

K&C Phase 4 – Brief project essentials

Asia-RiCE: Rice Crop Estimation and Monitoring

Shin-ichi Sobue

Remote Sensing Technology Center of Japan

Regional Cooperation for rice crop monitoring using space technology in Asia



Project outline and objectives

To develop the Asian rice crop estimation and monitoring. It is a component of the GEO Global Agricultural Monitoring (GEOGLAM) initiative to enhance regional and global agricultural production estimates through the use of Earth observations.

About 100 × 100 km/single province Technical Demonstration Sites (TDS) in Asia-RiCE members' countries. There are currently 10 Asia-RiCE TDS in 9 countries in Asia.

ALOS-2 ScanSAR and other data over all Phase 1 TDSs is a key to estimate of rice crop area and production estimates at the provincial level.

Technical Demonstration Sites for Asia-RiCE



Project outline and objectives

To develop the Asian rice crop estimation and monitoring. It is a component of the GEO Global Agricultural Monitoring (GEOGLAM) initiative to enhance regional and global agricultural production estimates through the use of Earth observations.

About 100×100 km/single province Technical Demonstration Sites (TDS) in Asia-RiCE members' countries. There are currently 10 Asia-RiCE TDS in 9 countries in Asia.

ALOS-2 ScanSAR and other data over all Phase 1 TDSs is a key to estimate of rice crop area and production estimates at the provincial level.

Supports **C**limate Change adaptation and **E**nvironmental **C**onservation with sustainable development in K&C theme

Asia-RiCE Home Page

Asia-RiCE
www.asia-rice.org/index.php




Home About Work Plan News/Events GEOGLAM Contacts Links



Rice is the staple food for more than half of humanity, with 90% of the world crop grown and consumed in Asia.

About

Asia-RiCE is the work of an ad hoc team of stakeholders with an interest in the development of an Asian Rice Crop Estimation & Monitoring (Asia-RiCE) component for the GEO Global Agricultural Monitoring (GEOGLAM) initiative.

Rice is the staple food for more than half of humanity - with 90% of the world crop grown and consumed in Asia.

World population, and therefore demand for food, has increased linearly over the last fifty years (+80M/year), and is projected to keep growing until around 2050 up to 9 billion inhabitants (United Nations Department of Economic and Social Affairs, Population Division 2004). This conjuncture is prone to create tensions in food markets that could lead to world food price crises, as in 2008 when the price of rice more than doubled in only seven months. In this context of price instability and threatened food security, tools to monitor rice production in real-time are highly needed by governments, traders and decision makers.

Accurate information is needed on the spatial distribution of rice fields, water resource management, risk occurrence and annual production projections. However, most agricultural surveys rely mainly on statistics based on limited ground samplings at which data are extrapolated on a national scale. Although the census can provide statistical estimates, slow and unsystematic collection of data can limit the ability to make timely decisions.

Moreover, rice agriculture is strongly linked to environmental issues, from water management to climate change. For these reasons, long term inter-annual monitoring is also required in order to study the production and cultural impacts of these factors. Satellite remote sensing can support this long term monitoring requirement at regional and global scales.

Objectives

Asia-RiCE describes a work plan for the definition and development of the Asia-RiCE component for GEOGLAM. The objectives are:

- To ensure that Asian countries receive the full potential benefits of GEOGLAM, and that they are suitably engaged and prepared to do so;
- To ensure that rice crop monitoring issues are given suitable priority and attention within the scope of the full GEOGLAM initiative, including in the development of the observing requirements; and
- To establish a framework for the coordination necessary to engage, manage and support the various stakeholders.

The regional activities suggested by the Asia-RiCE Work Plan will be consistent with and undertaken within the broader GEOGLAM Work Plan and there will be a number of interdependencies and interchanges between the two Plans.

Website provided by  JAXA  GEO GROUP ON EARTH OBSERVATIONS

Asia-RiCE
www.asia-rice.org/about.php




Home About Work Plan News/Events GEOGLAM Contacts Links

About

This work has been undertaken by an ad hoc team of stakeholders with an interest in the development of an Asia-Rice Crop Estimation & Monitoring (Asia-RiCE) component for the GEO Global Agricultural Monitoring (GEOGLAM) initiative.

GEOGLAM aims to enhance agricultural production estimates through the use of Earth observations. It was developed in response to the G20 Agricultural Ministers' concern about reducing market volatility for the world's major crops. The initiative builds on recent advances in Earth observation technologies. These technologies have great potential to contribute to timely forecasts of crop production and early warnings of potentially significant harvest shortfalls.

Importance of Rice Crop Monitoring

Rice is the staple food for more than half of humanity - with 90% of the world crop grown and consumed in Asia. Global rice production has increased continuously in the last half-century, since the Green Revolution. In the same period, the use of chemical inputs, the introduction of modern high-yielding varieties with short growing cycles, and the increased access to machinery and irrigation systems have led to a linear growth of the crop yields (+0.05ton/ha/year) as well as to an increase of the number of crops per year (Food and Agriculture Organization of the United Nations 2009).

This higher cropping intensity (from single to double or triple crop) together with the conversion of non arable land to arable land have resulted in a drastic increase of rice harvested areas in the 60s and 70s (+1.4Mha/year) which slowed down in the 80s and 90s (+0.46Mha/year) and has tended to stabilize over the last ten years as a result of approaching the limits of land use and of cropping intensity, however there is a large inter-annual variability due to climatic conditions and socio-economic factors. As both the increase in yield and in planted areas will be facing limitations in the next decades, it is unlikely that rice production can keep increasing at the same rate.

Meanwhile, world population, and therefore demand for food, has increased linearly over the last fifty years (+80M/year), and is projected to keep growing until around 2050 up to 9 billion inhabitants (United Nations Department of Economic and Social Affairs, Population Division 2004). This conjuncture is prone to create tensions in food markets that could lead to world food price crises - as in 2008 when the price of rice more than doubled in only seven months - and eventually to famines. In this context of price instability and threatened food security, tools to monitor rice production in real-time are highly needed by governments, traders and decision makers.



Top rice producing countries by MT, 2010 (Source: FAOSTAT).
Click to enlarge.



Accurate information is needed on the spatial distribution of rice fields, water resource management, risk occurrence and

Asia-RiCE Components

Red color is related to K&C research

ID	Target Agricultural Products
P1	Rice Crop Area Estimates/Maps
P2	Crop Calendars/Crop Growth Status
P3	Crop Damage Assessment
P4	Agro-meteorological Information Products
P5	Production Estimation and Forecasting

Research Topic

- Perform rice crop area and yield studies using ALOS-2 ScanSAR along with other polarimetric SAR (e.g. RADARSAT-2) new wide fine mode, European SAR (Sentinel-1), and DLR's TerraSAR-X with ground based observation systems (field routers) and rice crop models.
- Derive phenological information from SAR data (rice crop calendar and land use map) and perform a comparison with optical-based phenological information.
- Investigate the relation to rice crop growth stage; work on a correction method for incidence angle variations; and investigate the interoperability of optical and SAR data.

Asia-RiCE team phasing

CY	Target countries	Task	2013	2014	2015	2016-2018
Phase 1A	Indonesia, Vietnam, Thailand	Area estimation	APRISAF regional and bilateral cooperation with Japan and others			
		Outlook	Cooperation with AFSIS and Japan			
Phase 1B	1A + Japan, Malaysia, Chinese Taipei, Philippine	Area estimation				
		Outlook (1A + Philippine)		Cooperation with AFSIS and Japan		
Phase 2						-----➔

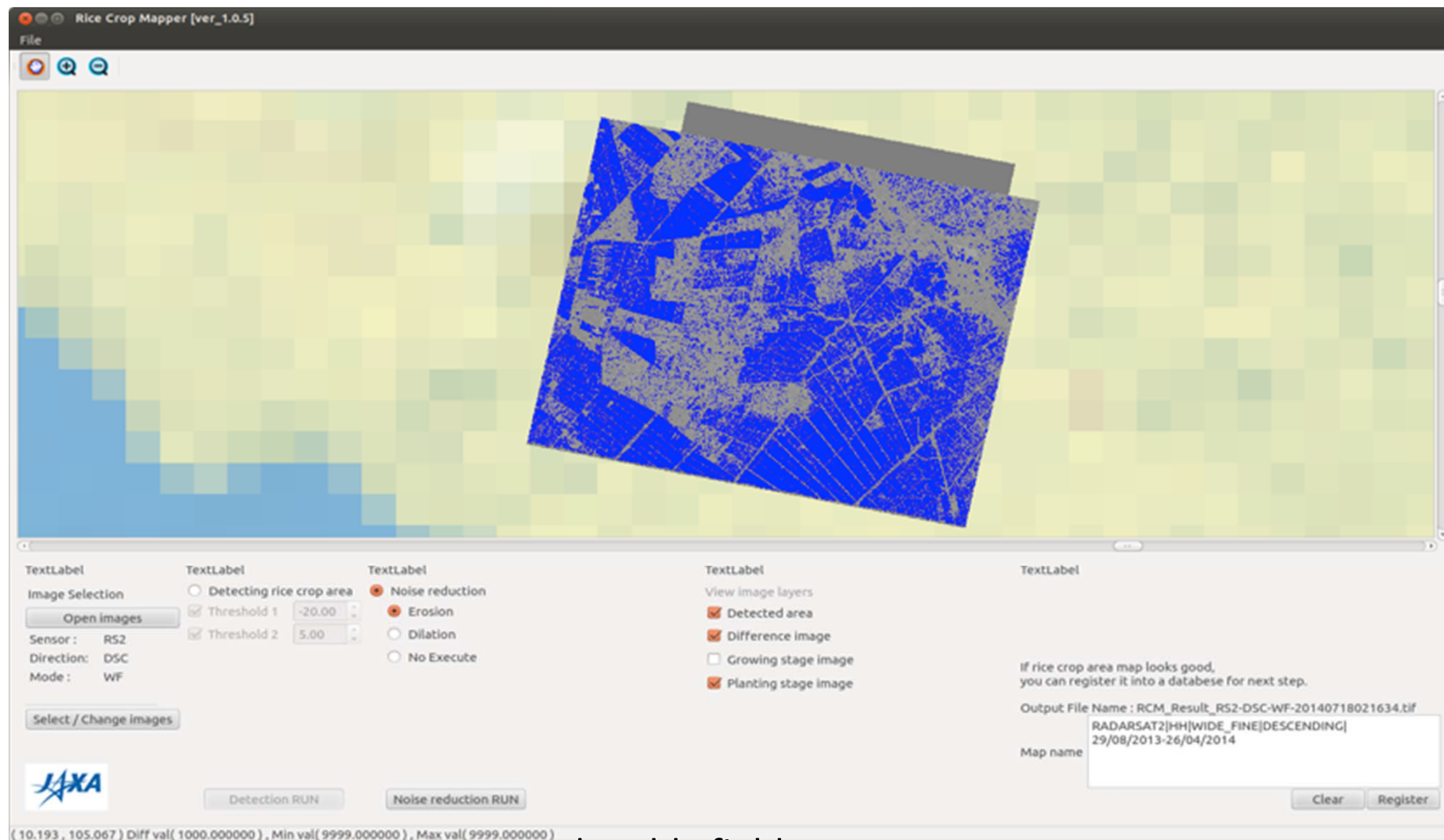
List ground truth data that will be shared with JAXA

Technical Demonstration Site	Field Photos	Field Measurements	High-resolution EO data	Other	Restrictions
Indonesia Subang, West Java Province Batola, South Kalimantan Province	– Photo of reference fields when available	– Coordinates, rice season (eg, timing of sowing and harvest, crop growth stage (vegetative, reproductive, maturity))			Based on data Acquisition, in 2014 field data are planned to be collected until Oct 2014. Due to our fiscal year, for next ground survey will be conducted in 2015. The number of reference fields will depend on the available funding
Thailand Suphan Buri Province	– Daily photos using field server with AWS	– Coordinates, rice season (e.g. timing of sowing and harvest), crop growth stage (vegetative, reproductive, maturity)			Need to coordinate with ADB project to share data
Vietnam Thai Binh (North)	– Photo of reference fields when available	– Dates, coordinates, rice variety, growth stage (vegetative/flowering), crop age, crop vigor, plant density, height, orientation, expected crop duration (in excel file format).	– Limited number of VNREDSat-1 scenes	– Monthly rice monitoring reports from Thai Binh Provincial Department of Agriculture and Rural Development	Need to coordinate with ADB project to share data
Vietnam An Giang (South)	– Photo of reference fields when available	– Coordinates, rice season (e.g. Autumn-Winter, Winter-Spring, Summer-Autumn), crop			The number of reference fields will depend on the available funding. The ground data will be released after analysis and reporting of the study team.

List ground truth data that will be shared with JAXA

Lao P.D.R. Savannakhet Province	– Photo of reference fields when available	– Coordinates, rice season (e.g. timing of sowing and harvest), crop growth stage (vegetative, reproductive, maturity)	Need to coordinate with ADB project to share data
Philippines Nueva Ecija (RIICE)	- Photo of reference fields when available	Coordinates, rice season (e.g. timing of sowing and harvest), crop growth stage (vegetative, reproductive, maturity)	Need to coordinate with IRRI/RIICE and ADB project to share data
India Bardhaman District, West Bengal State	Field photos where available	– Coordinates, rice season (e.g. timing of sowing and harvest), crop growth stage (vegetative, reproductive, maturity)	Limited scenes of high EO data (TBD)
Japan Tsuruoka, Yamagata Prefecture	– Daily photos using field server with AWS	– Coordinates, rice season (e.g. timing of sowing and harvest), crop growth stage (vegetative, reproductive, maturity)	
Malaysia Barat Laut Selangor Province	– Photo of reference fields when available	Coordinates of study area. Crop calendar giving the various stages.	Need to coordinate with IADA Barat-Laut Selangor Rice Project
Chinese Taipei (Taiwan) Chang Hua,	– Photo of reference fields when available	– Coordinates, rice season (First Crop and Second Crop), timing of	Limited number of Formsat-2 scenes (TBD)

P1: Expected product (deliverables) - Paddy Field Area Detection by temporal series SAR



Detected paddy field area

Data : Descending images with JAXA's software (INAHOR)

Sentinel-1 and ALOS-2 data for Asia-RICE

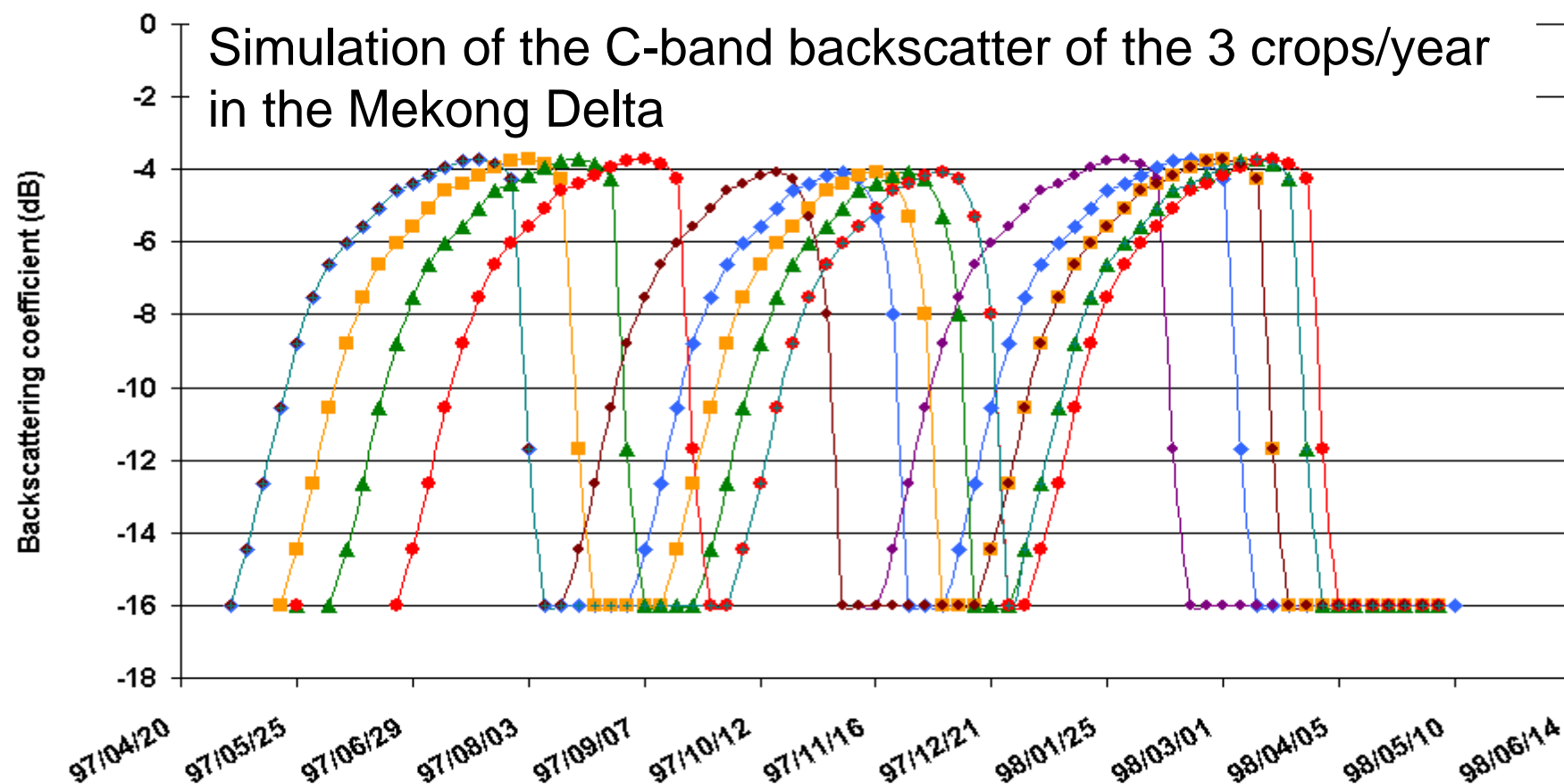
Thuy Le Toan
CESBIO, France

Mission	Instrument	Data adapted to rice monitoring
RADARSAT-2 (CSA/MDA)	C-band SAR (5.405 GHz) 24 days repeat cycle	Wide Fine mode(150 km, 20m), F0W2, Incidence 31-39°, VV and VH
Sentinel-1 (2014) (ESA)	C-BandSAR (5.405 GHz) 12 days	Stripmap mode (80 km swath, 10 m resolution. Incidence range 30-40°, VV and VH
RISAT-1 (ISRO)	C-Band SAR (5.350 GHz) 25 days	MRS (115 km swath, 22-43 m), Incidence 23-49° HH and VV
TerraSAR-X (DLR)	X-Band SAR (9.65 GHz) 11 days	a) StripMap (SM), 15x50 km 1.2x 6.6 m resolution, HH&VV 20-40° b) Tandem X: StripMap, interferometric mode, alternating bistatic, HH,
COSMO SkyMed (ASI)	X-Band SAR (9.6 GHz) 4 satellites/ 16 days	StripMap pingpong (20m, 30 km swath) HH and VV, Incidence >40°
ALOS-2 (2014) (JAXA)	L-band (1,270 GHz) 14 days	StripMap (10m, 70 km) 14 days HH and VV

SAR Data Requirements

1. Strong temporal variation of the radar backscatter of rice fields
2. Non uniform crop calendar of adjacent fields

→ **High temporal frequency data (Sentinel-1)**



ALOS

K&C Initiative

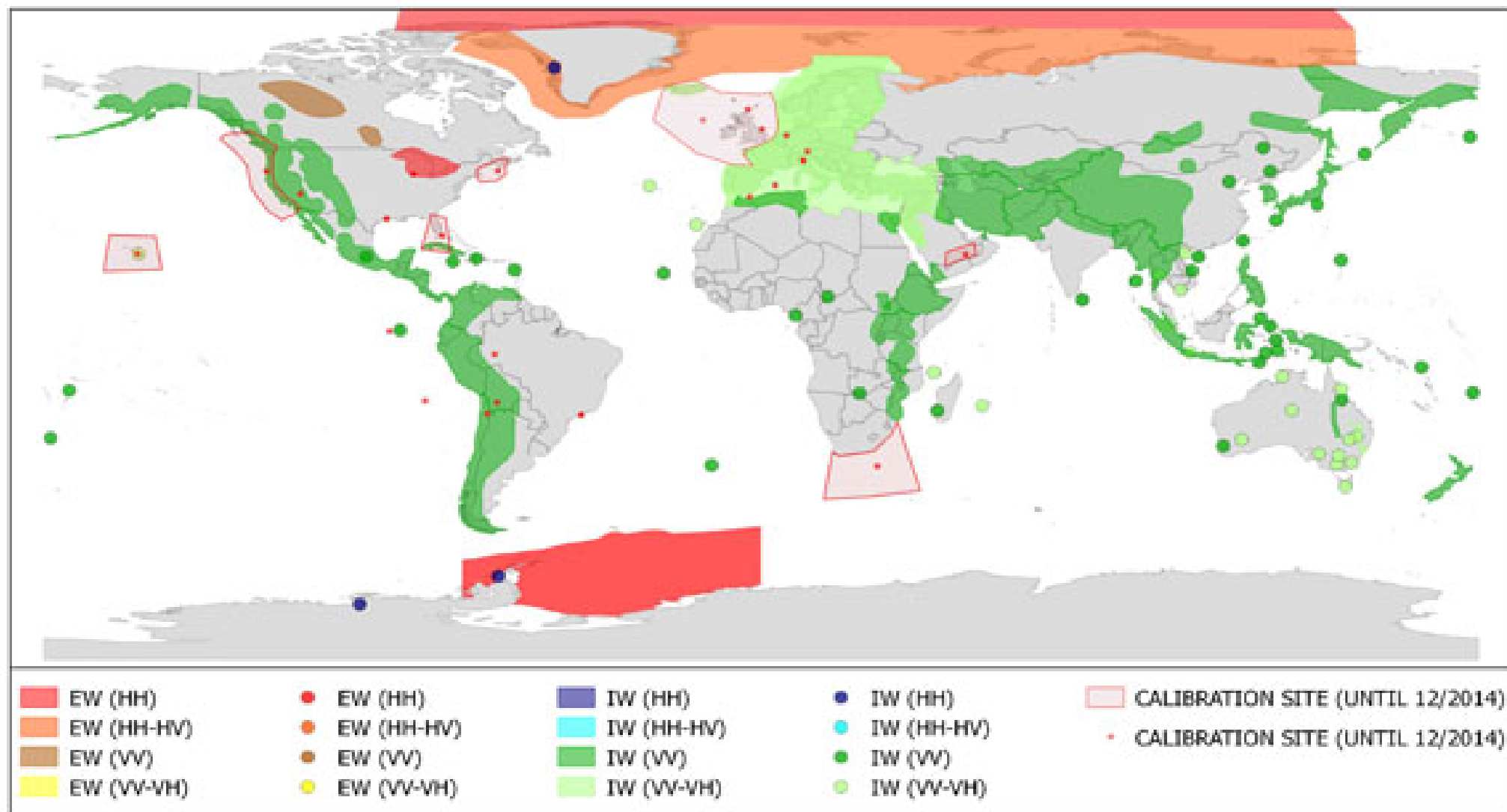
An international science collaboration led by JAXA

Asia-RiCE Technical Demonstration Sites



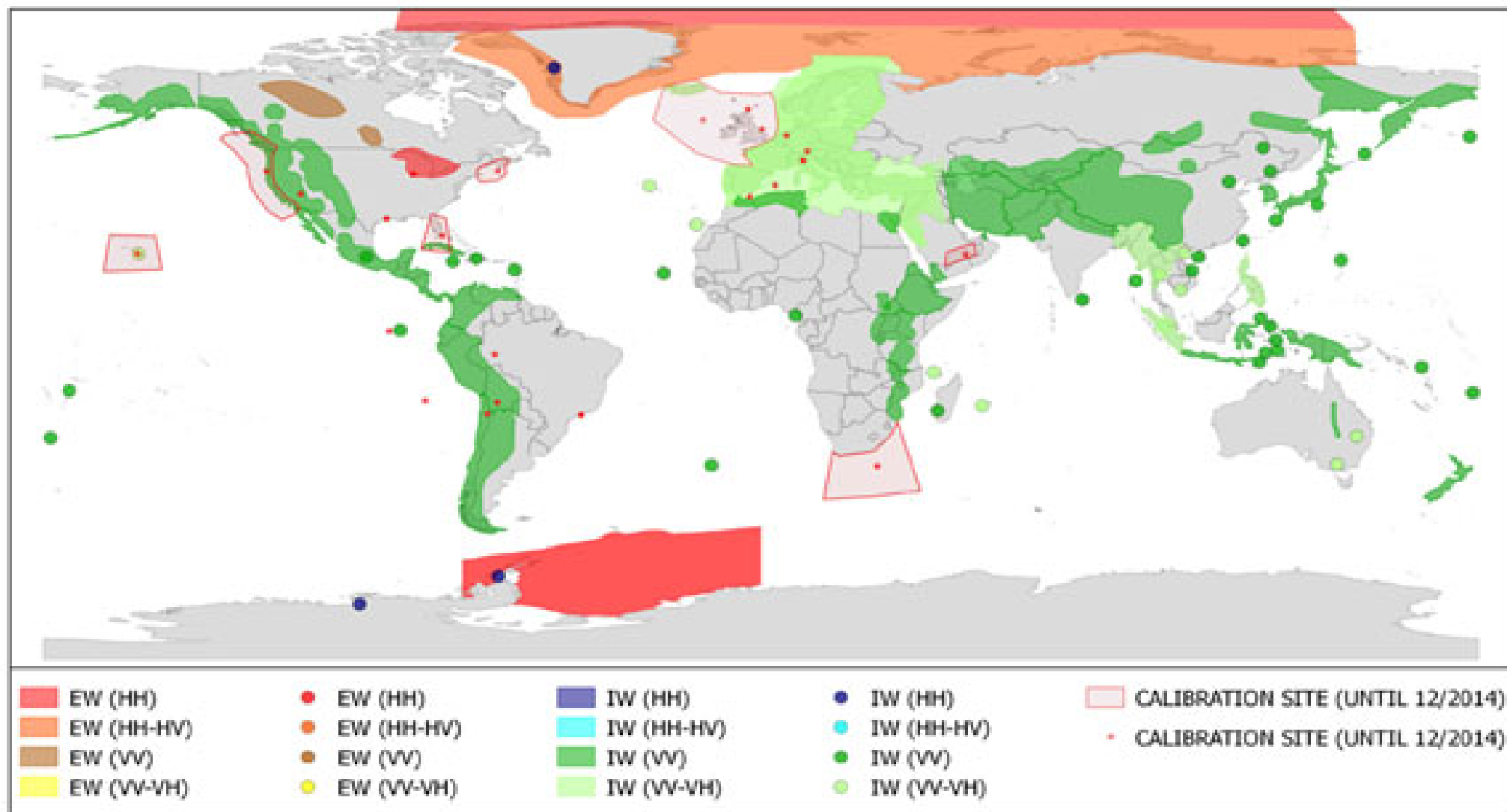


SENTINEL-1A - OBSERVATION SCENARIO 30.09.2014 - 12.10.2014 (CYCLE 29)



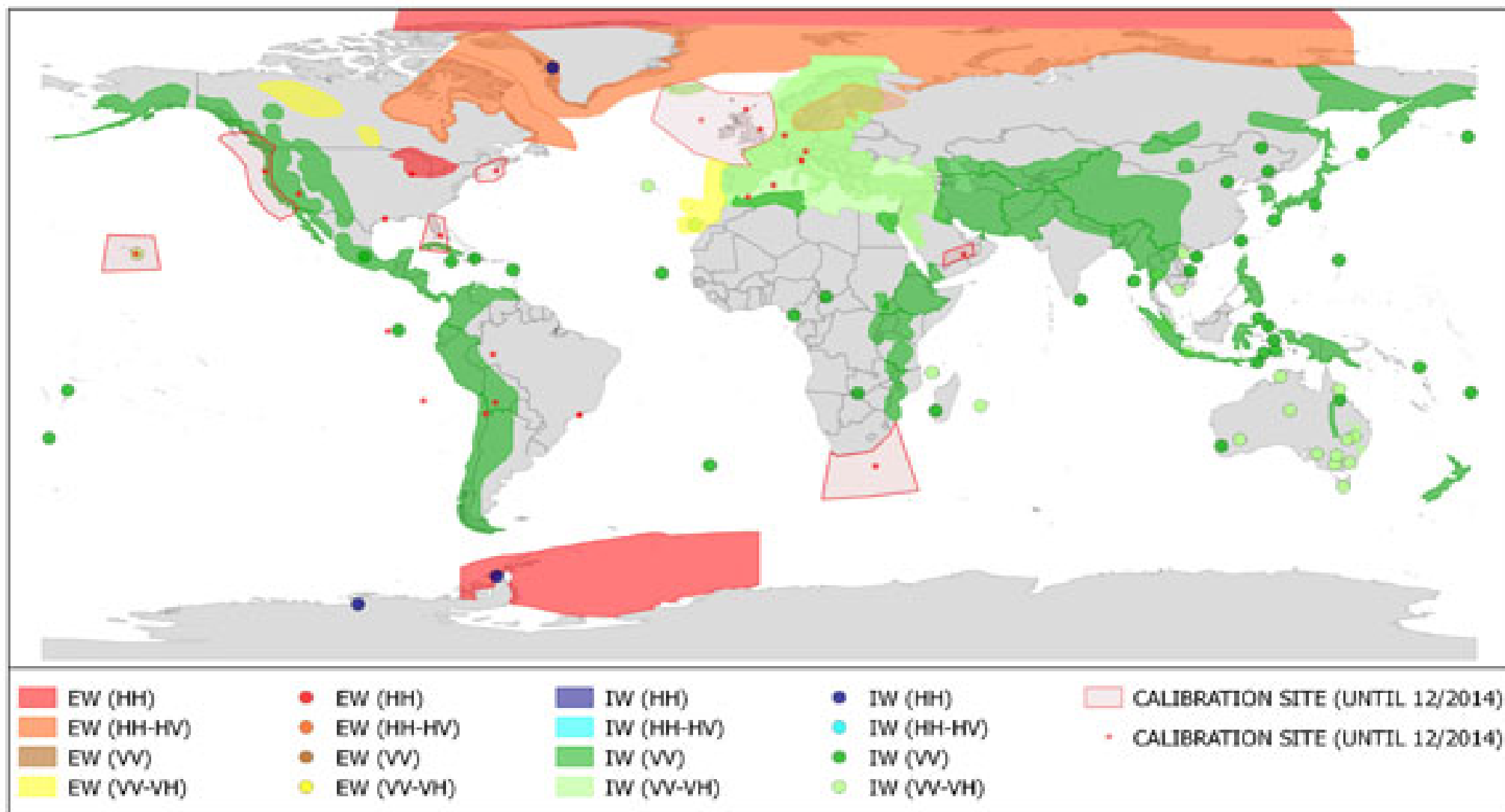


SENTINEL-1A - OBSERVATION SCENARIO 12.10.2014 - 24.10.2014 (CYCLE 30)



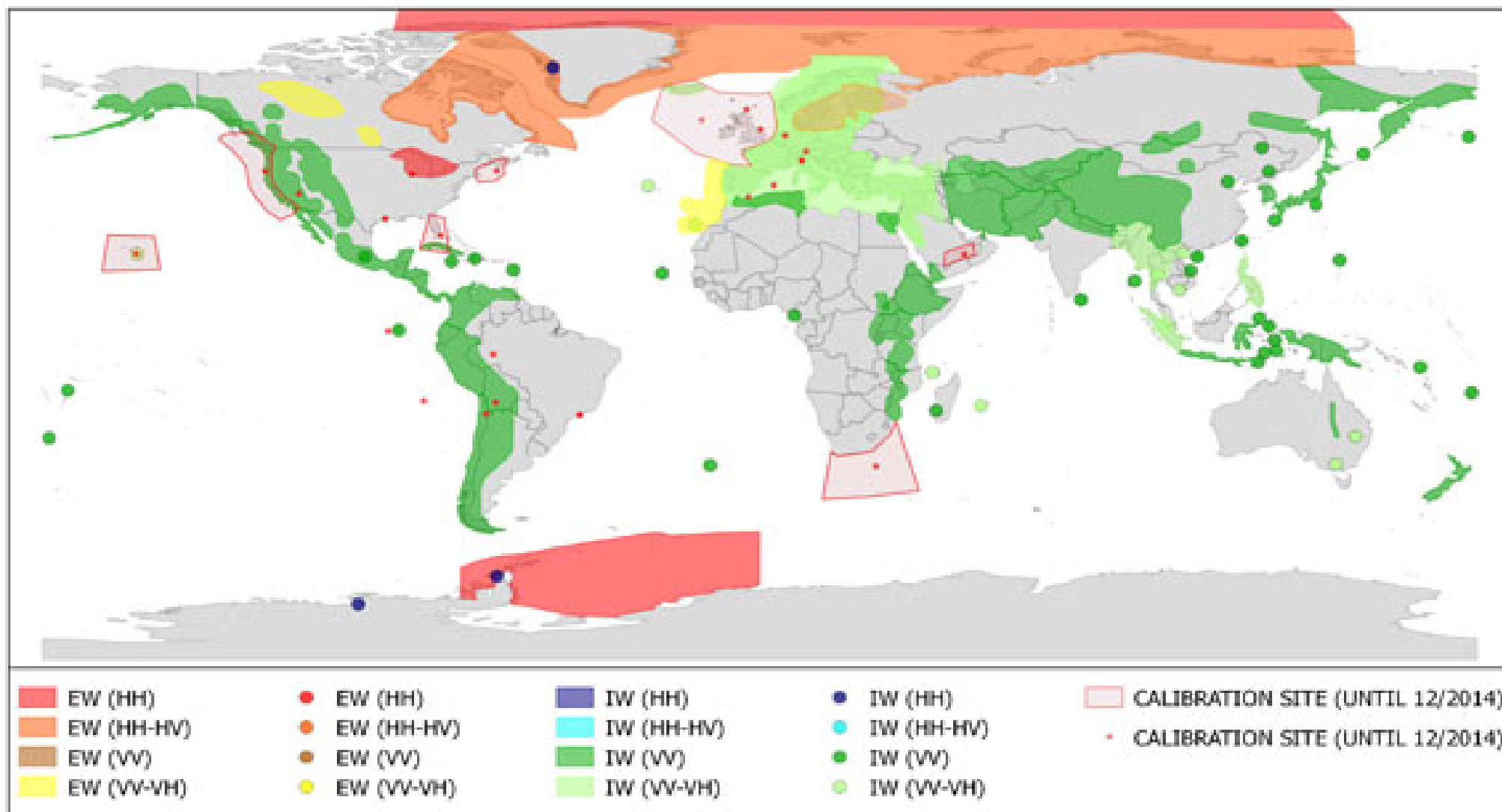


SENTINEL-1A - OBSERVATION SCENARIO 24.10.2014 - 05.11.2014 (CYCLE 31)



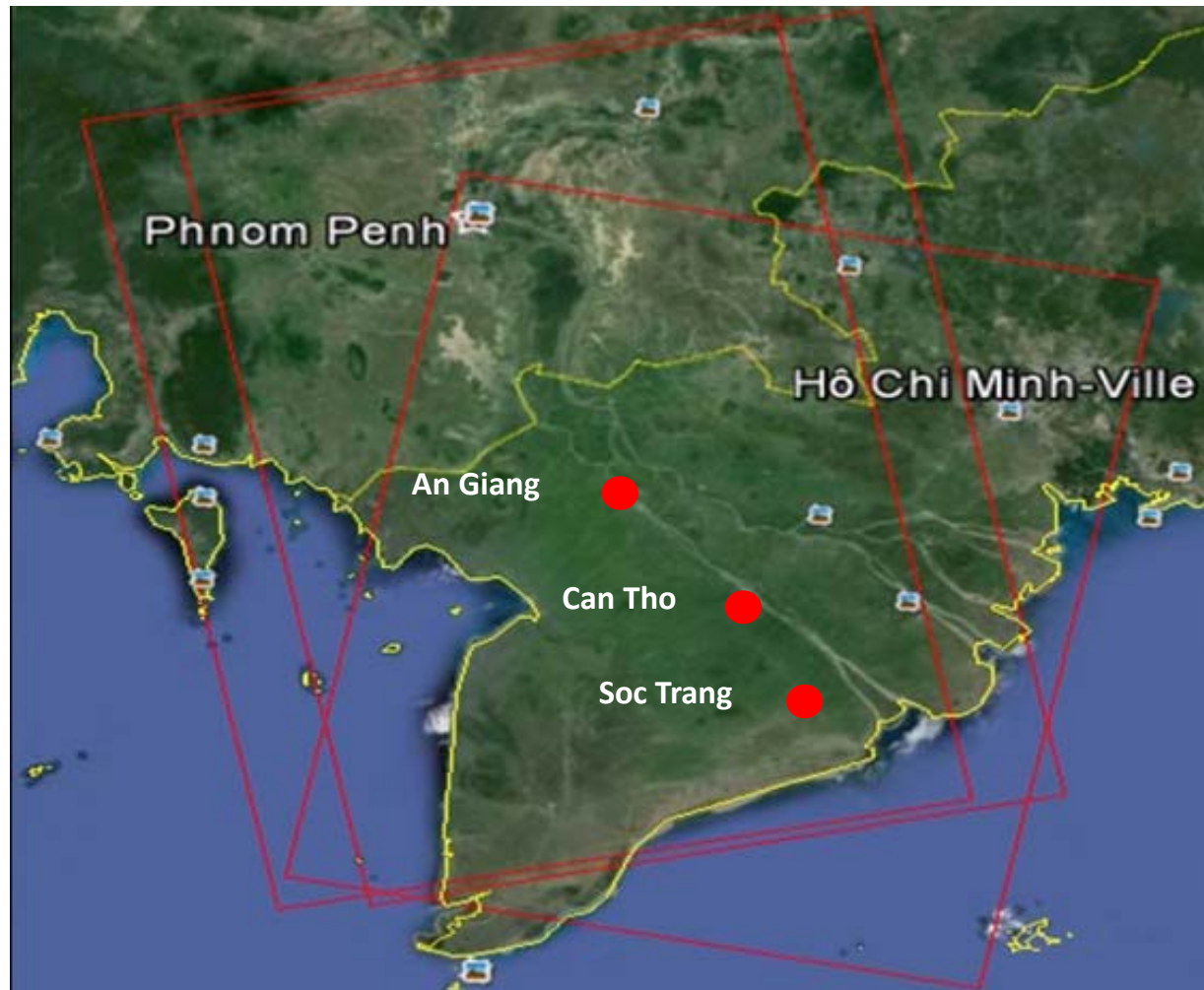


SENTINEL-1A - OBSERVATION SCENARIO 05.11.2014 - 17.11.2014 (CYCLE 32)



The Sentinel-1 Reference Site

Agreed in consultation with the Asia Rice -GEOGLAM CEOS adhoc working group.

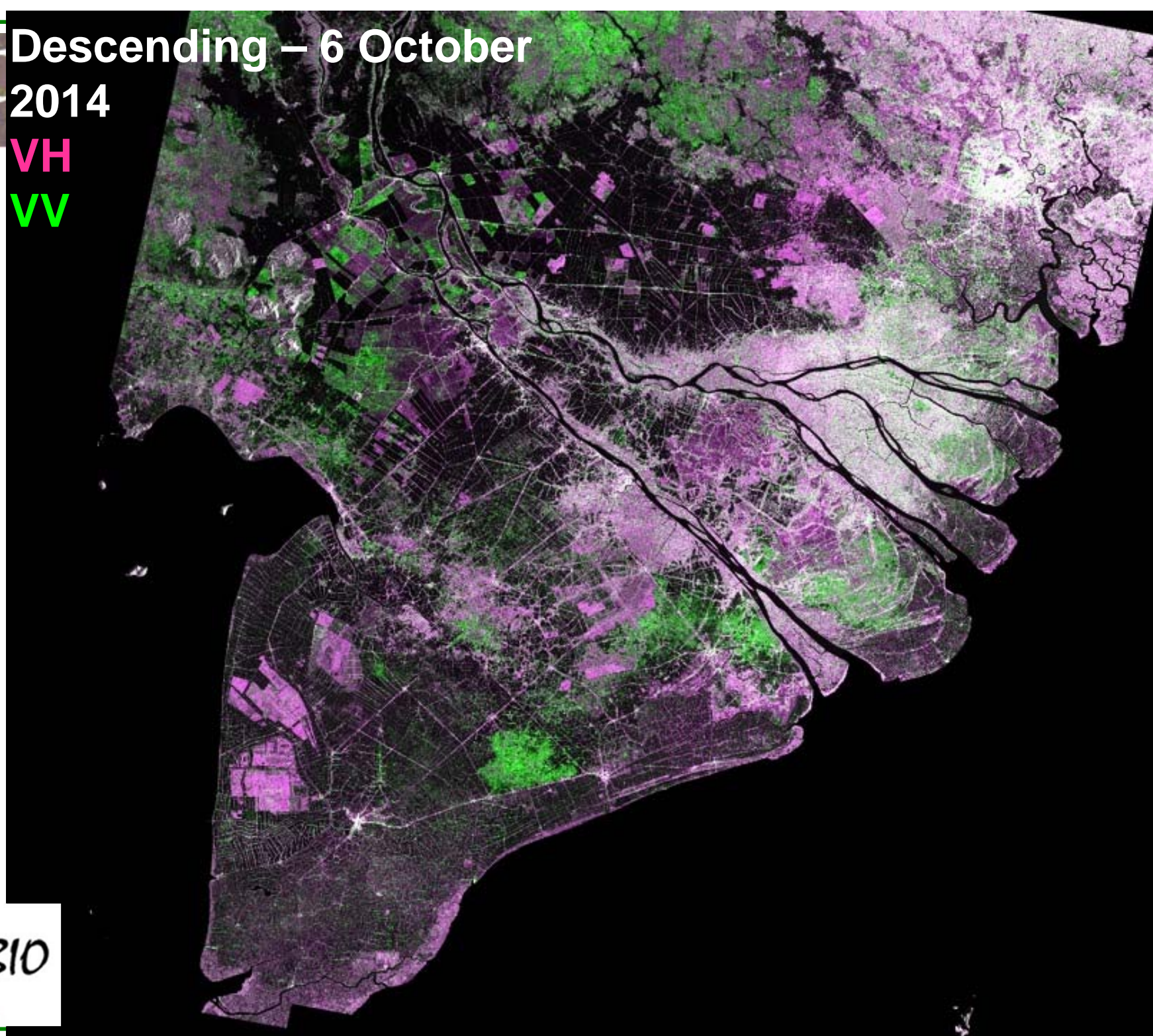


**Coordination of ground data collection for 3 sites
(Asia-Rice meeting, August 2014, Taiwan)**



Descending – 6 October
2014

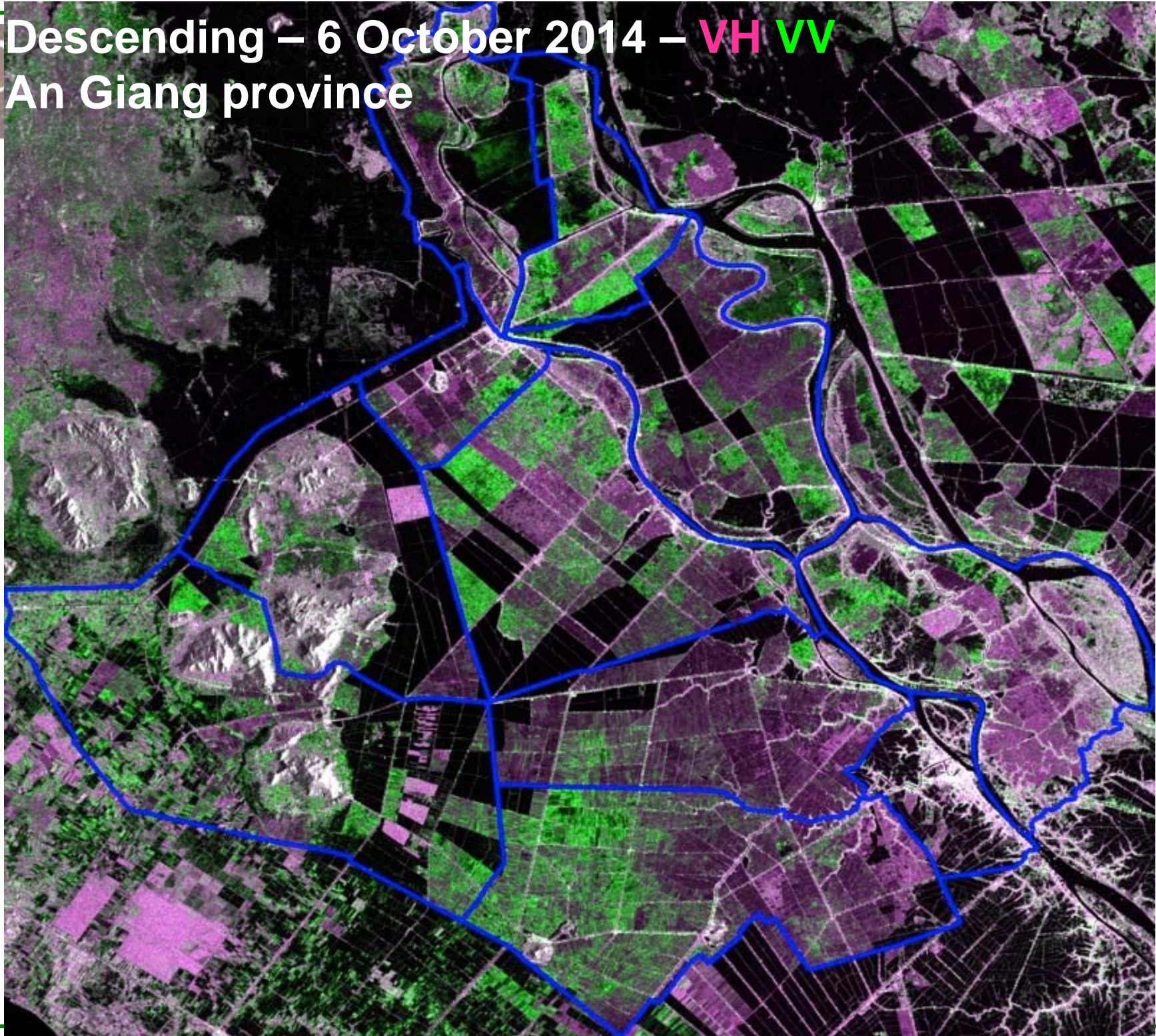
VH
VV





Descending – 6 October 2014 – **VH** **VV**
An Giang province

by JAXA



ALC

Descending – VH An Giang province

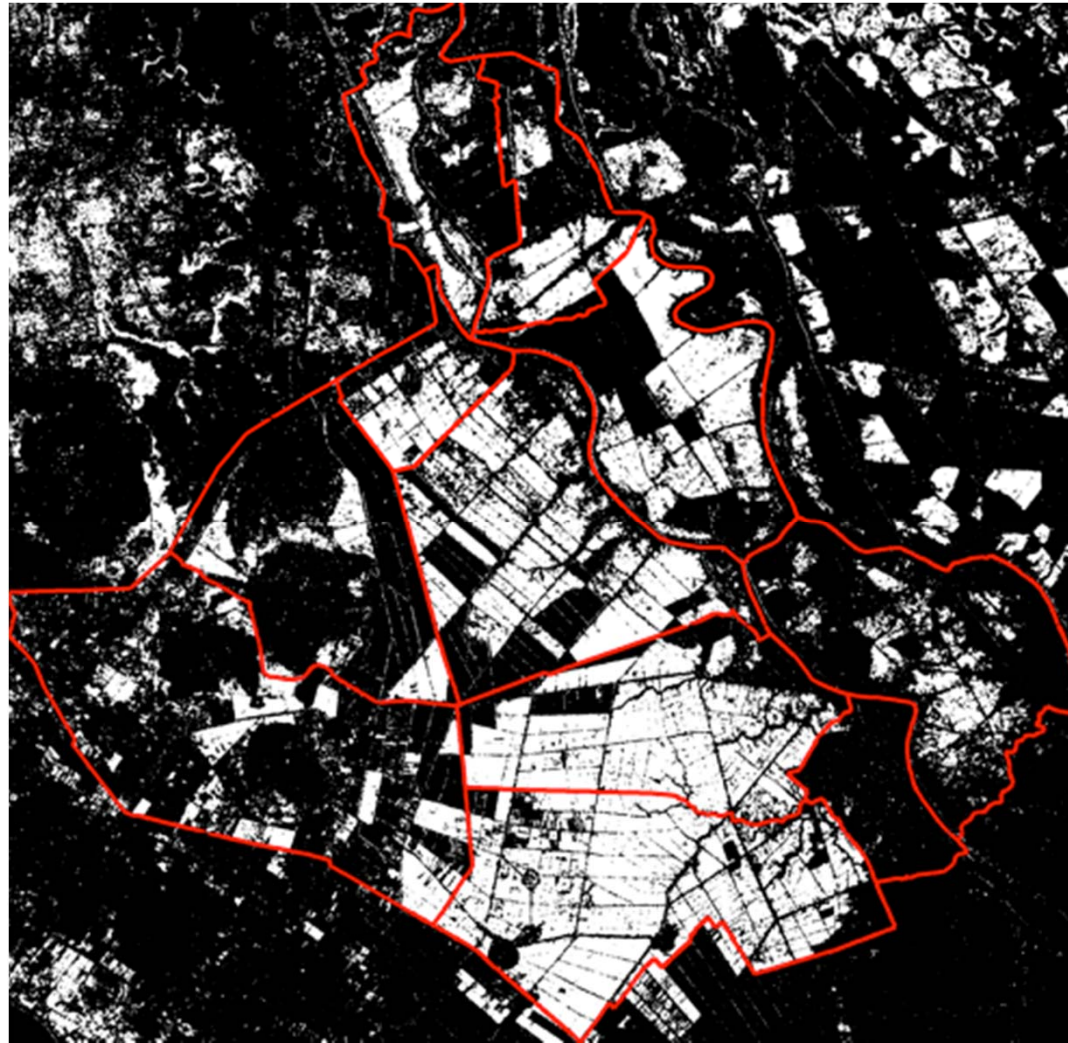
19 August 2014

31 August 2014

6 October 2014

d by JAXA

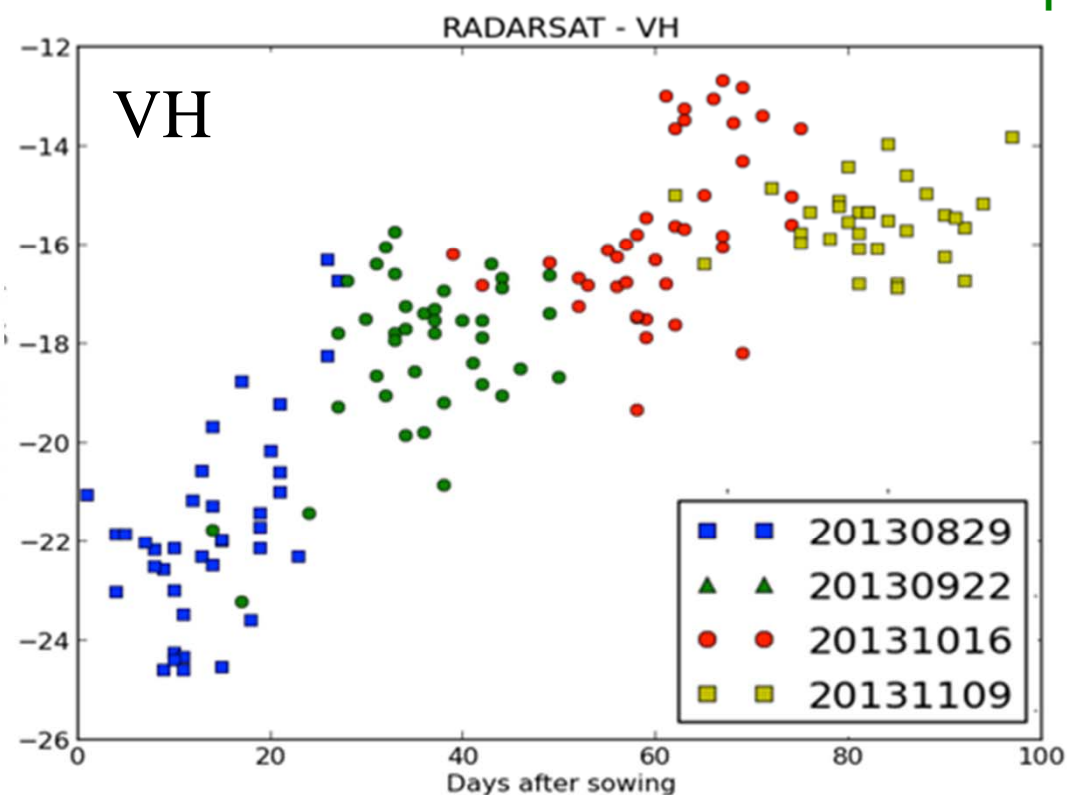
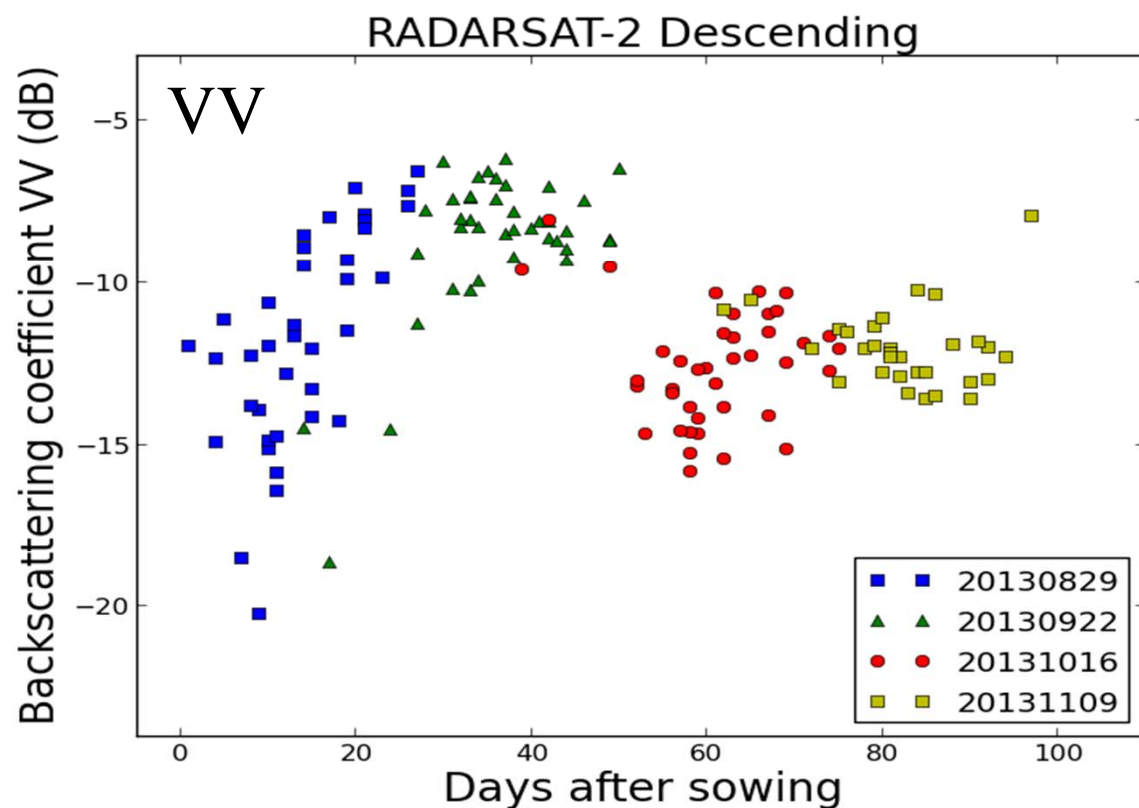


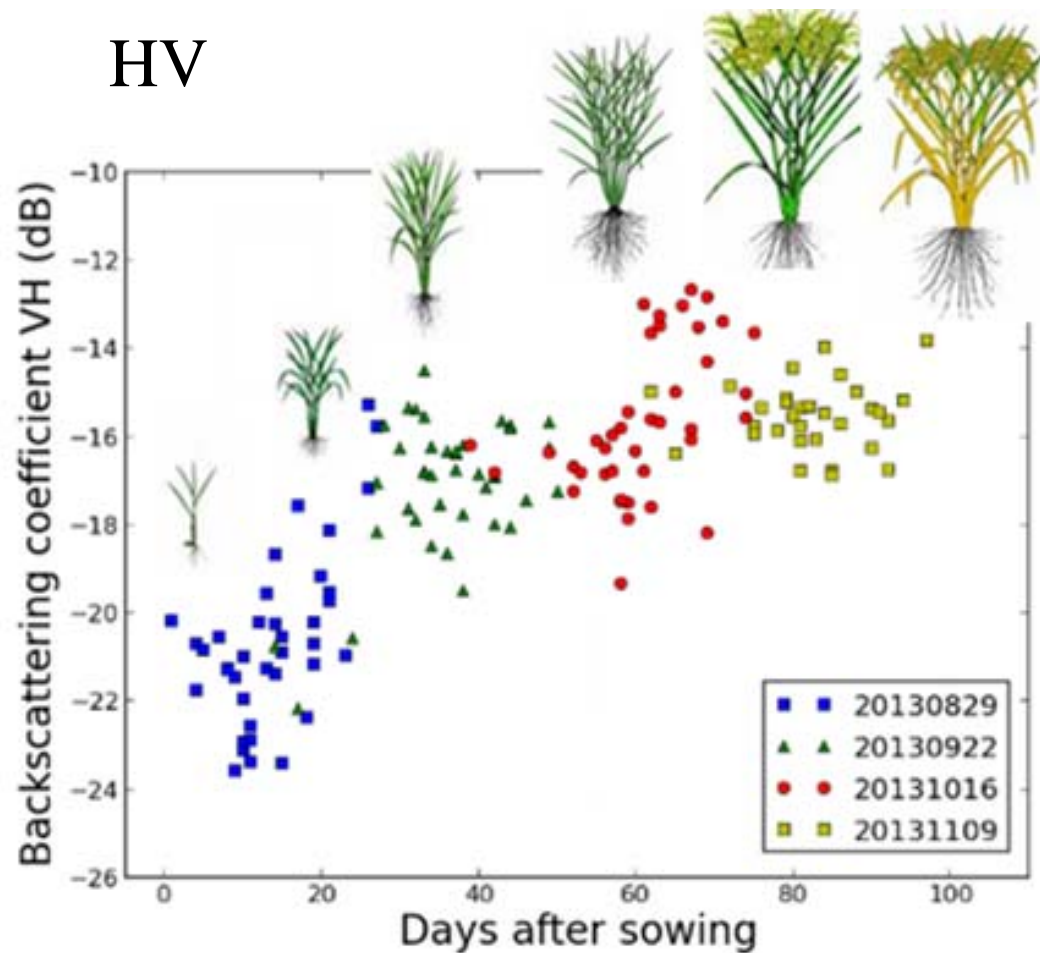


Autumn-Winter Rice in An Giang province, 6 October 2014
Using Sentinel-1 data

Data understanding for rice field mapping and monitoring rice growth

Using Radarsat 2, Wide fine 1 in 2013 (Asia-Rice-CEOS)





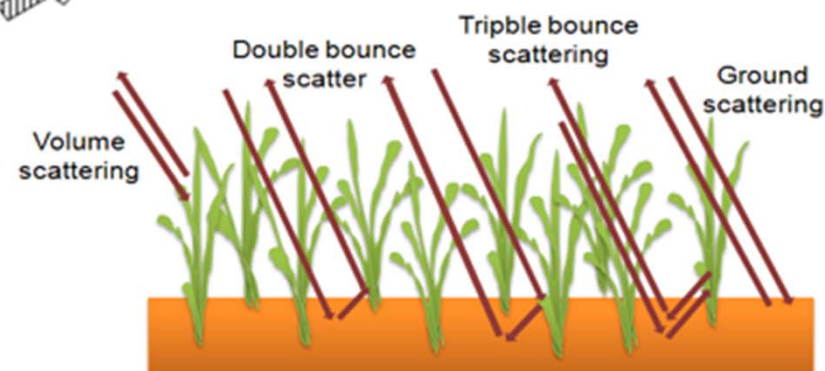
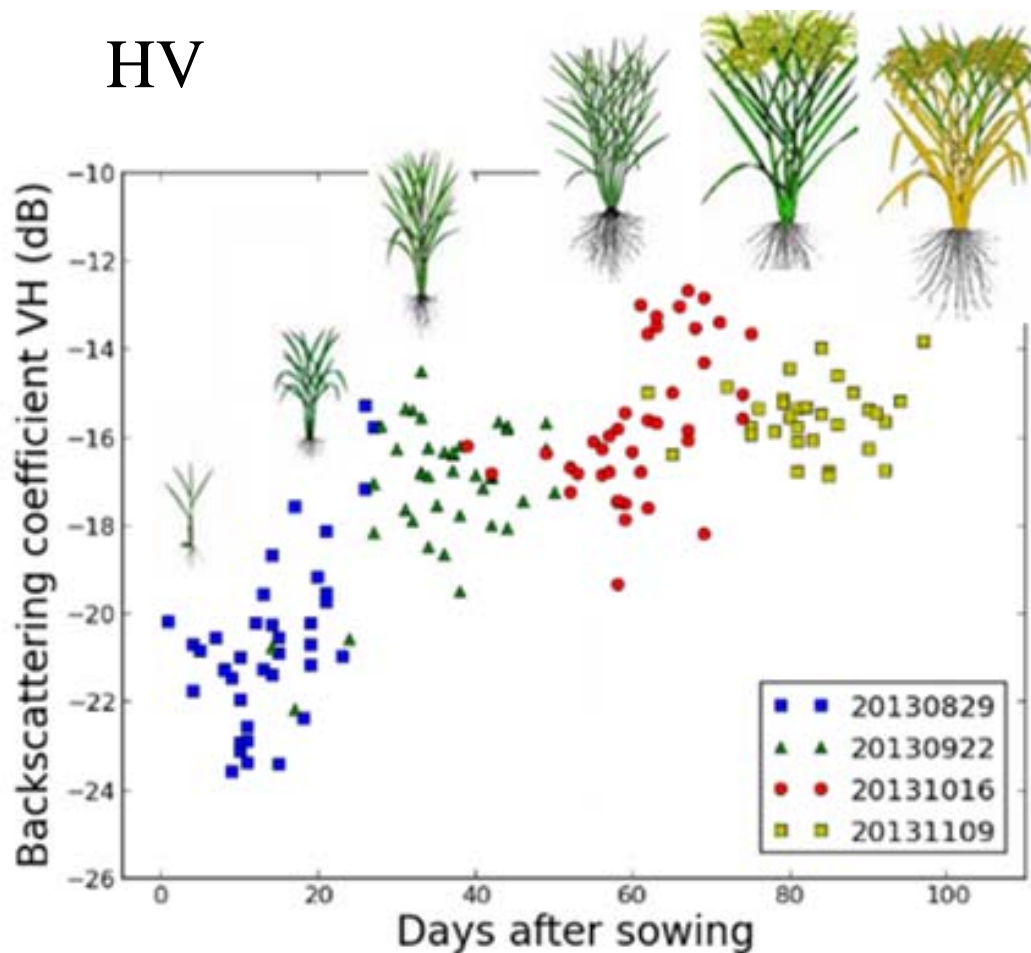
Increase of VH backscatter
8-10 dB during the cycle

→ *Use temporal change for rice mapping*

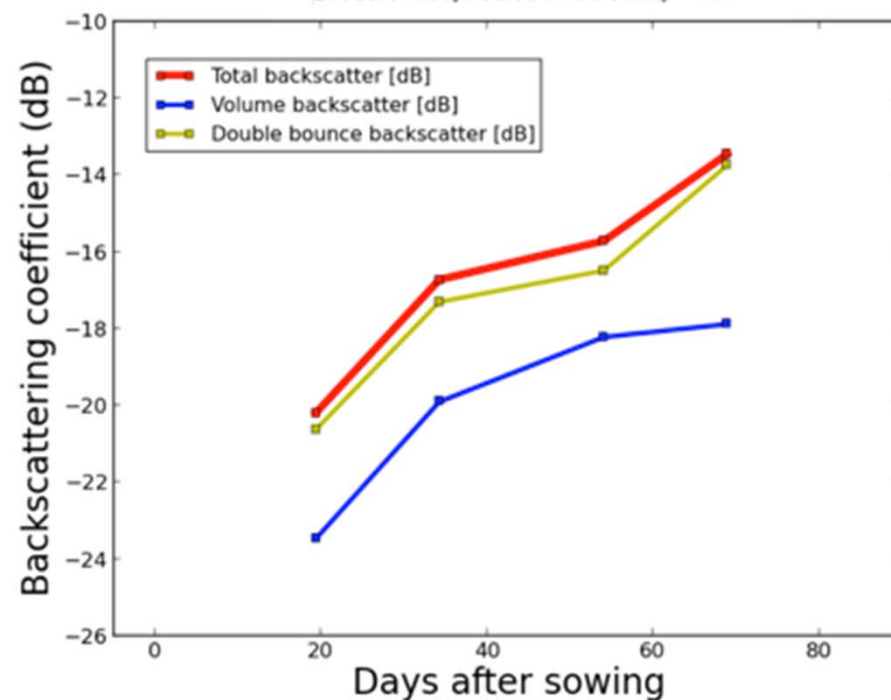
Electromagnetic modelling



HV

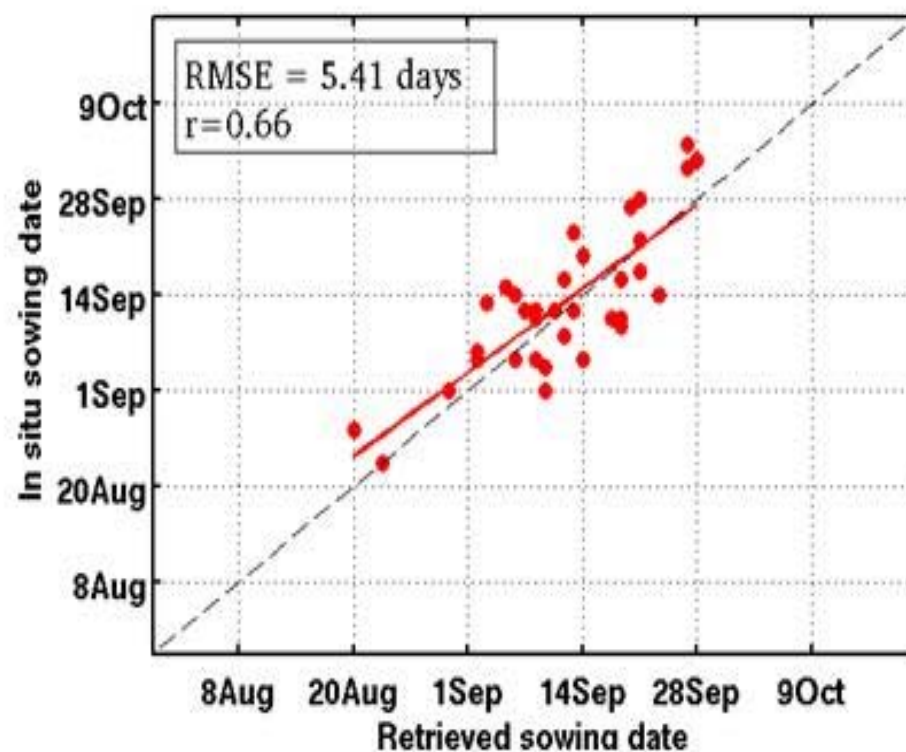
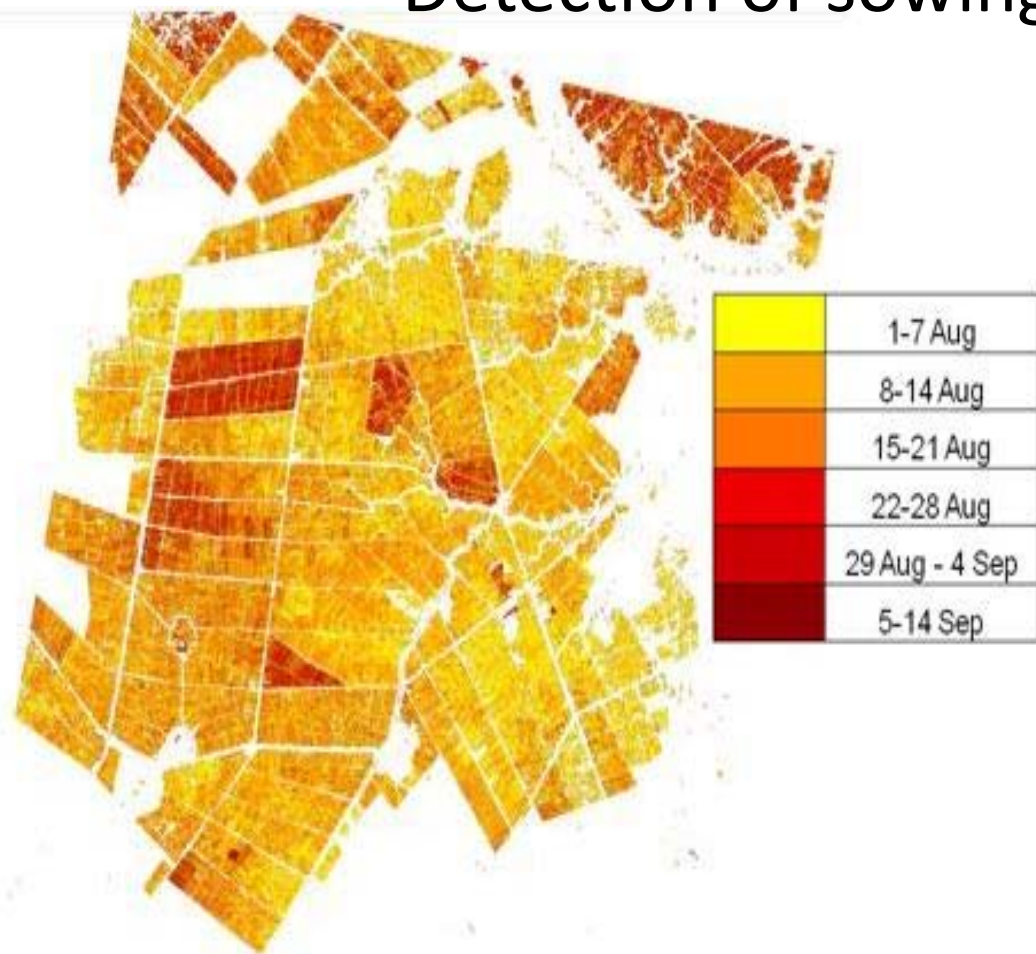


Electromagnetics modeling - VH



→ *Use temporal change for rice mapping*
Derivation of sowing date, rice biomass

Detection of sowing date with 3 RS-2 data, 2013



Sentinel-1A and ALOS-2

Sentinel-1A scheduled in 2015 on Asia Rice Technical Demonstration Sites

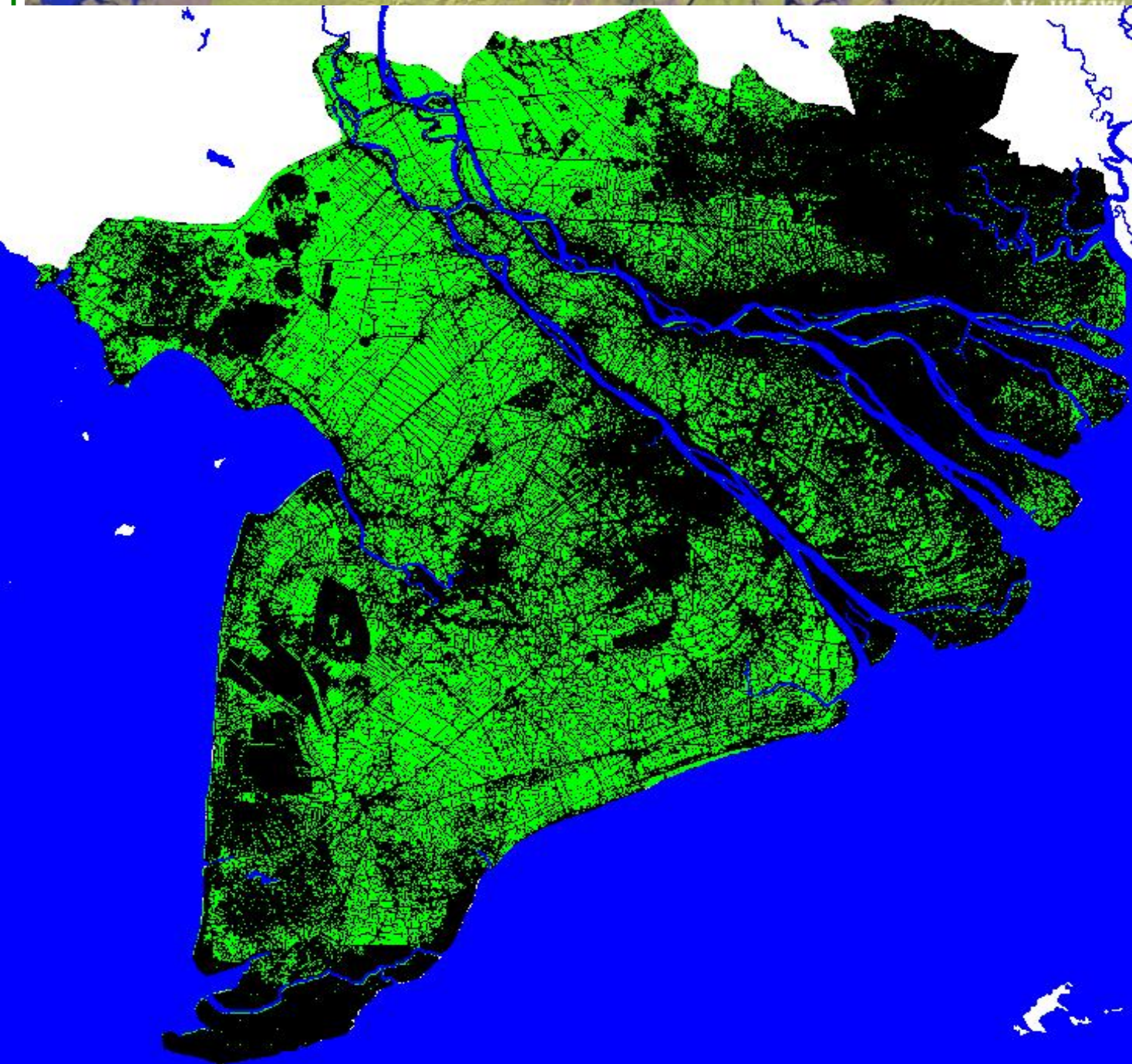
- ❑ For RS research at Asia-RICE demonstration sites
→ ALOS-2 stripmap data
- ❑ For large scale rice and wetland mapping
→ We expect to have ScanSAR ALOS-2 data

Towards an entire Asia Rice mapping?

ALOS

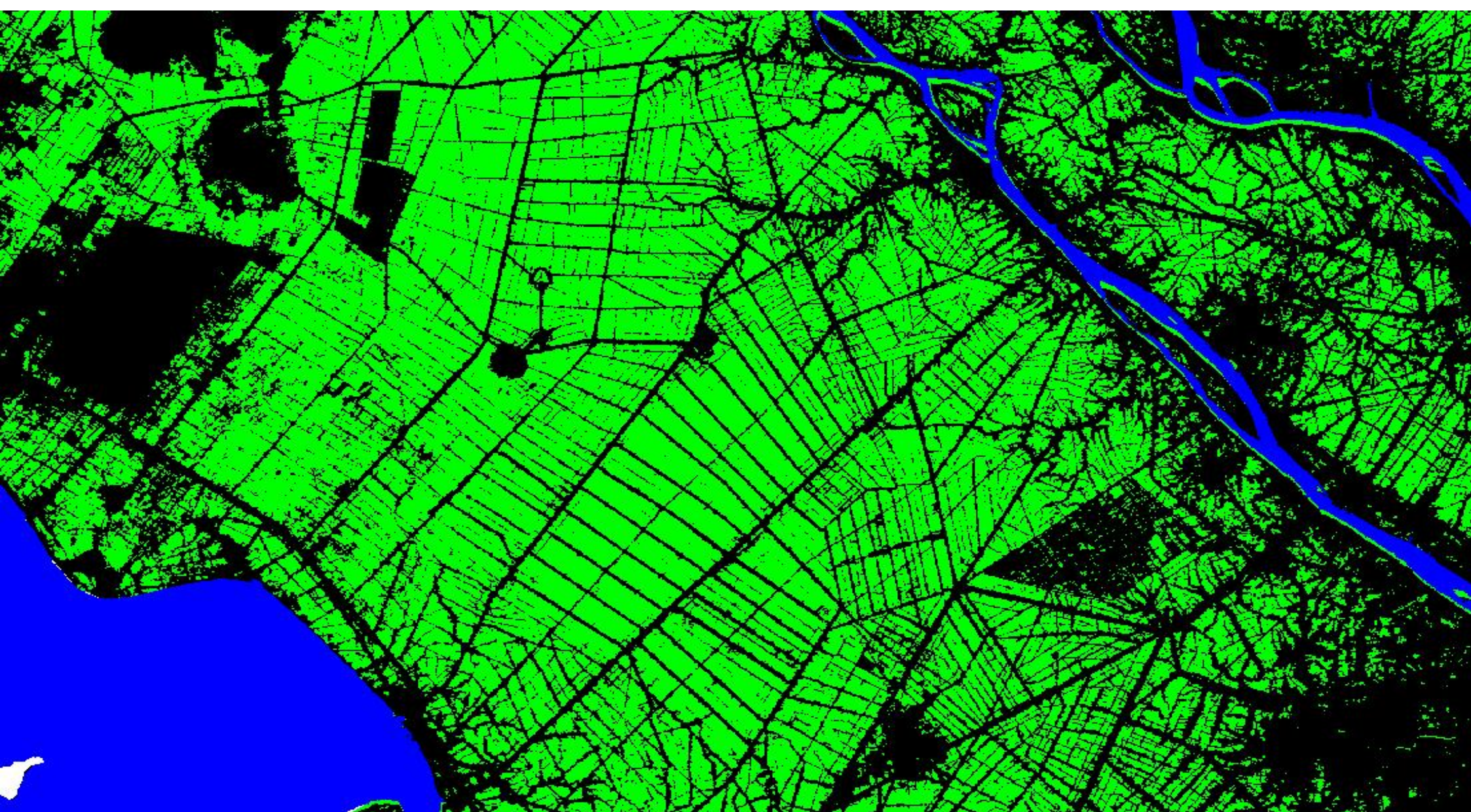
K&C Initiative

An international science collaboration led by JAXA



From PALSAR mosaic

2007



From PALSAR mosaic

Rice area in green

Trees or built areas in black