Feasibility Study of the Satellite System for the Japanese Future Altimetry Mission

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Introduction

The Japan Aerospace Exploration Agency (JAXA) is conducting a conceptual study of an altimetry mission for fishery, ocean current forecast, science etc. JAXA's internal conceptual study team names the mission COMPIRA (Coastal and Ocean measurement Mission with Precise and Innovative Radar Altimeter) and its main sensor SHIOSAI (SAR Height Imaging Oceanic Sensor with Advanced Interferometry). The sensor is a Cross-Track Interferometric Synthetic Aperture Rader (CT-InSAR) which enables much wider observable area than an existing nadir-looking radar altimeter.

This paper aims at reporting the present state of our feasibility study of the COMPIRA satellite system, especially concerning (1) the way how orbit was selected, (2) results of electrical power analysis, (3) data transmission analysis, (4) baseline deformation caused by thermal strain.

Current Nominal Orbit

Current nominal orbital parameters have been decided as Table 1 taking into account some critical factors, such as component tidal, observable area, observable area ratio, observable frequency, high precise orbital determination and advance in precise observation of sea surface height.

Table 1. Orbital Parameters of Current Nominal Orbit.

Orbital Altitude h[km]	Orbital Inclination i[deg]	Sub-Recurrent Parameters (Revolutions per day) N+L/M	Observation Repetition Cycle T_{obs} [day]	Cycle of Orbital Plane relative to the Earth: T_E[day]	Cycle of Orbital Plane relative to the Sun: T_S[day]
937.49	51.2	14 - 3 /10	9.9	0.99	74.2

N：Revolutions per day(Integer), L：the Number of ground tracks shifted per day, M：Recurrent Period.

Figure 1 shows observable ocean area. The area includes sea around Japan and ocean between Persian Gulf and West coast of America excluding southwest Indian Ocean in latitude ±51 deg. Figure 2 shows details of observable area around Japan. Observable area rate is more than 98% and average number of observation is 2.05 / 10 days around Japan (at latitude 35 deg).

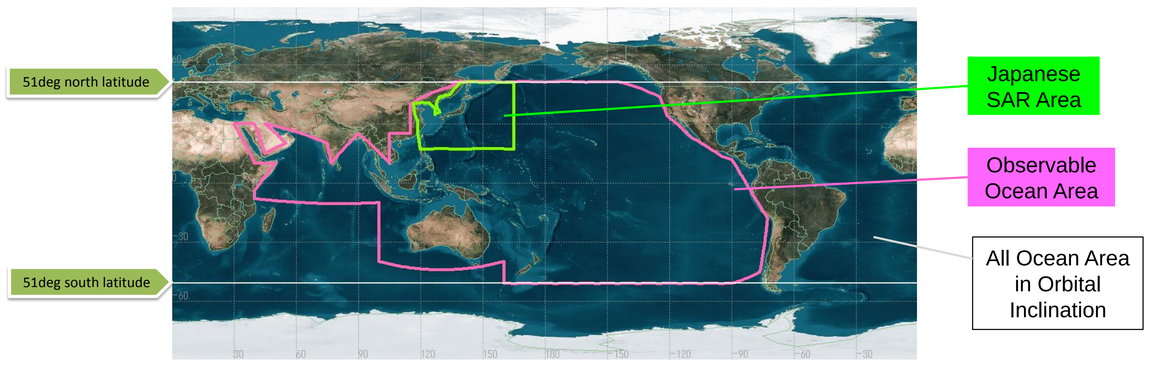

Figure 1. Observable Ocean Area

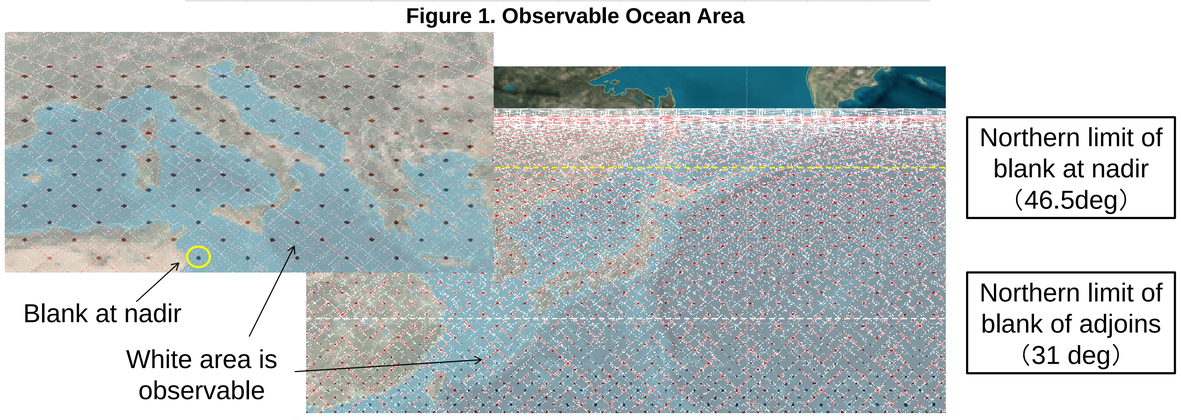

Figure 2. Observable area at the sea around Japan and Italy

Electrical Power Analysis

Assumptions
- Orbit: Current nominal orbit (see Table 1)
- Power consumption of spacecraft including the payload: 2.6 kW
- Observation duty: 100%
- Maximum permissible DOD (depth of discharge): 25%

Results
- Solar array paddle area: less than 55 m^2
- Battery capacity: less than 200Ah

Feasibility in terms of electrical power is satisfied. The solar array paddle and battery above enable COMPIRA to observe all ocean area in orbital inclination.

Data Transmission Analysis

Assumptions
- Observation band width: 120 MHz
- Data rate: 669 (mission), 765 (all) Mbps
- Data transmission rate: 800 Mbps (to EOC* and next-DRTS*)

* EOC:Earth Observation Center (Ground Station), DRTS: Data Relay Test Satellite

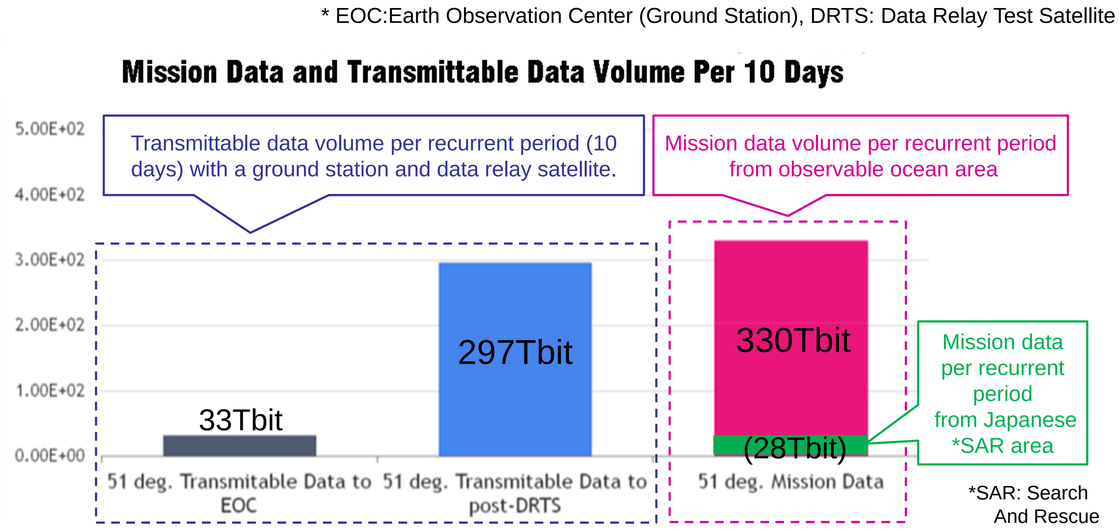

Figure 3. Results of Mission Data Transmitting Analysis.

Transmittable data volume will be comparable with mission data volume from observable ocean area per recurrent period (10 days). We have possibility to transmit mission data from all ocean area in inclination by partnerships of ground stations and/or data relay satellite with other space agencies.

Thermal Deformation Analysis

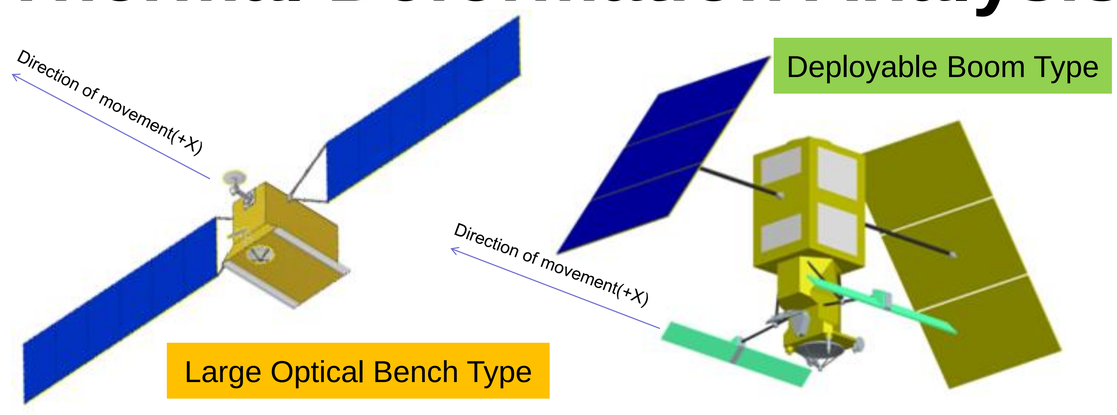

Figure 4. Schematic models of COMPIRA

On-orbit thermal deformation of SAR baseline is one of key issues to determine satellite configuration from Large Optical Bench Type and Deployable Boom Type (see Figure 4). To accomplish accuracy requirement of sea surface height, thermal deformation should hold in 5μm / 1min. Thus, requirements for rate of temperature change of measurement systems are also restricted.

Results of simplified thermal analysis (see Figure 5) show that rates of temperature change are sufficiently small, and baseline deformation of both types should be smaller than 5μm / 1min.

Assumptions
- Orbit: Current nominal orbit (see Table 1)
- Heat Input: Solar radiation, Albedo, Earth radiation, Internal heat (= Power Consumption: 2.6 kW)
- Heat Output: Panel radiation

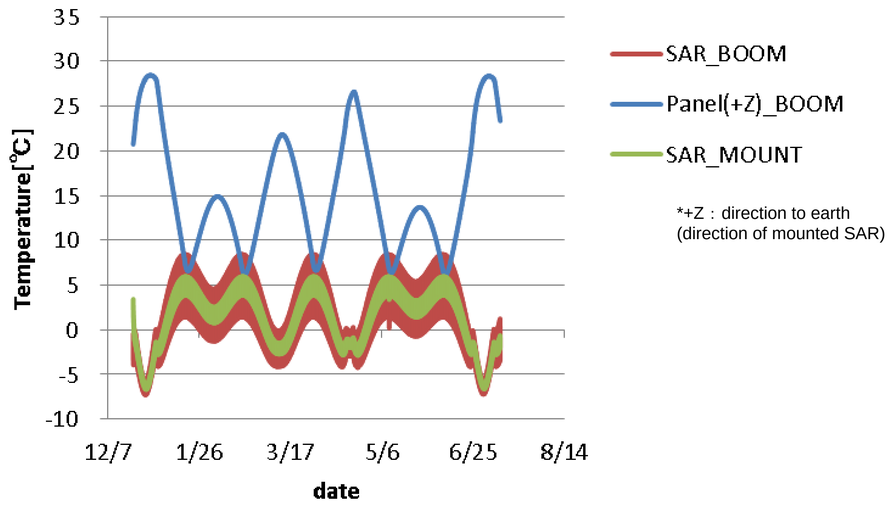

Figure 5. Results of Temperature Analysis