The first-light image of the Hyperspectral Imager SUIte (HISUI)

September 28, 2020
Japan Space Systems

The Hyperspectral Imager SUIte (HISUI) developed by the Ministry of Economy, Trade and Industry installed to the Kibo's Exposed Facility on the International Space Station (ISS) has acquired its first-light image as part of the initial checkout.

Jointly developed by the Ministry of Economy, Trade and Industry (METI) and the Japan Space Systems, the Hyperspectral Imager SUIte (HISUI) was launched from the US Cape Canaveral Air Force Base toward the International Space Station (ISS) on December 6, 2019 (Japan time). On the 12th of December, HISUI was successfully installed to the Kibo's Exposed Facility and is currently undergoing an initial checkout.

Using the data acquired from the instrument commissioning, a demonstration processing has been conducted and we are pleased to publish this as the first-light image.

Following the initial checkout as well as the sensor calibration, accuracy confirmation of the imagery data, maintenance of ground data processing etc., it is scheduled to start nominal operation observation from November 2020, and will begin its application demonstration by March 2021.

HISUI's high-spectral resolution data enables precise identification of substances on the surface of the earth. In the natural resources sector, it is possible to grasp the distribution of many minerals that are important indicators for resource exploration. Other applications include detailed classification of important forests and vegetation in the environmental sector, grasping the state of crops and soil in the agriculture sector, etc. New information that is not available in the widely used multispectral data will be obtained, and it is expected to be used in a wide range of sectors.

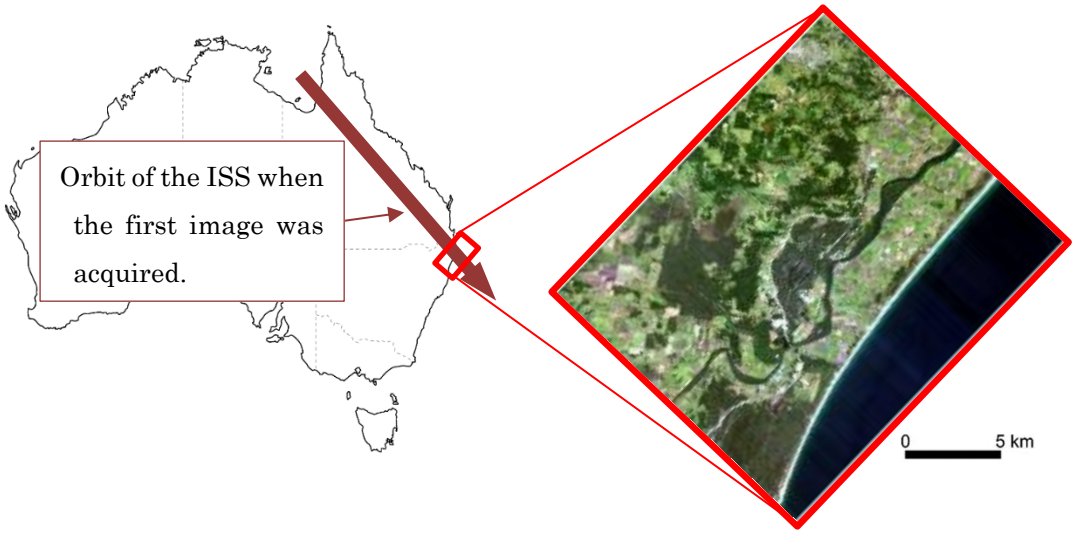


Figure 1: Natural color image over New South Wales, Australia captured by HISUI

Figure 1 is a natural color image acquired by HISUI over New South Wales, Australia on September 4, 2020, the color of which has been processed to look as it would do through the human eye.

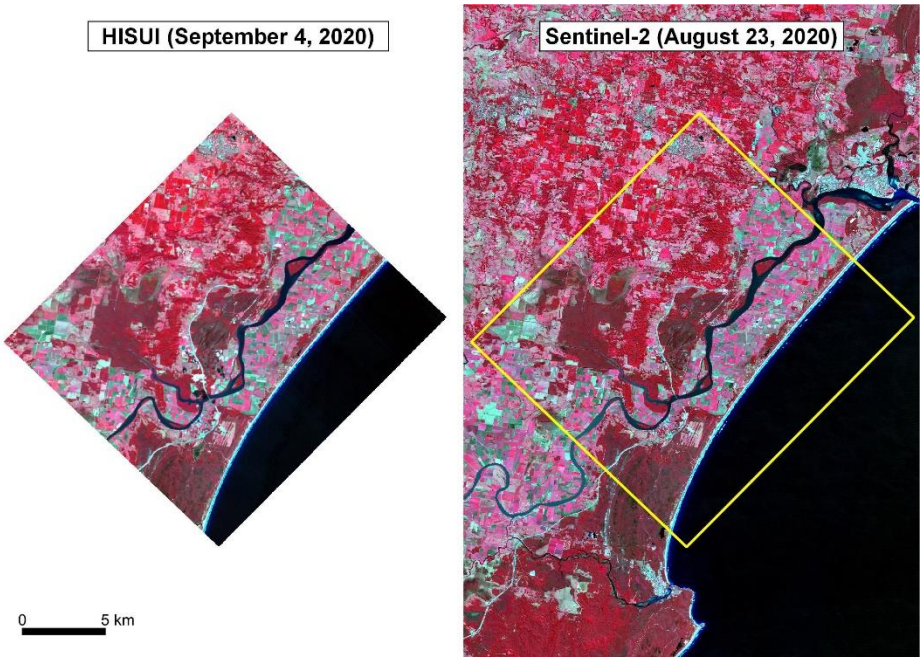


Figure 2: False color composite image by HISUI (left: taken on September 4) and Sentinel-2 (right: taken on August 23)

Figure 2 is a comparison of false color image of the HISUI and that of the Sentinel-2 taken on August 23 in the same area. This band combination is often used in remote sensing image processing to understand the distribution of vegetation, because vegetation reflects sunlight more strongly in the near-infrared region than in the visible region. The color distribution such as vegetation in both images looks almost the same.

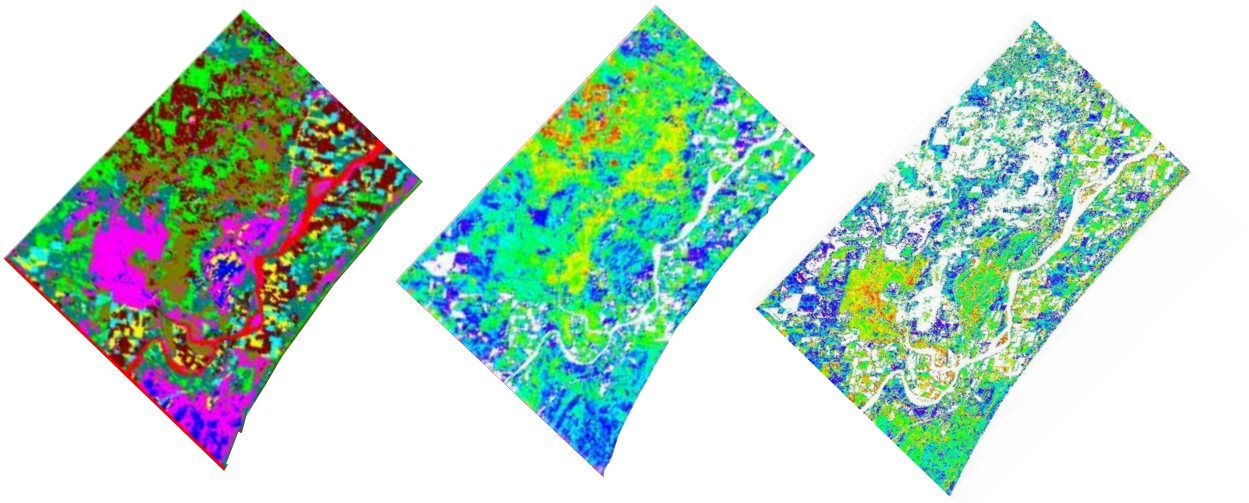


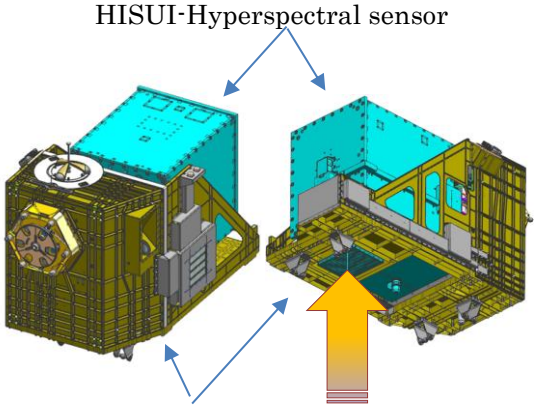
Figure 3: Differences in information extraction using bands from the visible region to the short wavelength infrared region, which are unique to HISUI
Wavelengths used: (Left) All 185 bands, (Middle) 650 nm and 860 nm (Right) 857 nm and 1241 nm

In remote sensing image processing, different information can be extracted by combining data of various wavelengths. Multispectral data has 20 or less bands, but the hyperspectral sensor HISUI can acquire 185 bands, so it is expected that the spatial distribution of various information can be grasped. Figure 3 is a diagram created by using the HISUI data before radiometric correction etc. and using a method commonly used in remote sensing analysis. The figure on the left is a land cover classification map created by automatically grouping all 185 bands of HISUI based on spectral similarity. From the figure, you can see that rivers, forests, urban areas, etc. are classified in the same color. The figure in the center is a distribution map of an index called NDVI (Normalized Difference Vegetation Index), which shows the activity of vegetation, and was created using the bands of 650 nm and 860 nm. It can be speculated that the red color has higher vegetation activity and the blue color has lower vegetation activity. The figure on the right is a distribution map of an index called NDWI (Normalized Moisture Index), which shows the difference in water content of vegetation, and was created using the bands of 857 nm and 1241 nm. It is used to evaluate vegetation moisture stress and fire risk.

<Overview of HISUI>

The HISUI system installed on the ISS consists of an exposed payload system and an onboard data storage system.

HISUI-Hyperspectral sensor



Bus part　Incident light

(Observation the earth)

●HISUI Exposure Payload System

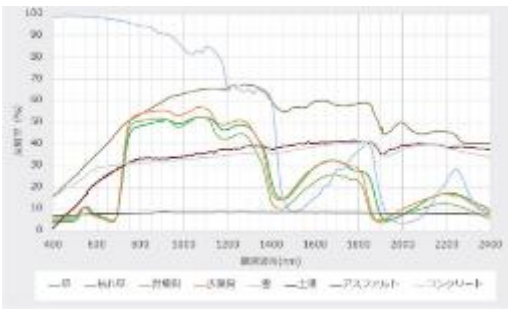
HISUI is a hyperspectral sensor for space demonstration developed with the main purpose of exploration of resources such as oil and gas for the stable supply of energy and resources in Japan. It has the ability to identify substances on the surface of the earth with higher accuracy than existing multispectral sensors. The bus section provides an environment for the HISUI sensor to observe and transmits observation data and telemetry.

- ○ Number of bands: 185
- ○ Observation wavelength band: 0.4 – 2.5 ㎛
- ○ Observation width: 20km
- ○ Spatial resolution: 20m to 30m
- ○ Mass: 550 kg

●HISUI onboard data storage system

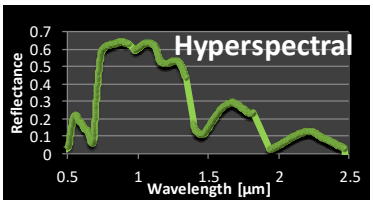
The HISUI onboard data storage system records the observation data and telemetry transmitted from the HISUI exposure payload system on a hard disk and transmits some of them to the ground.

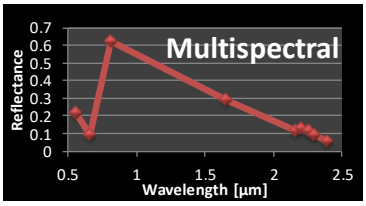
A hyperspectral sensor is a sensor that acquires the light reflecting from a substance on the ground as data that is continuously observed for each wavelength. Objects reflect light of most wavelengths, and therefore by using a curve (spectral curve) that shows the difference in reflectance for each wavelength, it is possible to speculate the substance that exists in a certain location. The HISUI acquires information by dividing the visible region to the short wavelength infrared region (400 nm to 2,500 nm) into 185 bands. (The multi-spectral sensor "ASTER" developed by the



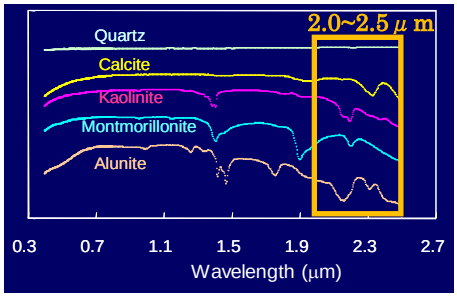
Examples of spectral curves that differ depending on the substance

METI and still in operation acquires information in 9 bands in the same wavelength range. The spectrum curve of vegetation acquired by each sensor is as follows. The shape is different.





The spectral curves of the minerals that make up rocks, especially those that are useful for energy and resource exploration, show distinctive shapes, mainly from 2,000 nm (2.0μm) to 2,500 nm (2.5μm). Based on these characteristics, the minerals on the surface of the earth are estimated, and the possibility of underground oil and gas resources and metal mineral resources is estimated from the geomorphological conditions.



Example of Spectral Curve

In the HISUI project, the Japan Aerospace Exploration Agency (JAXA) has provided support, namely through the transportation of the HISUI to the ISS, installation of the HISUI to the "Kibo", initial checkout of the acquired data and the transmission to the ground.

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