Tasking and data sharing status for ALOS-2 + S1, RCM, CSK/CSG

Shinichi Sobue, Takashi Omote,Ryuta Takaba,
Yuta Tochigi, Fumio Kudoh

ALOS-2 team
Japan Aerospace Exploration Agency (JAXA)

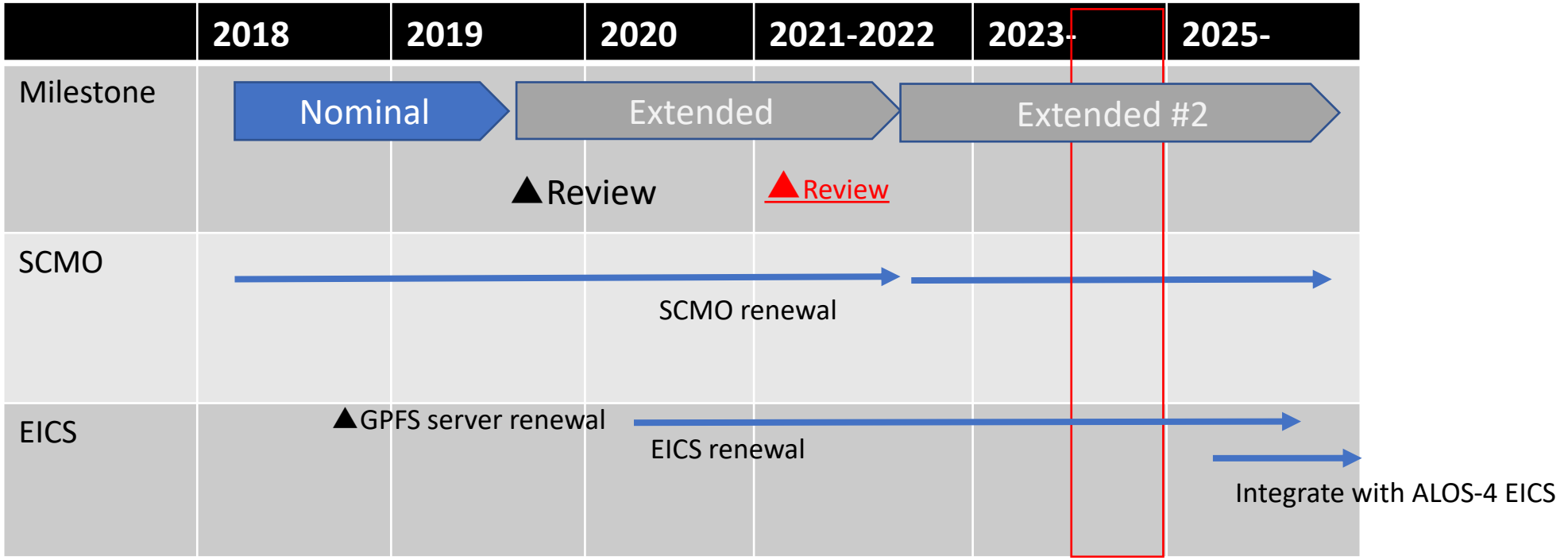
November 5, 2024

ALOS-2 system operation status summary

Subsystem	Status	Note
SAP	Green	-
EPS	Green	-
AOCS	Green	ESA operations are suspended
Propulsion	Green	-
CDMS	Green	-
DT	Green	-
DRS	N/A	August 5, 2017 DRTS operation was completed
MDPS	Green	System reset because of SEU
THERMAL	Green	-
PALSAR2	Green	System reset because of SEU

Cal/Val status: Green: https://www.eorc.jaxa.jp/ALOS-2/calval/calval_jindex.htm

Extended observation phase #2



Target of ALOS-2 mission for 2024 operations

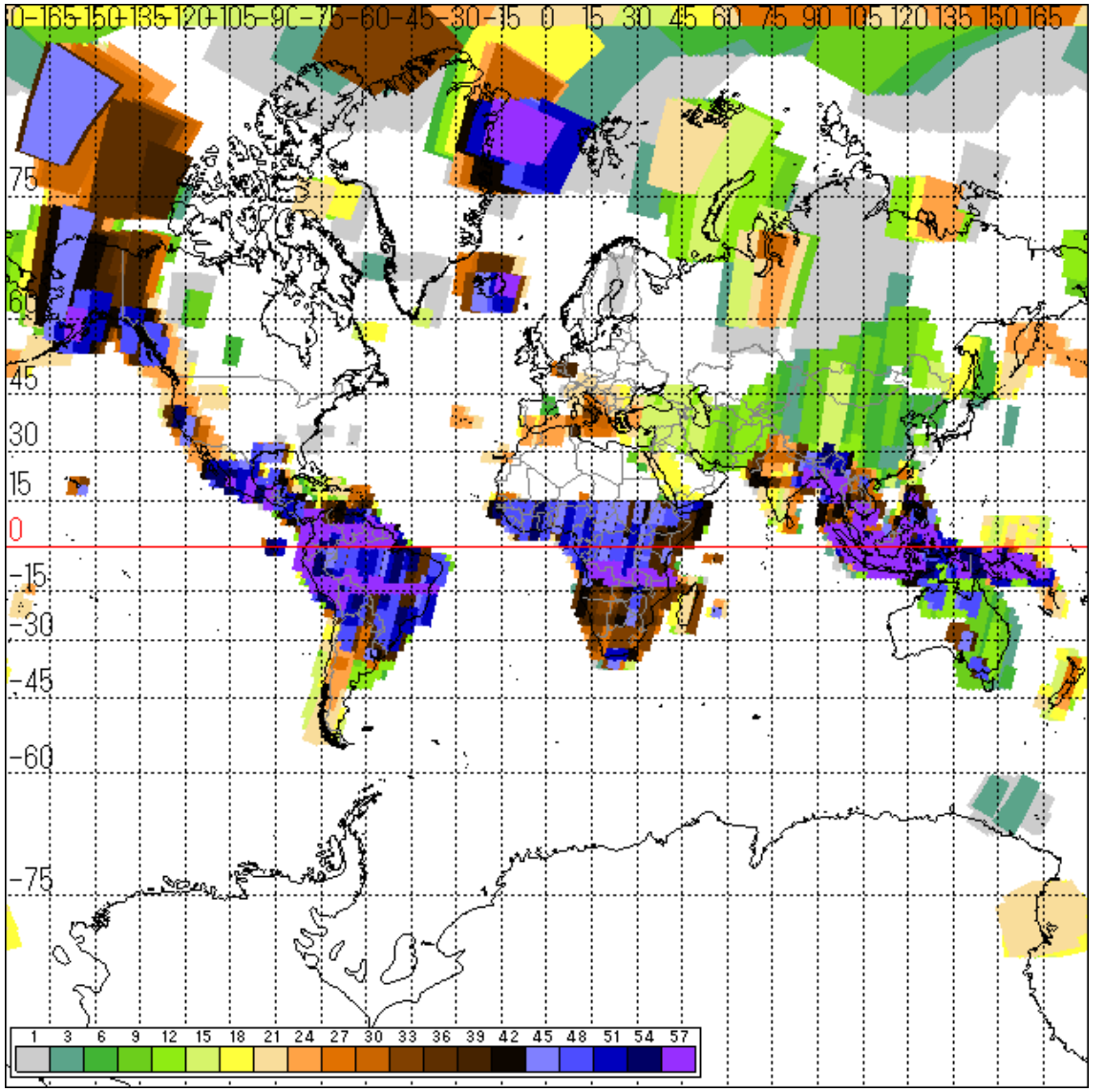
・10 years continuous observation operations

・Archive global and continuous SM3 and WD1 observations with intensive time series observations in selected areas, including research and development to prepare ALOS-4 bi-weekly SM3 observations and promoting multi frequency observations in cooperation with ASI, CSA, ESA, NASA and other international partners.

・2025 ALOS-2/4 constellation flight with high temporal or R/L observation in specific area

Observation result of Wetlands & Rapid deforestation monitoring and Crustal Deformation

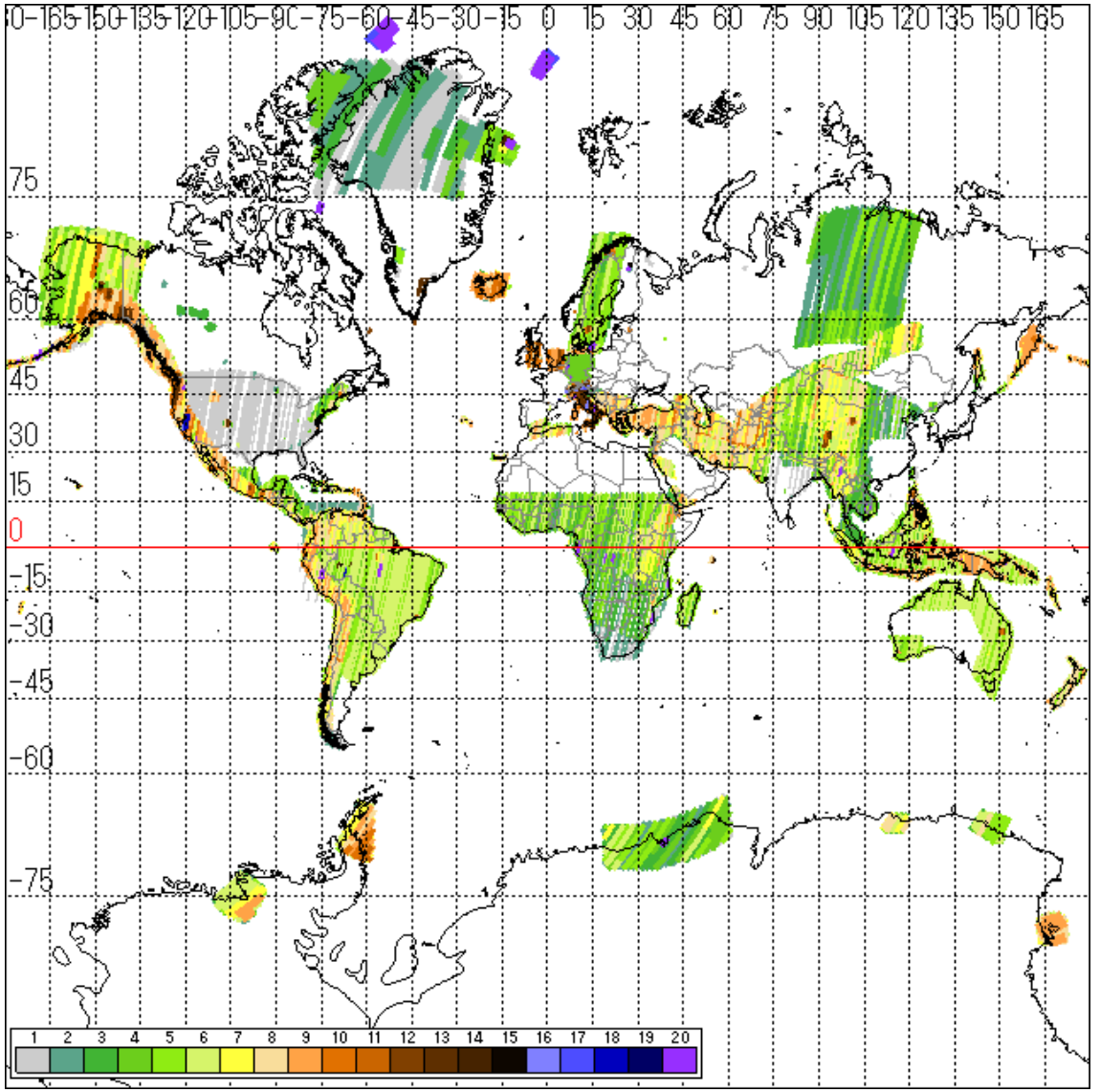
2014/8/4～2020/12/31	
acquired scenes	100,137



ScanSAR350km（W2）/HH＋HV/14MHz/ Descending /Right

Observation result of Forest＆Crustal Deformation

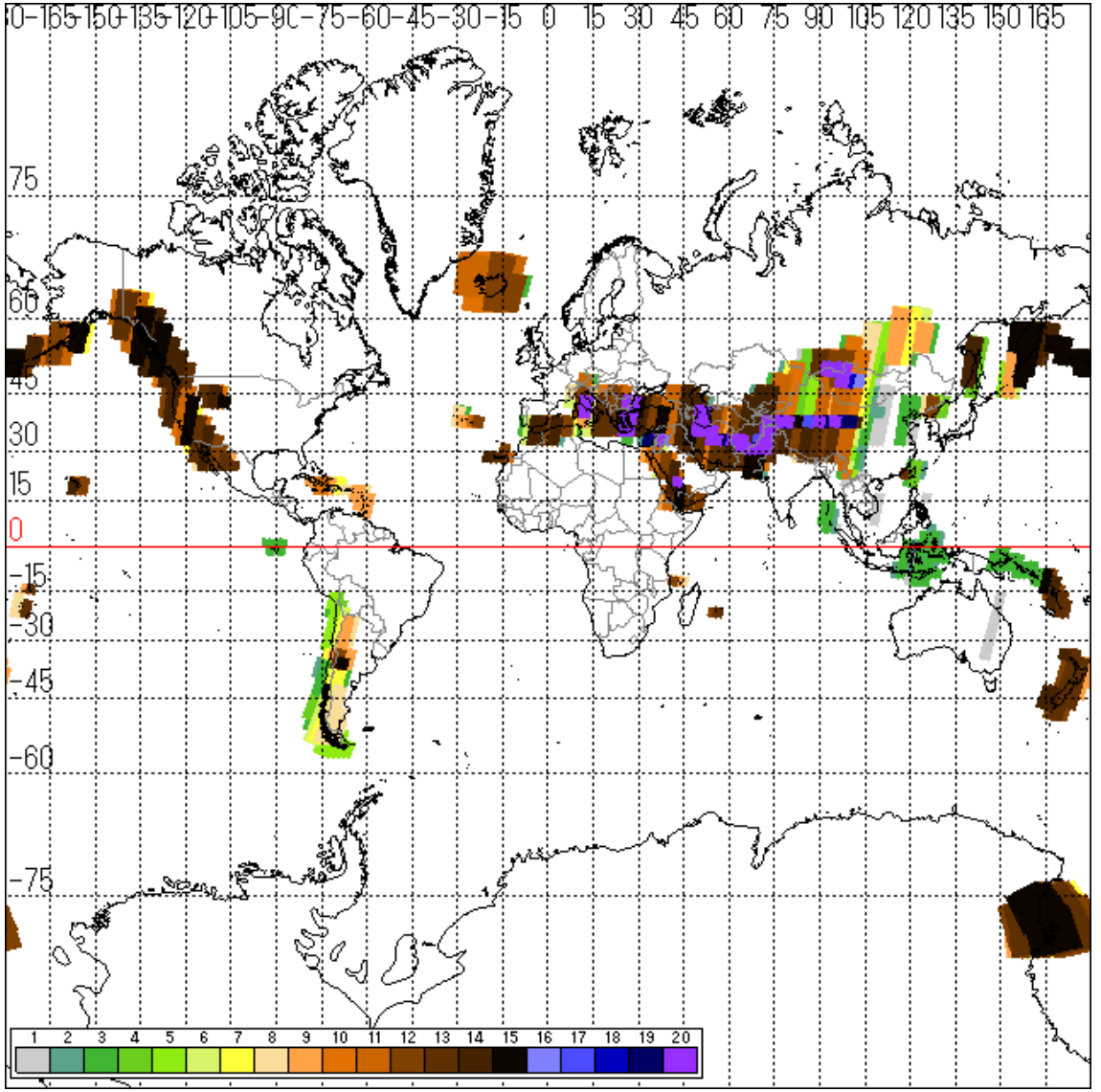
2014/8/4～2020/12/31	
acquired scenes	196,948



Strip map 10m（F2-5～F2-7）/HH＋HV/ Descending /Right

Observation result of Crustal Deformation

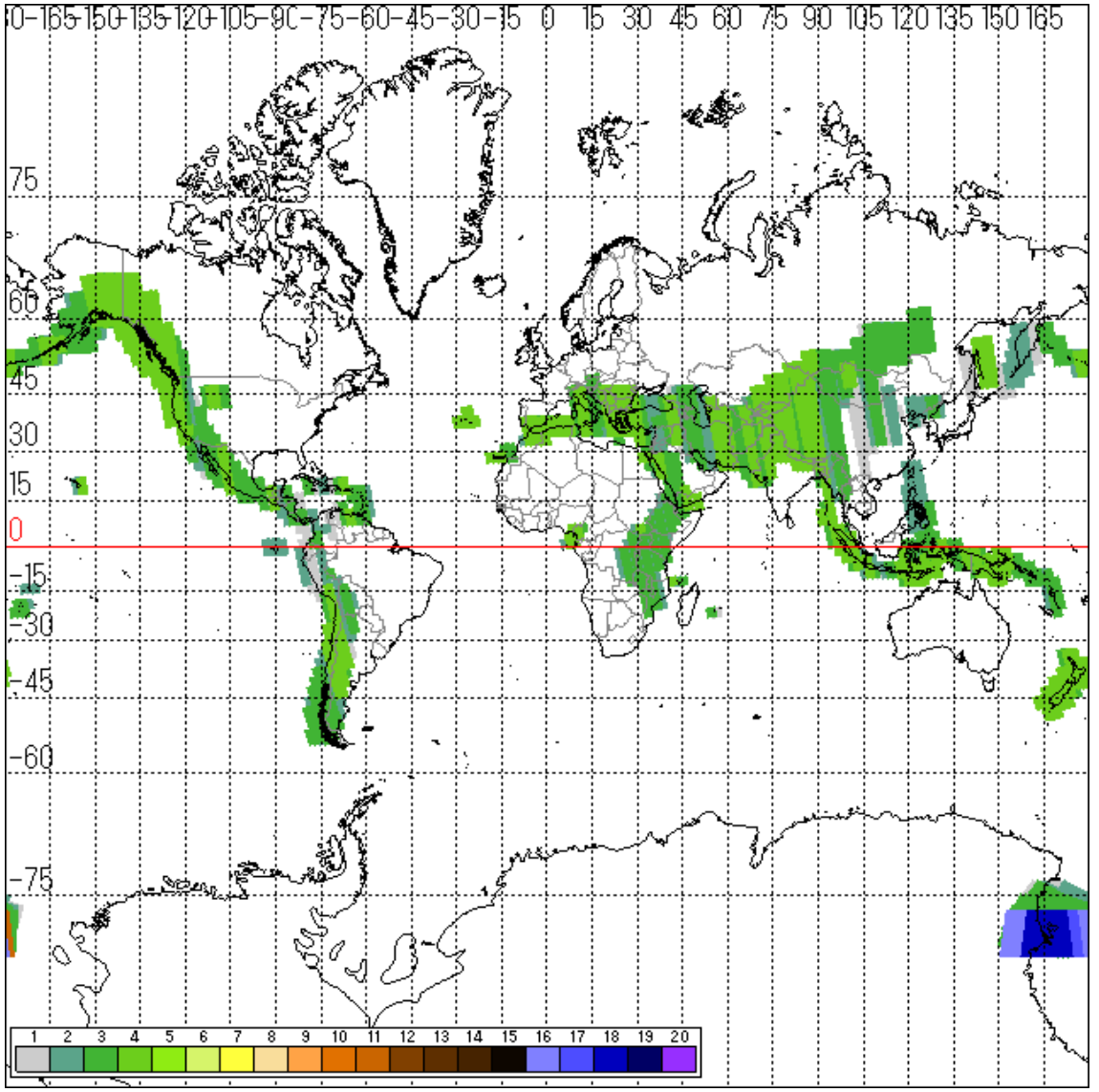
2014/8/4～2020/12/31	
acquired scenes	11,280



ScanSAR350km（W2）/HH/14MHz/ Descending /Right

Observation result of Crustal Deformation

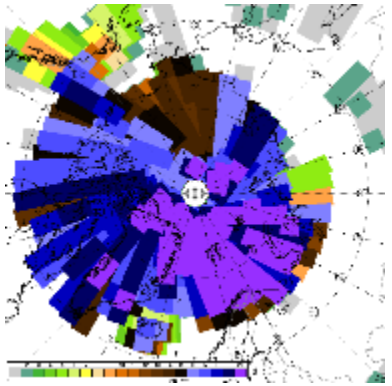
2014/8/4～2020/12/31	
acquired scenes	4,260



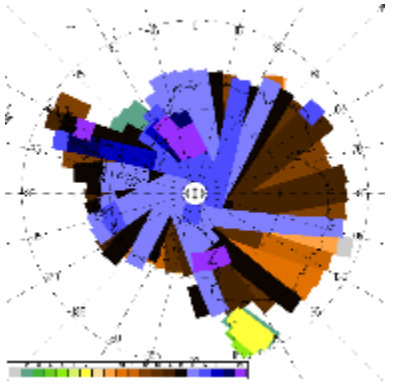
ScanSAR350km（W2）/HH/14MHz/ Ascending/Right

Observation result of Polar Ice

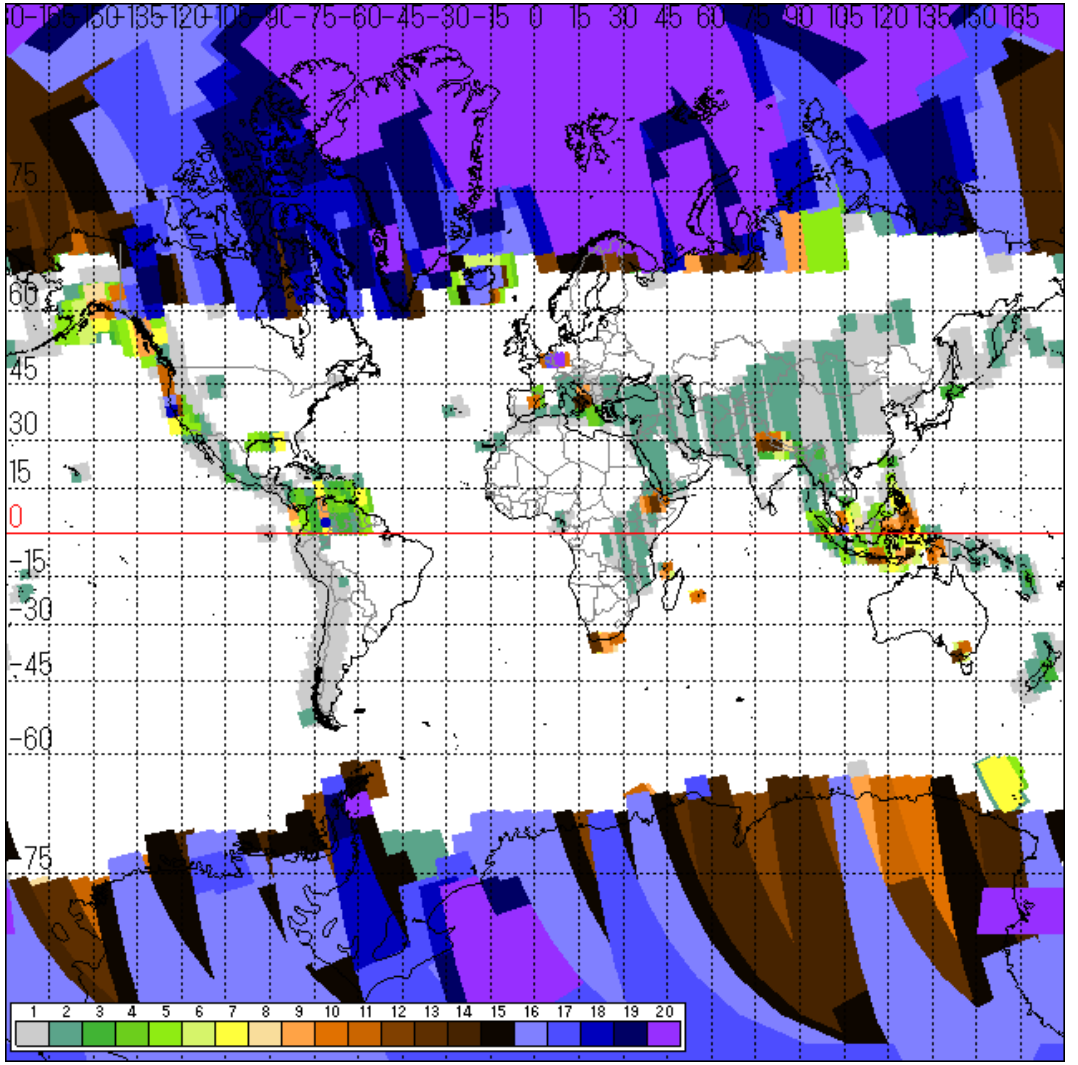
2014/8/4～2020/12/31	
acquired scenes	23,644



Arctic/Right



Antarctic/Left

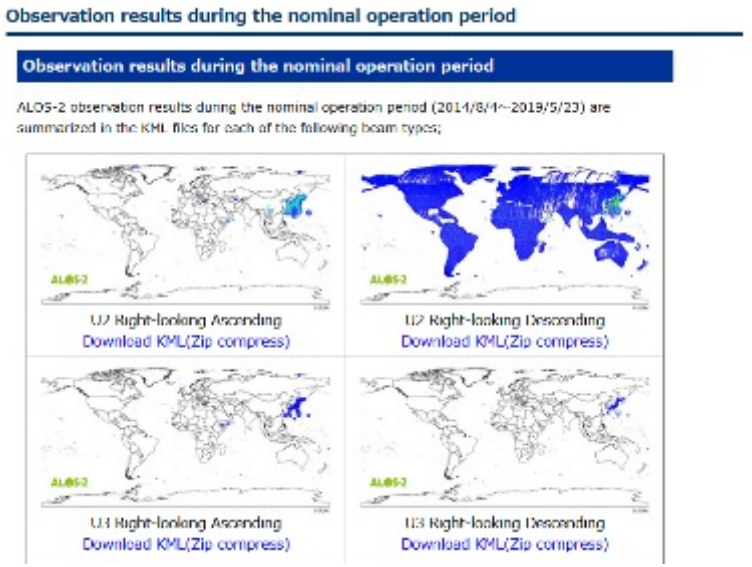


ScanSAR350km（W2）/HH＋HV/14MHz/ Ascending /Right＆Left

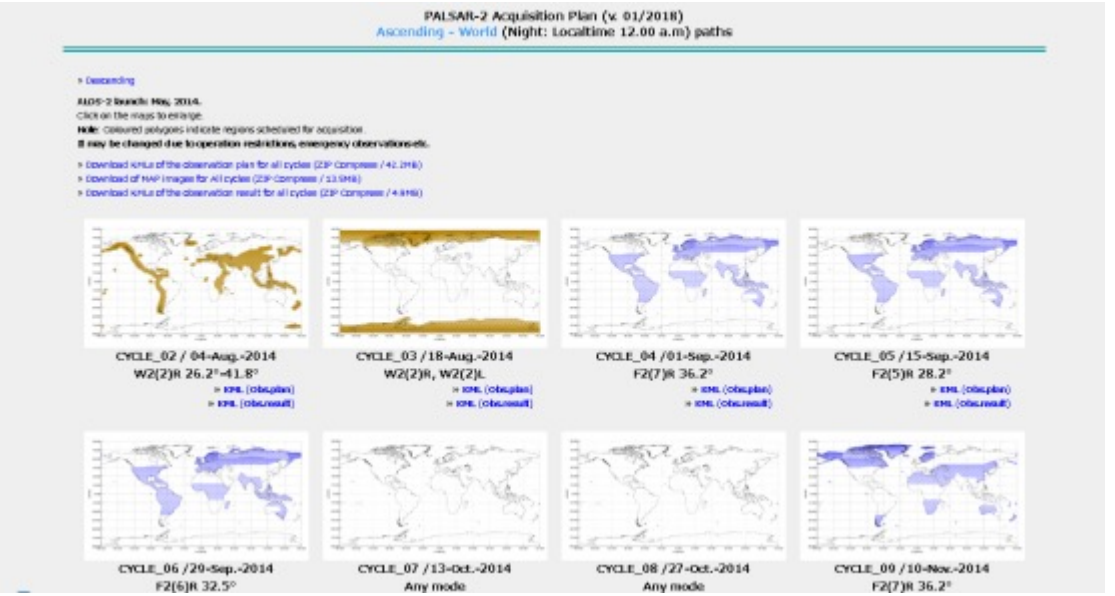
ALOS-2 observation results and the ALOS-2 Basic Observation scenario.

#You can get the map and kml files.

- In English
  https://www.eorc.jaxa.jp/ALOS/en/top/obs_top.htm
- In Japanese
  https://www.eorc.jaxa.jp/ALOS/top/obs_jtop.htm

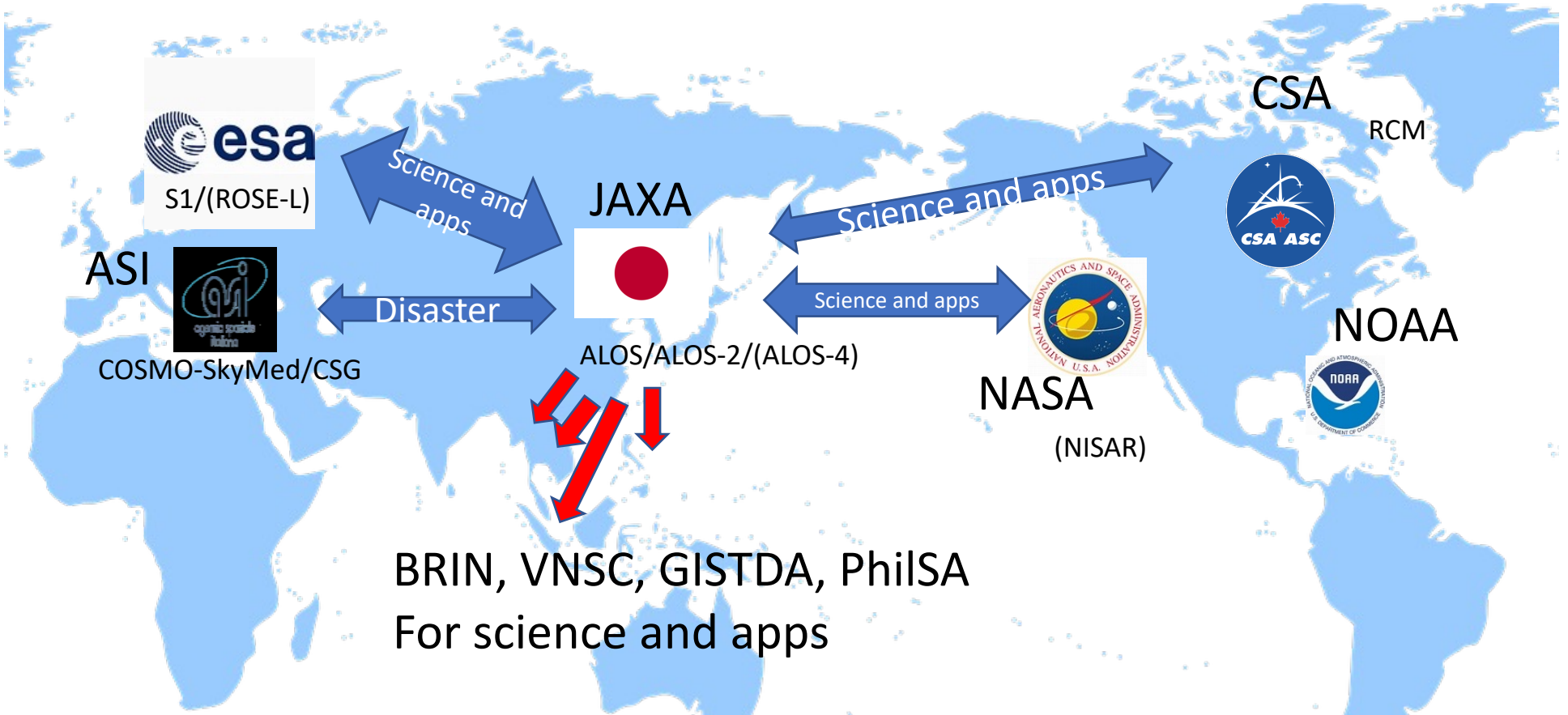


ALOS-2 observation results



Acquisition Plan of the BOS

SAR international cooperation

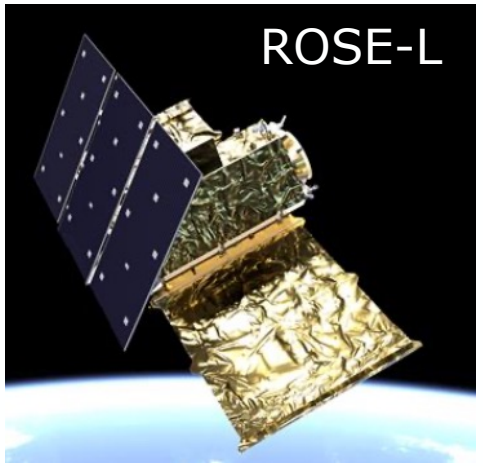


- Science and apps: Ocean (Sea Ice, ship detection, oil spills), Land use (agriculture, soil moisture, SWE, crustal deformation - volcanos, subsidence, LULCC, forests) with disaster response

Context of ESA-JAXA Mutual SAR Cooperation

- JAXA operates ALOS-2 L-SAR and ESA operates Sentinel-1 C-band SAR missions to study synergistic use of L+C
- JAXA and ESA are both developing new generation L-band SAR missions
  - ALOS-4 and Copernicus ROSE-L – Radar Observing System for Europe – L-band





- Synergistic use of L+C band spaceborne assets needs to be more systematically explored in various contexts
  - Operational services, environmental science, application projects
- Experience in operational use of L-band SAR in Europe limited but required to support preparations for future ROSE-L mission

STATUS of data provision to partner agencies

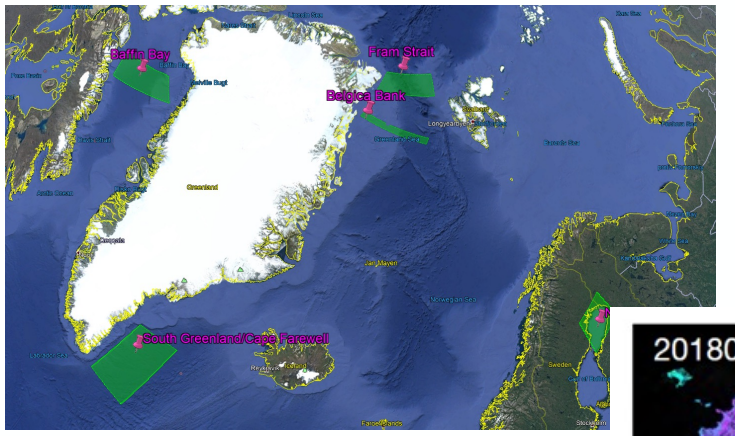
	CSA		NASA		ESA	
	JFY2023	JFY2024	JFY2023	JFY2024	JFY2023	JFY2024
	2023/04/01-2024/03/31	2024/04/01-2024/10/19	2023/04/01-2024/03/31	2024/04/01-2024/10/19	2023/04/01-2024/03/31	2024/04/01-2024/10/19
Cryosphere	228	119			150	57
CR(cal/val)						3
Ionosphere			14	7	239	48
Land(Forest and Wet)	292	203	267	129	566	316
Land(Hazard)	417	280	385	176	737	201
Land(incl Soil Moisture)	752	387	88	41	210	75
Maritime					100	88
Sea Ice	859	391	580	294	684	369
Total	2,548	1,380	1,334	647	2,686	1,157

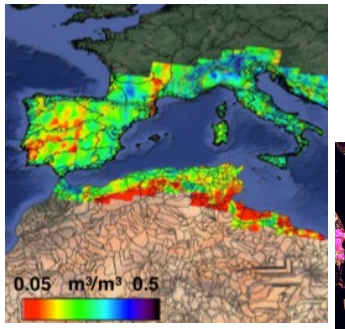
STATUS of ALOS-2 and Sentinel-1 Cooperation between JAXA and ESA

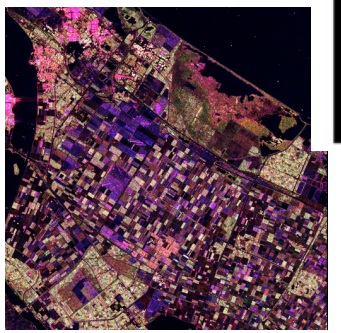
1. 3,843 scene of ALOS-2 observation data during April and October 2024 are delivered to ESA for joint research defined in PIP for the following topics
- Enhanced sea ice mapping including Campaign support
- Vessel detection and monitoring
- Oil spill mapping
- High-resolution soil moisture monitoring
- Snow mass and water content
- Forest/Biomass, Agricultural and land cover mapping (Monitoring of rice crops)
- Assessment of ionospheric impact and correction
- Natural Hazard (High-wind events (e.g. hurricanes, typhoons), Volcano monitoring)

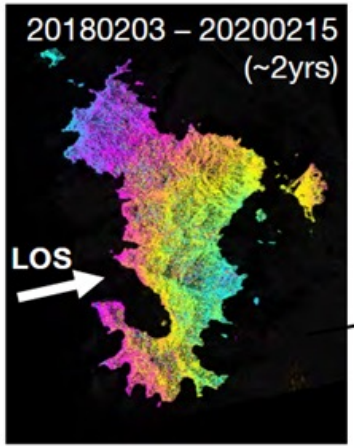
2. Conference
- JAXA-ESA joint study report, IGARSS 2023, July
- JAXA-ESA SAR session, FRINGE 2023, November
- EUSAR 2024, April
- JAXA-ESA joint session, LPS 2025, May 2025

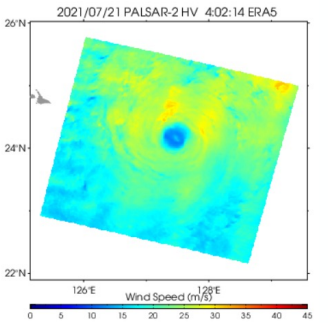
3. Way forward
- Enhance bilateral cooperation to promote L+C SAR science and application cooperation including campaign projects observation (e.g. high wind event, forest, Antarctica, Sea Ice cal/cal.)
- Promote Multilateral cooperation with NASA, CSA, ASI and VNSC under international SAR workshop framework with strong support by ESA to have #3 workshop in Japan in 2024



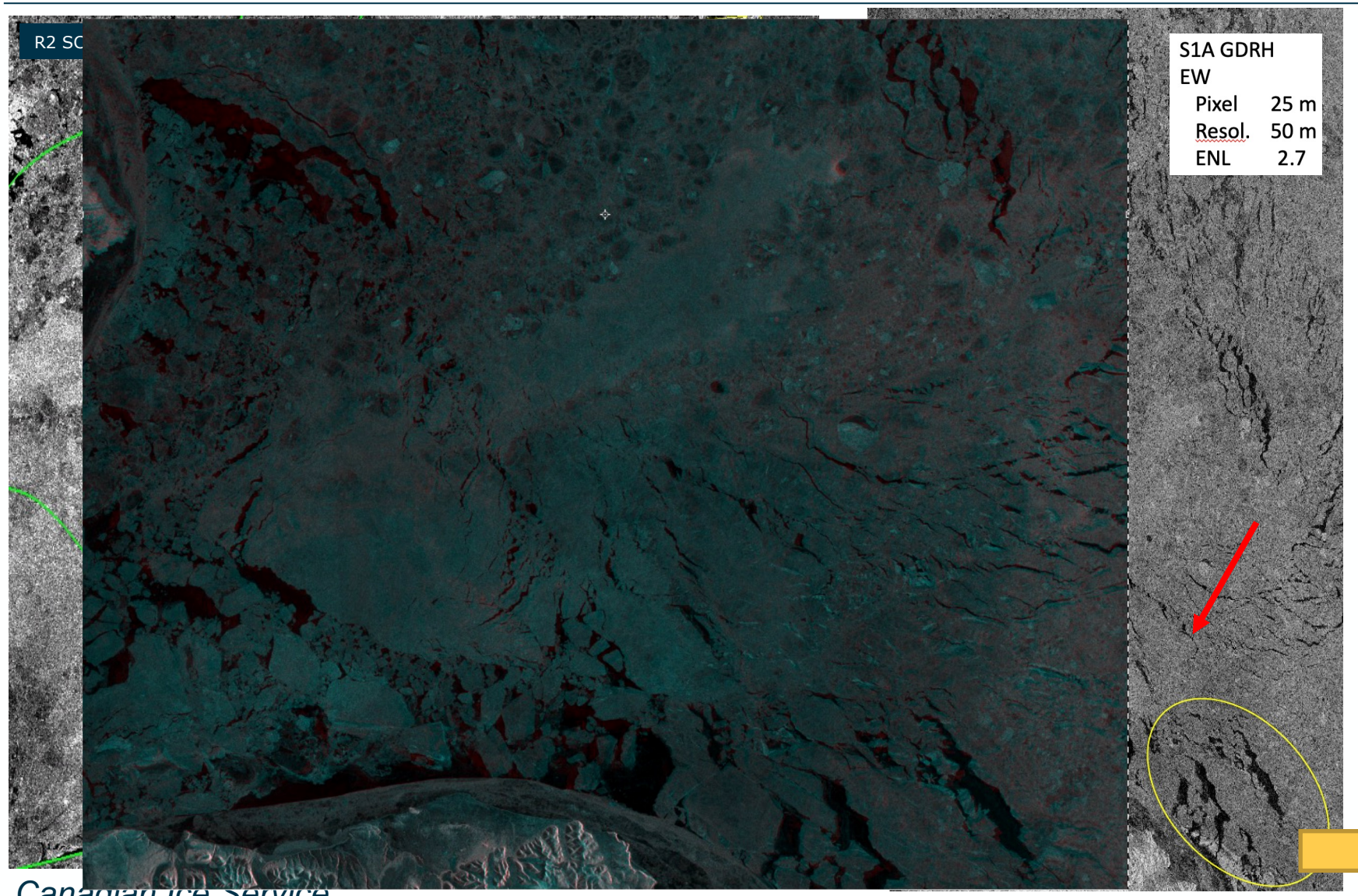


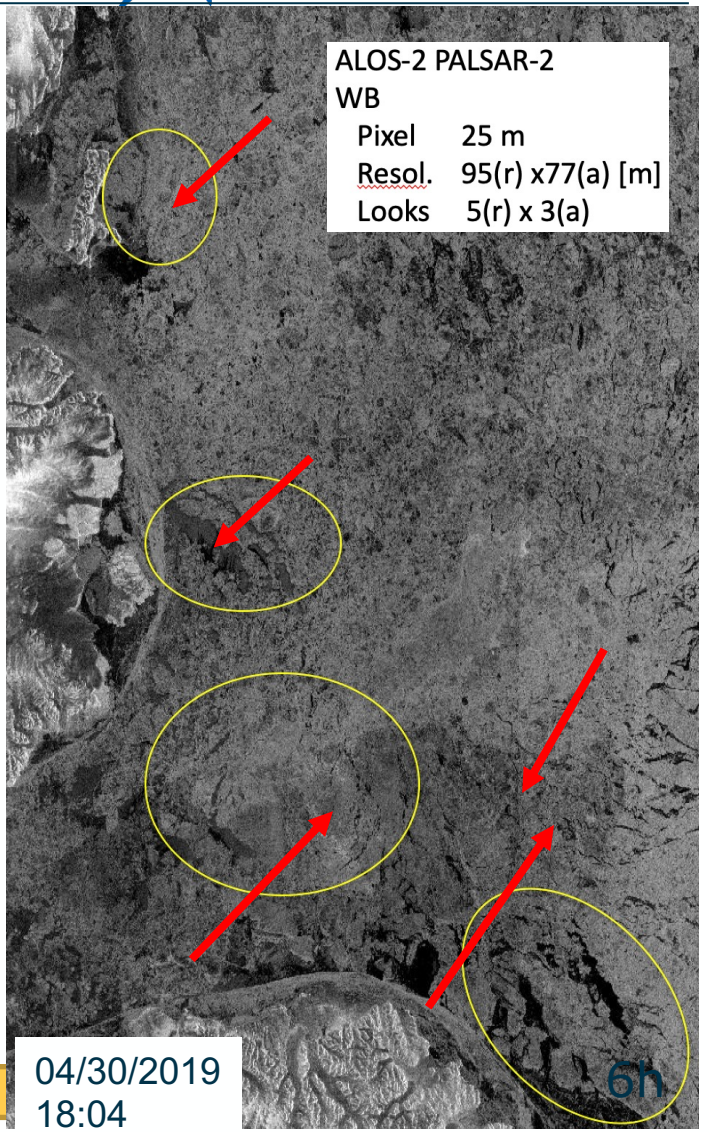






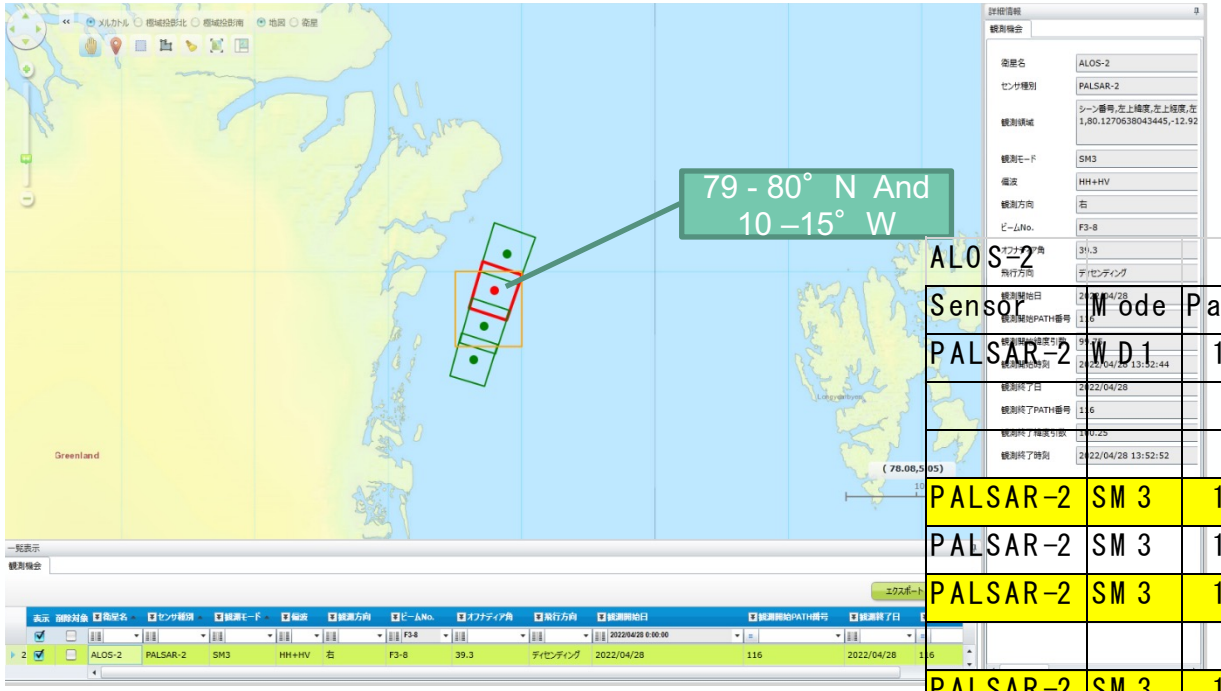
Sea ice of L- and C-band synergy (Baffin Bay)





Canadian Ice Service

ALOS-2 and Sentinel-1 back-to-back Observation result



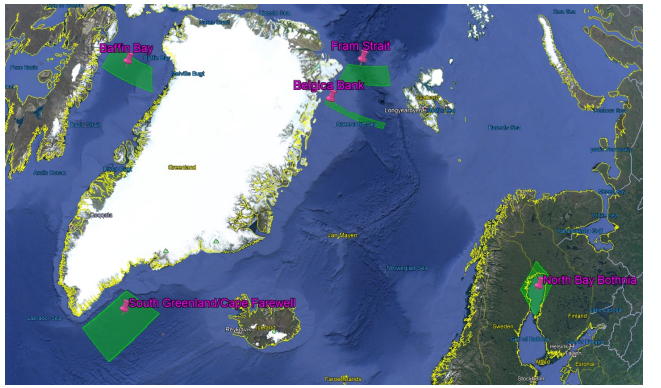
High temporal observation by ALOS-2 SM3 (10m) with Sentinel-1 EW (25m)

ALOS-2						Sentinel-1			
Sensor	Mode	Path	Frame	Obs date		Mode	Path	Frame	Obs date
PALSAR-2	WD1	118	2000	2022/4/24 14:06					
					17 hours	EW	240	155	2022-04-25T07:53:55
						EW	359	1709	2022-04-26T08:34:51
PALSAR-2	SM3	116	2000	2022/4/28 13:52	5 hours	EW	325	24	2022-04-28T08:18:14
PALSAR-2	SM3	119	1990	2022/4/29 14:13					
PALSAR-2	SM3	122	1990	2022/4/30 14:33	6 hours	EW	331	53	2022-04-30T08:01:51
					3hours	EW	194	59	2022-04-30T17:47:39
PALSAR-2	SM3	111	2010	2022/5/1 13:17	5 hours	EW	18	68	2022-05-01T08:43:19
					17 hours	EW	334	82	2022-05-02T07:45:31
PALSAR-2	SM3	117	2000	2022/5/3 13:59	5 hours	EW	332	97	2022-05-03T08:26:26
PALSAR-2	SM3	109	2010	2022/5/5 13:03	5 hours	EW	422	126	2022-05-05T08:10:24
PALSAR-2	WD1	115	2000	2022/5/7 13:45					
PALSAR-2	SM3	118	2000	2022/5/8 14:06					

STATUS of ALOS-2 and RCM Cooperation between JAXA and CSA

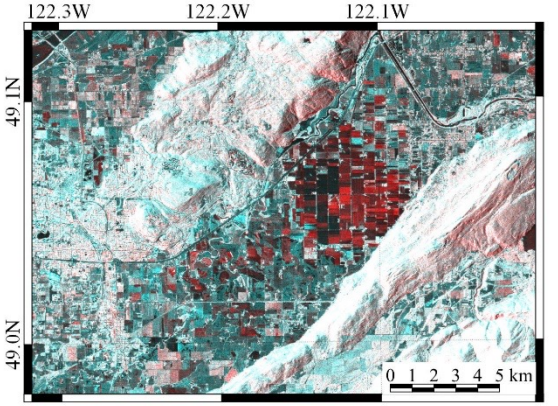
1. 3,928 scene of ALOS-2 observation data during April and October 2024 are delivered to CSA for joint research defined in PIP for the following topics

- 3.3. Exchange of Data Products during Emergency management
- 3.4. Exchange of Data Products of ocean monitoring (ship detection)
- 3.5. The Other environmental monitoring
  - 3.5.1. Sea Ice Monitoring
  - 3.5.2. Detection of small displacement and risk assessment
  - 3.5.3. Forest Mapping
  - 3.5.4. Deformation monitoring
  - 3.5.5. Monitoring Soil Moisture and Crop Characteristics
  - 3.5.6. Monitoring Endangered Marine Mammal Species Project



2. Conference

- JAXA-CSA joint study report, IGARSS 2023, July



3. Way forward

- Enhance bilateral cooperation to promote L+C SAR science and application cooperation including campaign projects observation (e.g. Antarctica, Sea Ice, MDA, cal/cal.)
- Promote Multilateral cooperation with NASA, CSA, ASI and VNSC under international SAR workshop framework with strong support by CSA to have #3 workshop in Japan in 2024

Possibility of cooperation area - Marine

Possible common interest area by EOSC users and Japanese Users for L/C SARs -> MDA(#MAR-391)／ICE(#MAR-100, MAR-110, MAR-150)

ICE	MDA
L band : first year ice C band : others Combined L+C bands is useful	L+C bands can improve time resolution



“Data Latency” is the issue with those needs

Discussion points

- ✓ Direct receiving data at each ground station respectively
  - -Option : Ka-band (optical DT needs demonstration experiment)
- ✓ Mutual tasking through ground station, **OR** utilize intersatellite communication
- ✓ Imaging SAR in orbit **OR** processing L0-L1 at receiving stations
- ✓ Loading both L and C band antenna onto a satellite PF
  OR Continuous observation with several satellites on the same orbit

Additional JAXA’s interests and needs

Oil spill(#MAR-120) · **winds over the ocean** (#MAR-130)
L+C bands is useful

Possibility of cooperation area - Land

Possible common interest area by EOSC users and Japanese Users for Land

Common Issues:

- ☐ Sharing data – daily
- ☐ Observation area (AOIs)

☐ Need to coordinate and prioritize common interest application theme

- **Forest**
  - -Algorithm is not established.
  - -Canopy height will transfer Optical＋LIDAR to ALOS-5 or MOLI

  #LAN-700, #LAN-710

- **Ecosystem/Coastline**
  - -Data integration (AI + Optical＋SAR)

  #LAN-400 #LAN-600

- **Soil moisture･Agriculture**
  - -Soil moisture detection by FP, Dual is performed as a research(different between upland and rice)
  - -Algorithm is not established

  #LAN-510

- **Iceberg**
  - -Utilize for melting glaciology iceberg･ice sheet Data integration (AI + Optical＋SAR)

  #LAN-210

Possibility of cooperation area - Land

Possible common interest area by EOSC users and Japanese Users for Land

Common Issues:

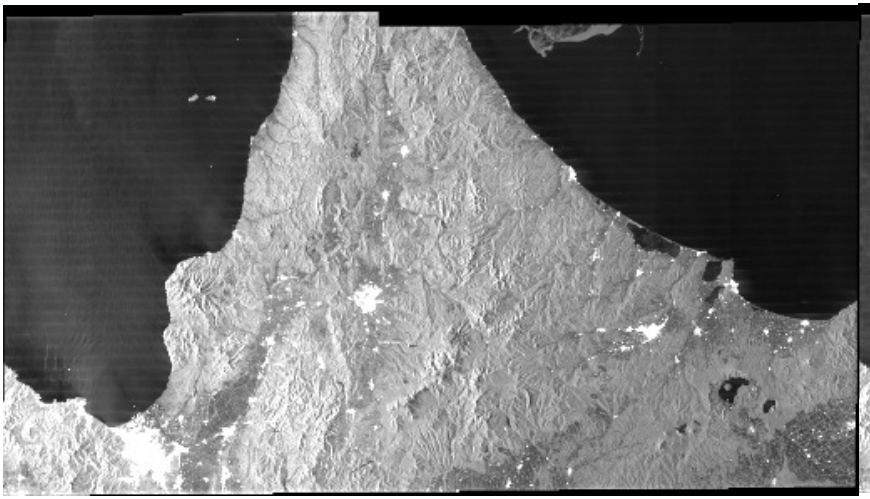
- ☐ Sharing data – daily
- ☐ Data latency
- ☐ Observation area (AOIs)

☐ Need to coordinate and prioritize common interest application theme

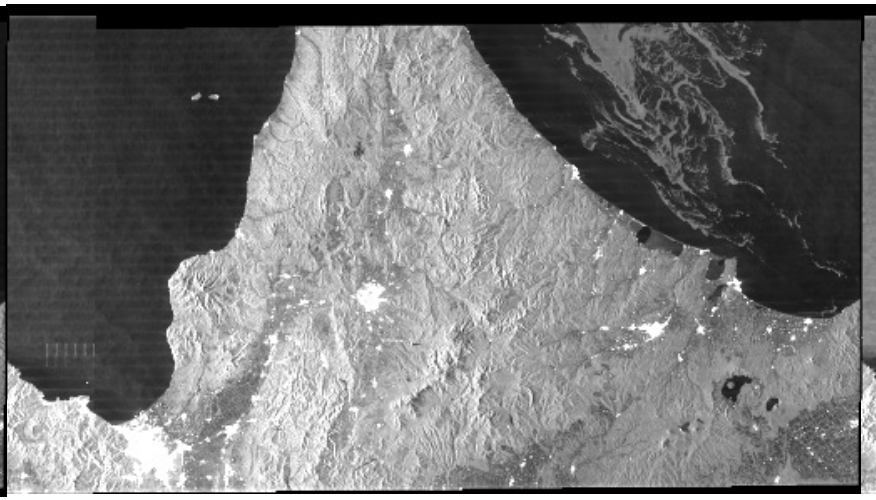
- Disaster
  - Infrastructure Integrity
    -L band : Infrastructure monitoring in vegetation area
    X band : others
    Infrastructure monitoring system X+L+C bands
    #LAN-800
  - Monitoring Seismically Active Areas / Areas and Volcanos
    -X+L band : needs in Japan
    #LAN-820
  - Active wildfire
    -Observation in X+L+C bands
    #LAN-720
  - Flood
    #LAN-440

RCM Sea Ice Monitoring in Sea of Ohotsuku (browse data Ship detection mode)

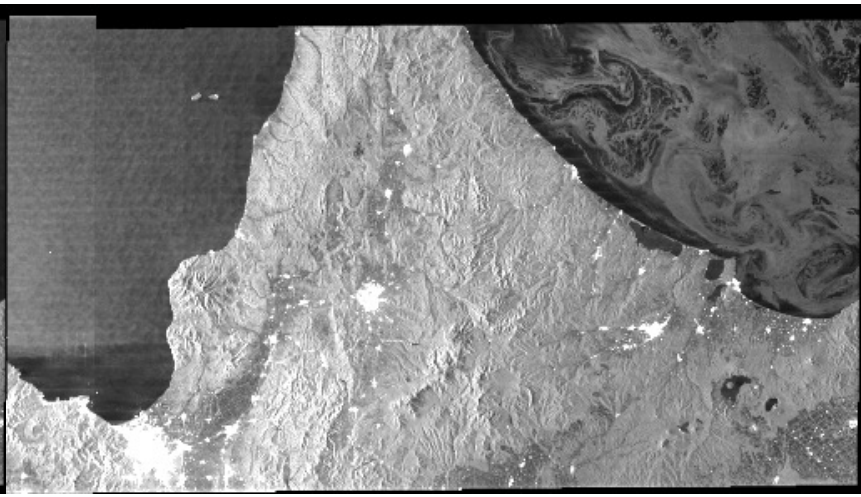
2021/1/12



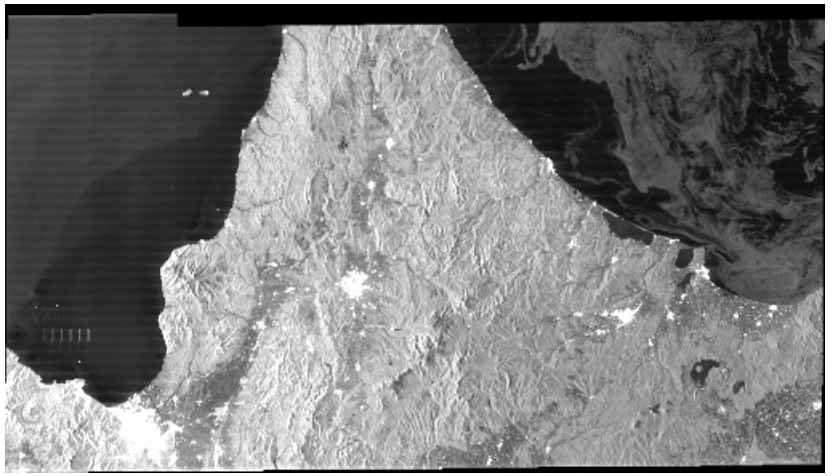
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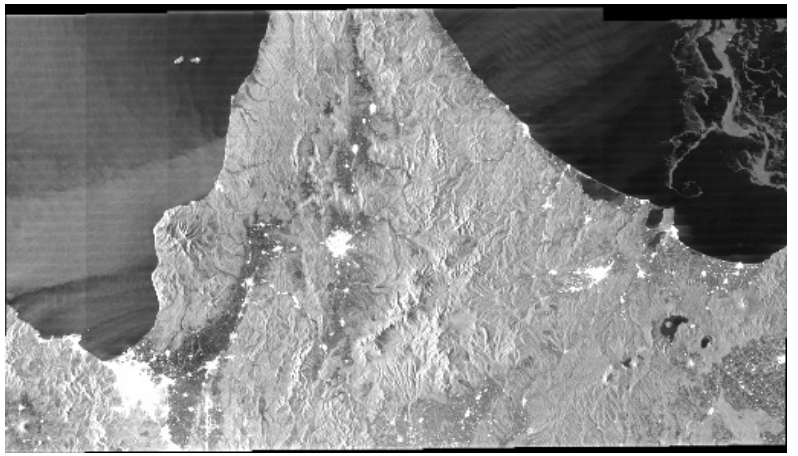
2/5



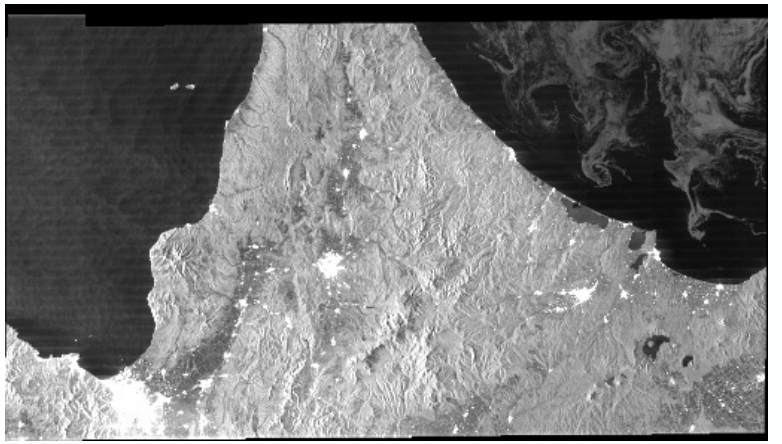
2/13



2/17



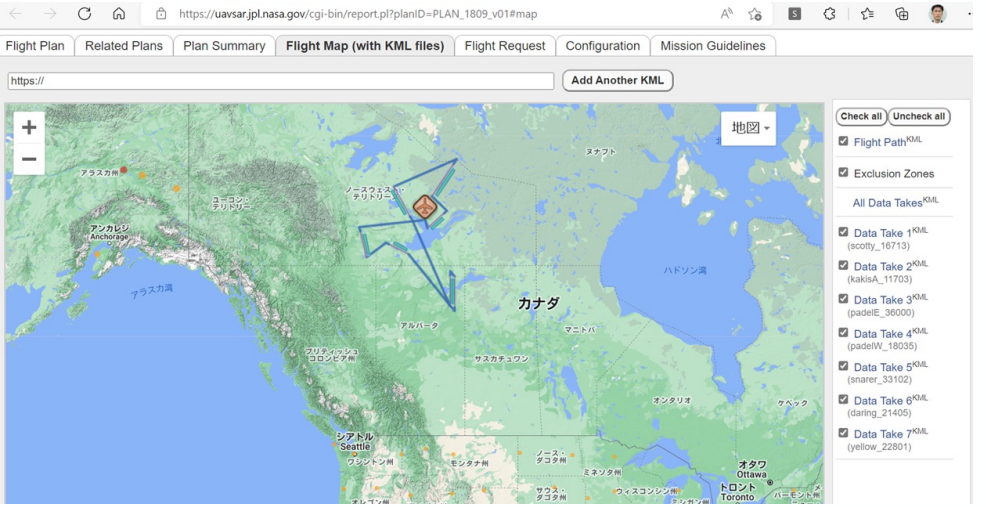
2/25



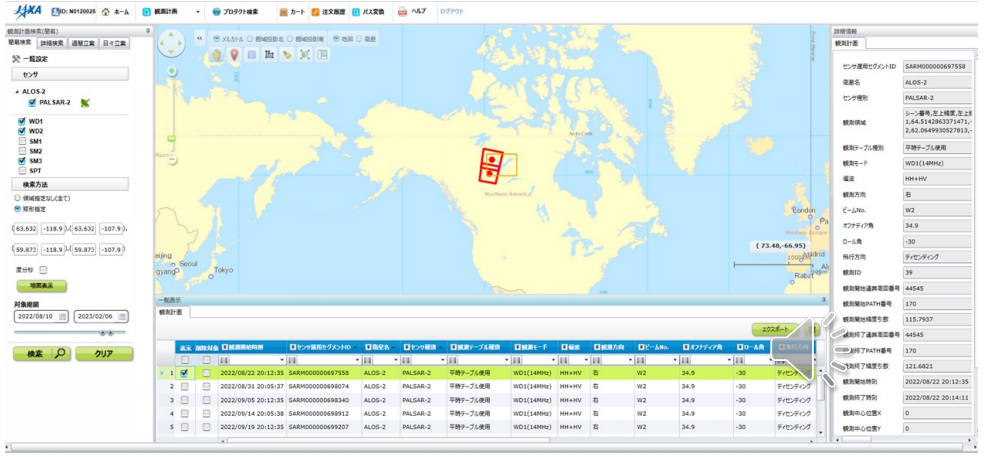
STATUS of JAXA-NASA cooperation for SAR

1. 1,981 scene of ALOS-2 observation data during April and October 2024 are delivered to NASA for joint research defined in PIP for the following topics
- 3.3.1. Polar Area/Sea Ice Monitoring
- 3.3.2. Forest and Wetland and Inundation Mapping

- 3.3.3. Ocean Monitoring
- 3.3.4. Soil Moisture
- 3.3.5. Monitoring Agriculture and Green House Gasses (GHG)
- 3.3.6. Natural Hazard Monitoring
- 3.3.7. Joint validation Algorithm development of SAR



2. Conference
- JAXA-NASA joint study report, IGARSS 2023, July
- JAXA-NASA joint session, AGU 2024, December



3. Way forward
- <u>Enhance bilateral cooperation to promote SAR science and application cooperation including campaign projects observation (e.g. forest, cal/val, etc.)</u>
- <u>Promote Multilateral cooperation with NASA, CSA, ASI and VNSC under international SAR workshop framework with strong support by NASA to have #3 workshop in Japan in 2024</u>

Grounding Zone Measurements from Spaceborne Interferometric SAR as a Crucial Descriptor of the Ice Ocean Interface of Glaciers

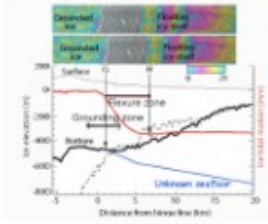
Bernd Scheuchl[1], Eric Rignot[1,2], Jeremie Mouginot[1,3], Pietro Milillo[1,4], Seongsu Jeong[2], Hanning Chen[1], Enrico Ciraci[1], Virginia Brancato[2]

[1] University of California, Irvine; [2] NASA JPL; [3] Université Grenoble Alpes; [4] University of Houston;

C15D-0614

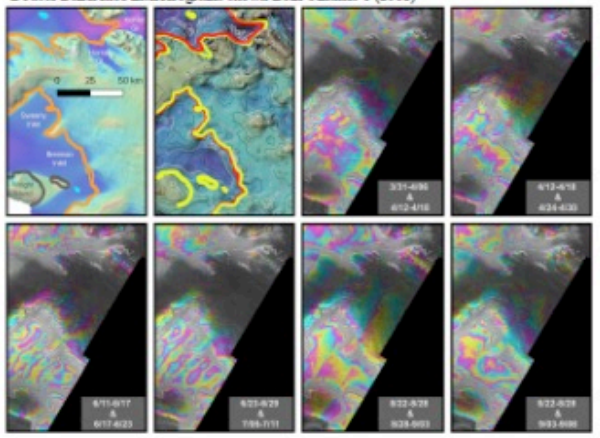
Background and Motivation

The ice-ocean interface of a glacier is a critical boundary and is described by the *grounding line* (GL), which delineates where ice detaches from the bed and becomes afloat and frictionless at its base. We use synthetic aperture radar (SAR) double difference interferometry to measure the GL position based on its sensitivity to differential tide state differences. Suitable data were sparse in the past, resulting in only a few GL collected for any given region in Antarctica. Current generation SAR missions acquire data suitable for GL measurements more frequently, enabling many GL delineations over the course of a year. Using this new wealth of data, we observe variations of the GL position at tidal cycles. This variation is significantly wider (typically 10 times) than expected from hydrostatic equilibrium. This short-term variation has an impact on the ice-ocean boundary and how it should be modeled.

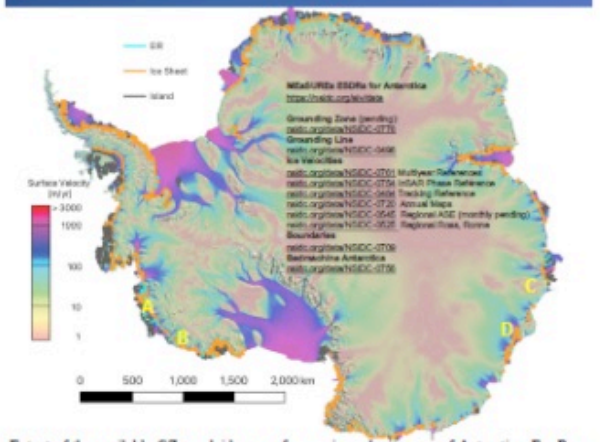


A double difference interferogram shows the flexing of the floating ice due to a difference in tide states in form of a band of dense fringes. The upstream bound of this fringe band is the GL. The location of the GL changes for different measurements. This is different from the flexure zone.

Example A: Kohler Glacier, Amundsen Sea Embayment and Eastern Getz Ice Shelf.
Double Difference Interferograms shown from Sentinel-1 (2018)



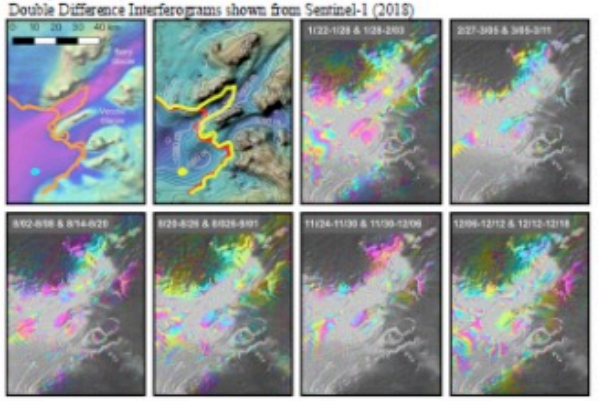
The Grounding Zone



Extent of the available GZ overlaid on a reference ice velocity map of Antarctica. For Ross and Ronne Ice Shelves not enough GL measurements are available.

We define the *grounding zone* (GZ) of a glacier as the short-term variability of GL positions at tidal cycles. Based on the frequency of GL measurements and Mohajerani (2021), we use data collected over one year to delineate the GZ. The primary data sources are the European Union Sentinel-1 mission for ongoing coastal coverage and the Italian Space Agency COSMO SkyMed constellation for targeted short-repeat acquisitions over fast glaciers.

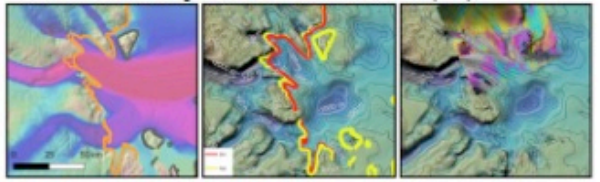
Example B: Berry Glacier, West Antarctica.
Double Difference Interferograms shown from Sentinel-1 (2018)



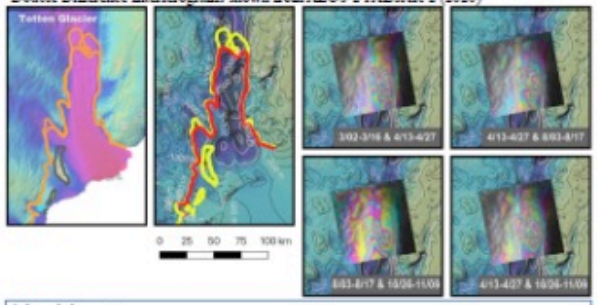
Implications

Evidence of tidal-frequency variation of the GL requires an update of the description of the ice-ocean interface. Our *grounding zone* product provides information of the areas susceptible to melt due to sea water intrusion at tidal frequencies. Publication of the GZ as Earth Science Data Record (ESDR) at NSIDC is pending, Product NSIDC-0778. The model of a fixed GL with zero melt should be replaced with one using a km-wide GZ with vigorous ice–ocean interaction. Changes of the GZ over time will be a better descriptor of glacier retreat. Ongoing SAR data collection with short-repeat orbit in coastal Antarctica are therefore crucial for GL measurements and the ability to map the GZ over time.

Example C: Denman Glacier, East Antarctica.
Double Difference Interferogram shown from ALOS-2 PALSAR-2 (2020)



Example D: Totten Glacier, East Antarctica.
Double Difference Interferograms shown from ALOS-2 PALSAR-2 (2020)



Acknowledgement:
This work was funded through the NASA MEaSUREs program and contains modified Copernicus Sentinel data 2018, processed by ESA. ALOS-2 PALSAR-2 data were made available by JAXA through the third Research Announcement (EO-RA3). MEaSUREs ESDR's are available at NSIDC.

GL and GZ related publications:

Chen et al. (in review). Grounding zone of Amery Ice Shelf, Antarctica, from differential synthetic-aperture radar interferometry. C22A-04.

Ciraci et al., (in review). Melt regime in the kilometer-wide grounding zone of Petermann Glacier, Greenland before and during a retreat. C55D-0633.

Milillo et al., (2022). Rapid glacier retreat rates observed in West Antarctica. Nature Geoscience 15, no. 1

Mohajerani, et al. (2021). Automatic delineation of glacier grounding lines in differential interferometric SAR data using deep learning. Scientific reports, 11(1).

Rignot et al., (2020). Grounding line retreat of Denman Glacier, East Antarctica, measured with COSMO-SkyMed radar interferometry data. GRL, 47(12).

Milillo et al., (2017). On the short-term grounding zone dynamics of Pine Island Glacier, W.A., observed with COSMO-SkyMed interferometric data. GRL, 44(20)

Scheuchl et al. (2016). Grounding line retreat of Pope, Smith, and Kohler Glaciers, West Antarctica, measured with Sentinel-1a radar interferometry data. GRL, 43(16).

Li et al., Grounding line retreat of Totten Glacier, east Antarctica, 1996 to 2013. GRL, 42(19).

Rignot et al., (2014). Widespread, rapid grounding line retreat of Pine Island, Thwaites, Smith, and Kohler glaciers, West Antarctica, from 1992 to 2011. GRL, 41(10).

Rignot, et al., (2011) Antarctic grounding line mapping from differential satellite radar interferometry. GRL, 38(10).

Example of PALSAR-2 data used in the Algorithm to Retrieve High-Resolution Soil Moisture for the NISAR Mission.

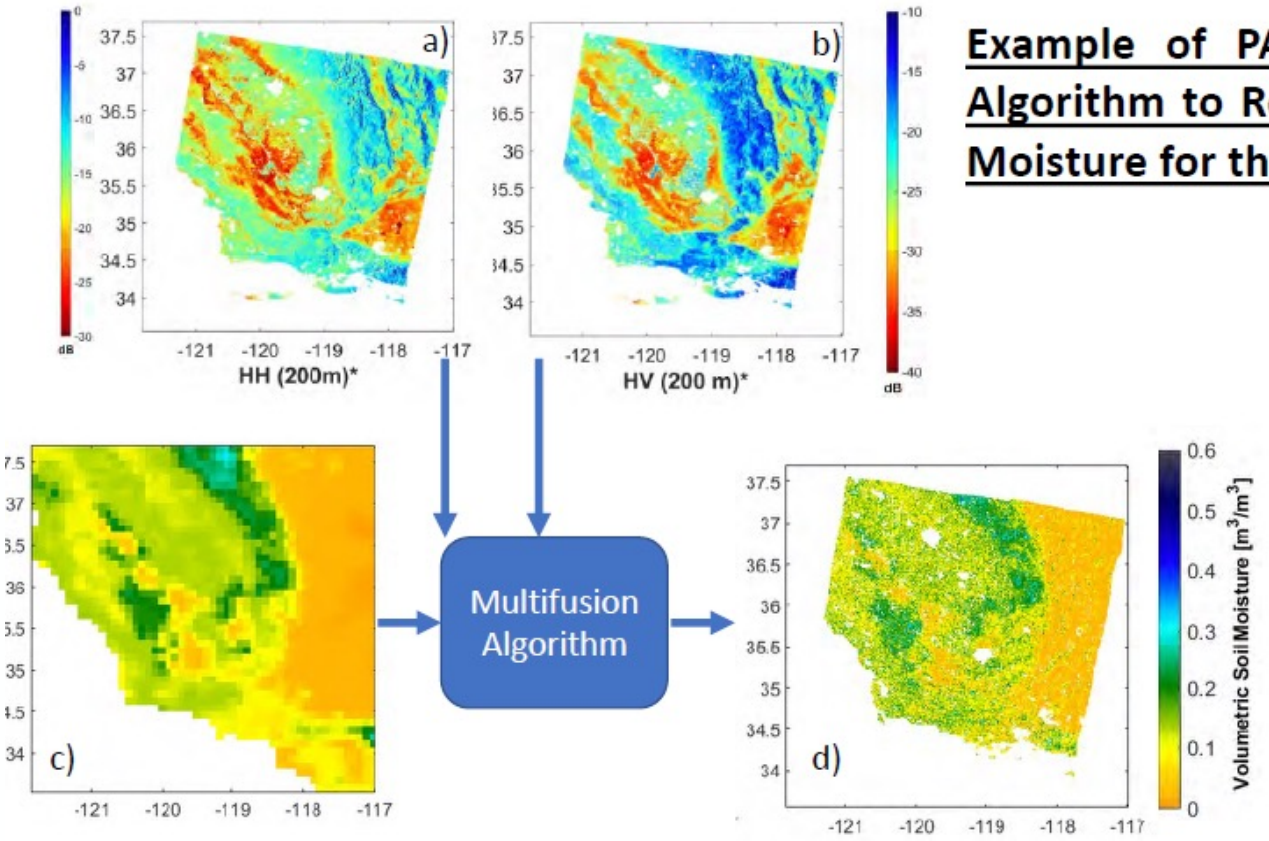


Fig.: (a) PALSAR-2 HH (200 m); **(b)** PALSAR-2 HV (200 m); **(c)** ERA5-Land soil moisture at a coarse resolution of ~9 [km], and; **(d)** High-resolution (200 m) soil moisture retrievals for the Southern California region (July 30, 2017).

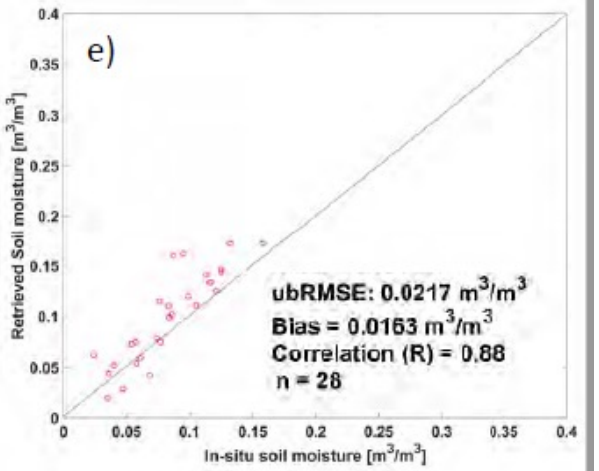


Fig.: **(e)** A comparison between the high-resolution (200 m) soil moisture retrievals and the in-situ soil moisture measurements over 28 in-situ location in Southern California, USA, for July 30, 2017.

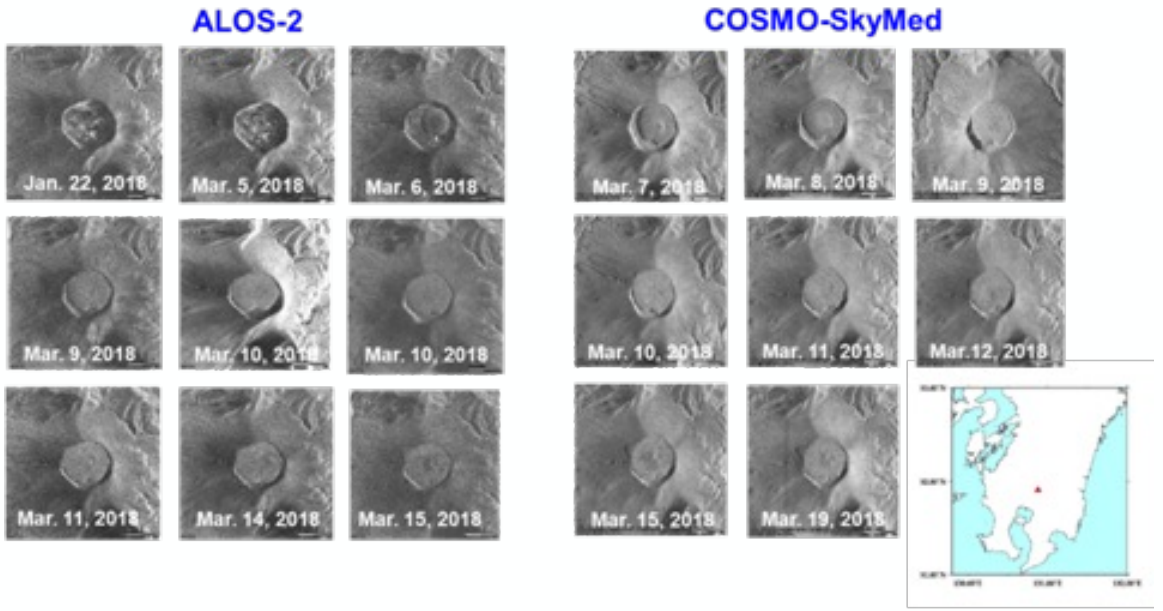
STATUS of CSK/CSG-ALOS-2 Cooperation

1. 461 scene of ALOS-2 observation data during April and October 2024 to ASI are delivered to ASI for archive data for disaster and joint research defined in PIP for the following topics. But there is some issue of system connective and need some times to fix it (data delivery delay)

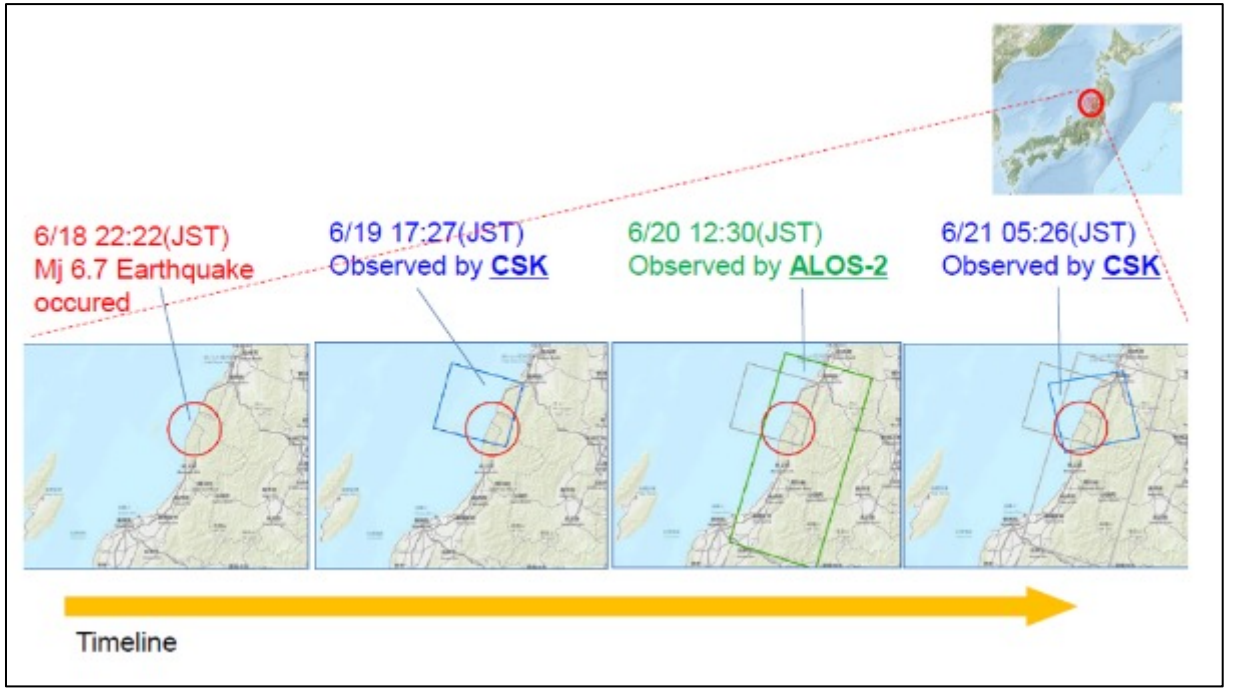
2. Conference
- JAXA-ASI joint study report, IGARSS 2024, July

3. Way forward
- Enhance bilateral cooperation to promote SAR science and application cooperation including campaign projects observation (e.g. forest, cal/val, etc.) and also hot spot Volcano monitoring using X/L in Japan.

- Promote Multilateral cooperation with NASA, CSA, ASI and VNSC under international SAR workshop framework with strong support by NASA to have #3 workshop in Japan in 2024

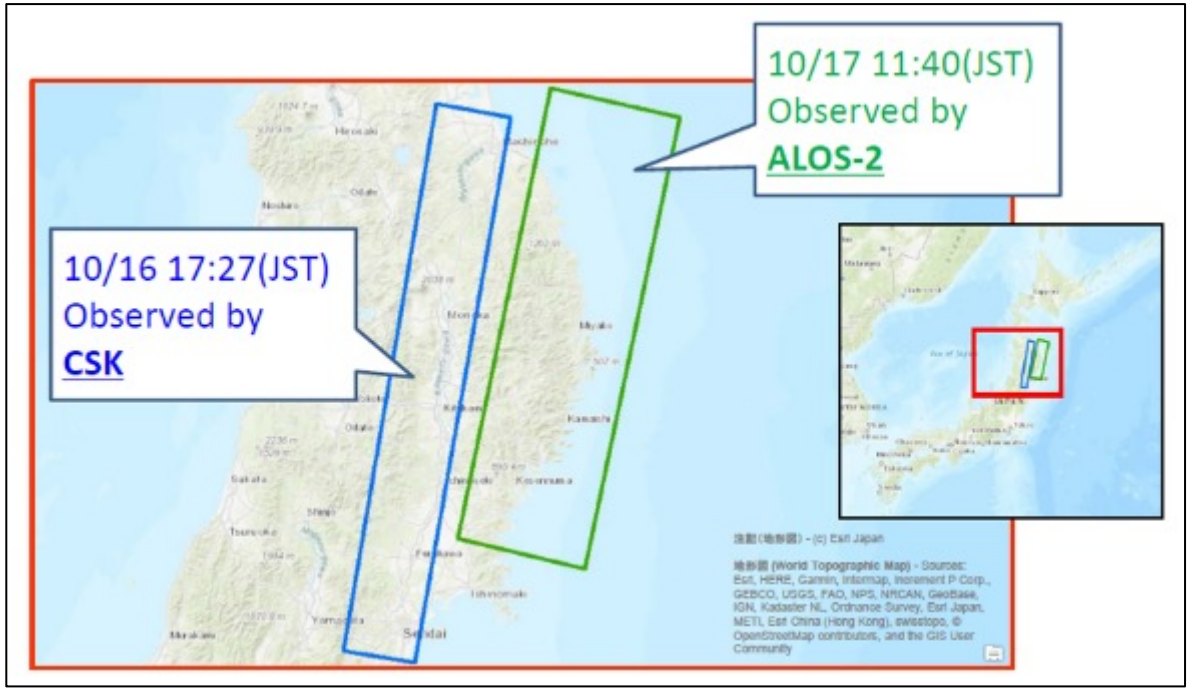


Sharing task by ALOS-2 and CSK as virtual constellation for disaster monitoring in Japan



Earthquake in Yamagata coastal area, 2019/6

High temporal observation

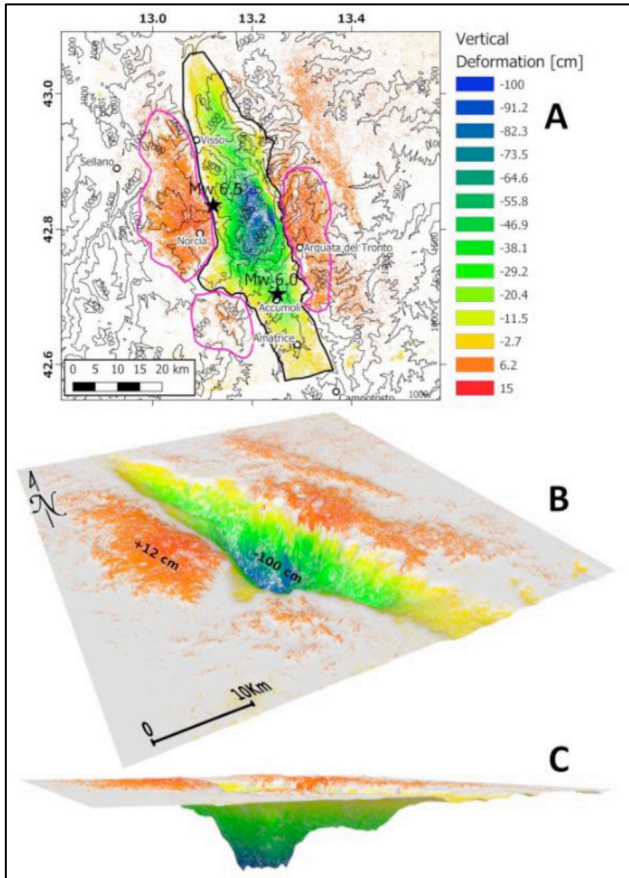


Typhoon 19, 2019/10

Wide area observation

Research result by ASI

ASI-JAXA Implementing Arrangement concerning Mutual Cooperation for Satellite Support to Disaster Risk Management Summary of the Achievements



Volume unbalance on the **2016 Amatrice - Norcia (Central Italy) seismic sequence** and insights on normal fault earthquake mechanism

Map showing the cumulated displacements occurred from September 2015 and November 9, 2016. It is recorded by the ALOS-2 DInSAR data, showing the areas collapsed and uplifted during the seismic sequence between Mw 6.0 August 24th and Mw 6.5 October 30th 2016 assuming that no pre-seismic deformation occurred.

Coseismic uplift is marginal with respect to subsidence.

The largest deformation is concentrated in the hanging wall of the master WSW-dipping normal fault system

Reference: Bignami et al. (2019) *Nature Scientific Reports* 9, 4250. doi: 10.1038/s41598-019-40958-z

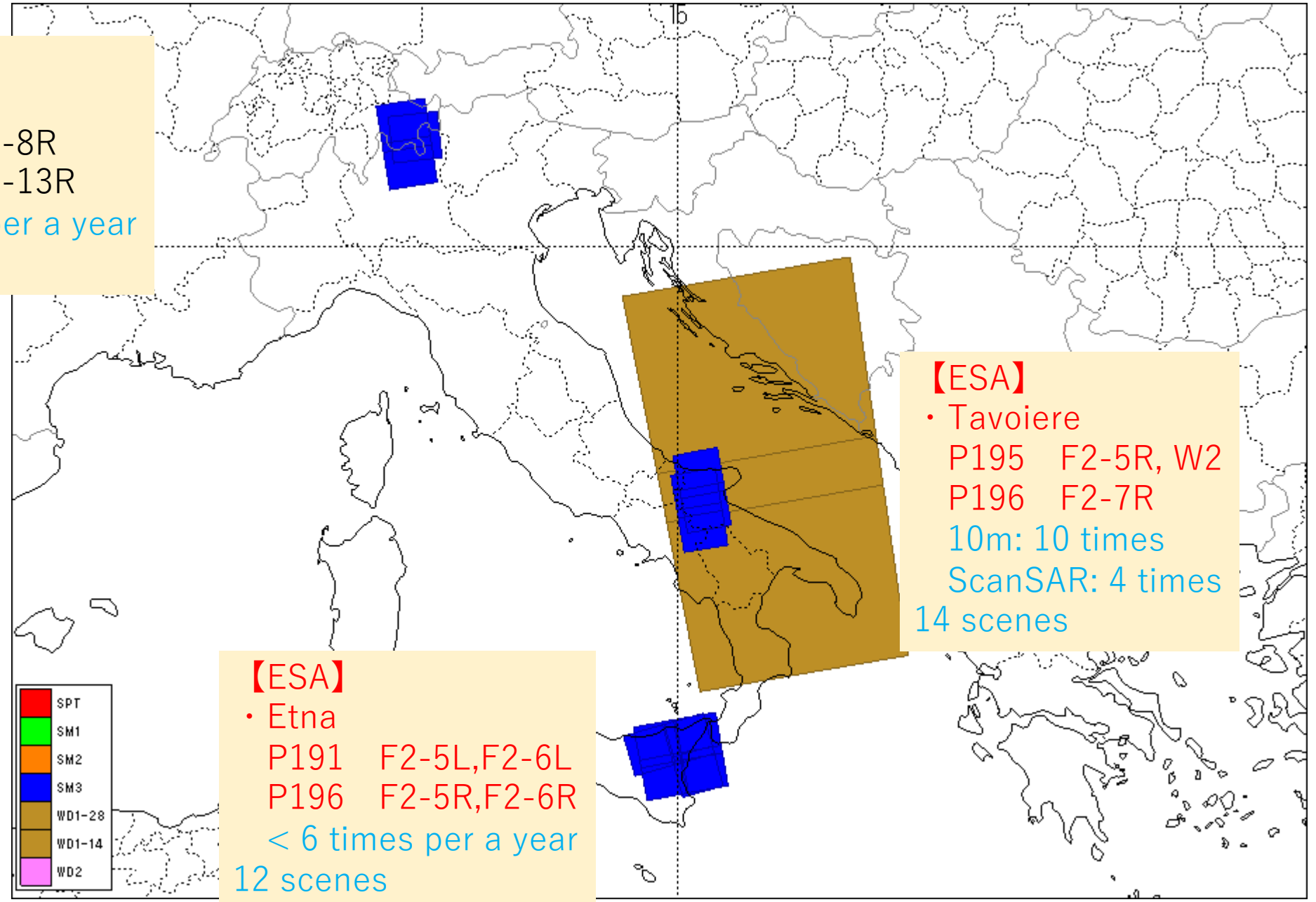
2016年のイタリア中部（Amatrice Norcia）における地震の正断層地震メカニズムに関する研究

ASI-JAXA disaster research

Jolanda di Savoia	44.86° 11.95°	agriculture / land cover land use	sufficiently long time series (cover at least one/two growing seasons) from March to September each year	93 2710 197 890		Currently only 7 products in Fine -> Only observation for **basemap** for ASI with JAXA
Tavoliere Pugliese	41.39° 15.49°	agriculture / land cover land use		195 196 91 90	820 820 2780 2780	With ESA cooperation Every 28-42 days target with SM3 Highest observation frequency, i.e. shortest revisit time as possible
Rome's rural hinterland	41.76° 12.28	land cover land use / impact of urbanization on local hazards	interferometric time series to observe changes over a long time interval	197 92 92 (SM1,2,3)	830 2770 2780	However, spatial resolution and temporal discontinuity may be technical constraints (SM1 and SM2 are only once for global data and other observation **are basemap** for ASI with JAXA). Currently very few and discontinuous archive high resolution image collections (5 + 3), but if more frequent and continuous high-Sensitive and/or Ultra-Fine new acquisitions could be accessed through ASI-JAXA cooperation, these modes would be the most suitable for this type of research -> Every 28-42 days target with SM1 is possible but miss low basemap observation
Campi Flegrei caldera	40.80° 14.12	volcanic hazard		195 196 91 90	820 820 2780 2780	Some data in Fine (Swath 70km/Resolution 10m) mode are available in ALOS-2 archive, but not yet dense and continuous -> Only observation for **basemap** for ASI with JAXA
Stromboli volcano	38.79° 15.21			196 196 90	760 770 2840	Some data in Fine (Swath 70km/Resolution 10m) mode are available in ALOS-2 archive, but not yet dense and continuous -> Only observation for **basemap** for ASI with JAXA
Mt. Etona				196 90	750 2840	With ESA cooperation Every 42 days target But sometime Seasonally DSC/ASC with SM3 Some data in Fine (Swath 70km/Resolution 10m) mode are available in ALOS-2 archive, but not yet dense and continuous
Calabria region rural areas	39.749639° 16.116883 39.167839° 16.152454°	Landslide hazard		195 195 90 90	780 790 2810 2820	Some data in Fine (Swath 70km/Resolution 10m) mode are available in ALOS-2 archive, but not yet dense and continuous -> Only observation for **basemap** for ASI with JAXA
Basilica region rural areas	40.50°	ground motion affecting		196 90	750 2840	Some data in Fine (Swath 70km/Resolution 10m) mode are available in ALOS-2 archive, but not yet dense and continuous -> Only observation for **basemap** for ASI

ASC-Spot observation area : 46 scenes

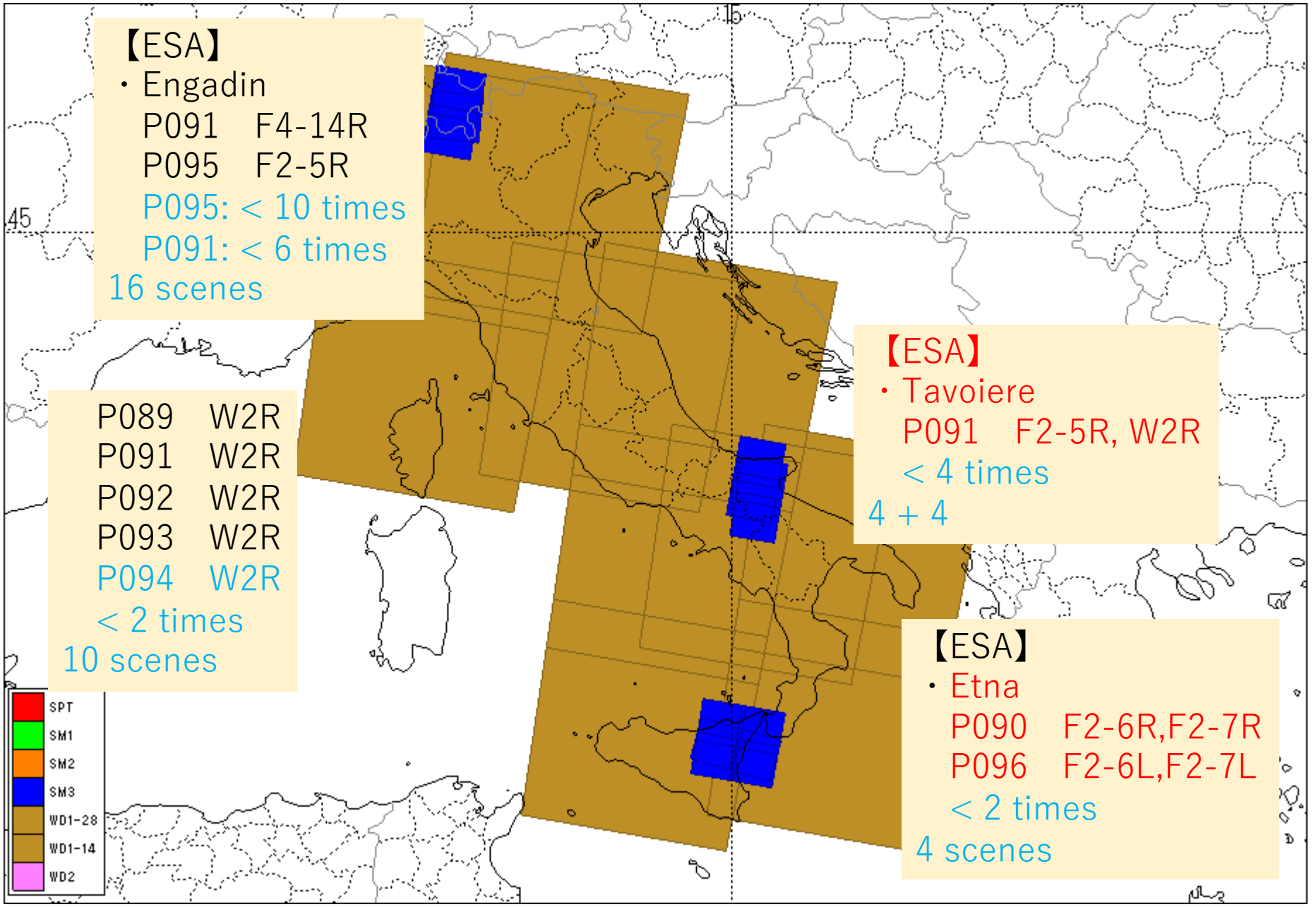
【ESA】
・Engadin
P199　F3-8R
P201　F4-13R
<10 times per a year
20 scenes



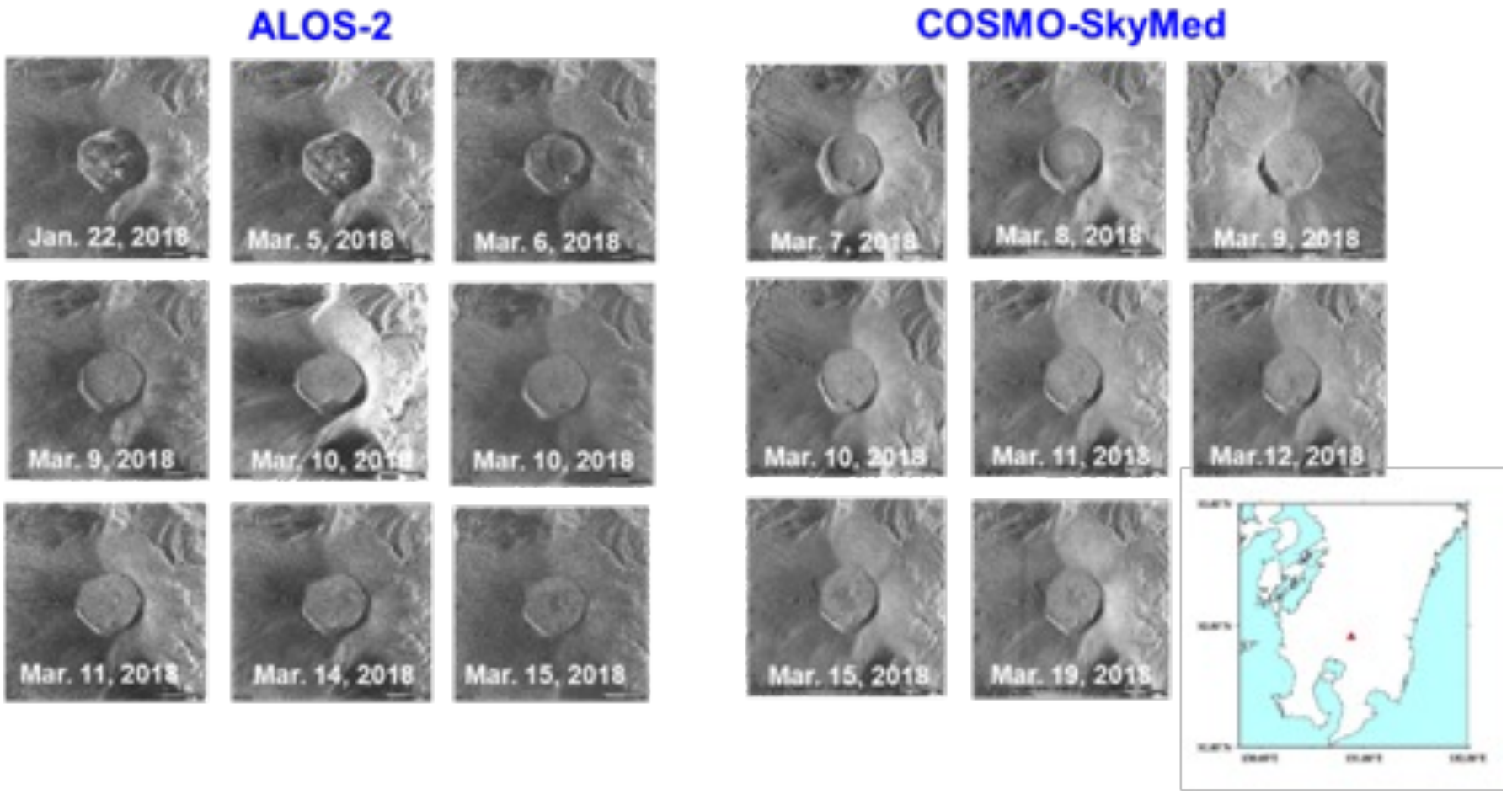
【ESA】
・Tavoiere
P195　F2-5R, W2
P196　F2-7R
10m: 10 times
ScanSAR: 4 times
14 scenes

【ESA】
・Etna
P191　F2-5L,F2-6L
P196　F2-5R,F2-6R
< 6 times per a year
12 scenes

DSC: 38 scenes

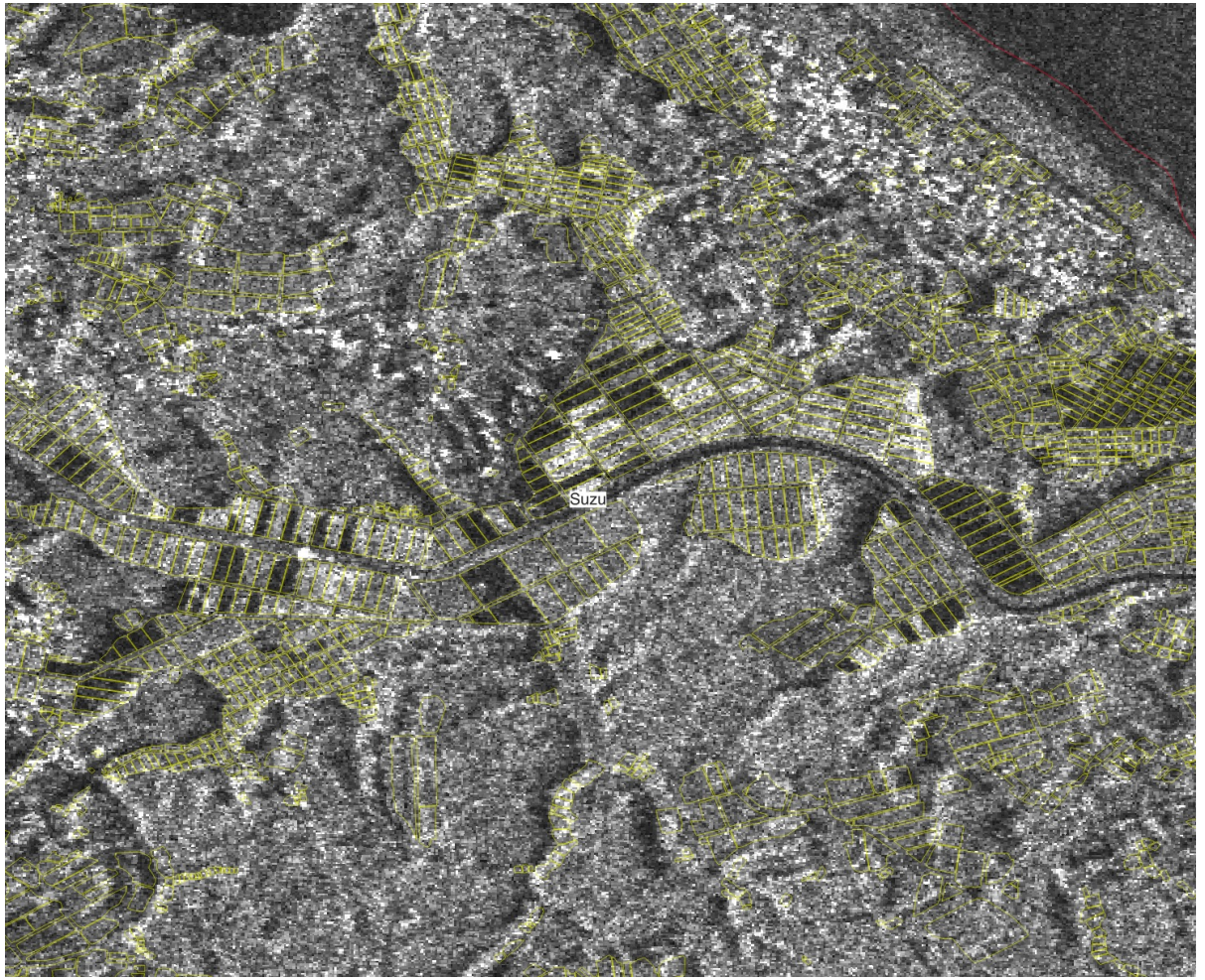


High temporal monitoring for active Volcano in Japan

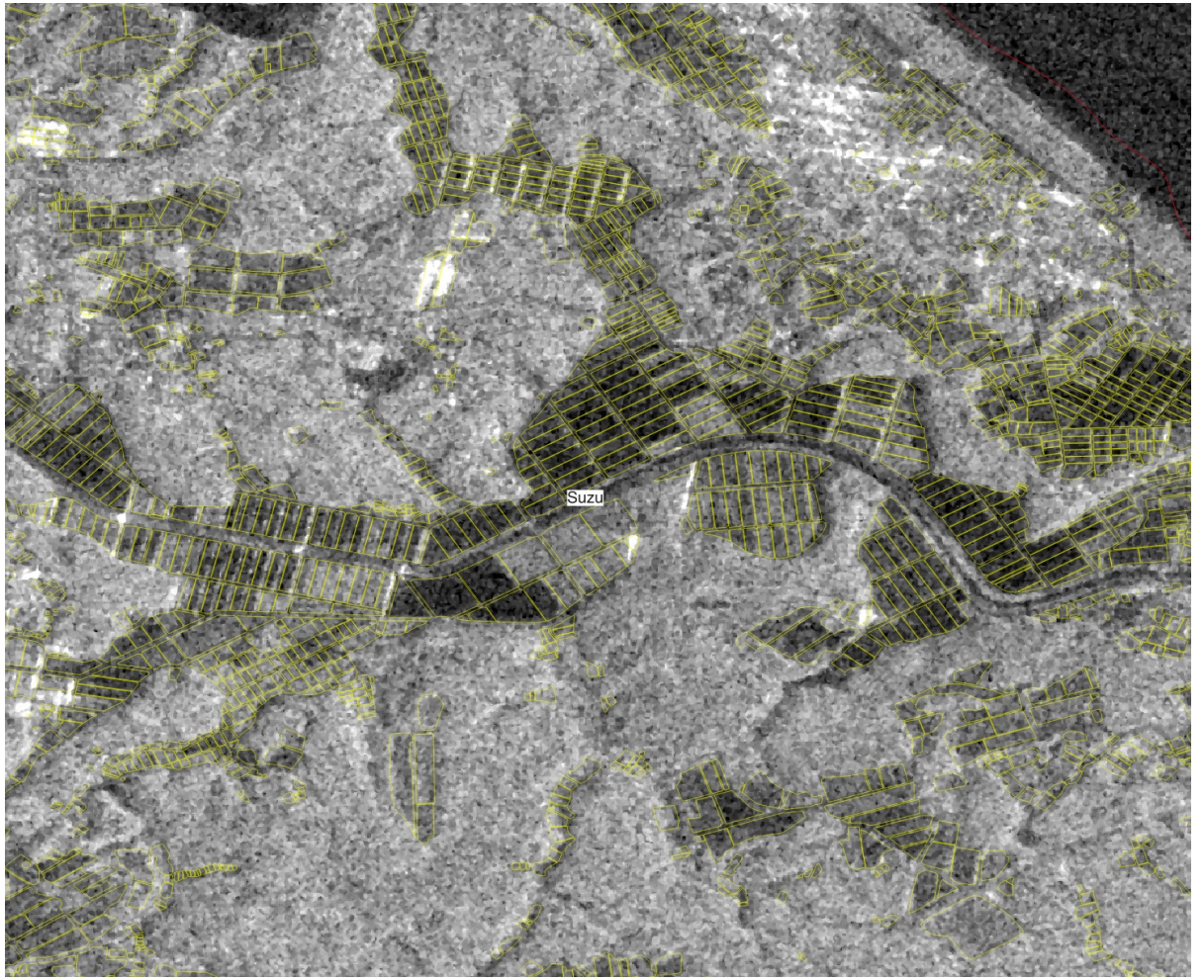


Request to have high temporal observation with same incident angle in JAXA selected active volcano in Japan by CSG/CSK with ALOS-2, especially Sakurajima

Cooperation with private sectors – Rice planting area estimation



StriX-1 (2024/05/11)

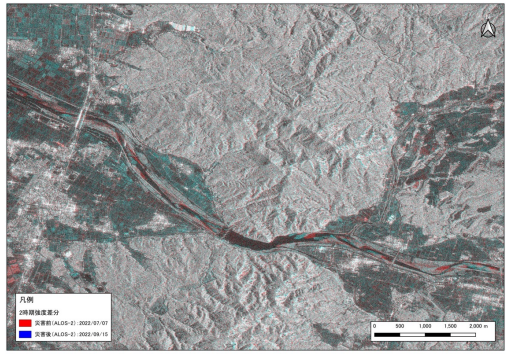


ALOS-2 SM1 (2024/05/19)

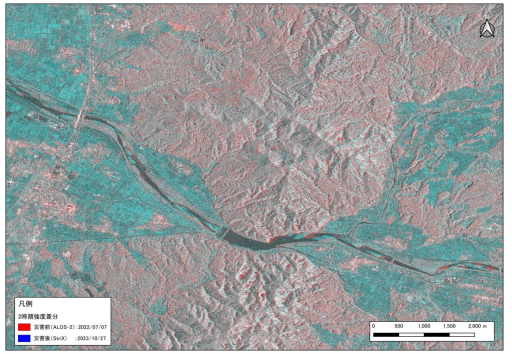
Yellow polygon are rice planted area and Strix detection of rice planting is more clearly than ALOS-2 because of frequency difference

Disaster monitoring (2024/8 heavy rain) by STRIX with ALOS-2

Before / After SAR image pseudo color composite

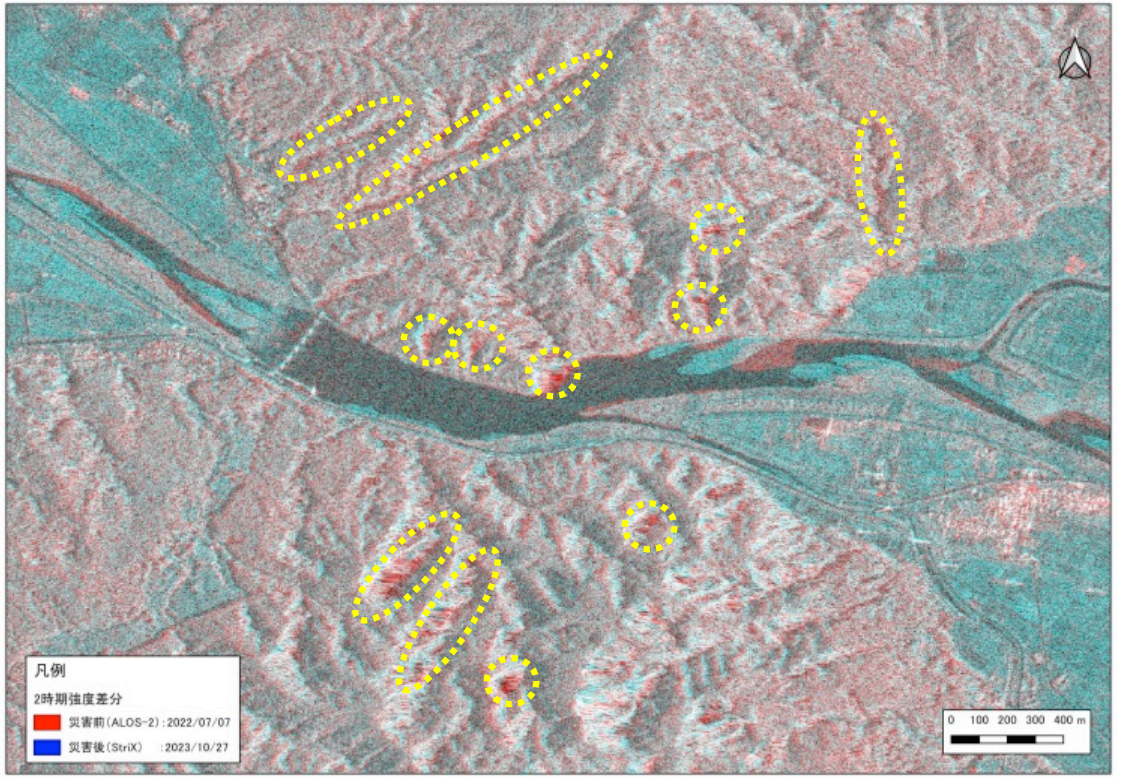


ALOS-2 – ALOS-2



ALOS-2 – StriX

Potential Land slide area detection using ALOS-2 – StriX



Yellow cycle area means expected Land slide by STRIX with ALOS-2 are land slide (25/36 area)

- Need to have archive data with same observation condition (incident angle, R/L look)
- Not much enough archive by small satellite constellations
- Need to promote the study of data fusion of small satellite constellations with governmental satellites such as ALOS-2/4, etc.

Way forward

- Continue international coordination for mutual interest area application with back cast to know users' needs
  - Disaster
  - Sea Winds – typhon, cyclone, hurricane
  - Sea Ice
  - Agriculture / Forest

- Application
  - Chip and que
  - Data fusion

- Cooperation with commercial satellites