Current status of the Japanese Altimetry Mission

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Introduction

- We are now studying a Japanese *wide-swath* new altimetry mission COMPIRA.
- We will make a presentation about our current status of the mission.
  - Overview of the mission
  - Subject of the mission
  - Mission requirement
  - Main specifications and system configurations
  - Design status for satellite and sensor
  - Airborne experiment

the meaning of COMPIRA

reference; http://busson.jp/

金毘羅

Compira is the god of water.

It has been dedicated as the ancient guardian deity of maritime transportation.

There are many shrines for Compira on hilltop overlooking the port in Japan.

Overview

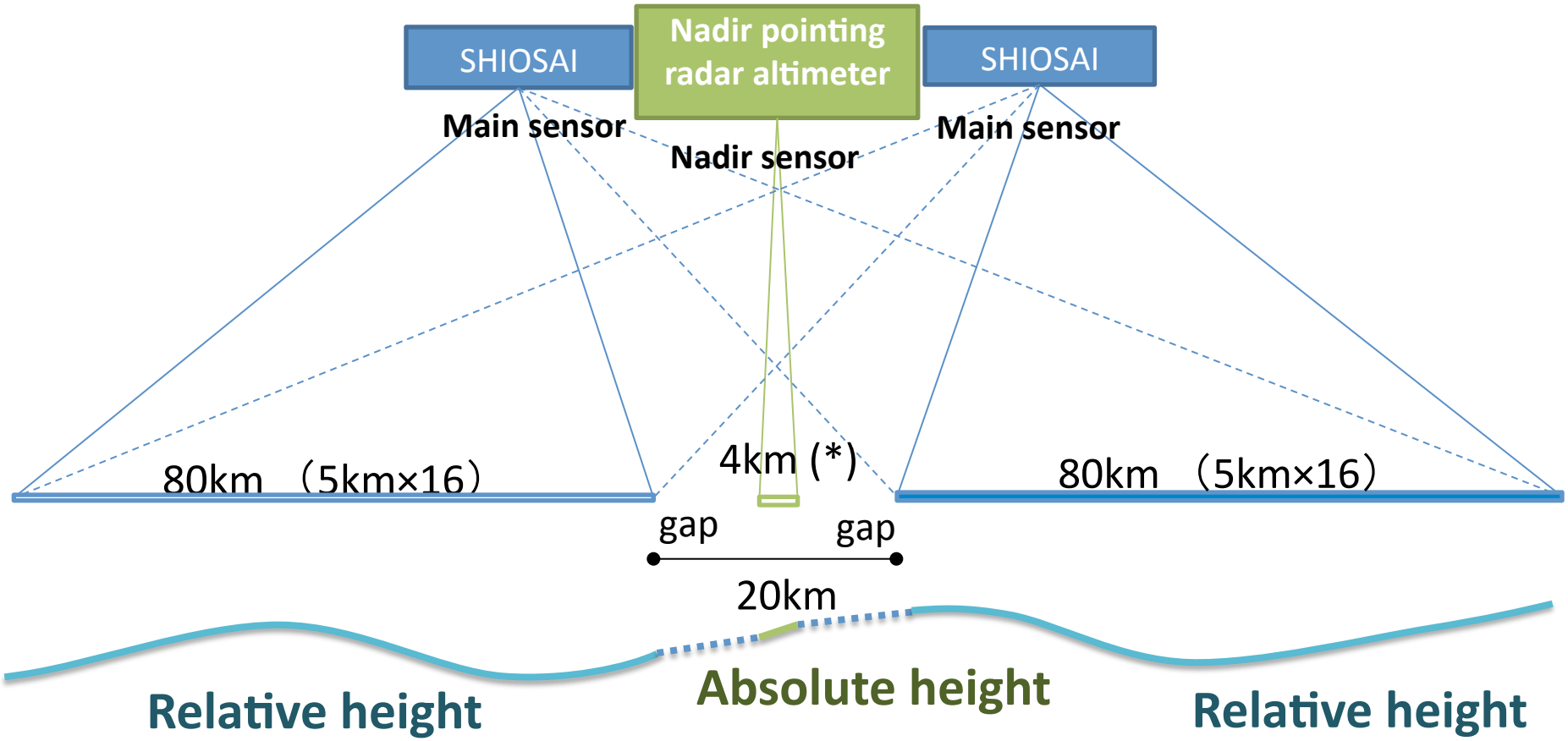
- Wide-swath Altimetry with 80 km× 2 swath
- Code name
  - Mission: **COMPIRA:** **C**oastal and **O**cean measurement **M**ission with **P**recise and **I**nnovative **R**adar **A**ltimeter
  - Main Sensor: **SHIOSAI:** **S**AR **H**eight **I**maging **O**ceanic **S**ensor with **A**dvanced **I**nterferometry

COMPIRA recent and near term events

- 2009: initial conceptual study of a Japanese new altimeter mission was started.
  - Users' requirements were collected and gathered.
  - Some initial studies about mission, satellite system, sensor, and orbit were conducted.
- June 2012:MDR (Mission Definition Review) was completed.
  - raised from pre-phase A to phase A
  - MDR
    - the first review for new mission to define the meaning and purpose
- Launch is planned to be 2019 (TBD).

Sensor system

Measurement of absolute sea surface height with wide-swath and high precision will be realized by combining **SHIOSAI (Interferometric SAR sensor; to obtain relative height)** and **nadir pointing radar altimeter (to obtain absolute height).**



(*) with significant wave height of 2 m

Mission Payload

Mission Payload	Reason to use
SHIOSAI Wide-swath altimeter 9.6 GHz	Main Sensor (Wide-swath altimeter)
Nadir pointing radar altimeter (dual frequency) 13.6 and 5.3 GHz	Mainly to convert relative ocean altitude into absolute ocean altitude, and to calibrate with other satellites.
Microwave radiometer (triple frequency) 18, 23, and 37 GHz (TBD)	To correct water vapor delay.
GPS receiver	For precise orbit determination
CCR (Corner cube reflector for satellite laser ranging)	
DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)	

Mission overview

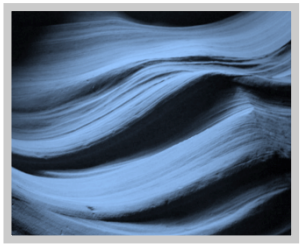
- Subjects

1. Fishery (demonstration for future operational use)

Contribution to search fertile fishing grounds.
Improvement the efficiency with saving fuel and hours of operation.

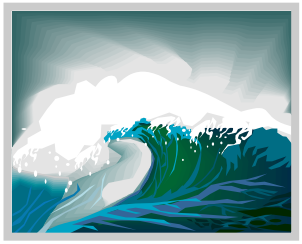
2. Ocean current forecast (demonstration for future operational use)

Wide swath observation of SSH by In-SAR.
Improving ocean current forecast *especially in the coastal region and the coastline sea.*
Contribution to marine salvage (current drift), efficiency of marine navigation with improved ocean current forecast.



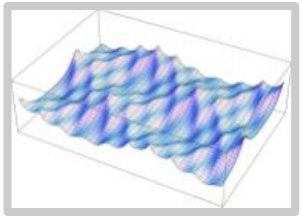
3. other themes (mainly for scientific themes)

Observation of mesoscale eddies and Tsunami by distant earthquake.



4. Technical demonstration

Technical development of sea surface height measurement technology with In-SAR technique.



Users' requirements

- We collected and gathered the users' requirements.
- Requirements for ocean current forecast (for example)

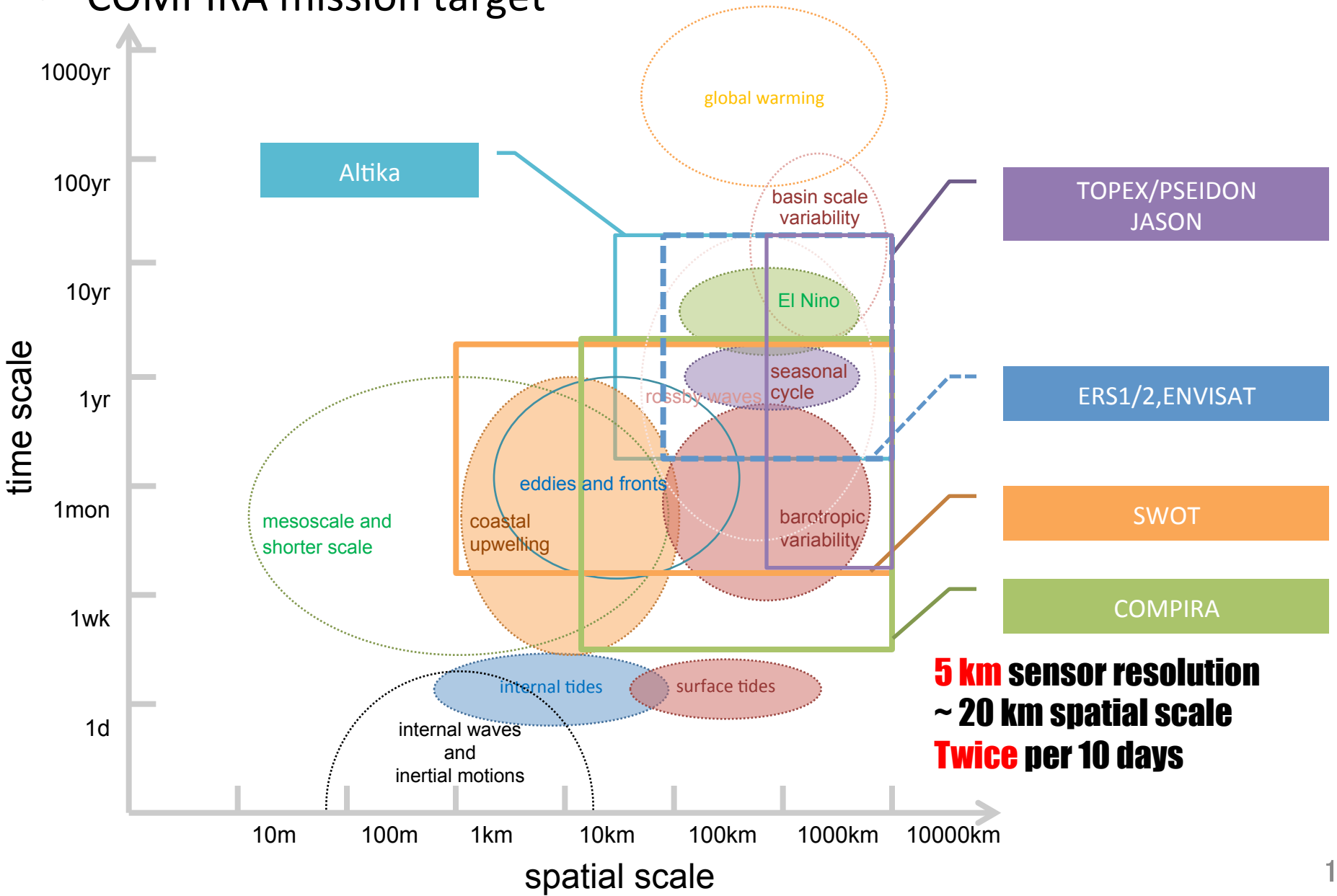
theme	specific items							
	spatial resolution	accuracy	frequency	observational sea	distance to coastal line	rain error	coverage	product
detection of current disturbance and small scale eddies	5km	absolute: 3～9cm	once per 5days	the seas surrounding Japan	-	0%	-	sea level anomaly
monitoring variation of coastal current	1～5km	absolute: ～5cm	once per 3days	the Japanese coast	5～10km	-	-	sea level anomaly
basic data of ocean current and surface height for ocean management	10～30km	absolute: 10cm	once per several days	coastline sea in the sea around Japan	-	-	-	sea surface height
improving tidal model	10～20km	absolute: several centimeter	-	ocean area within the orbit	5km	-	100%	Geophysical Data Record
forecast of hydrographic conditions	5km	absolute: 7cm～10cm	once per several days	ocean area within the orbit	several kilometer	-	-	sea level anomaly

Mission requirements

specific items		mission requirements		
spatial resolution		5km		
time to offer products		near-real-time products 6~12hours later	general products 3days later	high-precision products 60days later
accuracy ※average within swath	relative	**5.4cm※**	**5.4cm※**	**5.3cm※**
	absolute	**12.2cm※**	**7.5cm※**	**6.9cm※**
frequency		**twice per 10days**: observe **twice per 10days** in over 80% ocean area at latitude 35 degrees		
observational sea		**the sea around Japan, and from the Gulf to West Coast America**		
distance to coastal line		**10 km**		
rain error		**1 %**		
coverage		**98 %**: cover 98% of ground track at latitude 35 degrees per period (10days)		
product		**sea surface height, sea level anomary, absolute sea surface height, Geophysical Data Record**		
tide		**observation for computable harmonic constant of main tide** aliasing period of main tide within 6month and it is available to distinguish target tide in 3years		

Mission Target

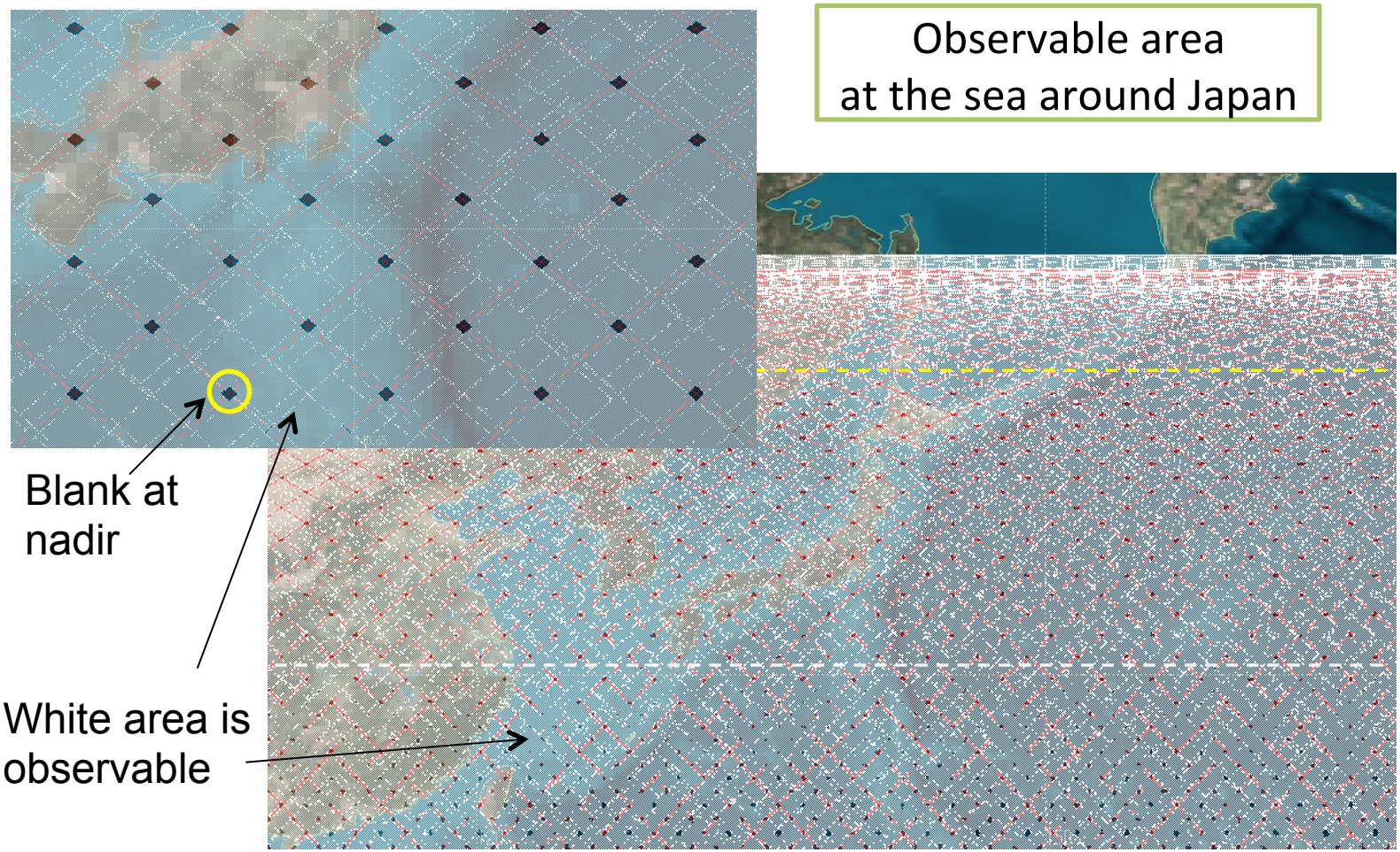
- COMPIRA mission target



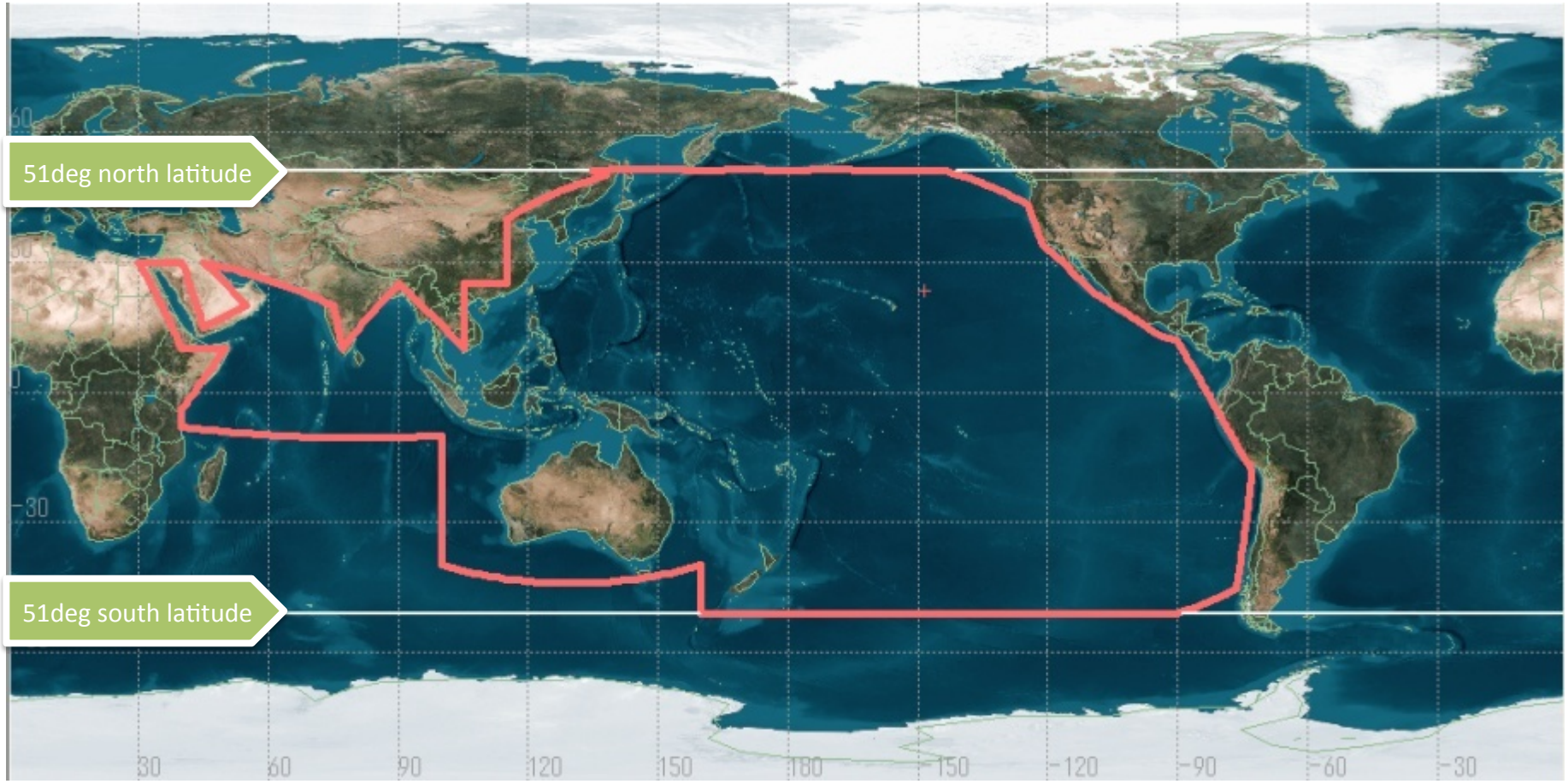
Ratio of Observation

Ratio of observation will be 98% at the sea around Japan (35 latitude).

Observation frequency will be 2 times in 10 days at more than 80% area of the sea around Japan (35 latitude).



Observational sea area



- Mainly Due to data transfer limitation and radar (SHIOSAI) duty ratio limitation, observation area will be limited.
- If down link station is added and limitation of SHIOSAI duty ratio is addressed, it will be possible to add possible observation area.

Orbit Selection

Main Orbital Parameters

Altitude (h)	Inclination (i)	Recurrent Period （Sub-Recurrent Parameters：N-L/M）
937.49km	51.2deg	10days （14-3/10）

Requirements for Orbit Selection

Factor	Requirement	Reason
Observable Area	Orbital inclination ≧ 50 deg	To observe around Japan
Ratio of Observation	Ratio of Observation ≧ 98%	For plane observation at almost all area
Observation Frequency	Subcycle days ≦ 5 days	For high frequency observation
Observation of Oceanic Tidal Constituents	To calculate tidal harmonic constant of dominant tidal constituents in 3 years → non-sunsynchronous orbit	To make a new accurate model of oceanic tidal constituents
High Precise Orbital Determination	Altitude ≧ 900 km	To decrease effect of atmospheric drag
Advance in Precise Observation	Lower Altitude is preferred	To decrease sensor error

Ratio of Observation = 100% - ratio of non-observable area in 1 recurrent

Standard (Level-2) products

✓COMPIRA Level-2 products consist of the following three types, depending on latency:

1) Near-real-time,
2) General, and
3) High-precision.

Summary of COMPIRA Level-2 products

Products	Latency	Accuracy
Near-real-time	6-12 hours	5.4cm(relative) 12.2cm(absolute)
General	3 days	7.5cm(absolute)
High-precision	60days	6.9cm(absolute)

※The near-real-time one aims at operational data delivery.
※Accuracies are defined as a swath-averaged value.

✓ Corrected Sea Level Anomaly (SLA)/ Absolute Dynamic Topography (ADT), and SLA/ ADT/ Geostrophic Current maps are produced from Geophysical Data Records (GDR)

Specifications for SHIOSAI（Main Sensor）

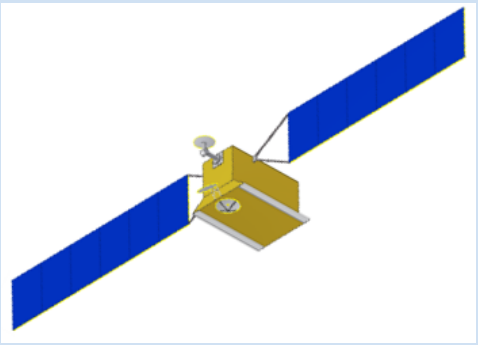
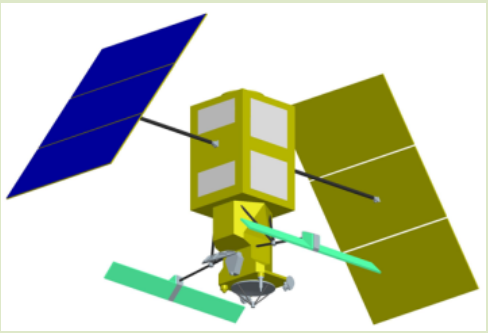
Item	Specification
Sensor system	Interferometry SAR（2 SAR antennas are installed along the ground range direction）
Swath	80km×2（Both side observation）
Frequency	9.6GHz band
Spatial resolution	5km × 5km
Sea height error (sensor-induced)	4.2cm*1（average in swath）

Item	Specification (Rader parameter)
Sea height error (sensor-induced)	4.2cm（Average in swath）
Center frequency	9.6GHz
Band width	120MHz
Baseline width	3-5m
Swath	80km×2（Both side observation）
Beam width	4.3deg
Ground range	10-90km（Both side observation）
Incident angle	0.7 ～ 6.3 deg
Polarization	HH/VV
Azimuth antenna length	4m-5.1m
Range antenna length	0.37m

*1 Height error except for error due to wet troposphere, dry troposphere, ionosphere, sea state bias, satellite altitude and orbit.

Satellite Configuration

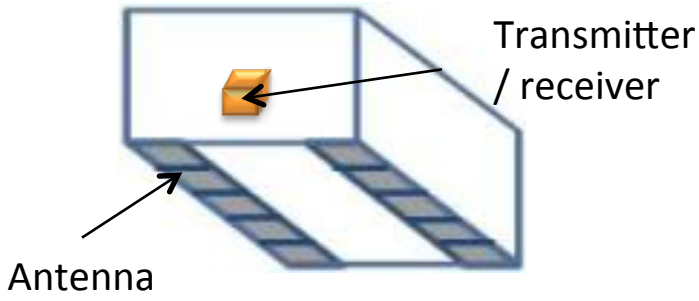
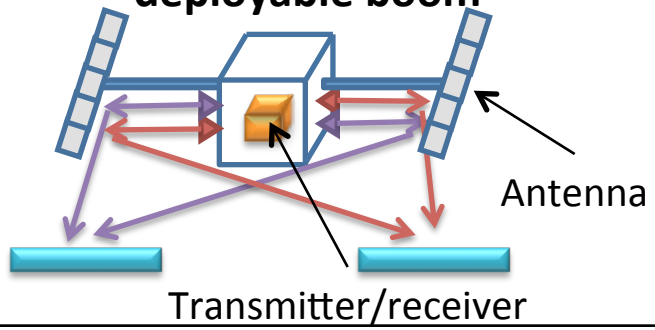
■2 Configurations are mainly studied as below.

Structure Attached Type	Type	**Deployable Boom Type**
	Schematic	
passive array antenna	Antenna Type	deployable reflectarray antenna
4m *Fairing size is restriction	Assumptional antenna length	5.1m *Fairing size is NOT restriction
3m *Fairing size is restriction	Assumptional baseline length	5m *Fairing size is NOT restriction
Large	Ocean altitude error from electrical machinery	**Small**
Small	Ocean altitude error from mechanical alignment	Large

Structure attached antenna improves ocean altitude error from mechanical alignment

Deployable antenna improves ocean altitude error from electrical machinery

SHIOSAI : outline of the specification

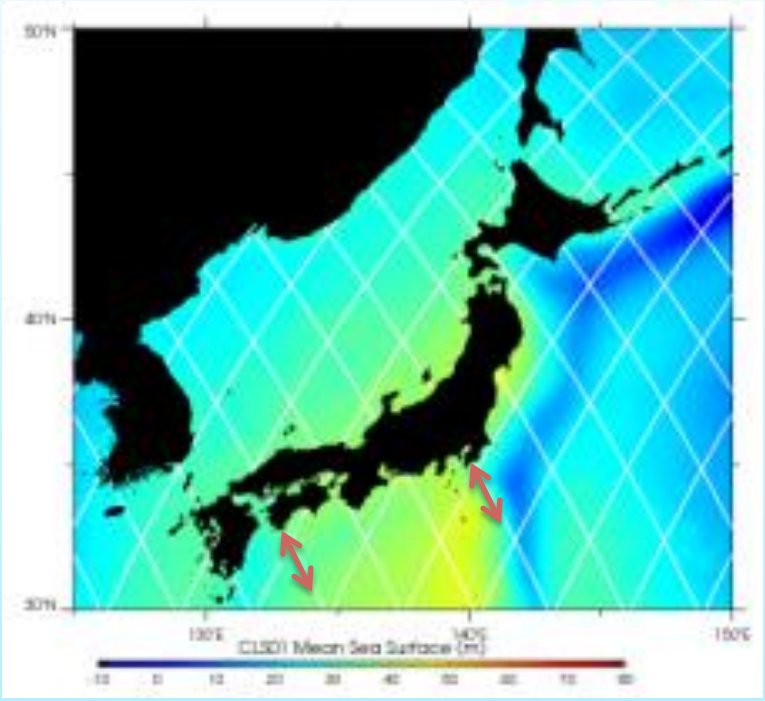
System	**Passive array antenna attached to satellite**  	**Reflectarray antenna with deployable boom** 
Installation of antenna	Antennas are mounted on satellite bus structure (without deployable boom).	Antennas are attached on the end of deployable booms.
Base line width	3 m	5 m
Antenna	**Patch or slotted antenna (existing technology)** Microwave is transmitted from patches/slots on the antennas.	**Reflectarray antenna (novel exploitation)** Microwave is transmitted from feedhorns in the satellite bus, and reflected on the antennas.
Transmitter /Receiver	**Centralized**: One set of the transmitter/receiver is installed in the satellite bus.	

Trade-off study is now ongoing, and the suitable configuration will be selected by the end of the current fiscal year.

Experiments

X-band Airborne In-SAR

Airplane



Jason-2 orbit around Japan

Airplane Experiments (Acquisitions of the X-band In-SAR correlation factor on the ocean and the check of the SHIOSAI implementability)

- Airborne In-SAR observation
- Pacific Ocean surrounding Japan
- Flights under Jason-2 orbits
- Experiments are planned be from December 2012 to January 2013

Conclusion

- MDR (Mission Design Review) of the Japanese first altimetry mission, COMPIRA was completed.

- We are now on Phase-A (conceptual design phase) of the COMPIRA satellite system.

- Coverage of 98 % (at 35 degrees N) will be realized with spatial resolution of 5 km and with 1 % data loss due to rain.

- COMPIRA will improve ocean current forecast especially in coastal region and coastline sea.