

CEOS Update:

JECAM EO Data Access & NASA/JECAM Cloud-Based SDMS

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Major Activities & Achievements of CEOS Ad Hoc Working Group (2012-Present)

- Characterize GEOGLAM's long-term EO acquisition requirements
- Evaluate missions capacity to meet EO requirements
 - Identify gaps in coverage, propose solutions
- Coordinate EO data for R&D Activities – JECAM & Asia-RiCE – and for GEOGLAM activities
- Investigate and prototype options for space data dissemination and management
 - Cloud-based systems for storage, analysis, and visualization
 - e.g. Asia-RiCE (radar intercomparison), upcoming JECAM

Major Activities & Achievements of CEOS Ad Hoc Working Group (2012-Present)

- Develop multi-user, multi-site agreements to utilize restricted data
 - e.g. Radarsat-2 for JECAM
- Encourage space agencies to prioritize food security
 - From mission planning stage through operations
- Engage commercial satellite agencies to contribute data to JECAM (e.g. RapidEye)
- Strengthened case for international space agency coordination
 - Constellation approach & optical-SAR data fusion
 - Scientific basis for free/open data (e.g. Sentinel missions)

WHAT?
(Spatial & Spectral)
WHEN AND HOW OFTEN?
(Temporal)
WHERE?

A	B	C	D	E	F	Target Products							M
Req #	Spatial Resolution	Spectral Range	Effective observ. frequency (cloud free)	Extent	Field Size	Crop Mask	Crop Type Area and Growing Calendar	Crop Condition Indicators	Crop Yield	Crop Biophys. Variables	Environ. Variables	Ag Practices / Cropping Systems	
Coarse Resolution Sampling (>100m)													
1	500 - 2000m	optical	Daily	Wall-to-Wall	All			X		L			
2	100-500m	optical	2 to 5 per week	Cropland extent	All	X	X	X	L	L	X	L	
3	5-50 km	microwave	Daily	Cropland extent	All			X	X	X	X		
Moderate Resolution Sampling (10 to 100m)													
4	10-70m	optical	Monthly (min 3 in season + 2 out of season); Required every 1-3 years	Cropland extent (if #5 = sample, else skip)	All	X	L/M					X	
5	10-70m	optical	8 days; min. 1 per 16 days	Sample (pref. Cropland extent)	All	X	X	X	X	X	X	X	
6	10-100m	SAR	8 days; min. 1 per 16 days	Cropland extent of persistently cloudy and rice areas	All	X	X	X	X	X	X	X	
Fine Resolution Sampling (5 to 10m)													
7	5-10m	VIS NIR + SWIR	Monthly (min. 3 in season)	Cropland extent	M/S	M/S	M/S						
8	5-10m	VIS NIR + SWIR	Approx. weekly; min. 5 per season	Sample	All		M/S	X		X	X	X	
9	5-10m	SAR	Monthly	Cropland extent of persistently cloudy and rice areas	M/S	M/S	M/S					M/S	
Very Fine Resolution Sampling (<5m)													
10	< 5m	VIS NIR	3 per year (2 in season + 1 out of season); Every 3 years	Cropland extent of small fields	S	S	S						
11	< 5m	VIS NIR	1 to 2 per month	Refined Sample (Demo)	All		X		X			X	

Coarse (>100 m)

Moderate (10-100 m)

Fine (5-10 m)

Very Fine (<5 m)



Effort through the **CEOS Ad Hoc Working Group for GEOGLAM**

- Multiple Iterations
- Refinements and discussion as best practices evolve



	How ?				Where ?	When ?	
Req#	Core Missions (future)	Contributing Missions (future)	Spatial Resolution	Spectral Range	Sample Type	Effective observ. frequency (cloud free)*	Growing Season Calendar

Coarse Resolution Sampling (>100m)

1	Aqua/Terra (1000m)	Suomi-NPP (750m) Proba-V (1000m) SPOT-5 (1150m)	>500-2000 m	optical	Wall-to-Wall	Daily	all year
2	Aqua/Terra (250/500m) Sentinel-3A (500m)	Suomi-NPP (375m) Proba-V (100/333m)	100-500 m	optical	Cropland Extent	2 to 5 per week	all year
3	Aqua GCOM-W1/W2	SMOS SMAP	5-50 km	microwave	Cropland Extent	Daily	all year

Moderate Resolution Sampling (10 to 100m)

4	Landsat 7/8 (30m) Sentinel-2A/2B (10-20m)	ResourceSat-2 (56m) CBERS-4 (20-40m)	10-70m	optical	Cropland Extent	Monthly (min 2 out of season + 3 in season). Required every 1-3 years.	all year
5	Landsat 7/8 (30m) Sentinel-2A/2B (10-20m)	ResourceSat-2 (56m) CBERS-4 (20-40m)	10-70m	optical	Sample	~Weekly (8 days; min. 1 per 16 days)	growing season
6	Sentinel-1A/1B (C) Radarsat-2 (C), RCM (C) ALOS-2 (L)	RISAT-1/1A (C) RISAT-3 (L)	10-100m	SAR Dual Polarization	Cropland Extent or Sample	~Weekly (8 days; min. 1 per 16 days)	growing season

	How ?				Where ?	When ?	
Fine Resolution Sampling (5 to 10m)							
7	RapidEye	SPOT-5/6, SPOT-7 CBERS-4	5-10 m	VIS, NIR, SWIR	Cropland Extent	Monthly (min. 3 in season)	growing season
8	RapidEye	SPOT-5/6, SPOT-7 CBERS-4	5-10 m	VIS, NIR, SWIR	Sample	~Weekly (8 days; min. 1 per 16 days)	growing season
9	Sentinel-1A/1B (C) Radarsat-2 (C), RCM (C) ALOS-2 (L)	RISAT-1/1A (C) RISAT-3 (L)	5-10 m	SAR Dual Polarization	Cropland Extent or Sample	Monthly	growing season
Very Fine Resolution Sampling (<5m)							
10		Pleiades, SPOT-6, SPOT-7	< 5 m	VIS, NIR	Cropland Extent	3 per year (2 in season + 1 out of season); Required every 3 years	all year
11		Pleiades, SPOT-6, SPOT-7	< 5 m	VIS, NIR	Refined Sample	1 to 2 per month	growing season

JECAM Request to CEOS Agencies

- JECAM has received a significant number of datasets from CEOS Agencies
- Improved access and coverage + early access to new mission datasets are needed to address the highlighted areas.

Measurement Resolution Measurement Type	Current Missions Future Missions	Crop Mask	Crop Type	Crop Condition	Rainfall and Soil Moisture	Spatial Resolution	Sample Type	Frequency	Calendar
Coarse Optical	Aqua/Terra (MODIS) NPP (VIIRS) Proba-V (VGT-P) Sentinel-3A (OLCI & STR)	X	X	X		100-2000m	Cropland Extent	Daily	Annual
Moderate Optical	Landsat 7/8 (ETM+/OLI/TIRS) ResourceSat-2 (AWiFS) Sentinel-2A (MSI)	X	X	X		20-70m	Cropland Extent and Sample	Weekly to Monthly	Growing Season and Annual
Fine Optical	RapidEye SPOT-5/6 SPOT-7	X	X	X		5-10m	Refined Sample	Weekly to Monthly	Growing Season
Very Fine Optical	Pleiades SPOT-6 Worldview-2 SPOT-7		X			<5m	Refined Sample	One per Season	Growing Season
Moderate SAR	Radarsat-2 (C) RCM (C) COSMO-SkyMed (X) TerraSAR-X (X) Sentinel-1A (C) RISAT-1 (C) ALOS-2 (L)	X	X	X		10-100m	Sample	Weekly to Monthly	Growing Season and Annual
Moderate Radar and Microwave	TRMM (PR/TMI) Aqua (AMSR-E) COM-W1/W2 (AMSR-2) SMOS (MIRAS) GPM (DPR/GMI) SMAP (L-Band)			X	X	10-50km	Cropland Extent	Daily	Annual

From the 2014 JECAM document
JECAM Guidelines: Definition of the Minimum Earth Observation Dataset Requirements

CEOS Support coordinating EO data access for >20 JECAM sites

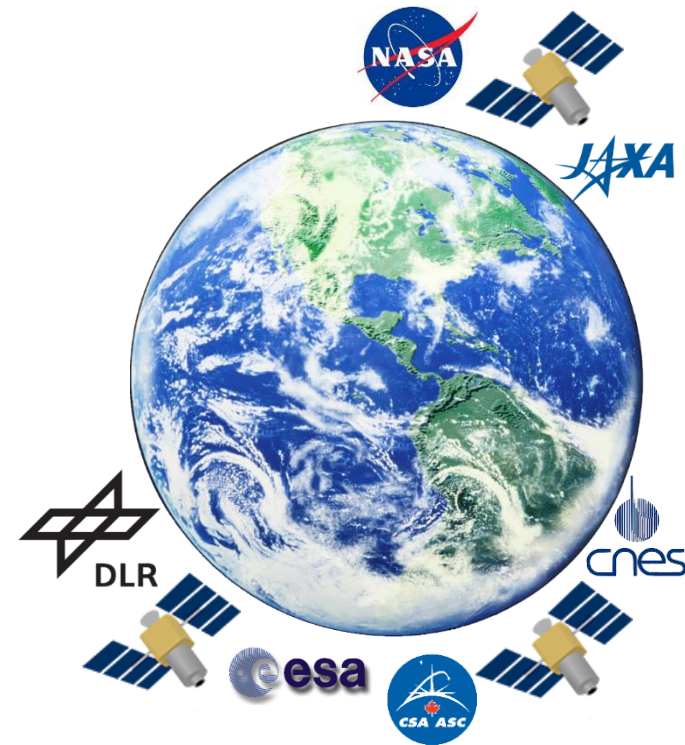
JECAM Site	COSMO SkyMed	RADARSAT-2	TerraSAR-X	AWIFS	DMCII	ASTER	HJ-1	Landsat	MODIS	Quickbird	Rapideye	SPOT-4/5/6	Worldview-2	Pléiades	Formosat-2	Deimos	Chris
Argentina	1	18 ¹	7	6	7						24	17					
Belgium		11						x			28	14					
Brazil – Sao Paulo								4	220				3				
Brazil – Tapajos								x ²			48			3		10	
Burkina Faso								11						7			
Canada CFIA – Ottawa								8				7					1
Canada/Red River		x						x			x						
Canada/South Nation			8					x			15						
China/Guangdong (Taishan)	12	6									4						
China/Heilongjiang	4	5	5				27		21		5	x					
China/Liangou ³																	
							21		46		5	18					
								7				15		3	16	8	
									x								
												25		9			
												36					
								x	x								
								x		4							
								7	20		11	135					
									x			x			x		
								21				25					
								6	x		29	17					
								x									



Only way to meet high temporal + moderate/fine spatial at present is through coordination between multiple missions & space agencies

CEOS Acquisition Plan for GEOGLAM

- **Annually updated plan for satellite data acquisition submitted to CEOS Plenary**
 - When, where, how often... which systems to meet requirements?
 - Endorsed in 2013, 2014, and 2015
 - Scope of Work Document also endorsed (2015)
- **At present, most data in the acquisition plan are acquired for R&D (test sites)**
 - JECAM, Asia-RiCE...
 - Challenge is to scale up to sustained, wall-to-wall or cropland extent



From T.D. Sites to Wall-to-Wall

Key Challenge: Sustained observations & easy data access (especially for wall-to-wall)... and institutional support on the user-end for data application

	Vietnam		Indonesia (top 10 provinces)		Thailand (maybe?)	
PoC	Shin-Ichi Sobue, VAST or HCMC**		Ministry of Agriculture, GEORICE, GISTDA		Shin-Ichi Sobue, GISTDA**	
Purpose?	<i>Planted area, crop growth monitoring, yield estimation, damage assessment</i>					
When?	May – Oct 2016 (Wet) Nov 2016 - April 2017 (Dry)		May – Oct 2016 (Wet) Nov 2016 - April 2017 (Dry)		May – Oct 2016 (Wet) Nov 2016 - April 2017 (Dry)	
What?	C&L band SAR Dual Polarization (VV/VH or HH/HV)	Optical	C&L band SAR Dual Polarization (VV/VH or HH/HV)	Optical	C&L band SAR Dual Polarization (VV/VH or HH/HV)	Optical
How often?	14 days (min. 30)	14 days <i>(reasonably cloud free!)*</i>	14 days (min. 30)	14 days <i>(reasonably cloud free!)*</i>	14 days (min. 30)	14 days <i>(reasonably cloud free!)*</i>
Spatial Resolution ?	20-100 m	20-500 m	20-100 m	20-500 m	20-100 m	20-500m

***institutional PoC pending*

Evaluation of CEOS capacity to meet requirements is pending...
**particularly for cloudy areas*

Data Services Prototypes: Status & Lessons Learned

JECAM Data Services Project

- **Sites:** Ukraine, Belgium, South Africa, Argentina, Germany, Canada
- **Datasets:** Radarsat-2, TerraSAR-X, and other optical datasets.
- Dedicated and cloud-based storage and SAR processing capabilities
- Secure access and data sharing within guidelines of license agreements
- **STATUS:** Ian Jarvis has been working with the Canadian Government to obtain new cloud based computing resources from Microsoft.
- **LESSONS:** Hosting of restricted datasets (Radarsat-2) requires careful planning and understanding. Users should pay for hosting.

Asia-RiCE Data Services Project for Indonesia.

- Secure access for JAXA and Indonesia Asia-RiCE science users.
- Dedicated storage for up to 35 Radarsat-2 images (provided by CSA) and cloud processing of SAR datasets using INAHOR tool. Amazon S3 system with 100 GB storage.
- **STATUS:** Data Services tool functioning well. No issues.
- **LESSONS:** Cloud-based services operate better when they are close to the user. Moving server to Singapore helped performance.



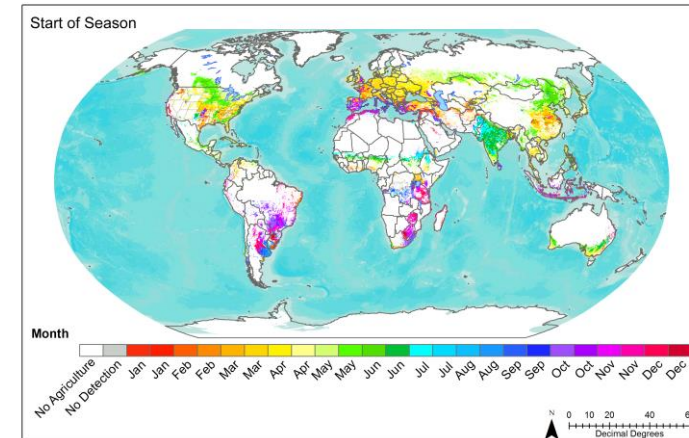
Archival Data Links Update

Archive Data for Baseline Product Generation

The accuracy of baseline datasets (e.g. crop type & calendars) could be improved through the use of fine to moderate resolution (<100 meter) archive data.

Benefits for progress toward implementation:

- Establishes data request process
- Facilitates evaluation of new data streams
- Supports future data acquisition planning.



Current Growing Season Calendars

How?

1. Obtain direct access to **archive metadata** (via **COVE** tool) STATUS: Ongoing; Links to Landsat, SPOT, Radarsat, Pleiades already in place; Sentinel-1, RapidEye (late 2015) upcoming
2. Request access to those which comprise a sufficient data record for baseline dataset generation (e.g., crop maps, crop calendars)



STATUS: Upcoming once archive links are complete & once we have support from space agencies for rapid processing of archival data

Component 4 Strategic Issues (1/2)

1. Scaling up acquisition & dissemination from R&D sites to broader scale (& to operations)
 - Securing broad-scale, reliable, continuous coverage
 - How to secure individual space agency support?*

2. Funding for data storage, processing, and dissemination systems
 - Legal/logistical barriers to data sharing/hosting
 - Where to find glue funding for “neutral” data servers?*

How to get CEOS agencies interested in open data policies for pan-initiative collaboration?

Component 4 Strategic Issues (2/2)

3. Gaining access to restricted and fee-based datasets
 - Securing funding for continued use of these valuable data
 - Engaging commercial space sector
 - How to engage for-profit business in a “public good” arena?*

4. Continued advocacy for AgMon at mission planning stages
 - Facilitating adoption of new satellite systems

5. Promoting access to improved atmospheric and *in situ* observations, *requires willful site/national participation*
 - Need for better short-term weather forecasts (R&D issue)
 - Need to further grow or establish (national) networks for *in situ* weather and agricultural measurements, including stronger linkages with WMO

Upcoming Activities for Component 4

- Scaling up to full cropland extent for Sentinel-1 for Asia-RiCE countries
- Evaluating “data readiness” of GEOGLAM partners
 - Initiating process of scaling up of data coordination to full cropland extent
- Archival analysis for baseline dataset development
- Requirements development and evaluation for RAPP
- Evaluating *national/regional* req’s with *national/regional* satellites for croplands
- Evaluating new data streams
- Continued improvement of the space data management systems
 - Implement further prototypes
 - **Develop standard preprocessing levels for input into SDMS**
- Incorporation of Sentinel-1 data and Sentinel-2/LDCM joint product into space data management system
- Engage WMO, NOAA for agrometeorological data
- Begin the process of improving *in situ* networks (e.g. rainfall, flux)

Thank you!

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GEOGLAM Program Website (update soon!)
www.earthobservations.org/geoglam

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