

The PacRim2000 Campaign Experiment in Japan: Summary and Some Results of Joint Flight Experiments of AIRSAR and Pi-SAR

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INTRODUCTION

For the “PACRIM2: AIRSAR deployment, 2000” campaign experiment, Communications Research Laboratory (CRL) proposed a research plan, titled “AIRSAR studies in support of PI-SAR environmental algorithm development and SAR cross-calibration” (PI: T. Kobayashi), which brought a joint flight experiment of AIRSAR and Pi-SAR in Japan. The Pi-SAR is an X/L-band polarimetric airborne SAR, developed and operated jointly by CRL and National Space Development Agency of Japan (NASDA). Main characteristics of the Pi-SAR are summarized in Table 1 with those of AIRSAR [1].

The main purpose of the research that CRL had planned was to study SAR applicability to the forestry using P, L, C, X-band data from the two SAR systems and to cross-calibrate the two L-band SAR’s common in the two systems. Since it was a valuable opportunity to obtain AIRSAR image data in Japan, we tried to expand research areas (including such as oceanography and volcanology), inviting researchers from other research/academic institutions into the project. As a result, a ‘PacRim2 experiment team’ of a large number of people with various research areas participated in the project with over 20 test sites all over Japan. They are summarized in Table 2 [2].

EXPERIMENT

The AIRSAR (boarded on a DC-8 airplane) flight experiment was carried out on Oct. 2 and Oct. 4, 2000, to cover all the sites in two full day flight. Coincidentally, Pi-SAR (boarded on a Gulfstream II airplane) flight was made on Oct. 1 to 5 (four and a half day flight) to cover the same area. The flight (azimuth) direction and altitude of the both airplanes were set to be same for all sites, so that we can obtain image data in the same viewing geometry from the both. The observation date/time differs by a few hours to a few days between the both depending on the site, as the cruising range is different between the DC-8 and the Gulfstream II.

RESULTS

After the flights, AIRSAR data had been processed in Jet Propulsion Laboratory (JPL) and delivered to

Table 1 Main characteristics of Pi-SAR and AIRSAR.

System	Pi-SAR		AIRSAR		
	CRL/NASDA		JPL		
Band	X	L	C	L	P
Center Freq.(GHz)	9.55	1.27	5.30	1.25	0.44
Bandwidth (MHz)	100	50	20/40	20/40	20/40
Antenna Size (L*W in m)	1.05 *0.19	1.55 *0.66	1.4 *0.2	1.6 *0.5	1.8 *0.9
Slant-range Resolution (m)	1.5	3.0	10/5	10/5	10/5
Azimuth Resolution (m)	1.5 (4look)	3.0 (4look)	1	1	1
Ground range swath (km)	8 – 12 km (typical)		10 – 15 km		
Polarimetric	Yes	Yes	Yes	Yes	Yes

Table 2 PacRim2 test sites in Japan.

Test Sites	Area types	Main Objective *1	AIRSAR flight	Pi-SAR flight
Mikawa	Plateau	(NASA)	Oct. 2	Oct. 3
Niigata	Urban (mix)	SAR Polarim.		Oct. 2
Tomakomai	Forest	Forestry		
Mt. Usu	Mountain	Volcanology		
Muroran	Coastal	Oceanography		
Mt. Iwate	Plateau	Vegetation		
Tsukuba	Urban (mix)	Hydrology		Oct. 1
Tokyo	Urban	Urban Environ.		–
Mt. Fuji	Mountain	SAR Interfero.		Oct. 3
Izu	Coastal	Oceanography		–
Kumano-nada	Ocean	Oceanography	Oct. 4	
Nara	Urban (mix)	Paleo-Environ.	Oct. 4	Oct. 3
Kyoto	Urban (mix)	Urban Environ.		
Kobe	Urban (mix)	Urban Environ.		
Awaji	Island	Geology		Oct. 4
Kojima-wan	Reclaimed	Agriculture		
Tottori	Dune	SAR Calibrat.		
Hiroshima	Coastal	Oceanography		
Akiyoshi	Karst	Geology		
Fukuoka	Coastal	Oceanography		
Unzen	Mountain	(NASA)		Oct. 5
Aso	Plateau	Vegetation		
Sakura-jima	Mountain	Volcanology		
Yaku-shima	Island	Vegetation		
Kuroshio	Ocean	Oceanography		

*1: Polarim.:Polarimetry, Interfero.: Interferometry, Calibrat.: Calibration, Environ.: Environment

CRL (through NASDA). Pi-SAR data had been processed in CRL.

We show in this paper, to illustrate imaging properties of each SAR system, obtained images of the Tottori site. Tottori site is a dune (the largest in Japan) where NASDA and CRL deployed some trihedrals and dihedrals for cross-calibration. Fig. 1 (a), (b) shows the Pi-SAR images of X, L-band. Fig. 2 (a), (b), (c) shows the AIRSAR images of C, L, and P-band.

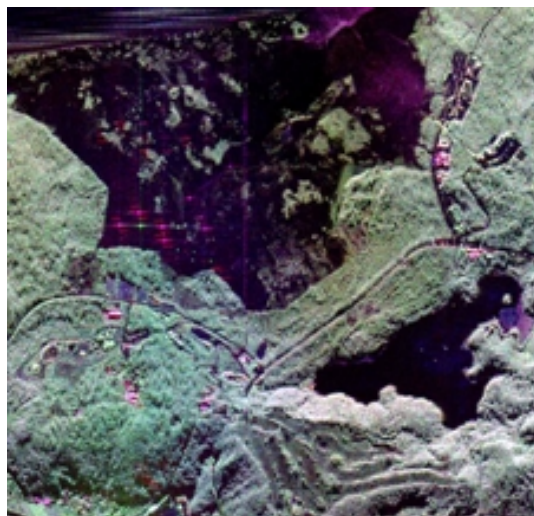
The Pi-SAR images are color composite ones using HH (Red), HV (Green), and VV (Blue) polarization data. They are ground-range projected 4 look images: 2km in azimuth (the flight from right to left) and 2 km in range (the illumination from top to bottom). Pixel spacing is 1.25m for X-band and 2.5 m for L-band. We can see a dark dune area in upper center (and ocean in the uppermost), in bottom left of which there are bright dots corresponding to trihedrals and dihedrals. Some of the dihedrals were rotated to select polarization to be reflected, resulted in different colors of dots. The surrounding are mostly trees and scattered buildings, as well as a pond (bottom right) and a golf course (bottom center). AIRSAR images are, on the other hand, slant-range projected 9 look (18 look for P-band) images and its pixel spacing is 3.33 m in range and 4.63 m in azimuth (for P-band, 6.66 m in range and 9.26 in azimuth). Quantitative analysis of the corner reflector responses has been made both in CRL and in NASDA [3].

CONCLUDING REMARKS

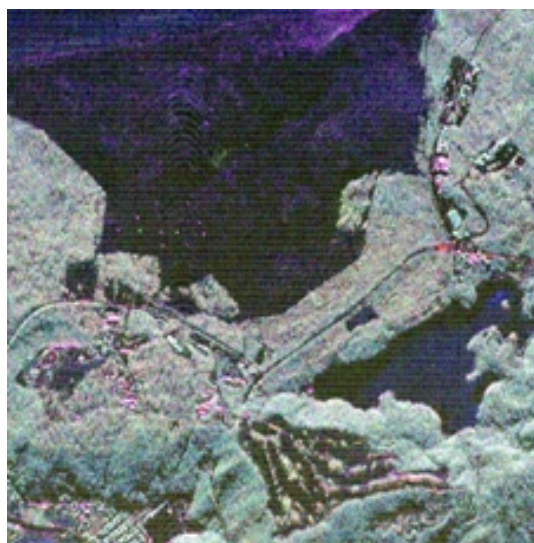
In the PACRIM campaign experiment in 2000, over twenty research sites were imaged by two airborne SAR systems. We had successfully obtained full-polarimetric high-resolution radar images, of four different frequency bands, all over Japan. (AIRSAR P-band operations were limited only in a few sites including Tottori, to avoid radio interference in existing use, though.) The data shall be effectively utilized to study polarimetric radar imagery. The scientists participated, as well as CRL ones, have been analyzing the data with various research objectives.

REFERENCES

- [1] Y. Lou, et al., The NASA/JPL Airborne Synthetic Aperture Radar System, <http://airar.jpl.nasa.gov/documents/genairsar/>.
- [2] S. Uratsuka, et al, Combination of two airborne SAR observations (PacRim2 over Japan), IGARSS 2001, Sydney, Australia, 2001
- [3] H. Wakabayashi, et al, Cross-calibration experiment of airborne polarimetric SAR, IGARSS 2001, Sydney, Australia, 2001.

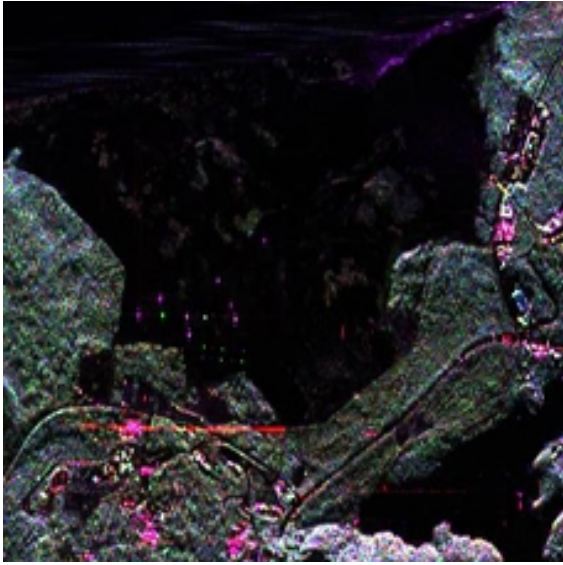


(a) X-band

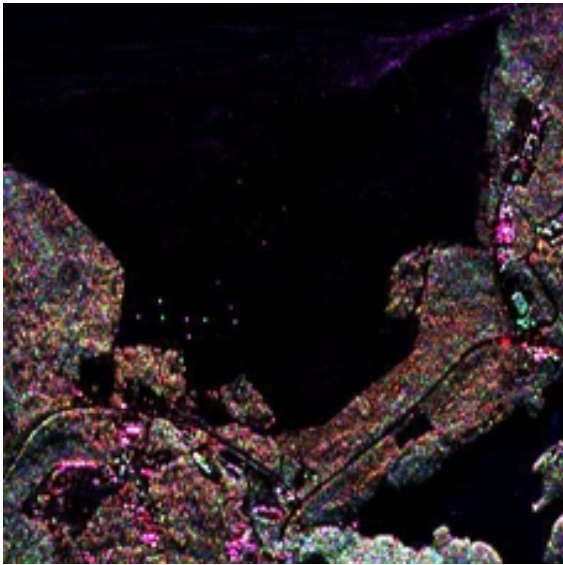


(b) L-band

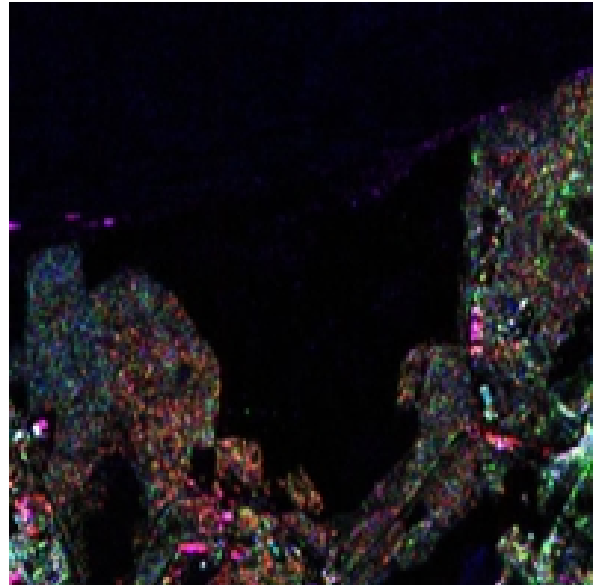
Fig. 1 Pi-SAR images of cross-calibration site in Tottori dune.



(a) C-band



(b) L-band



(c) P-band

Fig. 2 AIRSAR images of cross-calibration site in Tottori dune.