X-band interferometric SAR sensor for the Japanese altimetry mission and aircraft experiment

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Introduction

In the Japanese new altimetry mission (COMPIRA; Coastal and Ocean measurement Mission with Precise and Innovative Radar Altimeter), we will use wide-swath altimeter in order to maximize spatial coverage of the altimetry measurement maximize to reduce error of the tidal model in the shallow marginal seas. We have a plan to develop X-band interferometric SAR (interferometric synthetic aperture radar), SHIOSAI (SAR Height Imaging Oceanic Sensor with Advanced Interferometry) with two antennas for COMPIRA mission. In the paper, we will present current status of conceptual design of SHIOSAI sensor and current plan of the aircraft experiment.

Requirements

COMPIRA Requirements

Item		Specification		
Spatial resolution		5 km		
Time to offer product		6–12 h	3 days	60 days
Accuracy (*)	relative	5.4 cm	5.4 cm	5.3 cm
	absolute	12.2 cm	7.5 cm	6.9 cm
Frequency		Twice per 10 days		
Observational area		Sea around Japan, from the Persian Gulf to the west coast of the U.S.		
Distance to coastal line		10 km		
Rain error		1%		
Coverage		98% @ 35°N latitude		
Product		Sea surface height, sea level anomaly, absolute sea surface height, Geophysical Data Record		
Tide		Observation for computable harmonic constant of main tide		

(*) Average in swath

SHIOSAI Sensor Requirements

Item	Specification
Sensor system	Interferometry SAR （2 antennas along the ground range ）
Swath	80km×2 （Both side observation）
Frequency	9.6GHz band
Spatial resolution	5km × 5km
Sea height error (sensor-induced)	4.2cm (*)

(*) Average in swath

Figure 1. Target requirements for COMPIRA and SHIOSAI.

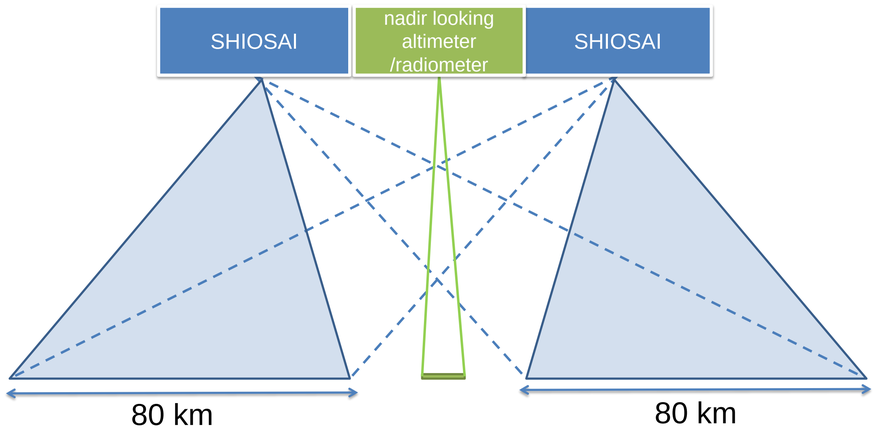
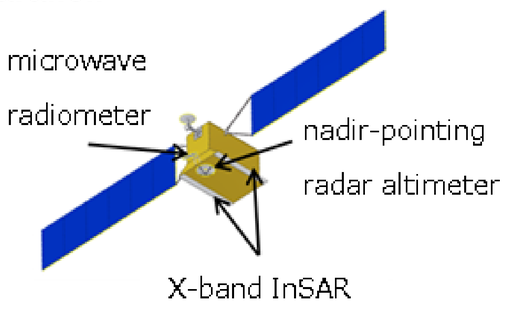


Figure 2. Wide-swath measurement of sea surface height.

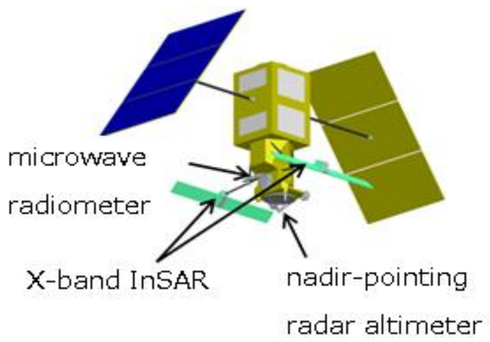
・Wide-swath measurement (80 km × 2)
・Large coverage (98% @ 35°N latitude)
・Small attenuation (adoption of X-band)

SHIOSAI Sensor Concept

To fulfill the requirement, we conducted a trade-off analysis of the antenna and transmitter/receiver systems, and set the radar parameters. We adopt a centralized transmitter/receiver system installed inside the satellite bus. We are studying two concepts in parallel.



Concept 1: Passive array antennas mounted on the satellite bus structure



Concept 2: Reflectarray antennas attached to the deployable booms.

Figure 3. COMPIRA satellite configurations.

Table 1. Comparison between SHIOSAI two concepts.

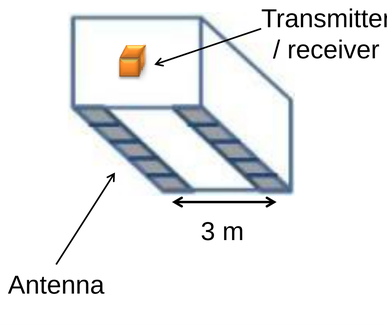
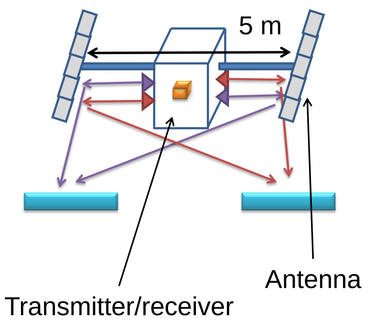
	Concept 1: Passive array	Concept 2: Reflectarray
Antenna System		
Installation of antenna	Antennas are mounted on the satellite bus structure (without a deployable boom).	Antennas are attached to the end of deployable booms.
Baseline length	3 m	5 m
Antenna system	Patch or slotted antennas (existing technology)	Reflectarray antennas (novel configuration)
T/R system	Centralized	

Table 2. SHIOSAI specifications.

Item	Specification (Radar parameter)	Specification for studying	
		Concept 1: Passive array	Concept 2: Reflectarray
Error (sensor-induced) (Average in swath)	4.2 cm	Same as on the left	
Center frequency	9.6 GHz	Same as on the left	
Bandwidth	120 MHz	Same as on the left	
Baseline length	>3 m	3 m	5 m
Swath	80 km × 2	Same as on the left	
Beam width	4.3°	Same as on the left	
Ground range	10–90 km	Same as on the left	
Incident angle	0.7–6.3°	Same as on the left	
Polarization	HH/VV	Same as on the left	
Peak power	NA	2000 W	2035 W
Mean power	~300W	300 W	269 W
RF duty ratio	~15%	15% (3.75% × 4)	13.2% (3.3% × 4)
Pulse repetition frequency	~17500 Hz	17420 Hz (4310 Hz × 4)	17600 Hz (4400 Hz × 4)
Pulse width	~7 μs	8.7 μs	7.5 μs
Azimuth antenna length	>4 m	4 m	5.1 m
Range antenna length	0.37 m	Same as on the left	

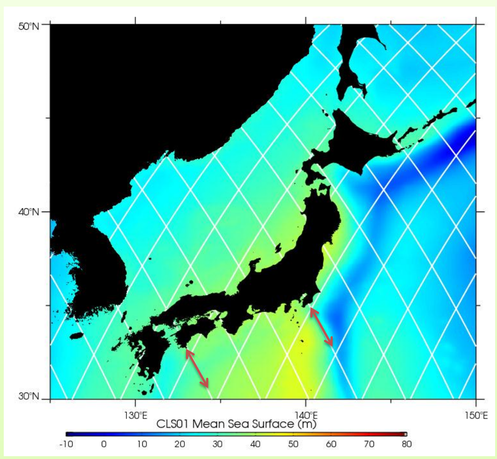
Aircraft Experiment

We will conduct an aircraft experiment from Dec. 2012 to Jan 2013.
Objectives for aircraft experiment are
- **To check decorrelation and the effects of multi-look processing**
- **To check validity of the sensor specifications.**

We will observe as the following specifications;
- **An X-band InSAR (ATSAR-X) on a Beechcraft 200T**
- **Remarkable SSH differences (around the Kuroshio Current).**
- **Synchronization with Jason-2**
- **Same incidence angle as SHIOSAI, and HH/VV polarization.**

ATSAR-X (Alouette Technology, Inc.).

Beechcraft 200T (Diamond Air Service, Inc.).



Target area for aircraft experiment

Figure 4. Aircraft experiment.

Conclusion

We are now under conceptual design of SHIOSAI sensor system. In parallel, we are preparing for the aircraft experiment. We will make more studies about technical constraint of the SHIOSAI sensor for two concepts. Also we will analyze data by aircraft experiment.