Processing of Fine-Beam HH ALOS PALSAR Stripmap Data

Gamma Remote Sensing AG 2-May-2006

JAXA has made available sample data acquired by the ALOS PALSAR instrument on 21-Mar-2006 over Kyoto Japan. PALSAR acquired the data using fine-beam single-pol mode (HH). The raw 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 this mode, the transmit signal is a linear FM chirp with 28 MHz bandwidth and lasting 2.7 x 10^{-5} sec. The raw data have the following characteristics as shown in Table 1.

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

Table 1 ALOS PALSAR Fine-Beam raw data characteristics

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.

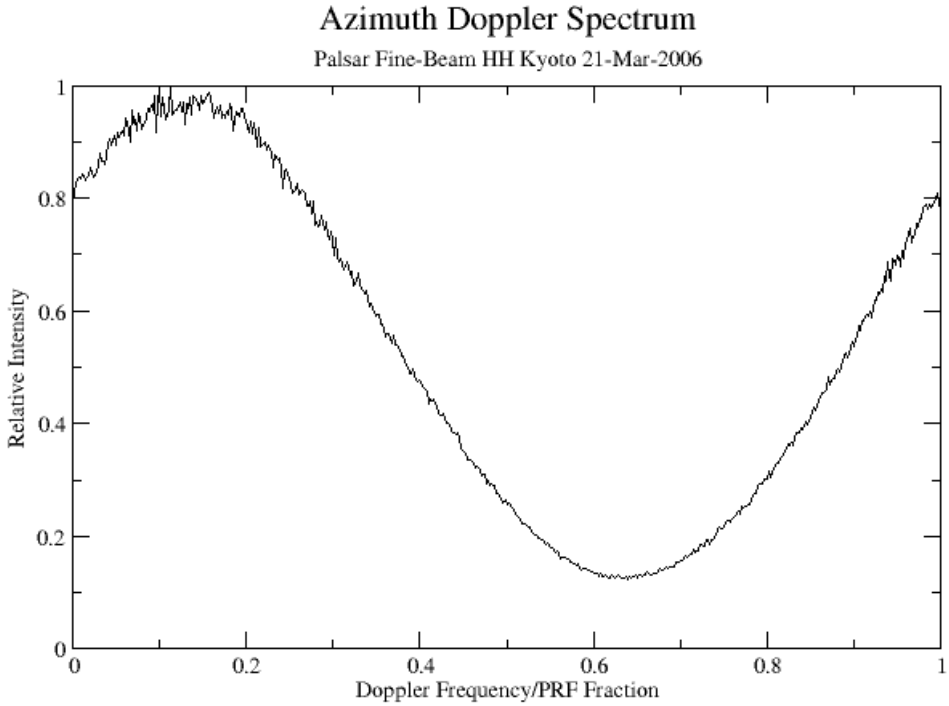

Figure 1 Azimuth spectrum at center-swath, modulo the SAR Pulse Repetition Frequency

The Doppler ambiguity was resolved using the (multi-look beat frequency) (MLBF) algorithm as described by Cumming and Wong [1]. The Doppler centroid as a function of range was estimated by cross-correlation of adjacent lines and is shown in Figure 2.

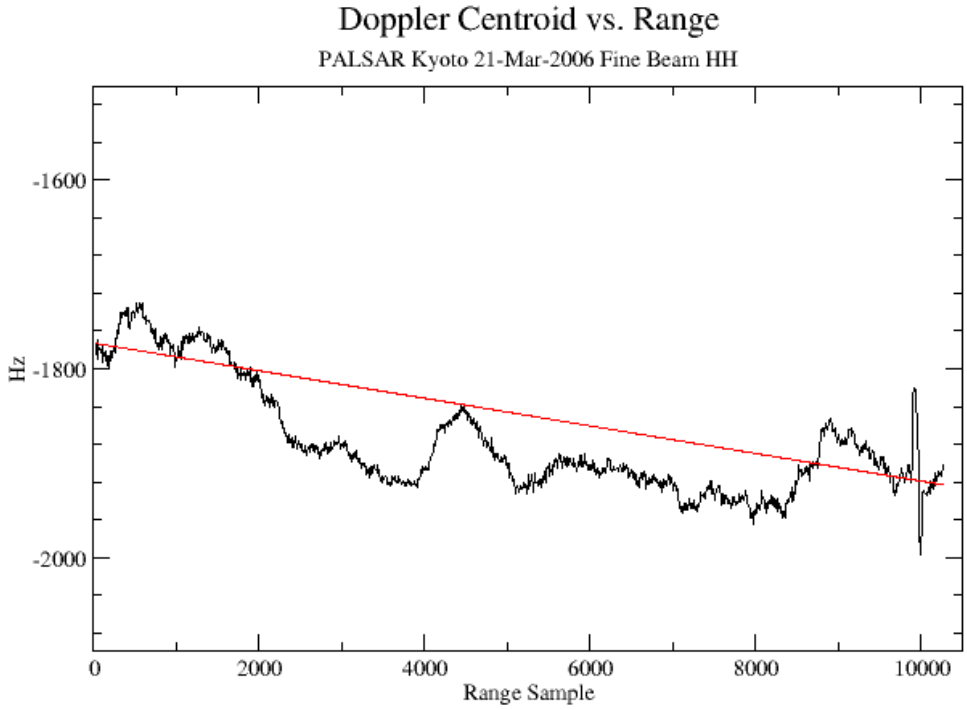

Figure 2 Doppler versus slant-range sample number

The image was processed using a range-Doppler processor using 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.

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

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

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.

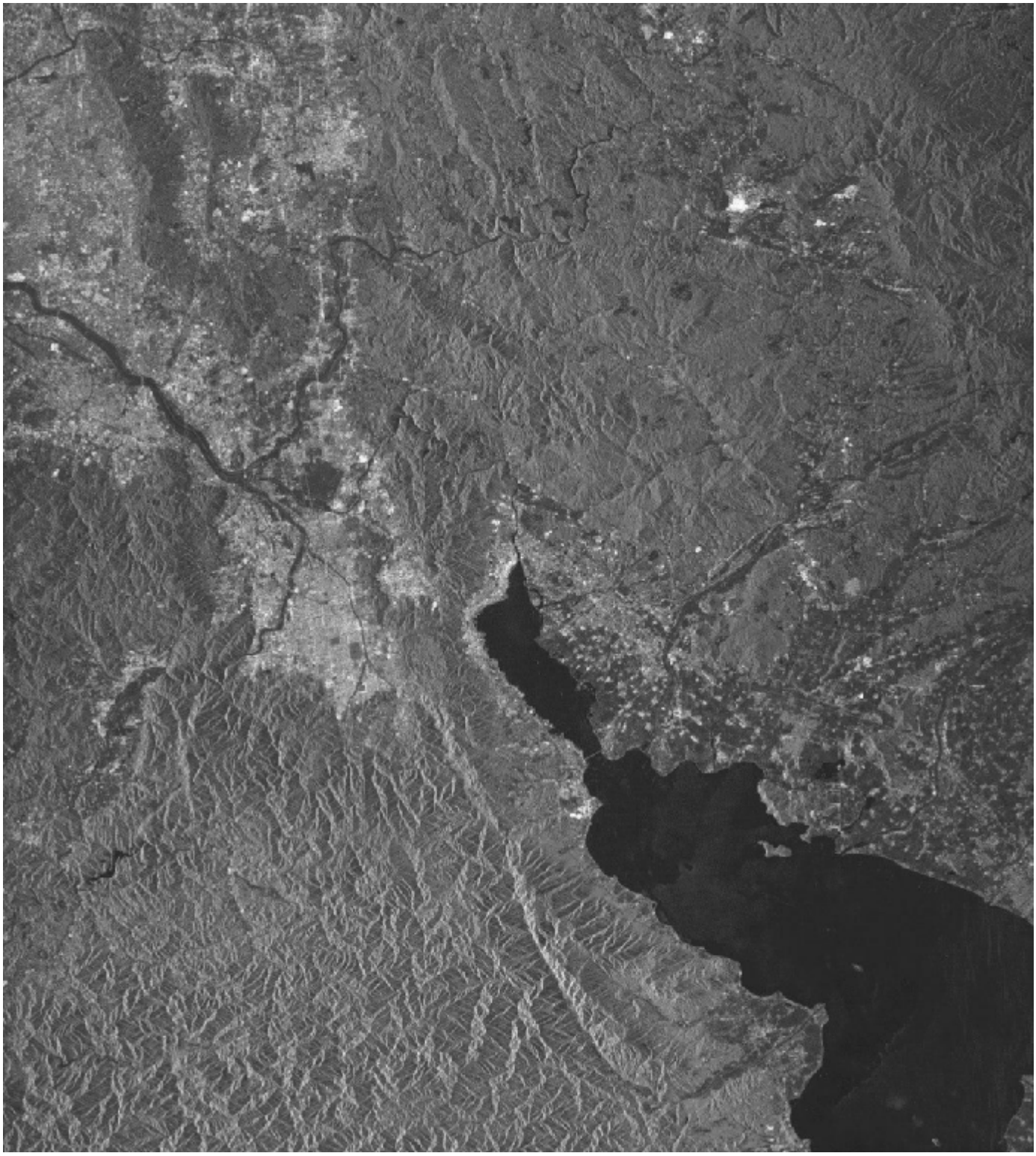

Figure 3 Multi-look Intensity Image of PALSAR image over Kyoto acquired on 21-Mar-2006 by ALOS in Fine-Beam single-pol HH mode. Incidence angle at center swath is 38.2 degrees. In this image there are 4 range looks and 10 azimuth looks. Pixel spacing is 29.96 m in range and 31.48 m in azimuth

Figure 4 Full range resolution section of the PALSAR Kyoto image acquired on 21-Mar-2006. Range ground range spacing is 7.87 m and azimuth pixel spacing is 9.55 m. Note the individual roads and buildings in the scene.

Further analysis was performed to evaluate the point target performance in the image. A bright target was selected in the center image and analyzed using the Gamma point target analysis program. 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.

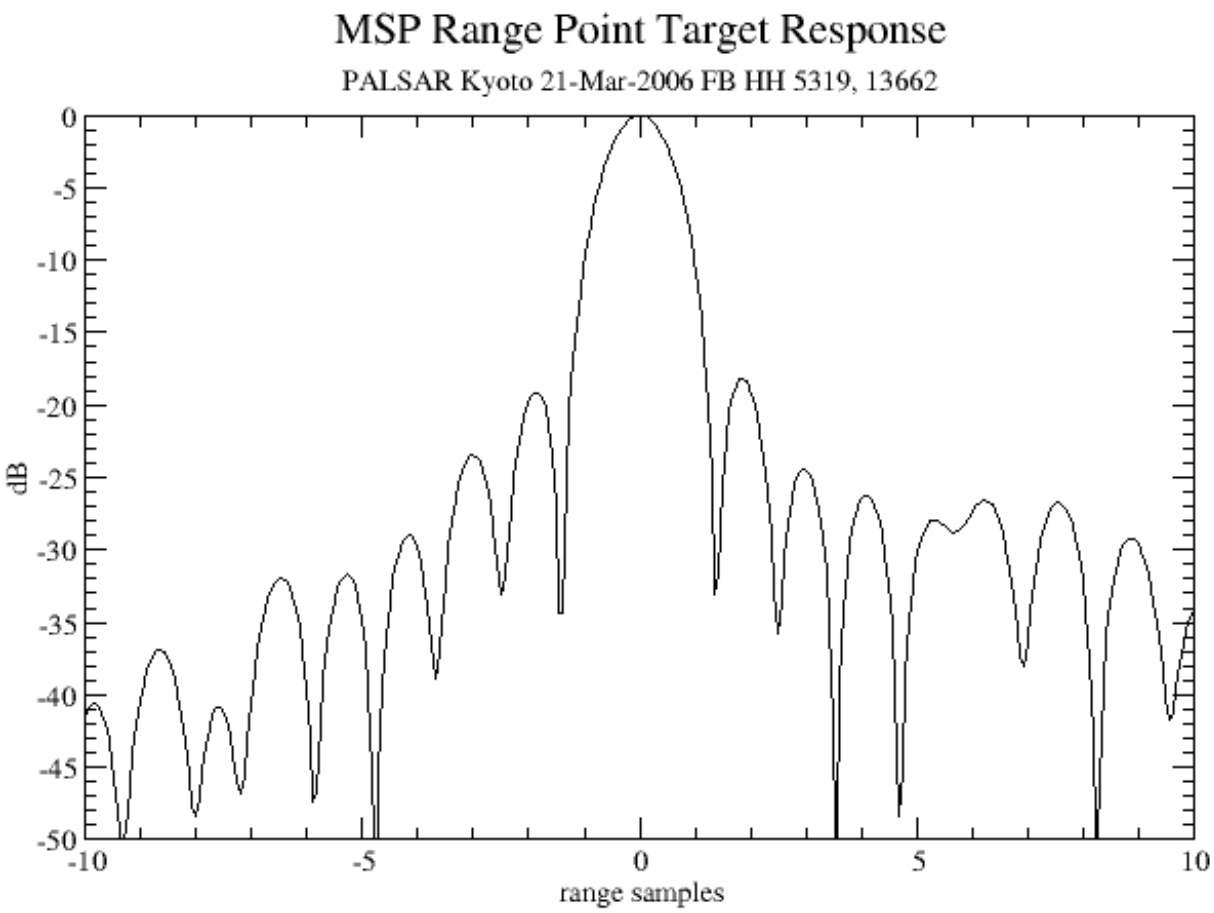

Figure 5 Range point target response

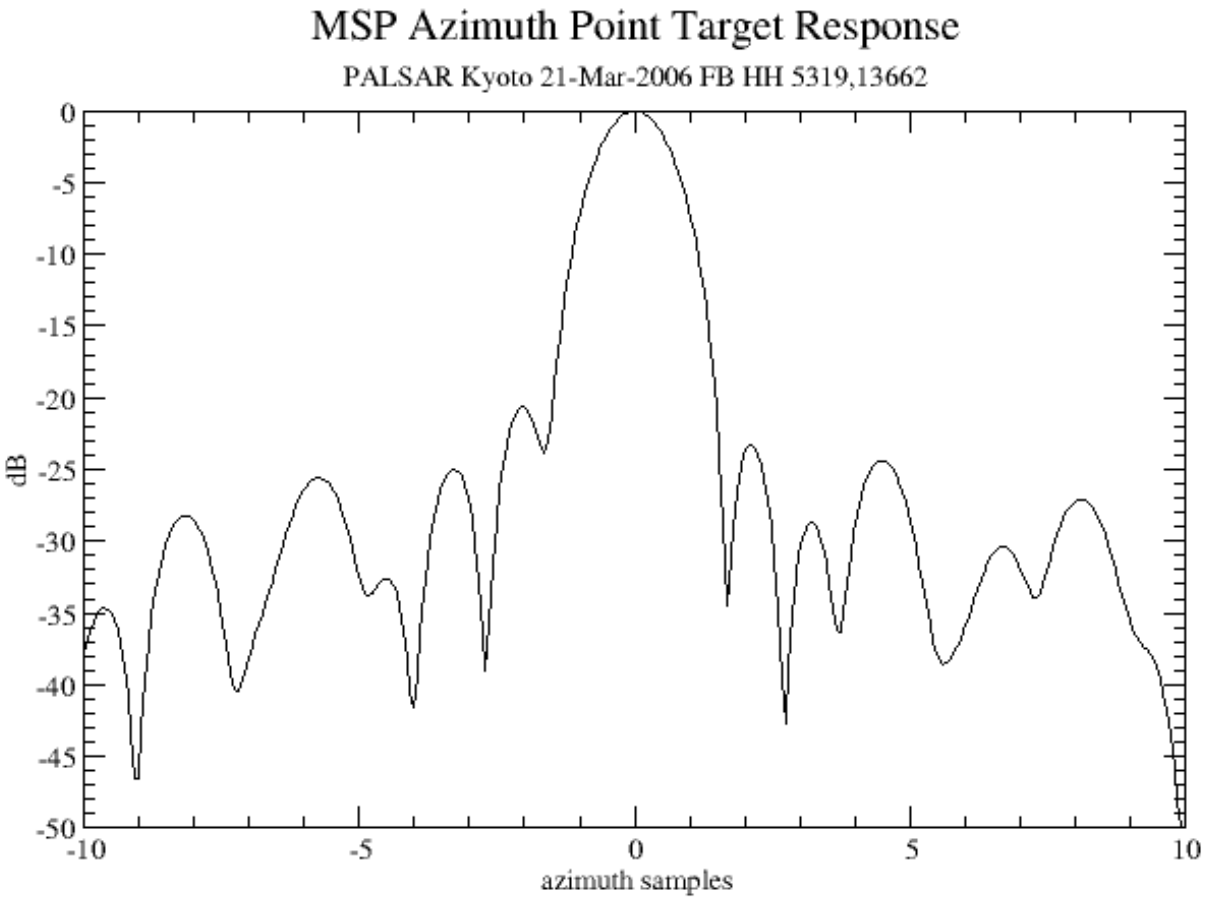

Figure 6 Azimuth point target response

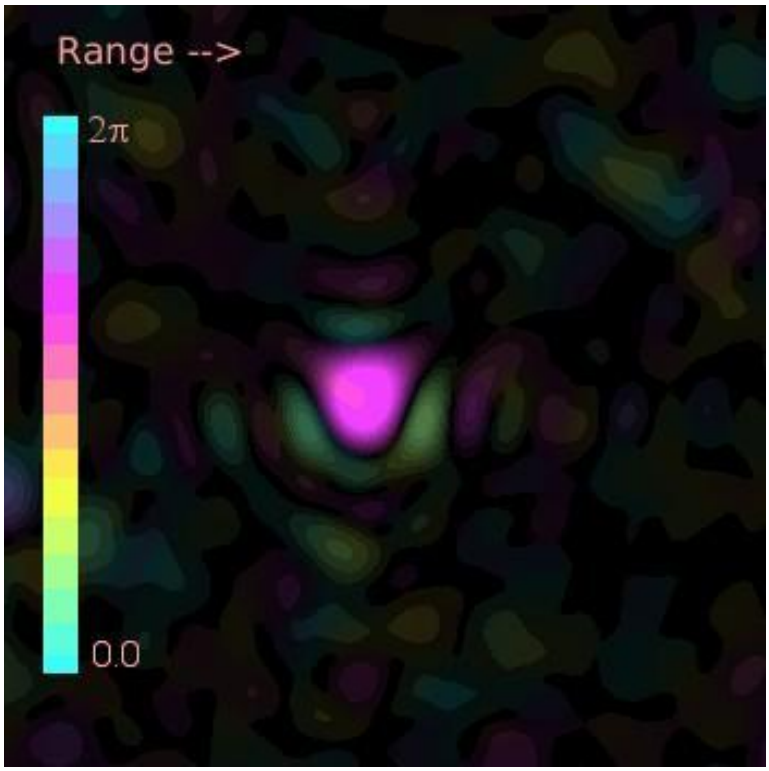

Figure 7. Over-sampled point target response. The phase scale covers the range from 0 to 2PI.

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

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

The data from this scene have been terrain geocoded using the Gamma DIFF/GEO package using the SRTM 3 arc-sec DEM available from USGS. The output terrain geocoded image is shown in Figure 8.

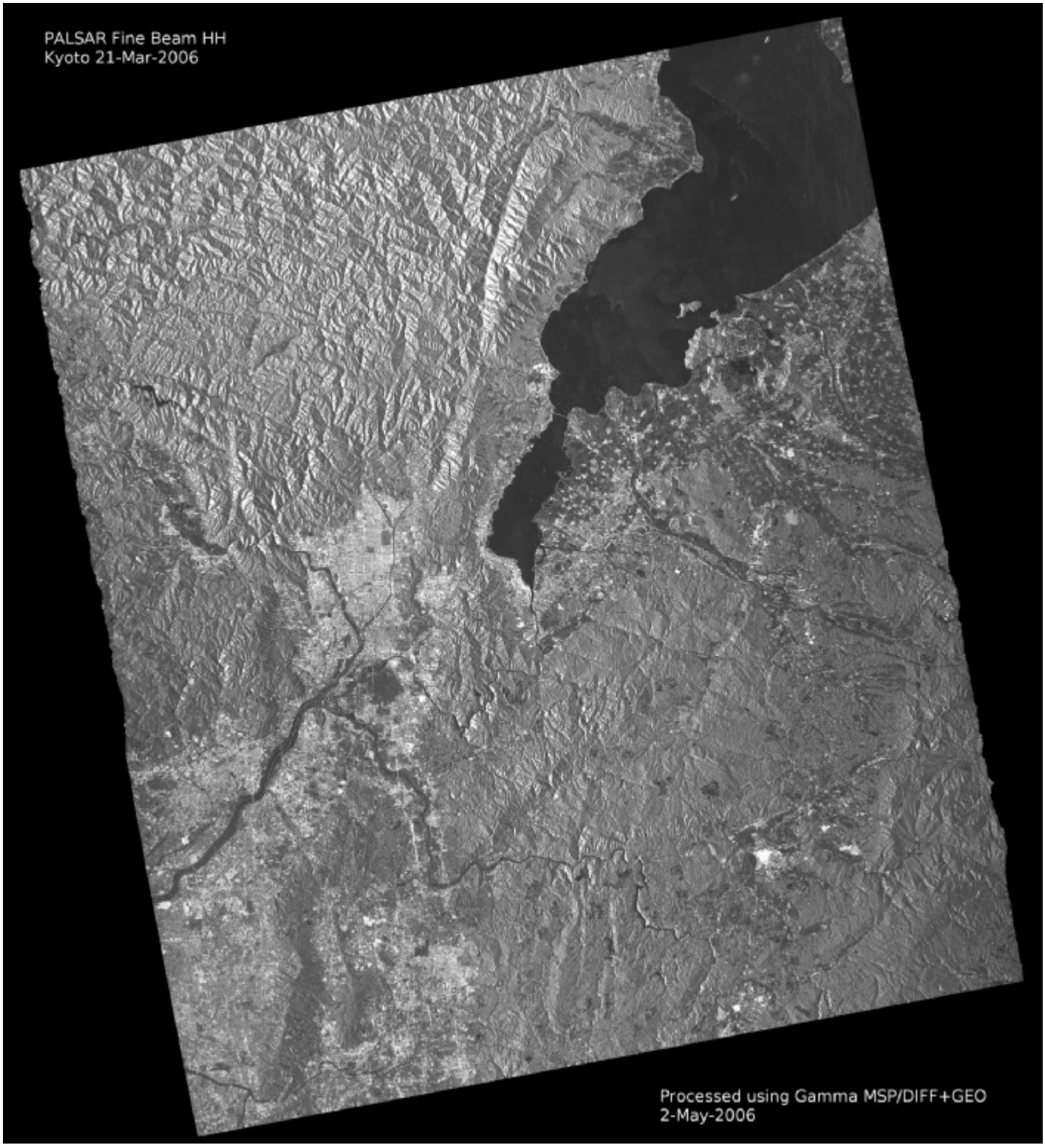

Figure 8 Terrain geocoded image from PALSAR of Kyoto acquired 21-Mar-2006. Processed using the Gamma MSP/DIFF+GEO software packages.

References

[1] Cumming, I., F. Wong, Digital Processing of Synthetic Aperture Radar Data, Chapter 12, pp. 481-565, Artech House, 2005