Status Update on The GEOGLAM Initiative

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CEOS SDCG-3 Meeting
February 7-9, 2013
Sydney, Australia

GROUP ON EARTH OBSERVATIONS

GEOGLAM
Global Agricultural Monitoring

G20 GEOGLAM Goal:

To strengthen the international community's capacity to produce and disseminate relevant, timely and accurate forecasts of agricultural production at national, regional and global scales through the use of EO

Outcome: an improved and more harmonized systems of systems taking advantage of new satellite assets and methods and a higher level of international coordination

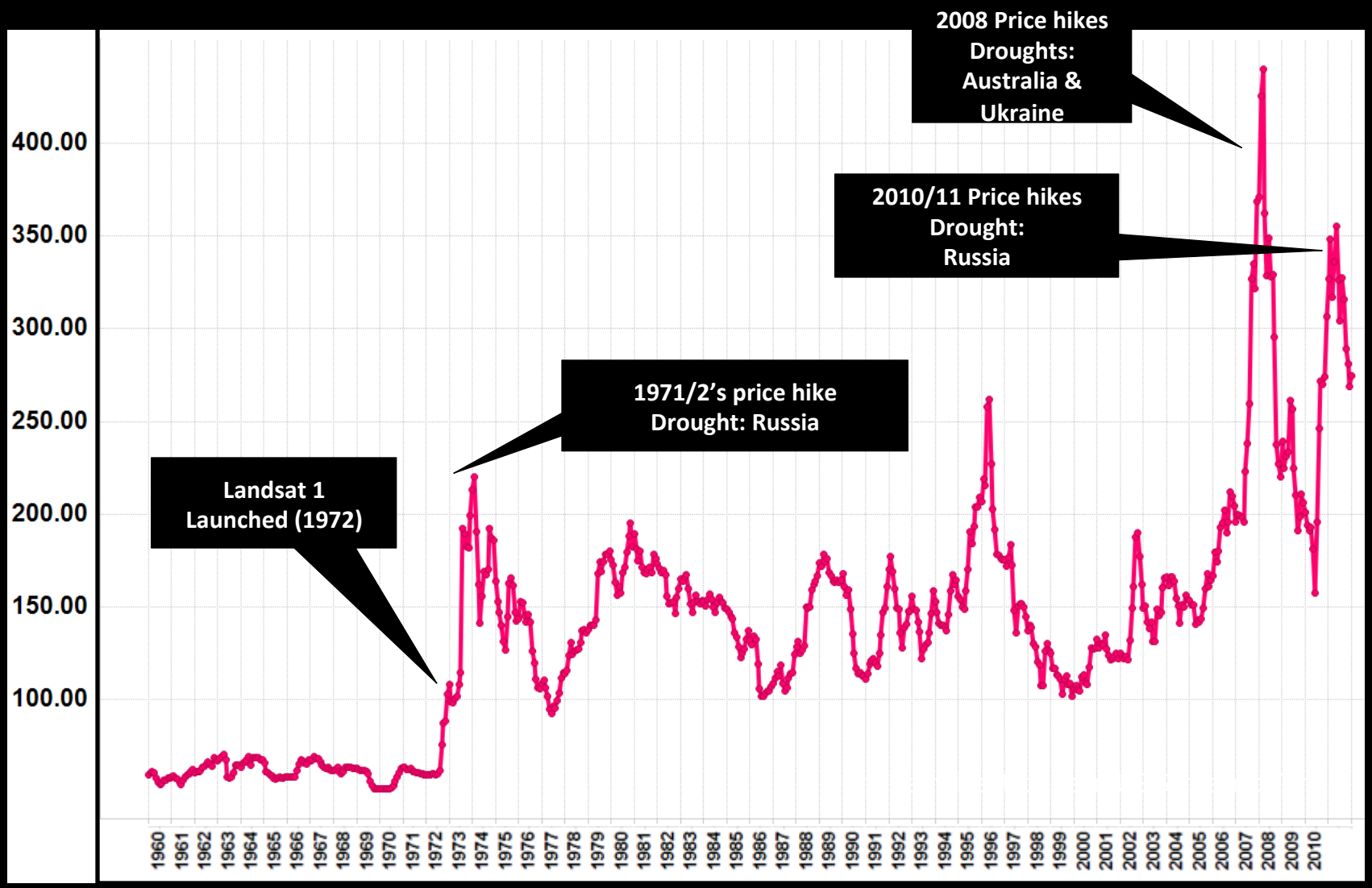
- GEO-GLAM will be implemented in the framework of GEO

NEED TO INCREASE FOOD PRODUCTION BY 50%-70% BY 2050! (FAO)

Challenges:

- extreme weather events (droughts) Climate change
- Price volatility
- Population growth and changing diets
- Limited land and water resources
- Biofuels - tighter connection to energy markets
- Low investment in R&D

Context for GEOGLAM



The GEO Global Agricultural Monitoring

(Initiated in 2007)

Task Co-Leads:

Chris Justice, University of Maryland, USA (NASA supported)

Derrick Williams, USDA FAS, USA

Wu Bingfang, Institute of Remote Sensing Applications, CAS, Beijing, China

Olivier Leo, Joint Research Centre, European Commission, Ispra, Italy

Task Executive Director: **Jai Singh Parihar**, Space Applications Centre (ISRO), India

JECAM Sub-task Lead: **Ian Jarvis**, Agriculture and Agri-Food Canada

Production Area Yield Lead: **Inbal Becker-Reshef**, UMD, Meng Jihua, China

CEOS GEO Agriculture POC: **Prasad Thenkabail**, USGS

GEO Secretariat PoC: **Joao Soares**, GEO Secretariat, Geneva

GEO GROUP ON EARTH OBSERVATIONS

GEO Agriculture Monitoring Community of Practice
(an open community of Data Providers, Brokers and Users)

- Several global/regional scale systems in place – with common data needs, few common standards and protocols and inconsistent results
- Most countries have a national agricultural monitoring system

Need for Improved Agricultural Intelligence

International recognition of critical need for improved information including at the World Summit on Food Security 2009, G20 Action Plan on Food Price Volatility and Agriculture, 2011

official statement of The Extraordinary Joint Intersessional meeting of the Intergovernmental Group (IGG/FAO) on Grains, Rome 2010:

"Unexpected price hikes and volatility are amongst major threats to food security and their root causes need to be addressed, in particular regarding ***the lack of reliable and up-to-date information on crop supply and demand and export availability****...."*

The G20 Initiative: GEO-GLAM

G20 Final Declaration

44. We commit to improve market information and transparency in order to make international markets for agricultural commodities more effective. To that end, we launched:

- The "Agricultural Market Information System" (AMIS) in Rome on September 15, 2011, to improve information on markets ...;
- The **"Global Agricultural Geo-monitoring Initiative" (GEO-GLAM)** in Geneva on September 22-23, 2011. This initiative will coordinate satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data.

- The G20 Cannes Summit (November 2011) Action Plan on Food Price Volatility and Agriculture
- Reaffirmed GEOGLAM commitment at the 2012 G-20 Los Cabos Declaration & in Agriculture Ministers Report

How We are Organized

- GEOGLAM Secretariat in Geneva- Project coordinator (Pascal K. to be seconded by France) + 2 support staff
- The GEOGLAM Coordination Committee: includes task team leaders of the agreed components of the initiative and a Project Manager, who serves as its chair
- The steering committee for GEOGLAM consists of the Executive Director of the GEO Secretariat and representatives from donors and stakeholders.
  - Its high level role is to provide guidance on key issues such as objectives, budgets, marketing strategy and resource allocation

- Distributed Component Offices:
  - Japan: Asia Rice
  - JECAM: Canada
  - National Capacity building: FAO (to be confirmed)
  - Global Producer Countries: JRC /USDA (to be confirmed)
  - Countries at Risk: USAID/ FAO (to be confirmed)

Support: Current, Anticipated, Potential

- NASA
  - GEOGLAM operation support
  - Drought monitoring system prototype
  - Global Soy Area Estimation
  - Wheat Yield Forecasting prototype
  - Indicated support for the initial prototyping of developing EO requirements
- Japan:
  - Asia Rice Initiative (JAXA)
- China:
  - GEO Agriculture- MOST, indication will support GEOGLAM next year

EU :

FP7 call for 9 Million Euro in support of GEOGLAM

France-

GEOGLAM operations- secondment of Pascal K- project coordinator (under negotiation)

Canada-

JECAM office

Gates Foundation –

Indicated interest in supporting Countries at Risk Component

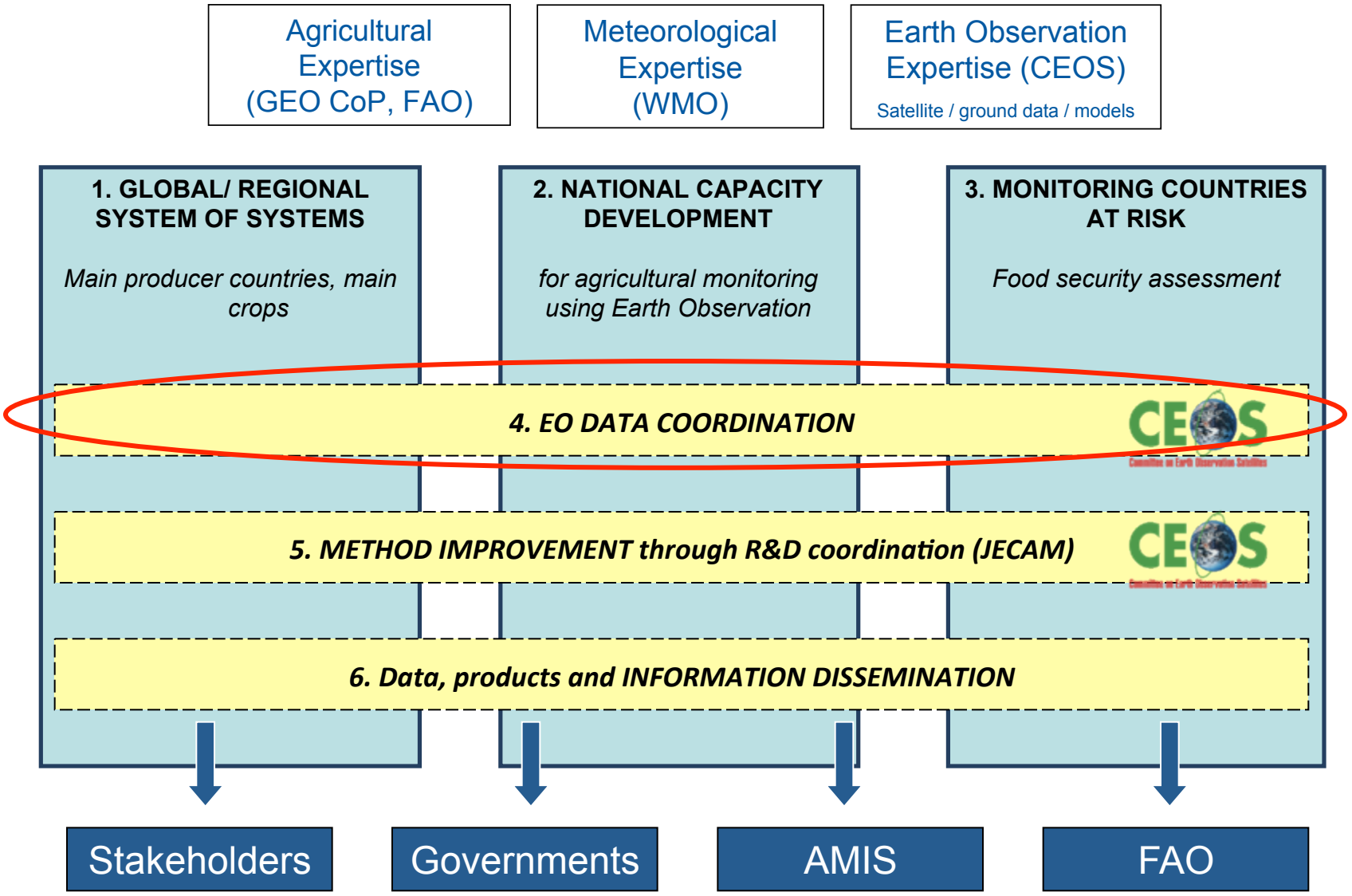
Germany

Indicated interest to support GEOGLAM

US GEO

expressed interest to help coordinate US support

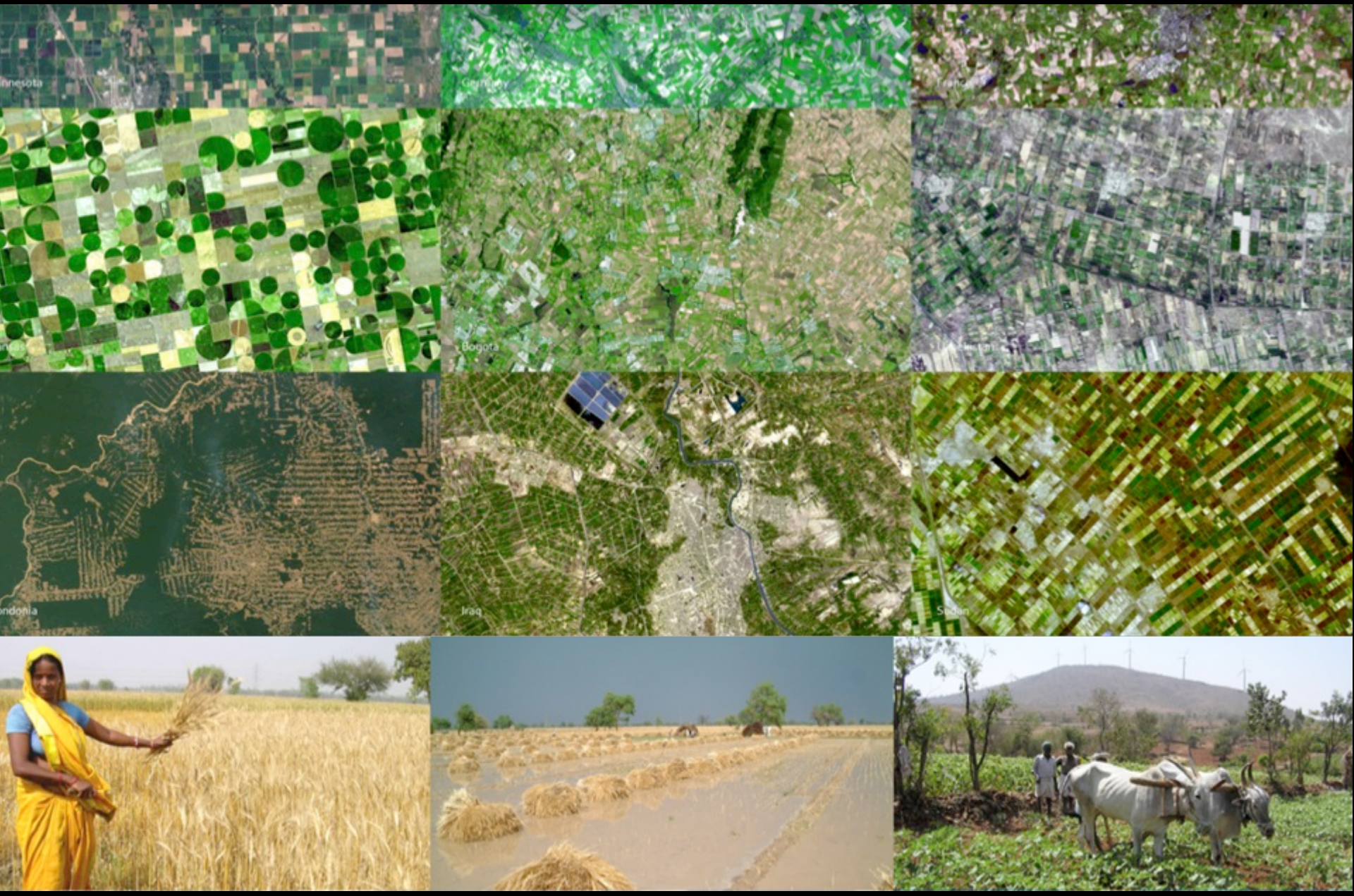
GEOGLAM Components



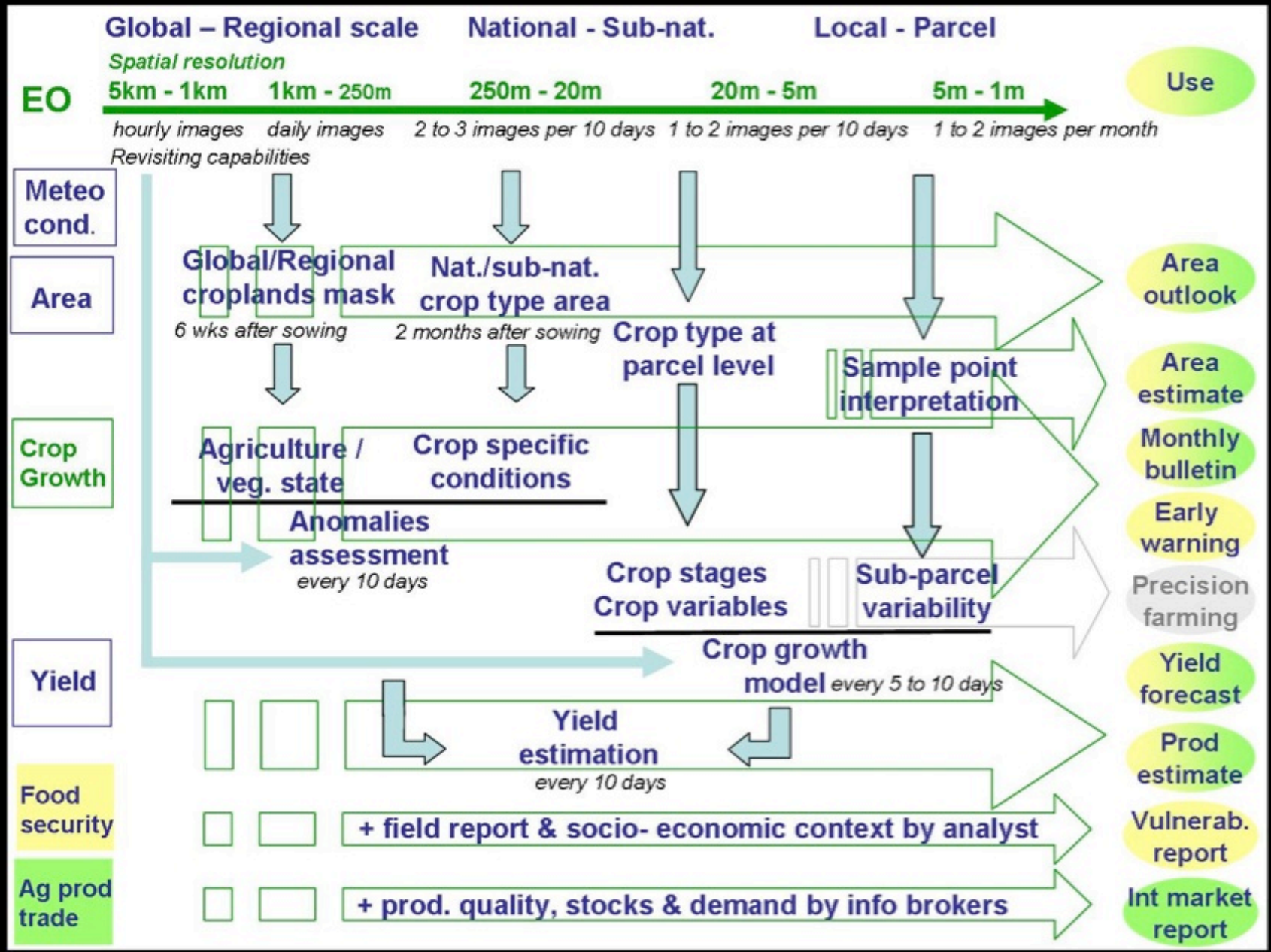
GEOGLAM Components

- **Component 1: Monitoring Global Producer Countries**
  - Focus: Global crop outlooks, markets and trade, long term trends (climate change implications, extreme events, etc)
- **Component 2: National Monitoring Systems**
  - Focus: National statistics, national policy, subsidies, insurance
- **Component 3: Countries at Risk**
  - Focus: Early warning & food security
- **Component 4:Earth Observations Coordination**
  - Focus on acquisition, availability, access needed for GEOGLAM implementation
- **Component 5: R&D**
  - Focus: Operational R &D, Best practices, Research to Operations, Joint Experiments -JECAM
- **Component 6: Information dissemination**
  - Focus on timely and transparent availability of information

Recognition that cropping systems are inherently diverse which dictates the monitoring observations and methods



Developing the Observation Requirements



GEOGLAM Component 4 Activities:

- Developing EO requirements strategy though phased approach
- Developing required baseline datasets and database for requirement assessment
- Interoperability of VIIRS with MODIS for agricultural monitoring
- Joint LDCM/Sentinel 2 processing for agricultural monitoring (ESA/NASA)
- Near real time data processing of MODIS and VIIRS
- Development of customized national crop condition monitoring systems

First GEOGLAM/CEOS Ad Hoc working group Workshop on Developing the GEOGLAM OBSERVATION REQUIREMENTS CSA, Montreal July 10-11, 2012

Tabulating the satellite observation requirements (spatial resolution, frequency, and period of coverage) for GEOGLAM

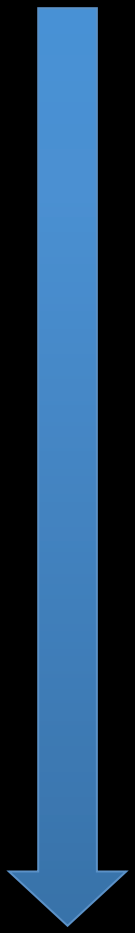
Identifying Information and Product Types

Information Products

- crop condition/outlook
- area estimate
- early warning
- yield forecast
- production estimate
- Food Sec/vulnerability report
- Statistics reports

Data Products

- Cropland mask
- Crop condition indicators
- Crop type
- Biophysical variables
- Environmental variables (soil moisture)
- ag practices
- yield forecasts
- production estimates



Workshop Outcome: EO Data Requirements Table

developed taking into consideration the observation needs, the derived products they will serve, and regional specificities; CEOS-GEOGLAM July 2012 Montreal)

	OBSERVATION & SENSOR TYPE			REGIONAL CHARACTERISTICS & GEOGRAPHICAL EXTENT						DERIVED PRODUCTS & MONITORING APPLICATONS							
	SPATIAL RES.	SPECTRAL RES.	TEMPORAL RES.	WHERE? (+ cropland mask & sampling scheme)				WHEN?									
Sensor Mission	Spatial resolution	Spectral range	Effective observ. frequency (cloud free)*	Swath / Extent	Sample (s), Refined (rs) or Wall -to-Wall (w2w)	Large, Medium, Small fields	Crop types diversity	Calendar/ Multiple cropping	Cloud coverage	Use (Primary or Secondary Source)	Cropland s mask	Crop type area	Crop cond. indicators	Crop bioph. var.	Env. variables (reservoir , water, soil moisture)	Ag. Practices / Cropping systems	Crop yield
MODIS (aqua/Terra), VIIRS(NPP), Vegetation (SPOT-5)	2000 - 500 m	thermal IR + optical	few per day	global	w2w					NRT products (PS)			x	x (L)			
MODIS (optical not SWIR), Sentinel 3? (future), CMA FY series?, Probe-V (future)	100-300m	optical + SWIR	2 to 5 per week	global	w2w	L/M/S		*		NRT products (PS)	x	x	x	x (L)		x (L)	x (L)
FUTURE	1-15km	passive microwave	daily	global	w2w					NRT products (PS)					x		
FUTURE	50-150 m	SAR dual pol. (X,C,L) ****	5 per season	main crops	s	L/M/S	rice area	entire growing season	high cloud cov.	NRT products (SS/PS)*	x	x	x	x (L)	x	x (L)	
FUTURE	5-20m	SAR dual pol. (X,C,L) ****	5 per season	main crops	s	L/M/S	rice area		high cloud cov.	NRT products (SS/PS)*		x	x	x	x	x	
FUTURE	Footprint	RADAR Altimetry	weekly		s					NRT products (PS)					x		
ETM+ (Landsat-7), ASTER (Terra), TIRS(LDCM), IRMSS (CBERS-3)	50-100m	thermal	daily ?	main crops	s	L/M/S		entire growing season		NRT products (PS)			x				
All Optical Mid-Resolution (Landsat, Terra, EO-1, ResourceSat-2, CBERS-3, Sentinel-2)	20-70m	optical + SWIR	1 per month (if possible same sensor) (min 2 out of season + 3 in season)	croplands	w2w	all M/S		year-round, focus on growing season		annual products (PS)	M/S	M					
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HGR (SPOT-5),Rapid Eye (optical)	5-10 m	optical (+SWIR)***	1 per month (if possible same sensor) (min 2 out of season + 3 in season)	croplands	rs	L/M/S (focus on S)		year-round, focus on growing season		annual products (PS)	L/M/S	L/M/S					
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HiRI (Pleiades), IKONOS, GeoEye, WorldView2 (optical)	< 5 m	optical	1 to 2 per month	croplands	rs3	demo. case (2 - 5% of croplands L/M/S)		2 - 4 coverages per year		annual products (PS)		x				x	x

spatial & spectral

How often ?

Where?

When?

For What?

Example: Global and regional monitoring- Component 1

Crop Condition Global Outlook: GEOGLAM input to AMIS

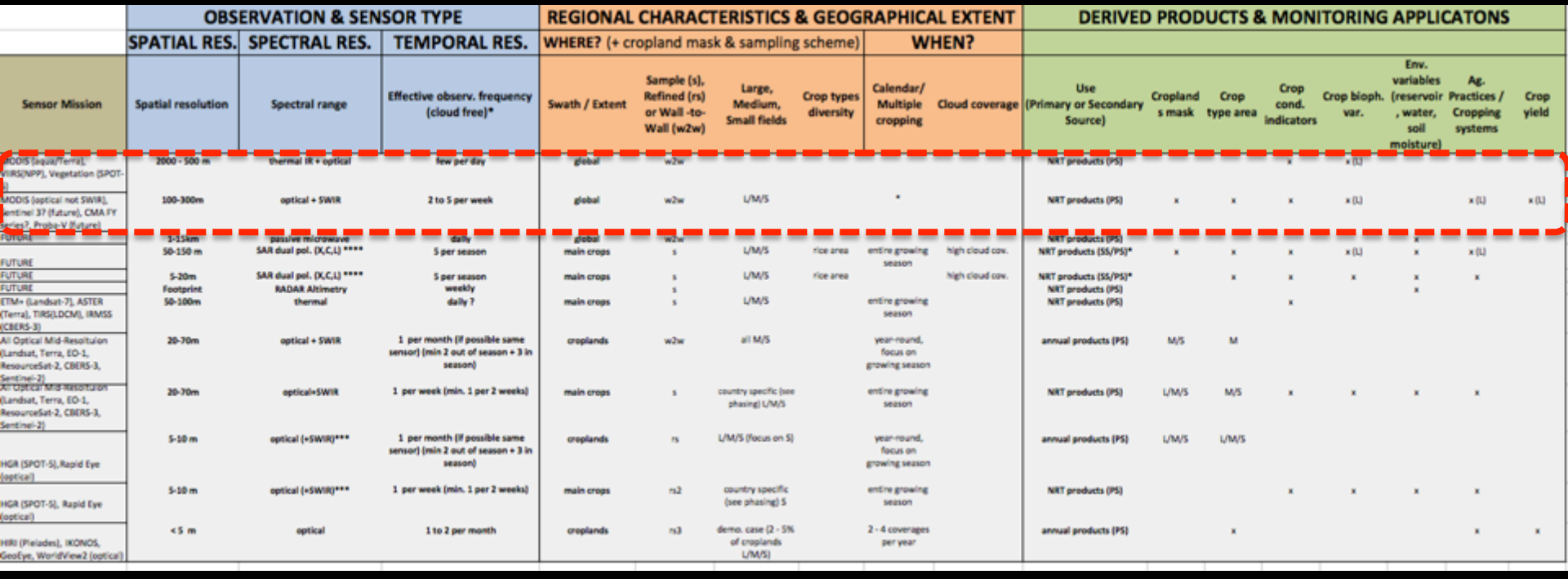
Sensors: MODIS, SPOT Vegetation, VIIRS

Resolution: 250m-1km

Frequency: Daily

Optical, SWIR

All Croplands



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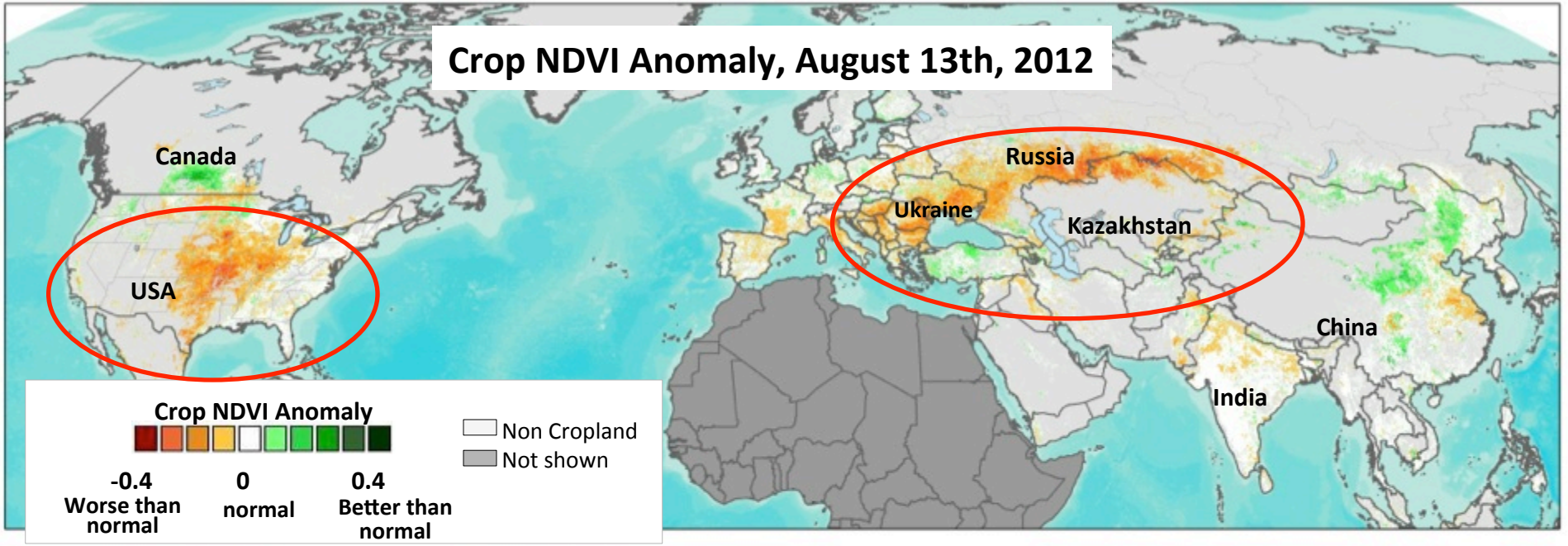
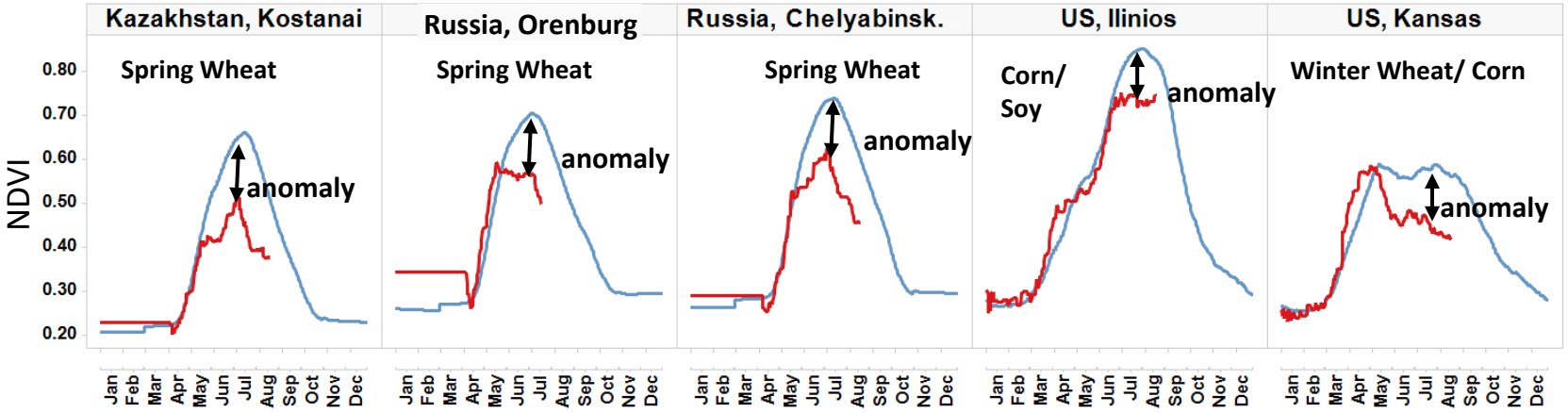
Crop Condition Global Outlook: Building International Consensus

GEOGLAM Global Agricultural Monitoring

Assessment of Crop Conditions in Northern Hemisphere- input to AMIS



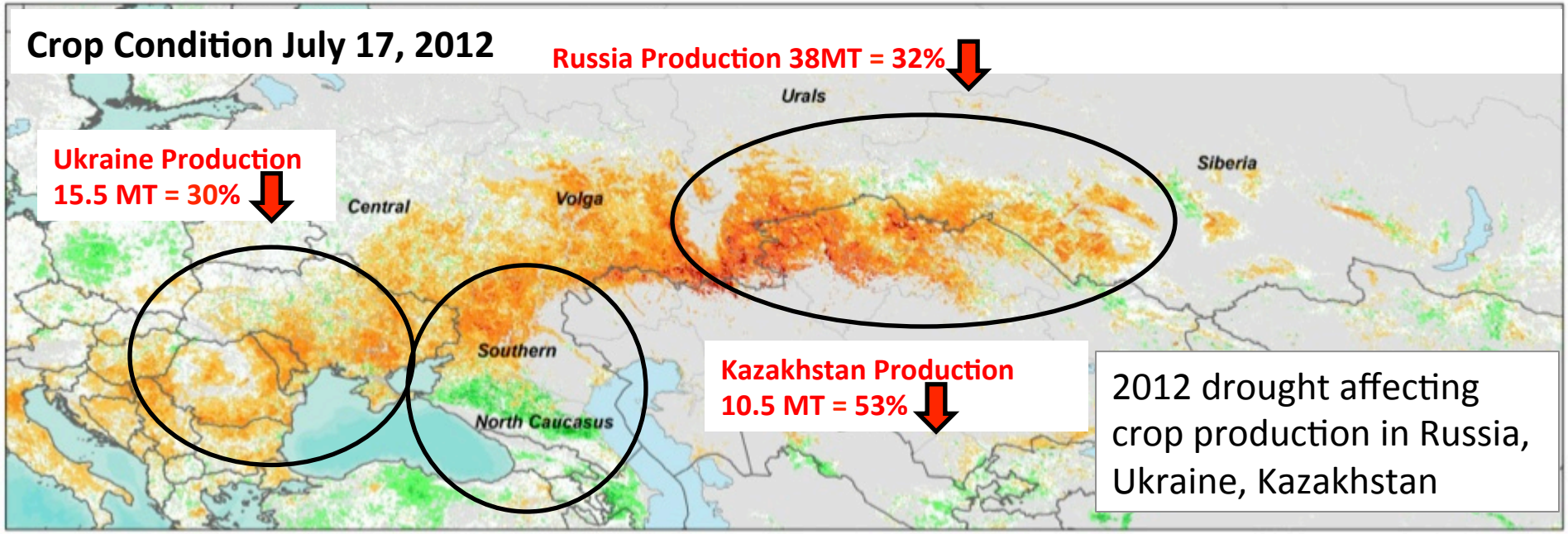


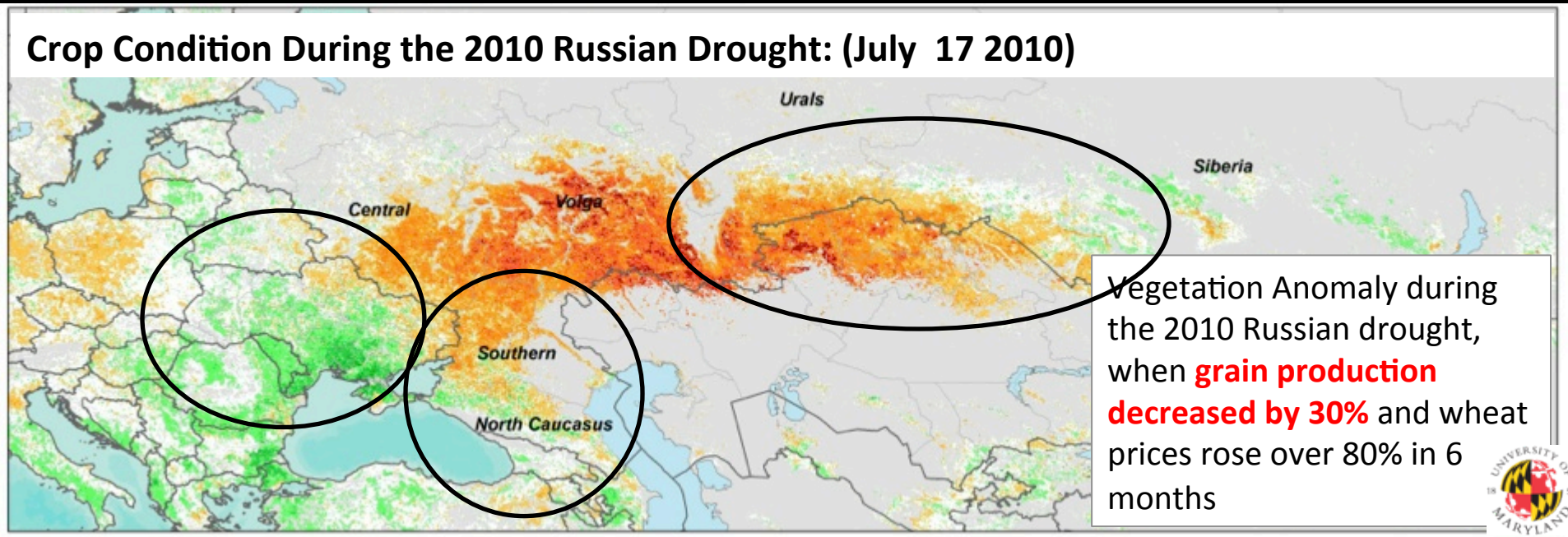
University of Maryland

NASA

Comparing the 2012 Black Sea Region Drought to the 2010 Drought

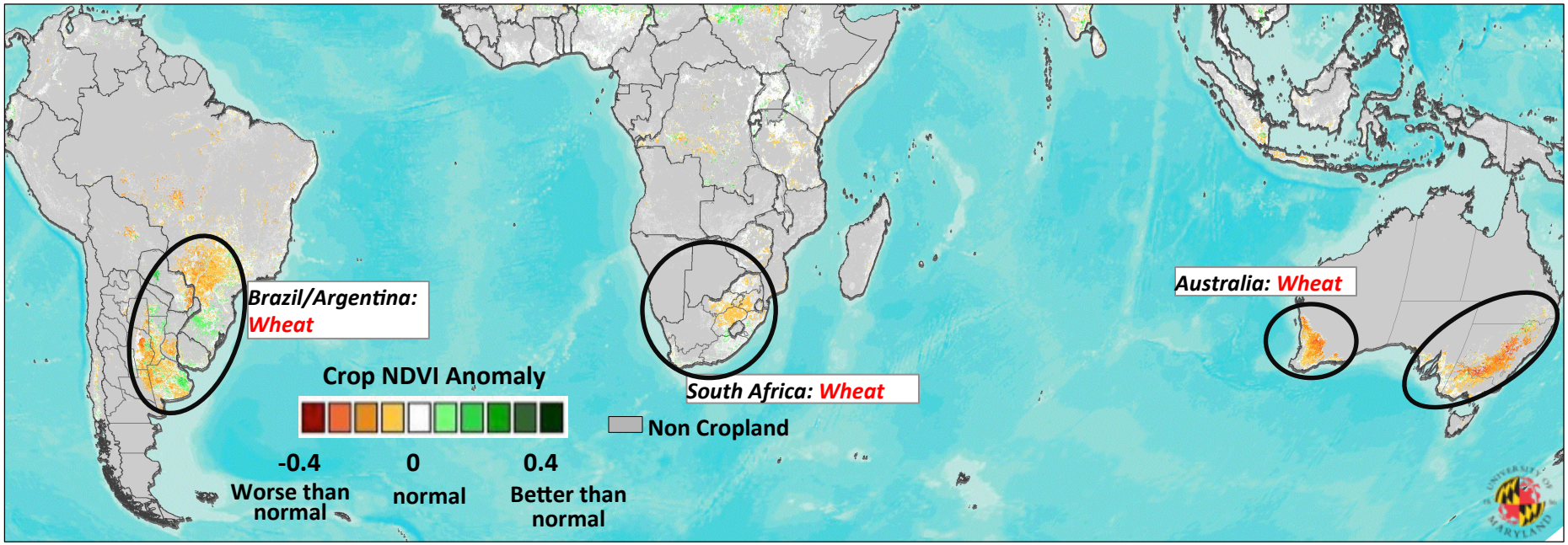
GEOGLAM Global Agricultural Monitoring

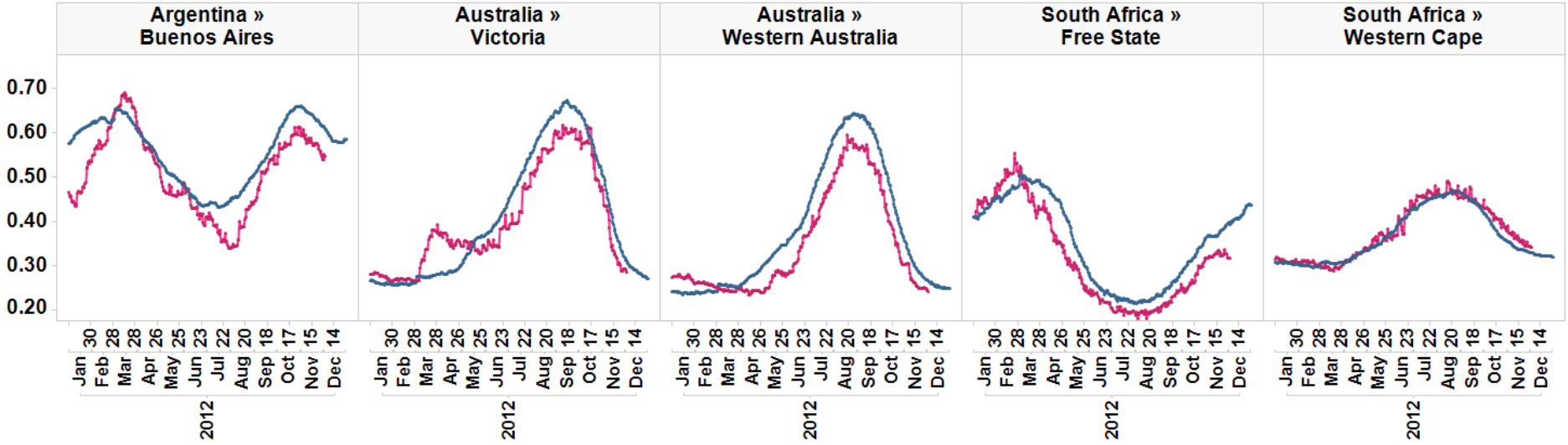




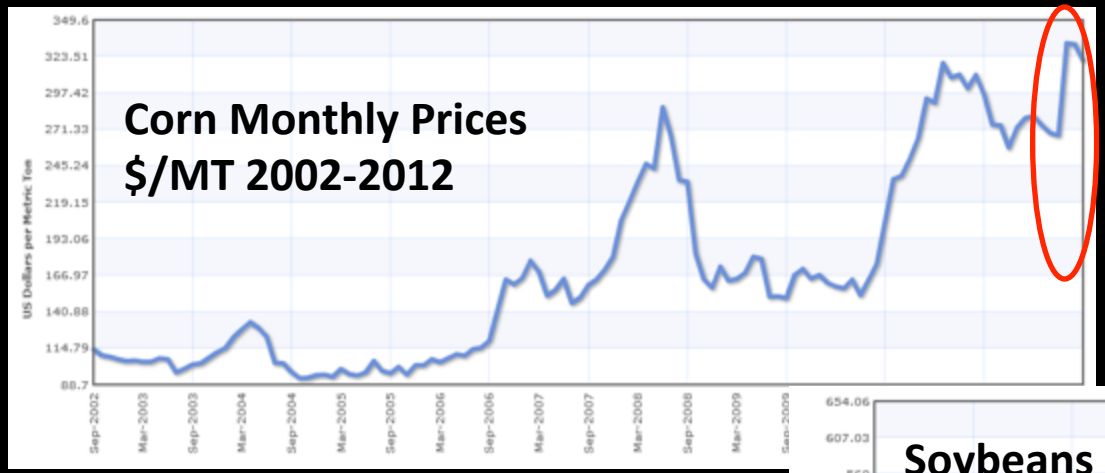
UNIVERSITY OF MARYLAND

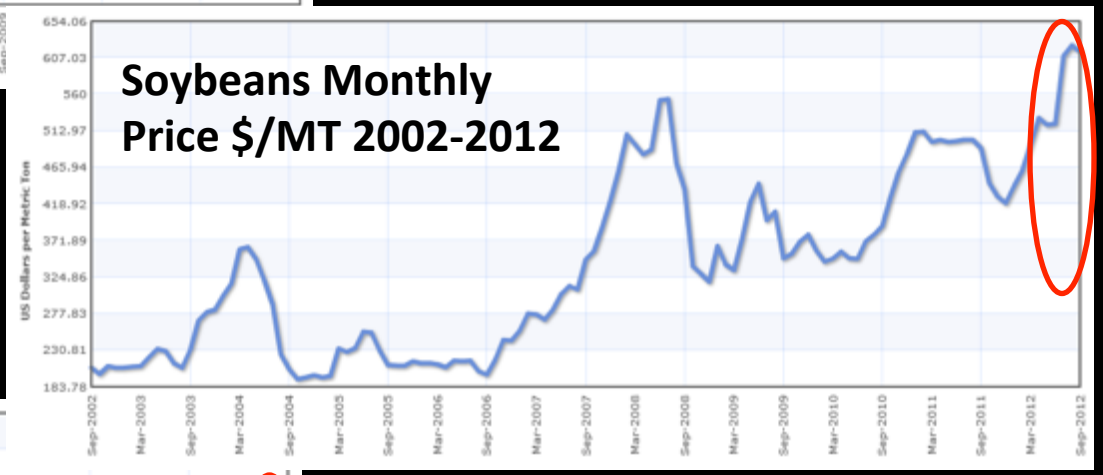
Southern Hemisphere Crop NDVI Anomaly, September 15th, 2012

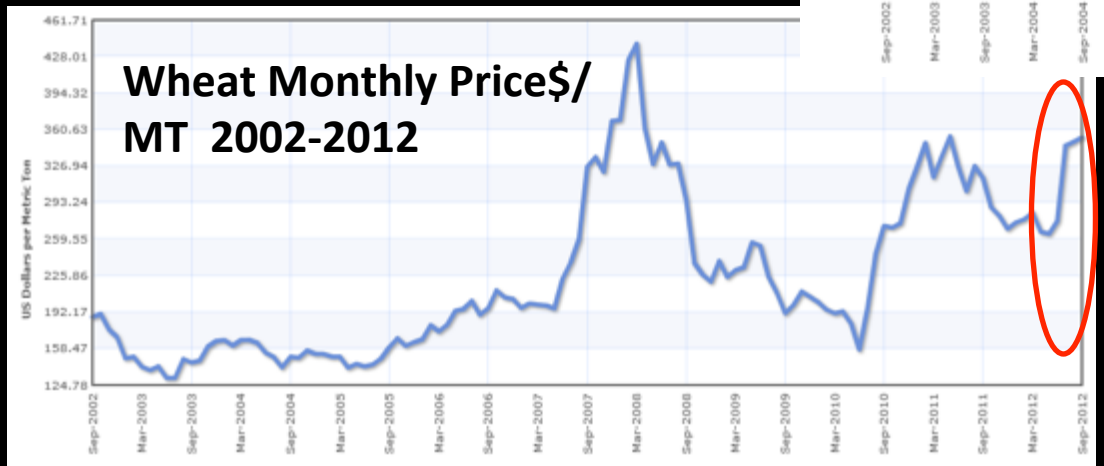




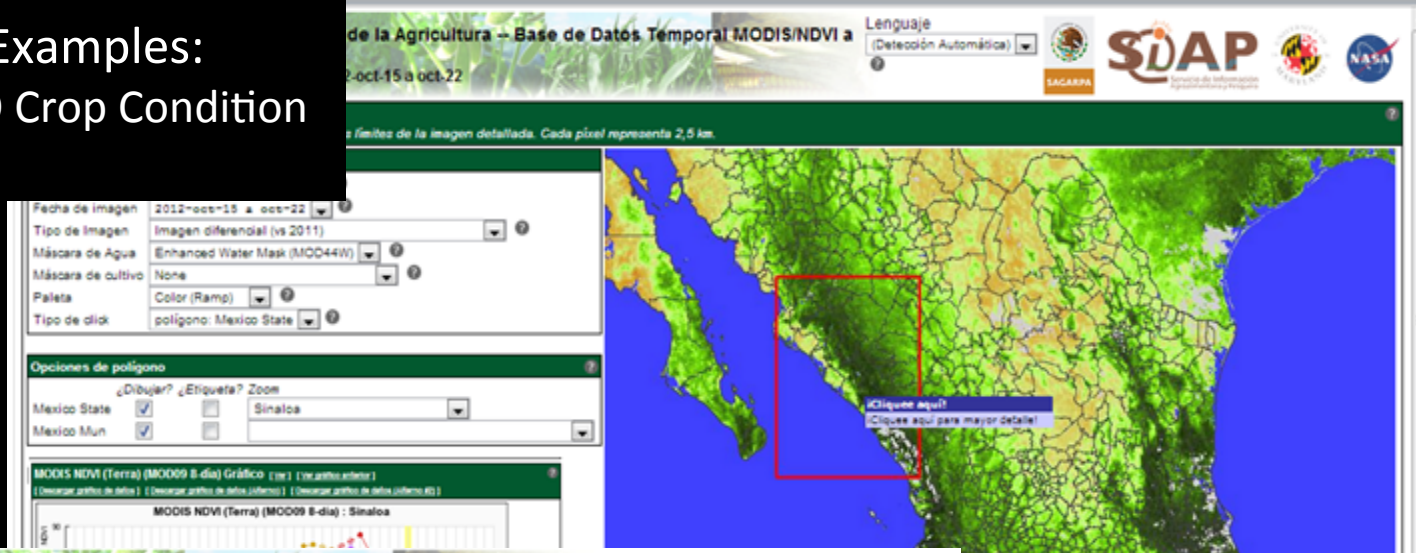
Monthly Market Prices of Corn, Soybeans and Wheat Highlighting Current Prices

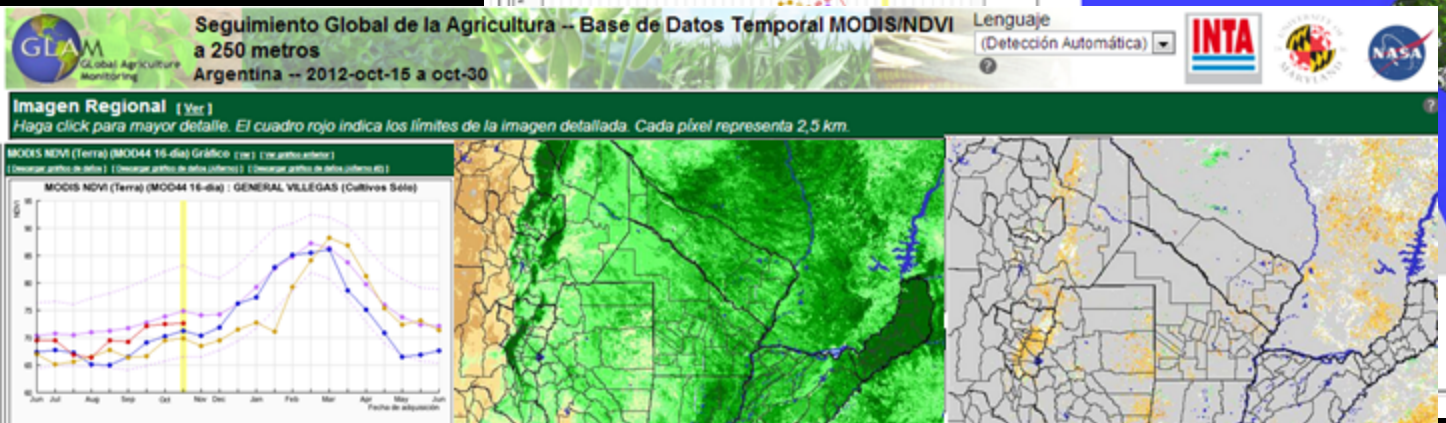






Mexico & Argentina Examples:
Developing National EO Crop Condition Monitoring Systems





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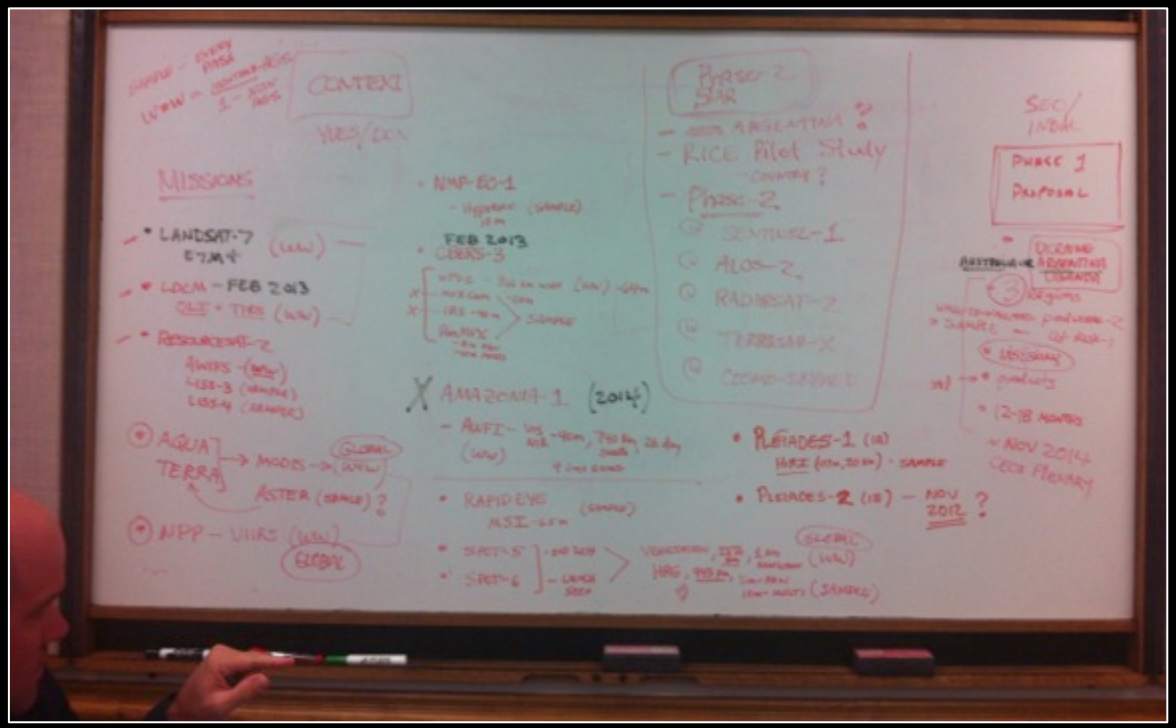
Developing a Phased Approach
CEOS-GEOGLAM meeting Langley November 2012

The proposed approach has three phases over five years, with growing capacity in:

- number of countries
- sensors and sensor types
- processing, product creation, distribution and assimilation,
- capacity building, particularly in at-risk countries for ingestion and processing of EO data



Proposed GEOGLAM Phased Approach

To be discussed at GEOGLAM Feb meeting

- **Phase 1 : Demonstration & Early Feasibility Phase (Nov2012 – Nov 2014)**
  - Developing requirements approach & strategy
  - Development of baseline datasets
  - Focused on 5 countries (4 large producer, 1 'at risk')
  - Initial volumetric assessments
  - Focus on available Optical and SWIR
- **Phase 2 : Assessment & Expansion (March 2014 – November 2015)**
  - Pilot global sampling strategy for the main producers
  - New countries (~ 5)
  - New missions (SAR & sentinels)
  - Asia Rice
  - Sampling strategy for at risk region- initiated
- **Phase 3: Pre-Operational (March 2016 - November 2017)**
  - Expand to all large producer countries (global producer sampling)
  - 3-5 At risk countries
  - New missions acquired and new products
  - Validation/evaluation
- **Phase 4: Operational (Begins Nov 2017)**
  - Hand-off from CEOS to GEOGLAM

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GEOGLAM Phased Implementation Approach

Ultimately, at the end of 5 years GEOGLAM would aim to cover :

- the main producer countries (producing 80% of global food) in order to generate national and global yield and area assessments for the 4 main crops
- 3-5 selected countries at risk (where we have in-country partners), in order to produce national level crop condition, area and yield assessments for selected crops
- regions of risk – ie. the areas that FEWSNET and GIEWS focus on, in order to generate regional level assessments of condition and crop production prospects

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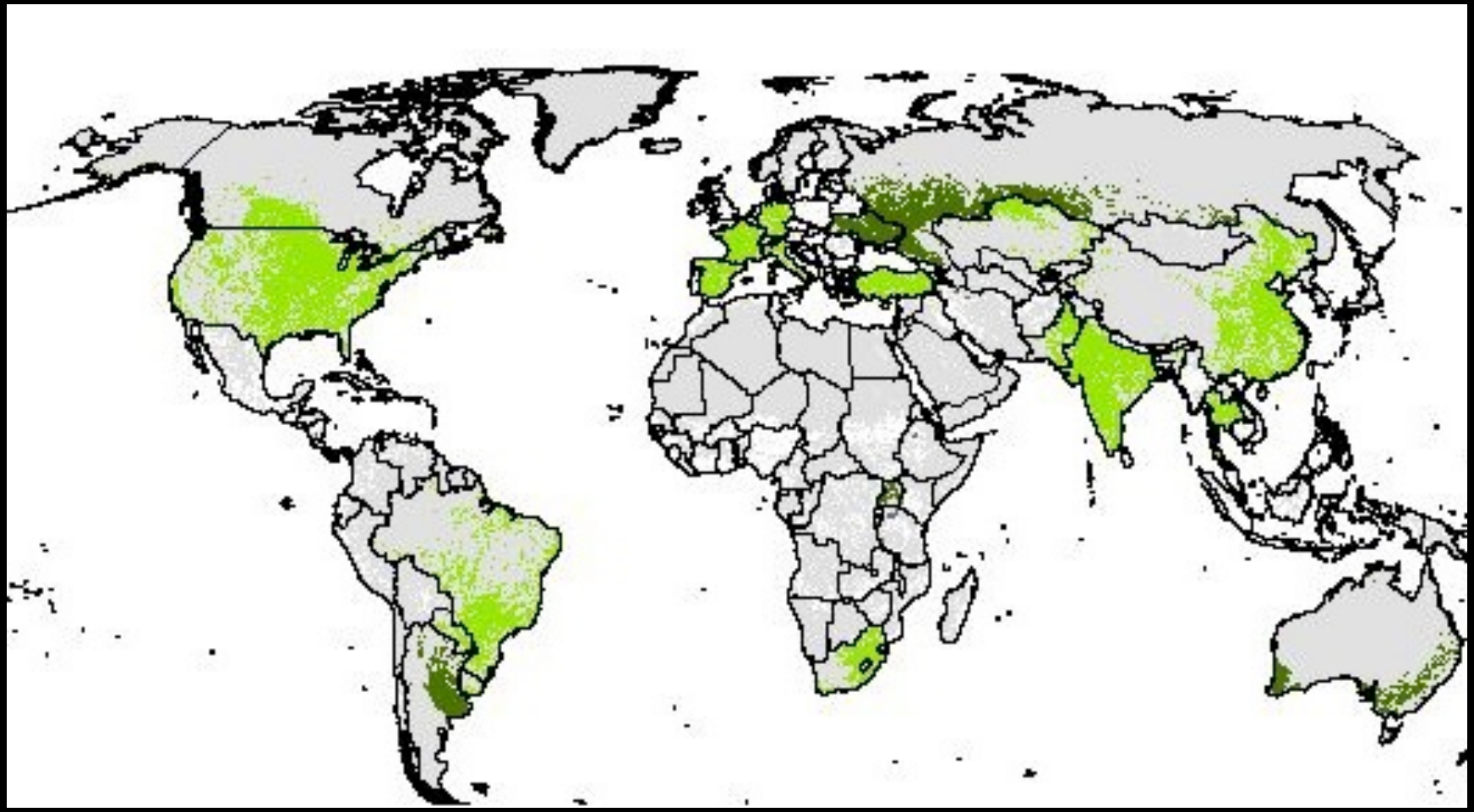
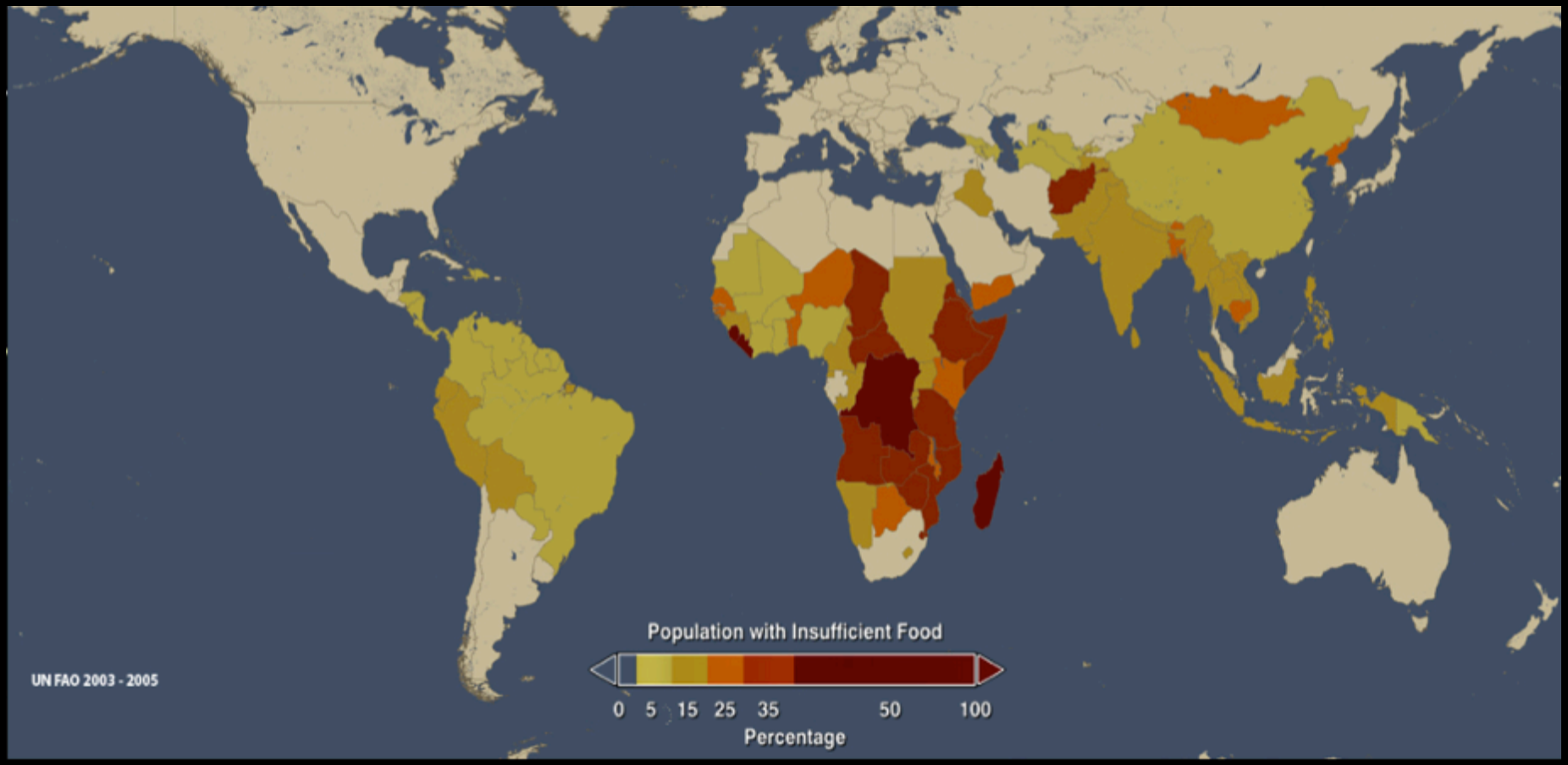
Countries responsible for 96% of total world exports of corn, soy, wheat and rice combined



Percent of Population by Country with Insufficient Food

UN FAO 2003-2005

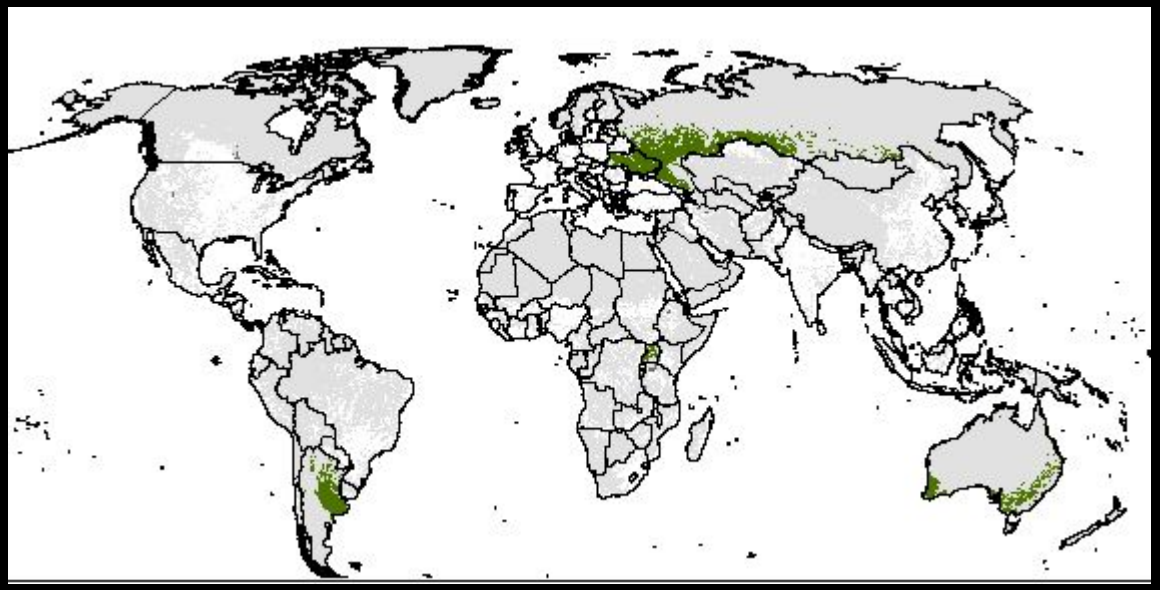
Primary countries at Risk – needs updating



Phase 1

- Proposed Countries (to be confirmed in Feb Meeting):
  - Ukraine, Russia, Australia, Argentina, Uganda
  - Crops: maize, wheat, corn soy (producer countries)
  - Focus on optical and SWIR, (SAR missions will only be used within the Asia Rice initiative)
  - Develop baseline data sets (crop calendars, field size distribution, cloud probabilities, cropland maps)
  - Develop relationship and strategy with country partners
  - Country needs assessment
  - Prototype and evaluate nested sampling frame approach
  - Prototype information products (according to country priorities)
  - Define criteria for success of phase 1
  - Evaluation of usefulness, robustness and affordability

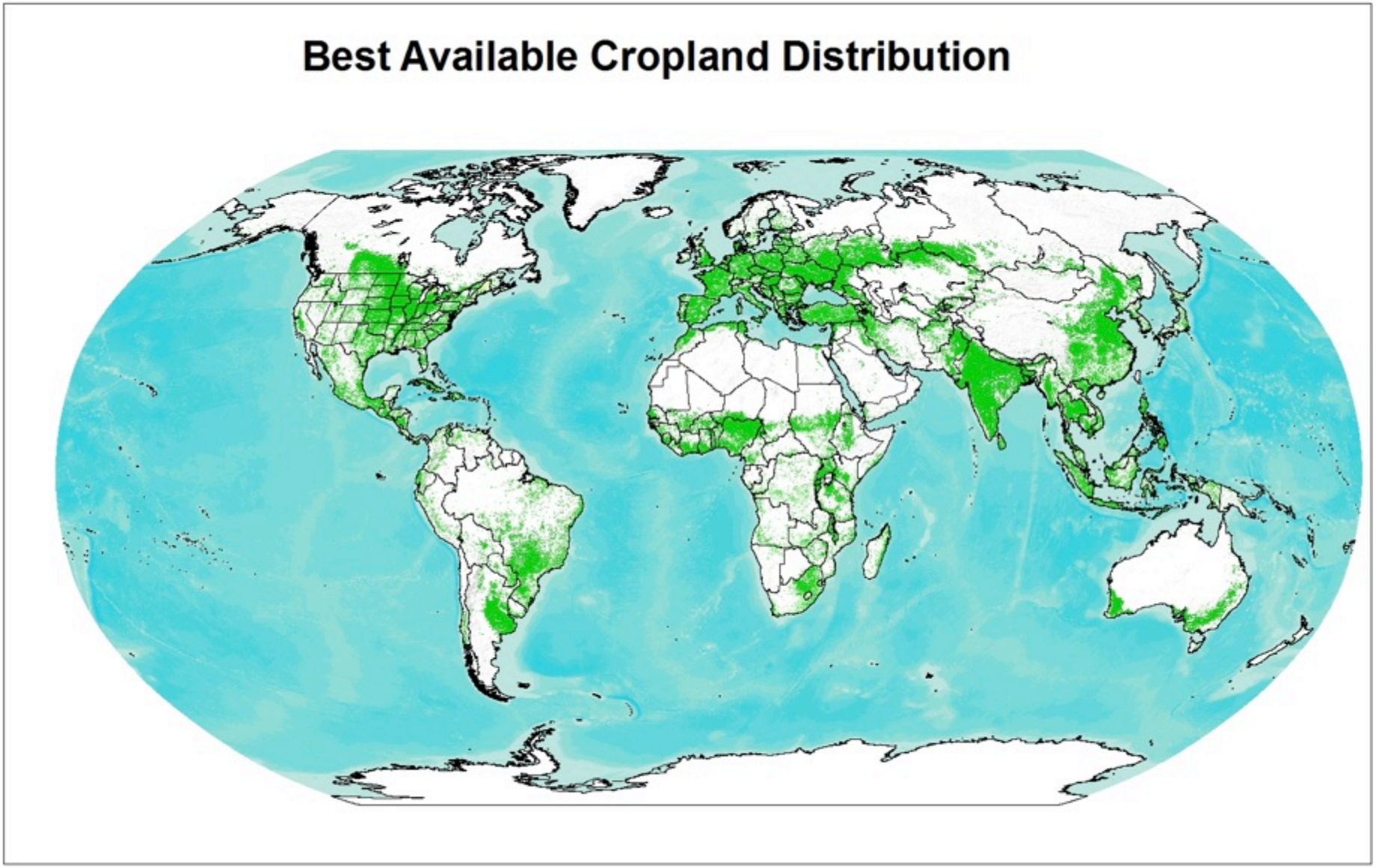
Phase 1 Proposed Countries



Phase 1 Countries	Major Crops	Area Harvested (1000 Ha)	Avg Growing Season Length	% Small Field Percent (< 1.5 ha)	% Medium Field Percent (< 1.5 - 50 ha)	%Large Field Percent (<50ha)
Argentina	soy, wheat, corn	33,000	6-9 months	4	55	41
Australia	wheat	22,000	5-8 months	2	38	60
Russian Federation	wheat, corn	44,500	4-8 months	7	57	36
Uganda	maize, millet, sorghum, cassava, beans, sweet potatoes, groundnuts	2,500	8-11 months	98	2	0
Ukraine	wheat, corn	22,000	6-8 months	6	60	35

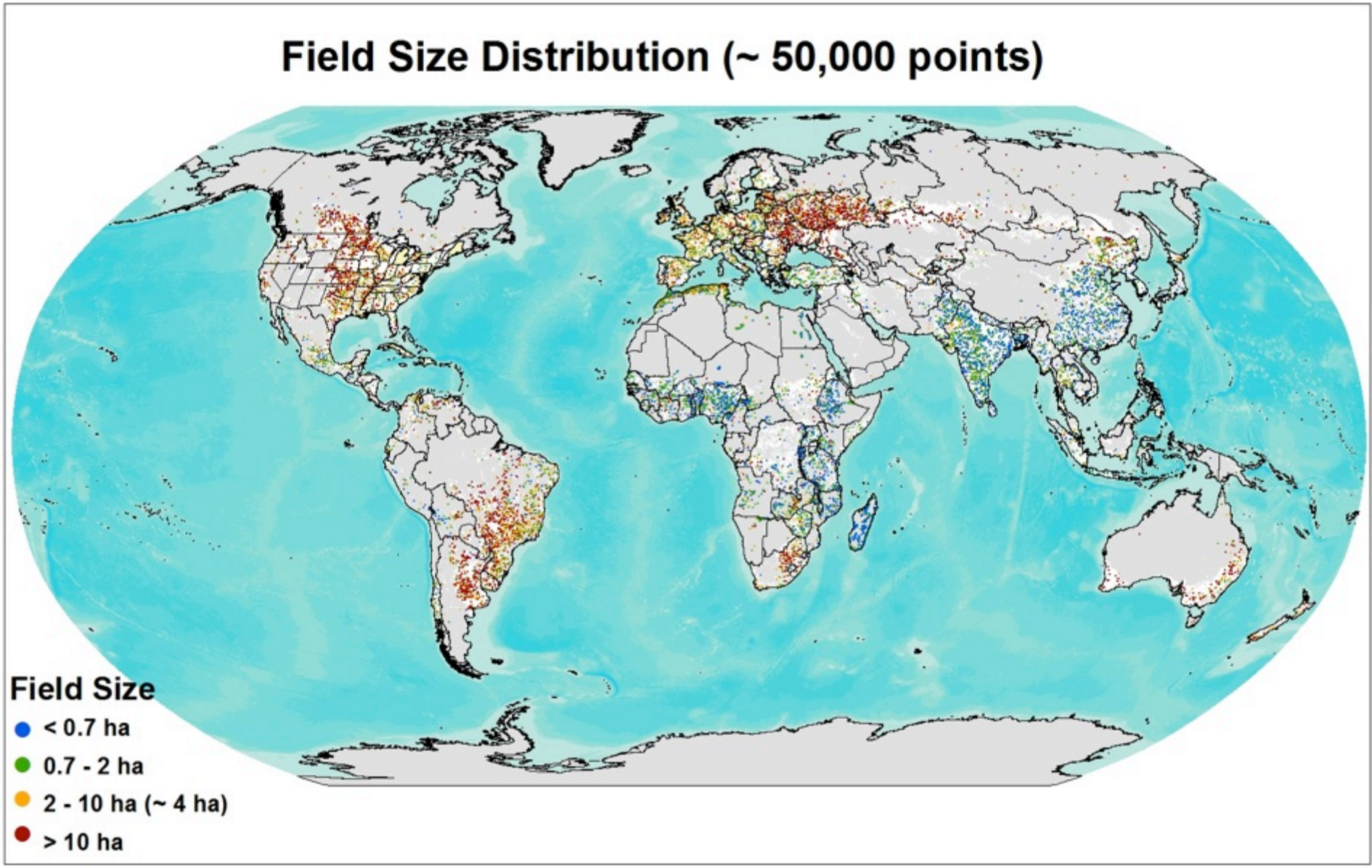
Phase 1: Baseline Data Sets Status

WHERE?



Source: IIASA, Fritz et al. Beta Version 1

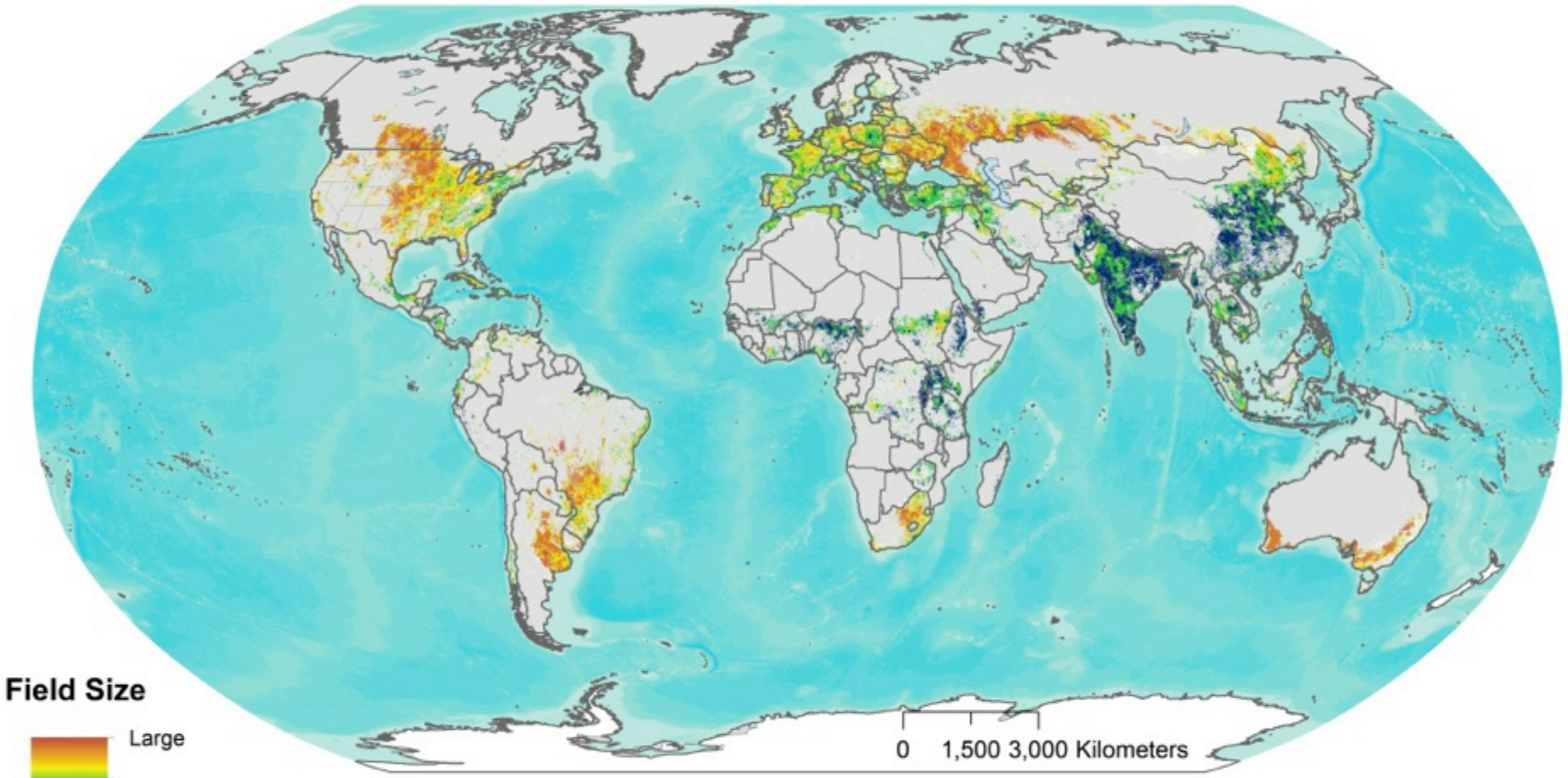
AT WHAT LEVEL OF DETAIL(SPATIAL RESOLUTION)?



Data Source: Fritz et al. IIASA, Ecosystems Services & Management

GEOGLAM
Global Agricultural Monitoring

Field Size Distribution



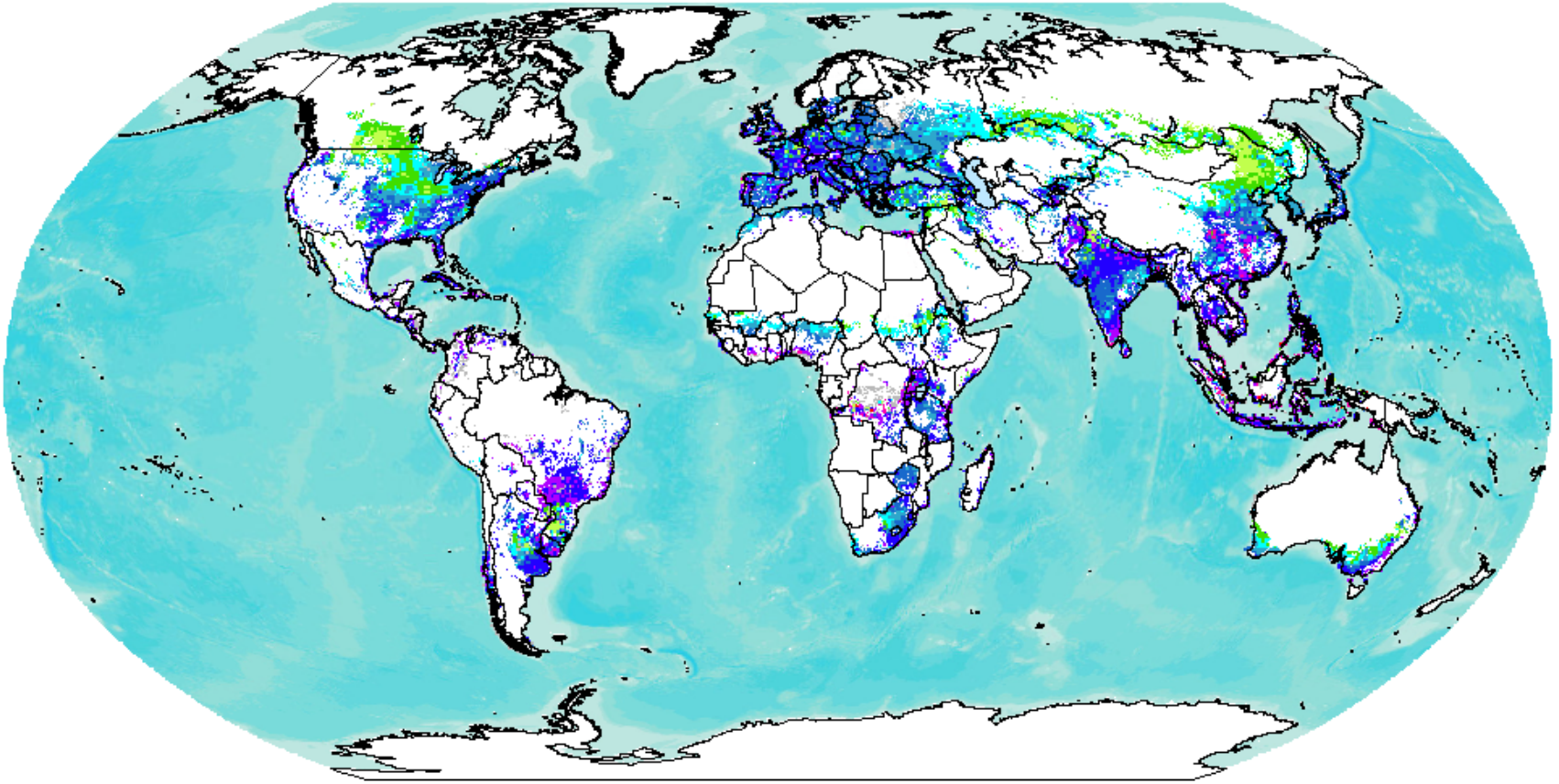
- Beta Version
- Next product will be designed early next year

Data Source: Fritz et al., based on interpolation of 50,000 GEOWIKI collected validation points

WHEN?

Median Growing Season Duration 2001-2010

Growing Season Calendar at 0.5°

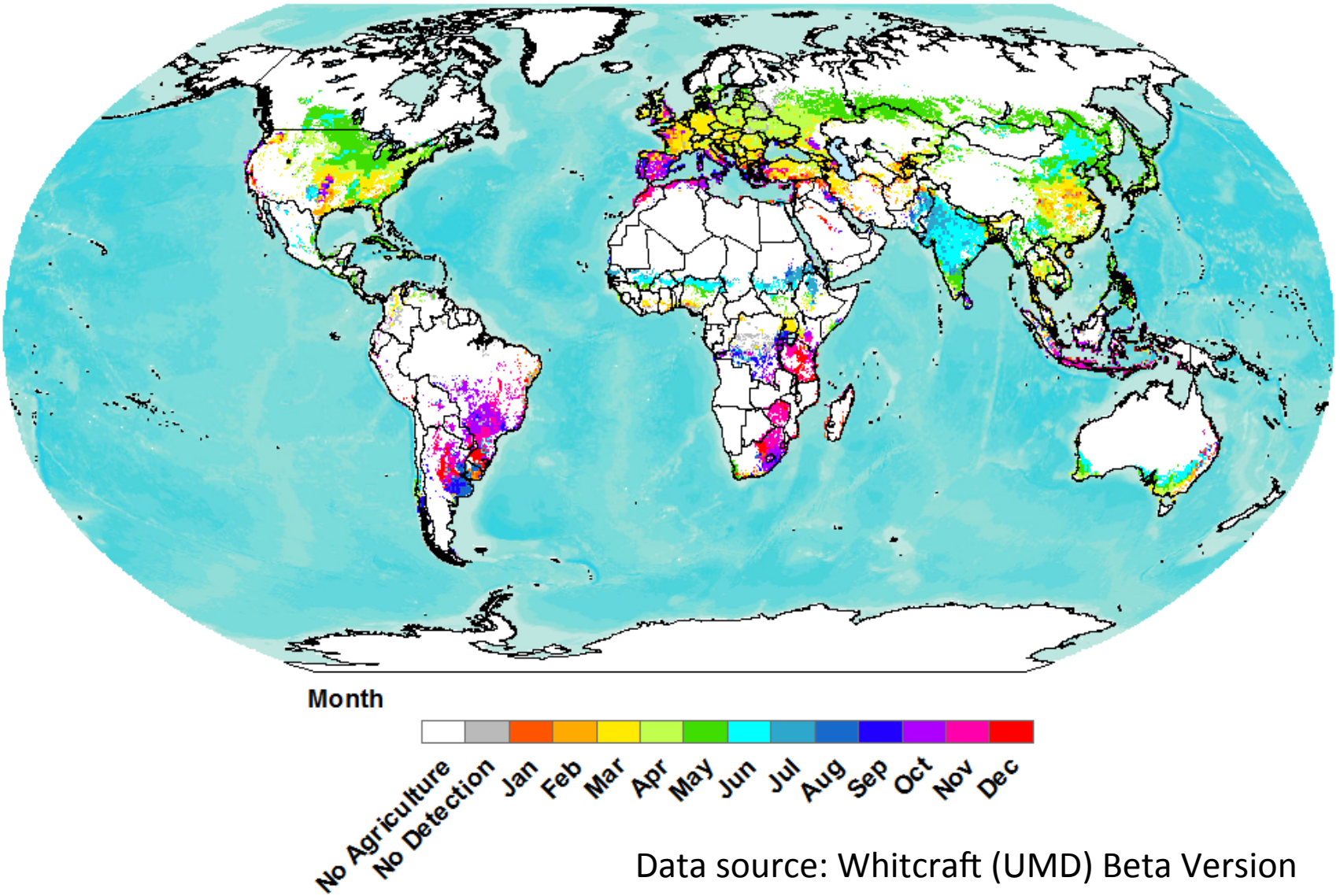


Data source: Whitcraft (UMD) Beta Version

WHEN?

Median Start of Season Date 2001-2010

Growing Season Calendar at 0.5°

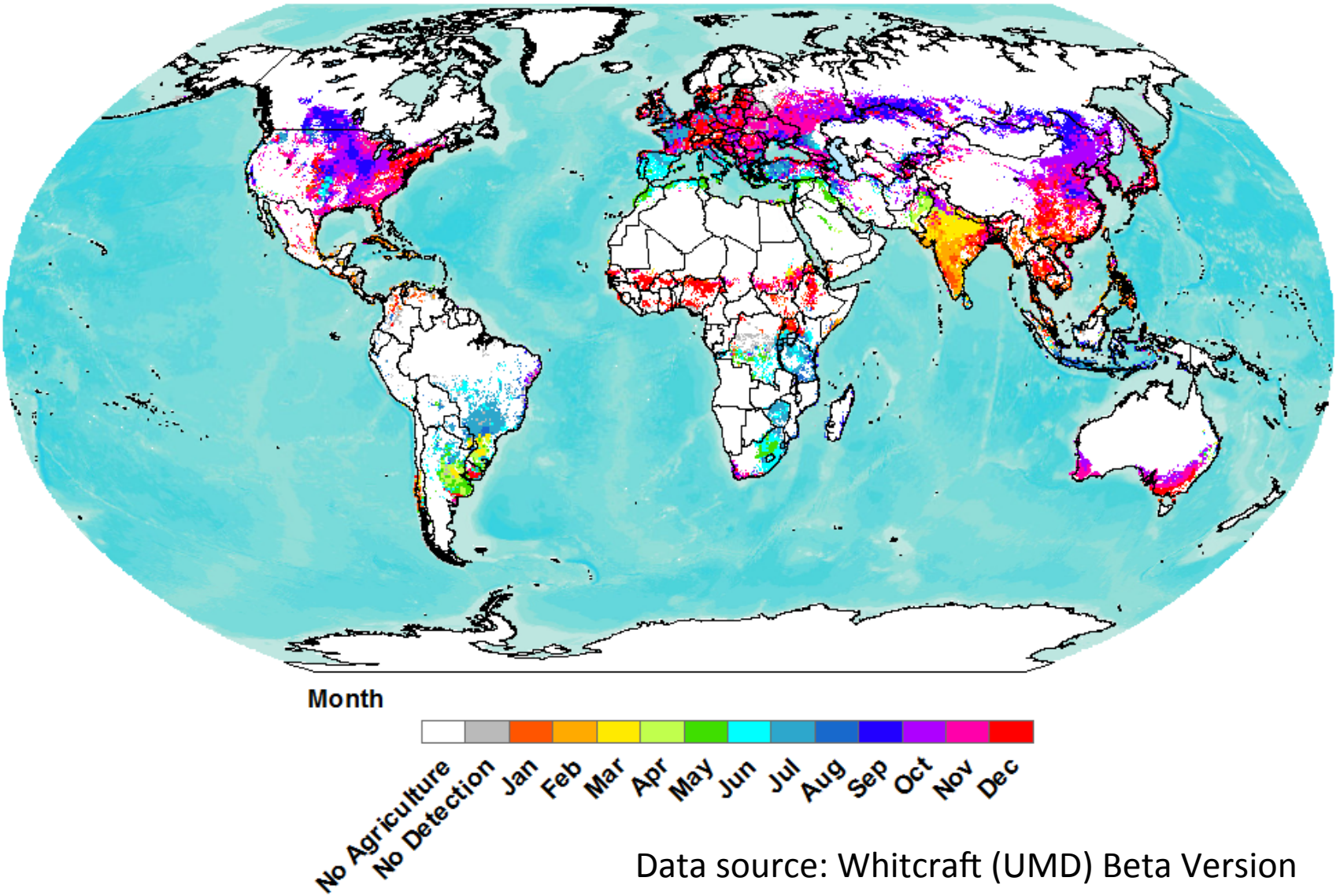


Data source: Whitcraft (UMD) Beta Version

WHEN?

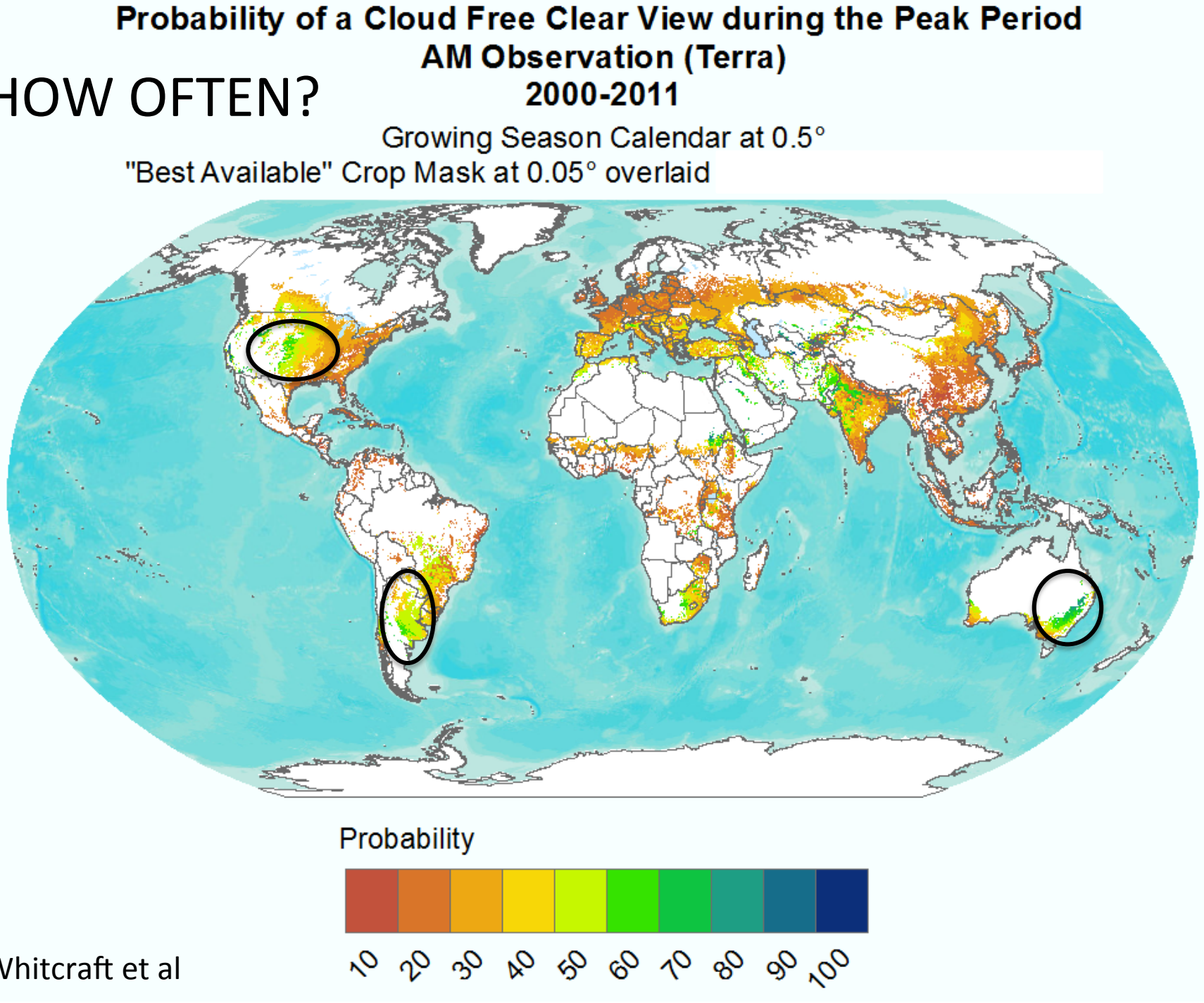
Median End of Season Date
2001-2010

Growing Season Calendar at 0.5°



Data source: Whitcraft (UMD) Beta Version

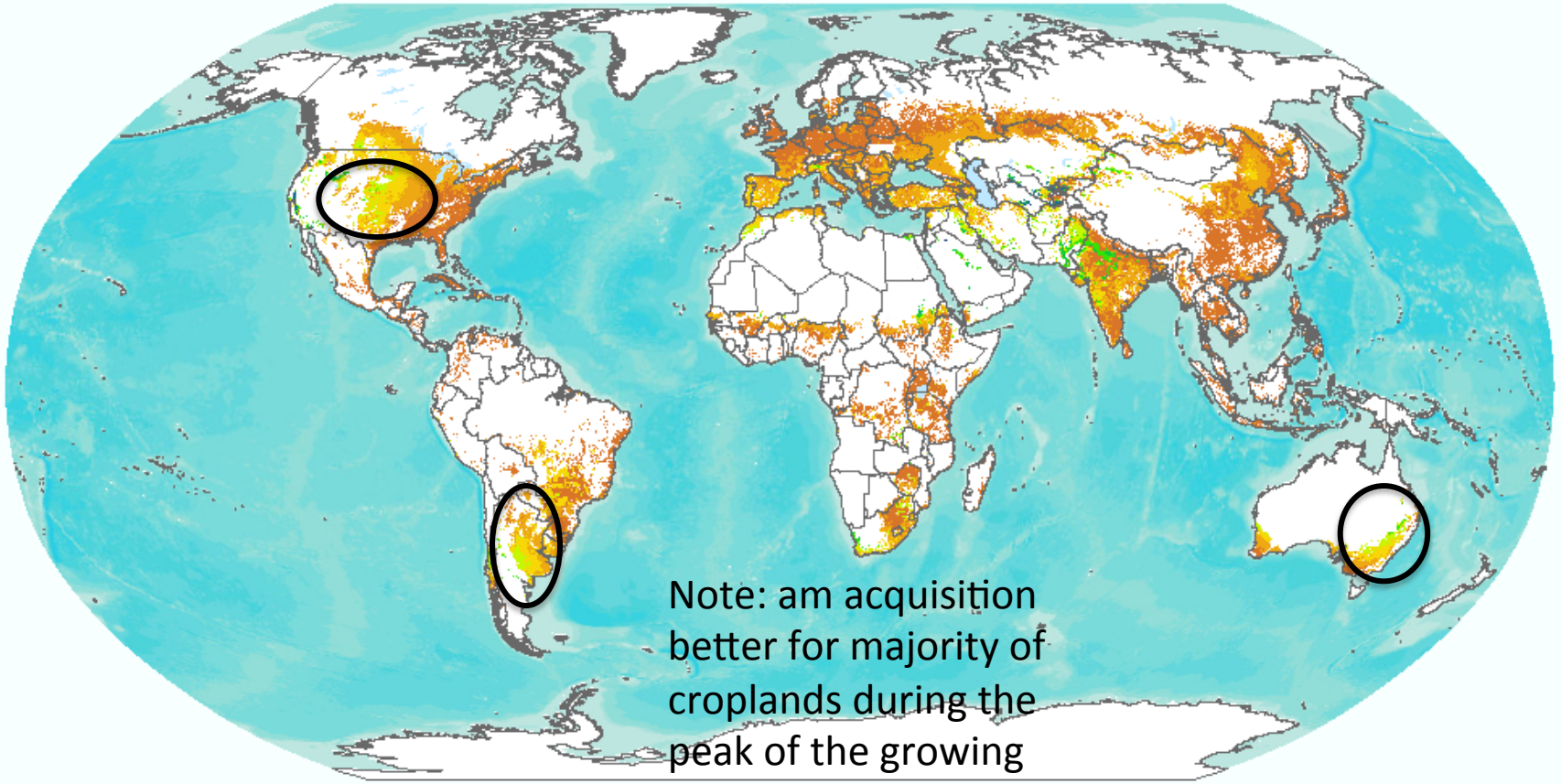
HOW OFTEN?



Whitcraft et al

Probability of a Cloud Free Clear View during the Peak Period
PM Observation (Aqua)
2002-2011

Growing Season Calendar at 0.5°
"Best Available" Crop Mask at 0.05° overlaid

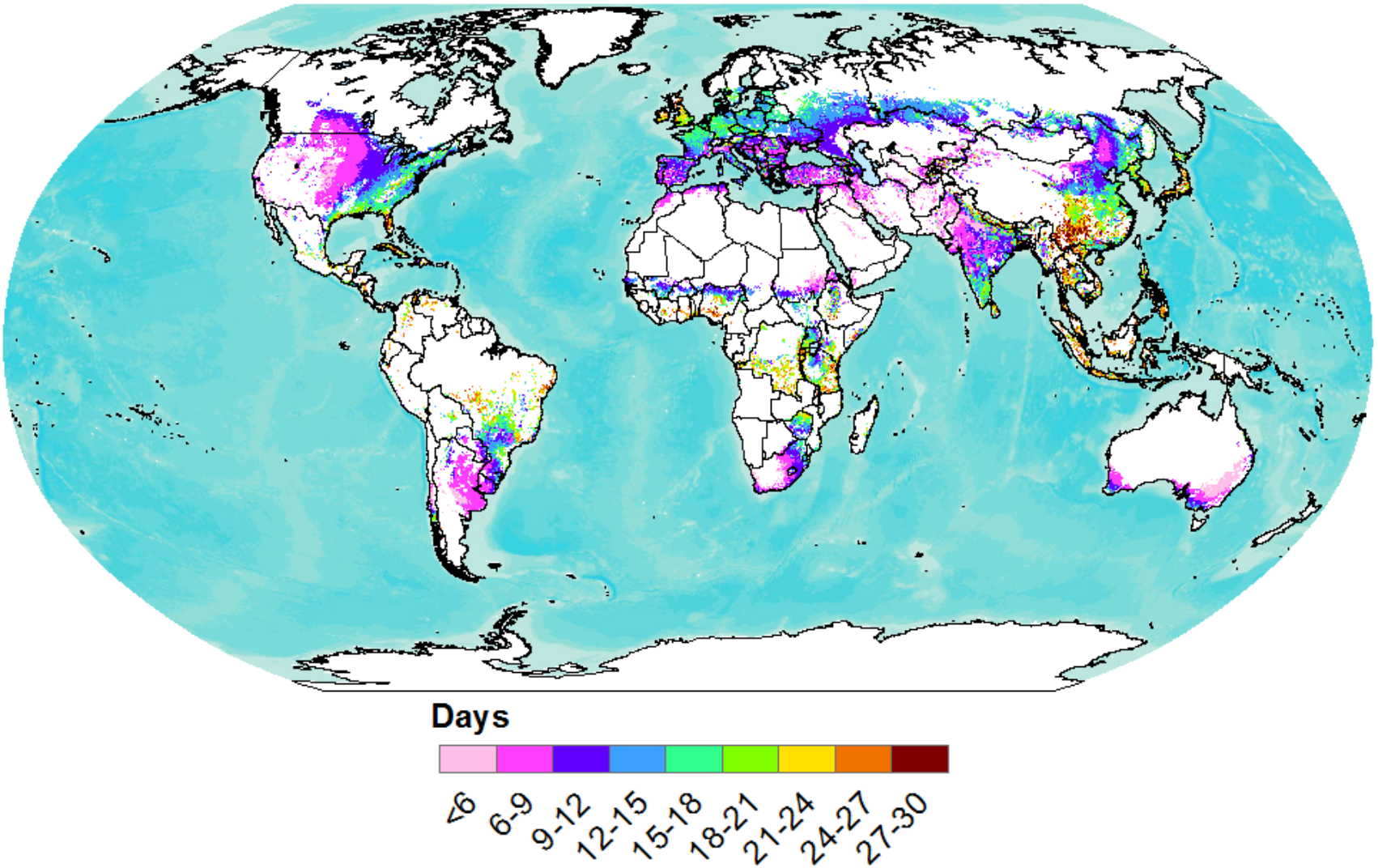


Note: am acquisition better for majority of croplands during the peak of the growing season

Probability

10 20 30 40 50 60 70 80 90 100

Days Until Clear View with 3 Day ACT (Repeat Time)
Peak +/- 30 Days
Terra (AM), 2000-2011

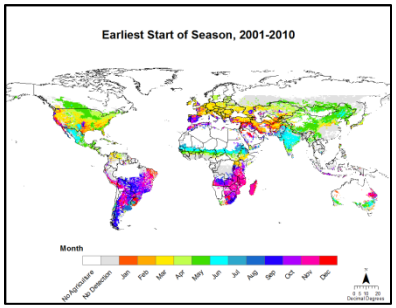


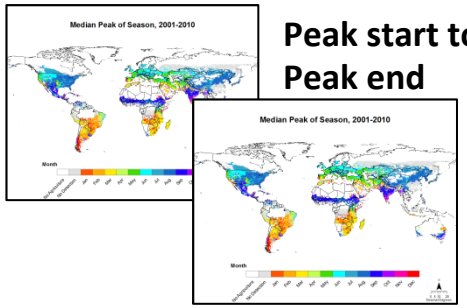
Data source: Whitcraft (UMD), based on MODIS Terra data from 2000-2011

Developing an EO Requirements Geodatabase

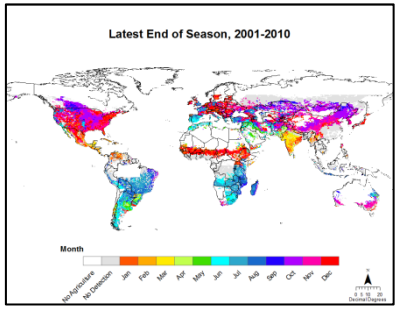
Example → 5-10 m Optical & SWIR

When?

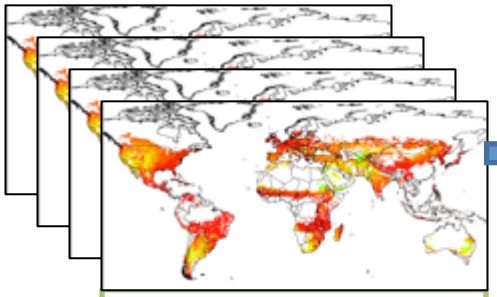




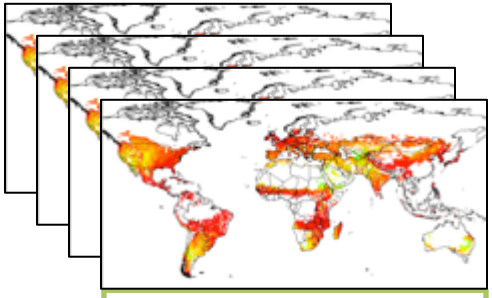
Peak start to Peak end



Frequency? Which fields?



Repeat time required for monthly image year round & during AGS [early, peak, late]: **All croplands**



Repeat time required for weekly image during AGS [early, peak, late]: **Main croplands**

Layer identifying small fields (both) & target countries (main croplands)

Imaging Start: 151
Imaging Peak: 220-255
Imaging End: 305
RTR, Early: 4 days
RTR, Peak: 3 days
RTR, Late : 4 days
RTR, Non-AGS: 16 days

Click a point

Step 2: Developing a Sampling Approach

Sampling Strategy

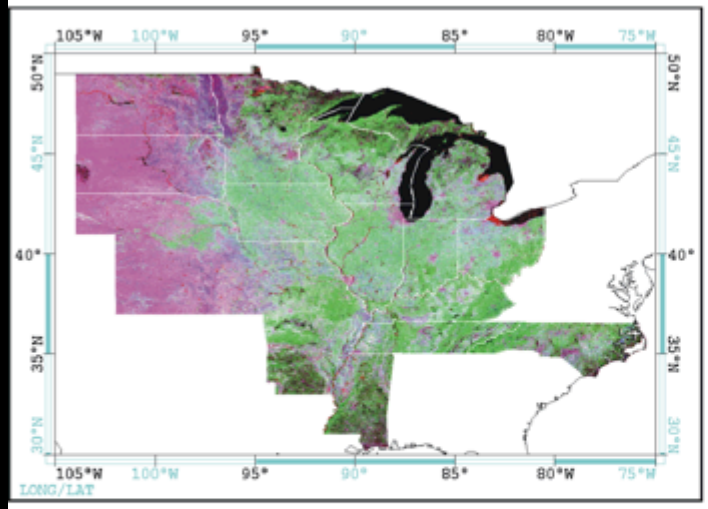
Preference is for wall to wall coverage BUT this is not feasible for all GEOGLAM regions, with high acquisition frequency, especially given cloud cover during growing season.

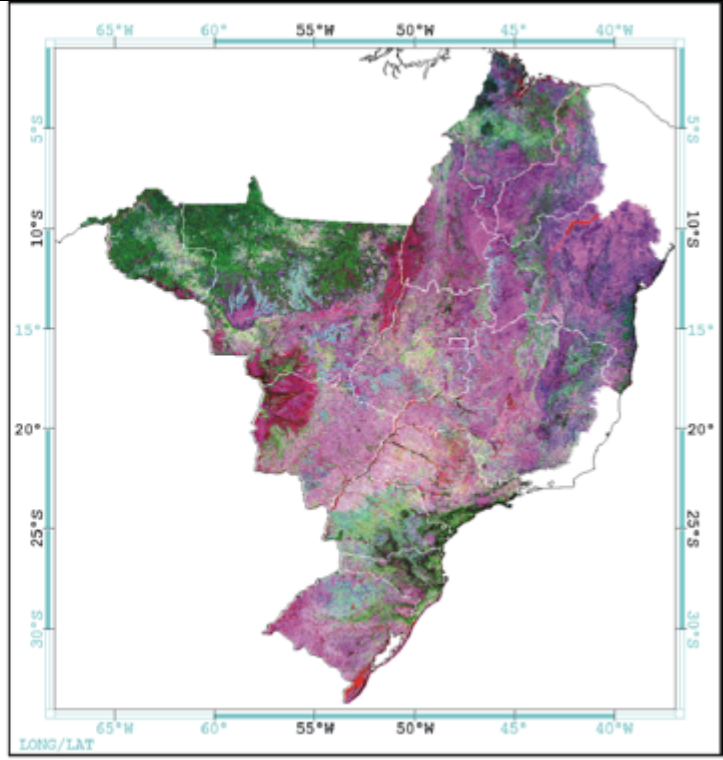
A nested stratified, multi-resolution sampling approach is an alternative which allows for more frequent acquisitions over selected sites that are statistically representative of entire area

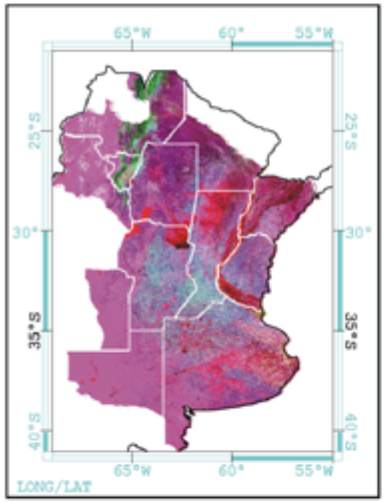
- S1: Moderate res sample blocks
  - Number of sample blocks depends primarily on variability of crop types, of crop rotations, size of region, desired standard error
  - Blocks should be quite small (5-20km)
- Frequency of acquisition, will depend on the complexity of the cropping system- approximately 5 scenes per growing season; 1-2 out of season
- S2: Smaller Subset of sample blocks requested for fine res with same acquisition frequency as S1 blocks
- **NASA likely to fund initial design of sampling approach**

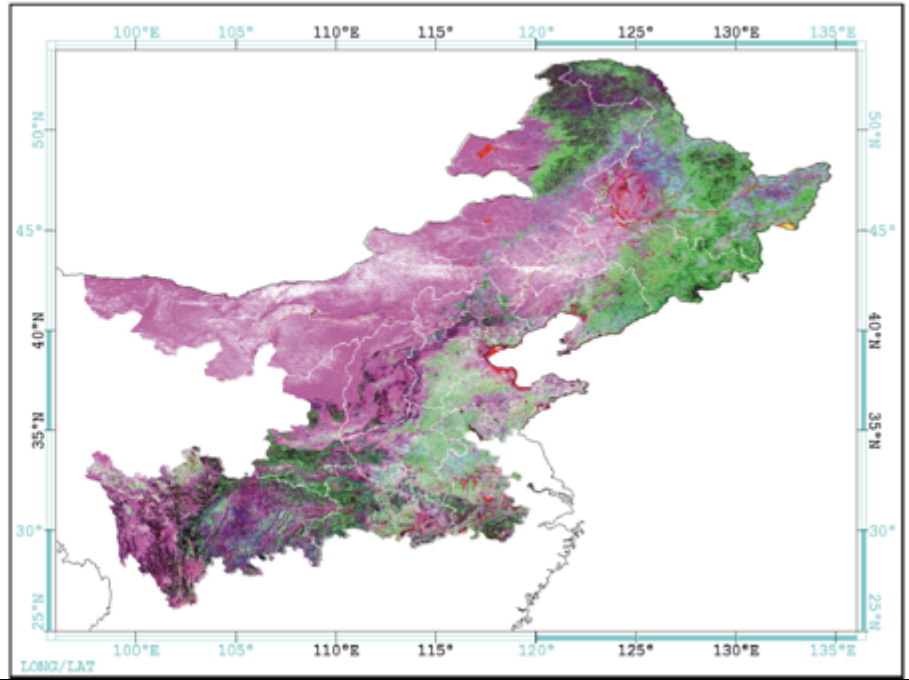
Sampling:

Example of proposed Sampling approach to global soy Area using multi-res data









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.

Hansen et al

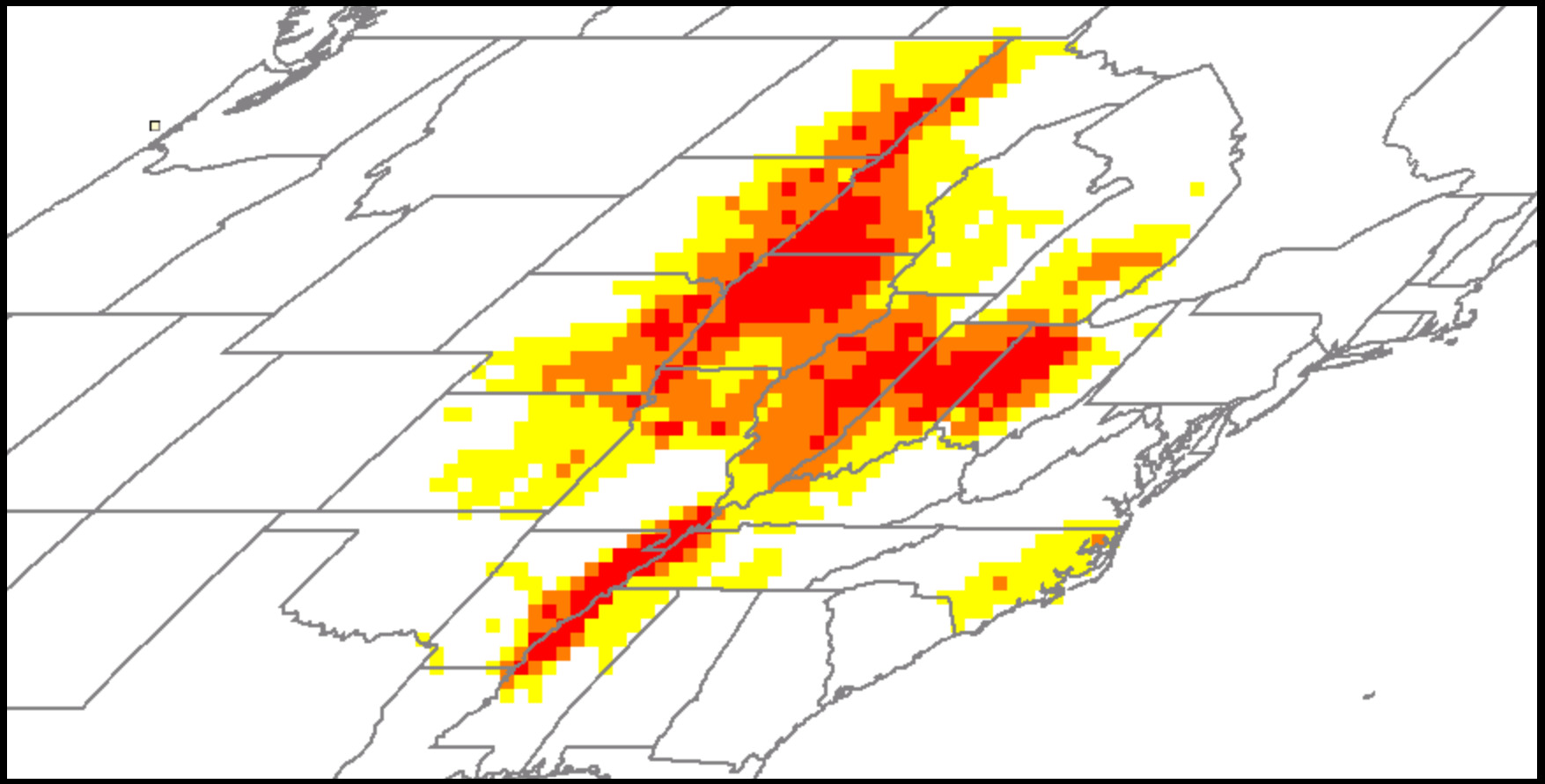
Objectives

- Employ multiple resolution data: MODIS, Landsat, RapidEye and field data to estimate national-scale crop area by type
- 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
- Illustrate the viability of remote sensing-based global crop type area estimation using a sampling approach

Method

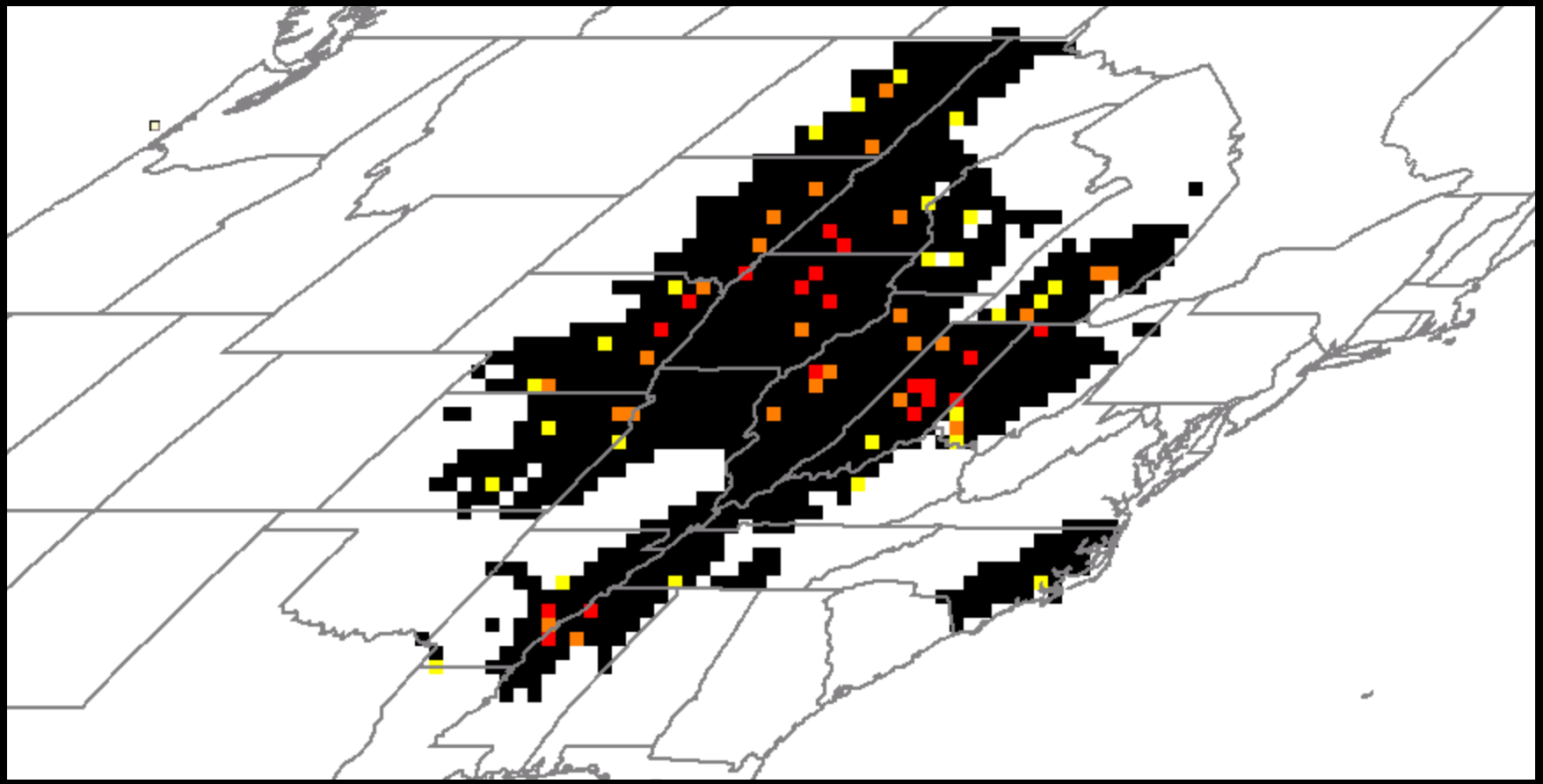
- **MODIS** used for turn-key, generalized models to generate per nation/sub-region to indicate within growing-season soybean cultivation based on sub-pixel percent cover training data
  - The models estimate percent soy-cover and enable the stratification of national-scale cropland growing regions for sampling purposes
- **S1- Landsat samples** used to map per sample block soybean cultivated area
- **S2- RapidEye** allows for per country/region calibration of Landsat area estimates
- The Landsat sample blocks are then analyzed to quantify national-scale crop type area

High, medium and low soybean strata using MODIS

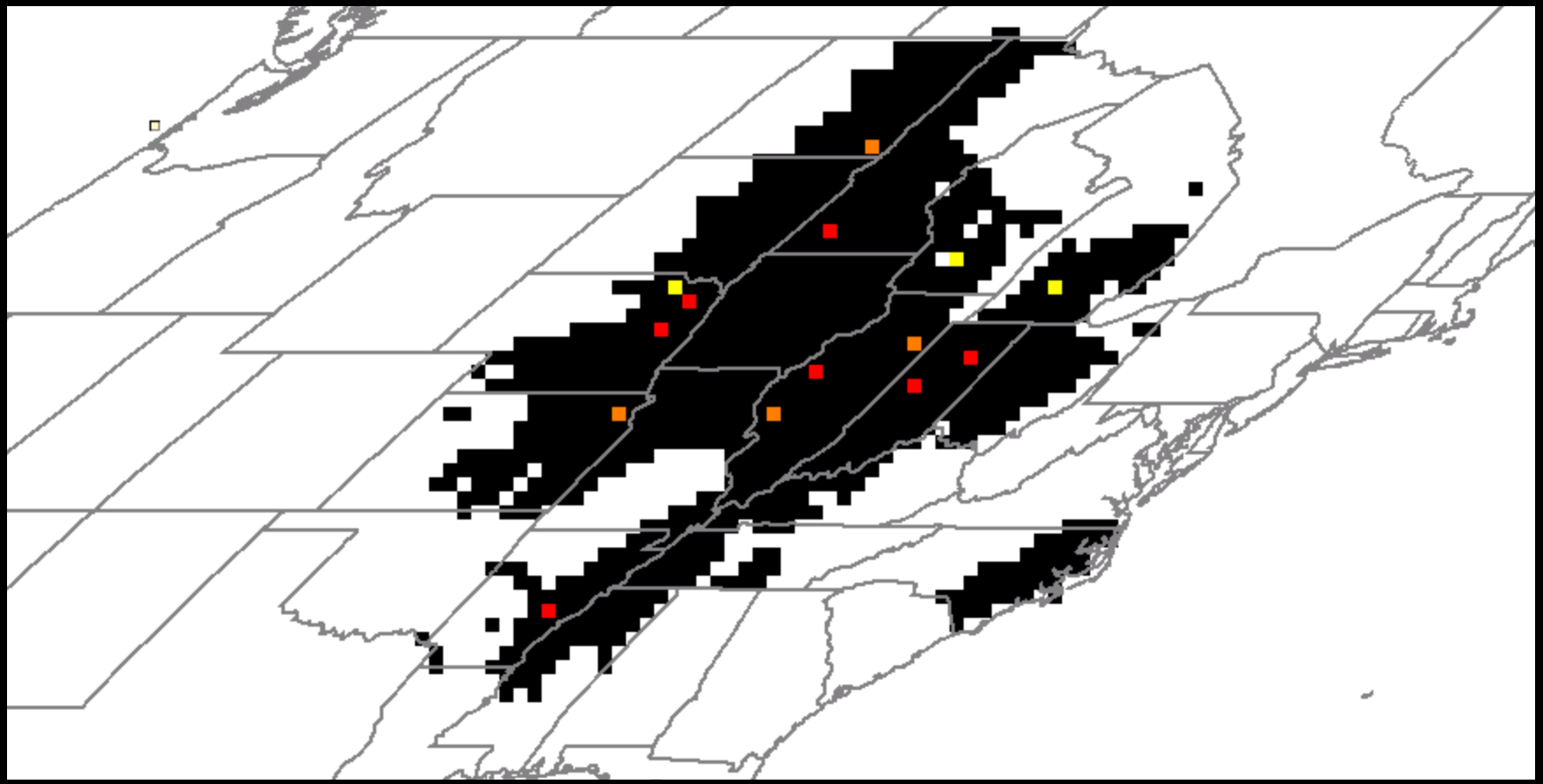


Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

Landsat sample blocks (S1)
3-4 acquisitions during growing season

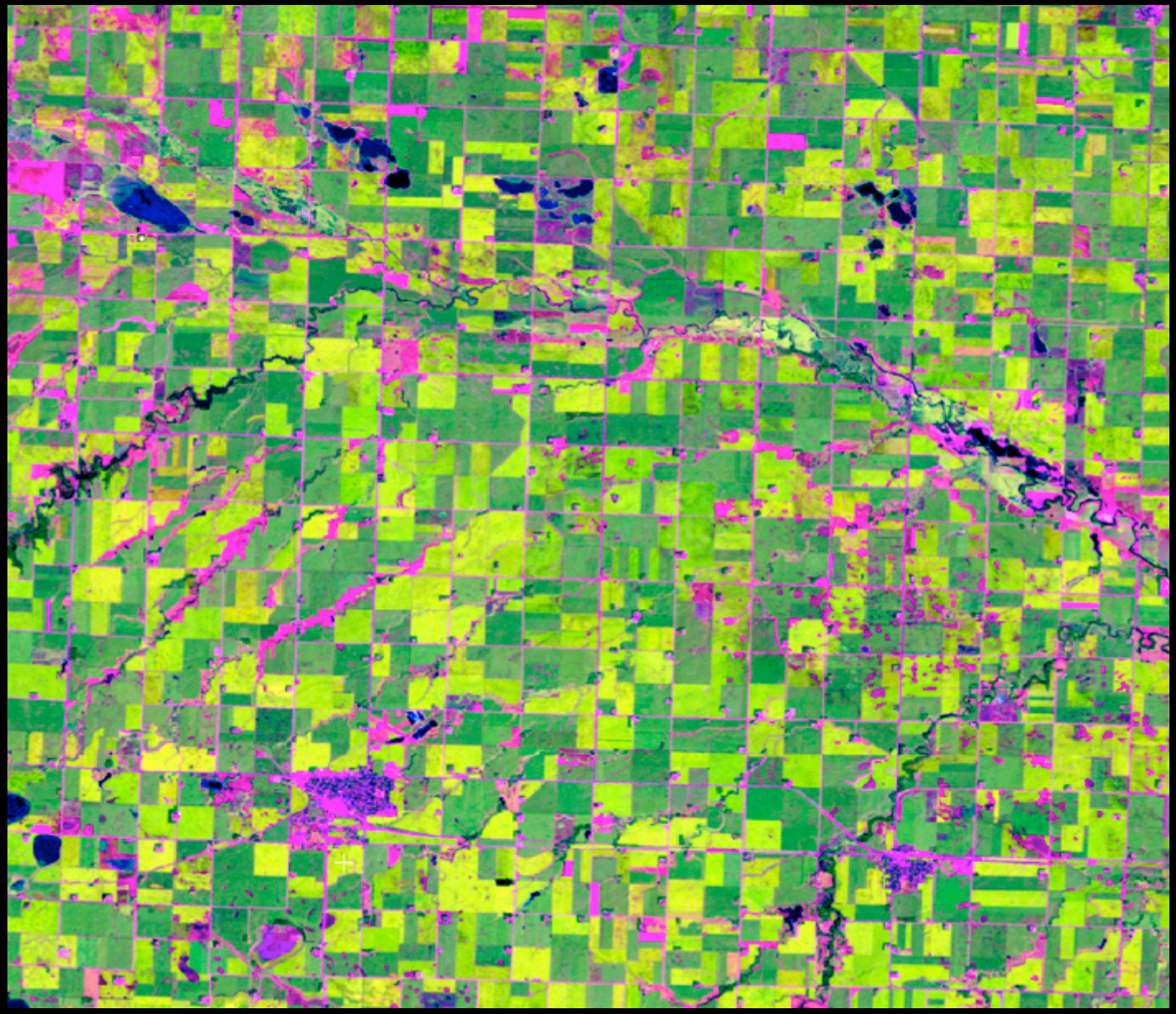


RapidEye sample blocks- S2

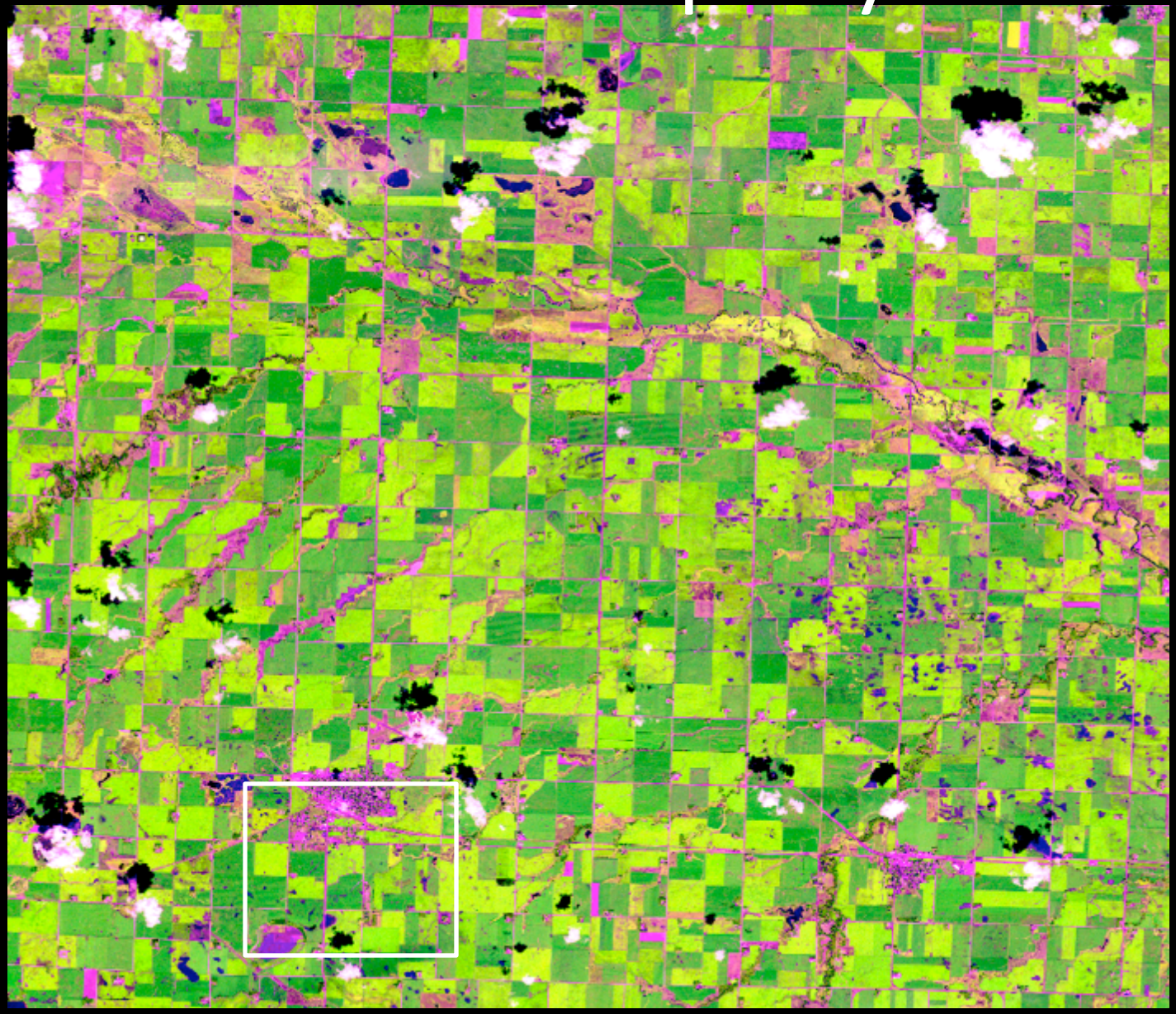


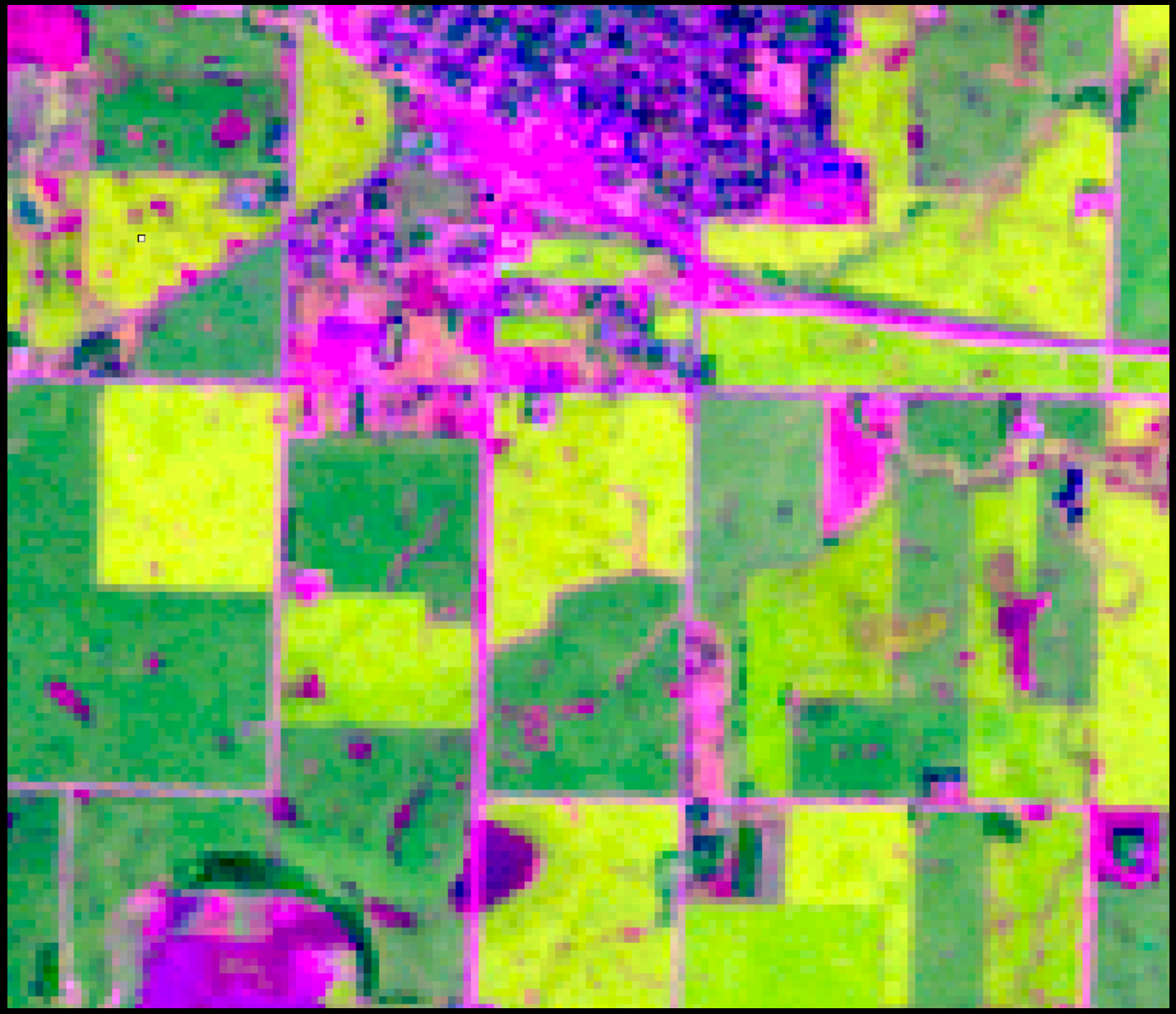
Red=high (>19.8%), orange=medium (7.2-19.8%), yellow=low (0.5-7.2%)

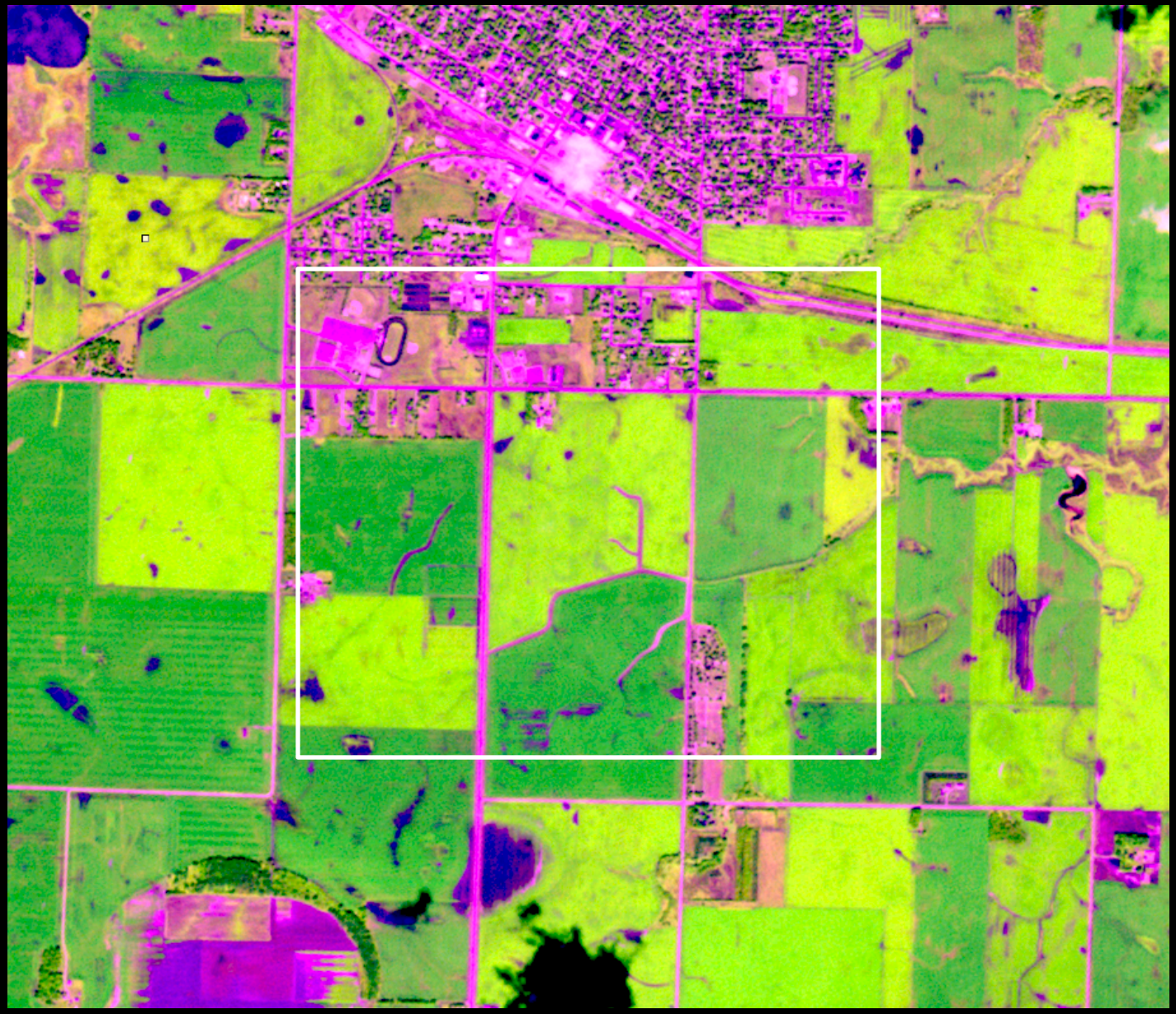
SW Minnesota Landsat 5-4-3

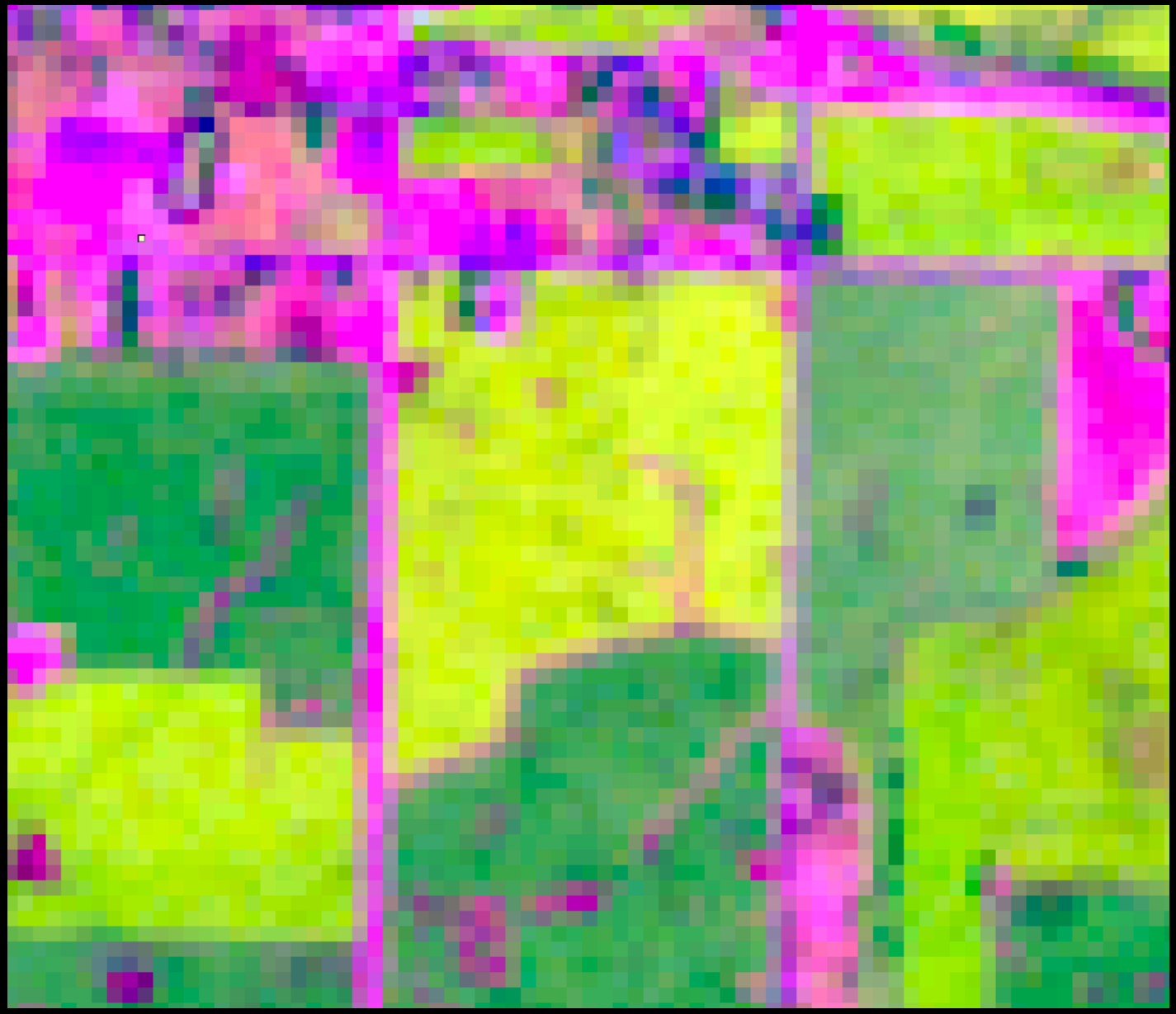


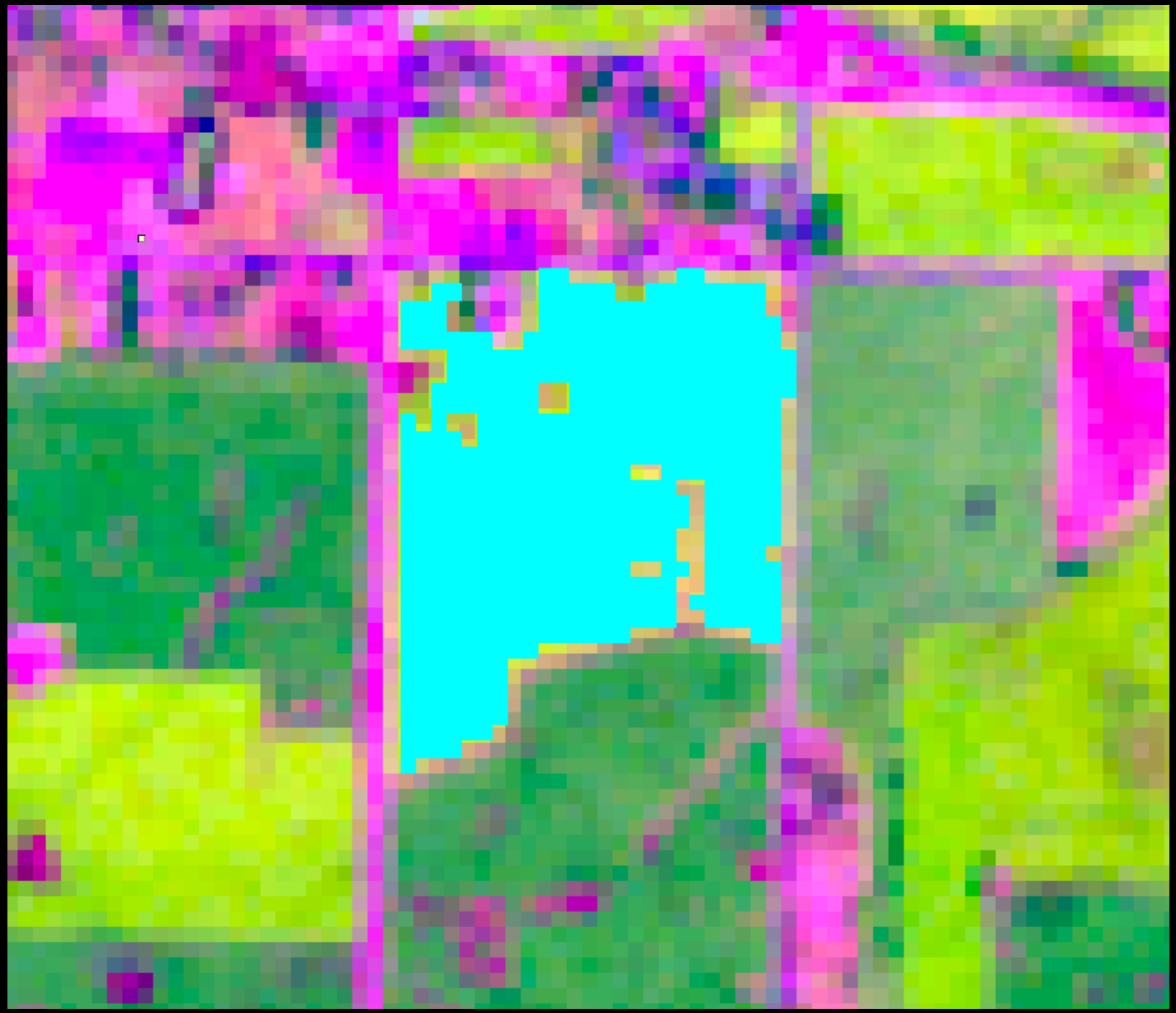
SW Minnesota RapidEye 4-5-3

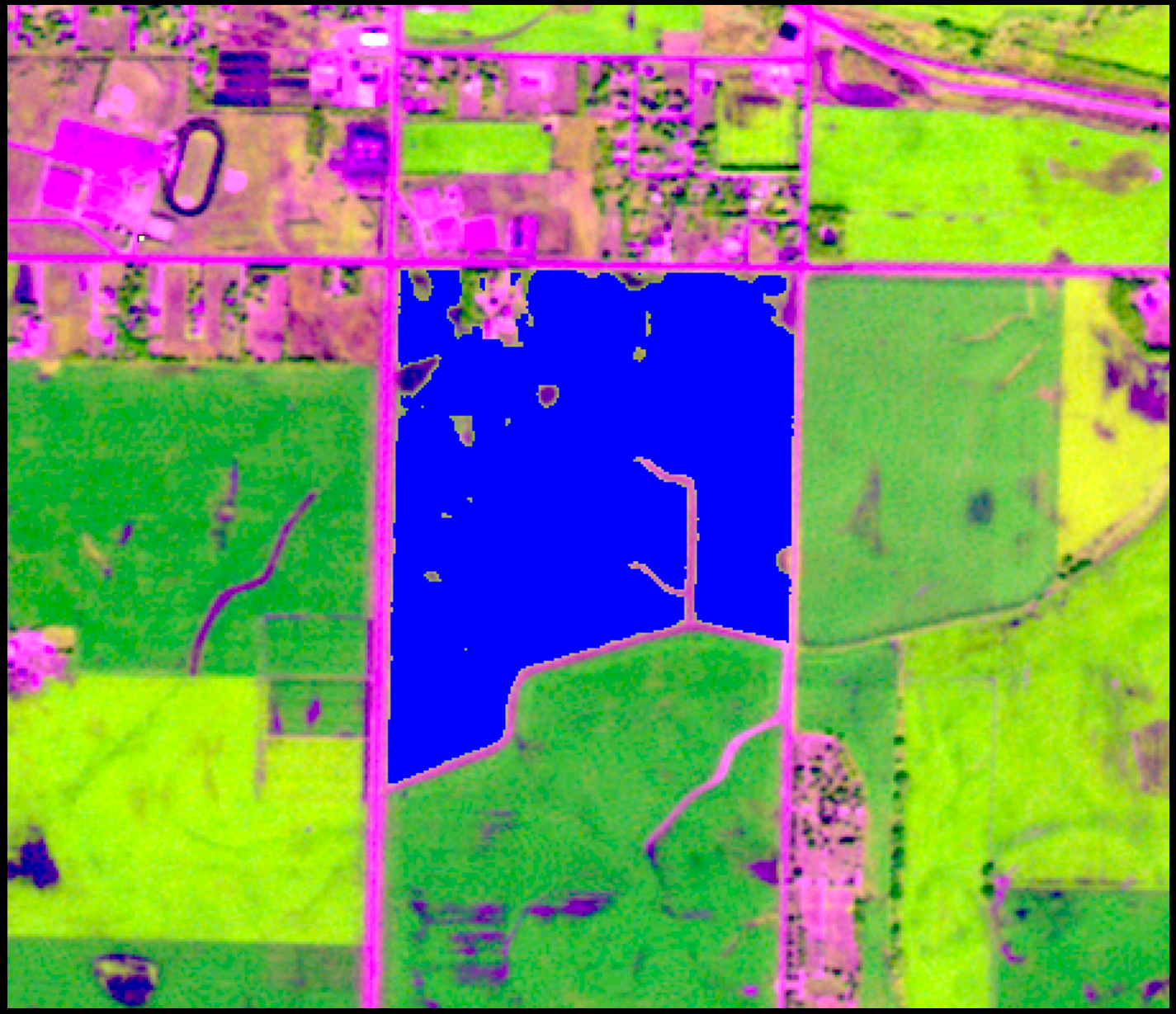






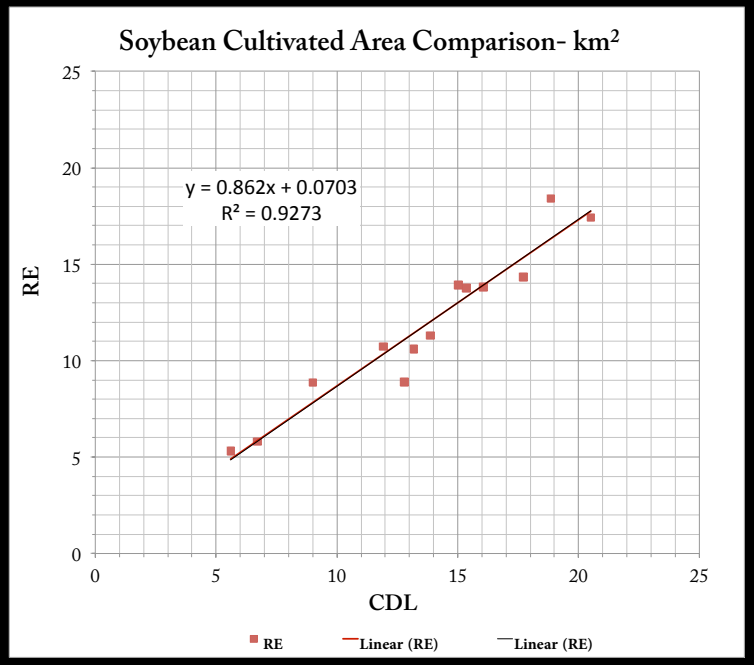




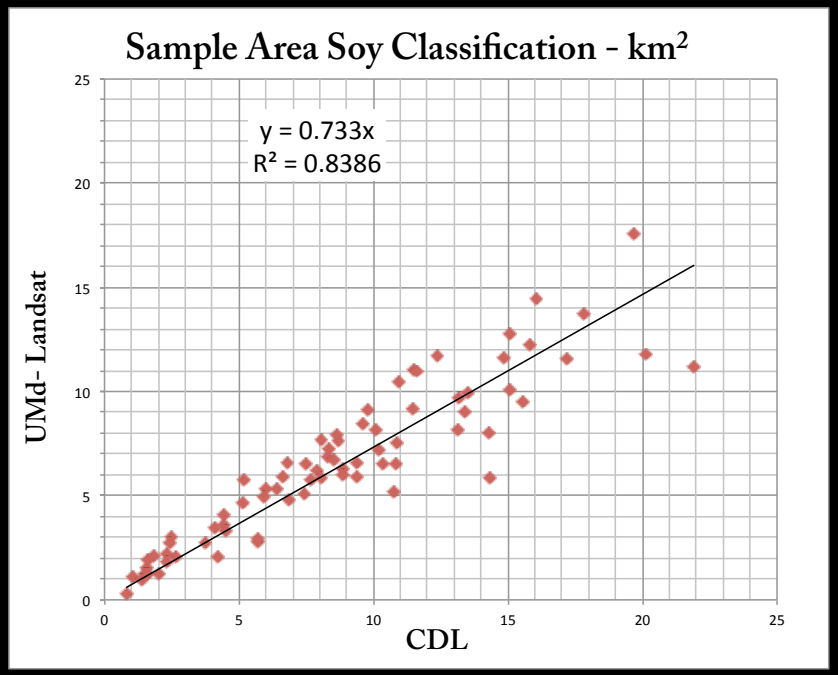


Preliminary Results

Calibration of Landsat with Rapid Eye
Rapid Eye vs. Landsat Area estimates per Block



Comparison of Area Estimates using Landsat sample blocks vs. wall to wall Landsat based estimate



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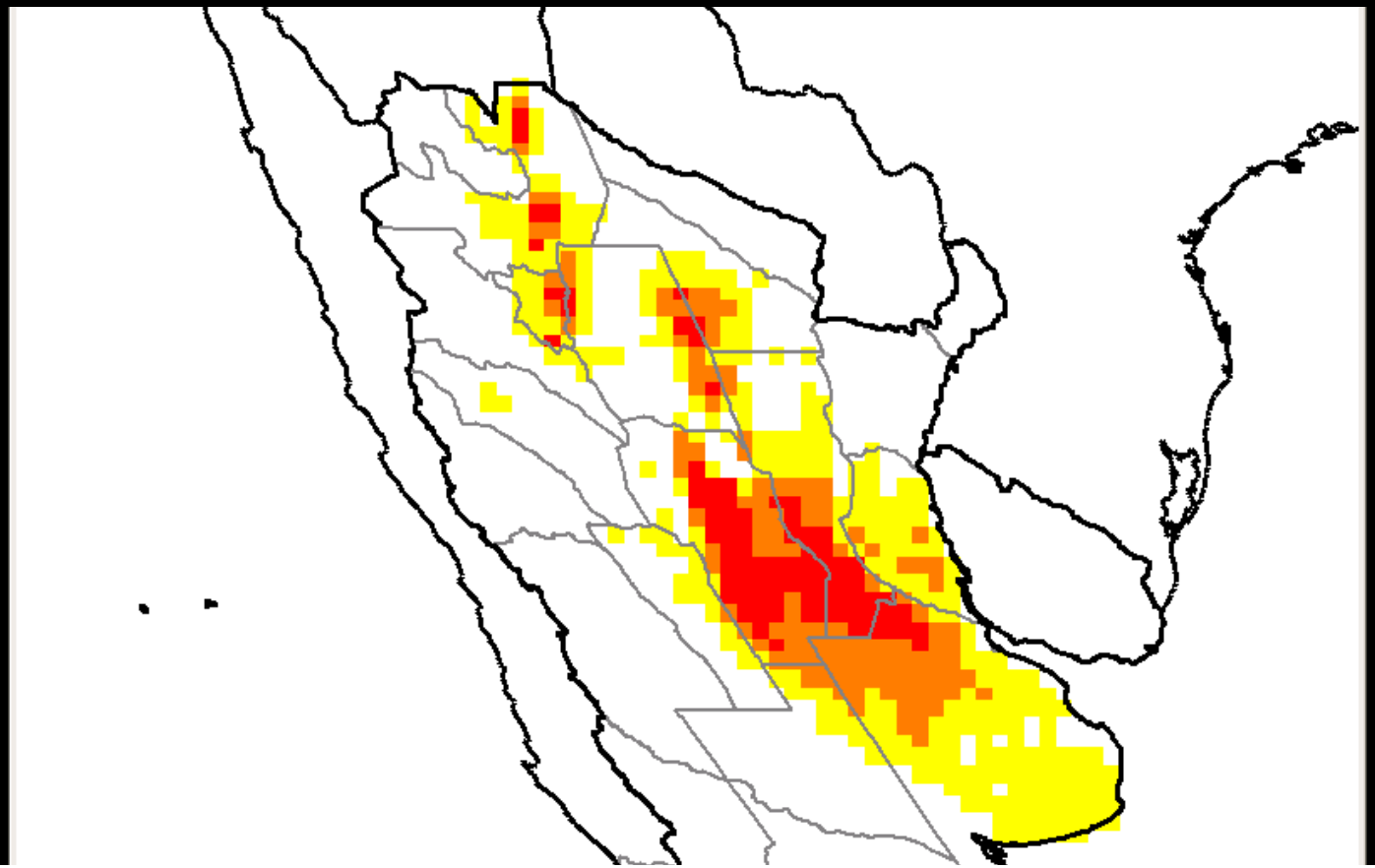
Argentina strata

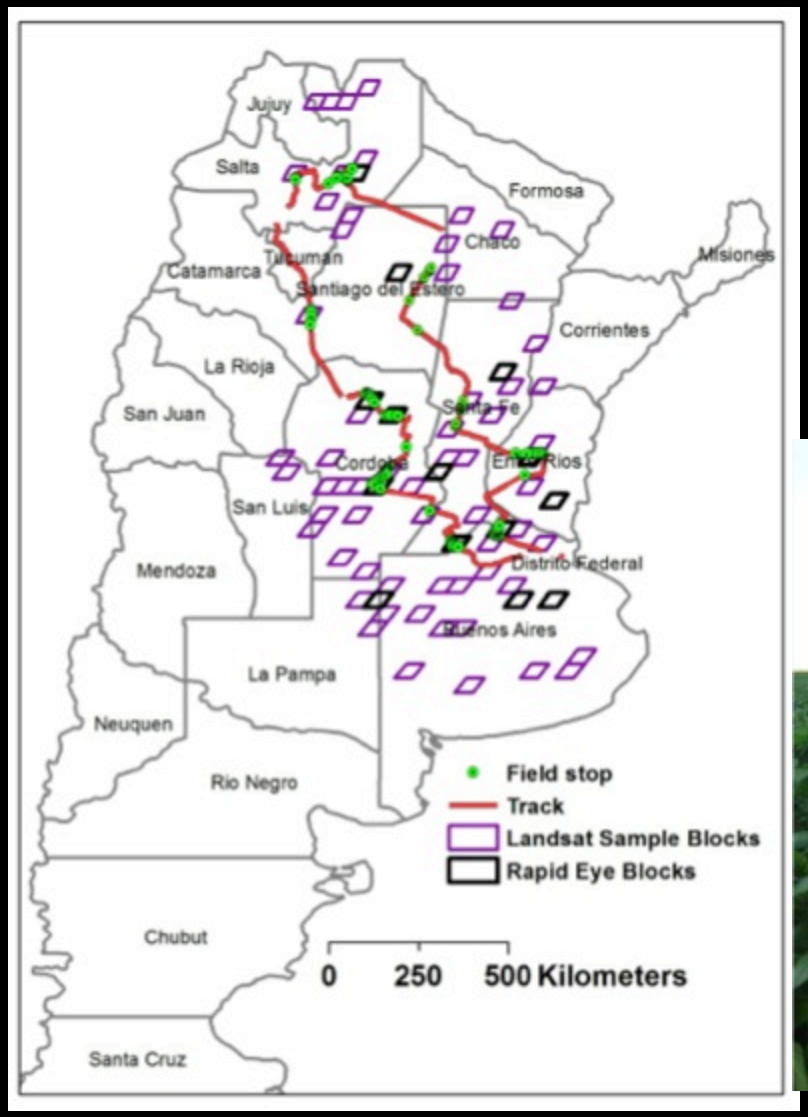


- Preliminary result: 160,030 km2 with a standard error of 10,600 km2

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

Hansen et al

Argentina field data collection over selected sample blocks of RapidEye and Landsat (Feb 2012)



Summary

- GEOGLAM has substantive and complex observation data needs (what, where and when) which underpin its implementation – no one satellite system can meet the data needs – international cooperation is needed
- Approach: work in close partnership with CEOS Ad hoc committee and commercial data providers to establish and implement data acquisition with a phased approach

- GEOGLAM requests:
  - limited support from SDGC within the next year for implementation of of phase 1, with an understanding that increased support will be needed in 2014
  - Feedback on proposed phased approach
  - Feedback on possible synergies between GFOI and GEOGLAM
  - Commitment to support GEOGLAM to implement its proposed phased approach
  - Clear steps required for GEOGLAM to become a CEOS priority initiative






Thank You!