APPENDIX 4

OVERVIEW OF THE ADVANCED LAND OBSERVING SATELLITE-2 (ALOS-2) MISSION

1. Introduction

The Advanced Land Observing Satellite-2 (ALOS-2) is succeeding to the radar mission of ALOS which had contributed to cartography, regional observation, disaster monitoring, and resources surveys.

ALOS-2 is equipped with a SAR antenna just under its body and with two solar array paddles at both sides, as shown in Figure 1. The observation data is transmitted directly to a ground station via X-band or through inter-satellite communication via Ka-band. The transmission speed is 800 Mbps maximum for X-band and 278 Mbps for Ka-band, respectively. Table 1 shows system specifications of ALOS-2. The local sun time of its orbit is at noon in order to complement other SAR satellites which are in dawn-dusk orbits.

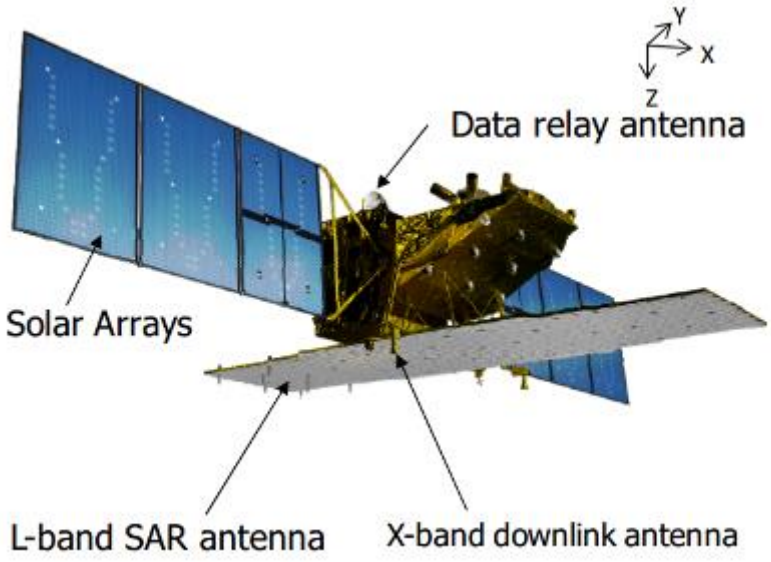


Fig. 1 ALOS-2 in-orbit configuration.

Table 1 ALOS-2 specification.

Observation mode	Stripmap: 3 to 10 m resolution, 50 to 70 km swath ScanSAR: 100 m/60 m resolution, 350 km/490 km swath Spotlight: 1×3m resolution, 25 km swath
Orbit	Sun-synchronous sub-recurrent orbit Altitude: 628 km Local sun time: 12:00 +/- 15 min Revisit: 14 days Orbit control: < +/-500 m
Launch	May 24, 2014 (JST), H-IIA launch vehicle
Life time	5 years (target: 7 years)
Satellite mass	Approx. 2 tons
Downlink	X-band: 800 Mbps (16QAM), 400/200 Mbps (QPSK) Ka-band: 278 Mbps (QPSK)

2. PALSAR-2 Characteristic

ALOS-2 carries the state-of-the-art L-band Synthetic Aperture Radar (SAR) called PALSAR-2. PALSAR-2 has a Spotlight mode (1×3m resolution in Az×Rg), a Stripmap mode (3 to 10 m resolution) and a ScanSAR mode. The Spotlight mode and a high resolution mode will allow providing users with more detailed data than ALOS/PALSAR. The ScanSAR mode will allow us to acquire a 350 to 490 km width (depends on number of scans) of SAR images at the expense of spatial resolution. The observation frequency of ALOS-2 will also be improved by greatly expanding the observable areas (2,320km). Right-and-left looking function by satellite maneuvering and electric beam steering using active phased array antenna establish the incidence angles from 8 to 70 degrees on both side of the satellite.

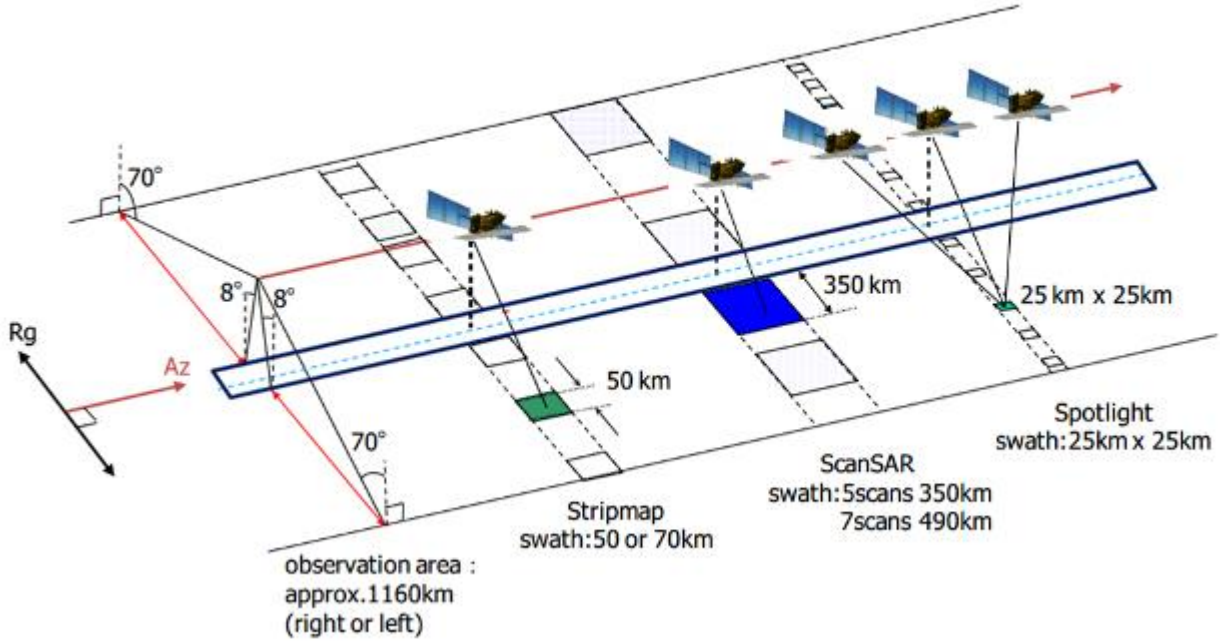


Fig. 2 PALSAR-2 observation modes.

Table 2 PALSAR-2 specification.

Observation mode		Spotlight	Stripmap			ScanSAR
			Ultra-Fine	High-Sensitive	Fine	
Incidence angle		8 to 70 degrees				
Band width		84 MHz	84 MHz	42 MHz	28 MHz	14 MHz/28 MHz*
Ground resolution		3 m x 1 m (Rg x Az)	3 m	6 m	10 m	100 m (60 m)
Swath		25 km	50 km	50 km	70 km	350 km (490 km)
Polarization		Single	Single/Dual	Single/Dual/ Full/Compact	Single/Dual/ Full/Compact	Single/Dual
NESZ		-24 dB	-24 dB	-28 dB	-26 dB	-26 dB/-23 dB
S/A	Rg	25 dB	25 dB	23 dB	25 dB	25 dB (20 dB)
	Az	20 dB	25 dB	20 dB	23 dB	20 dB

The parameters specified at 37degrees incidence angle above the equator.
* 28 MHz bandwidth in ScanSAR mode is used for only 350 km swath

PALSAR-2 is composed of two subsystems; Antenna subsystem (ANT) and Electric Unit (ELU). ANT is an active phased array antenna, which steers a beam both in elevation and azimuth direction (plus-minus 30 degrees in elevation and plus-minus 3.5 degrees in azimuth). Figure 3 shows the antenna configuration of PALSAR-2. The size of ANT is 10 m in azimuth and 3 m in elevation, and is composed of five electrical panels, which have 180 Transmit-Receive-Modules (TRMs) in total. The Spotlight mode and Ultra-Fine mode use the three of five panels to satisfy resolution requirement and the other modes use all panels. The transmitted power is 3950 W and 6120 W respectively.

Figure 4 shows the system diagram of PALSAR-2. Key components of the Electric Unit (ELU) are Exciter (EX), Transmitter (TX), Receiver (RX), Digital Processor (DP), and System controller (SC). As for RF signal, EX generates pulses, selects two chirp signals (up or down and phase modulation) with a selected center frequency either 1257.5, 1236.5 or 1278.5 MHz in order to avoid interference to Radio Navigation Satellite Services which use L-band, and stretches the signal to a selected bandwidth either 84 MHz, 42 MHz, 28 MHz or 14 MHz. Received radar echo signals are compressed by BAQ or DS-BAQ algorithm. Compression mode is selected from 4 bit, 2 bit, or no compression.

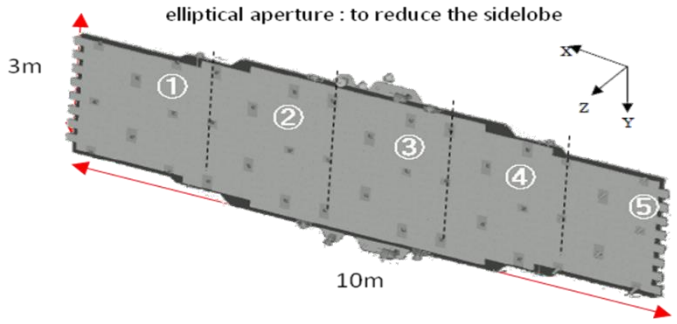
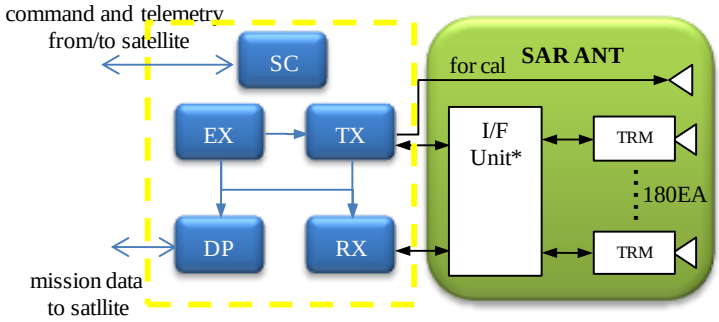


Fig. 3 PALSAR-2 antenna configuration.



*: Dual receive antenna system is seleceted at I/F Unit

Fig. 4 PALSAR-2 system diagram.

3. ALOS-2 Data Products

3.1 Definition of ALOS-2 Data Products

Two categories of data products are defined - level 1 product and higher-level products.

3.1.1 Level 1

Level 1 is radiometrically and geometrically calibrated data and is a standard JAXA product for ALOS-2 users.

3.1.2 Higher-level data product

Products above level 2 are higher-level data products. Higher-level data products are made more sophisticated by processing with digital elevation models. This is provided by JAXA's EORC as soon as ready.

3.2 Standard Data Products

Table 3 PALSAR Standard data products.

Level	Definition	Note
1.1	Range and azimuth compressed complex data on slant range. Full resolution	Beam modes: Full resolution mode, Low data rate mode, Polarimetric mode SLC: Single Look Complex used for interferometry
1.5	Multi-look processed image projected to map coordinates. Option G: Systematically Geo-coded (No option: Geo-referenced)	Map projection Resampling Pixel spacing
2.1	Ortho-rectified and slope corrected products	Map projection Resampling Pixel spacing

4. ALOS-2 Operation Concept and Observation Strategy

ALOS-2 is operated based on the Basic Observation Scenario-3 (BOS-3) that is optimized as the background mission while the emergency observation is the highly prioterized operation for the disaster mitigations. The BOS-3 is open to the public through ALOS-2 i.e. https://www.eorc.jaxa.jp/ALOS-2/en/obs/pal2_obs_guide.htm

The BOS-3 is designed to achieve the Earth observation using the several modes of the PALSAR-2, i.e. high resolution strip mode (84 MHz-singe polarization), Dual polarization mode (42 MHz-Dual Polarization), Quad-mode (42 MHz-Full polarization), Dual Strip (28 MHz), and ScanSAR (14 MHz-Dual-350 Km /490 Km swath) for observing the solid earth (deformation study), biosperic study (forest monitoring, carbon estimation) and Cryospheric study (sea-ice, polarer monitoring), and map generation.