JECAM
Joint Experiment for Crop Assessment and Monitoring

GROUP ON EARTH OBSERVATIONS

JECAM Guidelines: Definition of the Minimum Earth Observation Dataset Requirements

This document is version 1.0 of the JECAM minimum dataset requirements. It has been prepared based on 20 JECAM site reports, on the discussion at the CEOS-GEOGLAM co-community meeting held in Frascati, Italy in February 2014 and on SIGMA and Sen2-Agri project contributions as well as discussions during the JECAM Science Meeting, July 2014. This is a living document and will be updated and revised as required.

I. Objectives and background

The objective of the JECAM minimum data set requirements is to build a **common data set of satellite and in situ observations to support research and methods benchmarking activities across JECAM sites.** The JECAM network facilitates data sharing and collaborative research among its partners to develop crop assessment and agricultural monitoring methods for a large variety of agriculture systems. The enhanced coordination will facilitate a high level of bi-lateral and multi-lateral collaboration.

GEOGLAM was initiated in 2011, after JECAM inception in 2009. In response to GEOGLAM, JECAM has now become the foundation of the R&D component for GEOGLAM, consequently the JECAM objectives have evolved. The refocusing of the JECAM mandate has necessitated the need for a more coordinated approach to space-based EO observations as well as in-situ observations. This document outlines considerations and requirements for EO data, and a separate document outlines in-situ data considerations. It is expected the minimum data set concept will be applied to a subset of all JECAM sites. These sites will be selected based on their engagement level, representativeness, and desire to openly share EO and in-situ data within the JECAM community.

II. Definition of a Typical JECAM Site

A JECAM site is characterized by regular field observations that are systematically collected from year to year, providing a multi-year data set to be shared with JECAM partners in the context of a collaborative research effort. In return, satellite time series are provided by space agencies and commercial companies, facilitated through CEOS, in the context of GEO. Annual reports from the sites and JECAM guidelines are delivered to build best practices and standards for the agriculture remote sensing research community.

Originally no specific parameters or constraints were placed on the make up (e.g., size, shape) of JECAM sites. This was done to accommodate the great diversity of agro-ecosystems monitored, and make it easy for prospective sites to leverage on-going research for JECAM. Now, with the implementation of the minimum dataset concept it is necessary to impose a predefined site configuration. This is being done to: streamline and standardize data acquisition; simplify EO data acquisition logistics; clearly document the burden on supporting space agencies and commercial providers; and, enhance the inter-comparability of data. The site configuration presented below is intended to be a compromise that balances the desire for a compact site with the needs for representing a diverse range of cropping systems.

In order to encompass the diversity of regional crop types and crop development, a typical JECAM site will cover **an area of 25 x 25 km (625 sq. km) and be representative of one or several cropping systems** with a spatially nested core zone **of 10 x 10 km (100 sq. km)** for the most intensive field measurements, including those relating to crop stages and biophysical variables, that are repeated throughout the growing season.

III. Summary of JECAM Product and Measurement Requirements

The following table summarizes the JECAM product and measurement requirements for JECAM sites. JECAM requires a combination of optical, Synthetic Aperture Radar (SAR) and Microwave measurements over all JECAM sites to meet its overall objectives. To date, JECAM has received a significant number of datasets (see Section VI) and made great progress toward understanding the use of satellite data for agriculture monitoring, but more data is needed in a consistent manner over all JECAM sites. Such a minimum data set requirement can serve for data providers and for users as a testing ground for the constellation approach promoted by GEO. There are currently a few issues with dataset acquisition and availability, which are noted in the highlighted cells below and further detailed in Section VII.

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 & SLSTR)	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) GCOM-W1/W2 (AMSR-2) SMOS (MIRAS) GPM (DPR/GMI) SMAP (L-Band)			X	X	10-50km	Cropland Extent	Daily	Annual

IV. Minimum Satellite Datasets for JECAM Sites

The following table summarizes the desired satellite datasets needed at JECAM sites. Not all datasets are needed at each site. Section VI shows which datasets have been historically used by each site. There are few issues with dataset acquisition and availability, which are noted in the highlighted cells and further detailed in Section VII.

Mission (Instrument)	Space Agency or Provider	Product Requirements over JECAM sites	Frequency	Status
Optical Missions				
Terra (MODIS) Aqua (MODIS)	NASA	Surface Reflectance Bands 1-7 - 500m (ref. MOD09A1 & MYD09A1 respectively for Terra & Aqua)	Daily	Available, as needed
Suomi-NPP (VIIRS)	NASA	Visible, NDVI, SWIR and LIR (375m) bands	Daily	Available, as needed
Proba-V (VGT-P)	ESA-BELSPO	S1 and S10 TOC: 1000km free, 333m Proba-V Top Of Canopy (incl. atm. correct.)	Daily (S1) and 10 day composites (S10)	Only 1km free. 333m free >1 month old or with ESA approved R&D project. 100m data under evaluation.
HJ-1A (HSI)	CRESDA/CAST	100m Hyper Spectrum Imager	Periodic	Only used for China JECAM sites
Landsat 7 (ETM+) Landsat 8 (OLI/TIRS)	USGS	15m (Pan), 30m (Vis/SWIR) every orbit	Weekly to Monthly	Available, as needed. Landsat-7 data not used often due to SLC problem.
ResourceSat-2 (AWiFS)	ISRO	56m imagery	Weekly to Monthly	Need consistent AWiFS data acquisitions for adequate JECAM evaluation over multiple sites
Deimos (SLIM-6)	DMC Int. Imaging	Ortho product L1T - 22 m (MS imager)	Periodic	Planned for several JECAM sites in 2014. Feedback needed from sites.
UK-DMC-II (SLIM-6)	DMC Int. Imaging	Ortho product L1T - 22 m (MS imager)	Periodic	Planned for several JECAM sites in 2014. Feedback needed from sites.
NMP EO-1 (ALI)	NASA	10m (Pan), 30m (VNIR/SWIR)	Periodic	Currently used by Taiwan and Ukraine
SPOT-4/5/6 (HRG)	CNES	HRG, 5m (Pan), 10m (MS)	5-day revisit	SPOT4-Take5 (2103) project has provided many images for JECAM. More needed for 2015 (SPOT5-Take5). Older (>5 yrs) data is free, after processing (complete 2017).
RapidEye (REIS)	Blackbridge	Ortho product (L3A) - 6.5 m - with similar viewing angles if possible	Every 10 days	Currently provided to many JECAM sites as a commercial purchase and part of SPOT4-Take5. Evaluation data possible for free and DLR support needed for 2015 (before Sentinel-2 era).
Sentinel-2A (MSI)	ESA	10m (VNIR), 20m (SWIR)	Every 10 days	Forthcoming mission. JECAM sites to be included as early as possible in the ramp-up phase after launch.
Formosat-2 (Pan/MS)	NSPO	2m (Pan), 8m (MS)	Periodic	Currently used by France and Taiwan
Pleiades (HIRI)	CNES	2.8 m multispectral/similar viewing angle if possible	1 per growing season	CNES has provided data to Burkina, France and Madagascar JECAM sites. More data is needed for all JECAM sites to evaluate field campaign support and detailed crop type mapping in small fields.
Quickbird	DigitalGlobe	0.65m, MS images	1 per growing season	Purchased by 7 JECAM sites
Worldview-2 (WV110)	DigitalGlobe	0.46m, MS images	1 per growing season	Only used by Brazil, Italy and Tanzania. Commercial purchase.

Mission (Instrument)	Space Agency or Provider	Product Requirements over JECAM sites	Frequency	Status
SAR Missions				
Radarsat-2 (C-Band)	CSA	Fine Beam SLC, Quad Pol, Ascending, (from 35 to 45 deg.). Wide-Fine FOW2 (10m) for Asia-Rice.	Monthly to bi-monthly	Provided to many JECAM sites via the SOAR proposal process.
TerraSAR-X (X-Band)	DLR	Mode StripMap dual pol VV-VH - ascending (from 35 to 45 deg.)	Monthly to bi-monthly	Purchased by China, Canada, Taiwan, Argentina and Tunisia. Need consistent TerraSAR data acquisitions for adequate multifrequency evaluation over multiple JECAM sites.
Cosmos-SkyMed (X-Band)	ASI	Mode Stripmap Ping Pong VV-VH (from 35 to 45 deg.)	Monthly to bi-monthly	Purchased by China, Argentina, Italy, Tunisia
RISAT-1 (C-Band)	ISRO	ScanSAR (10 to 100m) with Dual/Full Polarization	Weekly for Asia-Rice	Acquired over some Asia-Rice sites,but not currently available for evaluation
ALOS-2 (L-Band)	JAXA	ScanSAR (10 to 100m) with Dual/Full Polarization	Weekly for Asia-Rice	New mission under evaluation and commissioning. Late 2014 ready for Asia-Rice sites and to be extented to other JECAM sites.
Sentinel-1A (C-Band)	ESA	Stripmap Mode (SM) dual pol (VV-VH) - ascending (from 35 to 45 deg.)	Monthly to bi-monthly	New mission. JECAM desires direct access to first released data for evaluation at all sites and planned coverage of sites.
Precipitation and Soil Moisture Missions				
TRMM (PR/TMI) GPM (DPR/GMI)	NASA/JAXA	Precipitation	Daily	Available, as needed
Aqua (AMSR-2) GCOM-W1 (AMSR-E)	NASA/JAXA	Precipitation and Soil Moisture	Daily	Available, as needed
SMOS (MIRAS)	ESA	Soil Moisture	Daily	Available, as needed

V. Minimum In-situ Datasets for JECAM Sites

Three types of *in-situ* data have to be systematically collected on the ground and/or possibly by airborne systems during the main growing season. The standardized approach to collecting this data is outlined in detail in another document. As an overview, these minimum types of data are defined as follows:

Crop Mask (Cropland – Non Cropland) dataset: field observation has to cover the cropland area with more than 100 fields but also includes a set of non-cropland samples covering the diversity of the landscape;

Crop Type dataset: each main crop type of a given JECAM site should be assessed by field observations with a minimum sampling density well distributed over the site. In addition a minimum sample of field observations should also cover the other crop types;

Crop Condition (Vegetation status) dataset: the main development stages (e.g. emergence, flowering, maturity, harvest) of the main crops should be described along the growing season for the JECAM site. On a best effort basis, biophysical variables such as LAI, fCover or fAPAR could be also measured for different crops over several fields.

VI. JECAM Space Data Usage Summary

The following table summarizes data used by JECAM test sites in 2013 and 2014. The data was compiled in April 2014 for the JECAM Annual Report.

	Low/Moderate Optical								Moderate SAR			Fine/Very Fine Optical					
JECAM Site	**Terra/Aqua (MODIS)**	**Terra (ASTER)**	**Landsat**	**ResourceSat-2 (AWiFS)**	**HJ-1**	**Proba (CHRIS)**	**Deimos-1**	**UK-DMC-II**	**RADARSAT-2**	**TerraSAR-X**	**Cosmo-SkyMed**	**RapidEye**	**SPOT**	**Pléaides**	**Quickbird**	**Worldview-2**	**Formosat-2**
Argentina				X				X	X	X	X	X	X				
Belgium			X						X			X	X				
Brazil – Sao Paulo	X		X													X	
Brazil – Tapajos			X				X					X		X			
Burkina Faso			X											X			
Canada CFIA Ottowa			X			X							X				
Canada/Red River			X						X			X					
Canada/South Nation			X							X		X					
China/Guangdong (Taishan)									X		X	X					
China/Heilongjiang	X				X				X	X	X	X	X				
China/Jiangsu																	
China/Shandong	X				X			X	X	X	X	X	X				
France			X				X						X	X			X
Italy Apulian Tavoliere	X																
Madagascar													X	X			
Morocco													X				
Russia	X		X														
Saudi Arabia		X	X												X		
South Africa	X		X									X	X				
Taiwan	X												X				X
Tunisia		X	X							X	X		X				
Ukraine	X		X						X			X	X				
Uruguay			X														
U.S.A.				X													

VII. Summary of Dataset Issues

Proba-V (ESA): Currently, only the 1000m data is free. 333m data is free for data older than 1 month or for ESA approved projects. 100m data products are under investigation. Availability of daily and 10-day composite data for JECAM would greatly improve global crop masks.

ResourceSat-2 (ISRO): Consistent acquisitions of AWiFS data over JECAM sites would allow improved integration with other optical datasets (i.e., Landsat) and allow improved cloud filtering. Coverage of all JECAM sites is desired at maximum frequency and ease of access to datasets is also needed.

SPOT (CNES): The SPOT4-Take5 project has provided significant data to JECAM in 2013. The SPOT5-Take5 project (proposed for Apr-Aug 2015) is under evaluation. Continuation of this dataset for JECAM sites is desired. In addition, older (>5 yrs) datasets are free, but require processing (proposed completion by 2017-2018). Rapid processing over JECAM sites before 2017 is desired for historical mapping.

Pleiades (CNES): CNES has provided datasets to several JECAM sites for small field crop typing. Additional datasets are needed for all JECAM sites to support field campaigns and test fine sampling methods.

RapidEye (facilitation by DLR): RapidEye was successfully used for various sites. Continuation of optical time series acquisition could be facilitated through DLR as they are needed for JECAM sites combining small parcels and cloud cover issues hampering the Landsat contribution.

Sentinel-2A (ESA): The acquisition planning of Sentinel-2A data over JECAM sites during the ramp-up phase could save one agricultural year in the Southern hemisphere as well as in some non-European JECAM sites.

TerraSAR-X (DLR) : The acquisition of SAR time series in X-band over a subset of JECAM sites involved in a multifrequency JECAM experiment is much needed to extrapolate very promising crop type mapping methods across sites.

Sentinel-1A (ESA): This new mission is still in the commissioning phase. JECAM desires direct access to datasets for continued work in evaluation and capacity building. To date, JECAM has used Radarsat-2 (C-Band) SAR for several sites. Sentinel-1A data coverage is strongly desired over all JECAM sites. The ability to use SAR data eliminates issues with cloud cover and time series in different bands expands potential results.

ALOS-2 (JAXA): L-band data are needed over a sub-set JECAM sites involved in a multi-frequency JECAM experiment in order to assess the complementarity of C-band and L-band for soil moisture and biomass estimates.

RISAT-1 (ISRO): The Asia-Rice project desires C-Band SAR data over Asia for evaluation and testing along with L-Band data from ALOS-2. Data has been taken by RISAT-1, but it has not been provided to the Asia-Rice team (JAXA). Testing of this dataset along with Radarsat-2 (C-Band) is strongly desired.

It is also important to mention that current licensing for several types of data (e.g., Radarsat-2, PROBA-V 100m, TerraSAR-X, ALOS-2, and Sentinel-1A) are not easily compatible with the objective of data sharing among JECAM sites. The JECAM group desires to create a common user license agreement whereby JECAM sites can share data, processing methods and products for the sole purpose of scientific research to benefit agriculture.