Rice Crop Monitoring Using Multiple EO Data in Japan

- Rice Growth Monitoing using C- and L-Band SAR Data -

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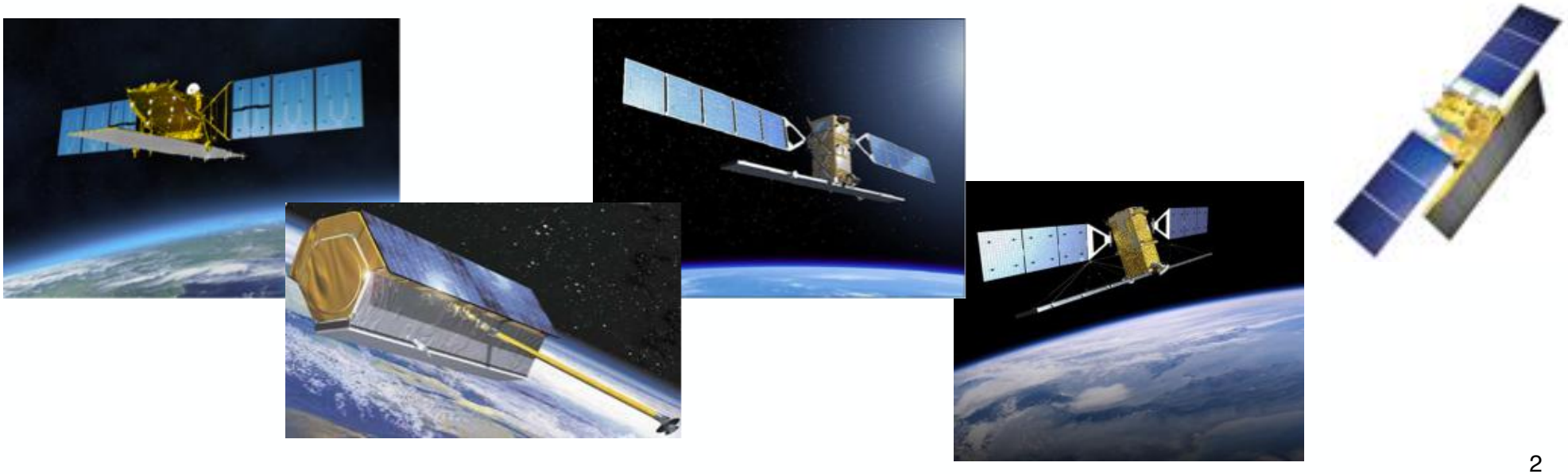
GEOGLAM Global Agricultural Monitoring

Asia-RiCE Crop Estimation and Monitoring

Tsukuba Space Center Japan Aerospace Exploration Agency JAXA

Synthetic Aperture RADARs (SARs)

- A fleet of SAR satellites with different frequencies, such as X-, C-, and L-bands, is currently available.
  - RADARSAT-2, RISAT-1, ALOS-2, Sentinel-1A/1B, TerraSAR-X etc.
- The integrated use of multiple SARs:
  - Enhance data acquisition reliability;
  - Improve data acquisition intervals;
  - Identify different physical parameters .



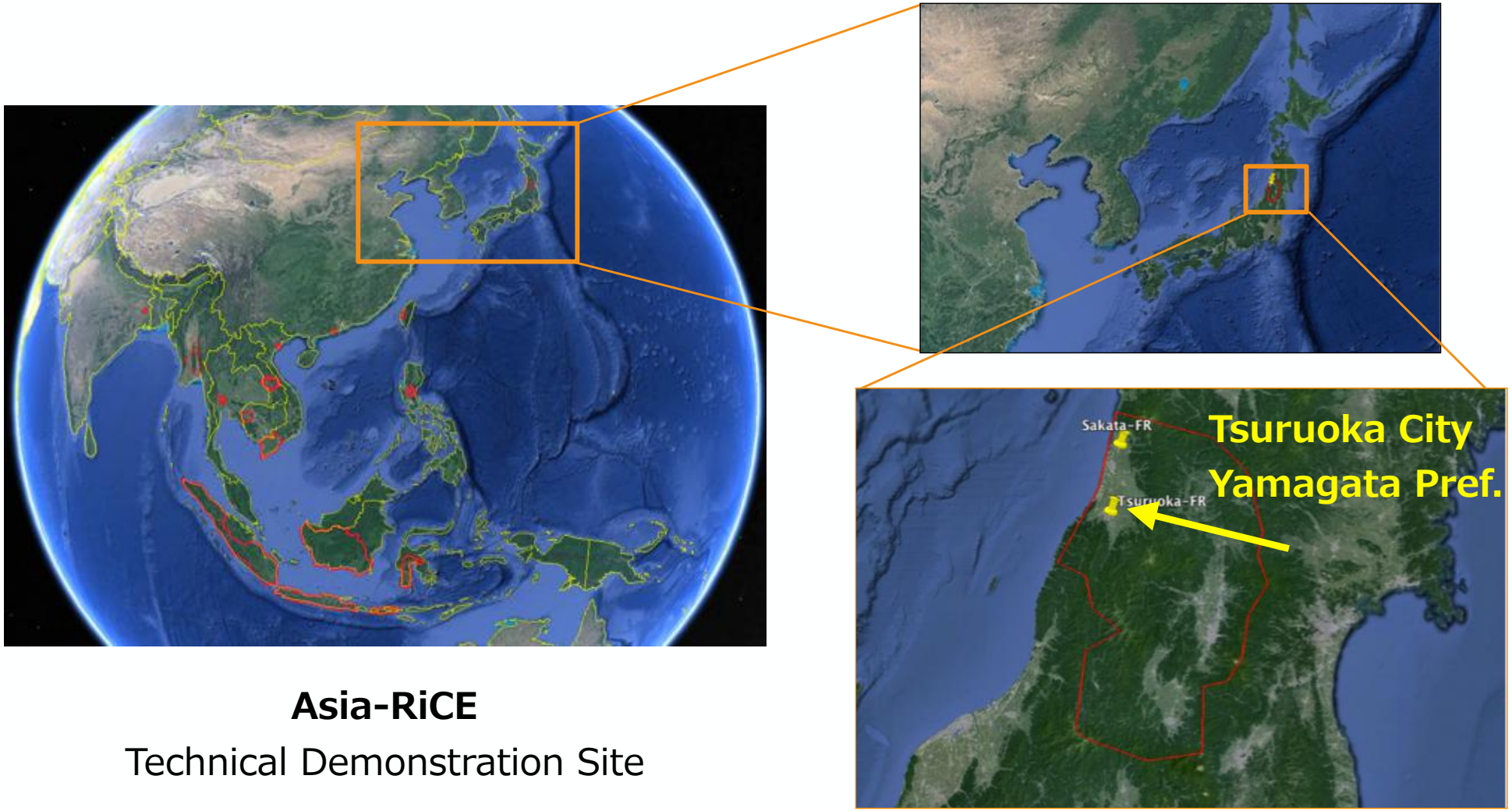
Objectives

- Intensive inter-comparisons have been already conducted by field experiment using ground-based scatterometers [Inoue et al. 2011, Kim et al., 2013]

- This study focuses on a practical demonstration by comparing C- and L-band actual multi-temporal and multi-frequency satellite SAR data for rice monitoring.

- In addition, we evaluate the sensitivity of the SAR C- and L-bands to each rice plant height and use this toward the integrated utilization of multi-frequency SAR data.

Study Area : Asia-Rice Site in Japan



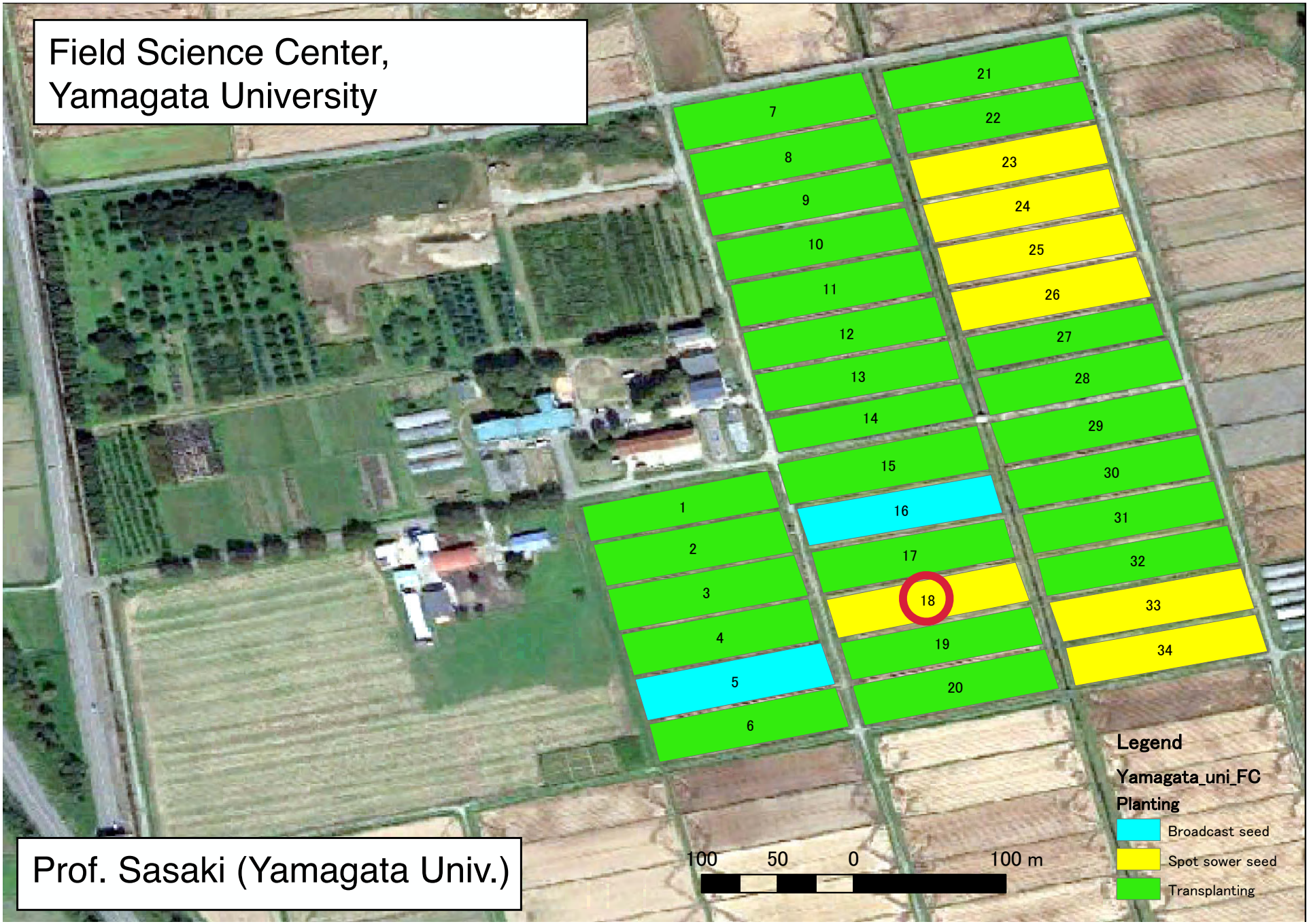
Asia-RiCE

Technical Demonstration Site

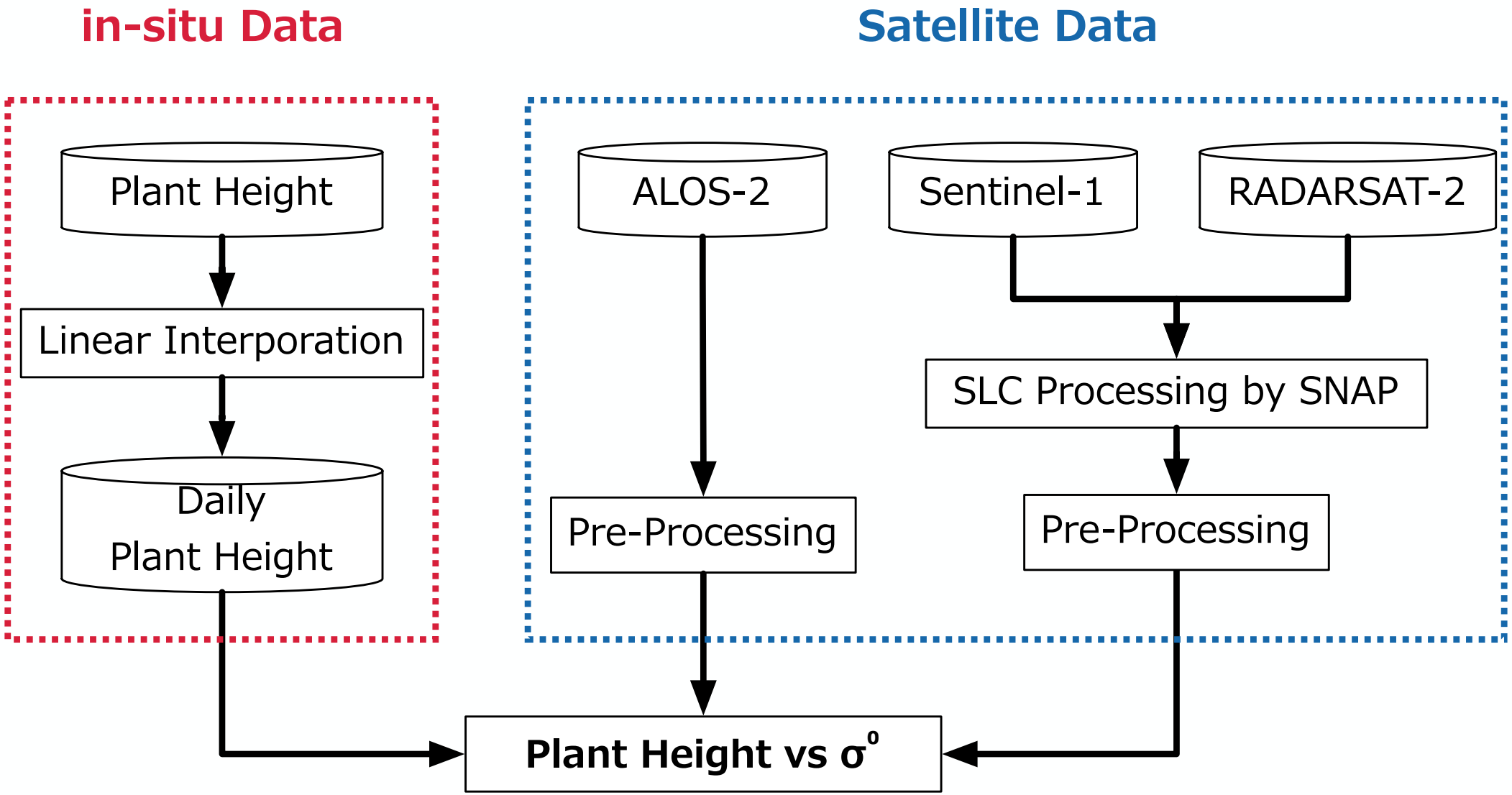
Rice Crop Calendar in Yamagata Prefecture

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendar					Planting				Harvesting			

Study Area: Tsuruoka City, Yamagata Pref.



Framework



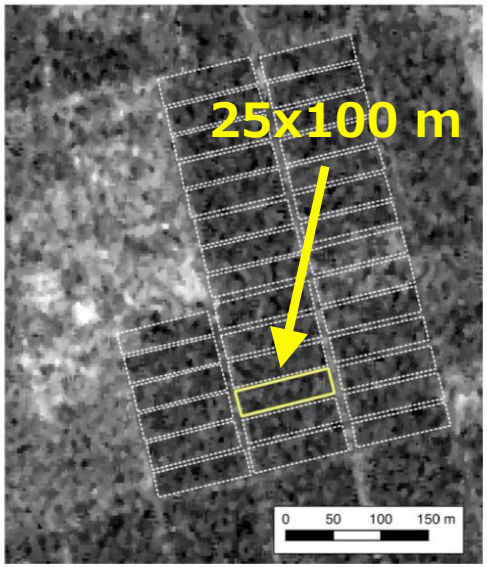
*pre-processing includes applying median filter (3x3) and image subset

In-Situ Data Measurements

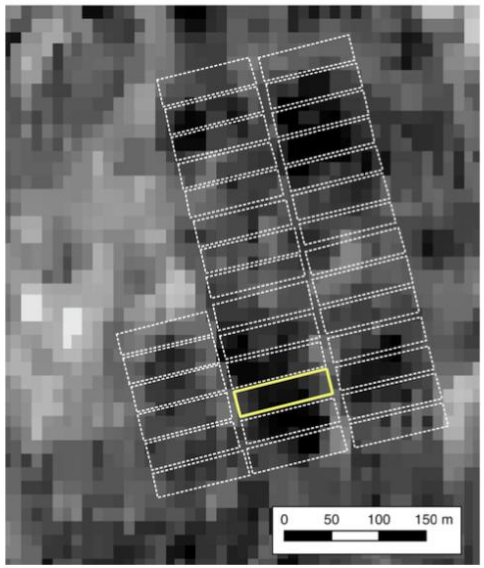
- **Collection Period**
  - May to Aug 2016
    (almost every 10 days)
- **Physical Parameters**
  - Plant height/length
  - Water depth
  - Number of tillers
- **Photo by AWS**

Specifications of SARs Used in This Study (2016)

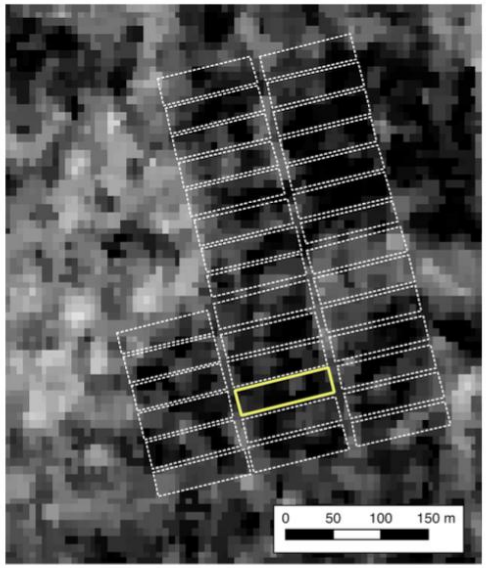
Sensor (Mode)	ALOS-2 (Fine)	Sentinel-1 (Interferometric Wide Swath)	Radarsat-2 (Wide Fine)
Frequency	1.25 GHz **(L-Band)**	5.405 GHz **(C-Band)**	5.405 GHz **(C-Band)**
Spatial Resolution	3.0 x 3.0 m	5.0 x 20.0 m	5.2 x 7.7 m
Polarization	HH	VV	VV, VH
Swath	50 km	250 km	150 km



a) ALOS-2 (HH, 24th May, 2016)



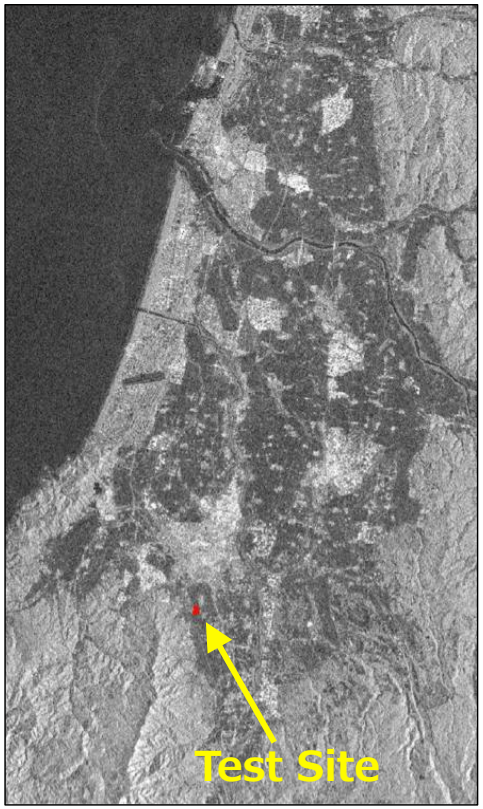
b) Sentinel-1 (VV, 30th May 2016)



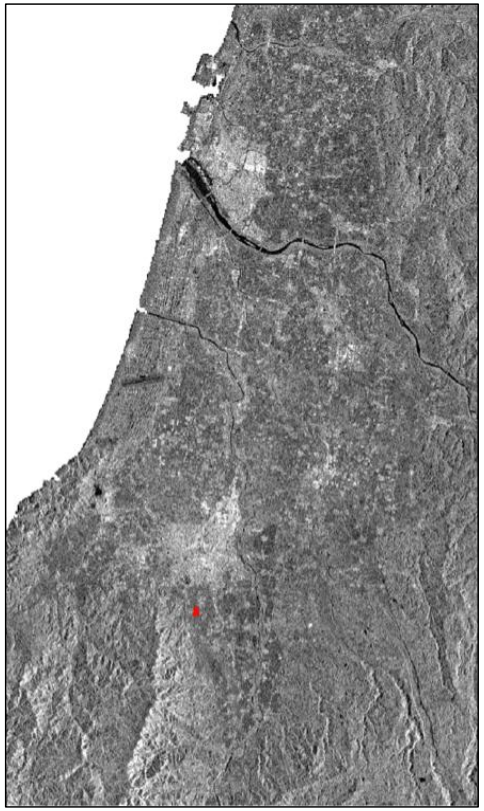
c) Radarsat-2 (VV, 30th May 2016)

SAR Images : Vegetative Season (July 2016)

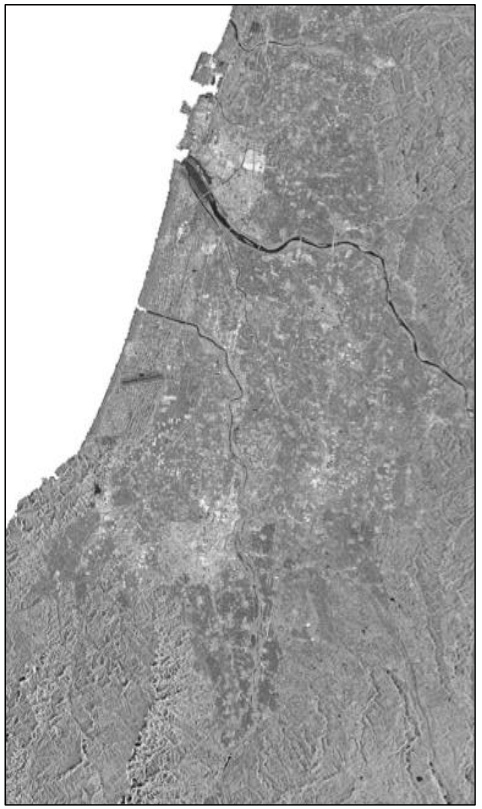
❖ L-band still shows low backscatter even in vegetative seasons.



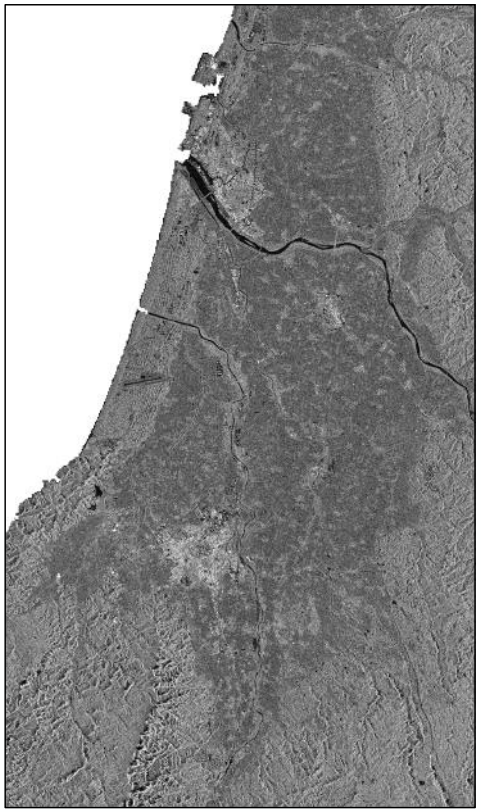
ALOS-2 HH
14 Jul 2016
Fine Mode (2.5m)



Sentinel-1 VV
17 Jul 2016
IW Mode (10m)

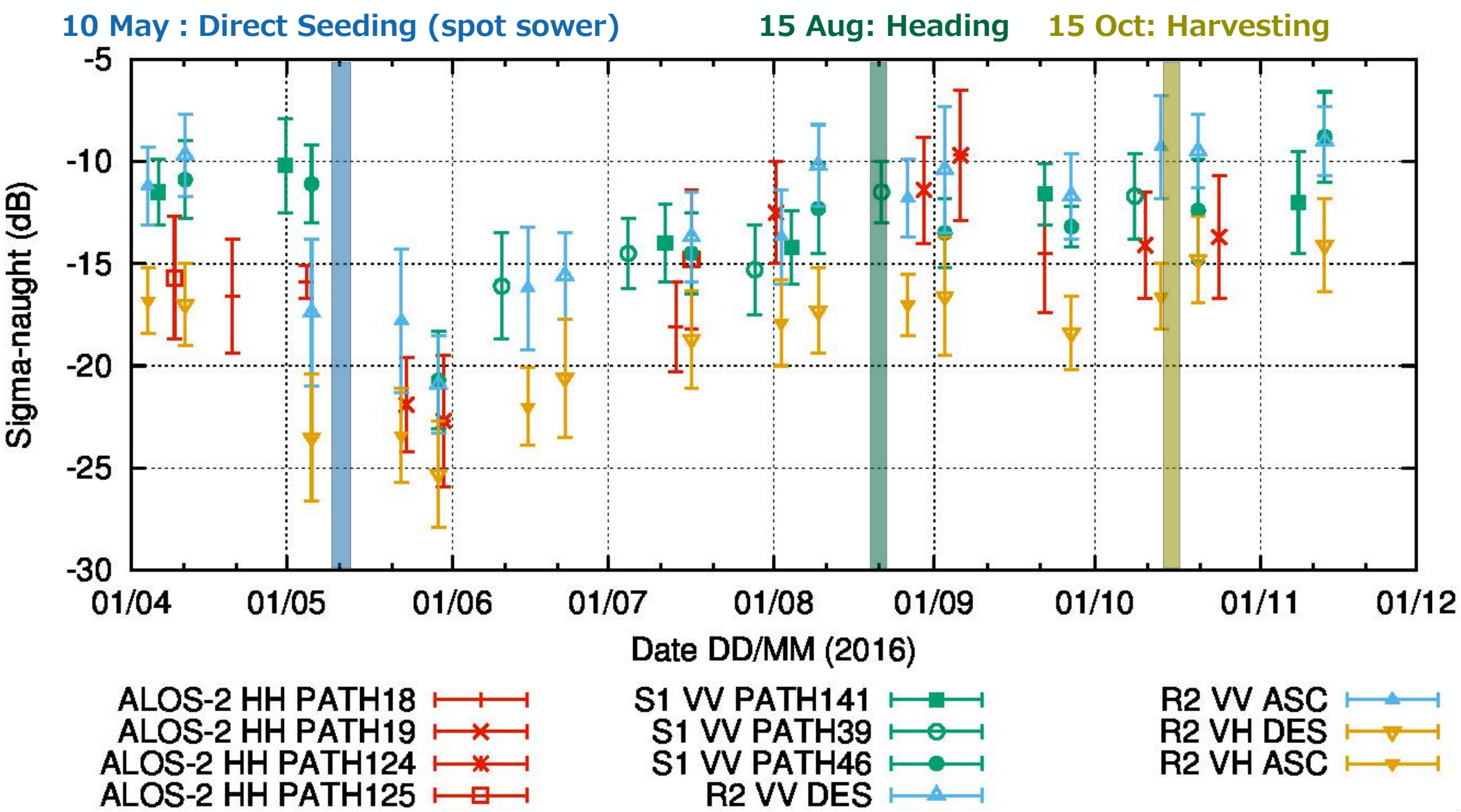


RADARSAT-2 VV
17 Jul 2016
Wide Fine (8m)



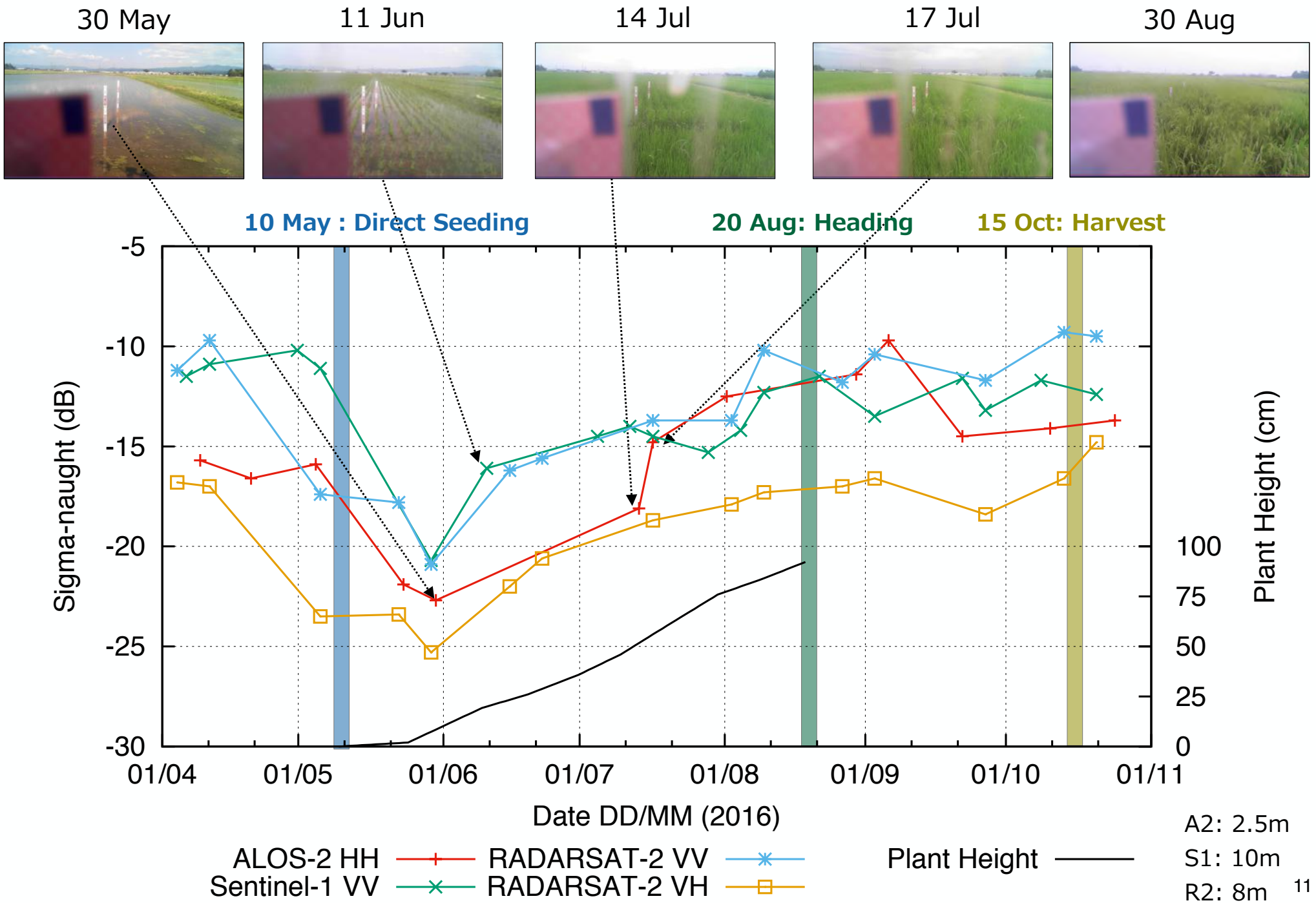
RADARSAT-2 VH
17 Jul 2016
Wide Fine (8m)

ALOS-2 (HH) vs Sentinel-1 (VV) vs RADARSAT-2 (VV, VH)



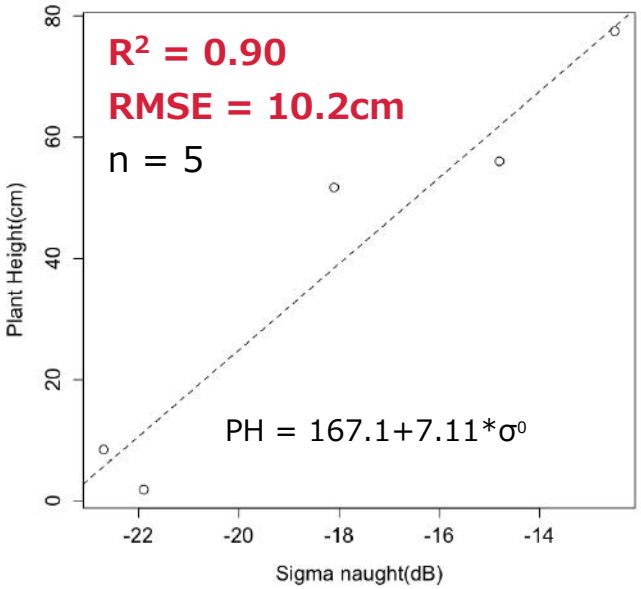
- ALOS-2 (13) + Sentinel-1 (18) + RADARSAT-2 (15) = **46 scenes !**
- 210 days / 46 scene = **4.6 days/scene !**

Seasonal Changes of Backscattering Coefficient

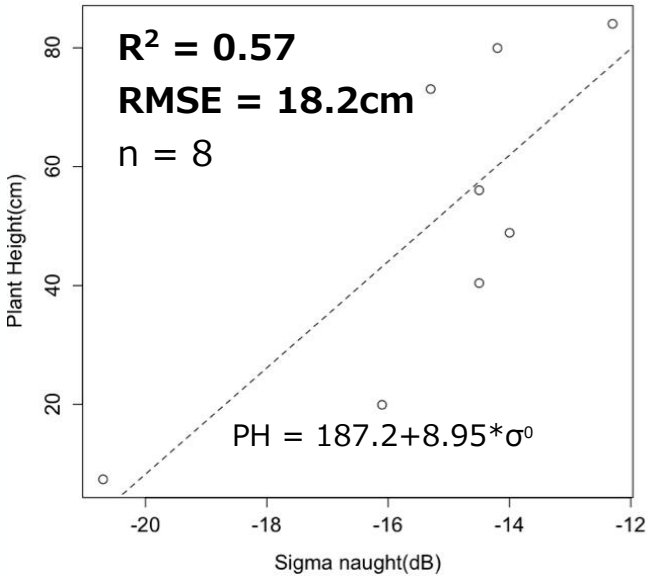


Rice Plant Height Estimation Result

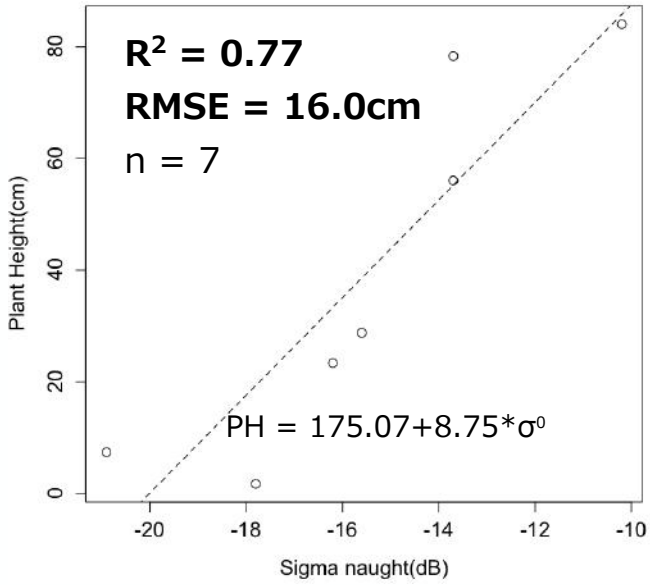
ALOS-2 (HH, Fine)



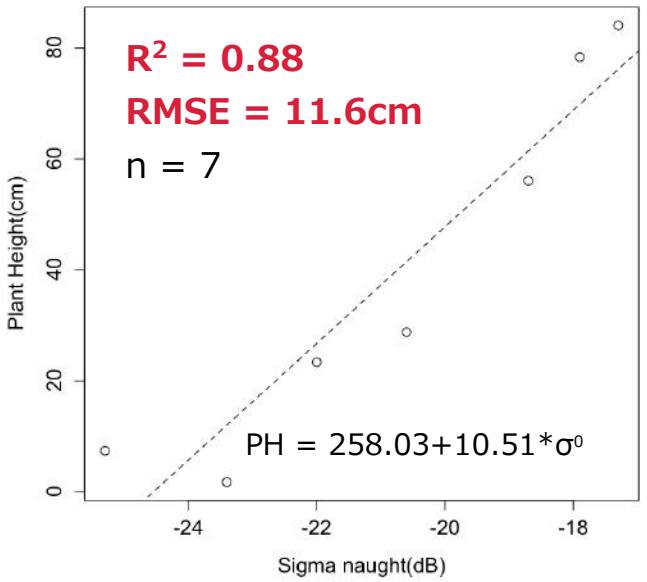
Sentinel-1 (VV, IW)



Radarsat-2 (VV, WF)



Radarsat-2 (VH, WF)



Discussions

- Our result corresponds to the previous studies using ground-based scattrometer that C- and L-band HH and HV polarization were highly correlated with plant height.

- The regression results of Radarsat-2 and Sentinel-1 VV polarization implies that spatial resolution is also a significant factor in estimating plant height more accurately if the target area is not homogeneous.

- The C-band had higher correlation with plant height during the early stage of growth and the L-band correlated with the subsequent stage, since a longer wavelength with deeper penetration depth has higher sensitivity to more complicated structures.

Way Forward

❖ 2017 (This Year)

- In-situ data: in addition to plant height, biomass, chlorophyl, water depth, and spectral data
- Satellite data:
  - RADAR: ALOS-2, Sentinel-1, Radarsat-2
  - Optical: Landsat-8, Sentinel-2, RapidEye
- Try to estimate physical parameters (plant height, biomas) and also chemical parameter (chlorophyl)
- L-band airborne SAR observation campaign (3rd Aug 2017)

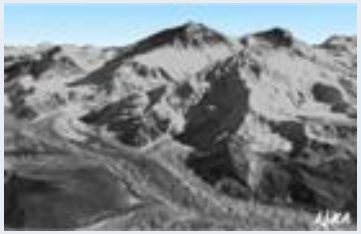
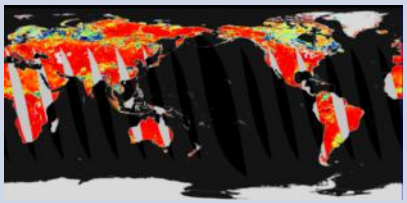
❖ 2018 (Next Year)

- Venμs (high resolution optical sensor, small satellite developed by CNES and Israel, 12ch, 16-40m) will be also available since Japan site was selected as Venμs RA theme.

Concluding Remarks

- This study investigated the rice plant height estimation by L-band (ALOS-2) and C-band (Sentinel-1, RADARSAT-2) data.
- L-band HH (ALOS-2) showed highest accuracy (10.2 cm), C-band VH (RADARSAT-2) showed the second-highest (11.6 cm).
- The C-band had higher correlation with plant height during the early stage of growth and the L-band correlated with the subsequent stage
- Further studies including the integrated utilization of X-band SAR data, optical data, or LAI/biomass estimation are important to enhance the ability of rice growth monitoirng.

Agriculture Related Free/Open Products Provided by JAXA

	Portal Name and URL
	**G-Portal: JAXA's Satellite data (GPM, TRMM, JERS-1, AQUA/AMSR-E....etc.)** https://www.gportal.jaxa.jp/gp/top.html *Free and Open Data **Raw Satellite Data**
	**JASMIN: Agro-Meteorological Information** http://suzaku.eorc.jaxa.jp/JASMIN/index.html *Free and Open Data **Agro-Meteorology**
	**GSMaP: Global Satellite Mapping of Precipitation** http://sharaku.eorc.jaxa.jp/GSMaP_crest/index.html *Free and Open Data **Rainfall**
	**Precise Global Digital 3D Map "ALOS World 3D" (30m resolution)** http://www.eorc.jaxa.jp/ALOS/en/aw3d/index_e.htm *Free and Open Data **Topography**
	**JASMES: JAXA's Satellite Monitoring for Environmental Studies** http://kuroshio.eorc.jaxa.jp/JASMES/index.html ***Free and Open Data** **Climate Variables**

Thank You for Your Attention !

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