Development of PALSAR Ground Data System

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ABSTRACT

The Phased Array Type L-Band Synthetic Aperture Radar(PALSAR) is one of the imaging sensors on board of the Advanced Land Observing Satellite (ALOS) scheduled for launch in 2005. The PALSAR is an active microwave sensor for cloud-free and day-and-night land observation. The sensor has a beam steerable in elevation and the ScanSAR mode which allows us to obtain a wide swath(250km~350km).

PALSAR Ground Data System (GDS) has been developed at ERSDAC since 1999. In the PALSAR GDS, raw data provided from JAXA will be processed to generate SAR images as final products which will be archived and distributed widely to the users. The SAR data processor is designed to achieve optimal data quality as well as maximum performance to meet the requirements from various users.

1. INTRODUCTION

Earth Remote Sensing Data Analysis Center (ERSDAC) is a non-profit foundation establishment in 1981 under the auspices of Ministry of International Trade and Industry (renamed in January, 2001 to Ministry of Economy, Trade and Industry). Since the establishment, ERSDAC has been playing an important role in the research and development of remote sensing technology especially for exploration of non-renewable resources as well as environmental monitoring on a global scale. ERSDAC has been operating the ground segments for JERS-1 and ASTER sensors to process and distribute the SAR and OPS data.

The development of PALSAR Ground System (GDS) was started at ERSDAC as a successor of JERS-1 SAR data processing segment, and is now being continued aiming the inauguration in 2004. PALSAR GDS will accept data acquisition requests from users, produce SAR images, archive and distribute the products to the users.

In the quality control of the SAR image, calibration process will be very important to ensure the final data quality. We are now studying a possible scenario of the SAR calibration that will be most effective and realizable to our GDS from a practical viewpoint.

2. PALASR Observation Modes

The PALSAR system (Ref.[1]) is designed to provide three kinds of observation mode, i.e., (1) fine resolution mode with single polarization and dual polarization options, (2) ScanSAR mode and (3) fully polarimetric mode. Figure 1 shows the beam configuration for each observation mode, and Table 1 shows the summary of the operation modes of the PALSAR. In the fine mode the PALSAR will generate high spatial resolution products (about 10 meters in range direction). It will image one of the eighteenth sub-swaths located over a range of incidence angles spanning from 8 to 60 degrees in HH or VV polarization as a standard operation or in dual polarization(HH+HV or VV+VH) as an option. The ScanSAR mode provides images of a wider strip (250km – 350km) with medium resolution (100m) in HH or VV polarization. The total swath consists of five sub-swaths and the PALSAR transmits bursts of pulses to each of the sub-swaths in turn in such a way that a continuous along-track image is built up for each sub-swath. The polarimetric mode will provide full polarimetric data for swaths of at least 30km, up to an incidence angle of 30 degrees with approximately 10-20 m resolution.

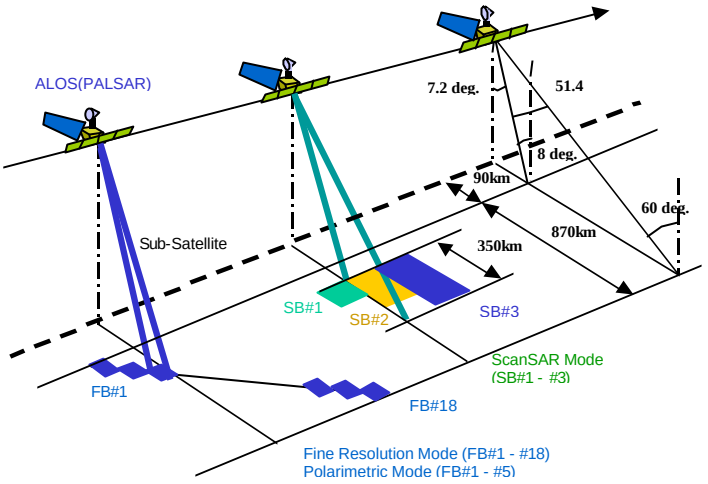

Figure 1 PALSAR beam configurations.

Table 1. Summary of operation mode of PALSAR

Mode		Fine Resolution	ScanSAR	Polarimetric	
				Dual	Quad
Antenna Size		AZ : 8.9m x EL : 2.9m			
Center Frequency		1270MHz (L-Band)			
Bandwidth		28MHz	28/14MHz	14MHz	
Polarization		HH / VV	HH / VV	HH+HV /VV+VH	HH+HV+VH+VV
Resolution *1	**Range**	10m	100m	20m	30m
	Azimuth	10m (2 looks)	100m	10m (2 looks) 20m (4 looks)	20m(4looks)
Swath Width *1		70km	250km(3 scan) 300km(4 scan) 350km(5 scan)	70km	30km
Incidence Angle		8 – 60 deg.	18–35deg.(3 scan) 18–40deg.(4 scan) 18–42deg.(5 scan)	8 – 60 deg.	8 – 30 deg.
Off-nadia Angle		7 - 51 deg.	16–33deg.(3 scan) 16–36deg.(4 scan) 16–38deg.(5 scan)	7 - 51 deg.	7 – 27 deg.
Quantization		3bits/5bits	5bits	3bits/5bits	3bits/5bits

*1 Fine Resolution mode : Off-nadir angle is 34.3 deg. ScanSAR mode : Off-nadir angle is 34.1deg.
Polarimetric mode : (Full) Off-nadir angle is 21.5deg. (Dual) Off-nadir angle is 34.3 deg

3 PALSAR GDS and Products

The detail of the system configuration and the products of PALSAR GDS are described as follows:

3.1 PALSAR GDS

Figure 2 shows the system configuration of PALSAR GDS. PALSAR GDS is composed of four subsystems, i.e., IMS, CSMS, PGS and EDB. The functions of each subsystem are summarized as below:

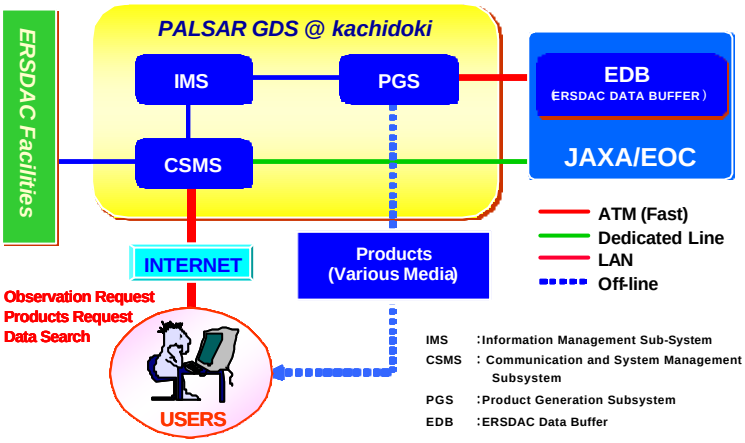

Figure 2. Configuration of PALSAR GDS

Figure 3. Picture of PALSAR GDS.
(Top)Parallel computer system.
(Bottom) Tape archive library(140TB).

IMS : Information Management Subsystem : The functions of this subsystem are to accept the requests of observation and/or data products from the users, and to provide users with necessary information.

CSMS : Communication and System Management Subsystem : The functions of this subsystem are the communication management between the subsystems of PALSAR GDS, the schedule management for data processing, and the resource management of the GDS. It also coordinates the observation schedule between JAXA and ERSDAC, and controls the EDB system.

PGS : Products Generation Subsystem : The function of this subsystem are level 0 data processing, higher order data processing, and management of products and files. We are using 3 parallel computers which equipped with 8CPUs for data processing.(SGI Origin3800 series. Fig.3). For the archives of data and products, DTF-2 cassette tapes in the Sony Petasite Mass Storage System is used.(Fig.3). PGS also has a CAL/VAL(Calibration and Validation) processor. This processor calculates the calibration coefficient of Radiometric, Geometric and Polarimetric by using external calibration data such as Amazon rain forest, Polarimetric Active Radar Calibrators(PARCs) and Corner Reflectors.

EDB : ERSDAC Data Buffer : This subsystem will be installed in the Earth Observation Center(EOC) of JAXA, whose function is to store temporally the level 0 data provided from JAXA and to transfer these data to ERSDAC.

3.2 PALSAR GDS Function and Products

The main functions of PALSAR GDS are summarized as below:

(1) To receive observation and products requests from users.

Observation requests:

Normal observation requests from designated users (resources exploration, environmental, science, education, commercial, etc.)

Urgent observation requests : in case of emergency Products Requests.

Data products requests and distribution to general users.

(Levels 1.0, 1.1, 1.5, 4.1 and 4.2).

(2) To send observation requests to JAXA.

(3) To acquire raw data (Level-0 Data) from JAXA via EDB:

500 scenes/day selected from 1,400 scenes/day (at maximum)

Level 0 to 1.0 conversion : 500 scenes/day (at maximum).

(4) To implement SAR data processing to generate SAR Images:

Level 1.1 (Dataset for accurate interferometry) : 10 Scenes/day (at maximum)

Level 1.5 (Fine Beam Mode) :100 Scenes/day (at maximum)

Level 4.1 (Multi-polarimetry) :10 Scenes/day (at maximum)

Level 4.2 (ScanSAR) :10 Scenes/day (at maximum)

(for more detail, please refer to the PALSAR GDS Products List described in Table 2)

(5) To archive original(Level 1.0) and processed data.

(6) To distribute SAR data and products to users.

Distribution via internet or in various media (CD, DVD, DAT, etc.)

Data will be validated from the users' viewpoint.

Table 2. Summary of PALSAR Products. (ERSDAC provides following Data)

Level	Product Description	Product type
1.0	Formatted phase history, CEOS format (8bit I,8bit Q per data sample) Not an image product,no correction applied Contains raw data for one scene Multi-polarimetric data is interleaved(line 1:HH,HV, line 2: VH,VV) ScanSAR data contains multiplexed bursts of sensor beams Distributed to users doing their own SAR processing	Fine beam single-pol. : 5bits Fine beam dual-pol. : 5bits Quad-pol. :3/5bits ScanSAR : 5bits Max. 500 scenes/day
1.1	Single-look complex image, standard SLC format(32bit I,32bit Q per SLC pixel) SAR image in natural pixel-spacing Primarily used for for interferometry applications	Fine beam single-pol Fine beam dual-pol Quad-pol.
1.5	CEOS Format : 16 bits/pixel Systematic geo-coded SAR image -Detected, multi-looked, resampled into map projection or ground-range path product Selectable projection : UTM, PS or ground range Selectable datum : GRS80, WGS84	Fine beam single-pol. Max. 100 scenes/day
4.1	Polarimetric mode products CEOS Format : 16 bits per amplitude value, 16 bits phase Systematic geo-coded SAR image -multi-looked, cross-product representation(3 real, 3 complex), resampled into map projection or ground–range path product Selectable projection and/or datum	Dual-pol.(HH+HV, VV+VH) Quad-pol. (HH+HV+VH+VV) Max. 10 scenes/day
4.2	Scansar mode products CEOS Format : 8 bits sample Systematic geocoded and multi-looked ScanSAR image Selectable projection and/or datum	ScanSAR mode 1 (2 looks) ScanSAR mode 2 (1 look) Max. 10 scenes/day

3.3 PALSAR External Calibration

The external calibration, using targets with known scattering characteristics, is used to complete the calibration process. Removing the antenna patterns during SAR processing forms a very important part of the calibration of SAR data. For the antenna pattern, the Amazon rain forest will be used as a homogeneous target. Calibration will be typically performed using the observed data sets of uniformly distributed natural targets (UDNT) such as the Amazon rain forest, deserts and dry lake beds (Refs. [2], [3]). As the standard calibration targets, trihedral corner reflectors (Tri-CR) and polarimetric active radar calibrators (PARC)[4] shown in Fig.4 are also considered. Calibration correction coefficients are passed to signal data processor for incorporation into processing.

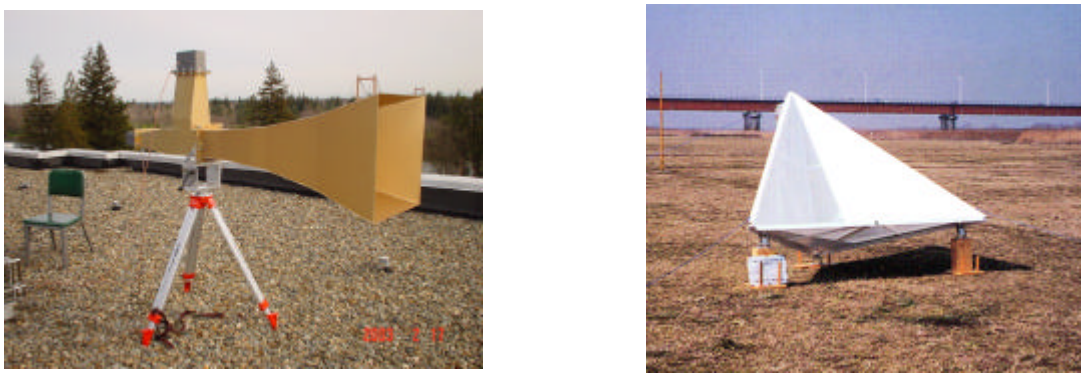

Figure 4. Picture of Tools for external calibration.
(Left) PARC(RCS=10-65dBm^2), (Right) Trihedral Corner Reflector(RCS=31dBm^2)

4. Conclusion

PALSAR GDS is now being elaborately developed to meet the users' earnest requirements for the high quality SAR images. To achieve such a high standard, a calibration procedure including field campaigns has to be considered in the SAR processing. Especially for the polarimetric SAR, we are now studying the calibration methods in various ways to find an optimal solution. So far we have studied, the use of dataset of uniformly distributed natural targets(UDNT's), trihedral corner reflectors(Tri-CR's) and polarimetric active radar calibrators(PARC's) is thought to be most possible from a practical viewpoint.

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