SHIOSAI, A Concept of wide-swath altimetry with interferometric SAR for the Japanese future altimetry mission, COMPIRA

A. Uematsu, R. Nakamura

Japan Aerospace Exploration Agency

Introduction

Primary aim of the Japanese future altimetry mission (COMPIRA; Coastal and Ocean measurement Mission with Precise and Innovative Radar Altimeter) is to improve ocean current forecast including coastal region and marginal seas. We are now ongoing an initial conceptual study on wide-swath altimetry using interferometric SAR (Synthetic Aperture Radar) with two antennas, SHIOSAI (SAR Height Imaging Oceanic Sensor with Advanced Interferometry). Main purpose is to observe mid-latitude marginal seas and coastal region with higher coverage. We will present current status of the SHIOSAI conceptual study.

SHIOSAI Requirements

COMPIRA Mission Target Requirements

Item	Specification	
	Goal	Threshold
Spatial Resolution	5[km]	
Sea Surface Height Error	6.8[cm] (except for coastal area)	10.0[cm]
Coverage	98.3[%] @N35[deg]	100[%] @N35[deg]
Swath	70×2[km]	
Data Acquisition rate	TBD[%]	TBD[%]

SHIOSAI Sensor Target Requirements

Item	Requirement
Spatial Resolution （Multi-look）	5[km]
Phase error	5.0[cm]
Swath	70×2[km]
Data Acquisition rate	TBD[%]

Make a study of sensor to meet requirements

・Trade-off analysis for frequency selection
・Comparison between X-band and Ka-band
・Calculation of phase error

COMPIRA Mission Error Budget

	Spec.		Remarks
Altimeter noise		5.0cm	Depending on observing swath and spatial resolution.
Satellite attitude		2.5cm	After post-ground processing to reduce roll angle errors (literature-based value from simulations)
RMS Orbit	12-18days	3-10cm	Under study (GPS+SLR)
	1-2days	10-20cm	
	2-6 hours	< 1m	
Dry troposphere		0.7cm	Based on results from nadir-altimeters Need to consider effects of swath due to spatial variance
Wet troposphere		1.2cm	1.2 cm/3.7cm (with/without microwave radiometer)
Ionosphere		0.5cm	0.5 cm/3.0 cm (with/without dual-freq. nadir altimeter)
Sea State Bias		2.0cm	2.0 cm/3.0 cm (with/without dual-freq. nadir altimeter)
Total RSS: SSH	Goal、RSS	6.8cm	
	Threshold	10.0cm	

Figure 1. Target requirements for COMPIRA and SHIOSAI

Trade-off Analysis for Frequency Selection

Table 1. Tradeoff for frequency selection

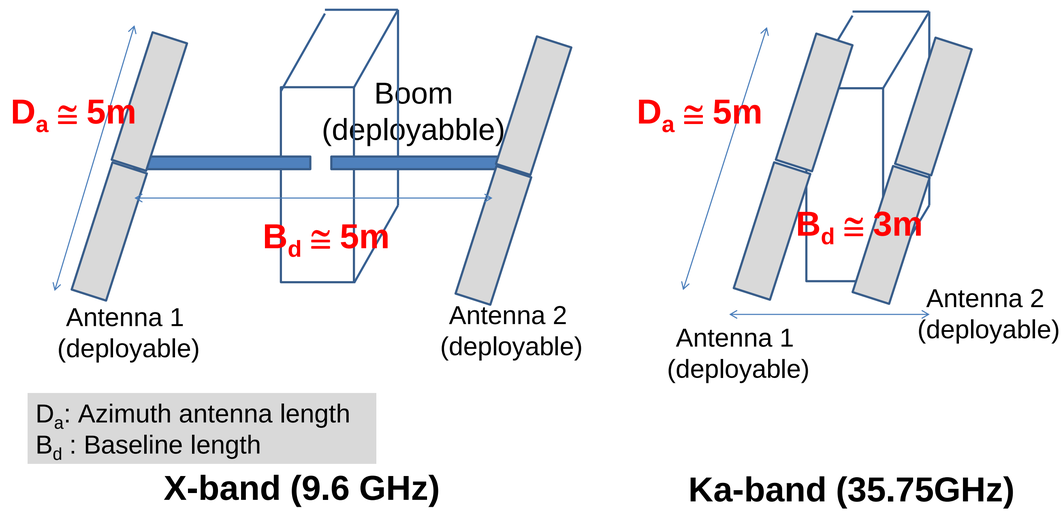
Band	P	L	S	C	X	X	Ku	K	K	Ka
Frequency[GHz]	0.435	1.26	3.20	5.41	8.60	9.60	13.50	17.25	24.15	35.75
Band-width/ MHz (Allowed)	6	85	200	320	100	600	500	100	200	500
Overlap with nadir-looking dual-freq. radar altimeter	-	-	-	NA	-	-	NA	-	-	-
Overlap with GPS	-	NA	-	-	-	-	-	-	-	-
Ionospheric error	NA	NA	NA	NA	AP	AP	AP	AP	AP	AP
Rain attenuation	AP	AP	AP	AP	AP	AP	AP	NA	NA	NA
Band-width/ MHz (used for calculation)	-	-	-	-	-	40	-	-	-	80
Phase error	NA	NA	NA	NA	AP	AP	AP	AP	AP	AP

AP:applicable
NA:not applicable

Select one frequency | Select one frequency

・Trade-off between P-band to Ka-band
・Baseline : X-band
・Alternative : Ka-band (with short base-line length)

Comparison between X-band and Ka-band and Calculation of Phase error



D_a: Azimuth antenna length
B_d : Baseline length

X-band (9.6 GHz) **Ka-band (35.75GHz)**

Figure 2. Conceptual diagram

・X-band: 5 m baseline length
・Ka-band: 3 m baseline length

Table 2. Tradeoff between X-band and Ka-band

	Advantage for Users	Technical Difficulty		
	Rain attenuation	Antenna	Boom	Transmitter/Receiver
X-band (Baseline)	Small impact	・Requirement for thermal distortion for X-band is reasonable. ・Evaluation of antenna weight is needed .	Deployable Boom (~2m) is required to ensure the base line width of ~5m	・Conventional technique can be used. ・Evaluation of mass and configuration are needed.
Ka-band (Alternative : for the case that deployment technique of boom is difficult for X-band case)	Large impact	・Requirement for thermal distortion for Ka-band is more than 3 times stricter than that for X-band.	No/short boom is required.	・Mass, size and power increase. ・Noise of receiver increases.

・Advantage for users: X-band (smaller rain attenuation)
・Advantage against technical difficulty: X-band (except for difficulty of boom) Ka-band (No/shorter boom)

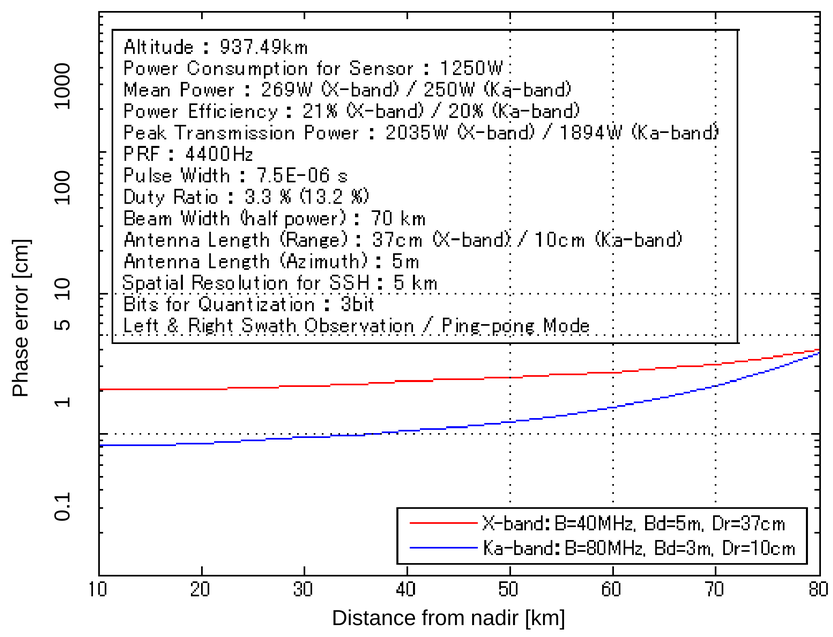


Figure 3. Calculation of phase error for X-band and Ka-band

In both X-band and Ka-band, phase error is less than 5 cm with the spatial resolution of 5 km, and the swath of 70 km x 2.

Conclusion

We are now under consideration of SHIOSAI basic sensor system parameters as discussed above. In parallel, we have started an initial conceptual design of the SHIOSAI sensor system for X- and Ka bands. We will make more comprehensive trade-off in terms of user benefit and technical constraint.