

# Research to Operations in Agricultural Monitoring

Chris Justice

The Center for Agricultural Monitoring Research,

Department of Geographical Sciences,

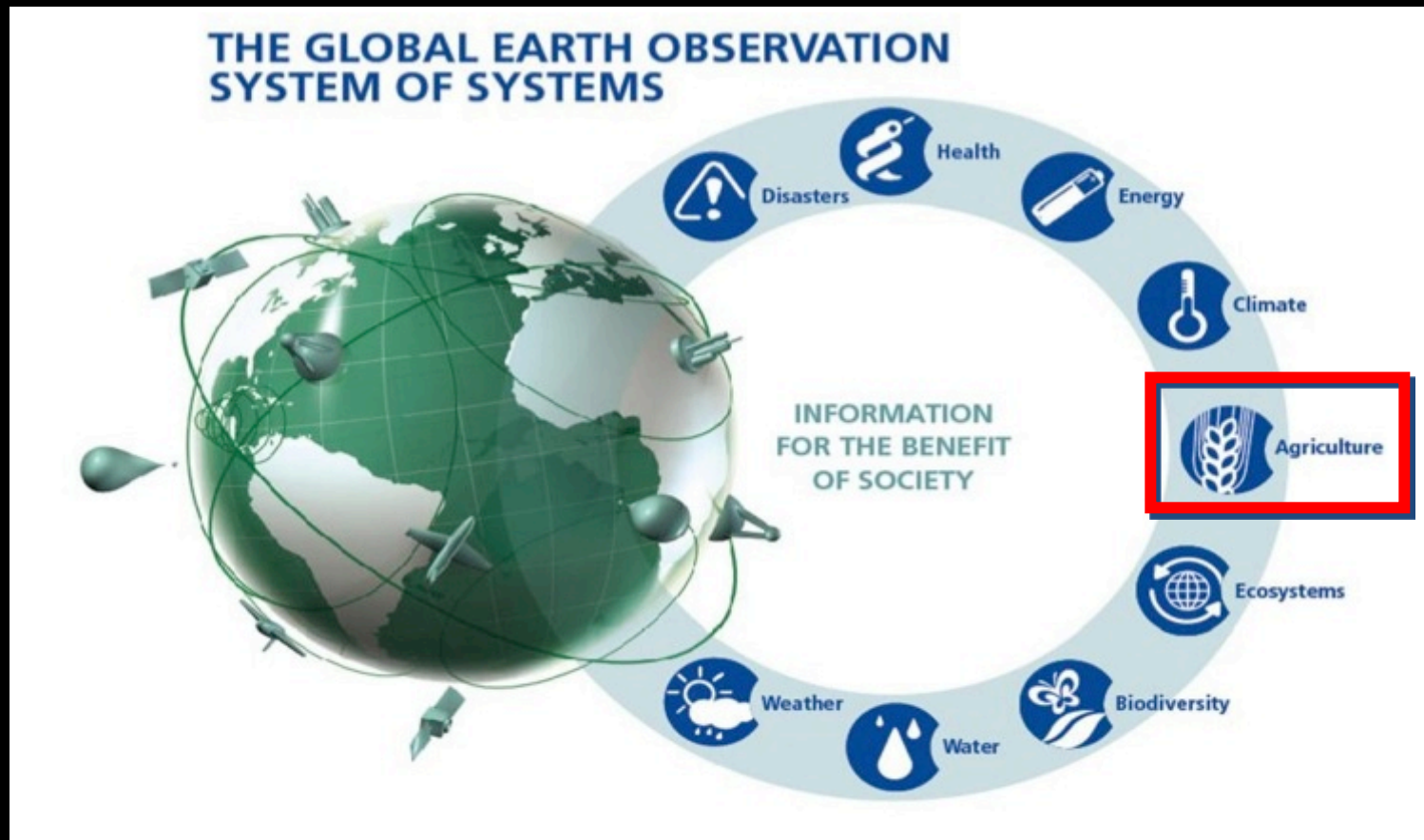
University of Maryland, USA

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# GEO is the international program focused on the use of Earth Observations for societal benefit

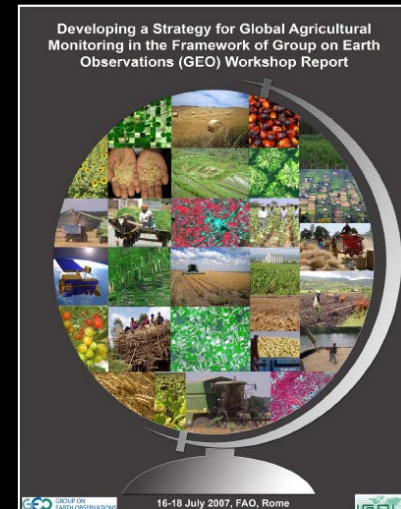
- GEO was initiated in 2005
- Agriculture is one of the GEO societal benefit areas
- GEOGLAM is GEO's Agricultural initiative





# Initial GEOSS/IGOL Agricultural Monitoring Workshop July 2007, UN-FAO

- IGOL/GEO workshop to develop a strategy for global agricultural monitoring in the framework of GEO
- 47 participants representing 25 national and international organizations attended and established the '*GEOSS/IGOL Agricultural Monitoring Community of Practice*'



- Reviewed the current state of agricultural monitoring identified gaps and developed a set of priorities and recommendations
- Recognized that international and national programs faced the same obstacles and challenges and that the full potential of EO had yet to be realized

Today the Community of Practice has over 300 members representing over 40 countries and organizations



# Thematic Workshop Series to Identify “Community of Practice” Priorities and Best Practices

- November 2009, Kananaskis, Canada: SAR data for Agricultural Monitoring
- May 2011, Curitiba, Brazil (SBSR): JECAM South America Workshop
- September 2011, Nairobi, Kenya: CRAM Agricultural Capacity Building Workshop
- October 2012, Beijing, China: Workshop on Agricultural Water Availability
- November 2012, Buenos Aires, Argentina: Regional Workshop on Agricultural Monitoring
- October 2013, Moscow, Russia: Workshop on Agriculture in Northern Eurasia



# Building a Community Agenda: Identifying and Addressing Common Issues facing Agricultural Monitoring

- Timeliness in obtaining EO data (satellite and in-situ)
- Accessibility to international satellite data
- Continuity of satellite data for operational monitoring
- Robustness of methods for national, regional to global application – lack of field level validation data, absence of best practices for different cropping systems and regions
- Difficulty in transitioning research methods into operational use
- Need for capacity building and support to use EO data in many operational monitoring institutions - including new sensors
- Quality and timeliness of global/national agricultural data and statistics
- Decline and privatization of in-situ weather data
- Accuracy of seasonal forecast data
- In general a low investment in agricultural research and agricultural extension services

# GEOGLAM Actors

## GEOGLAM Community of Practice

Open Community made up of individuals from international and national agencies concerned with agricultural monitoring including Ministries of Ag, Space Agencies, Universities, & Industry

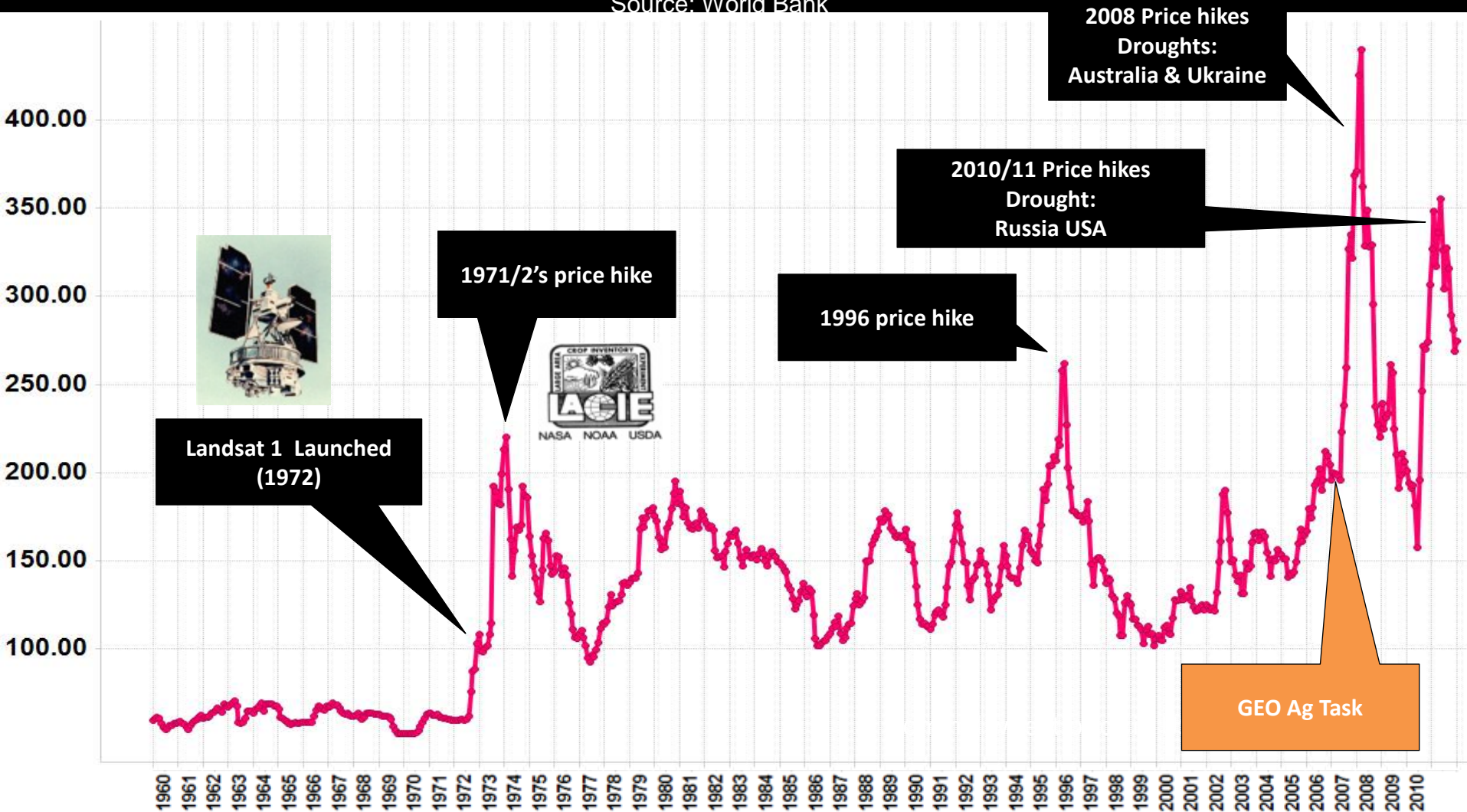




# Context For GEOGLAM

## Monthly Wheat Prices 1960-2011 (\$/Metric Ton)

Source: World Bank







International recognition of critical need for improved real-time, reliable, open information on global agricultural production prospects

Critical for agricultural policies, stabilizing markets, averting food crises and

Need to increase food production by 50%-70% by 2050 to meet demands (FAO)

# Policy Framework for GEOGLAM

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## 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.



# GEOGLAM: a GEO Initiative

- Vision: the use of coordinated, comprehensive and sustained Earth Observations to inform decisions and actions in agriculture... through a system of agricultural monitoring systems
- Aim: Strengthen the international community's capacity to utilize Earth Observations to produce and disseminate relevant information on agricultural production at national, regional and global scales
- Approach: Building on existing monitoring systems – strengthening international and national capacity
- Emphasis on: producer countries (G20+), countries-at-risk and national capacity building
- <http://www.earthobservations.org/geoglam.php>

# The GEOGLAM Components

## 1. Global / Regional Monitoring Systems


International/Global

## 2. National Monitoring Systems

National / Subnational

## 3. Monitoring Countries at Risk

Food Insecure and Most Vulnerable

4. EO Data Acquisition & Dissemination Coordination 

5. Research & Development toward Operations

6. Capacity Development for EO

## Improve market information and transparency



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[AMIS > About > AMIS Chair](#)

## The AMIS Chair

The AMIS Chair is elected by consensus among the AMIS participating countries and its term is of twelve months, covering two ordinary meetings of the Global Food Market Information Group and one of the Rapid Response Forum. The AMIS Chair does not follow the Chair of G20.

### List of AMIS Chairs




**United States of America (2015-2016)**  
 Robert Johansson, Chief Economist of the United States Department of Agriculture (USDA)



**United Kingdom (2014-2015)**  
 Ian Mitchell, Deputy Director for International Evidence and Analysis, DEFRA



**Australia (2013-2014)**  
 Karen Schneider, Executive Director of ABARES



**United States of America (2012-2013)**  
 Joe Glauber, Chief Economist of the United States Department of Agriculture (USDA)



**France (2011-2012)**  
 Eric Allain, General Director for Agriculture from the Ministry of Food, Agriculture, Fisheries, Rural Development and Territorial Planning

#### KEY DOCUMENTS

- AMIS Terms of Reference
- AMIS Rules of Procedure
- Process for electing the AMIS Chair
- Concept paper of the AMIS Rapid Response Forum
- Protocol for dealing with abnormal market conditions
- AMIS Multi-Donor Trust Fund

#### CONTACT US

**AMIS Secretariat**  
 Food and Agriculture Organization of the United Nations (FAO)  
 Viale delle Terme di Caracalla  
 00153 Rome, Italy

Tel: (+39) 06 570 52057  
 Fax: (+39) 06 570 53152  
 Email: [AMIS-Secretariat@fao.org](mailto:AMIS-Secretariat@fao.org)

[Contact us](#)

© AMIS 2015

inter-Agency Platform to enhance food market transparency and encourage coordination of policy action in response to market uncertainty [www.amisoutlook.org](http://www.amisoutlook.org)



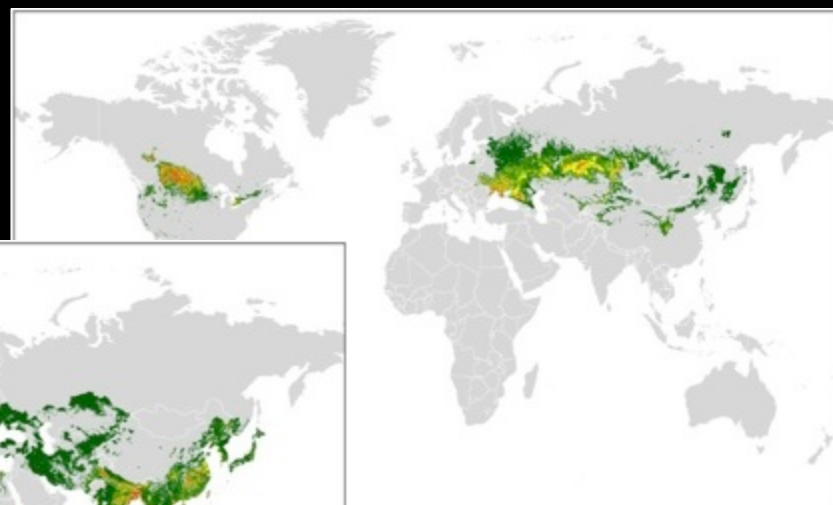
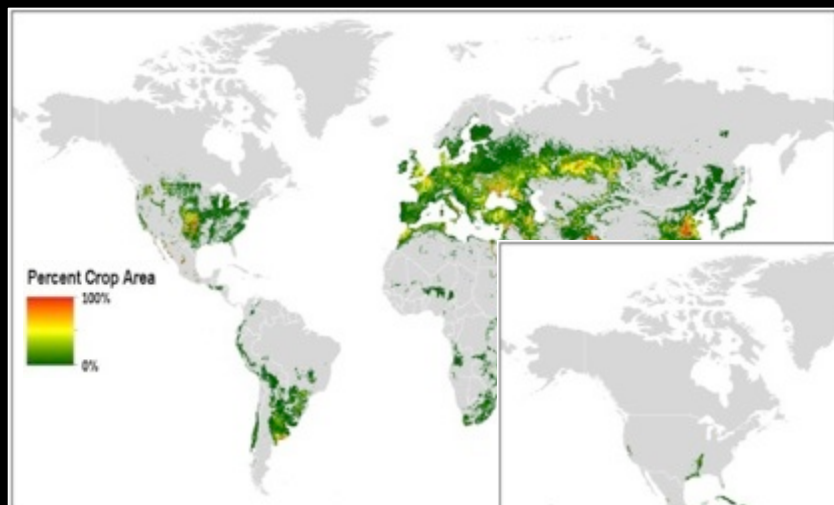
# GEOGLAM Crop Monitor for AMIS

- AMIS requested GEOGLAM to generate a monthly international consensus of crop conditions, from the various international/national monitoring systems
- Four major crops: wheat, maize, soybean, rice (9 total seasons)
- Focus: stabilizing/calming markets, avoid unexpected food price shocks
- <http://www.geoglam-crop-monitor.org>
- Consensus process, interface, submissions, telecons
- Summary information only

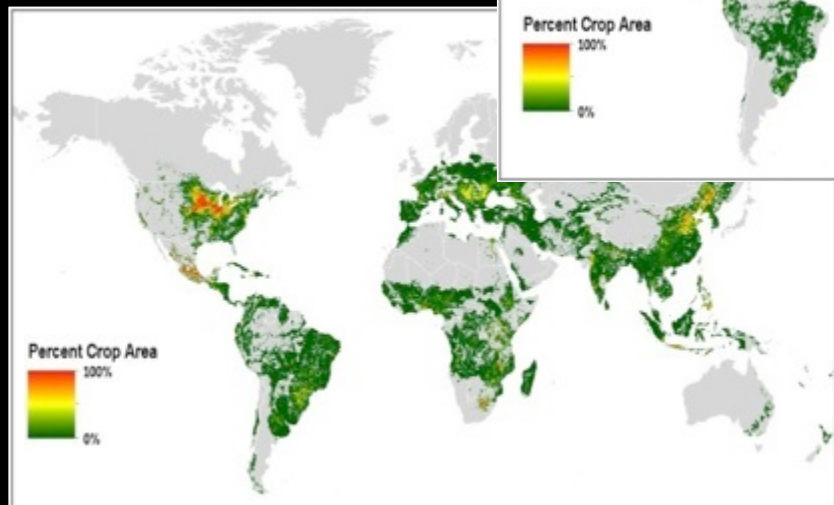
A world map illustrating the global distribution of the genus *Echinococcus*. The map uses three color codes: solid blue for countries where the genus is present, solid grey for countries where it is absent, and diagonal hatching for countries where its presence is uncertain. The distribution is highly concentrated in the Northern Hemisphere, particularly in North America (including Alaska and Canada), Europe, and across most of Russia and Northern Asia. In South America, Brazil and Argentina are shown in blue, while Chile and Peru are grey. In Africa, several countries in the north and south are hatched, while the rest are grey. In Asia, most countries are blue, with some hatched areas in Central Asia and the Indian subcontinent. Australia and New Zealand are blue, while Antarctica is grey.

# GEOGLAM Best Available Multi-Season Crop Masks

**Winter Wheat** 20 contributors and counting w. on going improvements **Spring Wheat**



**Maize**



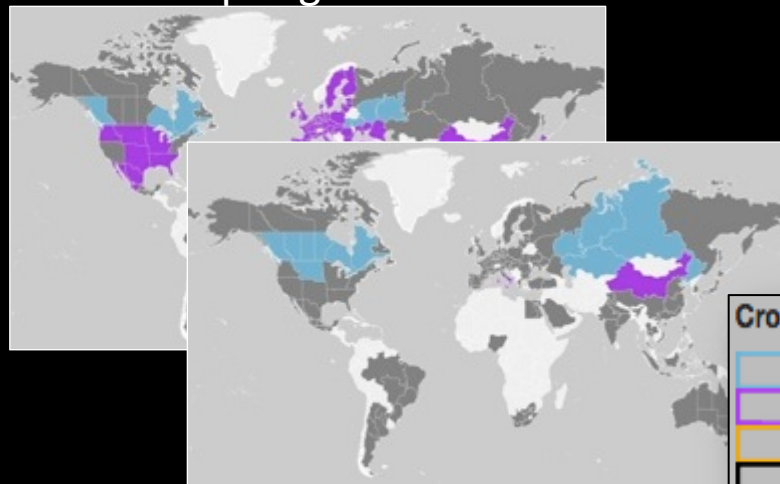
**Soybeans**



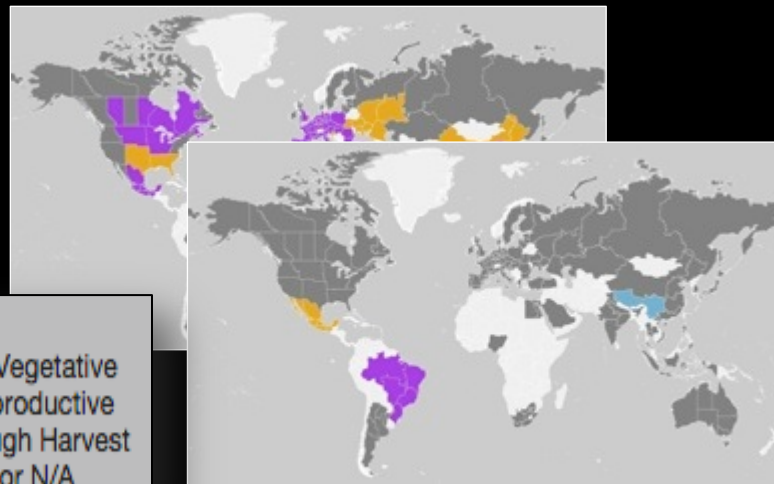


# Best Available Multi-Season Crop Calendars

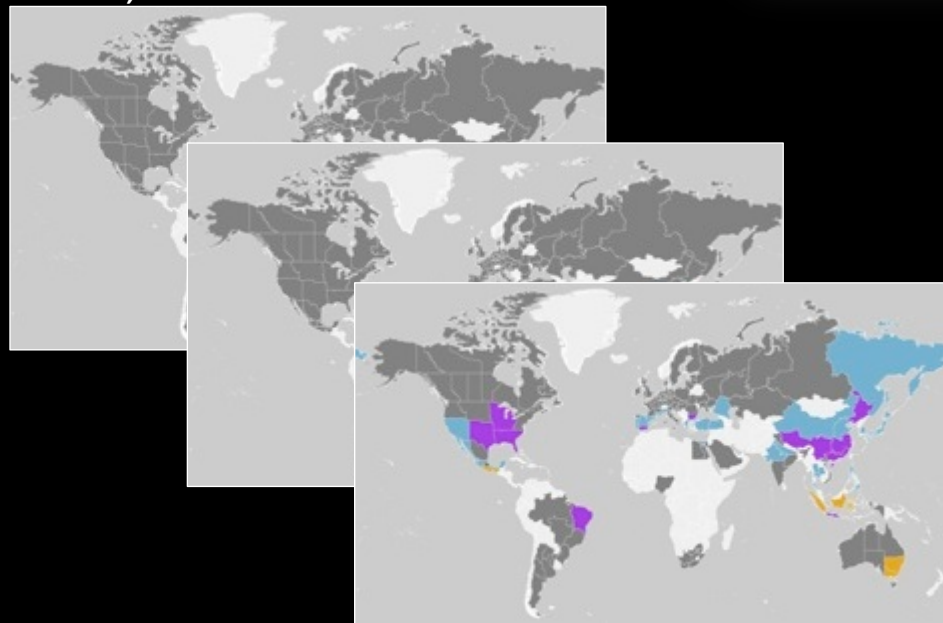
Winter & Spring Wheat



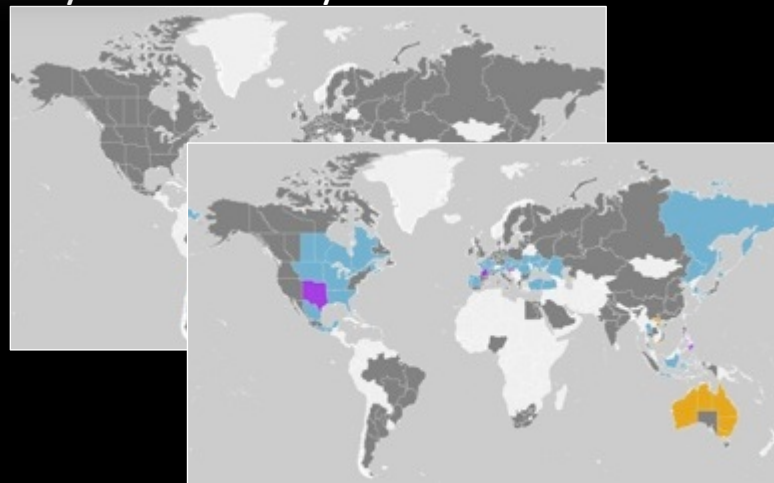
Maize 1 & Maize 2



Rice 1, Rice 2 & Rice 3

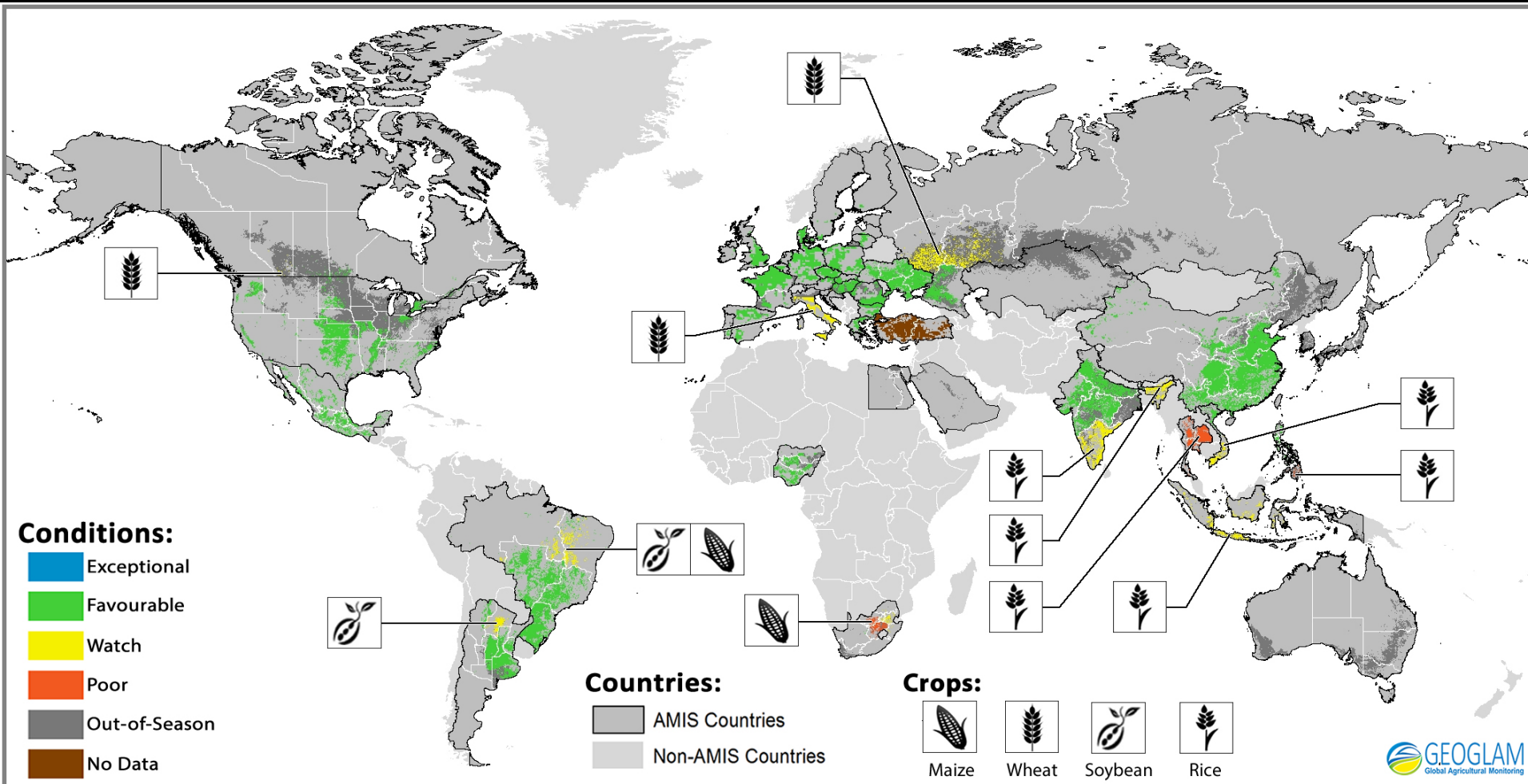


Soybean 1 & Soybean 2



Calendars reflecting multiple cycles of the same crop

# Crop Monitor : an international consensus assessment - March 28<sup>th</sup>



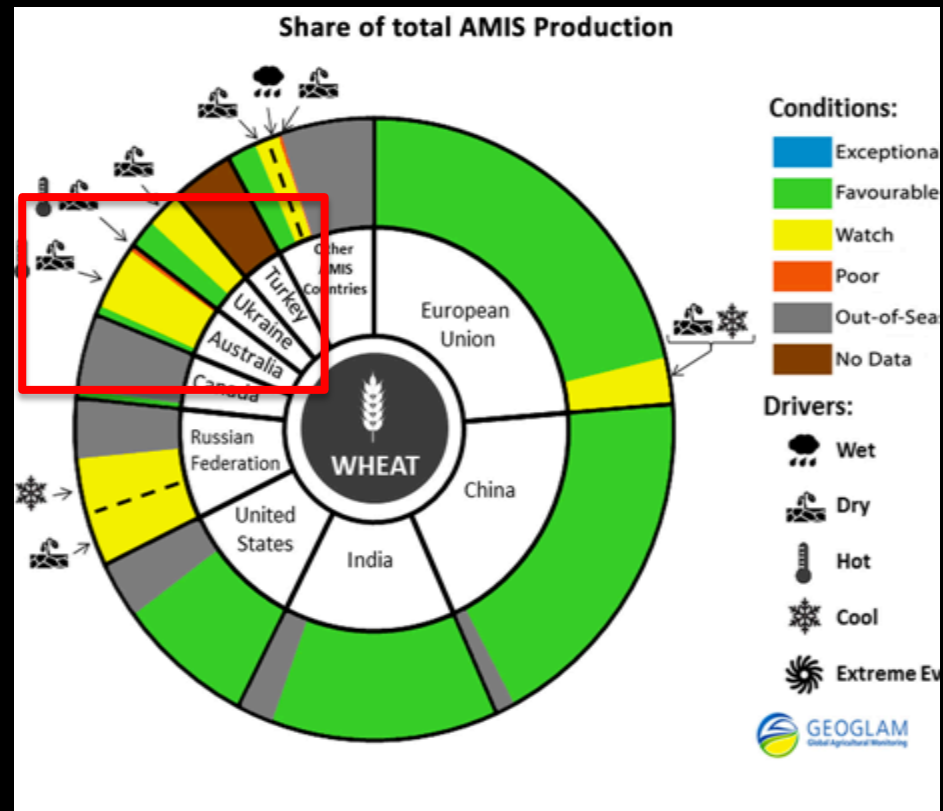
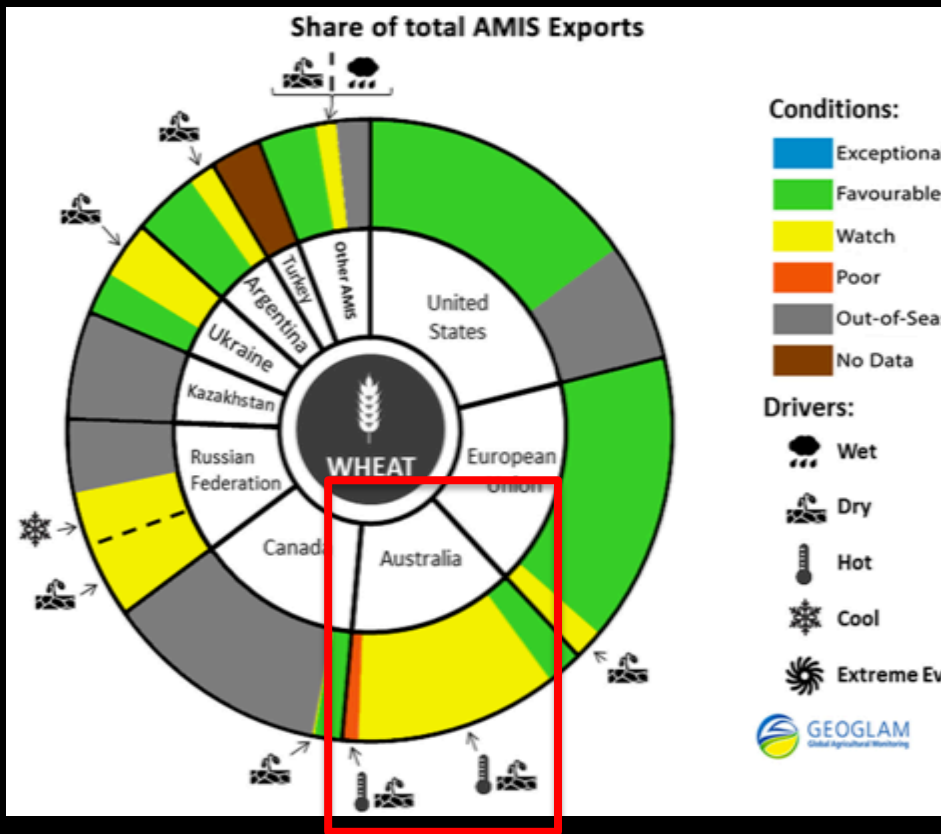
Crop condition map synthesizing information for all four AMIS crops. **Crops that are in other than favorable conditions are displayed on the map with their crop symbol.**

(Cropland area shown is an aggregation of all cropland areas)

# Wheat Production and Exports Pie Charts

As Share of total AMIS Exports

As Share of total AMIS Production

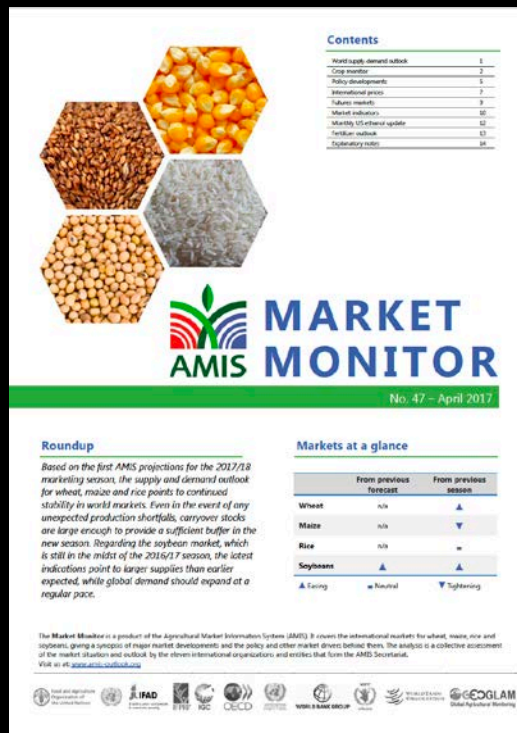


Crop Conditions as of October 28<sup>th</sup>, 2015



# 2011 Action Plan on Food Price Volatility and Agriculture

## AMIS – Markets/Stocks



## GEOGLAM – Condition/Supply



# GEOGLAM AMIS Crop Monitor Partners



> 35 Partners and Growing

# Next Steps for GEOGLAM /AMIS collaboration

- Develop more quantitative indicators of crop growing condition and production
- Broaden national and sub-national (state) participation in the Crop Monitor providing monthly updates on crop condition
- Strengthen linkages between the EO-based ag monitoring community and the AMIS community at the national level



# The GEOGLAM Components

## 1. Global / Regional Monitoring Systems

International/Global

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National / Subnational

## 3. Monitoring Countries at Risk

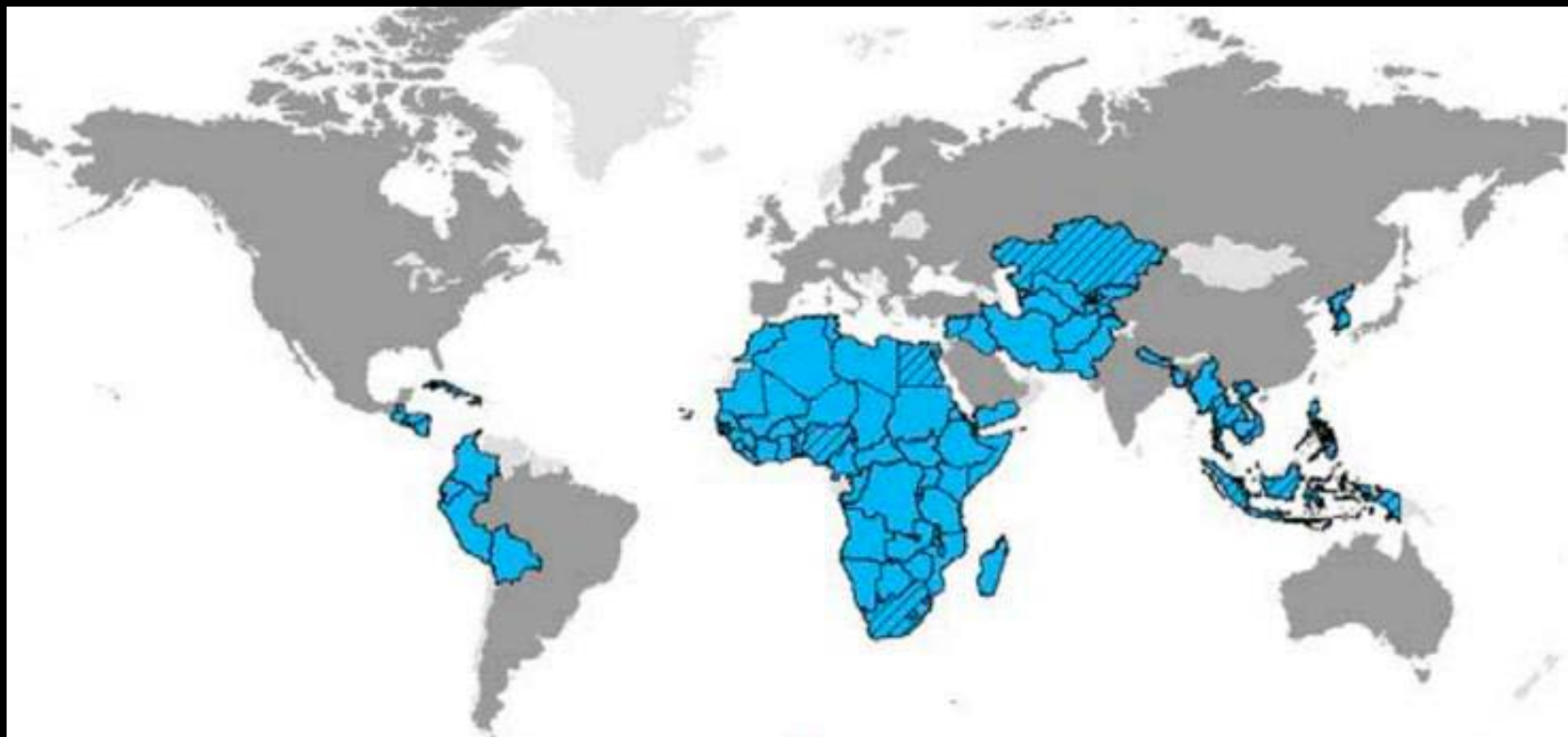
Food Insecure and Most  
Vulnerable

4. EO Data Acquisition & Dissemination Coordination 

5. Research & Development toward Operations

6. Capacity Development for EO

# Early Warning Crop Monitor Countries



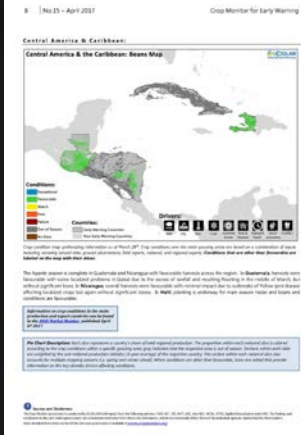
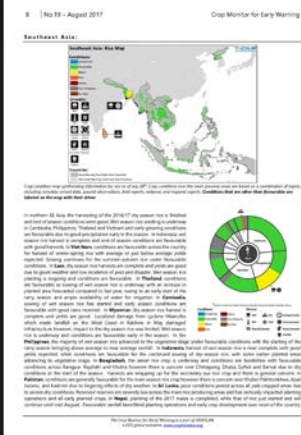
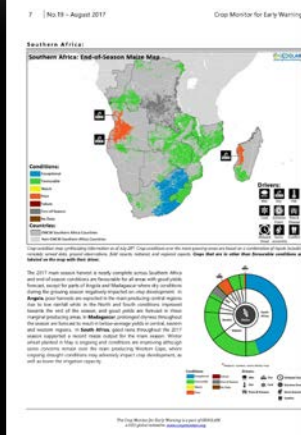
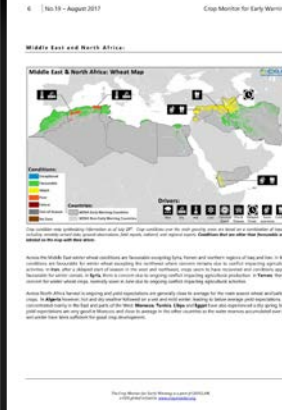
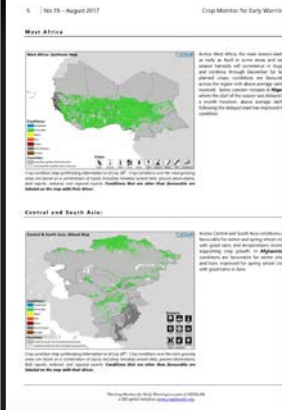
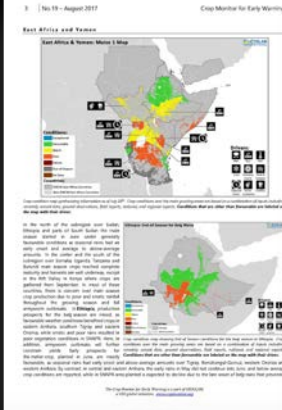
# Crop Monitor for Early Warning Bulletin

[www.cropmonitor.org](http://www.cropmonitor.org)

## CROP MONITOR FOR EARLY WARNING

**NO. 19**  
August 2017

The Crop Monitor for Early Warning brings together international, regional, and national organizations monitoring crop conditions within countries at risk of food insecurity. The focus is on developing timely consensus assessments of crop conditions, recognizing that reaching a consensus will help to strengthen confidence in decision making. The Early Warning Crop Monitor grew out of a successful collaborative relationship, the AMIS Crop Monitor (www.amis-outlook.org), which monitors the main producing countries.







# Crop Condition Reporting Interface



Dashboard

Map

CMET

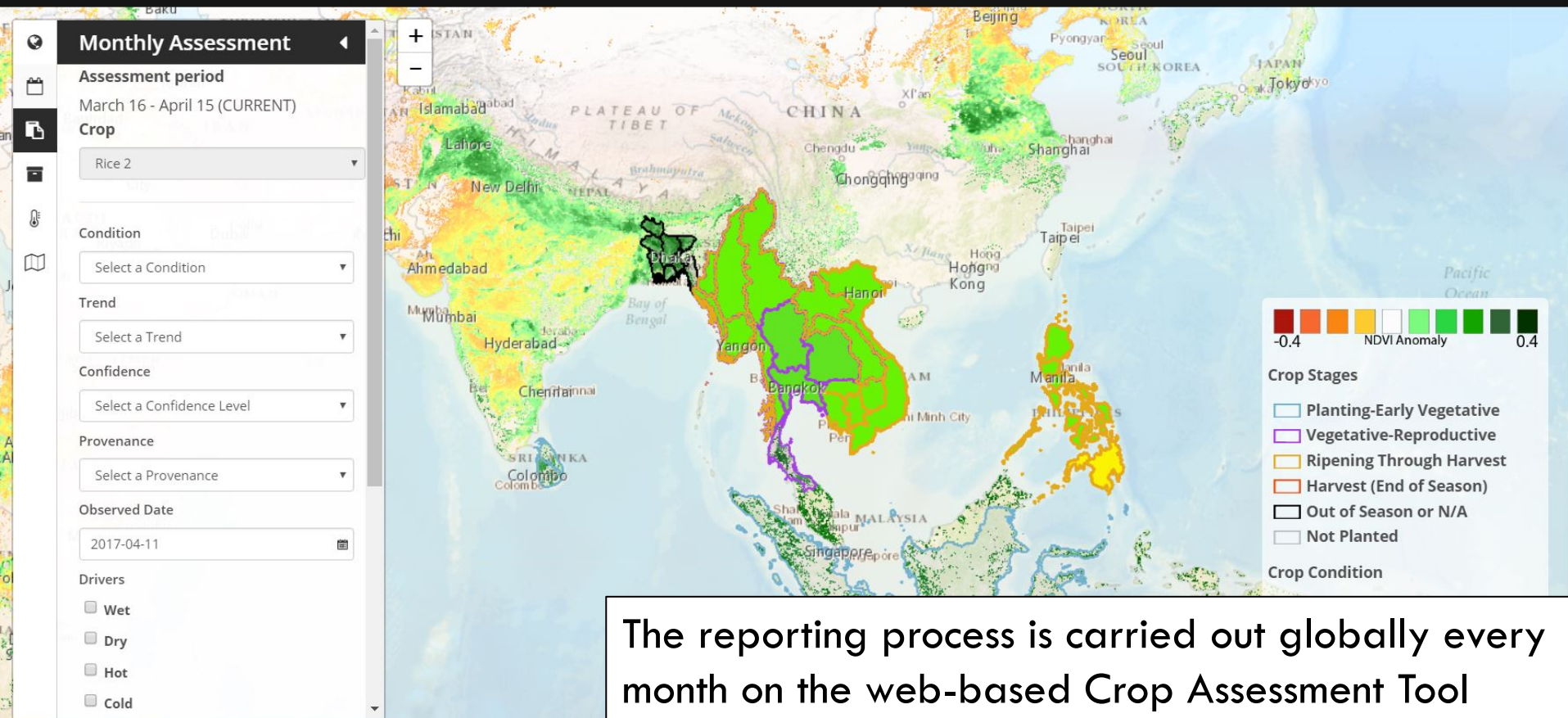
Monthly Assessment

Archive

Settings

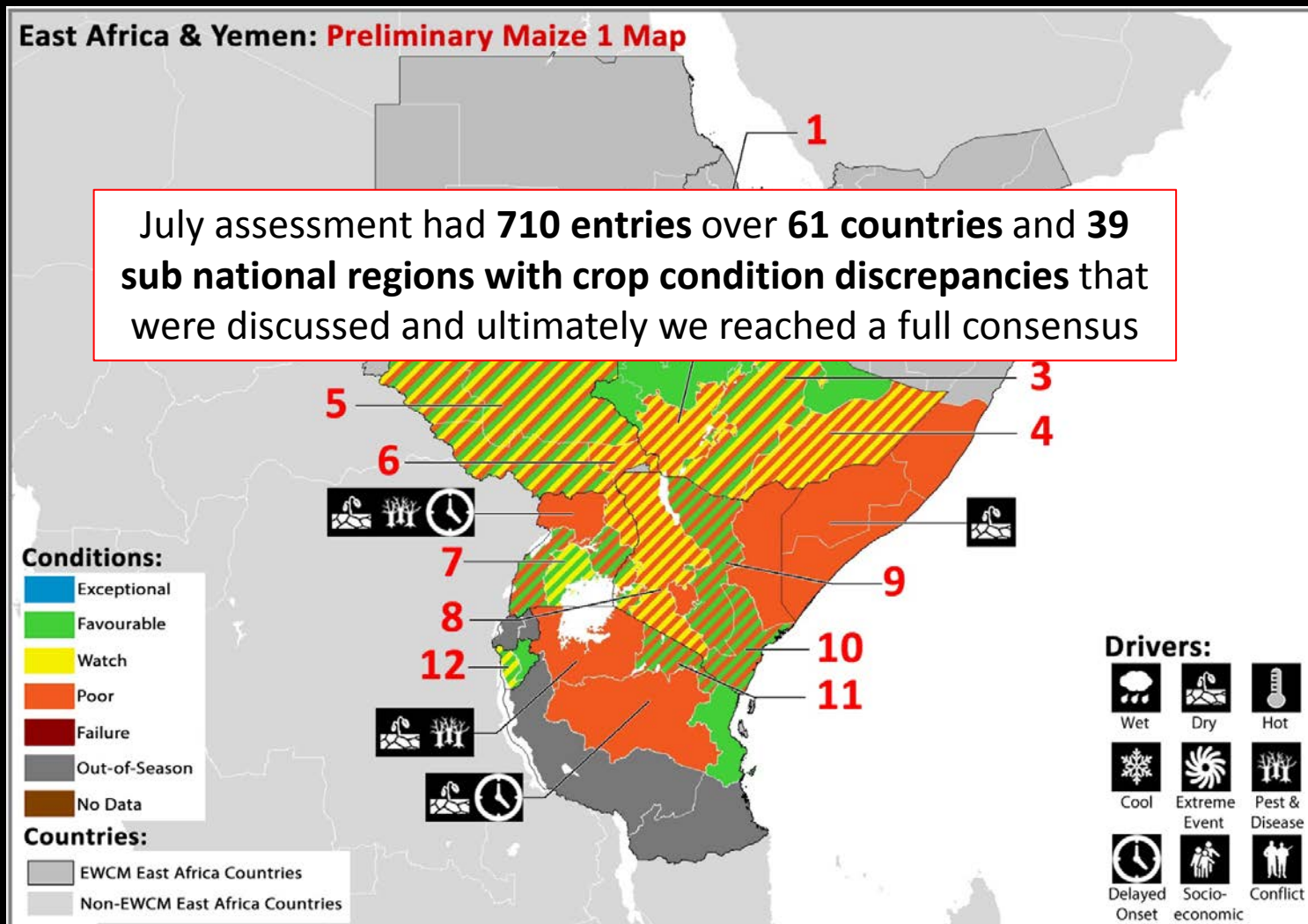
Admin

Logout



# Example discrepancy map

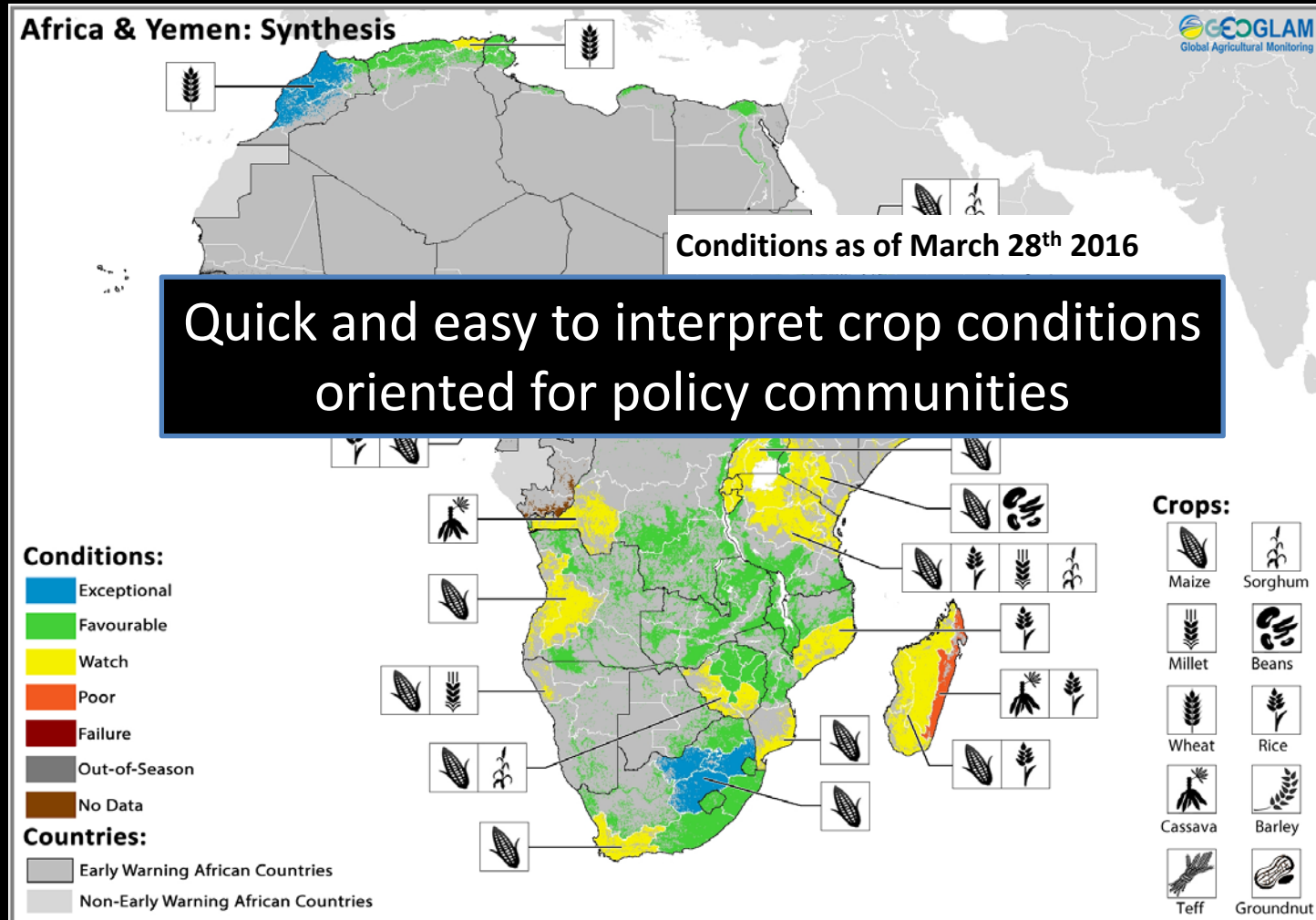
- Hashed areas show conflicting crop condition entries from different agencies



# Map Products

## Crop specific & regional synthesis map

- Synthesis maps provide an overview of regional conditions
- Crop specific maps convey the drivers behind those conditions





Business / Land & Agriculture

## Dry and brown Southern Africa will need food aid

BY EMIKO TERAZONO AND ANDREW ENGLAND, FEBRUARY 15 2016, 05:52

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### Zimbabwe: WFP Extends Food Aid to 2017

Tagged: Food and Agriculture • Aid and Assistance • External Relations • International Organisations • Southern Africa • Zimbabwe

programme (WFP) yesterday for the first time ever – not

## Vegetation Status and Crop Production Perspectives



**WFP VAM Report**

### Southern Africa Growing Season 2015-2016: A Season of Regional Drought

Left: NDVI in late February 2016, on a percentage of a 12-year average. Orange shades indicate below-average vegetation; green shades indicate above-average vegetation. Right: Maize production perspectives from a multi-agency assessment (20160204a).

spread drought. A joint assessment of crop production perspectives carried out by WFP and VAM confirms a very pessimistic picture across most of the region: the situation is mainly poor production in the rest of the country. Similar outcomes extend to the Malawi can also expect crop failures in its southern regions. Only regions such as northern Mozambique, Tanzania, northern Malawi and parts of Angola face normal production scenarios, as they benefit from El Niño induced rainfall enhancements typical of East Africa.

South Africa's maize production estimates for this season have been revised downwards slightly in February, to about 7.2 million tons, 27 percent below last year's and 38 percent below the 5-year average. The USDA Foreign Agriculture Service is more pessimistic, estimating production at 6.5 million tons. Similar variations may be expected for Zimbabwe, possibly Mozambique and Malawi, with more moderate losses in Zambia.

**FEWS NET Special Report**

**FEWS NET**

### SOUTHERN AFRICA Special Report

Illustrating the extent and impact of drought

A severe drought, related to El Niño, is ongoing across the Southern Africa region. While April/May harvests will provide some relief, the report presents a series of maps which show the extent of the drought. This report presents a series of maps which show the extent of the drought, current and expected impacts on food security, crop and rangeland conditions, food prices, and current and expected impacts on food security.

## Monitoring the globe

WFP

programme (WFP) yesterday for the first time ever – not

**Already informing agricultural decisions**

**ARC, South Africa**

## Southern Africa

Friday 25 March 2016 09:40

ANA

**Financial Times**


## South African corn withers amid worst drought on record

Impact of extreme weather on food prices set to remain serious

Agricultural Commodities + Follow

## Food crisis

Thursday 24 March 2016 - 4:04pm



## GEO Announces Launch of Early Warning Crop Monitor: A New Tool to Fight Food Insecurity

White Paper: White Paper Awards to Hidden Gems in South African Software

The Group on Earth Observations announced the launch of the Early Warning Crop Monitor (EWCM), a new tool to fight food insecurity. The announcement was made during the GEO 2016 Executive Meeting held in Geneva on 8 & 9 March.



Developed by the GEO Global Agricultural Monitoring Initiative (GEOGLAM), initiated by the G-20 Agriculture Ministers, the Early Warning Crop Monitor (EWCM) provides continuous reports on crop conditions in countries at risk of food insecurity in Central and South America, Africa

## The Family (FEWSNET) insecurity and 2016-2017 drought

In a new special report, FEWSNET expected from April/May, the Early Warning Crop Monitor (EWCM) shows that, as of February 28, crop failure had been confirmed in Lesotho, Swaziland, southern Mozambique, southern Zimbabwe and eastern Botswana.

Crop conditions in western Malawi, northern Mozambique and southern Zimbabwe are also poor, with production expected to be significantly below average.

## Joint Statement

**El Niño Set to Have a Devastating Impact on Southern Africa's Harvests and Food Security**

WFP World Food Programme

FEWS NET

European Commission

Food and Agriculture Organization of the United Nations

2015-2016

ected in April/May, the GEOGLAM Early Warning Crop Monitor (EWCM) had shown that as of February 28, crop failure had been confirmed in Lesotho, Swaziland, southern Mozambique, southern Zimbabwe and eastern Botswana.

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Food Insecure and Most  
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**Crop Conditions**

**Legend:**

- Crop Conditions:**
  - Cereals (Green)
  - Oilseeds (Yellow)
  - Legumes (Blue)
  - Other (Red)
- Countries:**
  - Tanzania
  - Kenya
  - Malawi
  - Mozambique
  - Zambia
  - Botswana
  - Swaziland
  - South Africa
  - India
  - China
  - USA
  - UK
  - France
  - Germany
  - Italy
  - Spain
  - Portugal
  - Greece
  - France
  - Germany
  - Italy
  - Spain
  - Portugal
  - Greece

**Fig. 1 This crop condition map synthesizes information for all crops as of 31<sup>st</sup> July 2016. Crop conditions over the main growing areas are based on a combination of national and regional crop assessment inputs along with remote sensing data and rainfall data provided by the Tanzania Meteorological Agency.**

**MAIN HIGHLIGHTS**

- Currently, it is not of season therefore it is only cereals, found in the fields other crops have been harvested and farmers are busy selling and storing their produce.
- The 2015/16 Preliminary Food Crop Production Forecast amounts 16,172,841 tonnes grain equivalent of which 6,947,106 tonnes constitute cereals and 6,713,733 tonnes comprise non-cereals.
- Requirement for 2016/17 marketing year amounts 23,159,326 tonnes of which cereals make up 8,355,767 tonnes and non-cereals constitutes the rest, 4,803,540 tonnes.
- Based on these availability and requirement figures, a self sufficient status of 223% is attainable in terms of total food crops whereby cereals make up 123% and non-cereals make up 140%.
- In terms of geographic analysis, this is respectively, 2,013,516 tonnes surplus of total food, of where cereal is 1,901,341 tonnes and non-cereal is 1,912,174 tonnes.
- At national level the upper and self sufficiency is impressively evidenced by 11 regions will be definitely produce surplus, 12 regions will be definitely self-sufficient and 2 regions will be definitely deficit.
- Towards operational setting to curb food insecurity in the country vulnerable areas are well organized in 43 districts in 15 regions out of the current total of 26 regions

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**Y. BULLETIN TANZANIA JULY 2016**

**MODIS 16 day NDVI (Pwani Region)**

For July 2014, and 2015 (Fig.2), 2016 for Pwani Region as compared to 2014 and 2016 long term mean.

For July 2014, and 2015 (Fig.2), 2016 were average. However, in 2016, the situation was back in the same period, and the situation is even worse over Pwani below average beginning May years.

Y. all harvested except Cassava. Farmers needs and availability of seedling/shelling.

**Y. BULLETIN TANZANIA JULY 2016**

**Average Price (TZS/kg)**

Crop	Price (TZS/kg)
Maize	1,800
Sorghum	1,600
Millet	1,400
Cowpea	1,200
Beans	1,100
Sesame	1,300

ation with average price data for the 10 highest prices for rice ranging from set prices ranging from (964) to 1059 while Songea, Babati, Mpanda and rice were reported in Songea market (r). Tembe, Undi, Itala, Mwanza, 2/3 to 1,860/p kg while Babati, to 1,150/p per kg).

at grain equivalent of which 9,437,108 it for 2016/17 marketing year amounts constitute the rest, 4,803,560 Shilling % is available in terms of total food surplus analysis, this is respectively, 341 tonnes coexists with a non-cereal

**versus Requirement and Gap/Surplus**

Category	Requirement	Surplus
Cereals	9,407	9,437,108
	5,322	8,355,267
	9,115	1,101,341
Non-cereal	2,099	6,715,733
	5,325	6,803,560
	7,163	1,932,174
TOTAL	16,172,881	15,155,326

of maize flours (4) in Mwanera and light also affected Maize Rice and it was reported during March

**Y. BULLETIN TANZANIA JULY 2016**

**Percentage of Condition**

Crop	Percentage
Maize	60%
Sorghum	10%
Millet	10%
Cowpea	10%
Beans	10%
Sesame	10%

tion agents across the Morogoro Region a near normal season, 68% of pasture conditions as most of 2015 reporting above the average at

ditions as for July were below average for the southwestern of pasture conditions as most of

ern. The vegetation indicating pasture conditions Morogoro and the north east region.

pests, disease, drought, and floods in February. Water logging resulting in the maize borer was the major reason for low yields. It was another factor identified by farmers involved in the data collection sets, and lowered grain quality from

**U – NIEWS**  
The Official Government of Uganda Inter- Ministerial Agencies  
Monthly National Integrated Multi-Hazard Early Warning Bulletin

**15<sup>th</sup> NOVEMBER to 15<sup>th</sup> DECEMBER 2016**

Vol. 01 Series No. 01 Issue No. 01

**FOOD INSECURITY – CROP & PASTURE CONDITIONS OF UGANDA**

**Crop and Pasture Conditions 2/11/2016**

**Key to crop condition map**

- Exceptional:** Conditions are much better than average time of reporting.
- Poor:** Conditions range from slightly below to slightly above average. Conditions are not far from average, but there is a potential risk to production.
- Poor:** Conditions are well below average. Crop yield are likely to be 10 and more below the average.

**Districts:**

- Poor
- No Data
- Pasture

**Conditions:**

- Exceptional
- Poor
- No Data
- Pasture

**Source:** [www.ugandaCropMonitor.gov Uganda](http://www.ugandaCropMonitor.gov Uganda) \*The crop condition map synthesizes information for all crops as of 2/11/2016. 2016. Crop conditions over the main growing areas are based on a combination of national and regional crop analysis inputs along with remote sensing and rainfall data.

**Early Warning by Region:**

- Adhisi:** Most of Adhisi under watch conditions except Pader where crop conditions are poor and worsening due to dry weather.
- Central Hill, East Central:** Poor watch conditions are prominent in the regions due to poor conditions affecting growth at the beginning of the growing season.
- North:** Conditions were reported from most of Elgon, Gulluuli, Sorok and Bududu where conditions are under watch and improving.
- Karamoja:** Most areas are out of season for most crop but pasture conditions are generally poor.
- Large:** Mostly under poor conditions due to dry weather in the beginning of the growing season.
- South western:** Under watch conditions all districts, except Buwisi, Bushenyi and Mitooma which are poor from dry weather and flood which is localised.
- West:** Conditions are poor in Teso, except in the North west districts of Arua and Katakwi which are under favorable and watch respectively.
- West Nile:** Crops are under watch but improving due to intermittent rains during early October. Kumbo district has been receiving and estimate 2,000 people of concern from South Sudan since July 2016. The dramatic increase of population in Kumbo area has implications on food security.

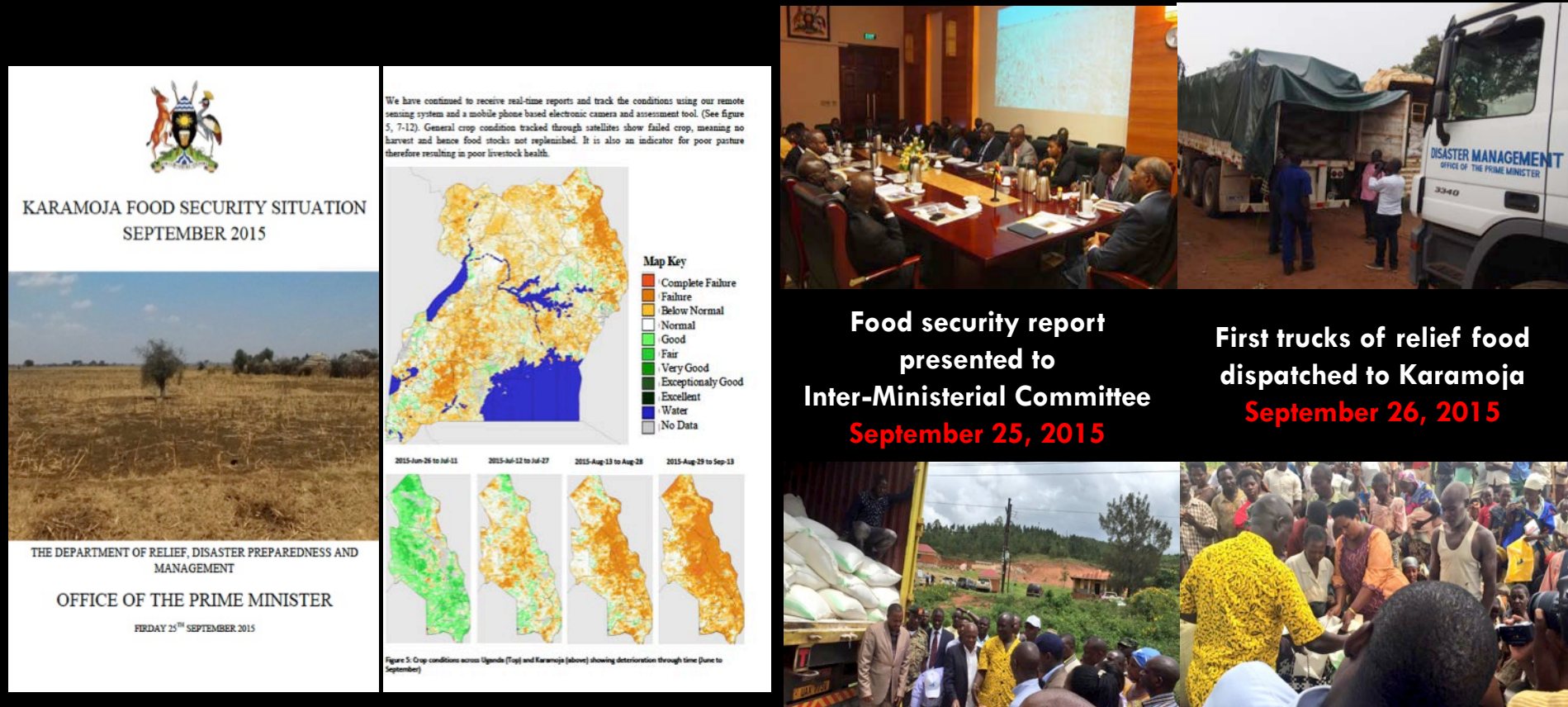
*The Inter-Ministerial/Agencies Monthly National  
Integrated Multi-Hazard Early Warning Bulletin,  
published by the Uganda Office of the Prime Minister*



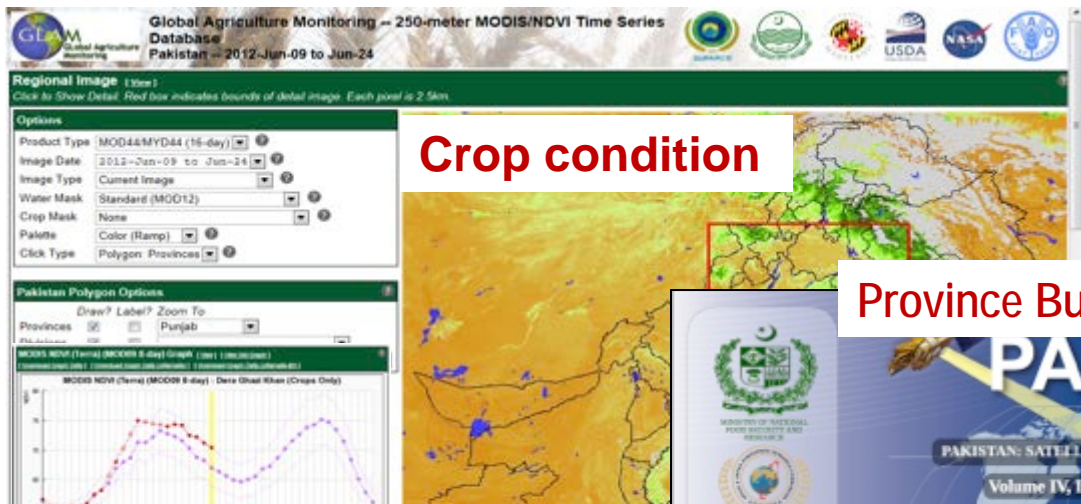
# Informing Decisions in Uganda: September 2015

“Karamoja Food Security Situation” report used to justify mobilization of food aid in the Karamoja region.

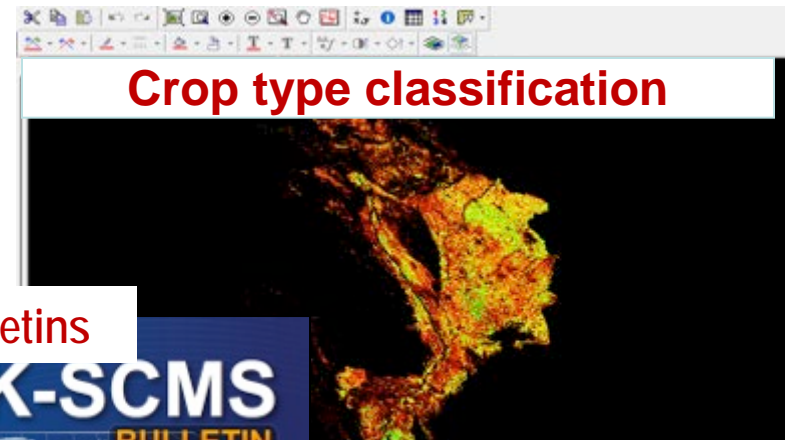
Report applied remote sensing for timely, accurate, actionable in-season monitoring of crop conditions.



# Example : Pakistan Agricultural Information System (Collaboration among CRS, USDA, FAO, SUPARCO & UMD)

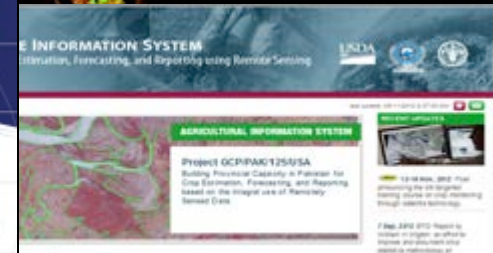


**Crop condition**



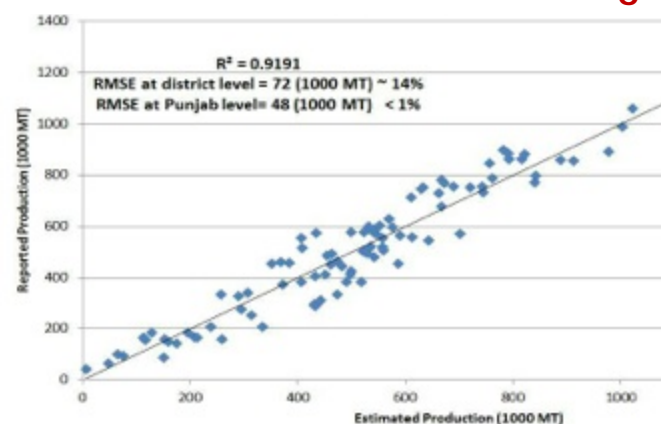
**Crop type classification**

**Province Bulletins**



**Project information**

**EO Wheat Production Forecasting**

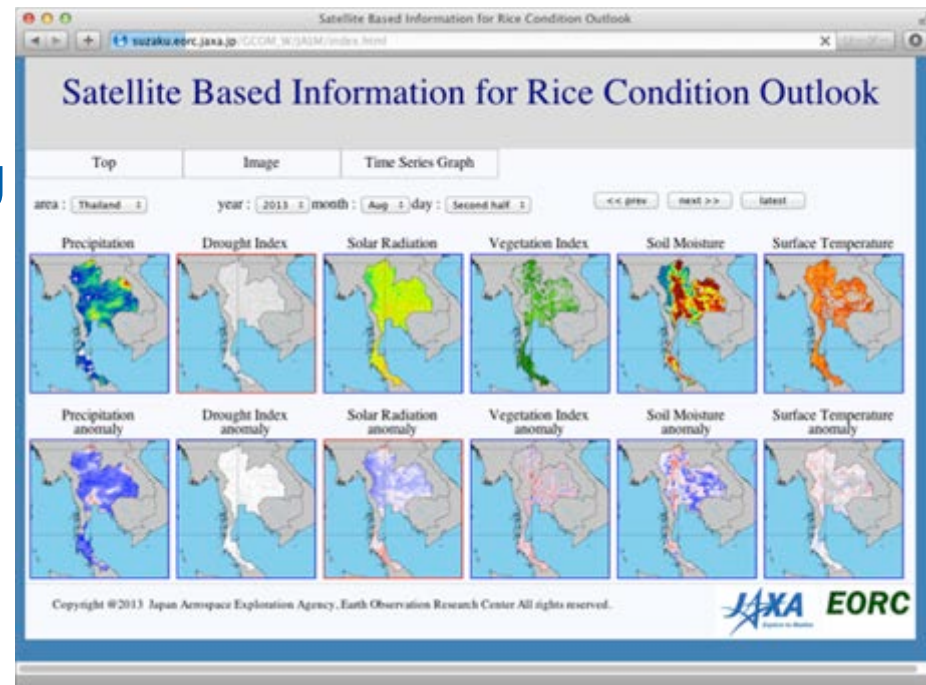






# Asia-RiCE Regional Monitoring

- A multi-national project led by Japan (JAXA), with collaborations in ASEAN+3 countries and India
- A regional view using agro-meteorological data derived from low resolution optical satellite imagery (MODIS, GCOM-W, TRMM and others)
- A local view to estimate rice crop area and production using available radar and other satellite data with ground observation data and statistical information (test-sites in Indonesia, Thailand and Vietnam)

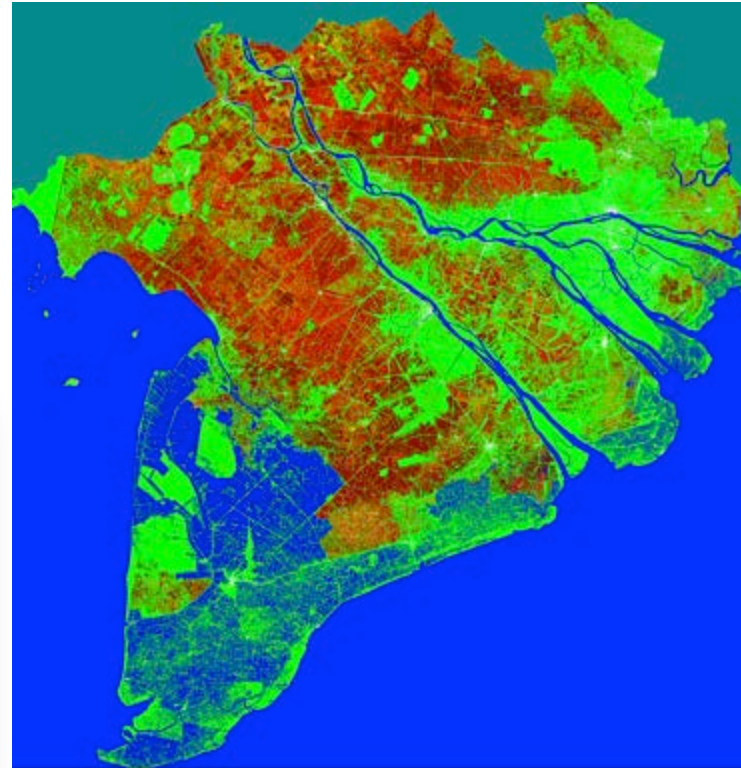
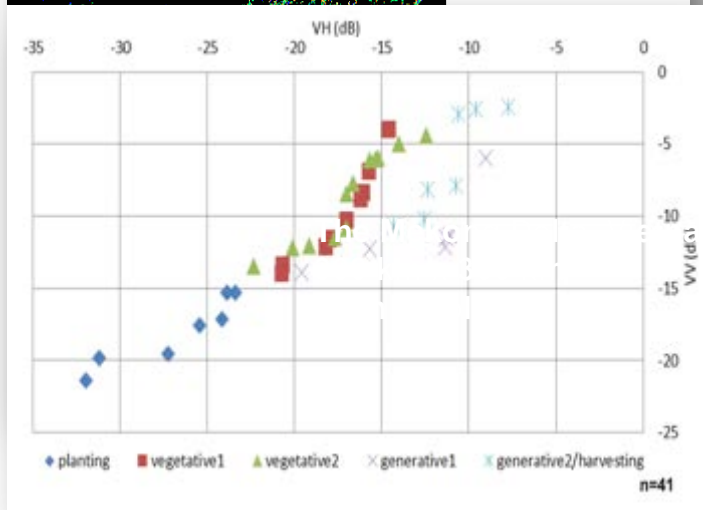
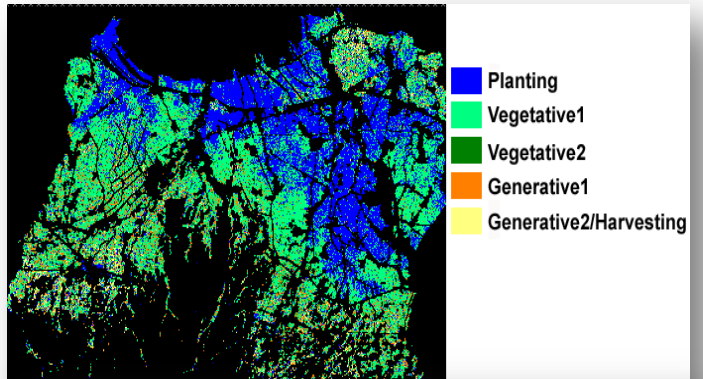


<http://www.asia-rice.org>



# Vietnam Rice Crop Area Estimates/Maps

Setinel-1a rice crop monitoring in Vietnam



**Rice Phenological Stages Classification using  
Radarsat-2 Data (VH\_VV)  
29 July 2014 (Subang Area, West Java) by MOA,  
LAPAN with JAXA**

- Rice: early stage
- Rice: tillering stage
- Rice: reproductive stage
- Rice: maturity stage
- Non rice (forest, other LULC)
- Water (ocean, river, aquaculture)
- Land outside the Vietnam Mekong delta

# The GEOGLAM Components

## 1. Global / Regional Monitoring Systems

International/Global

## 2. National Monitoring Systems

National / Subnational

## 3. Monitoring Countries at Risk

Food Insecure and Most  
Vulnerable

4. EO Data Acquisition & Dissemination Coordination 

5. Research & Development toward Operations

6. Capacity Development for EO

# Developing the EO Data Requirements for GEOGLAM: through a CEOS/GEOGLAM Ad Hoc Working Group

## Goals of the EO Data Coordination Component.

- Articulate data requirements for agricultural monitoring
- Coordinate international satellite acquisition over agricultural areas during the growing season
- Promote near-real time data availability
- Increase the frequency of moderate resolution data
- Standardize processing of data, facilitating data interoperability
- Promote easy data access for operational users
- Advocate for continuity of critical data streams/products

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

No one system can meet agricultural monitoring needs



# GEOGLAM CEOS: 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 APPLICATIONS							
	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 3P (future), CMA FY series?, Proba-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. (K,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. (K,C,L) ****	5 per season weekly	main crops	s	L/M/S	rice area		high cloud cov.	NRT products (SS/PS)*		x	x	x	x	x	
FUTURE	Footprint 50-200m	RADAR Altimetry	daily 7	main crops	s	L/M/S		entire growing season		NRT products (PS)			x		x		
ETM+ (Landsat-7), ASTER (Terra), TIRS(LDCM), IRMSD (CBERS-3)	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					
All Optical Mid-Resolution (Landsat, Terra, EO-1, Resourcesat-2, CBERS-3, Sentinel-2)	20-70m	optical+SWIR	1 per week (min. 1 per 2 weeks)	main crops	s	country specific (see phasing) L/M/S		entire growing season		NRT products (PS)	L/M/S	M/S	x	x	x	x	
HRG (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					
HRG (SPOT-5), Rapid Eye (optical)	5-10 m	optical (+SWIR)***	1 per week (min. 1 per 2 weeks)	main crops	rs2	country specific (see phasing) S		entire growing season		NRT products (PS)			x	x	x	x	
HRG (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?

GEOGLAM data plan submitted to the CEOS plenary in 2013



## Access Summary

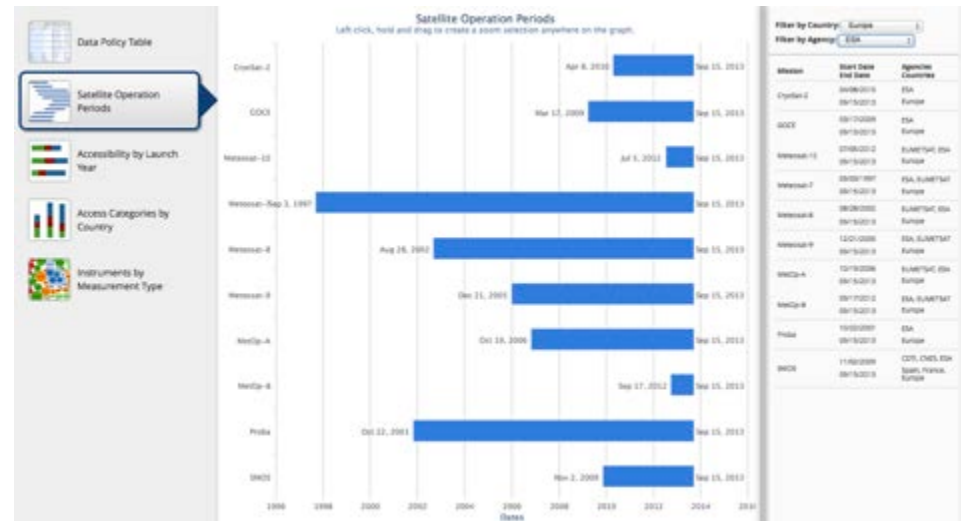
- ❑ Open (no registration) = 36%
- ❑ Open (simple registration) = 21%
- ❑ Open (advanced approval) = 5%
- ❑ Restricted = 33%
- ❑ Unknown = 5%

## Comments

- ❑ This summary includes **205 missions** launched since 1990 and 615 mission-instrument combinations.
- ❑ **62%** of CEOS mission data is OPEN and accessible.

**Are the data acquired for Ag areas during the growing season ?**

**Are they easily accessible ?**


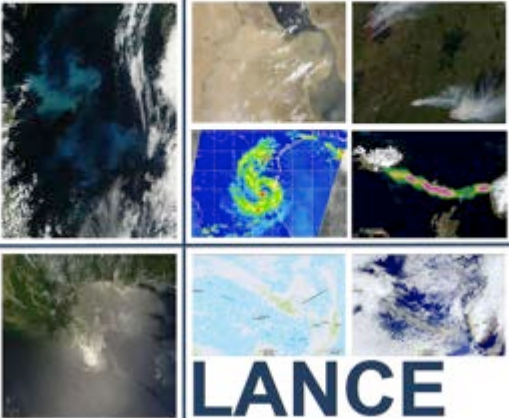


# Requirement for Near Real Time Data for Agricultural Monitoring

## Timely data are critical for crop monitoring

- NASA EOS near-real-time daily observations are processed and provided < 3 hours from observation
- VIIRS now available

National Aeronautics and Space Administration

**LANCE**

**AIRS AMSR-E MLS MODIS OMI**

Near-real-time data for applications, disaster response and field campaigns

- ✓ Products within 3 hours of observation
- ✓ Highly available processing and distribution system
- ✓ Products based on science algorithms

**lance.nasa.gov**



Real-time Capability for EOS

**EARTHDATA**  
Powered by EOSDIS

ABOUT DATA COMMUNITY RESOURCES

Search datasets, news, articles, and information

Earth Observation Data • **LANCE: NASA Near Real-Time Data and Imagery** • Near Real-Time VIIRS Products Now Available through LANCE

**Data**  
Disciplines:  

**Related Content**

- Grand Canyon, AZ
- Visible Infrared Imaging Radiometer Suite (VIIRS)
- User Profile: Dr. Christian Kummerow
- Bushfires in Tasmania
- MCD14DL

**Near Real-Time VIIRS Products Now Available through LANCE**

VIIRS I-band (375 m) Active Fire and Corrected Reflectance products are the newest near real-time products available through LANCE.

News Date: 2/10/2016

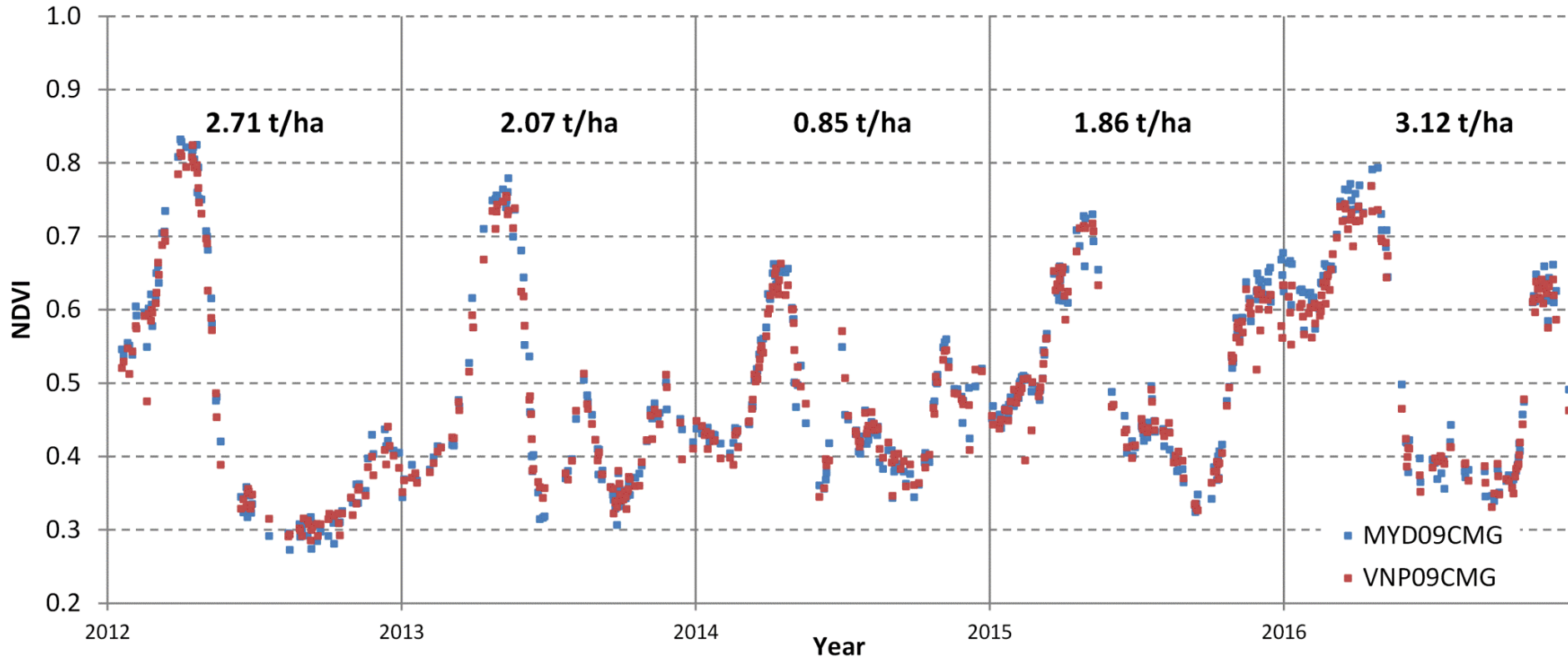
Josh Blumenfeld, EOSDIS Science Writer

Knowing where fires are occurring when they are occurring—especially in remote and hard to reach areas—is one of the many benefits provided by NASA's fleet of Earth observing satellites. Through the Earth Observing System Data and Information System (EOSDIS) Land, Atmosphere Near real-time Capability for EOS (LANCE), those concerned with managing, forecasting, and coping with wildfires have a new near real-time fire management data product to add to their tool box: the Active Fire product from the Visible Infrared Imaging Radiometer Suite (VIIRS).





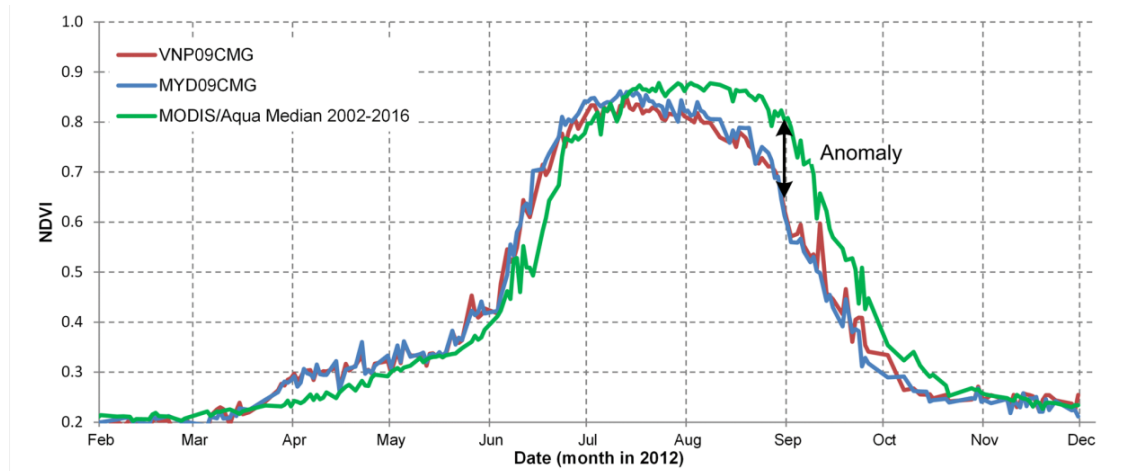
## Transitioning from VIIRS to MODIS: Agricultural applications



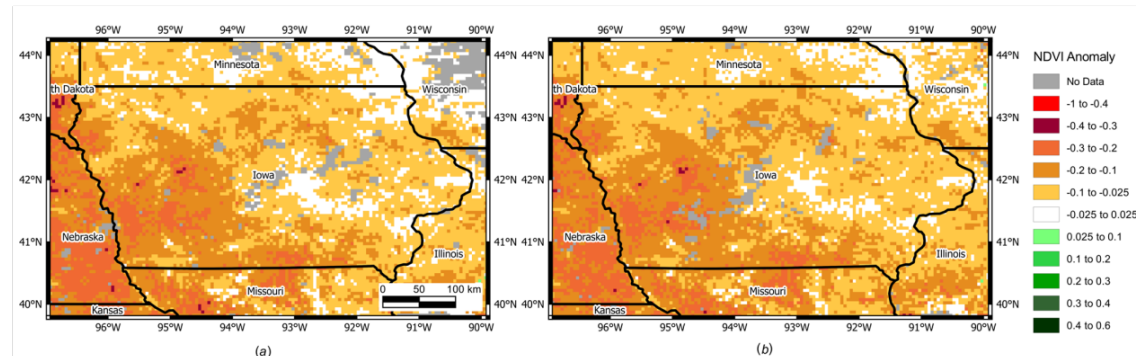
A time series of NDVI values derived from MODIS/Aqua (MYD09CMG) and VIIRS/SNPP (VNP09CMG) daily products at 0.05° resolution for Harper County, Kansas, USA. Shown also are final winter wheat yields derived from USDA NASS statistics. The figure shows that the yield values co-vary with the maximum NDVI values from each season.

**MODIS** and **VIIRS NDVI** data can be **used interchangeably** for applications with an **uncertainty of less than 0.02 to 0.05** (NDVI units), depending on the scale of spatial aggregation, which is typically the uncertainty of the individual dataset.

# Transitioning from VIIRS to MODIS: Agricultural applications



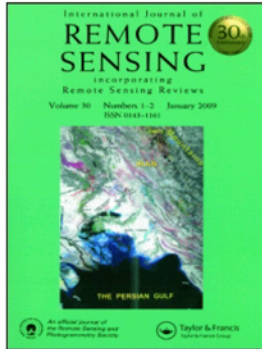
Corn growth dynamics derived from MODIS/Aqua and VIIRS in 2012 in Iowa (US) compared to the median NDVI values for 2002–2016 derived from MODIS/Aqua. Due to a drought, corn growth started to decrease significantly from June which resulted in a 25% yield reduction.



NDVI anomalies at  $0.05^\circ$  spatial resolution for the state of Iowa (US) derived from MODIS/Aqua (a), and adjusted VIIRS (b) data on August 21, 2012. Anomalies were computed by subtracting NDVI values from the median NDVI values for 2002–2016 derived from MODIS/Aqua.

There is a good both **temporal** and **spatial consistency** between MODIS and VIIRS derived surface reflectance and NDVI products.

# Transitioning from MODIS to VIIRS



## International Journal of Remote Sensing



ISSN: 0143-1161 (Print) 1366-5901 (Online) Journal homepage: <http://www.tandfonline.com/loi/tres20>

## Transitioning from MODIS to VIIRS: an analysis of inter-consistency of NDVI data sets for agricultural monitoring

Sergii Skakun, Christopher O. Justice, Eric Vermote & Jean-Claude Roger

To cite this article: Sergii Skakun, Christopher O. Justice, Eric Vermote & Jean-Claude Roger (2018) Transitioning from MODIS to VIIRS: an analysis of inter-consistency of NDVI data sets for agricultural monitoring, International Journal of Remote Sensing, 39:4, 971-992, DOI: [10.1080/01431161.2017.1395970](https://doi.org/10.1080/01431161.2017.1395970)

To link to this article: <http://dx.doi.org/10.1080/01431161.2017.1395970>



# Sentinel contribution to JECAM & GEOGLAM

## Primary missions for all targets Products



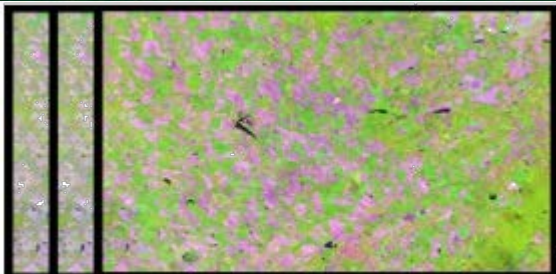
						Target Products						
Req#	Spatial Resolution	Spectral Range	Effective observ. frequency (cloud free)*	Sample Type	Field Size	Crop Mask	Crop Type Area and Growing Calendar	Crop Condition Indicators	Crop Yield	Crop Biophysical Variables	Environ. Variables	Ag Practices / Cropping Systems
Coarse Resolution Sampling (>100m)												
1	500 - 2000 m	thermal IR + optical	Daily	Wall-to-Wall	All			X				
2	100-500 m	optical + SWIR	2 to 5 per week	Cropland Extent	All	X	X	X	L	L		L
3	5-50 km	microwave	Daily	Cropland Extent	All			X	X		X	
Moderate Resolution Sampling (10 to 100m)												
4	10-70m	optical + SWIR + TIR	Monthly (min 2 out of season + 3 in season). Required every 1-3 years.	Cropland Extent	All	X	L/M					X
5	10-70m	optical + SWIR + TIR	Weekly (min. 1 per 16 days)	Sample	All	X	X	X	X	X	X	X
6	10-100m	SAR	Weekly (min. 1 per 2 weeks)	Cropland Extent of persistant cloudy areas/Rice	All	X	X	X	X	X	X	X

# Toolbox for 4 S2-based products in line with the GEOGLAM core products



Monthly cloud free surface reflectance composite at 10-20m

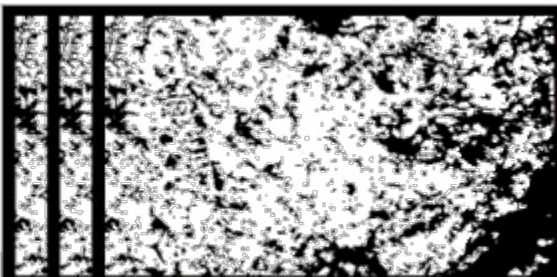
CLOUD FREE SURFACE REFLECTANCE COMPOSITES



Growing season  
(monthly updates)

Vegetation status map at 20m delivered every 10 days (NDVI, LAI, pheno index)

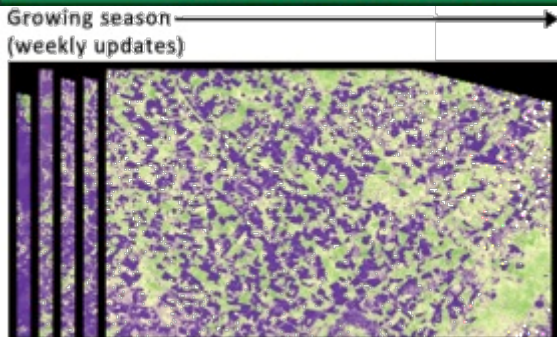
DYNAMIC CROPLAND MASK



Growing season  
(monthly updates)

Open source toolbox  
Capacity building and training

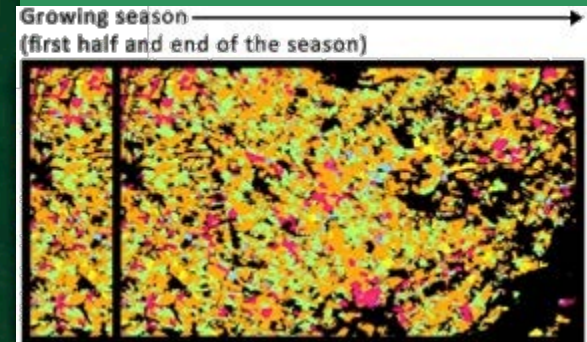
VEGETATION STATUS



Growing season  
(weekly updates)

Binary map identifying annually cultivated land at 10m updated every month

CULTIVATED CROP TYPE MAP



Growing season  
(first half and end of the season)

Crop type map at 10m for the main regional crops including irrigated/rainfed discrimination

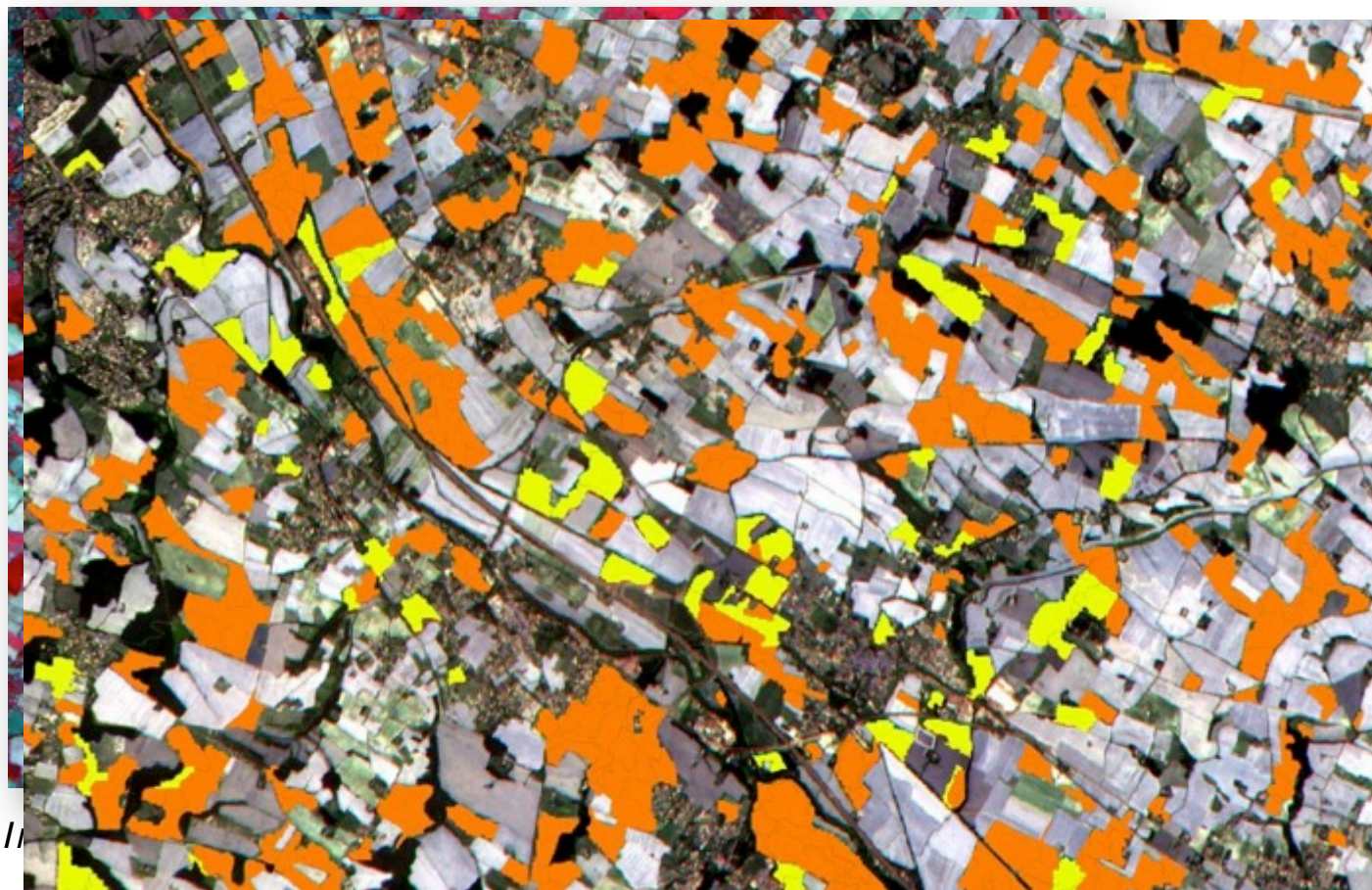


# First S2-based prototype product



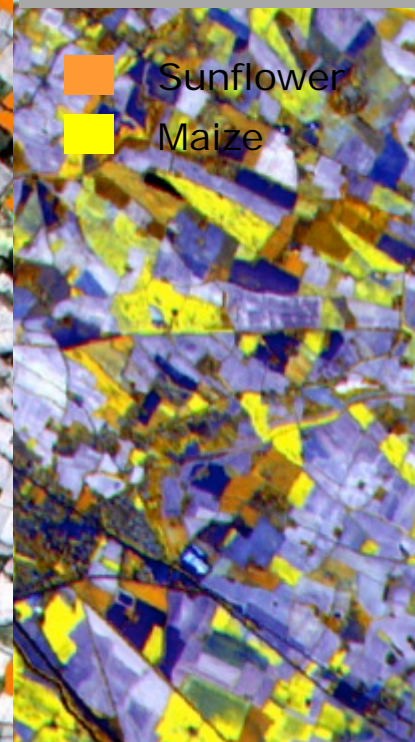
Toulouse area (France) - Sentinel-2 – 06 July 2015

New red-edge band to discriminate summer crops : maize vs sunflower



Summer Crops  
Map – 6 July 2015

Orange Sunflower  
Yellow Maize



*New red-edge color composite  
orange versus yellow*



• AGRICULTURE

Contains Copernicus data (2015)

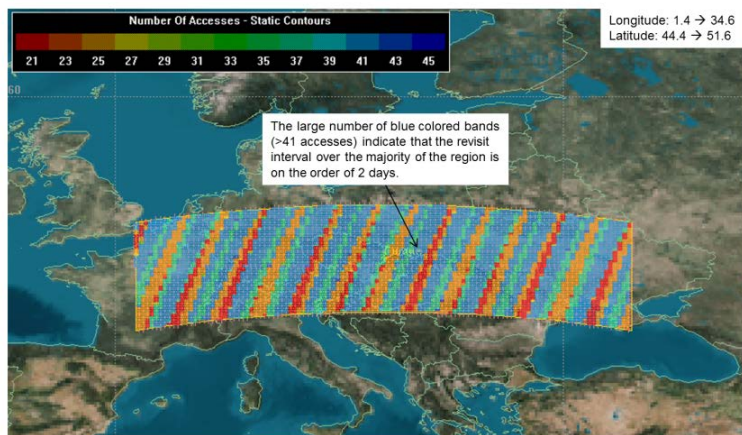




# Harmonized Landsat Sentinel-2 (HLS) Project

- **Merging Sentinel-2 and Landsat data streams can provide 2-3 day global coverage**
- **Goal is “seamless” near-daily 30m surface reflectance record including atmospheric corrections, spectral and BRDF adjustments, regridding**
- **Project initiated as collaboration among GSFC, UMD, NASA Ames**

## Sentinel 2A and B - LDCM Europe

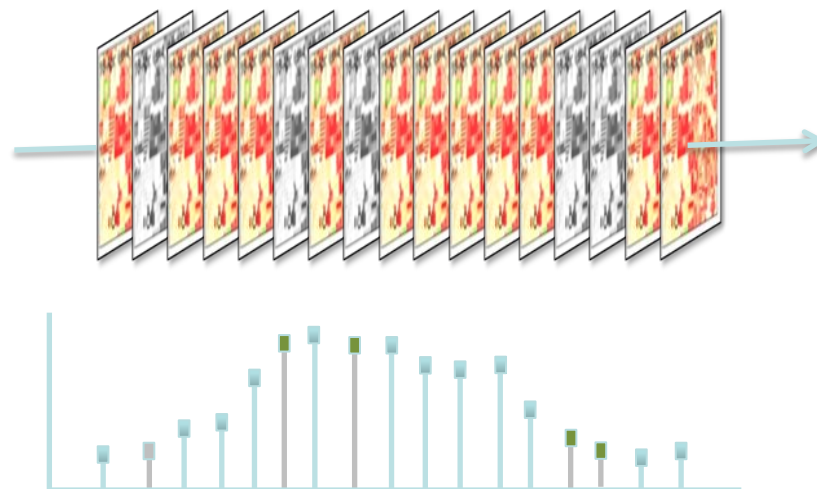


- The picture shows the number of times LDCM and the Sentinel 2 satellites accessed areas on the ground over an 80 day period of time.

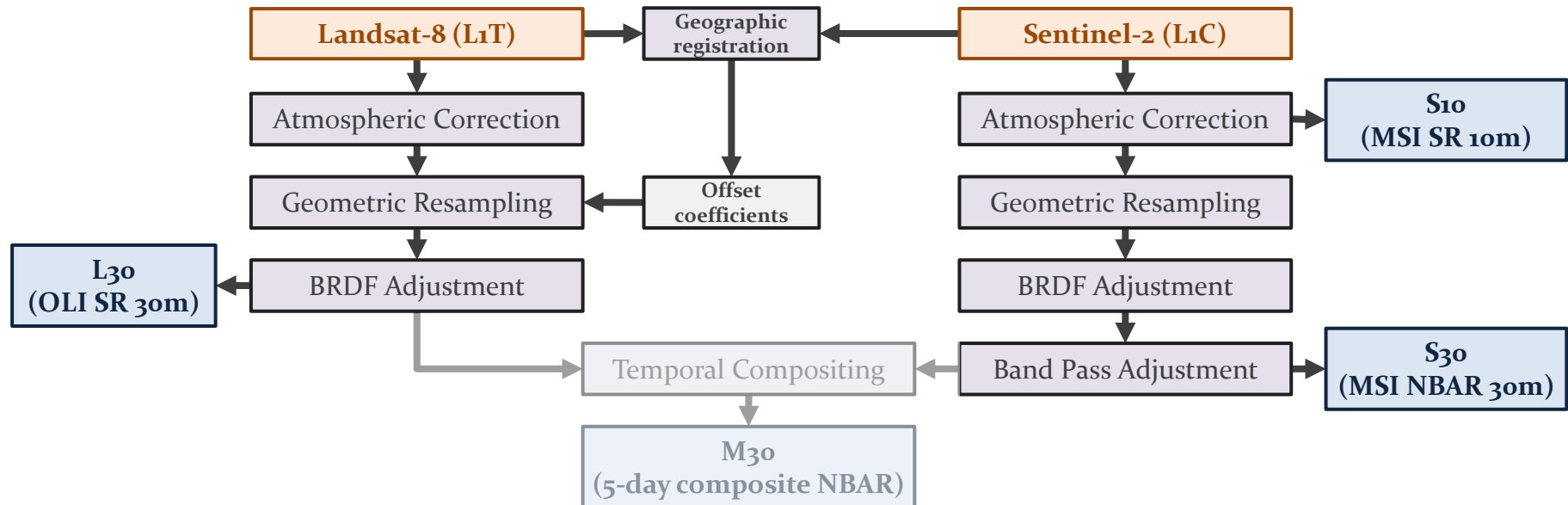
- 21 accesses indicates a maximum revisit interval of ~3 days 19 hours
- 46 accesses indicates a minimum revisit interval of ~1 day 18 hours

7

Courtesy Brian Killough, NASA LARC



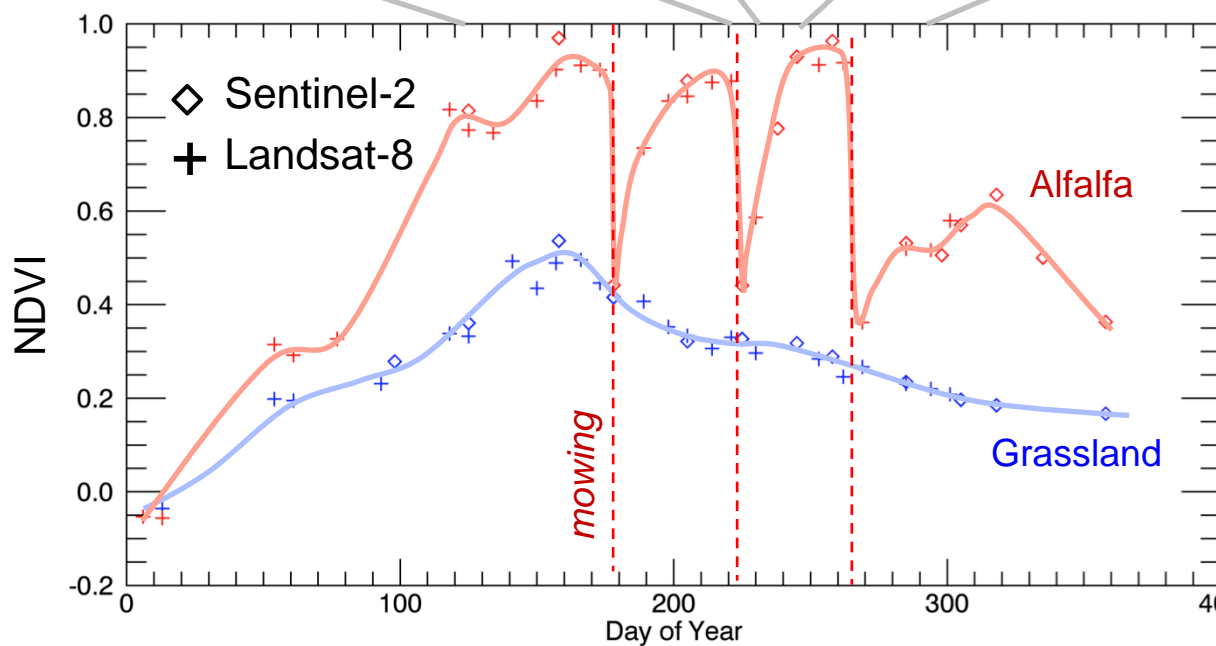
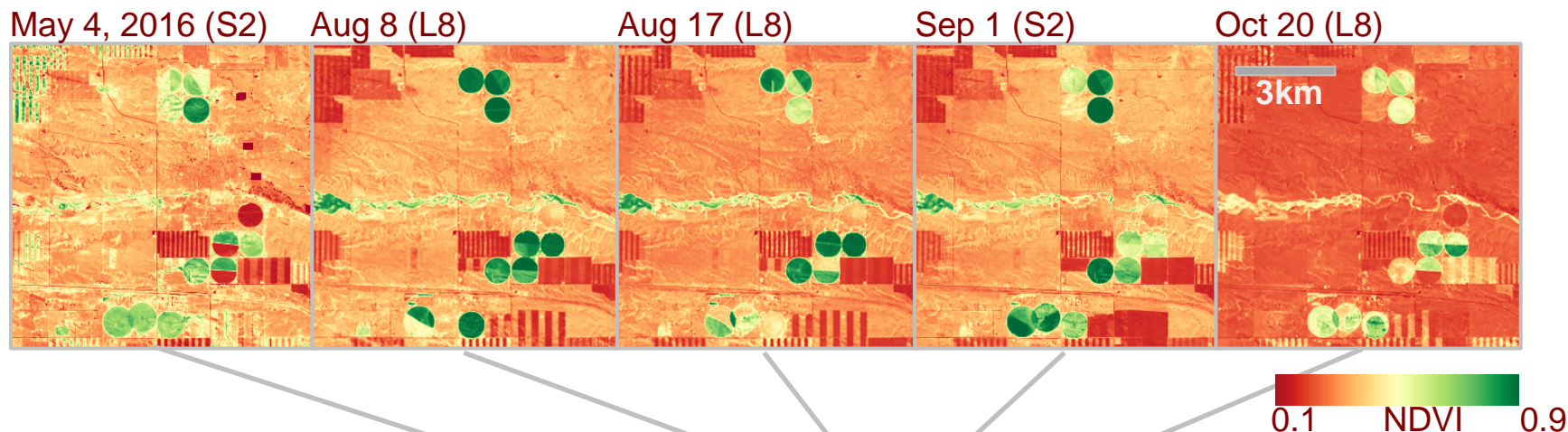
# HLS Algorithms overview and status



Algorithm	Current (V1.2)	Other Options
Geographic registration	AROP (Gao et al. 2009, JARS)	-
Atmospheric Correction	OLI and MSI: Landsat-8 6S algorithm	CNES MACCS
Cloud/Shadow Mask	OLI: Landsat-8 6S algorithm output MSI: BU MSI Fmask	CNES MACCS
BRDF Adjustment	Fixed BRDF (Roy et al. 2016, RSE)	Downscaling MODIS BRDF + Fixed BRDF as Backup
Band Pass Adjustment	Fixed, per-band linear regression	Regression-tree (based on spectral shape)
Temporal Compositing	TBD	-

# Harmonized Landsat / Sentinel-2 Products

Laramie County, WY

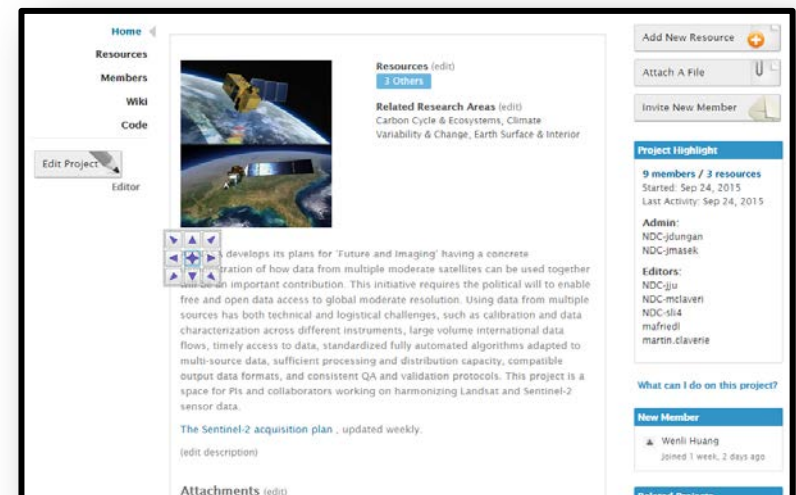
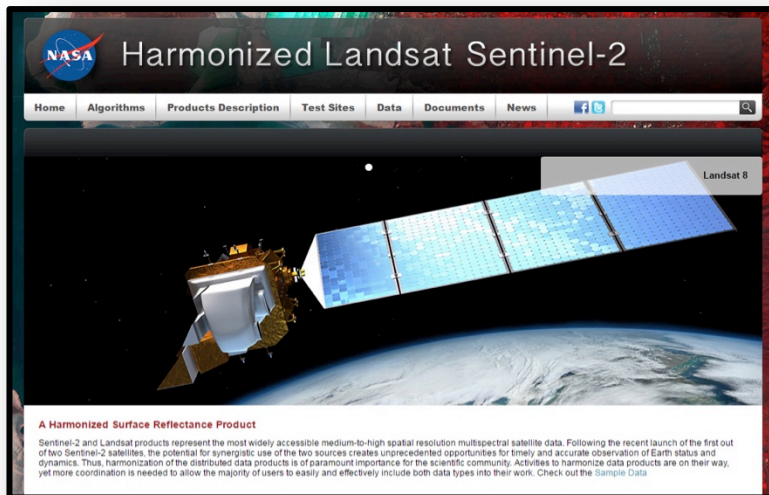


Seasonal phenology (greening) for natural grassland (blue line) and irrigated alfalfa fields (red line) near Cheyenne Wyoming observed from Harmonized Landsat/Sentinel-2 data products. The high temporal density of observations allows individual mowing events to be detected within alfalfa fields. HLS Products available from <https://hls.gsfc.nasa.gov>



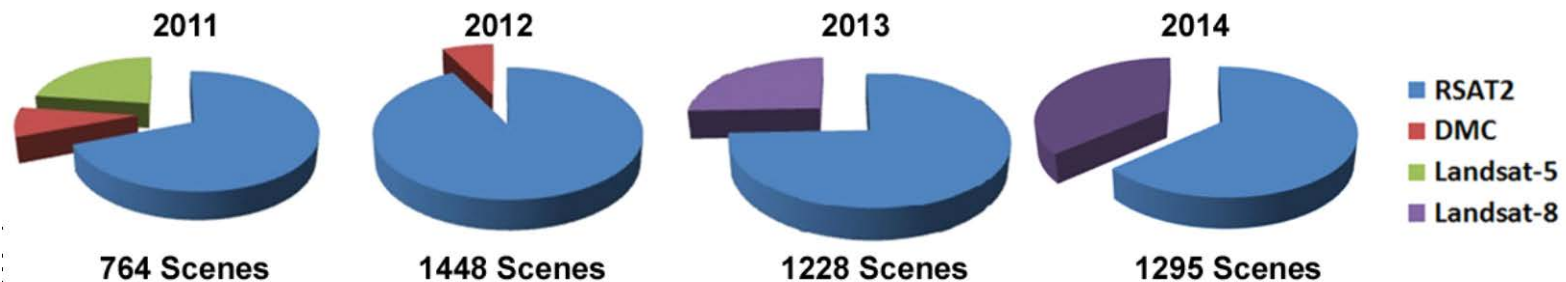
# HLS Websites and Public Interface

- <https://hls.gsfc.nasa.gov>
  - Public access
  - Sample data available (via FTP)
  - Algorithm & Product descriptions
- <https://nex.nasa.gov/nex/projects/1371>
  - Registered user access
  - All HLS data available
  - Documents (slides, user guides)



# Canada's Annual Crop Inventory: Integration of Optical and Synthetic Aperture Radar Data

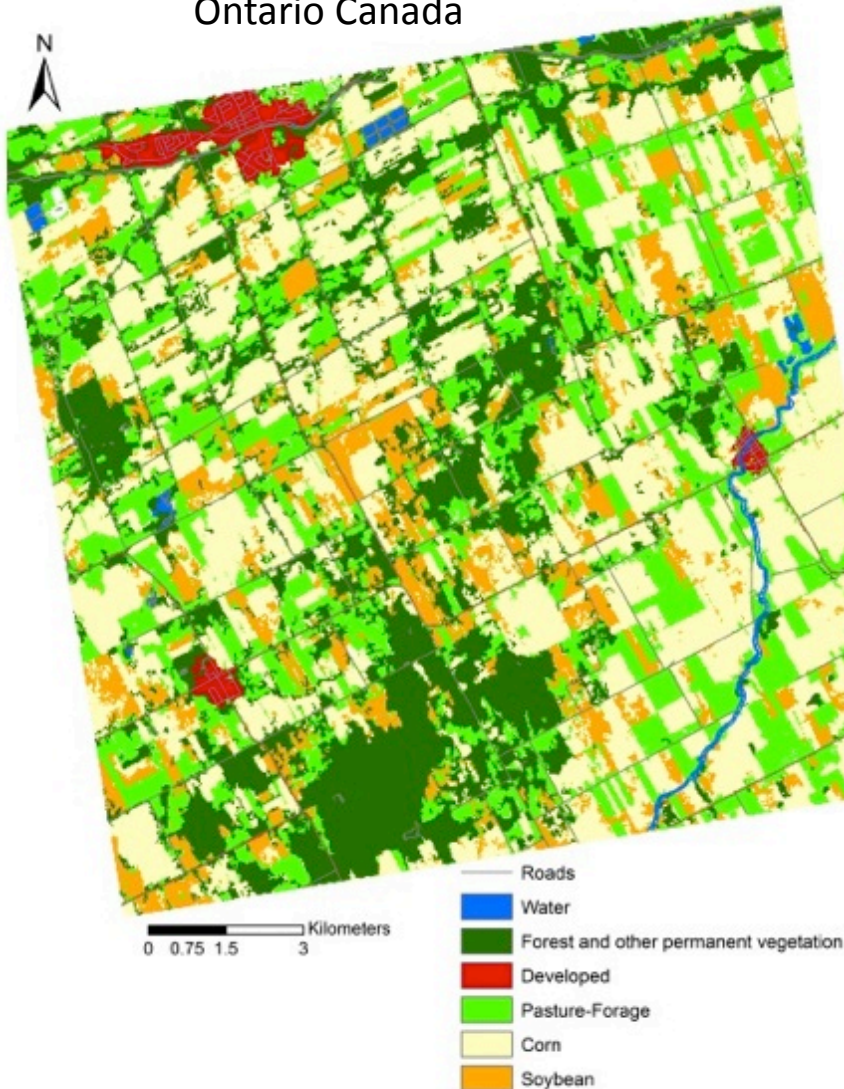
## Image Data



- Multispectral optical data can adequately classify crop if available during critical time periods
- Accuracies decrease significantly when gaps in data collection occur
- Operational burden of cloud masking
- Accuracy increases with SAR; magnitude depends on crop, timing of acquisitions and amount of optical data available

# In Development: Early Season Crop Identification

South Nation Watershed,  
Ontario Canada



End of season TerraSAR-X crop  
classification: Ottawa 2012  
Overall accuracy: **97.2%**

Early season: Corn can be  
identified at V6 or 6<sup>th</sup> leaf collar  
stage (about 6 weeks after  
planting)

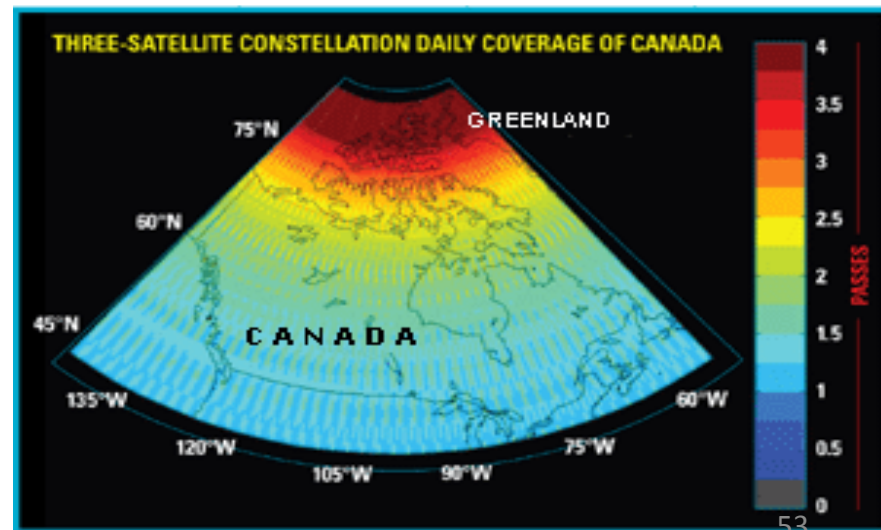
*McNairn, H., Kross, A., Lapen, D., Caves, R., and Shang J. 2014. Early season monitoring of corn and soybeans with TerraSAR-X and RADARSAT-2, International Journal of Applied Earth Observation and Geoinformation 28 (2014) 252–259.*



# RADARSAT Constellation Mission

<http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp>

- Evolution of the RADARSAT Program → 3 satellites – 600 km orbit, 32 minutes separation
- Multi-pol and fully polarimetric, high-resolution
- 15 min/orbit imaging (avg) x 3 satellites
- Average daily global access; 4-day exact repeat
- Focus on Marine Surveillance, Disaster Management and Ecosystem Monitoring (*including Agriculture*)
- Open data policy ?





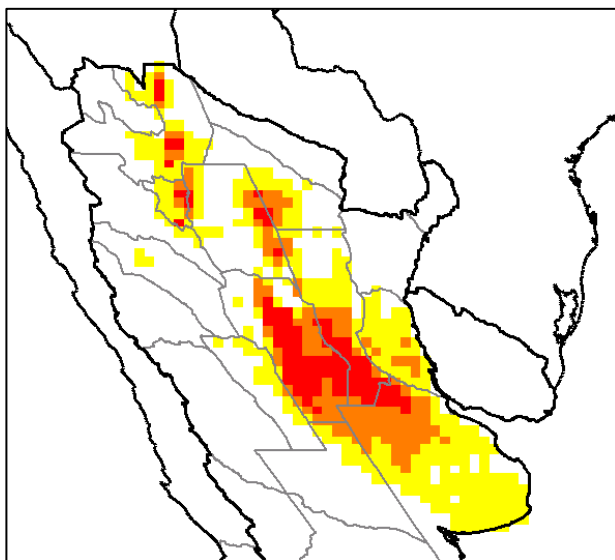
## Seeing a Changing Playing Field – Small Sat optical systems



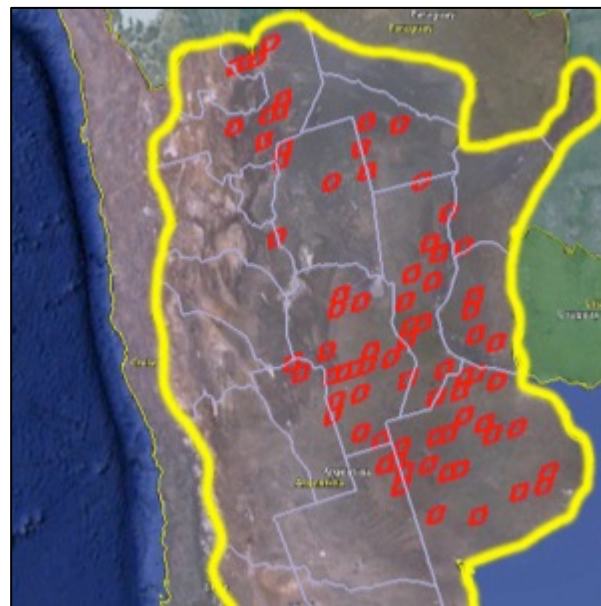


# High Resolution Sampling Strategy for Soybean Area in Argentina

- Some requirements (high temporal and/or spatial resolution) are for entire **cropland extent**; others are on a **sampled basis**
  - **Sampling strategy** in development;
  - For Phase 1A (e.g. Argentina):



Argentina Sample Strata



Derived Rapid Eye Sample Blocks  
40 km x 40 km ;  $n = 75$



# The GEOGLAM Components

## 1. Global / Regional Monitoring Systems


International/Global

## 2. National Monitoring Systems

National / Subnational

## 3. Monitoring Countries at Risk

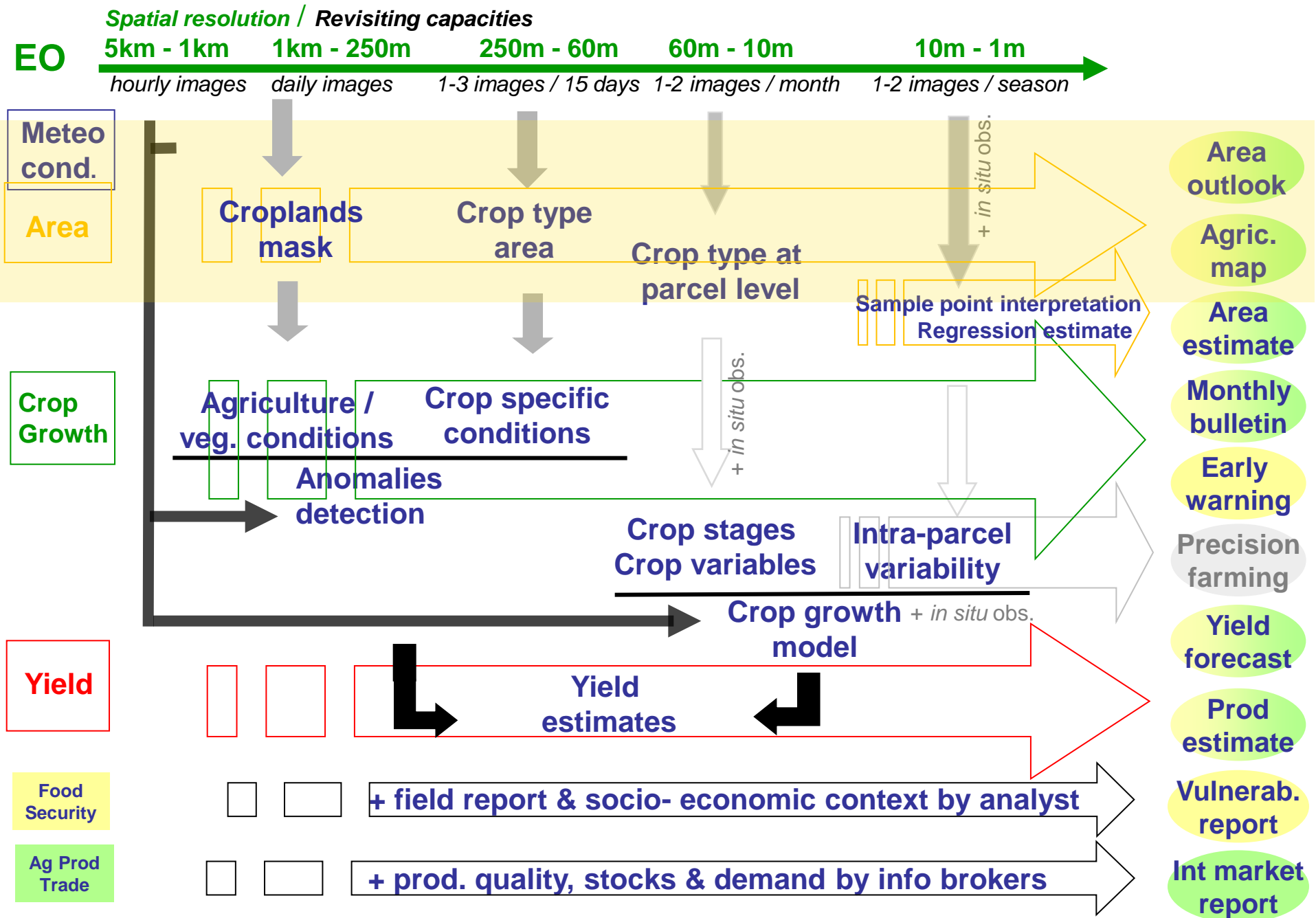
Food Insecure and Most Vulnerable

4. EO Data Acquisition & Dissemination Coordination 

5. Research & Development toward Operations

6. Capacity Development for EO

# Agricultural Monitoring : EO data and Final products



# Research Foci at the Joint Experiment for Crop Assessment and Monitoring (JECAM) Sites

Developing Methods for:

- Crop Type mapping
  - Crop Condition monitoring
  - Yield Estimation modeling
  - Soil Moisture estimation
  - Residue and Tillage monitoring
- 
- EC SIGMA Project, Sentinel 2 Agri and BMGF STARS are strengthening the JECAM field data collection protocols and intercomparison

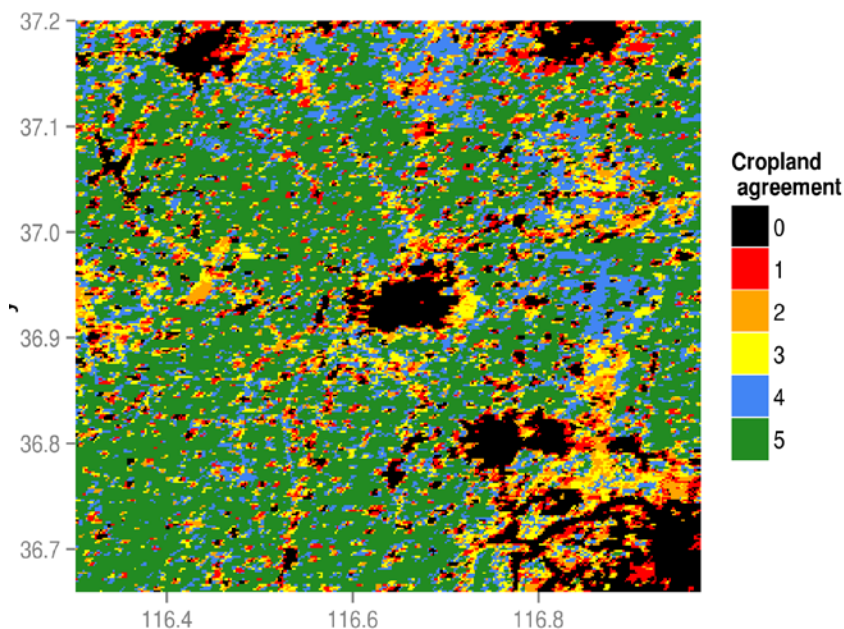


JECAM.org

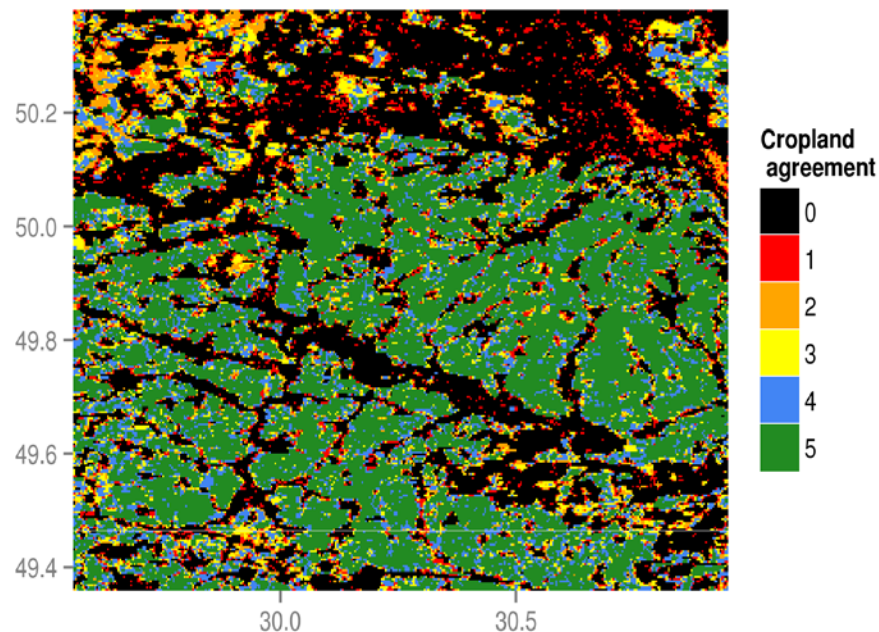


## JECAM – SIGMA methods benchmarking results

- Similar cropland mapping accuracy performances of all methods for a site
- Different performances according the site : ag.landscape impact
- Influence of the satellite data quality used as input



CHINA



UKRAINE

# So in Summary

## What is GEOGLAM doing?

- Increasing communication and sharing experience amongst the Ag Monitoring Community of Practice and with related programs
- Helping improve national agricultural monitoring systems
- Translating EO data into policy relevant information
- Promoting EO-based approaches to agricultural monitoring and raising the importance of agricultural remote sensing
- Articulating and advocating for community requirements to the EO data providers
- Increasing the awareness of EO by the econ/policy community
- Method testing and inter-comparison, developing best practices
- Developing new monitoring capabilities and products

# The NASA Food Security and Agriculture Consortium (FSAC)



Inbal Becker-Reshef, Chris Justice et al.,  
University of Maryland,  
Center for Global Agricultural Monitoring Research



# The NASA Roses A.51 Call For Proposals

## Broad, comprehensive call for developing NASA's program on Food Security and Agriculture

- Pilot a program of activities for applying RS to improve food security & agriculture
- Transdisciplinary, multi-sectoral team interacting as a Consortium
- Advance uses of EO data and models through:
  - Applied R&D and applications development
  - End user characterization and engagement
  - Innovative communications work
  - Socioeconomic impact assessment
- International & domestic food security
- Understanding the value of EO applications
- Focus on adoption and sustained use of EO based on solid business models
- NASA contribution to the GEOGLAM flagship
- Agility in responding to changing priorities

# FSAC key objectives and approach

- **Objective: develop a coordinated program to enhance decision support (domestically & internationally) through utilization of EO**
  - Working closely from the start with a range of stakeholder communities
- Leveraging successful domestic and international activities
- Utilizing public & private EO data alongside socioeconomic, agmet. & ground data to develop information products
  - In support of a range of management and decisions, planning, investments, assessments, and policy at scale
- Foundation in user-driven operational R&D
- Emphasis on transitioning applications to operations & capacity building
- Implemented through a large multi-sectoral, multi disciplinary consortium
  - 45 partners, over 70 participants
  - UMD Hub
  - Partnership with the NASA GSFC Food Security Office (FSO)
- In final negotiations with NASA HQ and GSFC FSO, expect to launch at AGU

# The Consortium

- Leading individuals/institutions from public, private NGO, inter-governmental, humanitarian sectors working in Agriculture and Food Security
- Consortium Partners named explicitly
  - Have both experience and on-going funded activities in the agricultural application of EO data
  - Represent a range of end-user communities, & includes socio-economic, outreach and communication expertise
  - Link to wide range of networks, key organizations, service providers, & end users
- Seed Starter Program, to engage new users and partners
- Advisory Committee, advise & facilitate new partnerships, review progress & provide guidance
- Work in close partnership with the new GSFC Food Security Office



# End Users

- Range of end users included in Consortium, & involved in its development:
  - From farmers to national agricultural ministries, international food security agencies, domestic market and trade sectors, NGOs, agribusiness, insurance and financial sector stakeholders
- Areas of focus for End User Engagement
  - International Crop Production Forecasts, Markets, and Trade
  - Domestic Commercial Agriculture and Farm Management
  - Regional and National Level Food Security, Early Warning, and Policy
  - Smallholder Agriculture Farm Management and Resilience Micro-Insurance
  - Strategic Targeting of New, Non-traditional End Users