L-band SAR-based ground deformation monitoring in Japan

— Application of ALOS-2 InSAR time series analysis to volcano monitoring

Yudai Sato, Tomokazu Kobayashi, Yu Morishita
(GSI, Geospatial Information Authority of Japan)

国土地理院
Geospatial Information Authority of Japan

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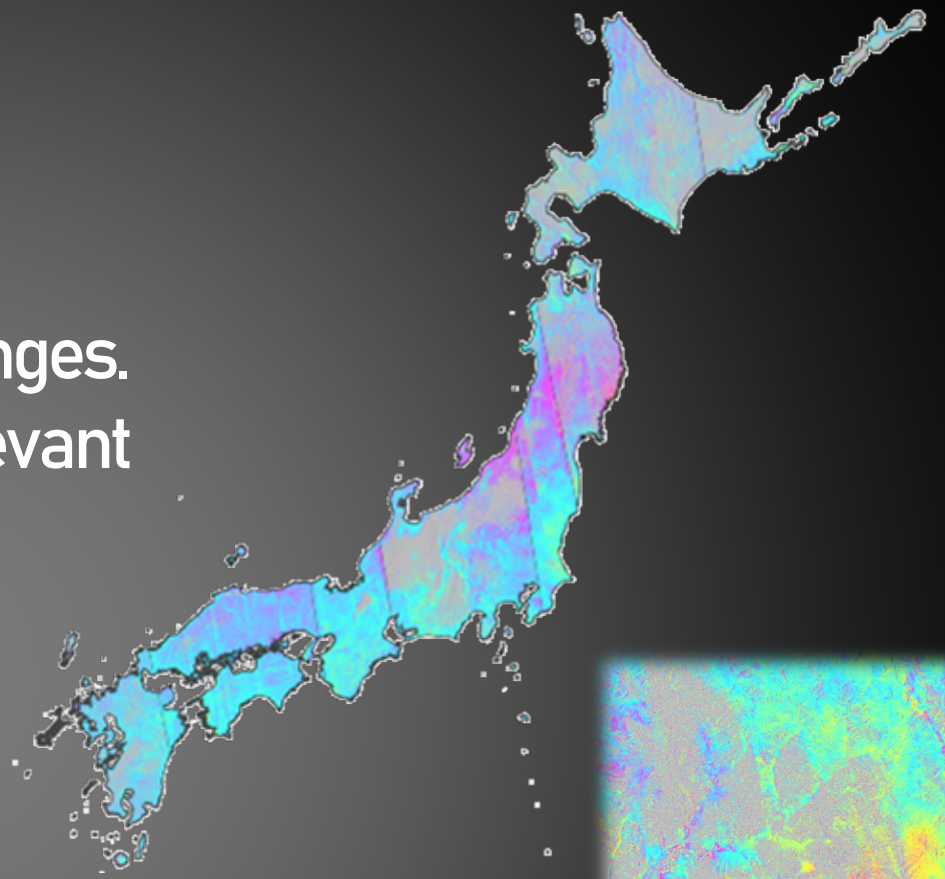
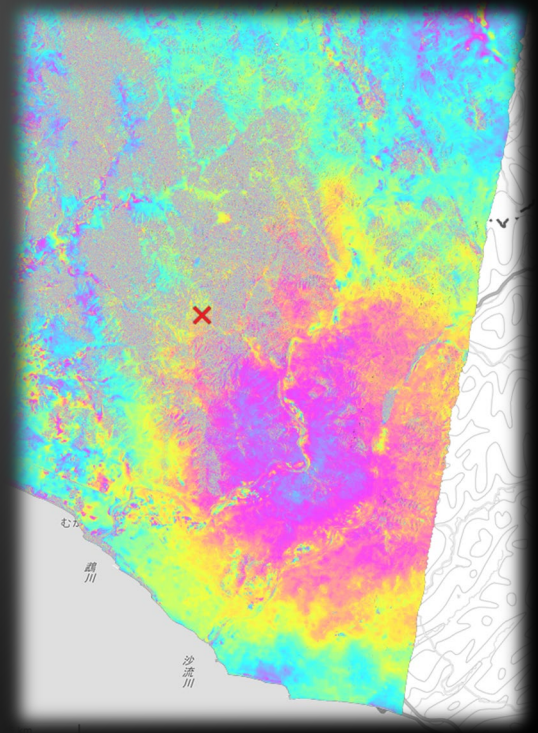
GSI's missions using ALOS-2

1. Regular InSAR analysis
- For monitoring nationwide surface changes.
- The interferograms are provided to relevant organizations.

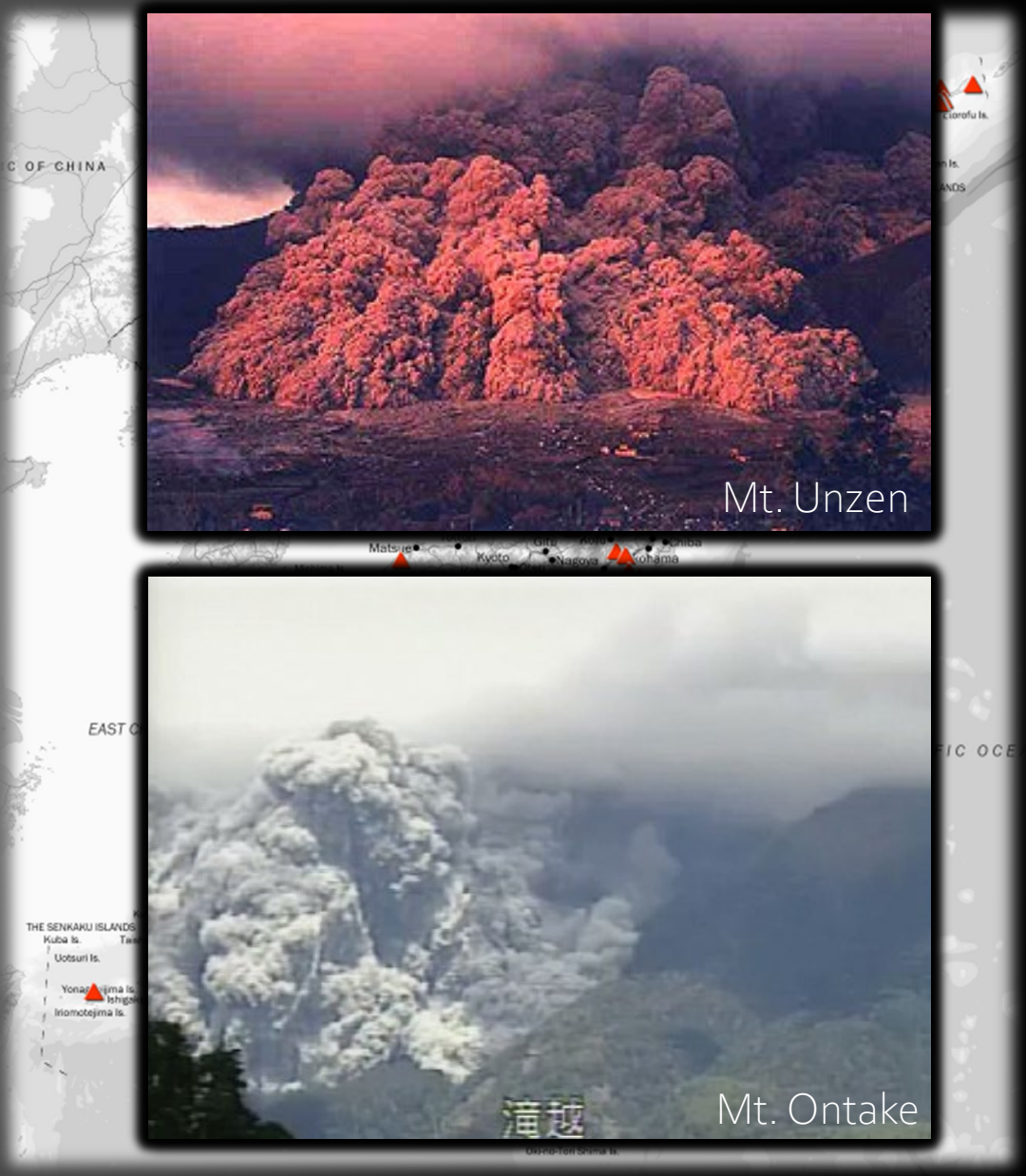
2. Emergent InSAR analysis
- For responding to disasters such as earthquakes, volcanic activities.
- The interferograms are provided to relevant organizations and also made available to the public through the GSI's website.





Active volcanoes in Japan

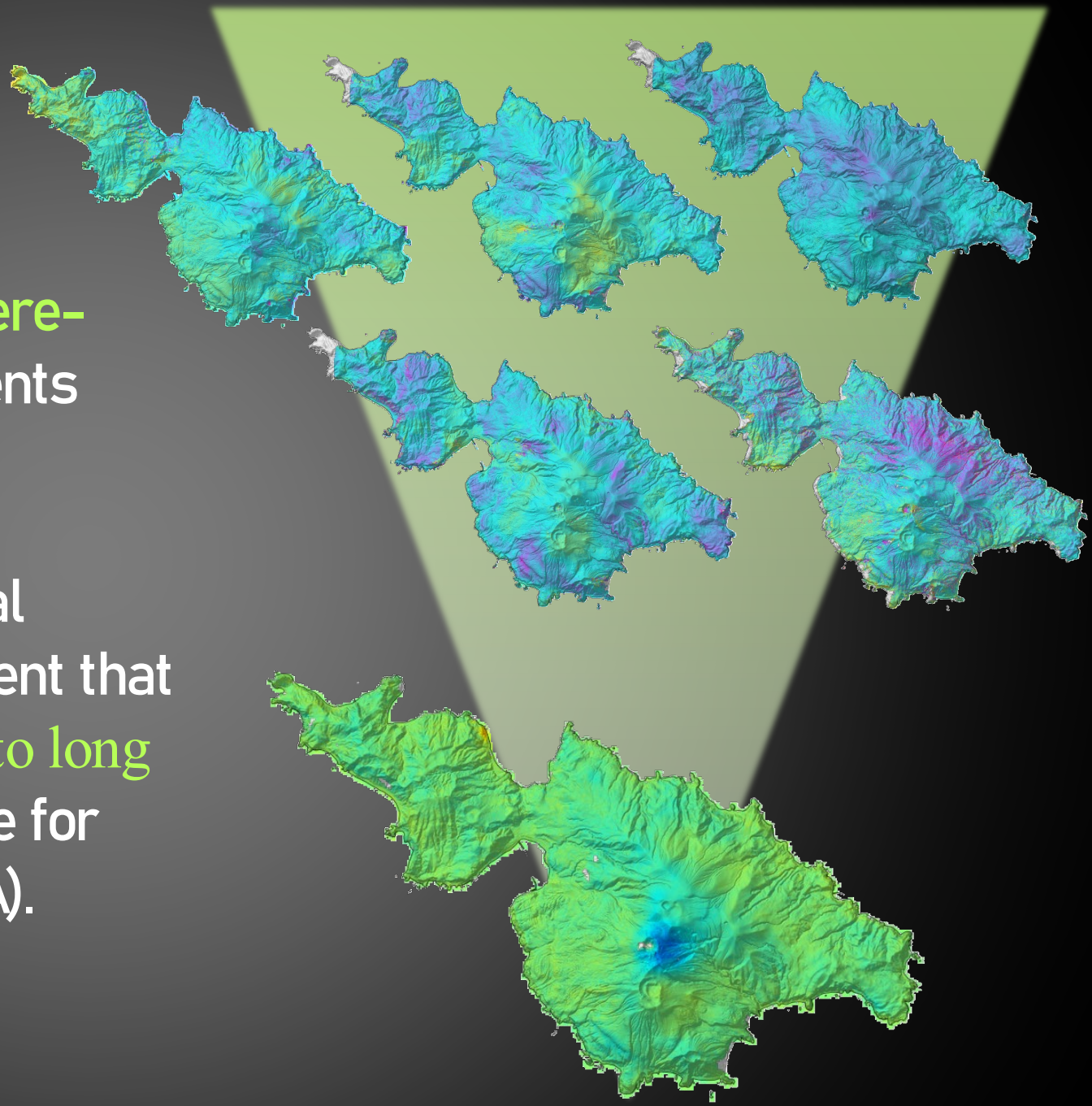
- There are 111 active volcanoes in Japan.
- Hazardous eruptions have repeatedly occurred historycally.
  (e.g. 1990 Mt. Unzen, 2014 Mt. Ontake)
- GSI, Japan Meteorological Agency (JMA), and other research institutes are monitoring volcanic activities by GNSS, tilt meters, seismometers, InSAR and so on.
- InSAR is a very effective tool to thoroughly monitor the surface displacement.



InSAR time series analysis
for monitoring ground deformation

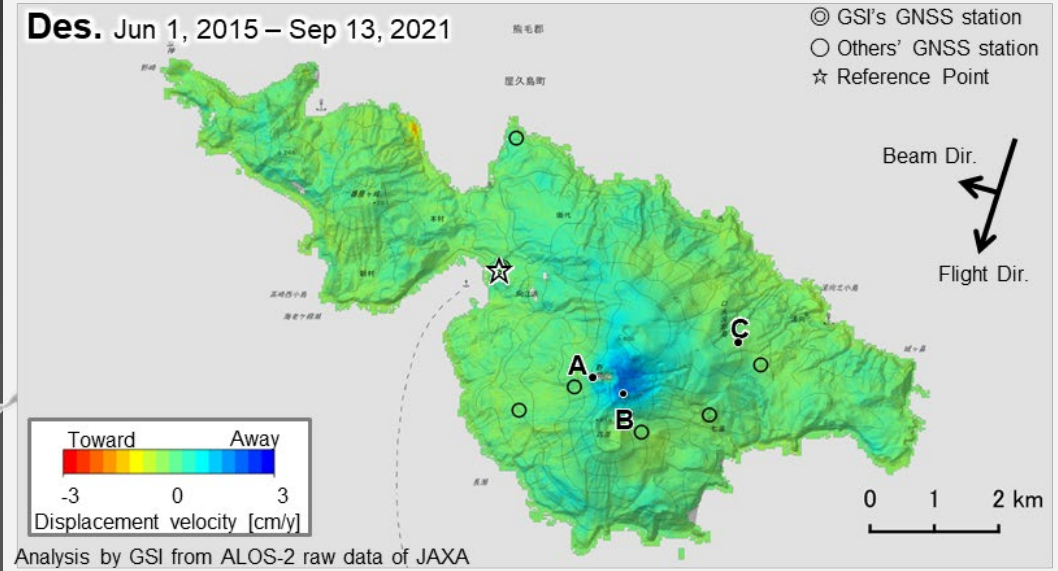
- InSAR often suffers from atmosphere-related noises etc. and likely prevents detecting anomalies.

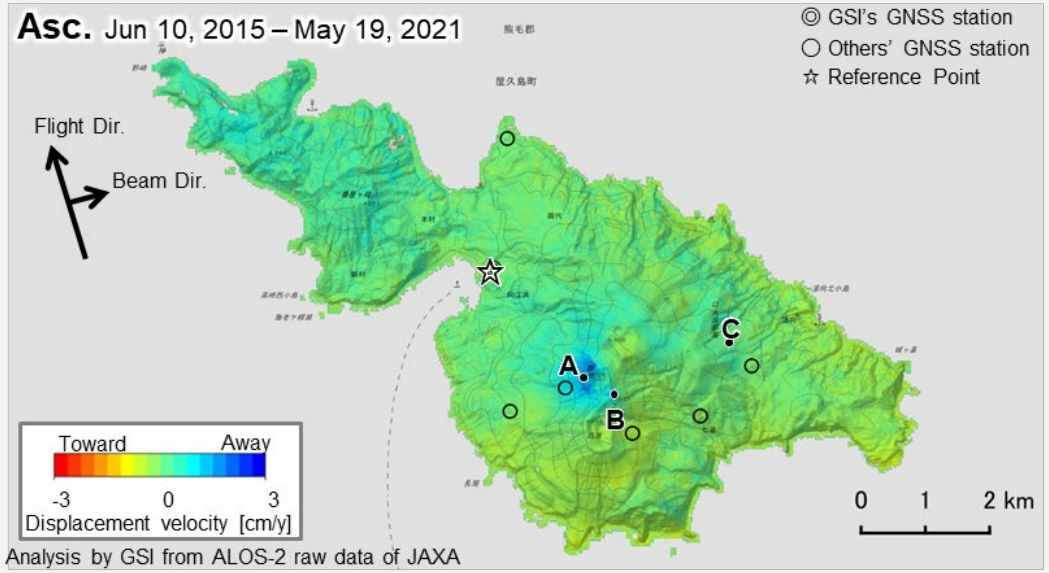
- In order to observe spatio-temporal development of surface displacement that slowly proceeds over the medium to long term, GSI has developed a software for InSAR time series analysis (GSITSA).



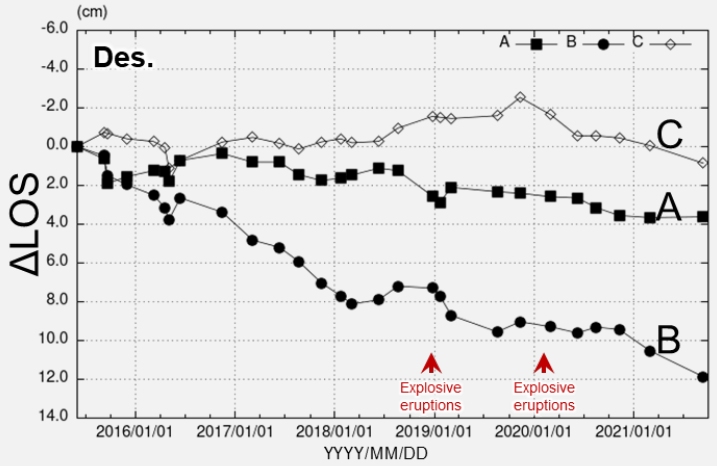
Kuchino-Erabujima Island

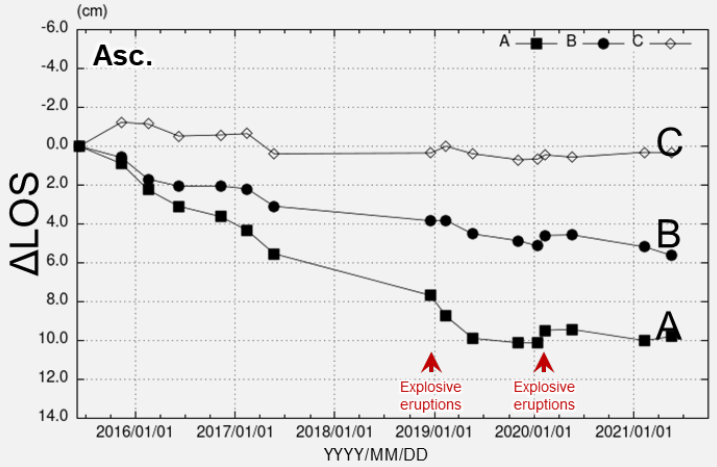
Displacement velocity





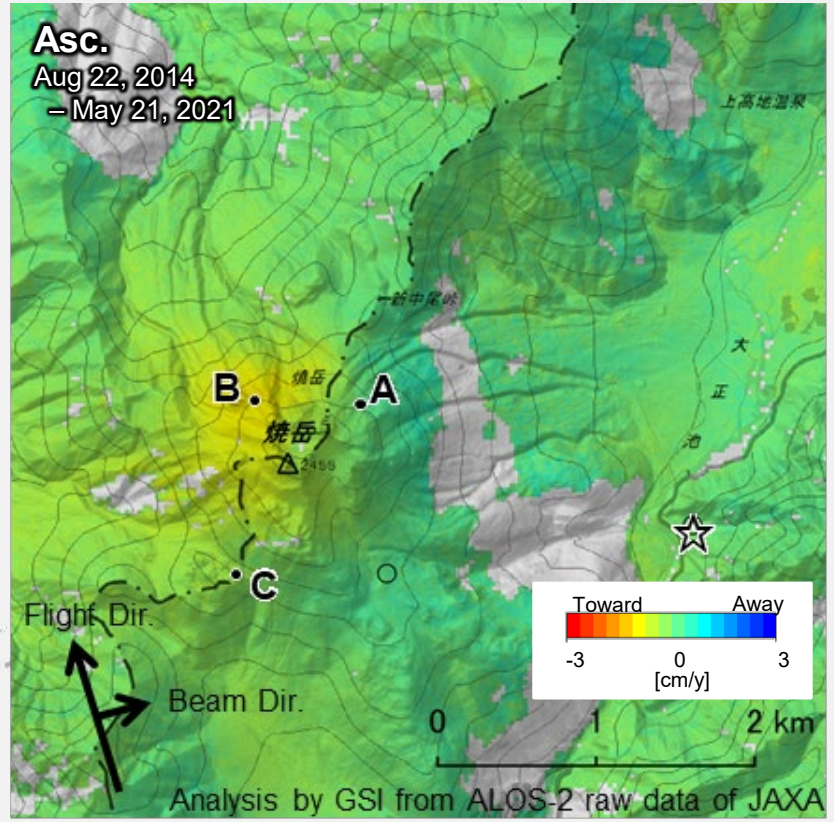
Deformation time series

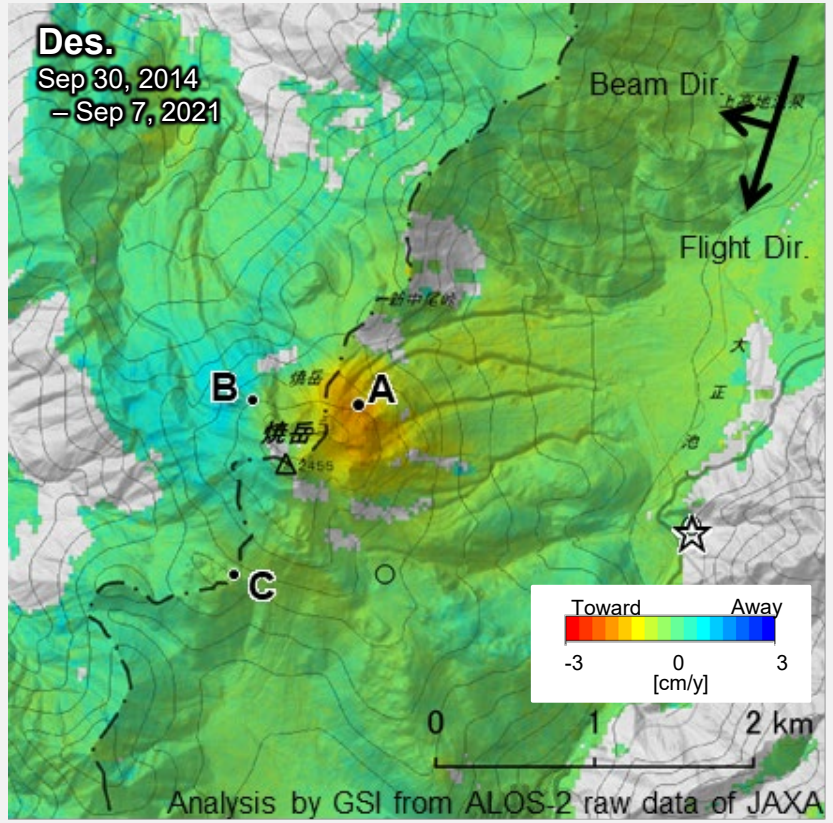


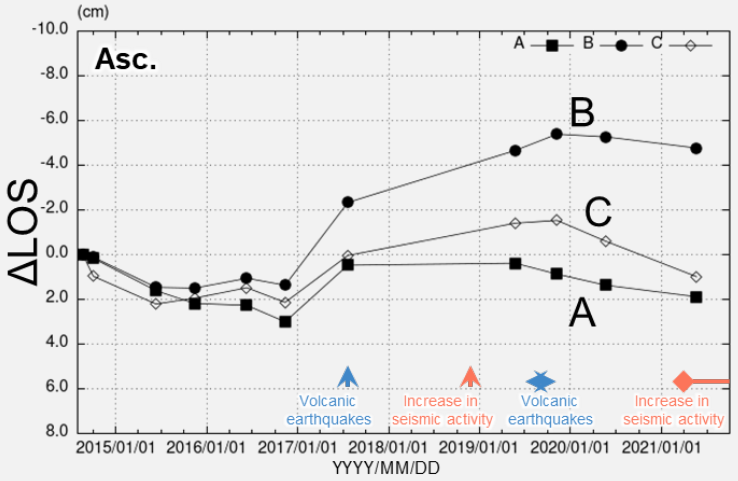


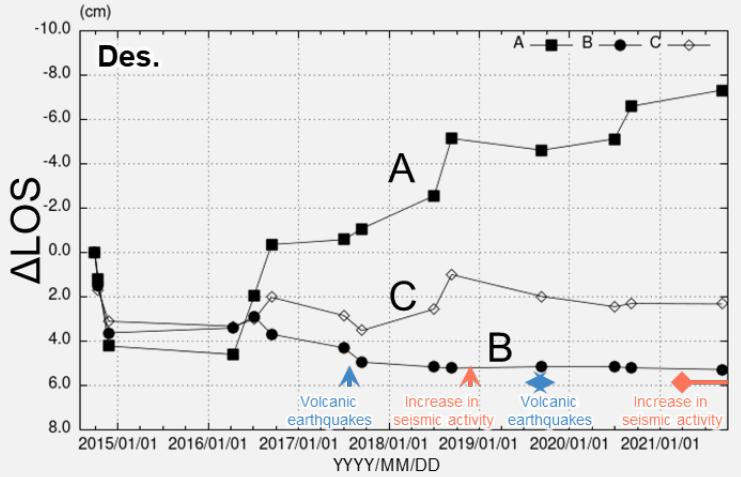
Mt. Yakedake

Displacement velocity









Deformation time series

Contribution to the evaluation of volcanic activities

Coordinating Committee for Prediction of Volcanic Eruptions (CCPVE)

CCPVE was established in 1974.

Missions:

- **Evaluate** volcanic activity for contributing to disaster prevention.
- **Promote** R&D related to prediction of volcanic eruptions.
- **Discuss** a policy of research and observation related to prediction of volcanic eruptions comprehensively.

Members

25 representatives of administrative organizations, universities and other research institutes.

The evaluation of volcanic activities is **released to the public twice a year**.

Comparison of L-band and C-band SAR

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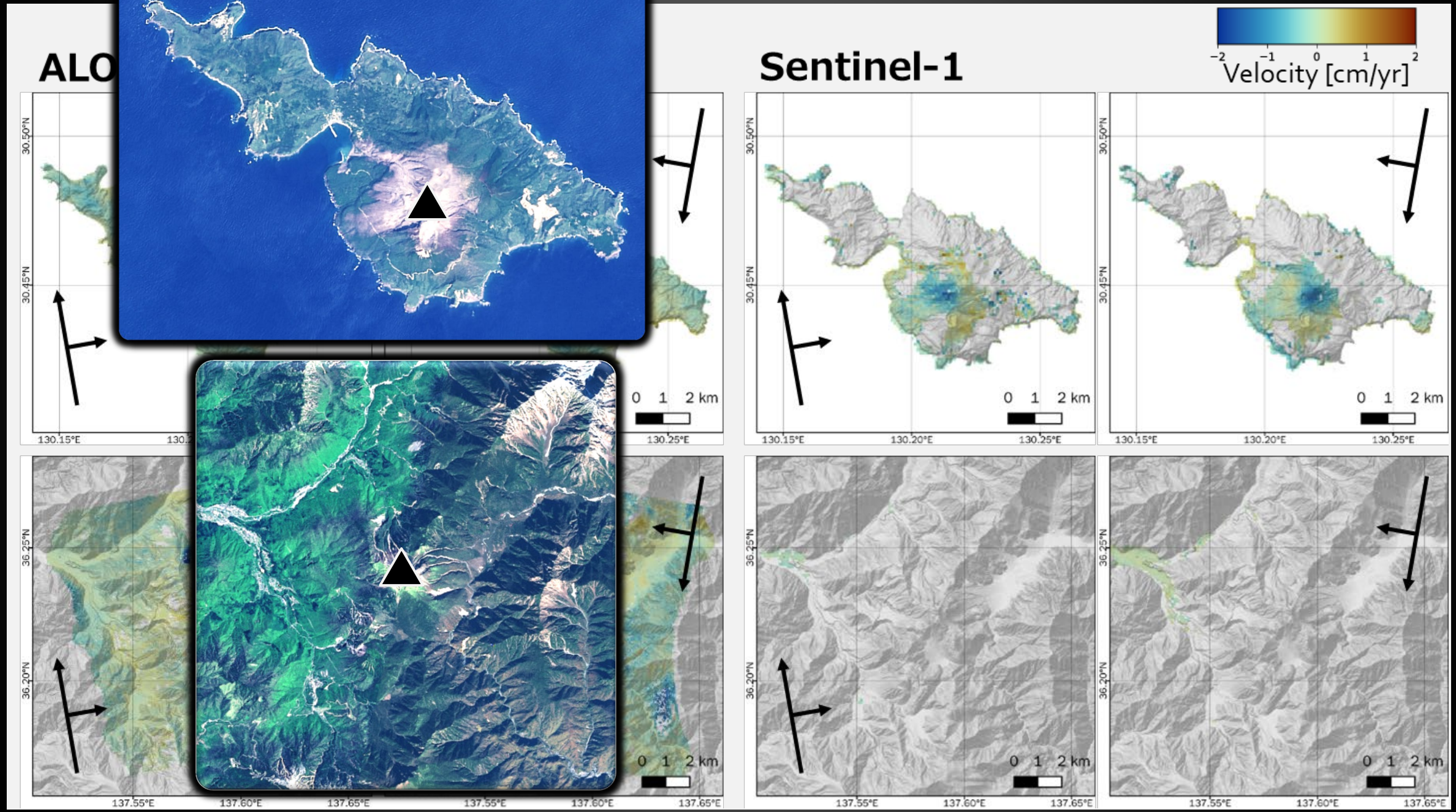
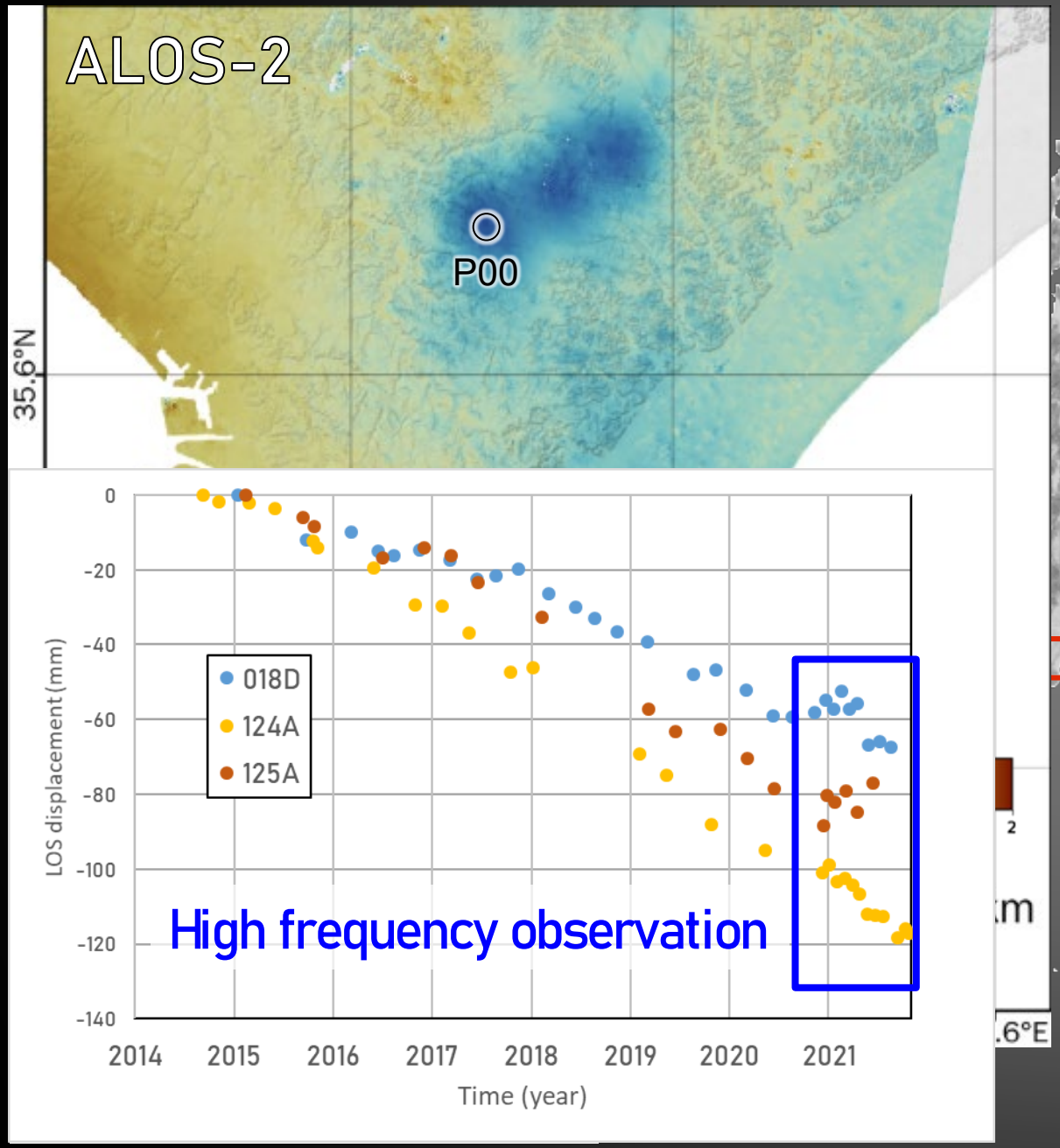
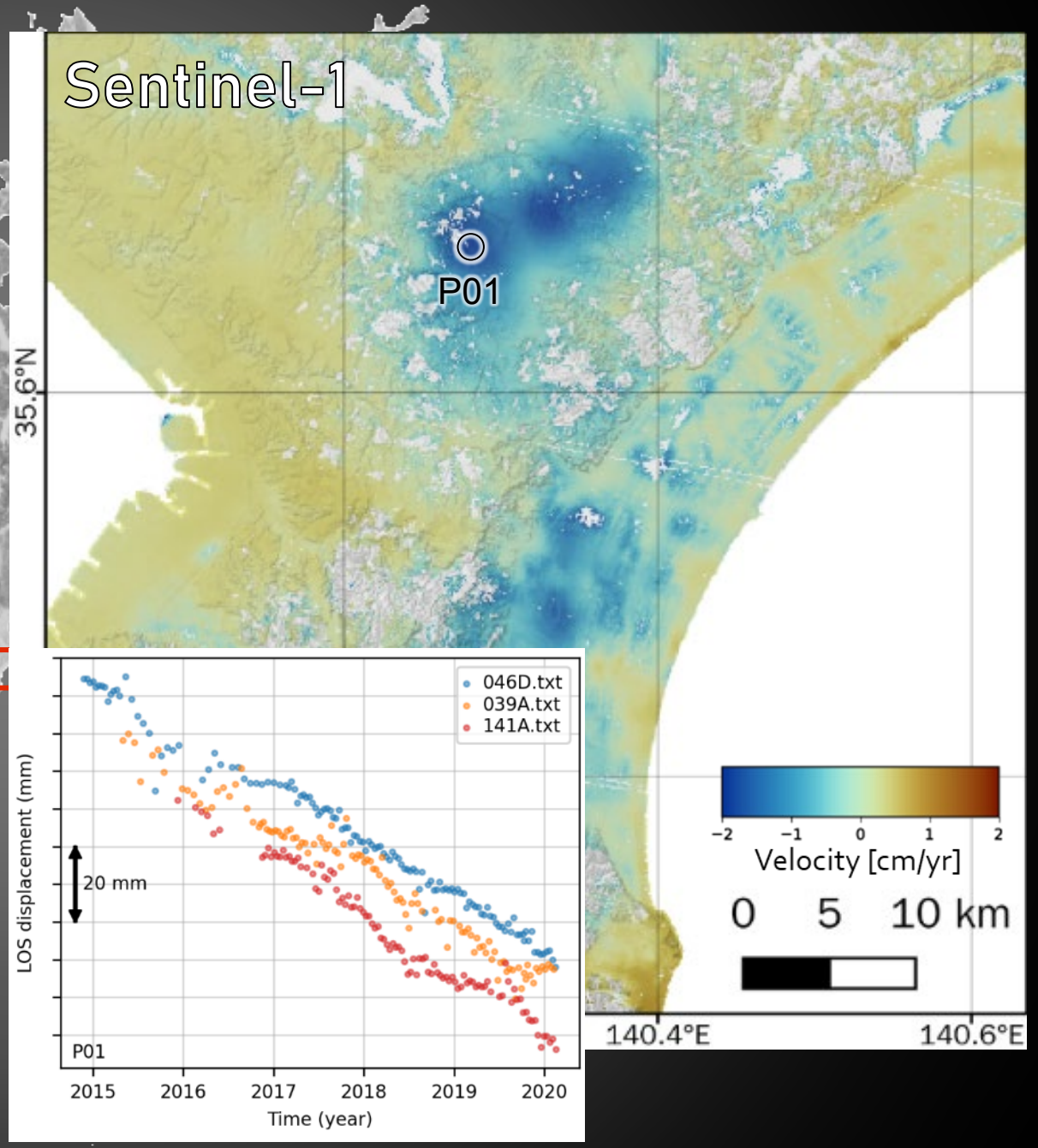
Satellite	ALOS-2	Sentinel-1	ALOS-4
Period of operation	2014-		2022?-
Frequency	L-band	C-band	L-band
Observation (obs. / year)	2-4	15-30	about 20
Short-term Non-linear deformation	-	detectable	detectable

Active volcanoes

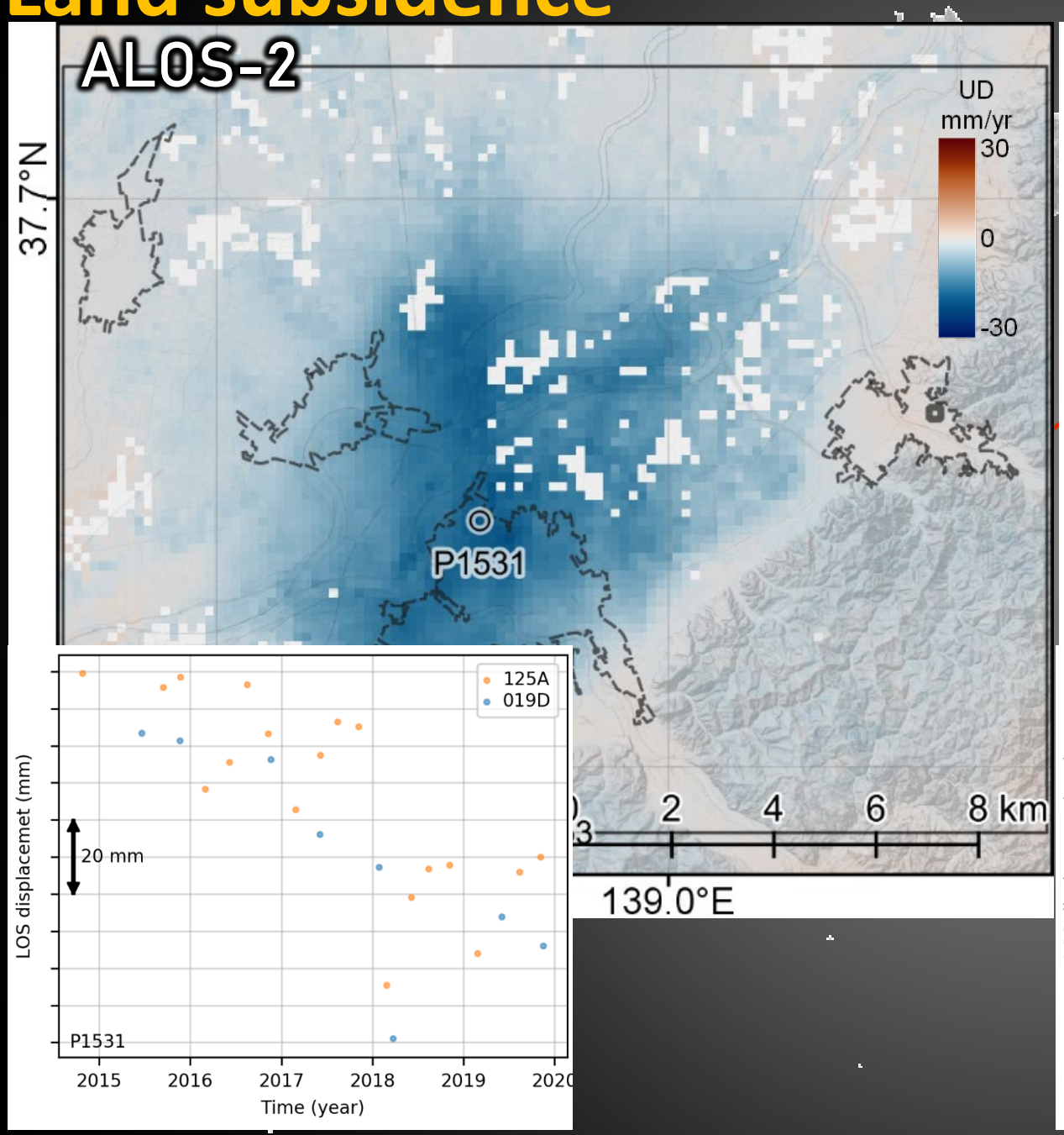


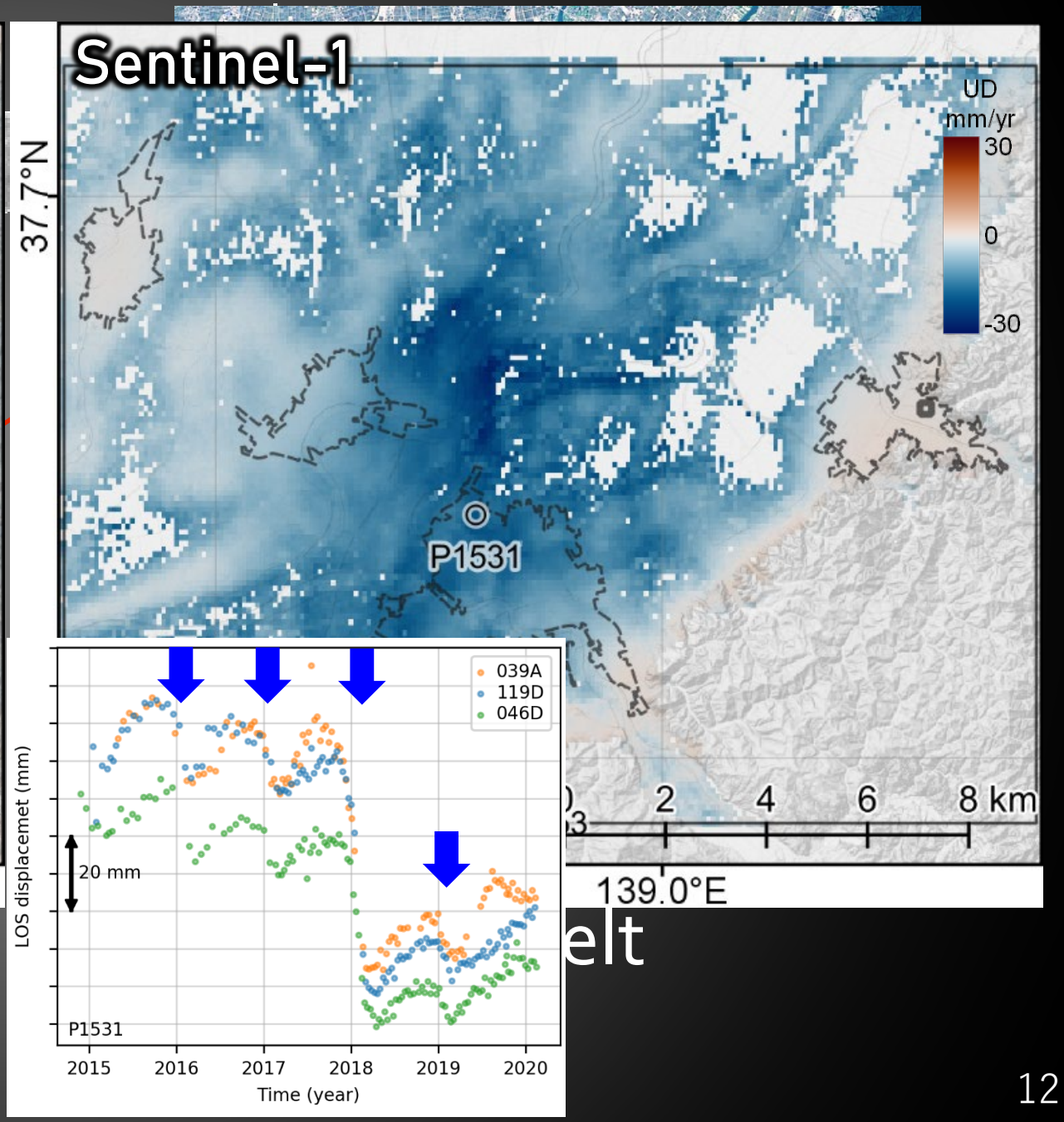
Land subsidence





Land subsidence





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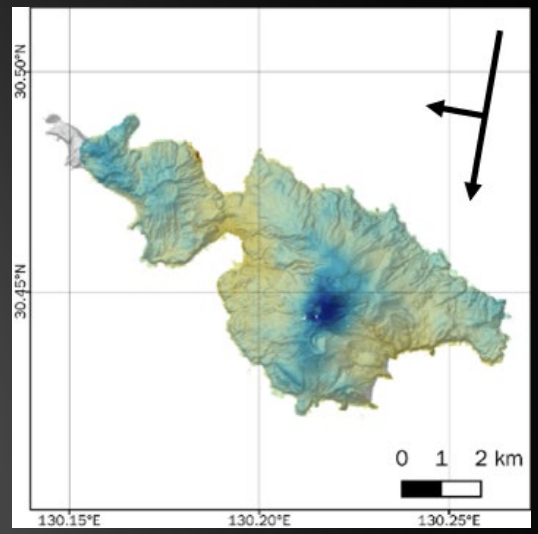
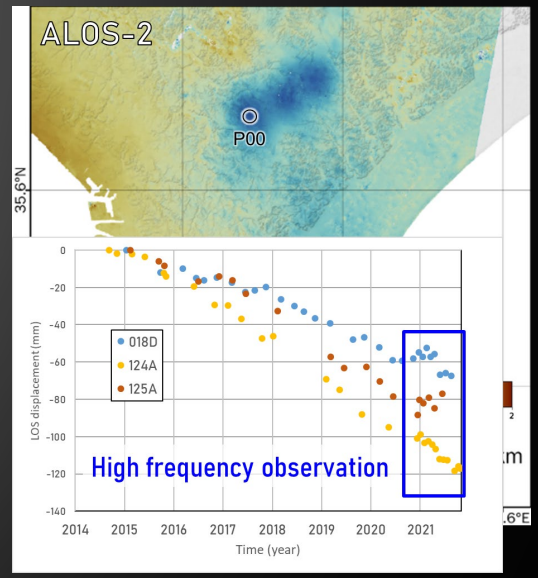
Summary

- GSI has been nationwide monitoring crustal deformation by InSAR of ALOS-2.
- There is Coordinating Committee for Prediction of Volcanic Eruptions (CCPVE) in Japan, which evaluates volcanic activities for disaster prevention.
- L-band SAR is an effective tool for monitoring volcanoes covered with vegetation.
- C-band SAR shows high spatial resolution that is effective for monitoring land subsidence.
- We expect that ALOS-4 will greatly enhance our ability to monitor ground deformation.





Thank you for your attention.

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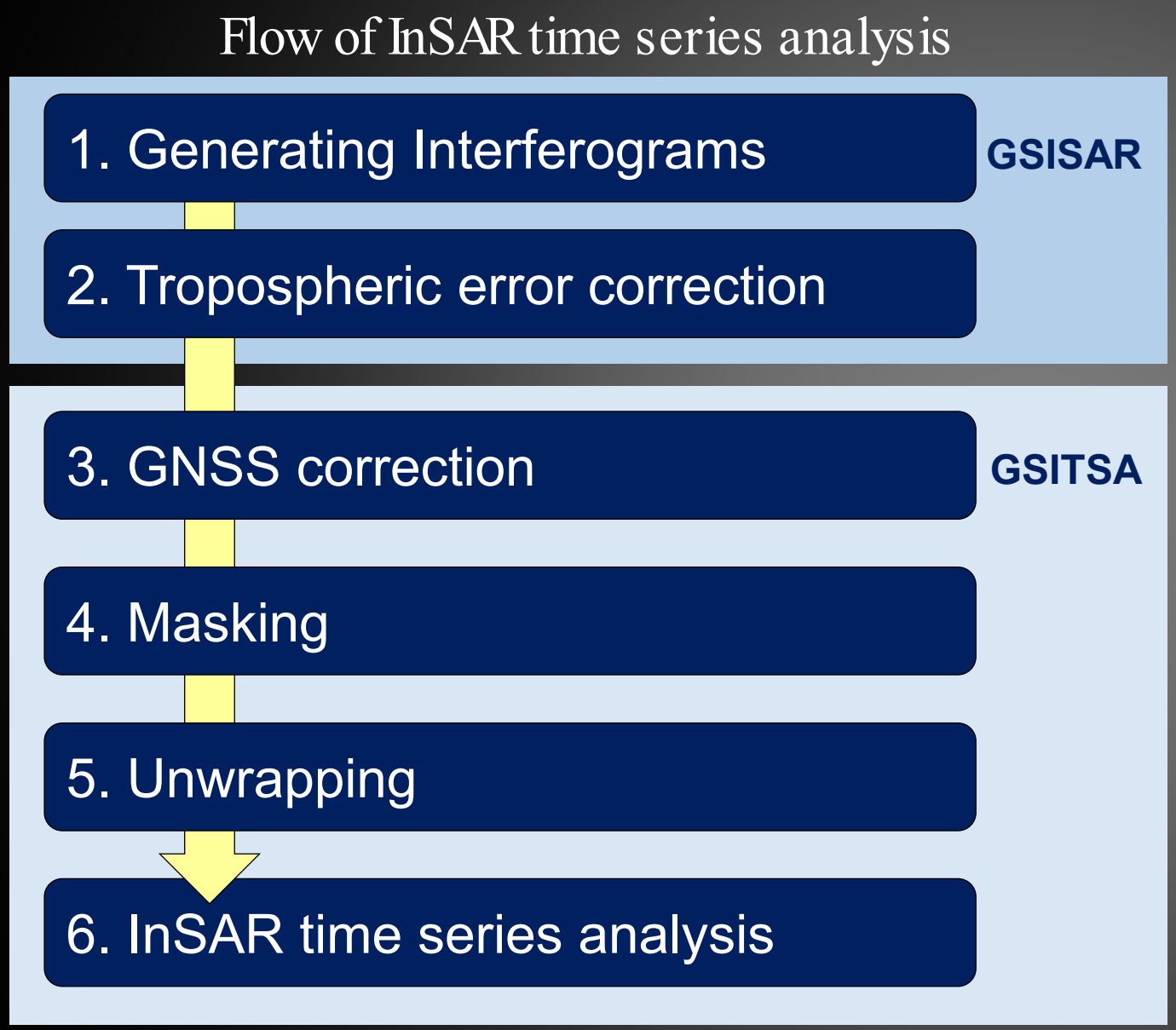
Overview of GSITSA



- ✓ There are several processes to reduce errors.
- ✓ Tropospheric error of each interferogram is estimated using a numerical weather model of JMA.
- ✓ GNSS correction adjusts the InSAR displacement with the nearby CORS displacement.
- ✓ Small Baseline Subset (SBAS) algorithm is implemented for time series analysis.