

250 meter MODIS data used to identify the study area and samples, Landsat for mapping each sample rapideye for calval

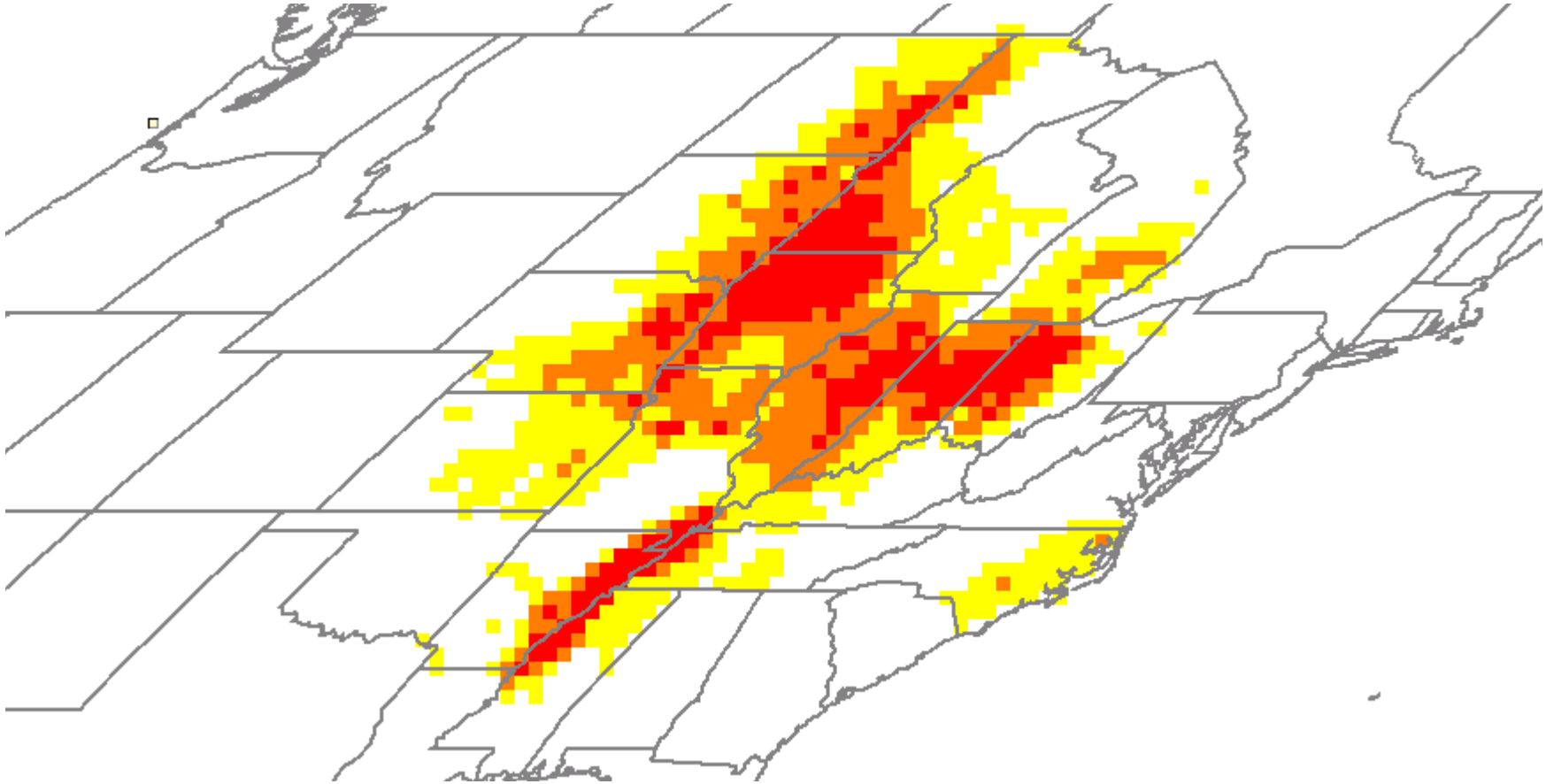
High Temporal Frequency is Critical for Crop Type Discrimination



Sample population – MODIS percent soybean per 40km block, 2007 to 2010

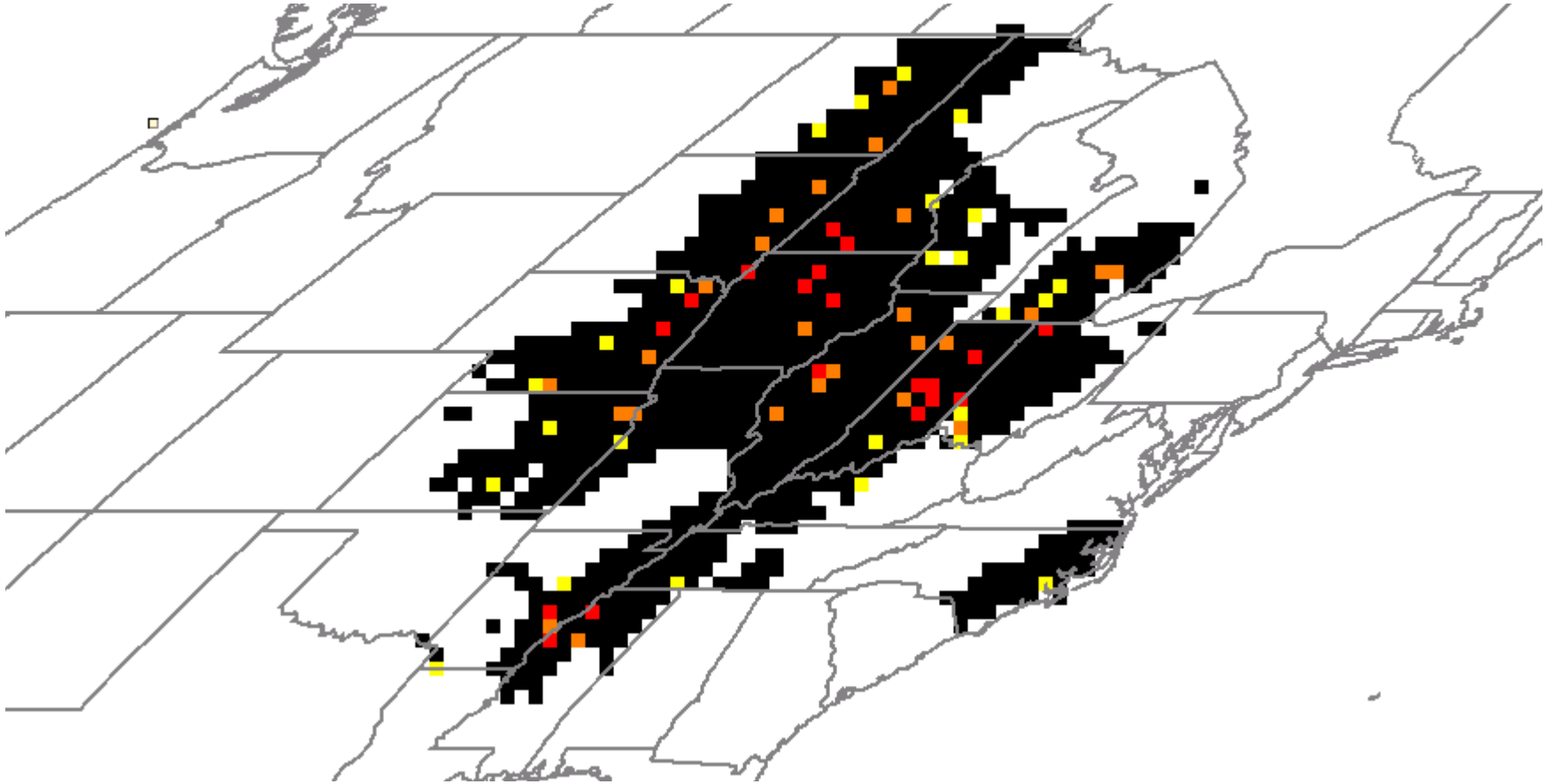


High, medium and low soybean strata



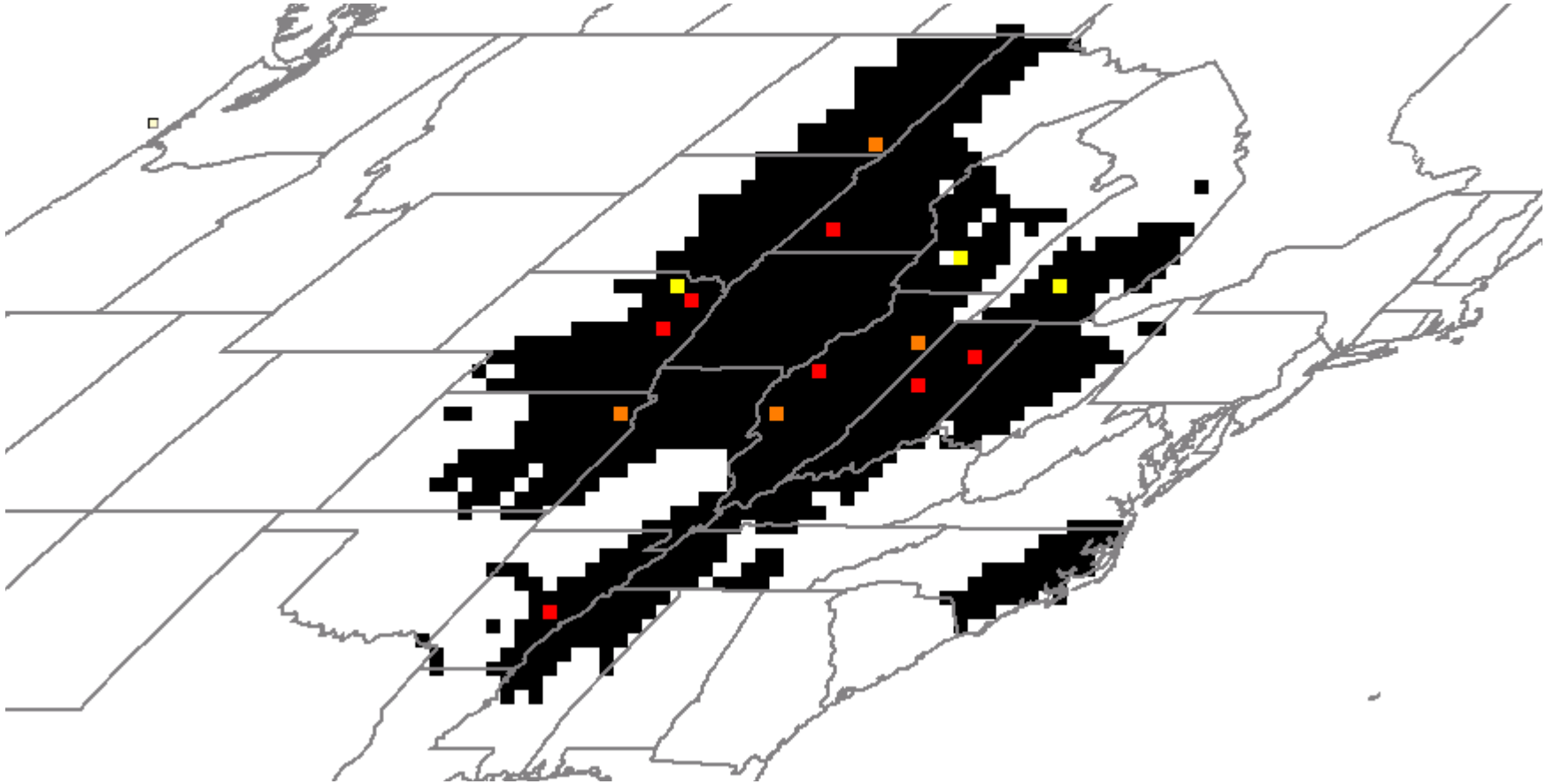
Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

Landsat sample blocks



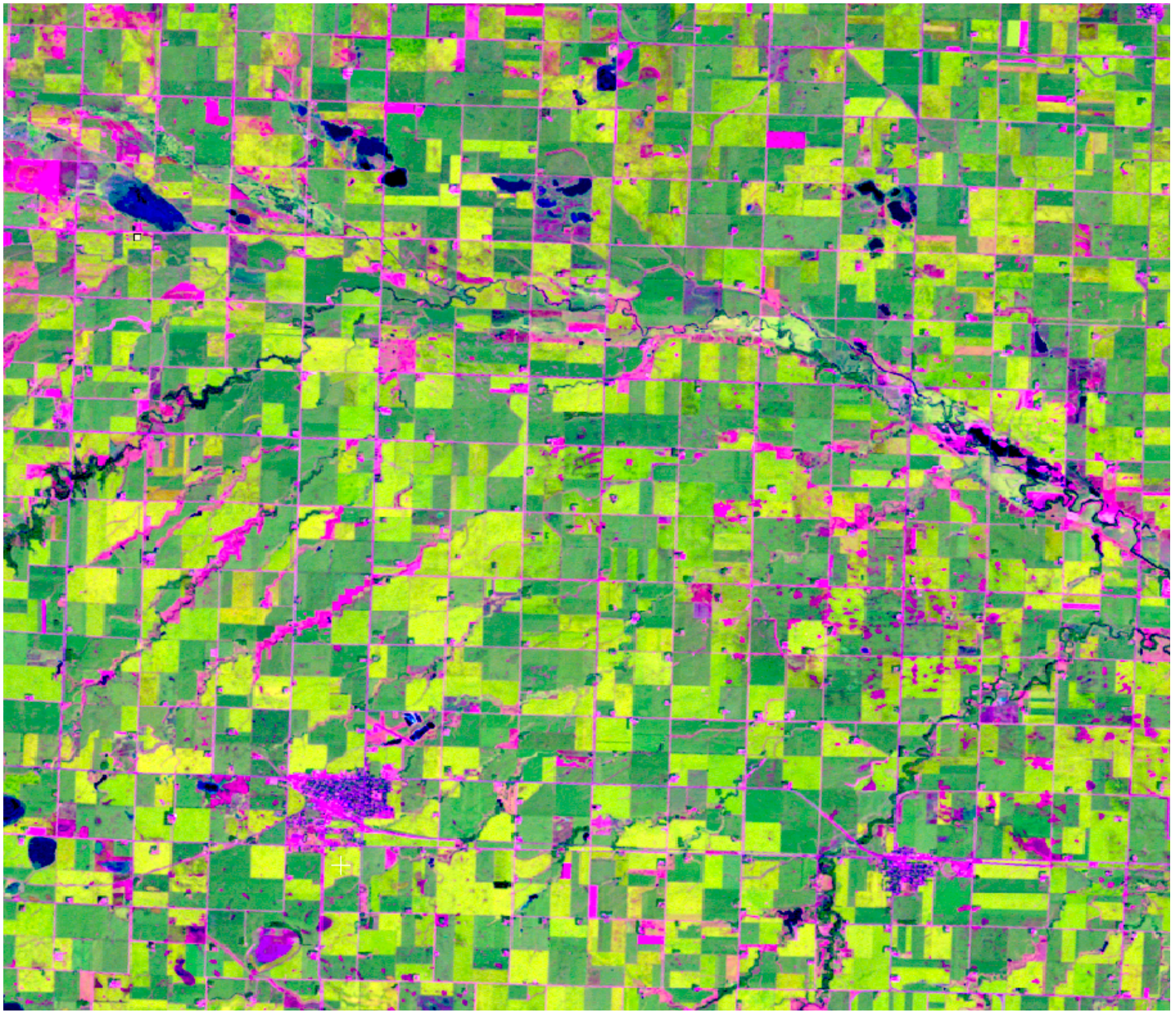
Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

RapidEye locations



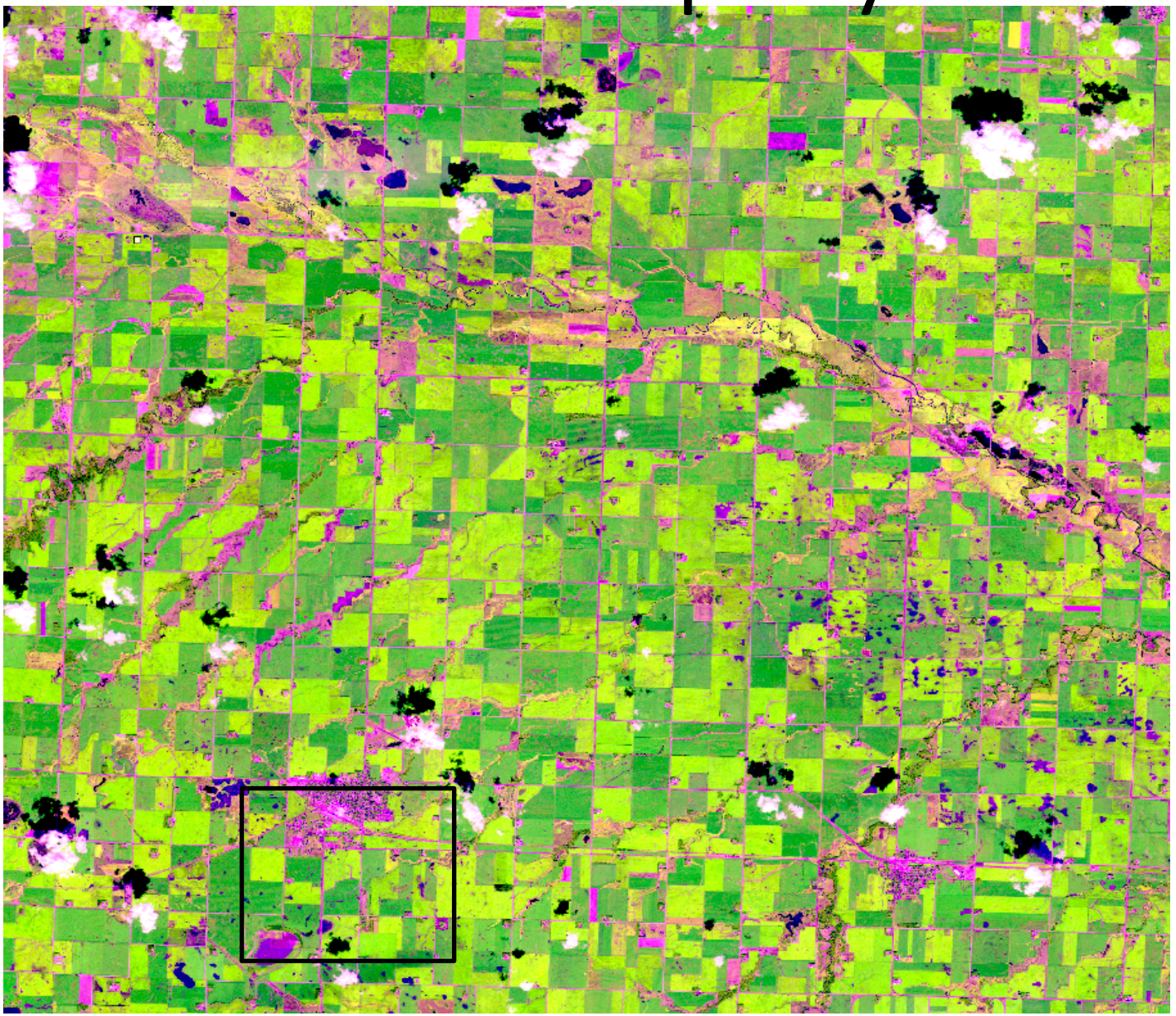
Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

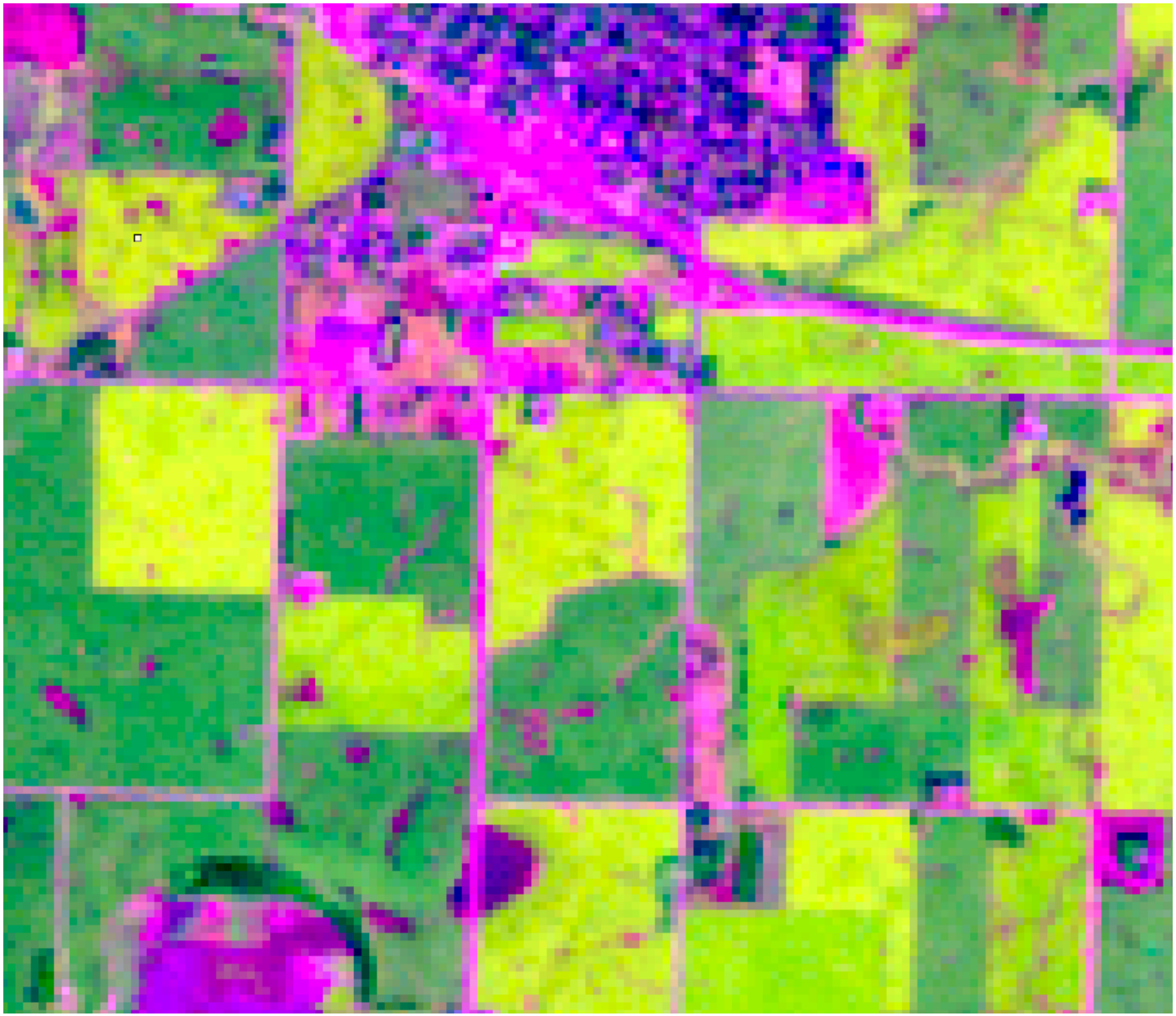
SW Minnesota Landsat 5-4-3

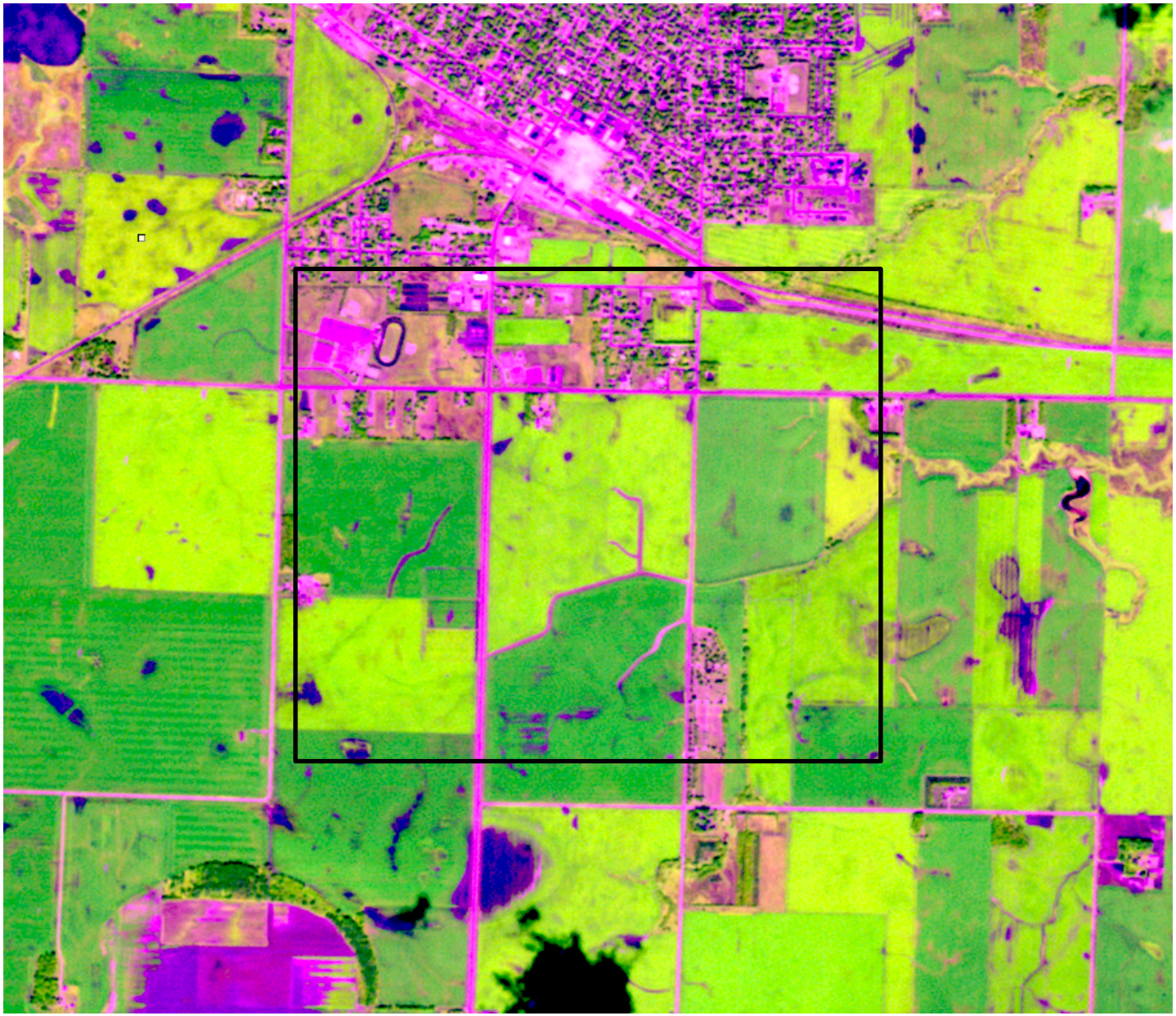


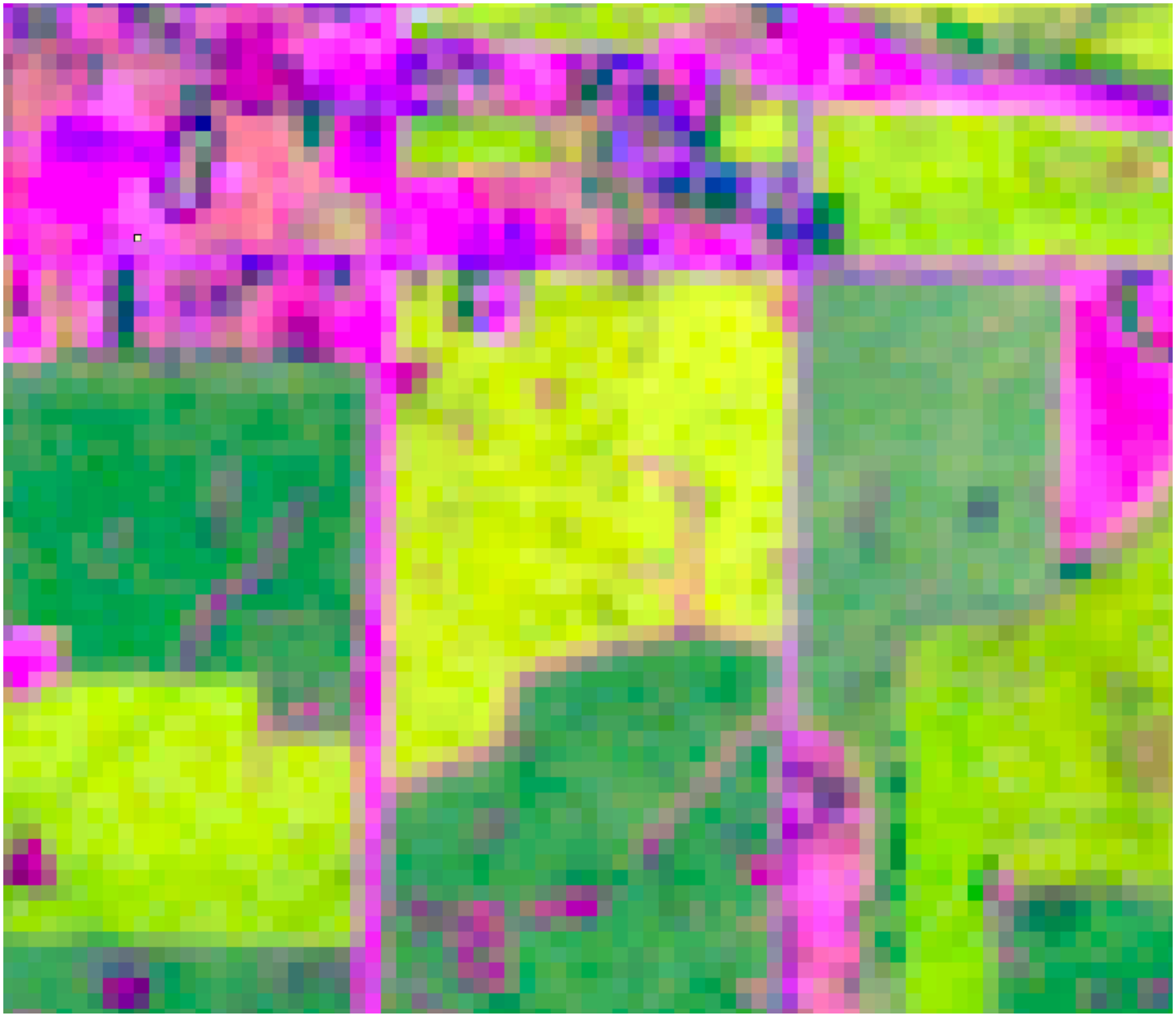
24km x 20km, centered on 95 35 24W, 44 19 38N

SW Minnesota RapidEye 4-5-3

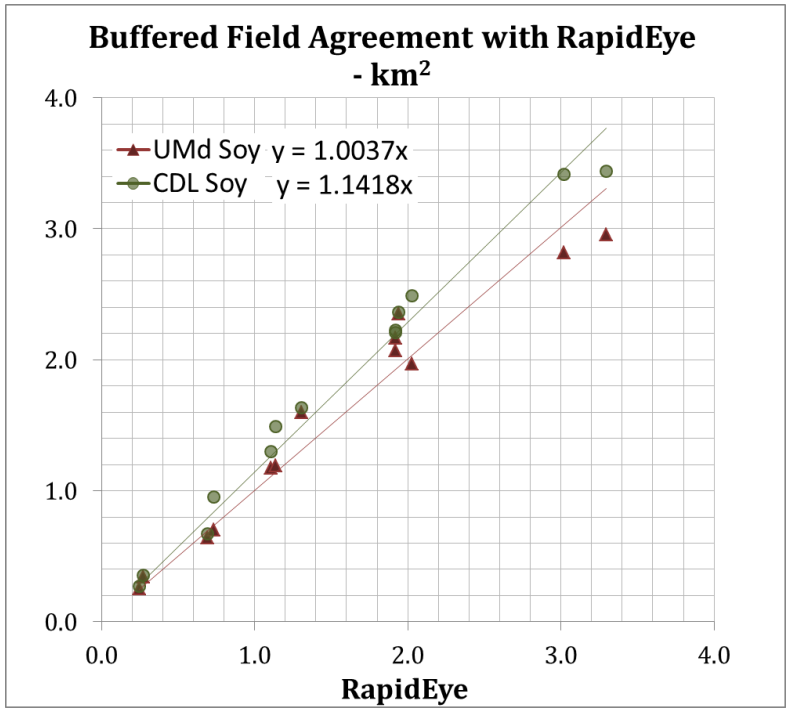








Field-Scale Classification Comparison

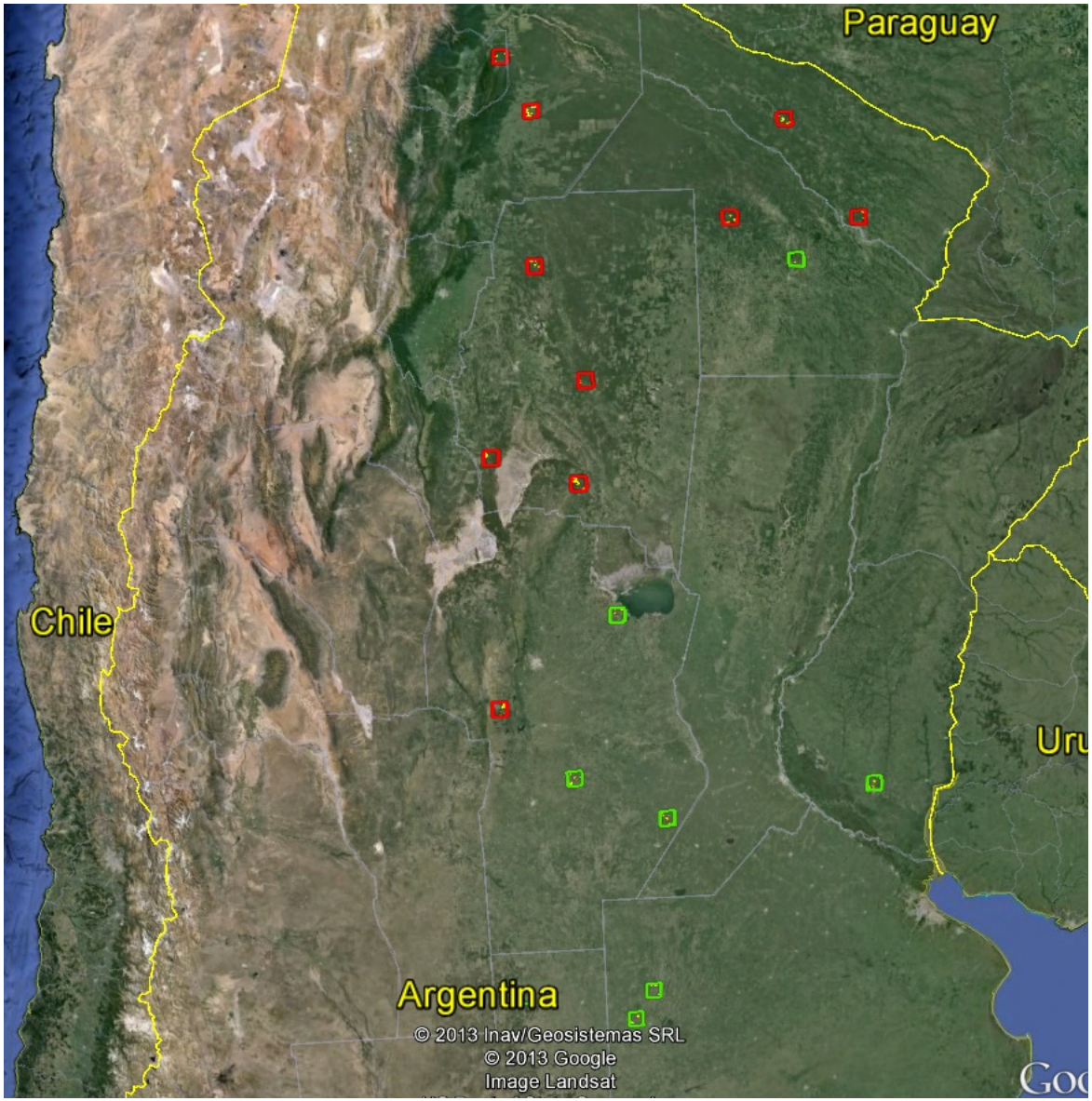


Field

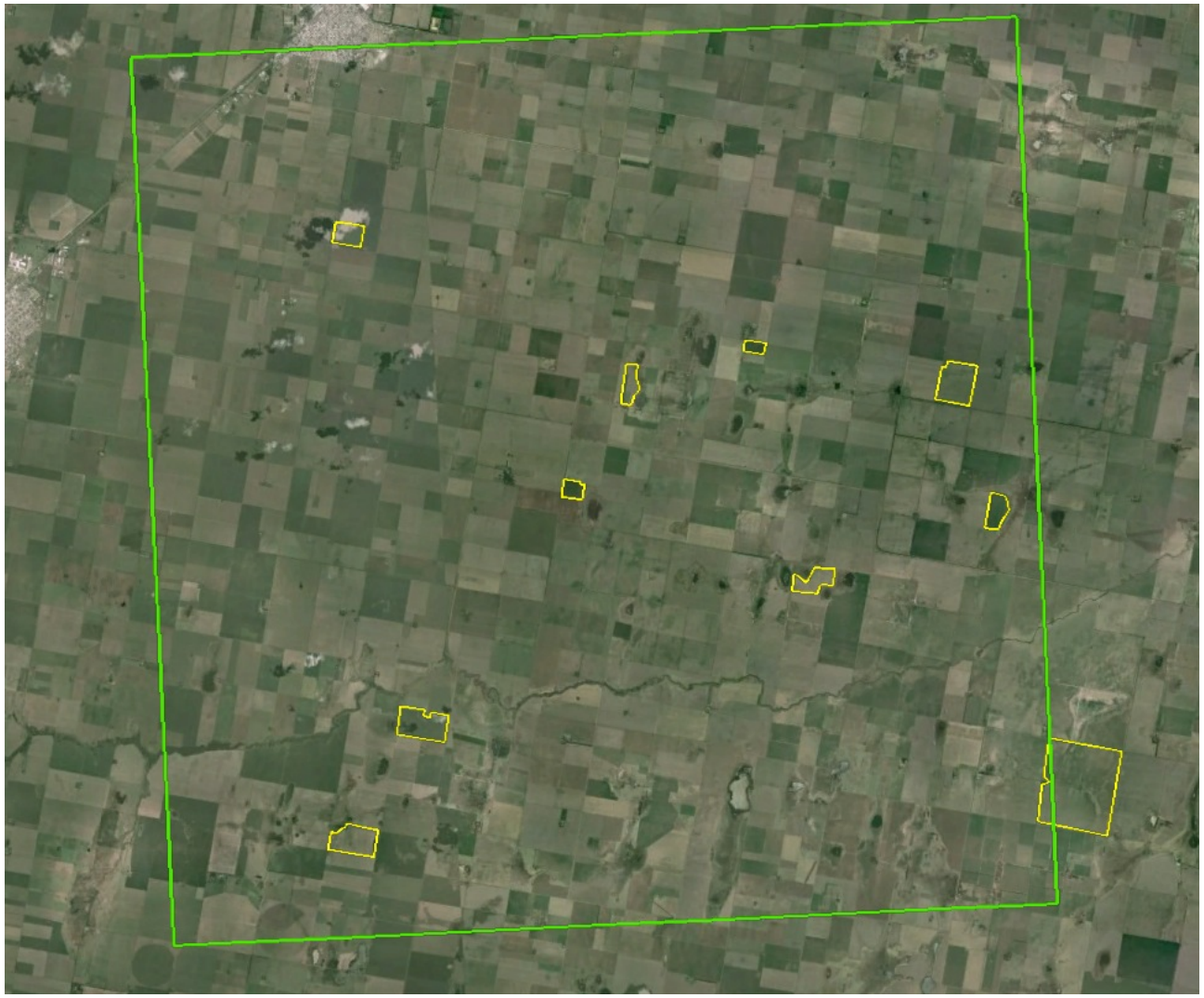
RapidEye	Landsat: No	Landsat: Yes
No	0.2%	2.5%
Yes	0.4%	97.0%

RapidEye	CDL: No	CDL: Yes
No	0.0%	2.7%
Yes	0.1%	97.2%

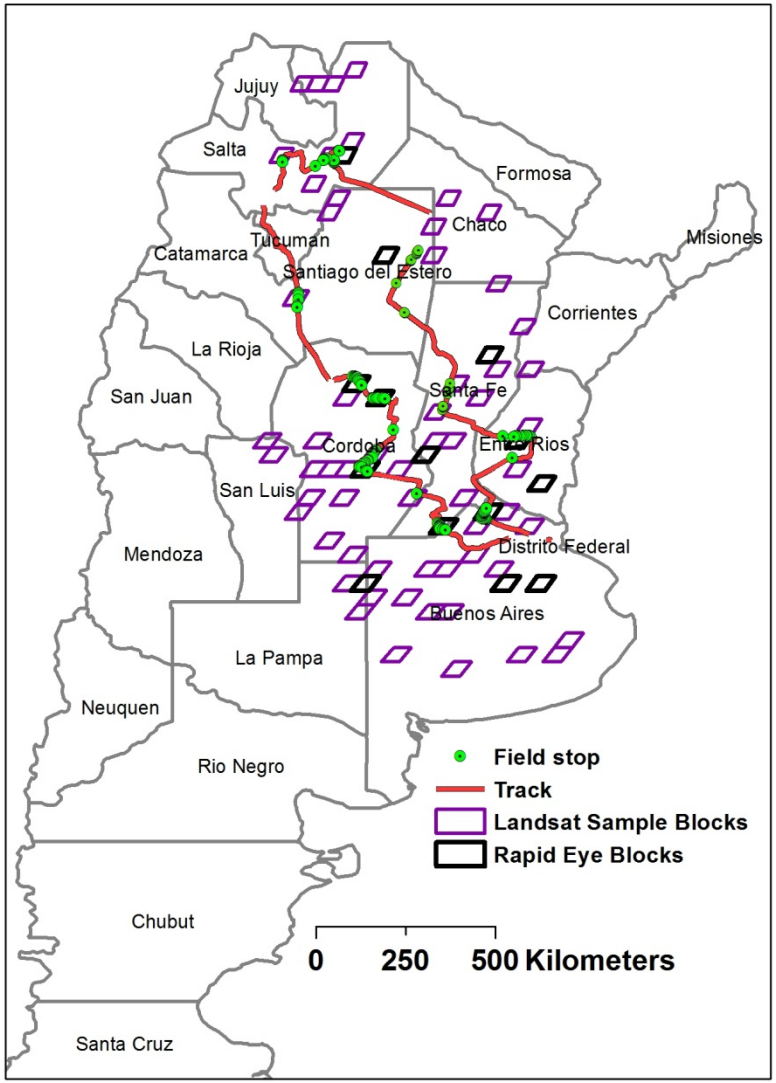
Argentina RE Sample Blocks



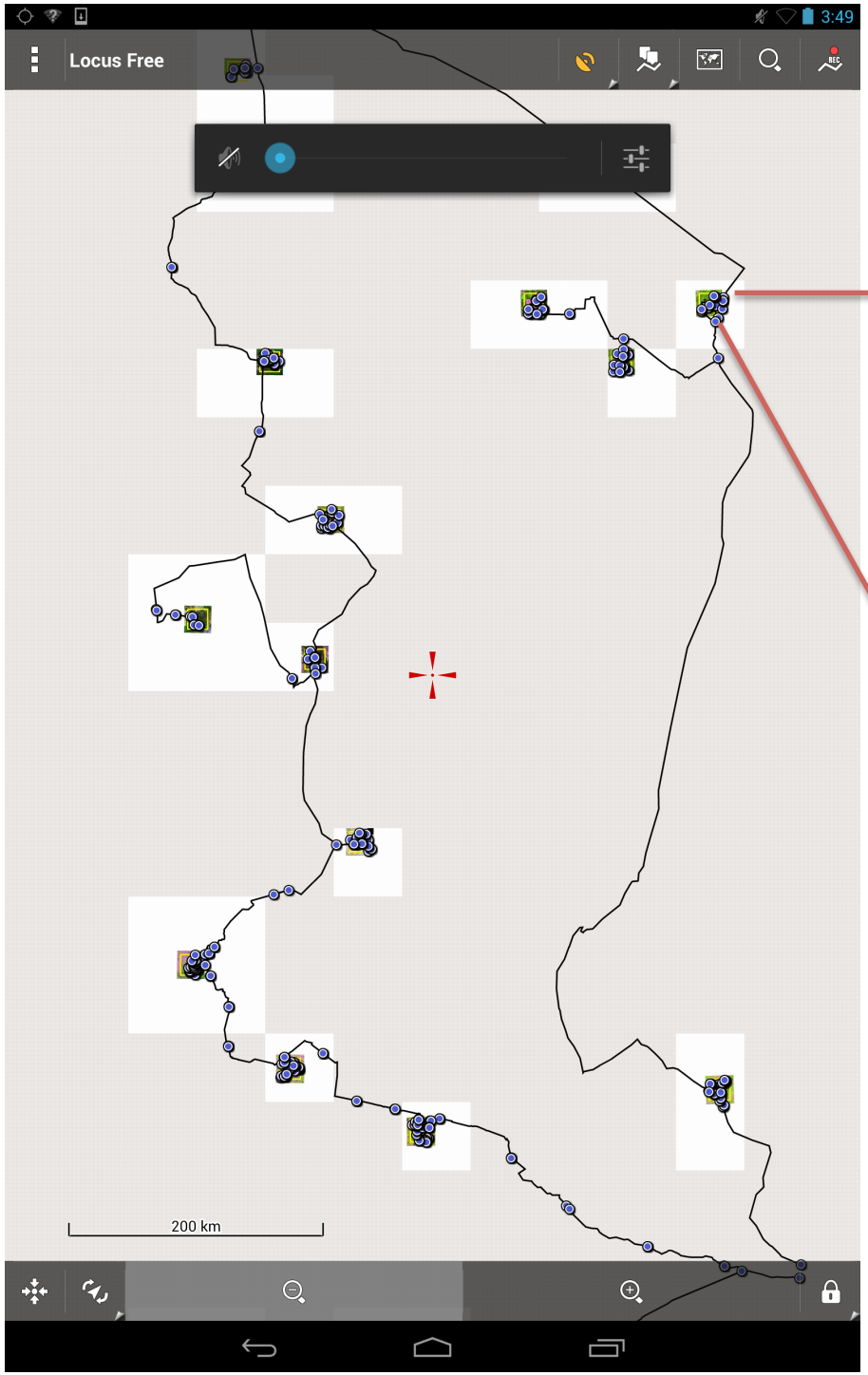
Sampled Fields visited for Validation within a block

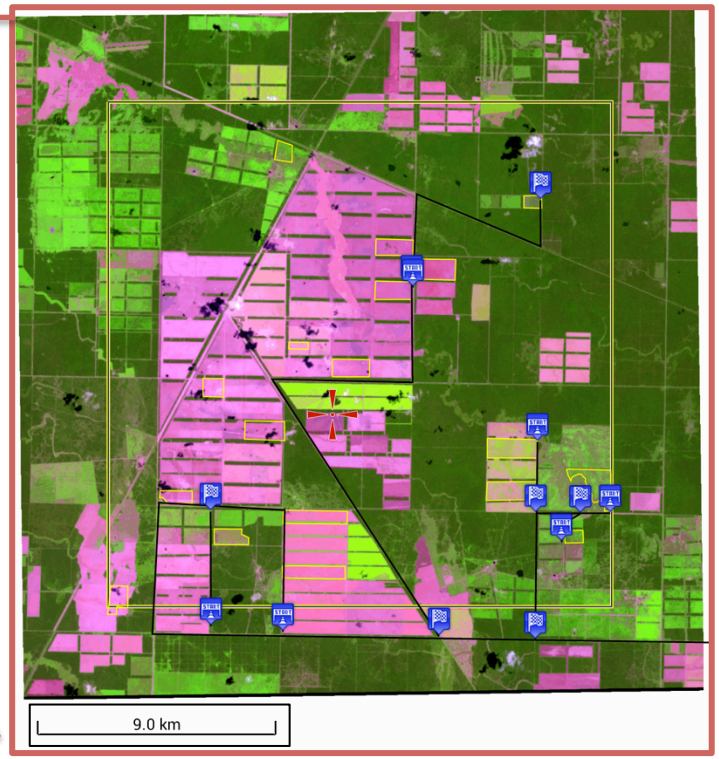


Argentina 2011-12 Field Campaign



RE Blocks and 2014 Field Campaign

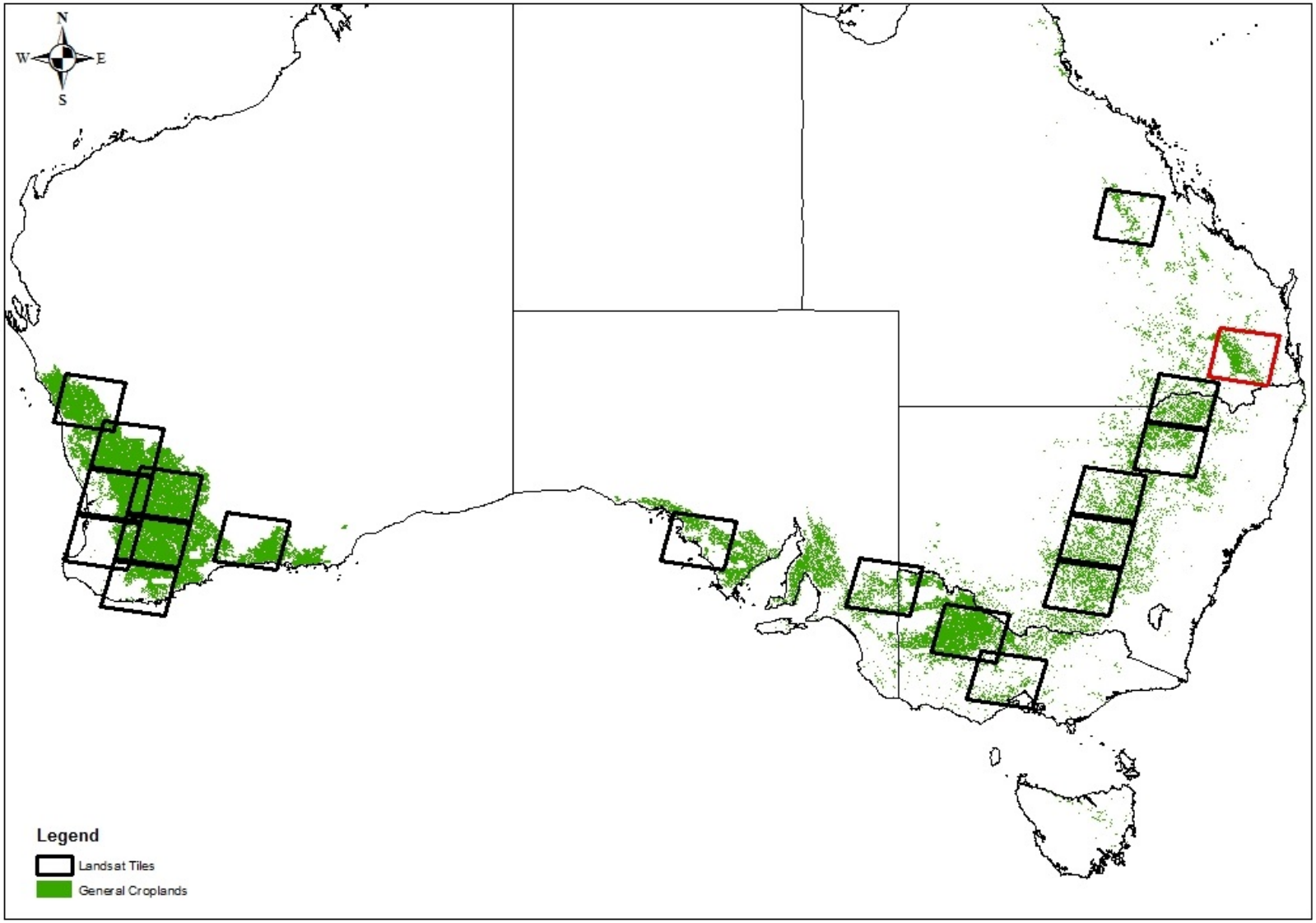




Example results to date for 2011

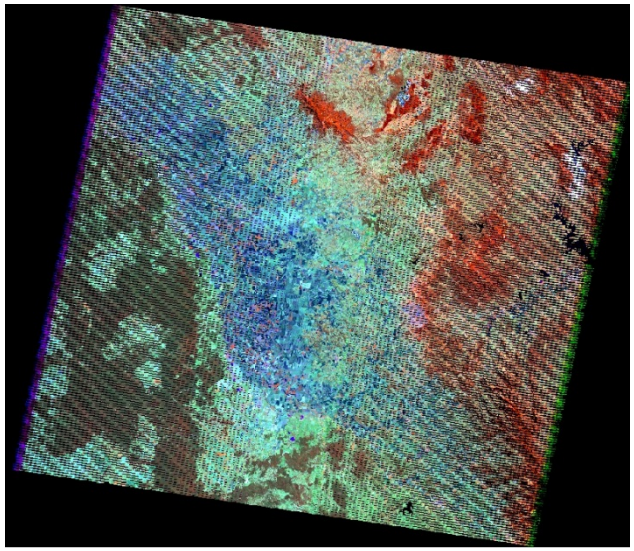
- Argentina
  - USDA estimate – 178,000km2
  - MODIS/Landsat estimate – 117,800km2 +/-6,502 SE
- USA
  - USDA estimate – 298,600km2
  - MODIS/Landsat estimate – 212,324km2 +/-6,645 SE
- Brazil
  - USDA estimate – 250,000km2
  - MODIS/Landsat estimate – 171,000km2 +/-9,064 SE

Landsat tile selection based on a general croplands mask and available cloud free scenes

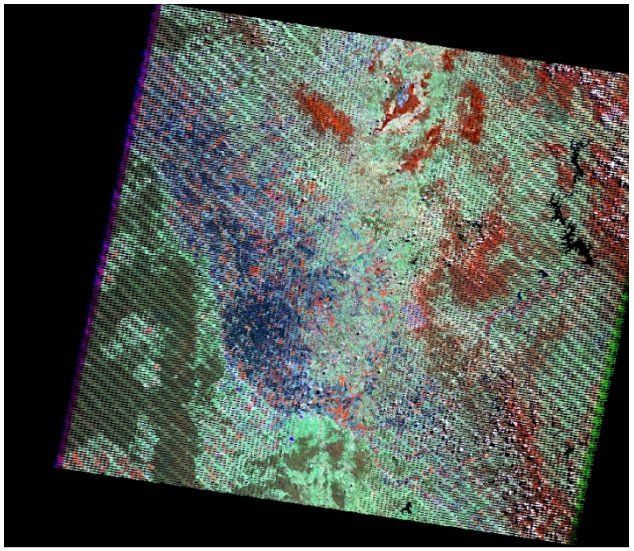


Three Landsat scenes chosen for training: before peak, peak, and after peak

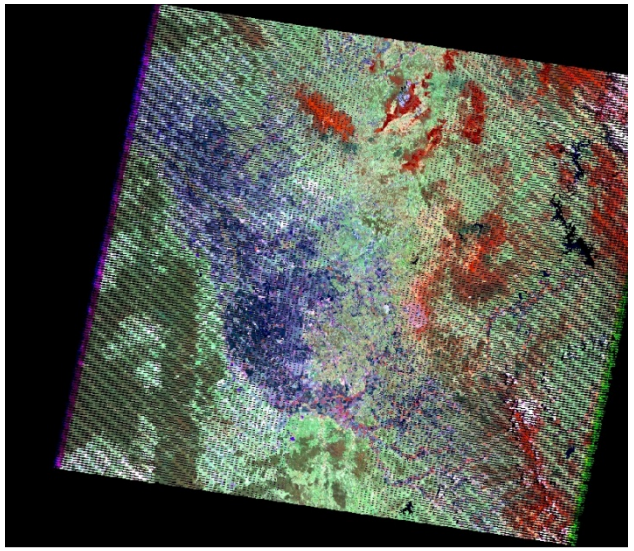
May 9th 2012



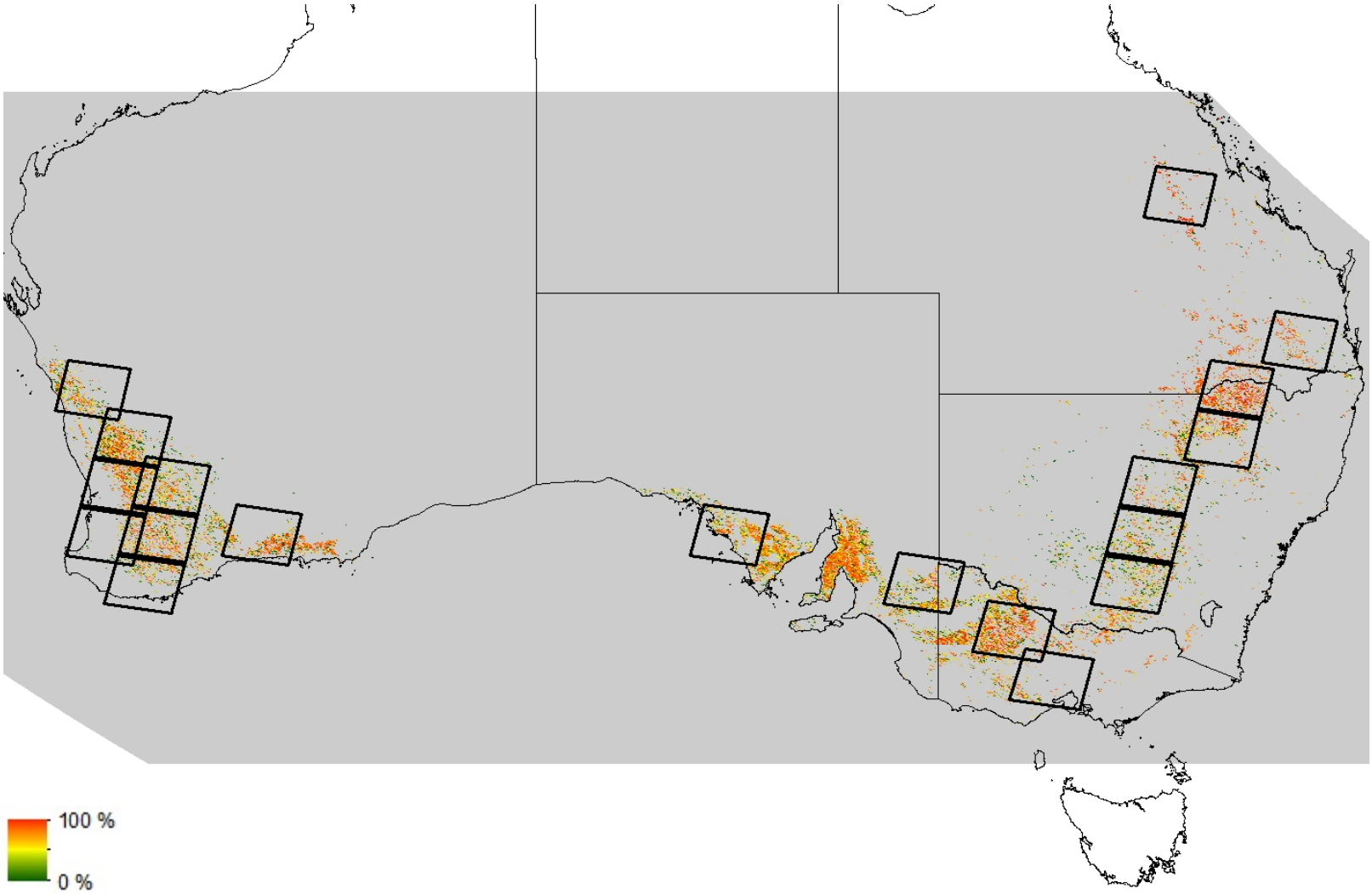
September 14th 2012



November 1st 2012



Final MODIS level wheat mask for Australia expanded out beyond initial training Landsat tiles



Conclusions

- **Still R&D mode- objective is to evaluate operational feasibility**
- **For area estimation of crop type using earth observations, sampling is a viable option**
  - In most cases, there are not sufficient time-series observations at an appropriate spatial resolution to perform wall-to-wall mapping of crop type
- **Developing a sound sampling strategy is complex and costly!**
- **Scale must be considered per agricultural growing region**
  - Can MODIS be used for a stratification – or does landsat need to be used?
  - can Landsat or RapidEye provide reliable area estimation in China for soybean cultivated area? How many within-season images are needed for more complicated early/late planting systems as in Argentina?
- **Validation of sample block data is critical!!**
  - Crop type identification (per field classification)
  - Field extent (pixel counting and possible bias in area mapped per field)
- **Coarse Res (MODIS) is important**
  - Used to stratify regions to improve sampling efficiency
  - Used as a within-season crop indicator auxiliary variable in a regression estimator procedure to reduce uncertainty
- **Generic methods that can be ported globally are possible**
  - Will provide internally consistent comparisons for global production estimation
- GEOGLAM needs to develop requirements for sampling this calendar year- commentary to requirements developed within JECAM