

ALOS PALSAR data processing using GAMMA Software

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1. Introduction

JAXA has made available sample data acquired by the ALOS PALSAR instrument on 21-Mar-2006 over Kyoto Japan [1]. PALSAR acquired the sample data using fine-beam single-polarization mode (HH). These sample data were downloaded by GAMMA and used to conduct an initial adaptation of the GAMMA Software to ALOS PALSAR data processing. Apart from the software adaptation and characteristics of these PALSAR data were assessed – knowing that these data are preliminary and not corresponding entirely to standard PALSAR data.

2. PALSAR raw data characteristics

The sample data included raw data of fine-beam single-polarization mode (HH) acquisition. The raw data have the following characteristics as shown in Table 1.

Preprocessing steps included estimation of the unambiguous Doppler ambiguity number and centroid. The Doppler spectrum at the center of the swath, modulo the SAR pulse repetition frequency is shown in Figure 1. The Doppler ambiguity was resolved using the multi-look beat frequency (MLBF) algorithm as described by Cumming and Wong [2]. The Doppler centroid as a function of range was estimated by cross-correlation of adjacent lines and is shown in Figure 2.

Table 1 ALOS PALSAR Fine-Beam raw data characteristics

Polarization	HH
Range Bandwidth	28.000 MHz
Chirp Duration	27 micro-sec.
Range Sample rate (IQ)	32.000 MHz
Number of range samples/echo	10304
Number of echoes	32421
Number of bits/sample	5
Pulse Repetition Frequency (PRF)	2159.827 Hz

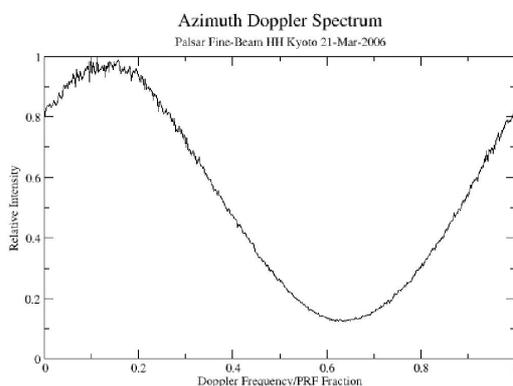


Figure 1 Azimuth spectrum at center-swath, modulo the SAR Pulse Repetition Frequency

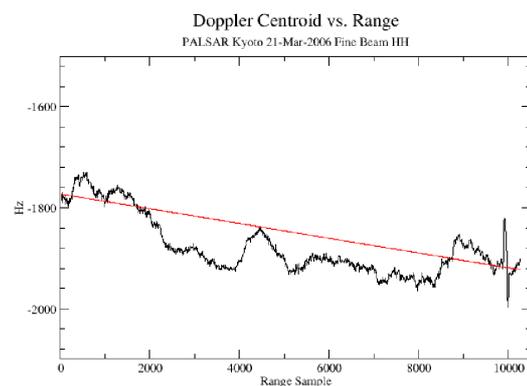


Figure 2 Doppler versus slant-range sample number

3. SAR processing

Level-1 complex signal samples were processed using the Gamma MSP to produce an single-look complex (SLC) and multi-look intensity (MLI) images. In fine-beam mode the transmit chirp is 28 MHz and lasts 27 micro-seconds. The raw data have the following characteristics as shown in Table 1.

The image was processed using a range-Doppler algorithm including secondary range migration. Autofocus confirmed that the effective along-track velocity determined from the state vectors was accurate at the level of .5 m/s. Since these data as provided by JAXA are uncalibrated, no antenna pattern is provided. The data were processed using a constant value for the antenna gain. The MSP processed SLC image parameters are shown in Table 2. The multi-look intensity image is shown in Figure 3. A small section of the image near the center bridge showing the full range resolution and 3 azimuth looks is shown in Figure 4. Note the individual roads and buildings visible in the scene. For the 1 range x 3 azimuth looks MLI an equivalent number of looks (ENL) of 2.3 to 2.5 was determined.

Table 2 SLC image parameters for the Kyoto PALSAR Fine-Beam HH image processed using the Gamma MSP

Range samples:	10240 (includes 800 samples range extension)
Azimuth samples:	27964
Slant-range pixel spacing:	4.684 m
Azimuth pixel spacing:	3.148 m
Slant-range scene width:	47.96 km
Azimuth scene length:	88.03 km
Incidence angle (center-swath)	38.2 deg.
Near range	846.01431 km
Doppler centroid (center-swath):	-1871 Hz
Image center lat/long (deg.) :	35.425 N, 135.811 E



Figure 3 PALSAR Multi-look Intensity Image over Kyoto acquired on 21-Mar-2006 by ALOS in Fine-Beam HH pol. mode.



Figure 4 Full range resolution section of the PALSAR Kyoto image acquired on 21-Mar-2006. The slant range sampling corresponds to an approx. ground range sampling of 7.9 m, the azimuth pixel spacing (3-look) is 9.55 m.

4. Point target characteristics

In the processed SLC further analysis was performed to evaluate the point target performance in the image. A bright target was selected in the center of the image and analyzed using the Gamma point target analysis program to evaluate range and azimuth resolution, peak and integrated sidelobe levels and phase characteristic. Plots of range and azimuth cuts of the point target response are shown in Figures 5 and 6. An image of the point, over-sampled by a factor of 16 in rang and azimuth is shown in Figure 7. Peak and integrated sidelobe levels are summarized in Table 3.

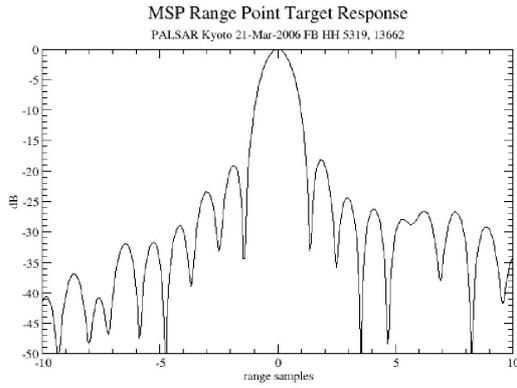


Figure 5 Point target response in range.

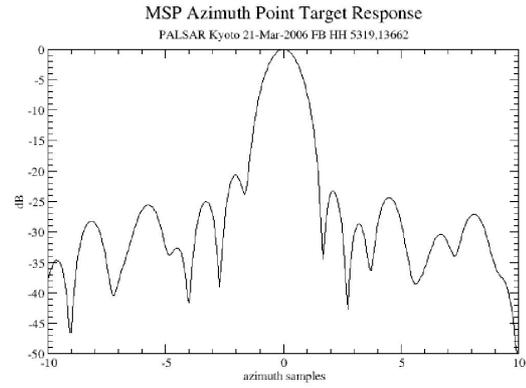


Figure 6 Point target response in azimuth.

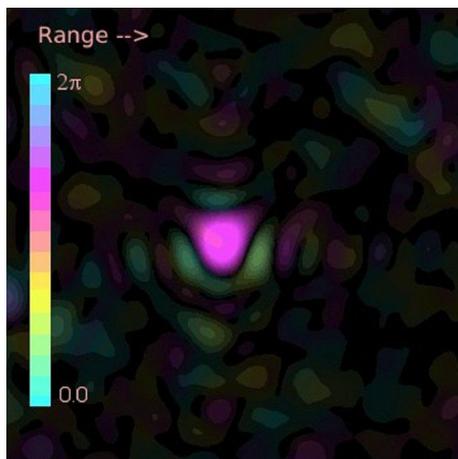


Figure 7. Over-sampled point target response. The color scale covers the phase range 0 to 2π.

Table 3 Point target resolution, peak side-lobe, and integrated side-lobe levels in range and azimuth

range -3 dB width (samples):	1.188
range -10 dB width (samples):	1.996
range PSLR (dB):	-16.787
range ISLR (dB):	-16.851
azimuth -3 dB width (samples):	1.371
azimuth -10 dB width (samples):	2.332
azimuth PSLR (dB):	-20.661
azimuth ISLR (dB):	-18.247

5. Geocoding

The multi-look intensity image was terrain corrected geocoding using the SRTM-3" DEM available from USGS as height and positional reference. In a refinement step a correlation analysis between SAR intensities simulated based on the DEM and the real SAR data was conducted (in SAR geometry) to reduce inaccuracies in the orbital and projection parameters. Matching in the sub-pixel range was achieved. The output terrain geocoded image is shown in Figure 8.

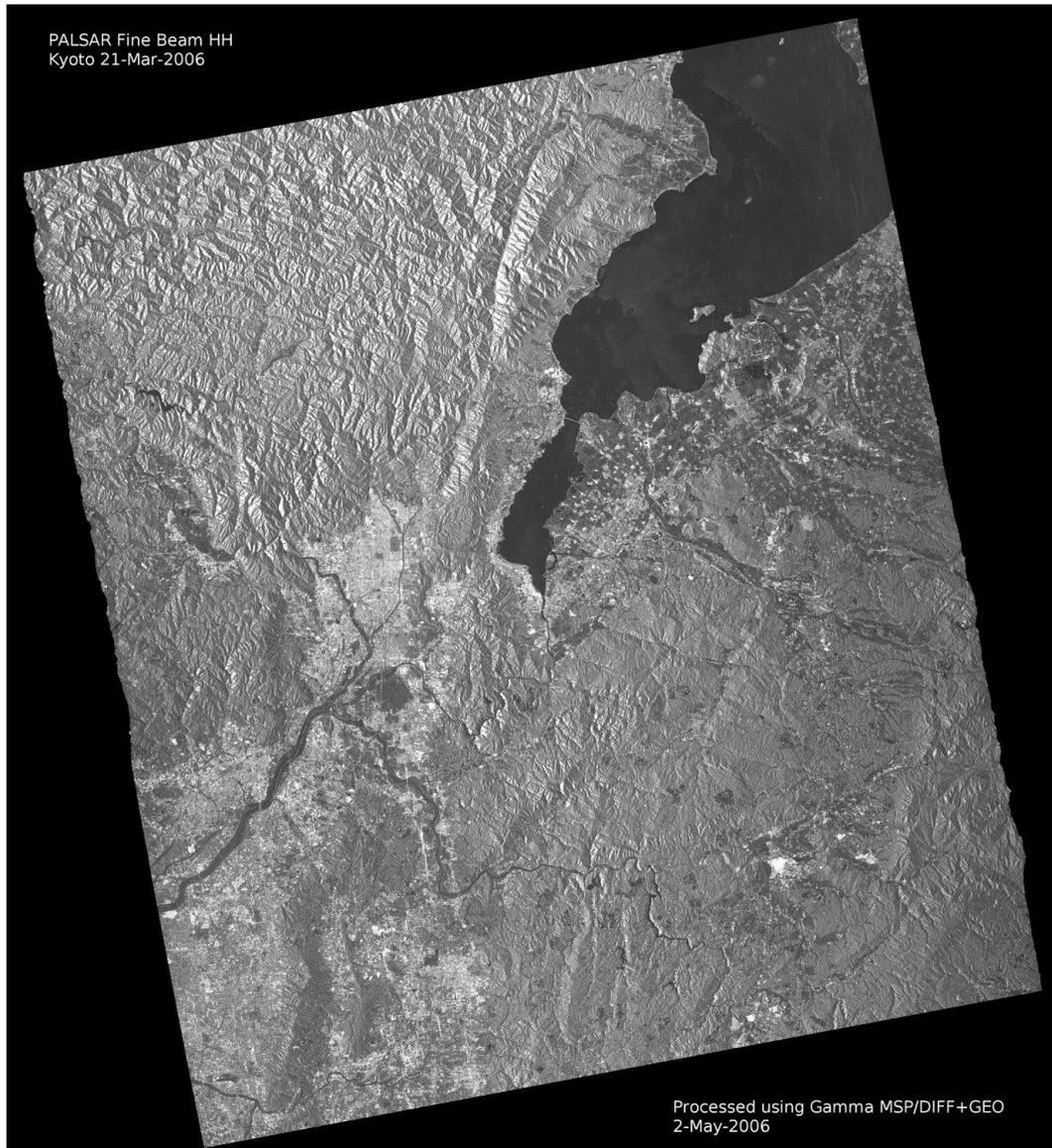


Figure 8 Terrain corrected geocoded HH-pol. PALSAR image of Kyoto acquired on 21-Mar-2006.

6. References

- [1] www.eorc.jaxa.jp/ALOS/doc/sproduct.htm
- [2] Cumming, I., F. Wong, Digital Processing of Synthetic Aperture Radar Data, Chapter 12, pp. 481- 565, Artech House, 2005.