Operation Plan Study for Japanese Future Hyperspectral Mission: HISUI

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Abstract - Japanese future spaceborne hyperspectral mission, Hyperspectral Imager Suite (HISUI), will be launched in 2015 or later as one of mission instruments onboard JAXA's Advanced Land Observation Satellite 3 (ALOS-3). HISUI will consist of a hyperspectral imager and a multispectral imager with 30 m and 5 m spatial resolution and 30 km and 90 km swath, respectively. Although observation requests to HISUI from users in various application fields are expected to be so many, the instrument duty time and the allocation of downlink resources of ALOS-3 will limit actual observation of HISUI. Various plans of HISUI operation, which satisfy as much as possible within allocated resources, will be presented.

Keywords: downlink, swath, global mapping

1. INTRODUCTION

Japanese Minister of Economy, Trade, and Industry (METI) has developed and operated several spaceborne instruments for the earth observation. HISUI, Hyperspectral Imager Suite, will be Metes' third spaceborne imaging system after JERS-1 OPS and Terra ASTER(Ohgi et al., 2010). Its major feature is hyperspectral observation capability together with wider swath and higher spatial resolution multispectral observation. HISUI will provide the earth observation data for global energy and resource issues as well as for other applications such as environmental monitoring and forestry. In this paper, HISUI and its operation plans, which are being studied, are introduced.

2. HISUI AND ALOS-3 SPECIFICATIONS

HISUI (Fig. 1) will consist of a hyperspectral imager and a multispectral imager with 30 m and 5 m spatial resolution and 30 km and 90 km swath, respectively. Its major specifications are summarized in Table 1. HISUI will be launched as one of mission instruments of Japan Aerospace Exploration Agency (JAXA)'s Advanced Land Observation Satellite 3(ALOS-3). Major specifications of ALOS-3 are summarized in Table 2. Although ALOS-3's downlink capacity is quite large due to use of relay satellites, the amount of the data generated from HISUI and JAXA's panchromatic stereo camera will exceed the downlink capacity of the satellite significantly. So careful planning of HISUI operation will be necessary to achieve HISUI's objective.

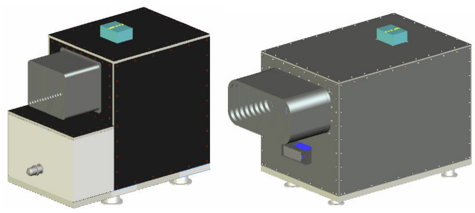

Figure 1. HISUI Hyperspectral Imager (left) and Multispectral Imager (right).

Table 1. HISUI Specifications.

	Multispectral Imager	Hyperspectral Imager
Spatial resolution	5 m	30 m
Swath	90 km	30 km
Spectral coverage	0.45 - 0.90 μm	0.4 - 2.5 μm
Spectral resolution	60 - 110 nm	10 nm (VNIR) 12.5 nm (SWIR)
Number of band	4	185
Signal to noise ratio	> 200	>450 @ 620 nm >300 @ 2100 nm
MTF	> 0.3	> 0.2
Dynamic range	12 bits	12 bits
Data compression	Lossless (70%)	Lossless (70%)
Pointing capability	None	≈7 3 ° (±30 km)
Data rate (70 % compression)	1 Gbps	0.4 Gbps
Maximum data amount per day	1600 Gbyte	690 Gbyte

Table 2. ALOS-3 Specifications.

Orbit type and altitude	Sun synchronous, ≈ 620 km
Local time at descending node	10:30 (TBD)
Orbits per day	15
Repeat cycle and interval between orbits	60 days and 45 km
Launch vehicle	H-IIA
Downlink speed	800 Mbps
Onboard storage	> 200 GB
Maximum downlink amount	1440 Gbyte / day
Other mission instruments	High resolution panchromatic stereo camera

3. HISUI OPERATION PLAN STUDY

3.1 Maximum observation time in one orbit.

The cumulative land observation time of each ALOS-3 orbit is shown in Fig. 2. Although time necessary for land observation in a orbit varies from 48 to 2030 seconds, its average is about 15 minutes which is close to HISUI's maximum total observation time in a orbit. In addition, HISUI can separate its observation time to several segments to avoid open oceans and observe land and coastal areas efficiently. According to the simulation, five segments will be enough for most of daytime land observation.

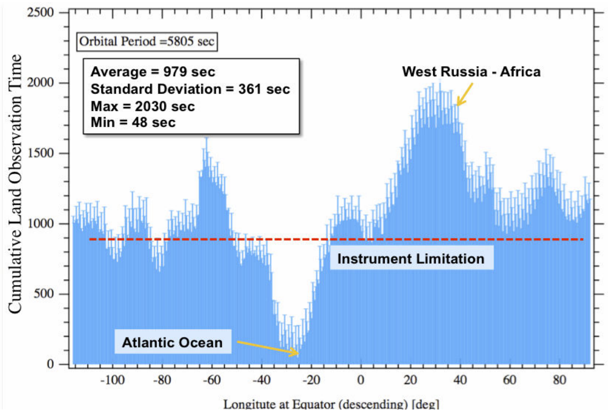

Figure 2. Cumulative Land Observation Time of ALOS-3 Orbits.

3.2 Global Mapping by HISUI Hyperspectral Imager

Global mapping by HISUI Hyperspectral Imager is limited by its narrow swath and huge data amount. Table 3 shows the simulation results of global mapping achievement by HISUI Hyperspectral Imager for various observation days. If HISUI Hyperspectral Imager can downlink 300 Gbyte data per day, which is about 20% of ALOS-3's downlink capacity, more than 40% of global land surface will be observed at least once in four months and more than 97% in ten months.

Table 4 shows the simulation results of global mapping achievement in a year for various downlink allocations. If the allocation to HISUI Hyperspectral Imager is 200 Gbyte or more, more than 90% of global land surface will be observed at least once in a year. In case of 50 Gbyte per day, however, only 25% of land will be observed in a year. The month in which each scene is observed by HISUI Hyperspectral Imager is shown in Fig. 3 for 300 Gbyte case.

Note that, in both simulations, the cross track pointing capability of HISUI Hyperspectral Imager is activated to fill the gaps between ALOS-3 orbits.

Table 3. HISUI Global Mapping (one time) Achievements and Observation Days. Downlink allocation is 300 Gbyte per day.

Observation days	Global mapping achievement (%)
60	36.1
120	43.6
180	56.9
240	86.7
300	97.4
360	99.7

Table 4. HISUI Global Mapping (one time) Achievements and downlink resource allocation. The observation period is one year.

Downlink allocation (Gbyte / day)	Global mapping achievement (%)
50	25.5
100	45.5
150	71.2
200	94.6
300	99.7

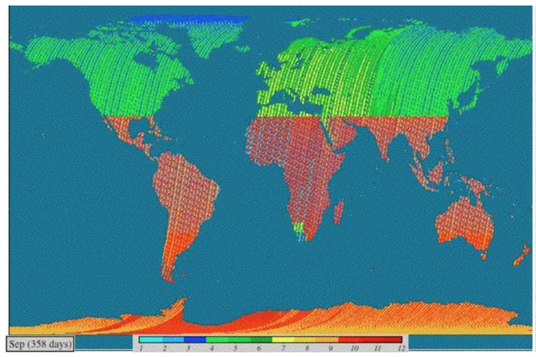

Figure 3. Observation month of each HISUI Hyperspectral Imager scene for 300 Gbyte case.
Light blue = January and Red = December.

3.3 Continental Scale Regional Mapping

Continental scale regional mapping by HISUI Hyperspectral Imager was simulated for African continent as a target. The results are summarized in Table 5. As the narrow swath of HISUI Hyperspectral Imager is a stronger limiting factor, downlink allocation equal to or larger than 100 G byte is enough for this case and more than 60% of the continent can be mapped in two months and 90% in 6 months.

Table 5. Africa Mapping Achievement, Observation Days, and Downlink Resource Allocation.

Observation days	Downlink allocation (Gbyte / day)				
	300G	150G	100G	50G	30G
60	62.5	62.5	61.9	33.8	20.0
120	87.8	87.8	87.0	47.7	28.5
180	90.6	90.6	90.3	77.4	47.6
360	99.9	99.9	99.9	99.9	81.0

CONCLUSIONS

The operation plan study for HISUI was conducted and it was shown that global and continental scale mapping by HISUI will be possible if appropriate downlink resource is allocated to HISUI.

REFERENCES

N. Ohgi, A. Iwasaki, T. Kawashima, and H. Inada, “Japanese hyper-multi spectral mission,” in Proc. IEEE IGARSS, Jul. 2010, pp. 3756-3759.