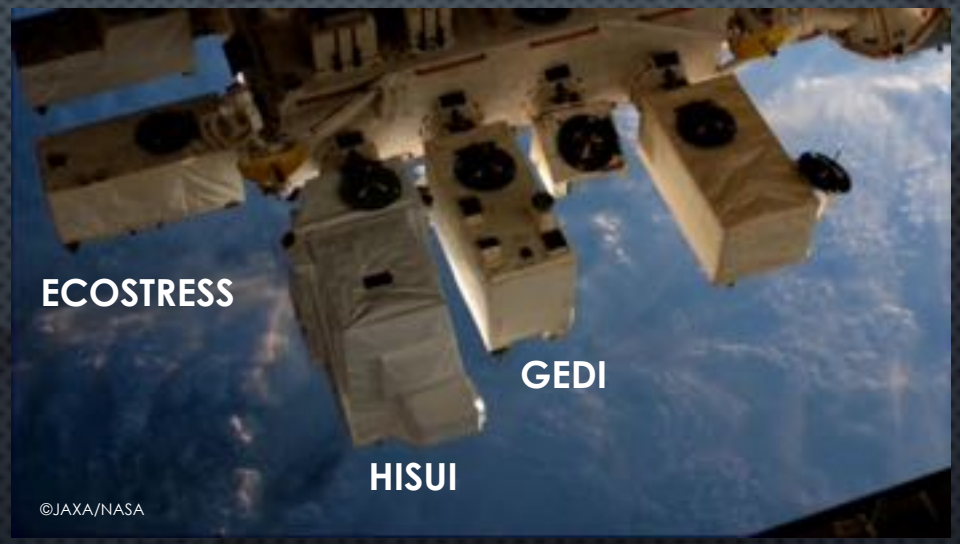
2nd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy
19–21 October 2022 | La Collinetta Eventi, Frascati IT
esa

HYPERSPECTRAL IMAGER SUITE (HISUI) ONBOARD INTERNATIONAL SPACE STATION:



TSUNEO MATSUNAGA, NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES, JAPAN;
OSAMU KASHIMURA, JAPAN SPACE SYSTEMS, JAPAN;

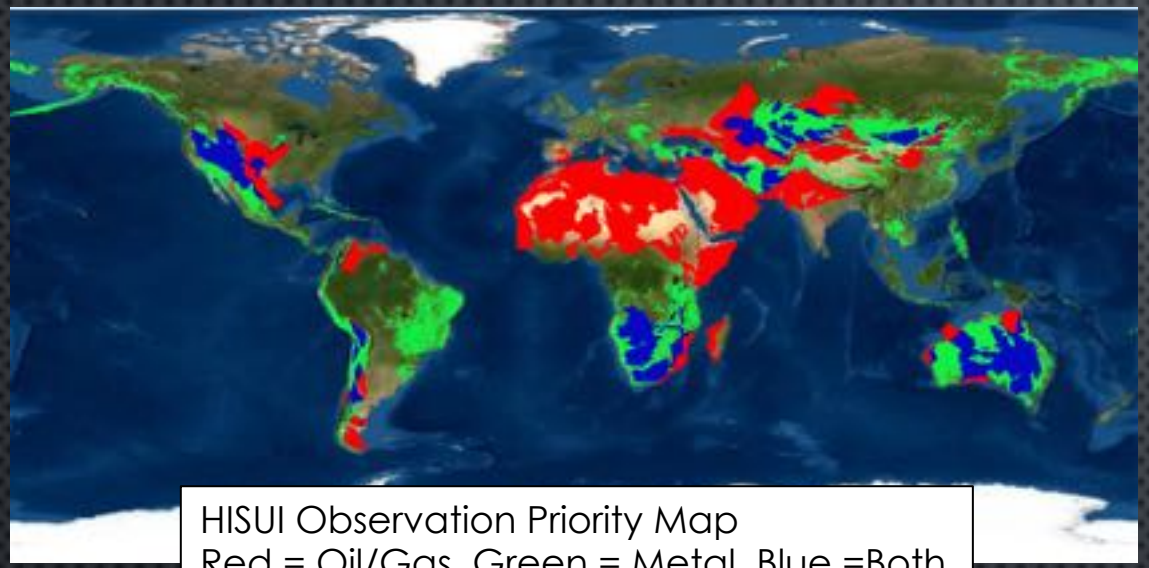
HYPERSPECTRAL IMAGER SUITE (HISUI)

Funding		Ministry of Economy, Trada, and Industry (METI), Japan
Operation		Japan Space Systems
Launch		December 2019
Platform		International Space Station
Imaging Type / Spectral Dispersion		Pushbroom / Grating
Spatial Resolution / Swath		20 m (CT) x 30 m (AT) / 20 km
Spectral	Range / Bands	0.4 - 2.5 μm / 185 bands
	Resolution	10 – 12.5 nm
	Binning	4 (VNIR) and 2 (SWIR)
SNR (30% albedo)		≥ 450 @620 nm ≥ 300 @2100 nm
MTF		≥ 0.2
Dynamic Range		Saturated at 70% albedo
Spectral Calibration		VNIR : 0.2 nm SWIR :0.625 nm
Radiometric Calibration		Absolute : ±5%, among bands :±2%
Onboard Calibration Sources		Halogen lamp and filter wheel
Quantization / Data Compression		12 bits / Lossless (70%)
Telescope Diameter		≈ 30 cm
HISUI Exposed Payload Dimensions / Mass		≈ 2.3 x 1.5 x 1.6 m, ≈ 570 kg
Mass Storage		30 HDDs were launched with HISUI.

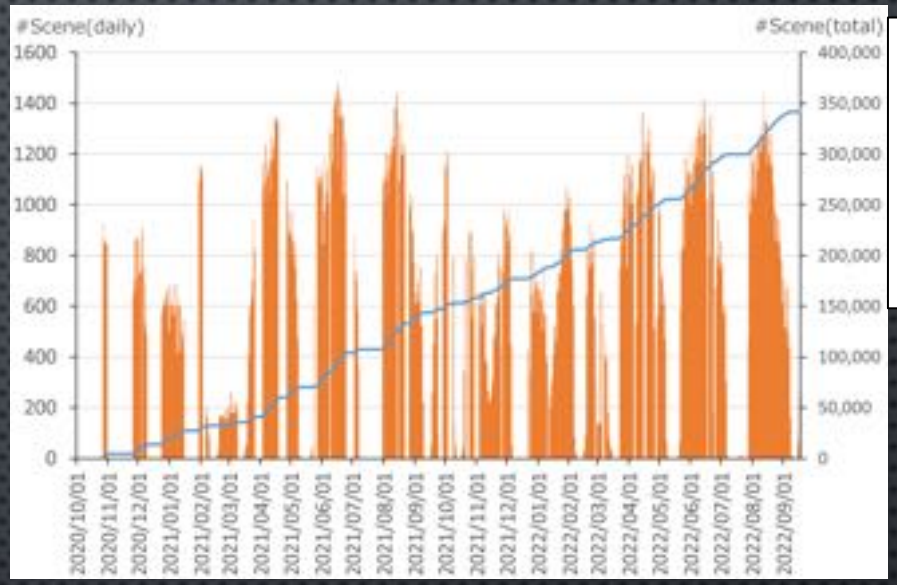
EVENTS

- ✓ Successfully launched and installed on ISS Japan Experiment Module (JEM) / Exposed Facility in 2019.
- ✓ More than six months were spent to solve data communication problems. HISUI observation finally resumed in September 2020.
- ✓ The 1st, 2nd, 3rd and 4th HDD deliveries from ISS to the Earth were in July and September 2021 and January and September 2022. The data in HDDs were about 14 TB, 11 TB, 15 TB, and 8 TB.
- ✓ According to onboard calibration data with lamps and filters, radiometric sensitivity has been stable during its launch and the operation in space. To remove stripes and even/odd differences, new gains and offsets are used in the new L1 processing.
- ✓ The current absolute spectral calibration is based on the absorption features caused by the Earth's atmosphere. A paper published.
- ✓ According to the latest implementation schedule of Basic Plan on Space Policy of Japan, HISUI will be operated until FY2023. The operation in FY2024 and beyond is being discussed.

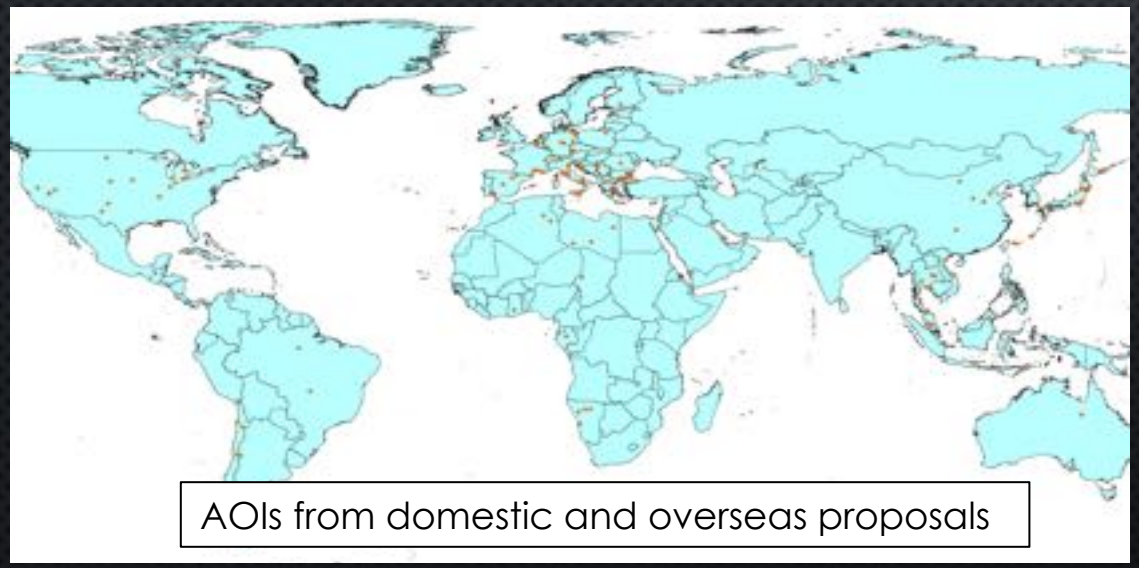
MAPS AND CHARTS



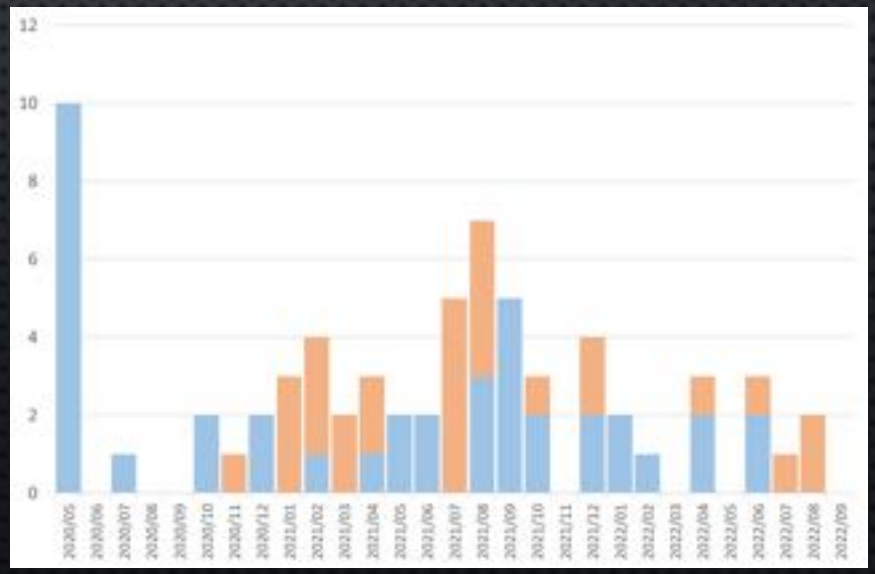
HISUI Observation Priority Map
Red = Oil/Gas, Green = Metal, Blue =Both



HISUI has acquired 340,000 scenes (≈ 200 M km^2) in 1.9 year (October 2020 to Sep 2022).



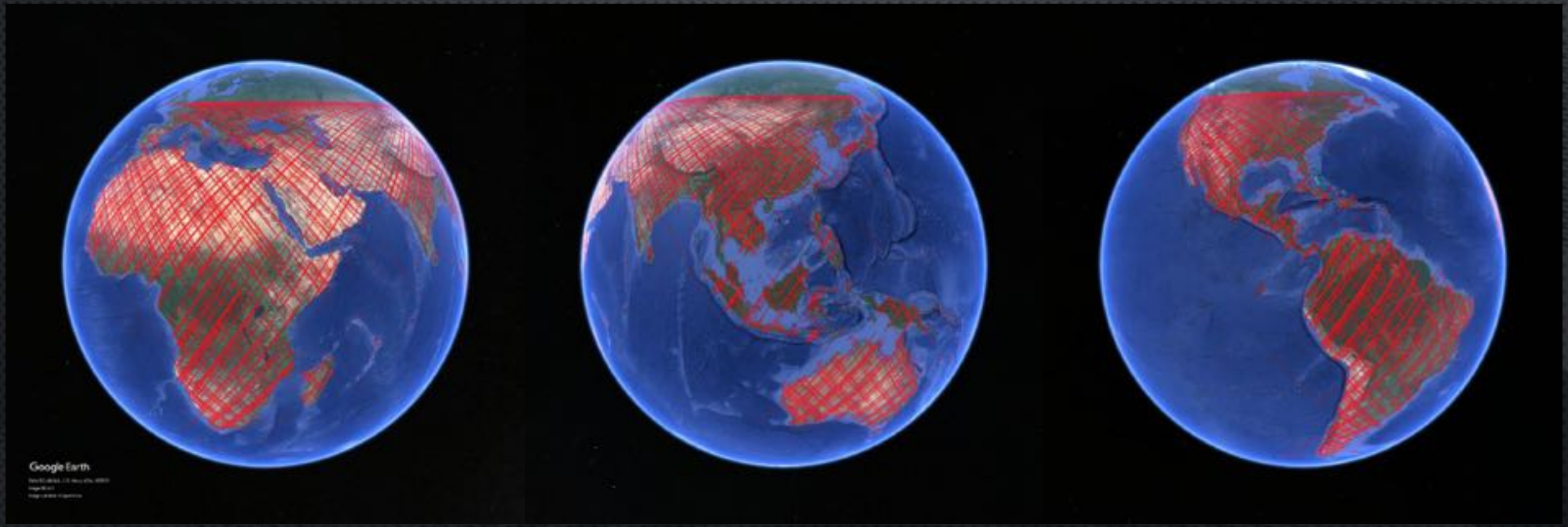
AOIs from domestic and overseas proposals



HISUI Research Announcement
Accepted Proposals

Blue = Domestic (40)
Orange = Overseas (28)

HISUI COVERAGE MAPS (16MONTHS)

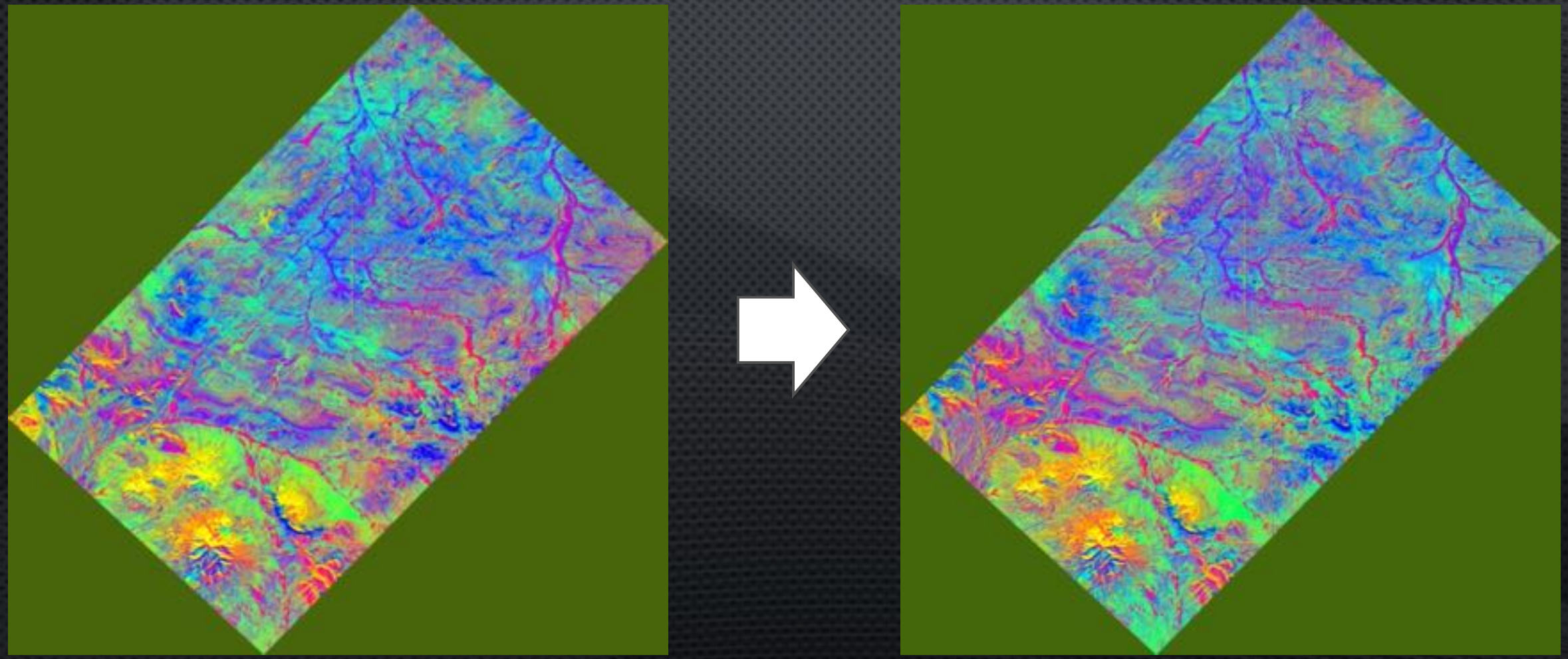


Period: October 2020 – January 2022

HISUI PRODUCT LIST

Name (Format)	Description
Level 0	Raw data
Level 1A (TIFF + Binary)	Raw DN product with all radiometric calibration coefficients. Spatial resampling is not applied.
Level 1R (TIFF + Binary)	Top-of-atmosphere spectral radiance product. Spatial resampling is not applied.
Level 1G (GeoTIFF)	Geometrically corrected / orthorectified top-of-atmosphere spectral radiance product. Parallax correction, keystone property, and spectral continuity between VNIR and SWIR spectrometers are considered.
Level 2G (TBD)	Atmospherically corrected surface spectral reflectance product generated from L1G with QA information. This is **Science Product** for research purpose and will be validated at selected validation sites.

DESTRIPING



HISUI SWIR Decorrelation Stretch Images (Band 118:159:162)

HISUI SPETCRAL CAL. - VNIR

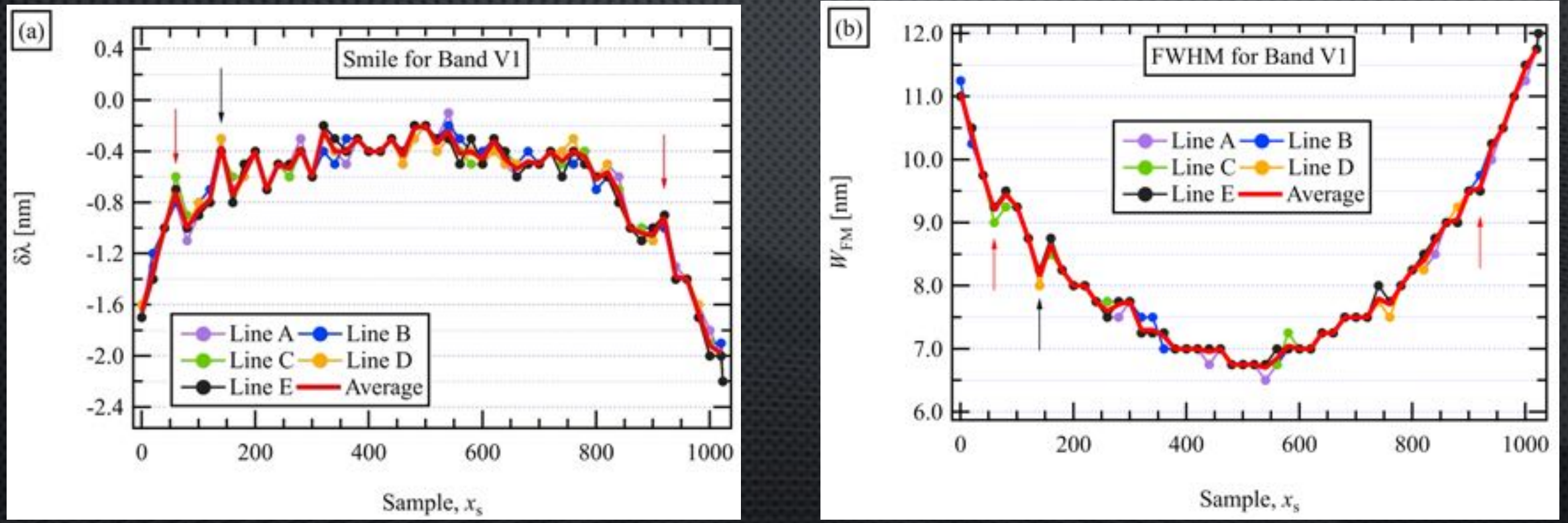


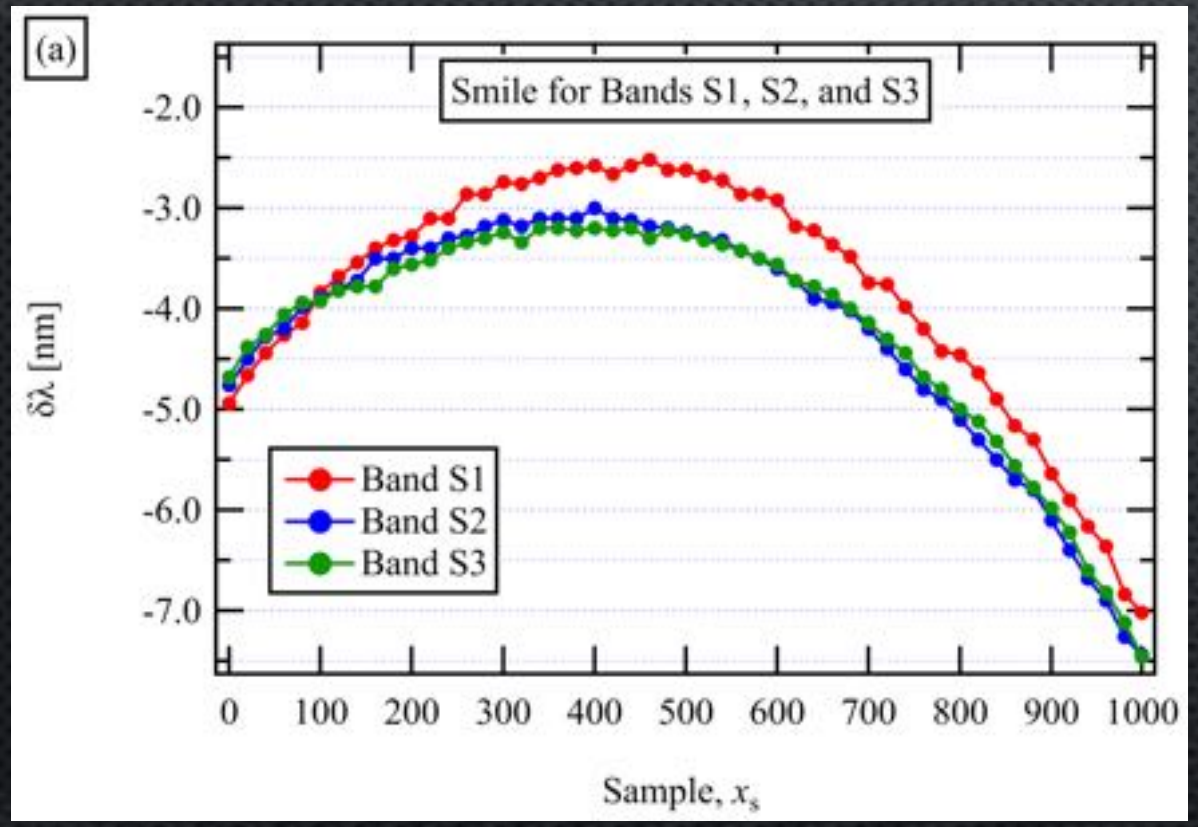
Fig. 7. Values of (a) δλ and (b) W_{FM} for Band V1 (O_2 absorption band at λ = 765 nm) for ID 210603 plotted against x_s. Red curves indicate the average of the five lines A, B, C, D, and E in Fig. 6. Black arrows denote an inherent jagged pattern at x_s = 140, and red arrows denote inherent jagged patterns at x_s = 60 and 920.

δλ : Wavelength deviation from its original wavelength assignment

W_{FM} : FWHM of the Gaussian Model

Yamamoto et al, IEEE TGRS, 2022

HISUI SPETCRAL CAL. - SWIR



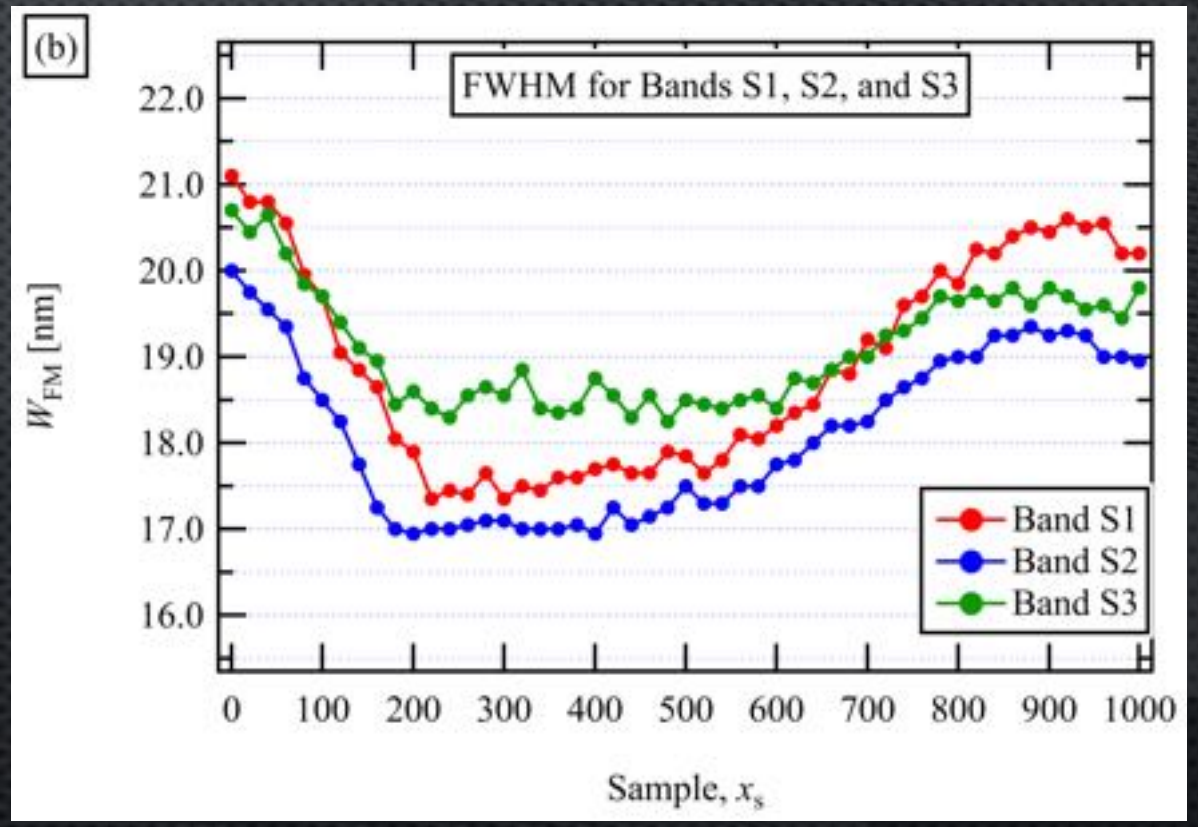


Fig. 8. (a) δλ and (b) *W*FM for SWIR for Bands S1 (O_2 1260 nm absorption band), S2 (CO_2 2010 nm absorption band), and S3 (CO_2 2060 nm absorption band) .

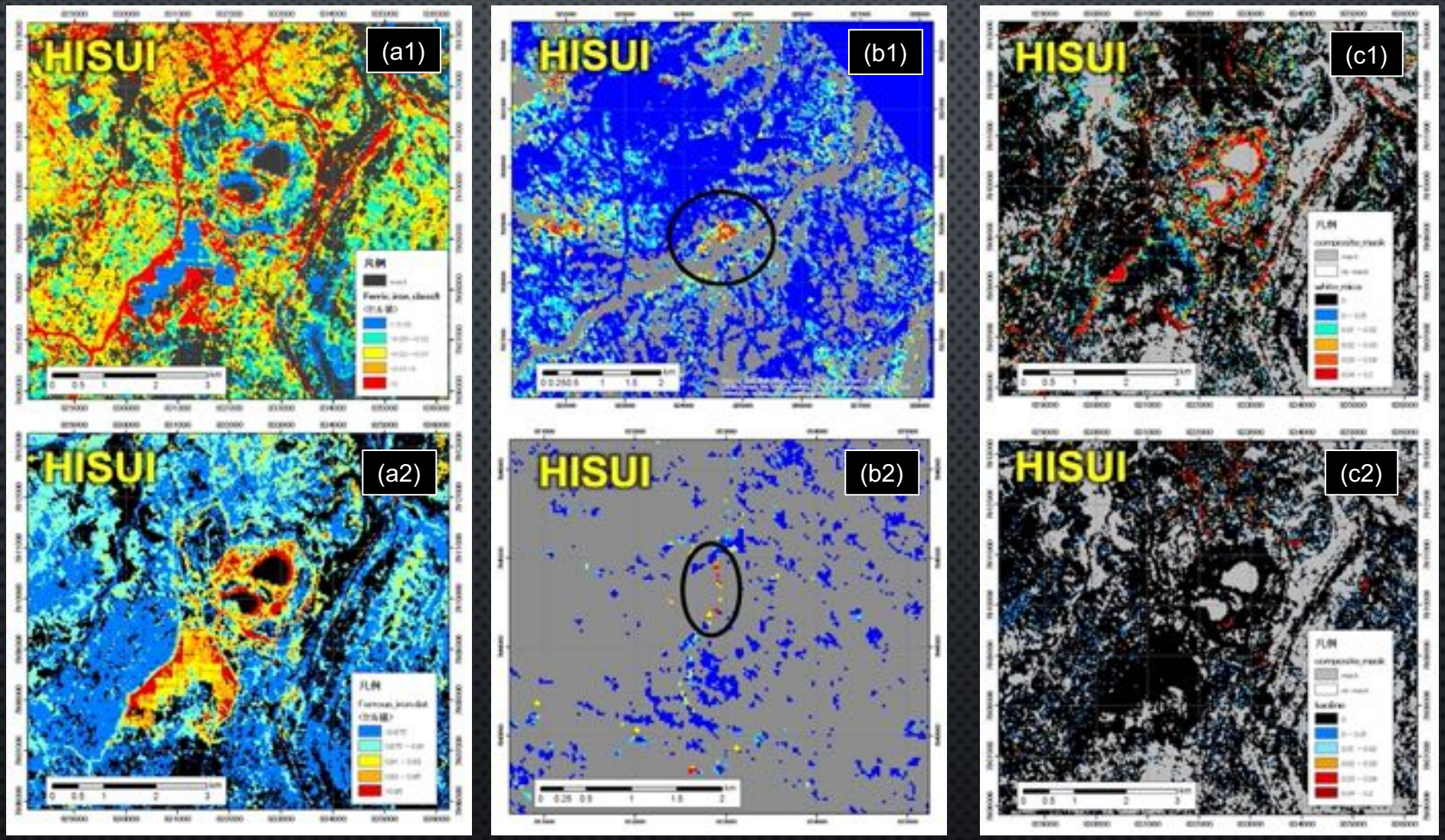
δλ : Wavelength deviation from its original wavelength assignment

W_{FM} : FWHM of the Gaussian Model

"The updated smile correction table improves the spectral smile and cross-track dependence of W_{FM} in VNIR and reduces the amount of spectral smile in SWIR to be within 2.1–2.2 nm."

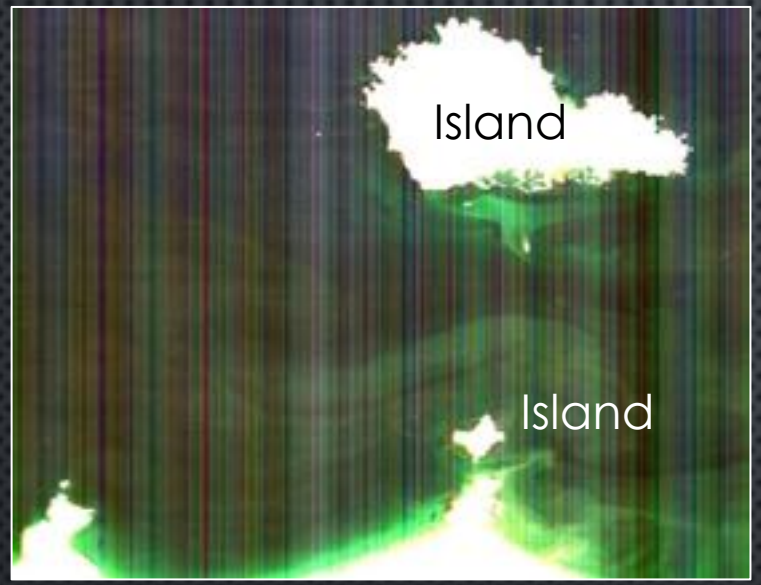
Yamamoto et al, IEEE TGRS, 2022

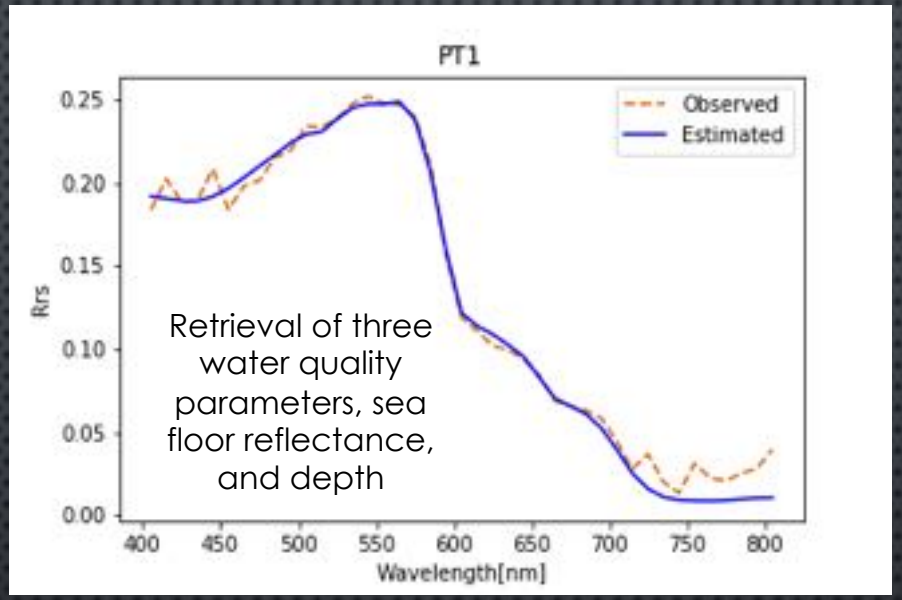
ANALYSIS RESULTS (MINERALOGY)

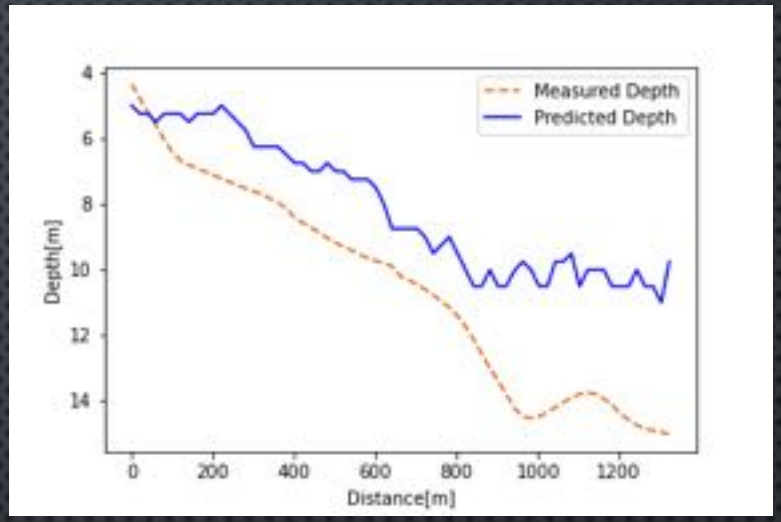


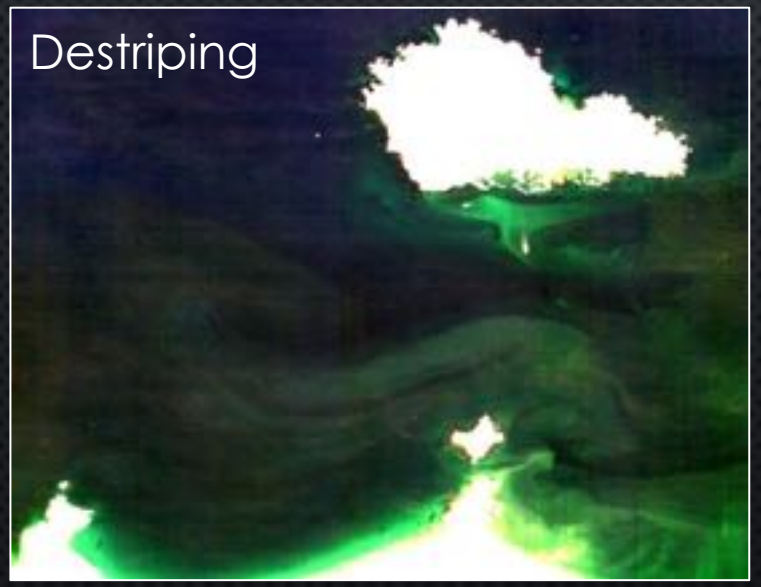
HISUI spectral mapping examples for (a1-a2) Fe-bearing minerals (ferric iron and ferrous iron), (b1-b2) oxidized copper minerals, and (c1-c2) clay minerals (white mica and kaoline).

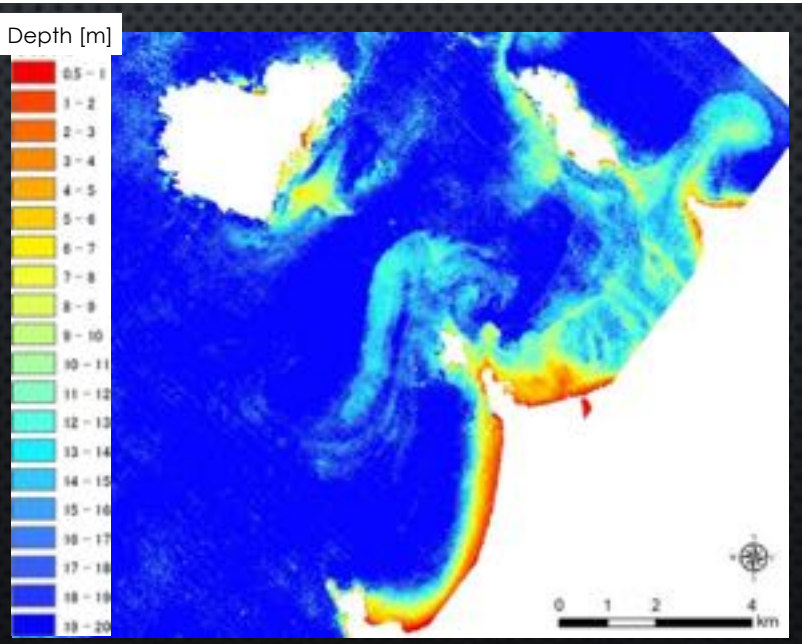
BATHYMETRY

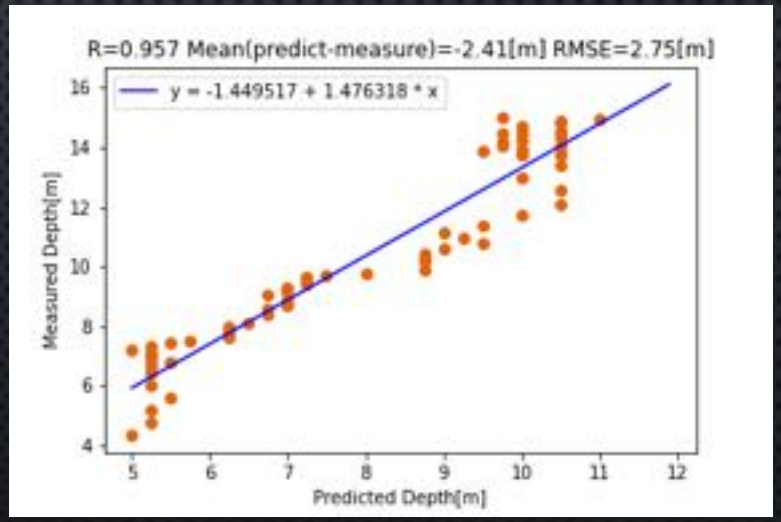








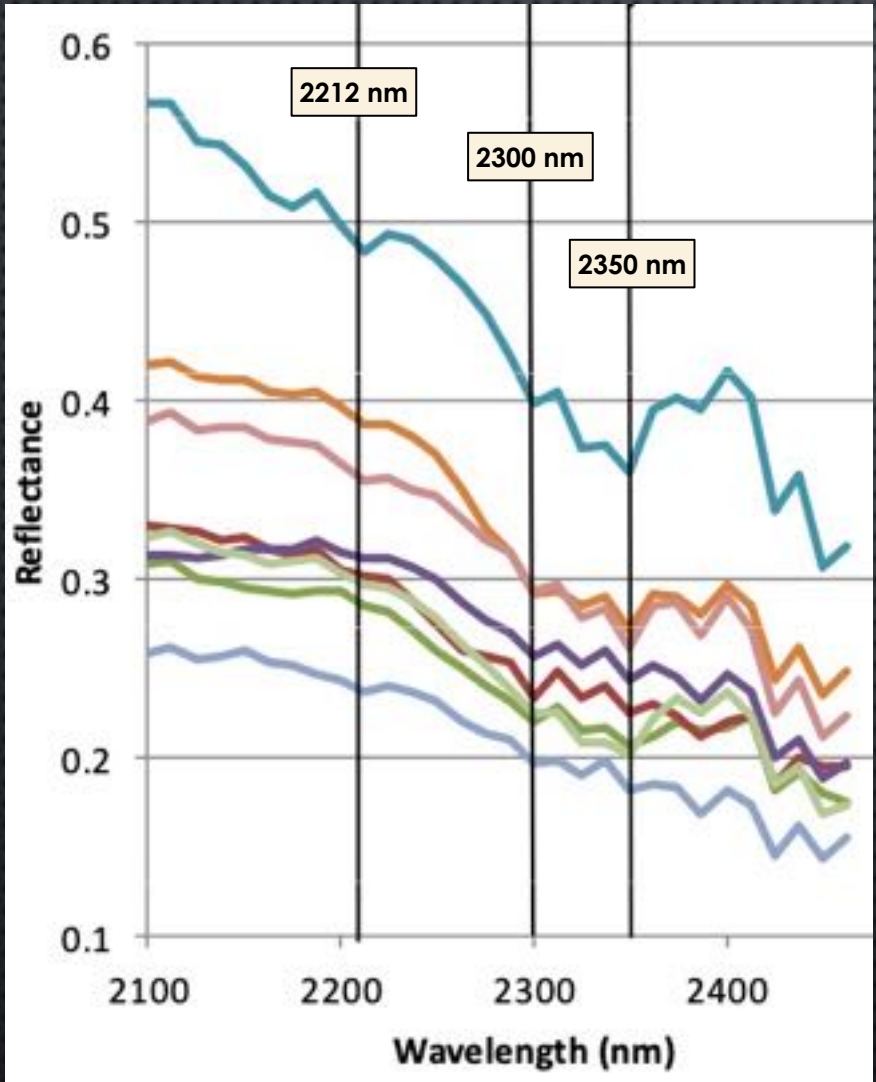




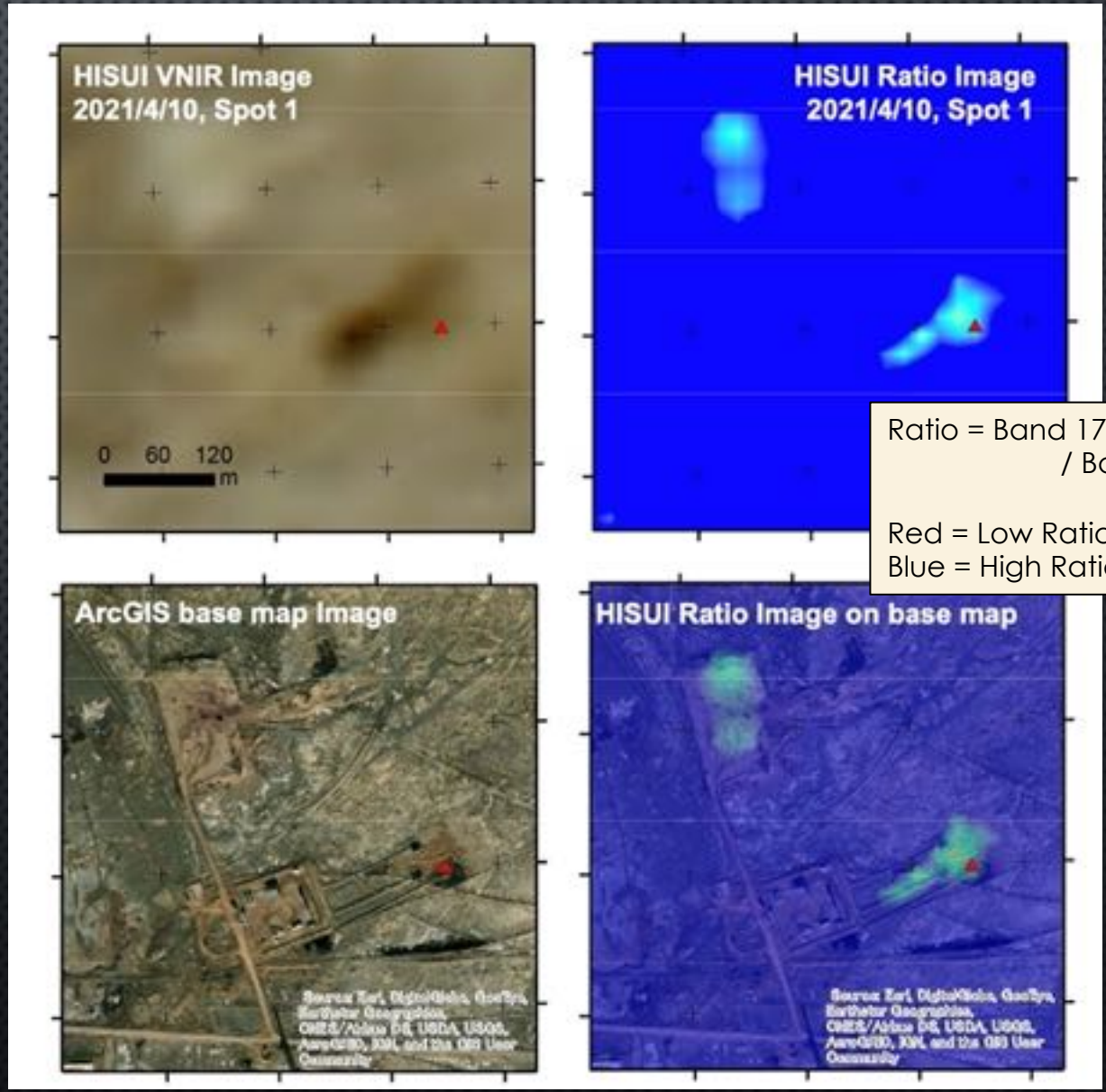
Validation using existing bathymetry maps.
RMSE ≈ 2 - 3 m

T. Matsunaga (NIES)

METHANE MAPPING



Methane signatures in HISUI land surface spectral reflectance



Ratio = Band 171(2300 nm)
/ Band 152 (2063 nm)

Red = Low Ratio = High CH4
Blue = High Ratio = Low CH4

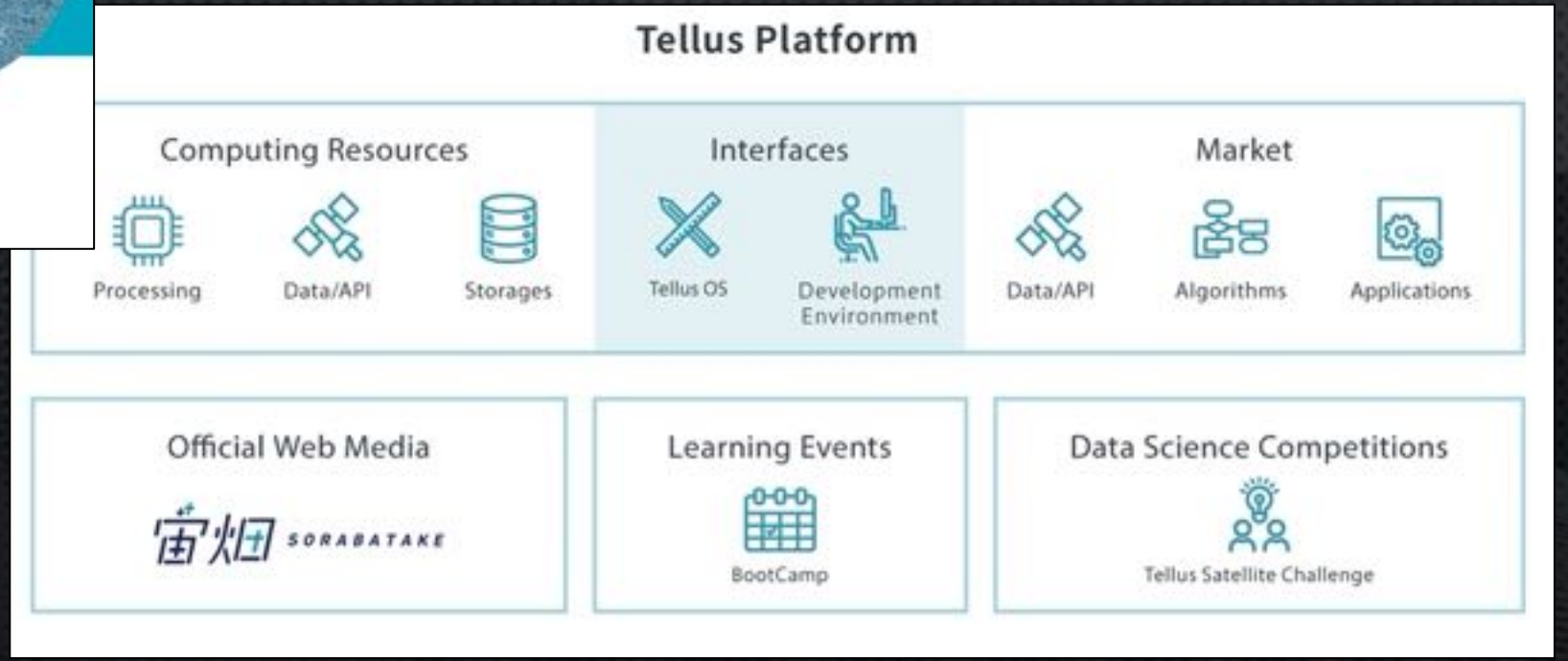
T. Matsunaga (NIES)

ADDITIONAL INFO.

- **Data policy**
  Free data. Anyone will be able to access the same data.
- **Data request procedures / access**
  Submit Research Announcement proposal to JSS.
- **Upcoming mission priorities**
  Obtain data as much as possible until mission termination
- **Mission calibration and data validation**
  The National Institute of Advanced Industrial Science and Technology (AIST) is responsible HISUI calibration.
  Japan Space System (JSS) is responsible HISUI validation.
- **Harmonisation of data formats, products definition and toolboxes**
  Data from HISUI and other national satellites will be utilized in Tellus. (https://www.tellusxdp.com/)

TELLUS
JAPANESE SATELLITE DATA PLATFORM
HTTPS://WWW.TELLUSXDP.COM/

Tellus



CONTACT

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About HISUI Project and Research Announcement :
hisui-info@hisui.jspacesystems.or.jp
https://www.hisui.go.jp/en/index.html
hisui_application@jspacesystems.or.jp
https://www.jspacesystems.or.jp/en/project/observation/hisui/

The delivery of HISUI data to Research Announcement users (priority domestic users) started.