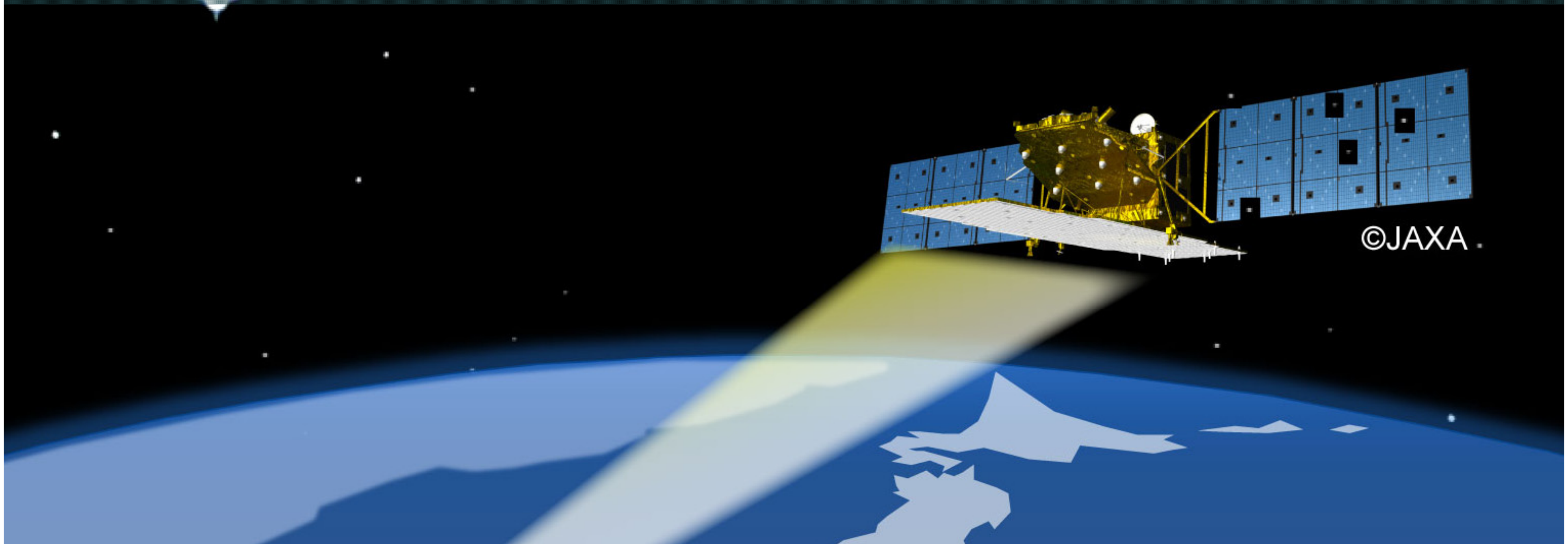
ALOS-2-based observation of crustal deformation associated with large earthquakes



Tomokazu KOBAYASHI

(Geospatial Information Authority of Japan)

ACKNOWLEDGEMENTS: The data analyzed here were provided by the Japan Aerospace Exploration Agency (JAXA) under a cooperative research contract between the Geospatial Information Authority of Japan (GSI) and JAXA

Nov. 01, 2018@6th JPTM

Partnership between GeoSpatial Information Authority of Japan & JAXA

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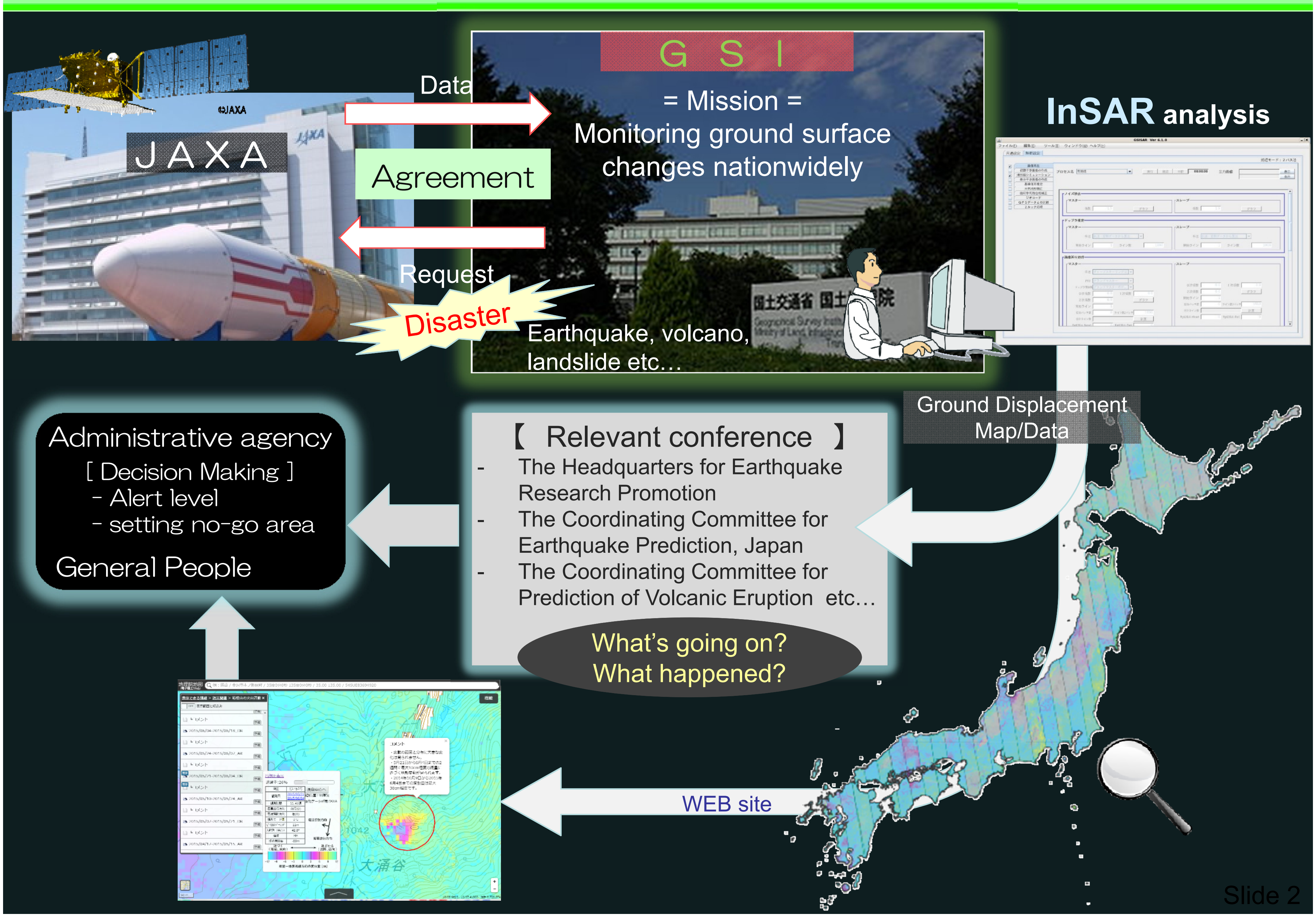
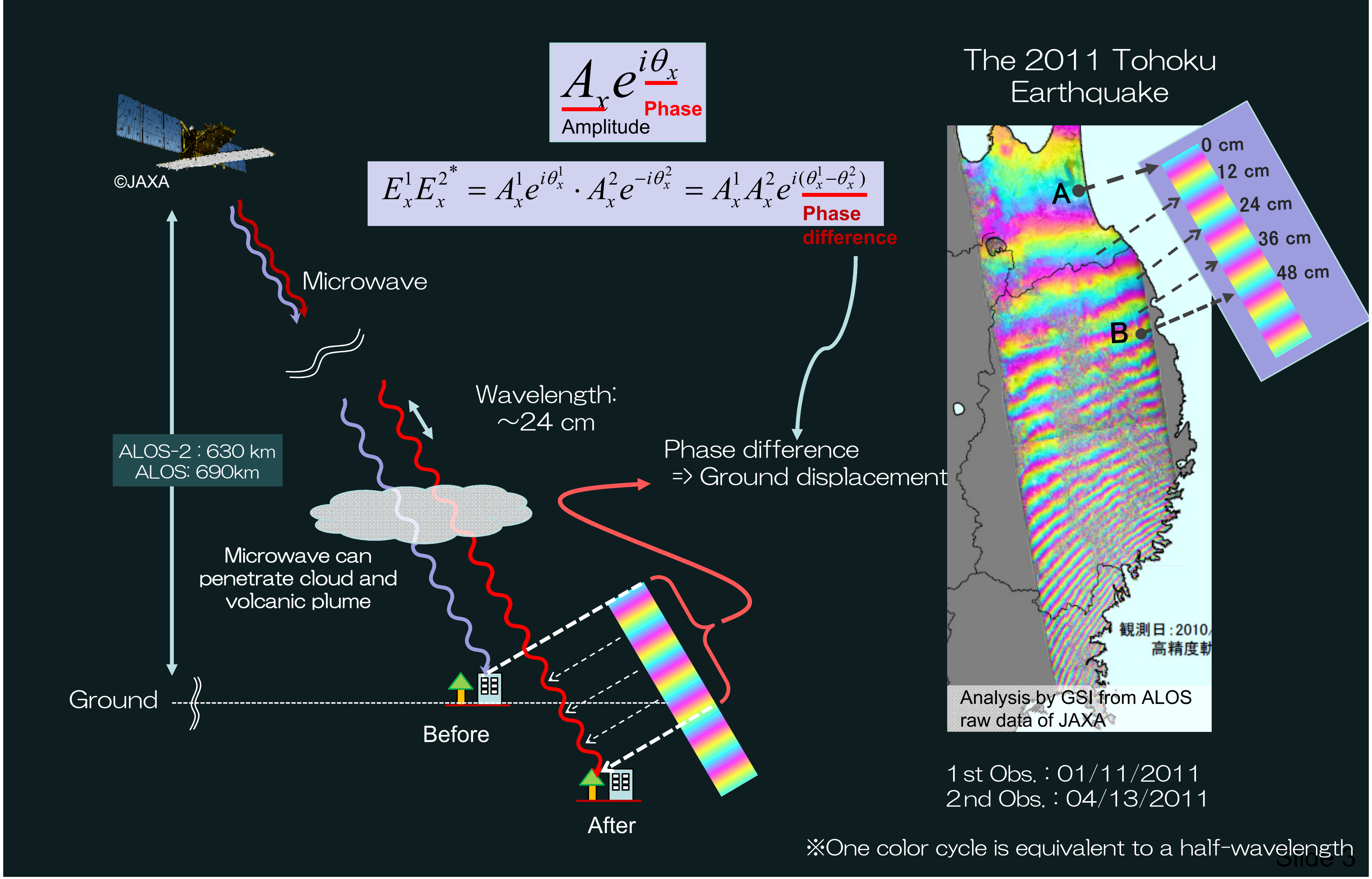


What's InSAR?

InSAR : Measurement technique for crustal deformation observation



Earthquake/Volcano observation by ALOS-2 [2014-]

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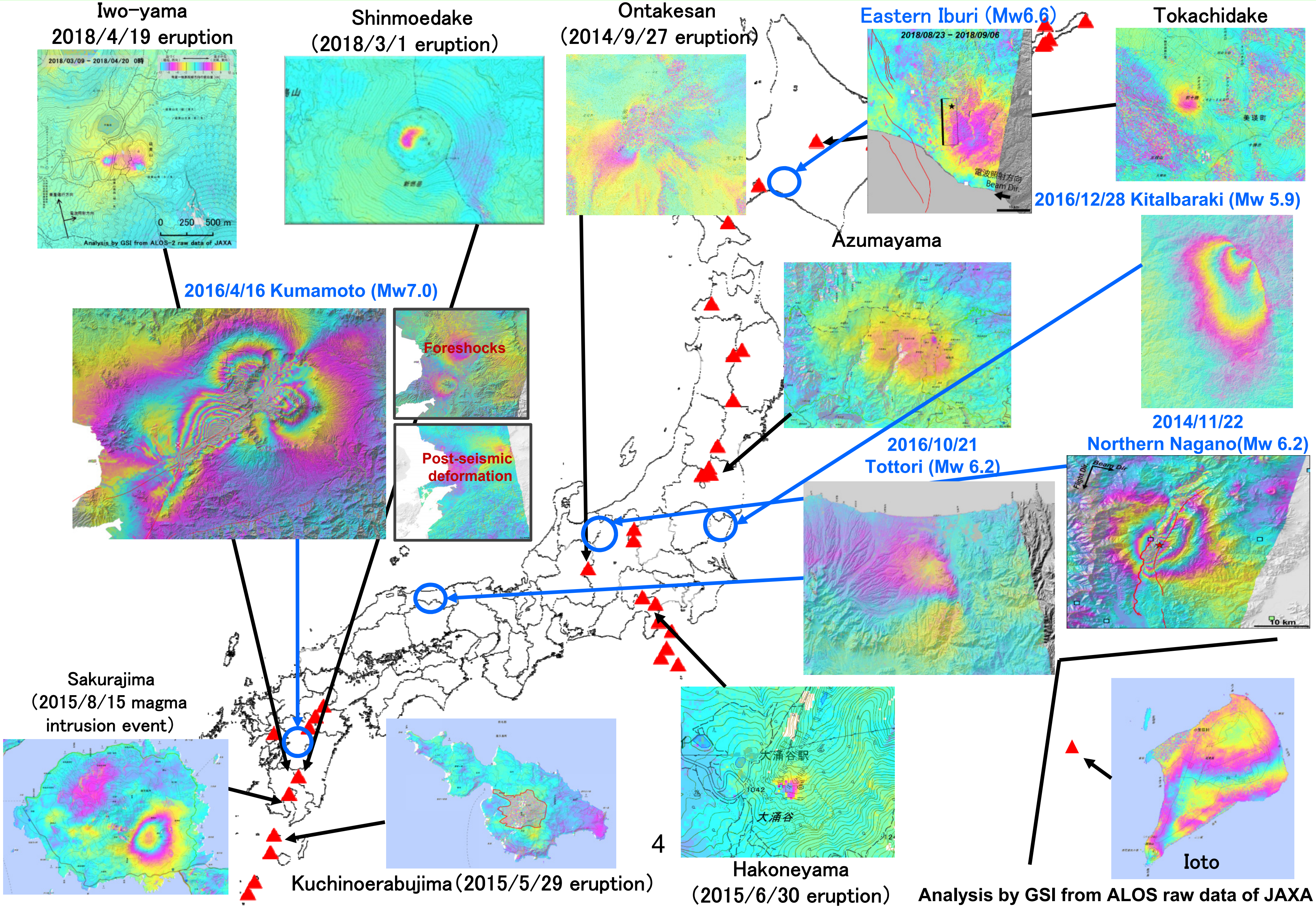

Earthquake/volcano observation by InSAR (ALOS-2) [2014-]

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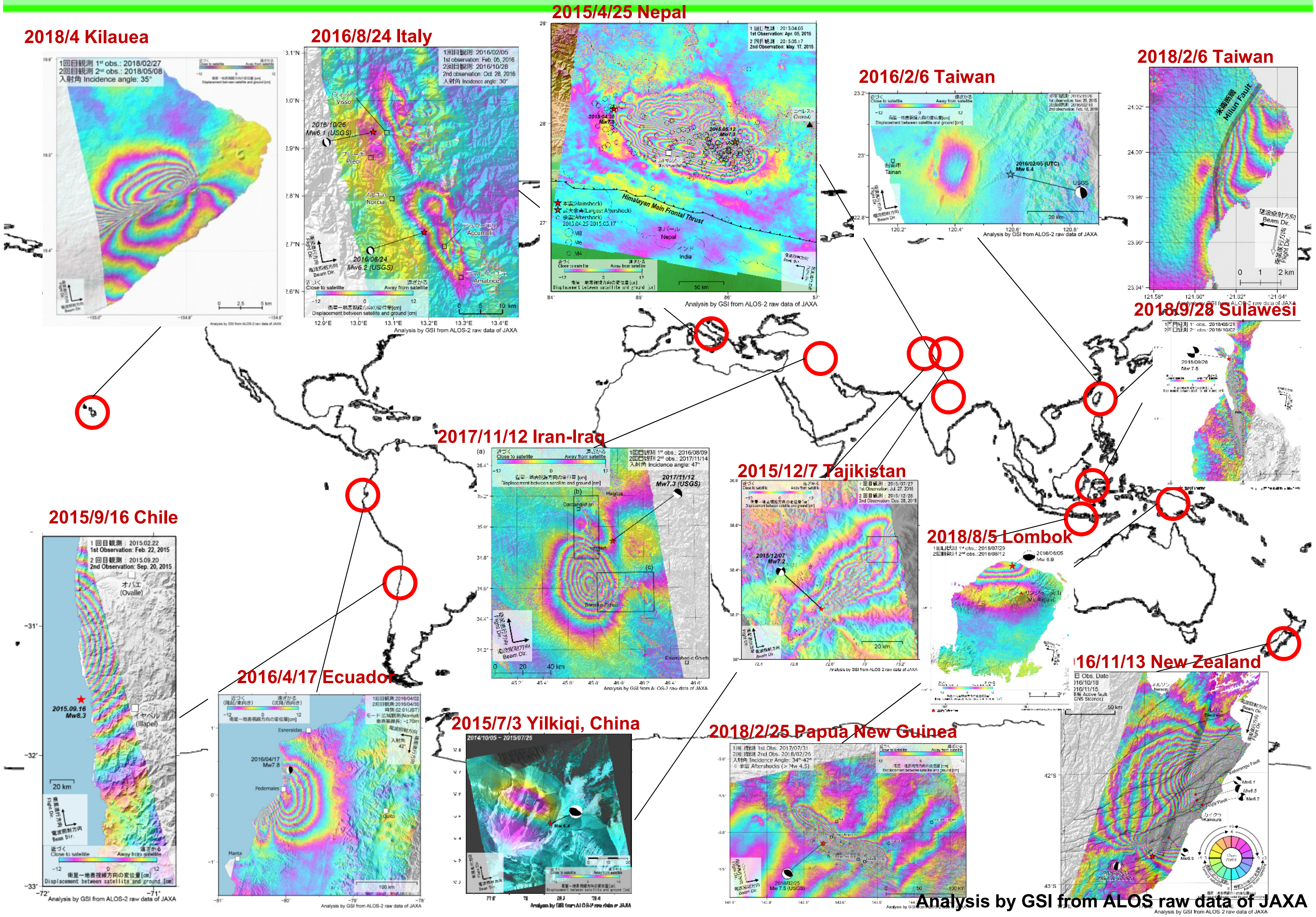

Today's topics

■ Topic 1

Earthquake observation using ALOS-2

through the application to the latest Japanese inland earthquake:

the 2018 Hokkaido Eastern Iburi Earthquake

■ Topic2

Mapping of three-component displacements associated with large earthquake

Application 1: The 2016 Tottori earthquake, Japan

Application 2: The 2016 Kumamoto earthquake

The 2018 Hokkaido Eastern Iburi Earthquake

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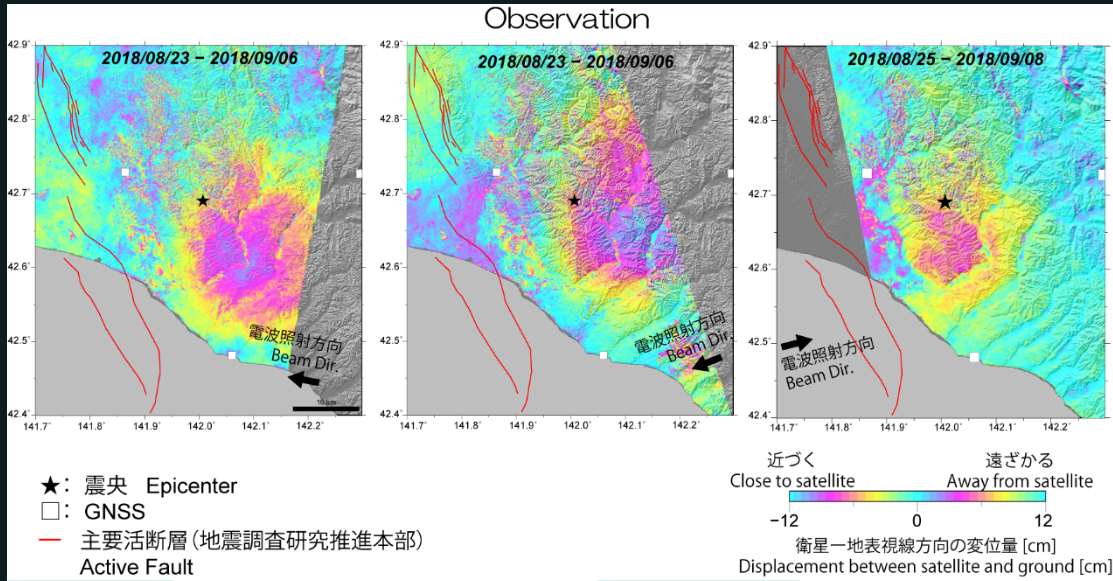
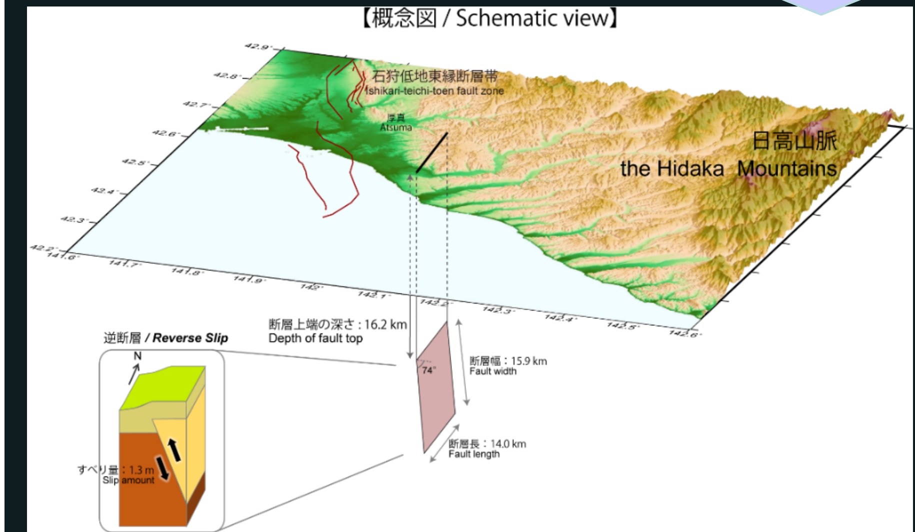
Date: Sep. 6, 2018　Mj6.7　/ Mw6.6
Seismic intensity: 7 (Highest rank)
Depth: 37 km

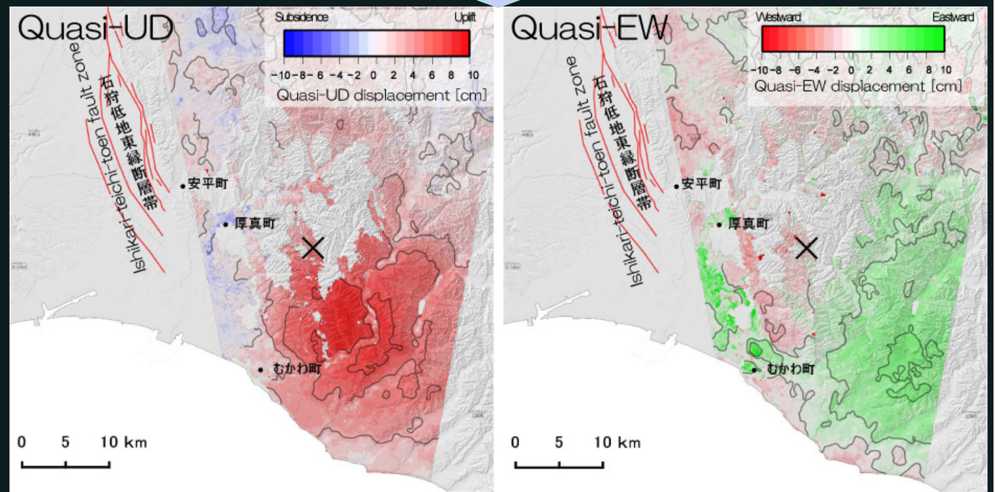


Model Estimate

1-D (LOS)

2-D

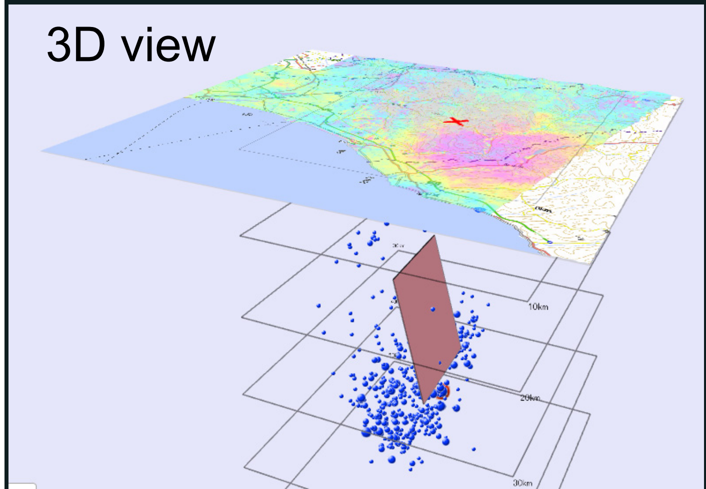


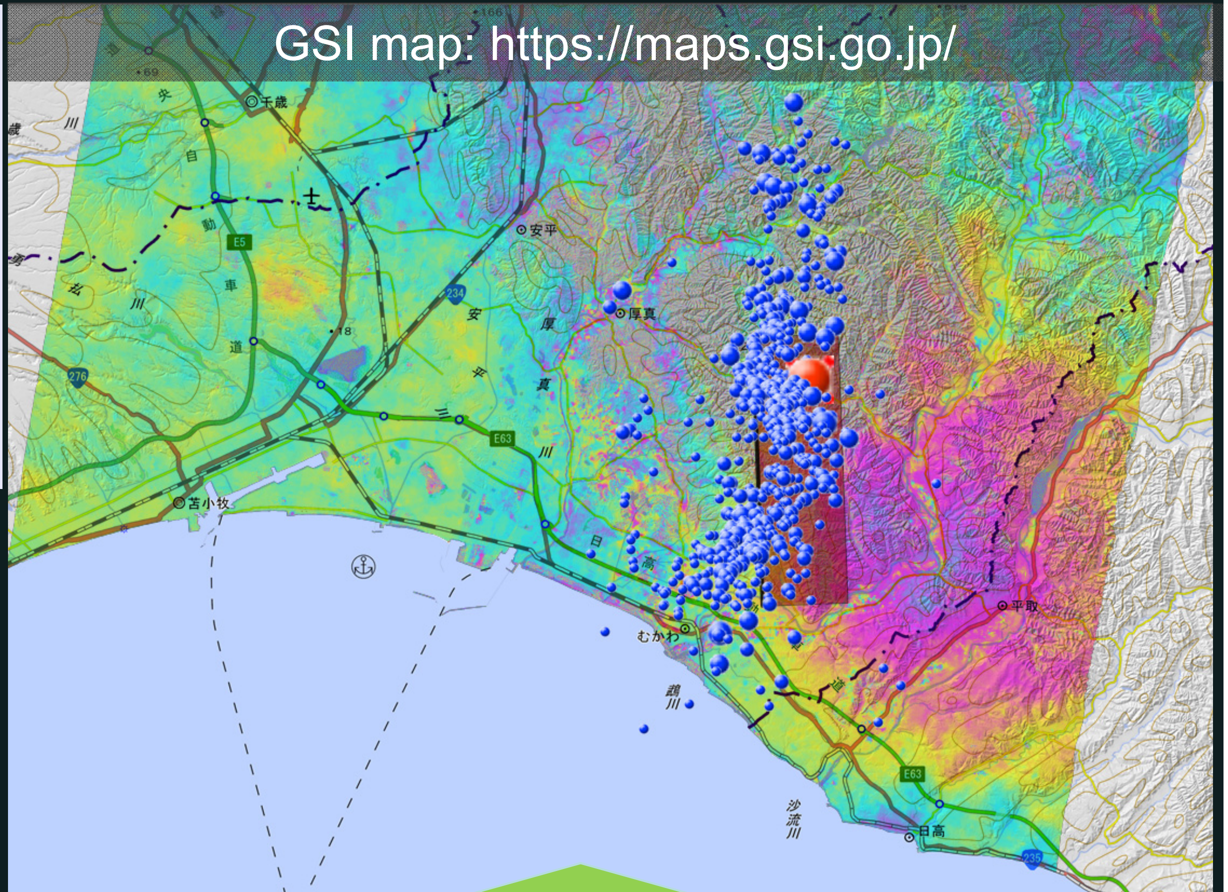


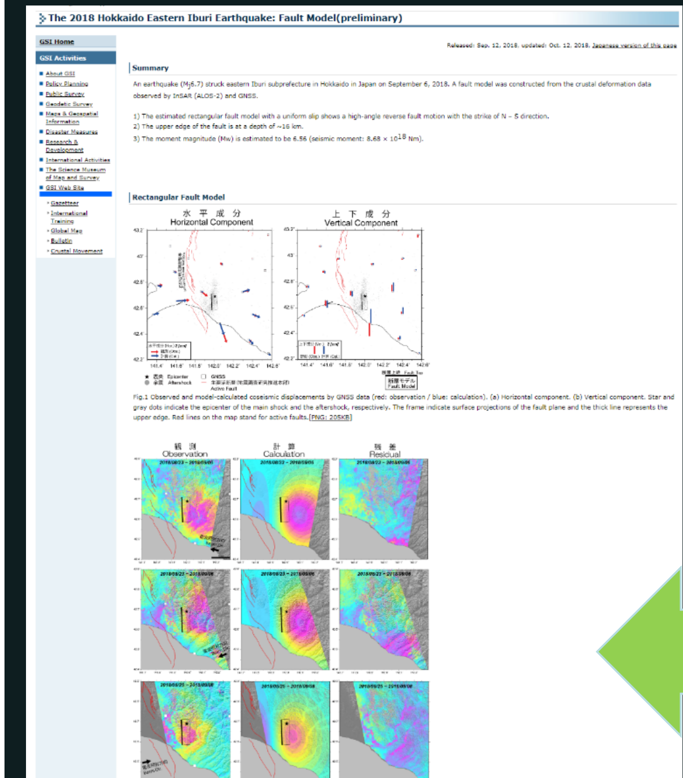
EW & UD: helpful to understand the movements

cf. http://www.gsi.go.jp/cais/topic180912-index-e.html

SAR-derived information on GSI map







The 2018 Hokkaido Eastern Iburi Earthquake: Fault Model(preliminary)

GSI Home

GSI Activities

- About GSI
- Policy Planning
- Public Survey
- Geodetic Survey
- Maps & Geospatial Information
- Disaster Measures
- Research & Development
- International Activities
- The Science Museum of Map and Survey
- GSI Web Site
  - Gazetteer
  - International Training
  - Global Map
  - Bulletin
  - Crustal Movement

Released: Sep. 12, 2018, updated: Oct. 12, 2018, Japanese version of this page

Summary

An earthquake (Mj6.7) struck eastern Iburi subprefecture in Hokkaido in Japan on September 6, 2018. A fault model was constructed from the crustal deformation data observed by InSAR (ALOS-2) and GNSS.

1) The estimated rectangular fault model with a uniform slip shows a high-angle reverse fault motion with the strike of N – 5 direction.
2) The upper edge of the fault is at a depth of ~16 km.
3) The moment magnitude (Mw) is estimated to be 6.56 (seismic moment: 8.68×10^{18} Nm).

Rectangular Fault Model

水平成分 Horizontal Component

上下成分 Vertical Component

Fig.1 Observed and model-calculated coseismic displacements by GNSS data (red: observation / blue: calculation). (a) Horizontal component. (b) Vertical component. Star and gray dots indicate the epicenter of the main shock and the aftershock, respectively. The frame indicate surface projections of the fault plane and the thick line represents the upper edge. Red lines on the map stand for active faults.[PNG: 205KB]

観測 Observation

計算 Calculation

残差 Residual

You can superimpose various information such as fault model

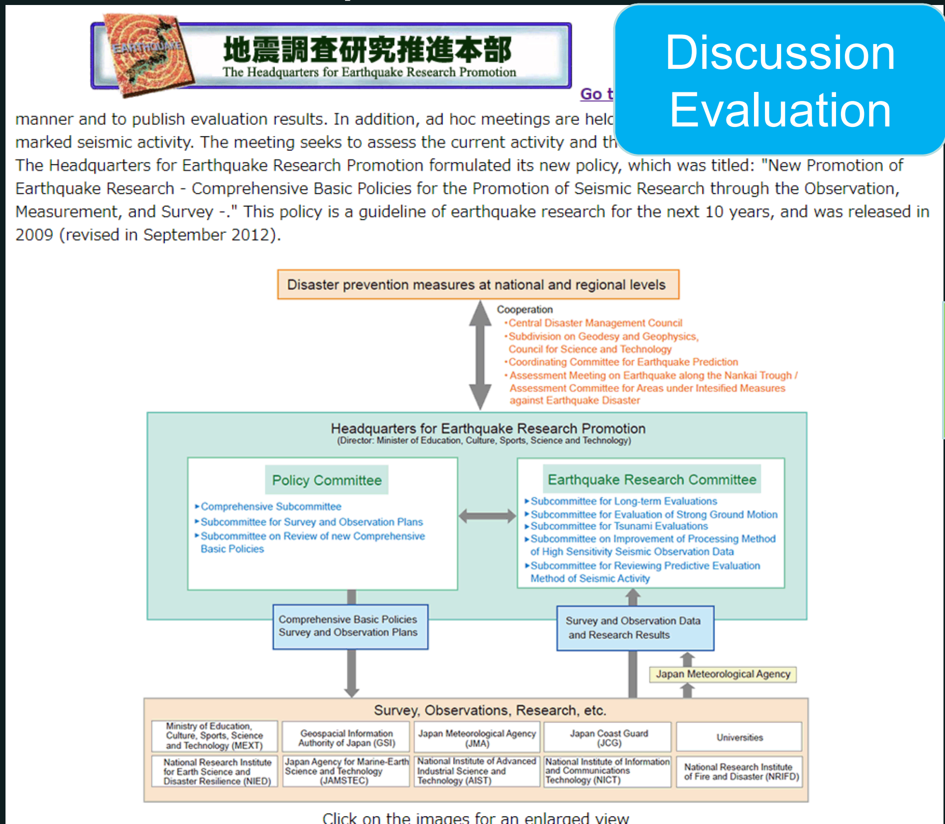
Web site for the fault model

http://www.gsi.go.jp/cais/topic180912-index-e.html

Contribution to official evaluation

国土地理院

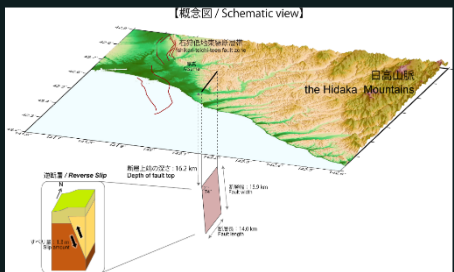
The Headquarters for Earthquake Research Promotion
Earthquake Research Committee

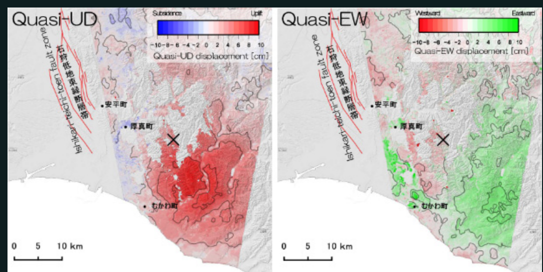


Discussion Evaluation

https://www.jishin.go.jp/main/index-e.html

Report





Official evaluation

平成３０年１０月１２日
地震調査研究推進本部
地震調査委員会

平成 30 年北海道胆振東部地震の評価

○ 2018 年９月６日 03 時 07 分に北海道胆振地方中東部の深さ約 35km でマグニチュード(M)6.7 の地震が発生した。この地震により胆振地方で最大震度７を観測し、被害を伴った。この地震の発震機構は東北東－西南西方向に圧力軸を持つ逆断層型で、陸のプレート内で発生した地震である。

○ その後の地震活動は、M6.7 の地震の震源を含む南北約 30km の領域で、減衰しつつも活発な状態が継続している。９月６日 06 時 11 分と 10 月５日 08 時 58 分に発生した地震により最大震度５弱を観測したほか、10 月 12 日 10 時までに最大震度４を観測した地震が 20 回発生するなどしている。10 月 12 日 10 時までの最大規模の地震は、９月６日 03 時 20 分に発生した M5.5 の地震である。

○ 今回の地震に伴い、安平（あびら）町の K-NET 追分観測点で 1796gal（三成分合成）など、大きな加速度を観測した。

SAR-derived results

○ ＧＮＳＳ観測の結果では、地震に伴って、日高町の門別（もんべつ）観測点が南に約5cm、苫小牧市の苫小牧観測点が東に約4cm移動するなどの地殻変動が観測された。また、陸域観測技術衛星２号「だいち２号」の合成開口レーダー干渉解析の画像によると、震央周辺で最大約 7cm（暫定値）の隆起及び、隆起域の東側で最大約 4cm（暫定値）の東向きの地殻変動が観測された。

○ 胆振地方東部・日高地方から浦河沖の周辺では、陸域で通常発生する地殻内の地震よりも深い場所でも地震が多く発生している特徴が見られ、今回の地震活動はこのような特徴がある地域で発生したものである。

○ 地震活動の分布や地殻変動などから、今回の地震の震源断層上端の深さは 15km 程度にまで達している可能性がある。また、地震活動が続いている場所の西側の地表付近では、石狩低地東縁断層帯が南北方向に延びている。

○ 地震活動は減衰しつつも活発な状態が継続しており、10 月に入ってからも最大震度５弱を観測する地震が発生している。一連の活動は当分続くので、注意が必要である。

注：ＧＮＳＳとは、ＧＰＳをはじめとする衛星測位システム全般をしめす呼称である。
　K-NET とは、国立研究開発法人防災科学技術研究所が整備した強震観測網である。

https://www.static.jishin.go.jp/resource/monthly/2018/20180906_iburi_3.pdf

ALOS-2 data contribute to official comprehensive evaluation of survey results for the earthquake

Today's topics

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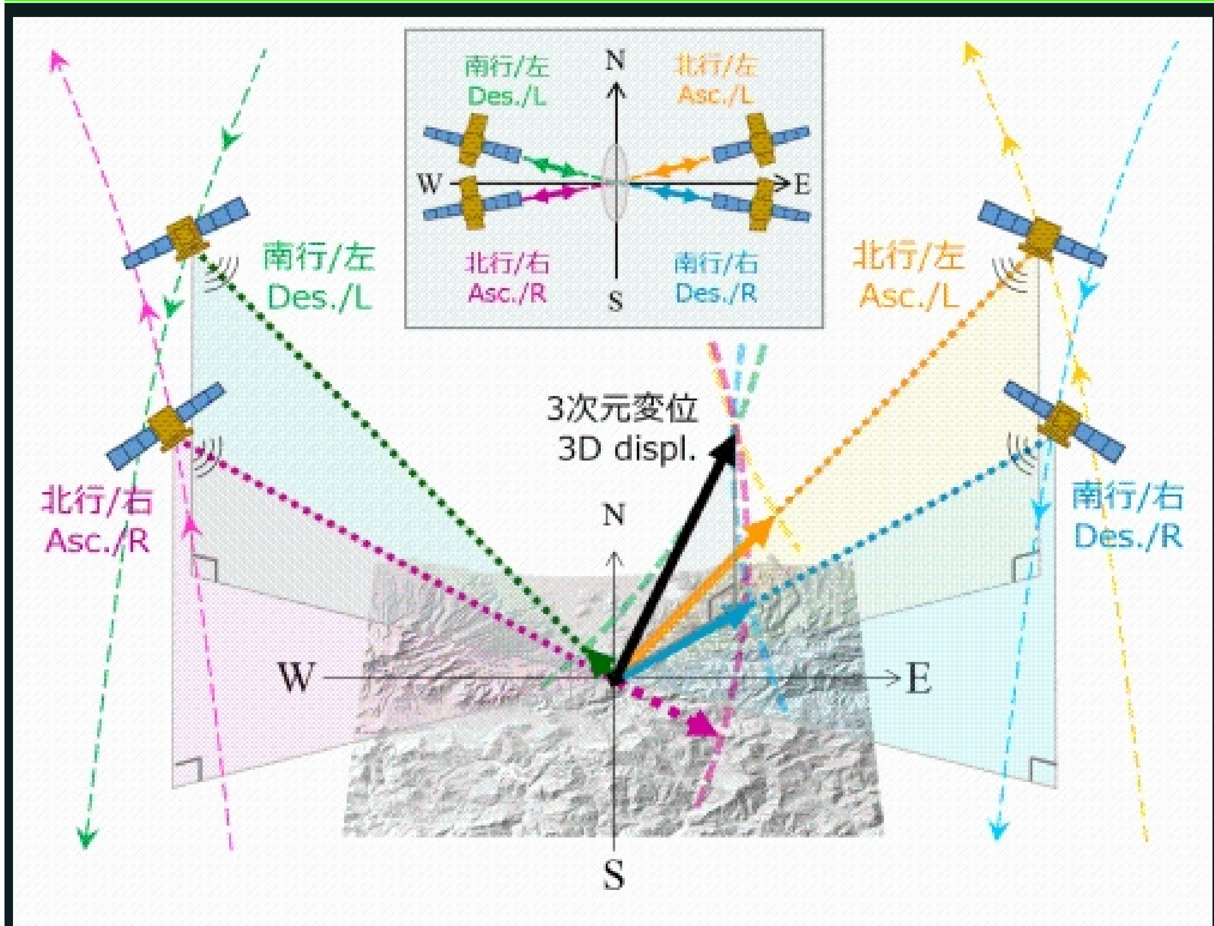
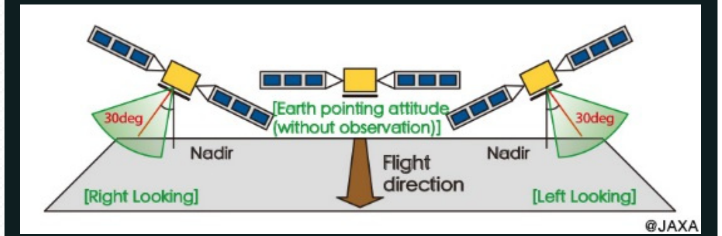
Use of both Right- & Left-looking modes



http://www.gsi.go.jp/cais/topic161027-index.html



ALOS-2 possesses the capability of both right- and left-looking.

ALOS-2 can provide images from four directions

1) Ascending orbit + Right-looking
2) Ascending orbit + Left-looking
3) Descending orbit + Right-looking
4) Descending orbit + Left-looking

Least Squares Method

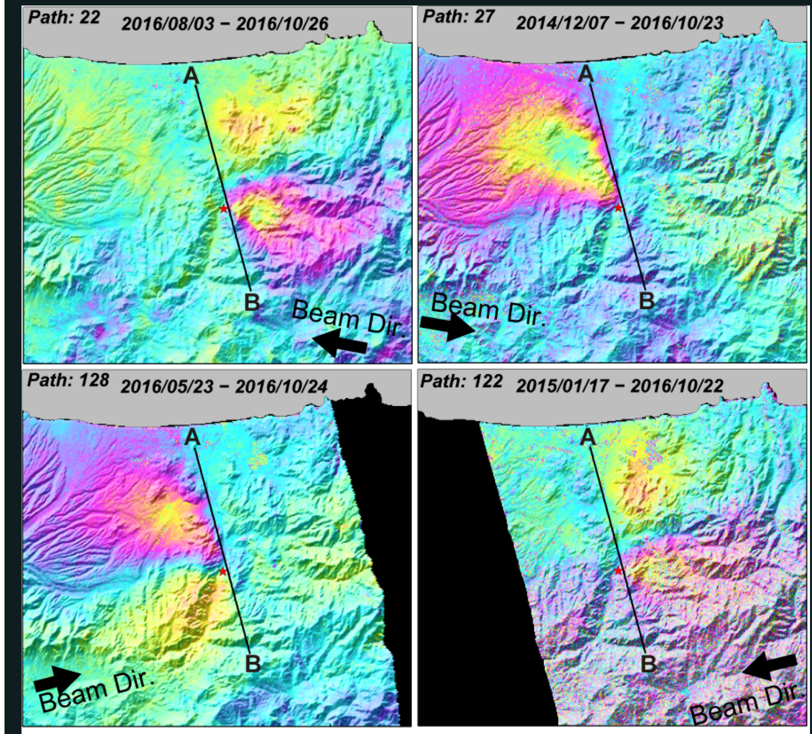
3 components

EW, NS, UD

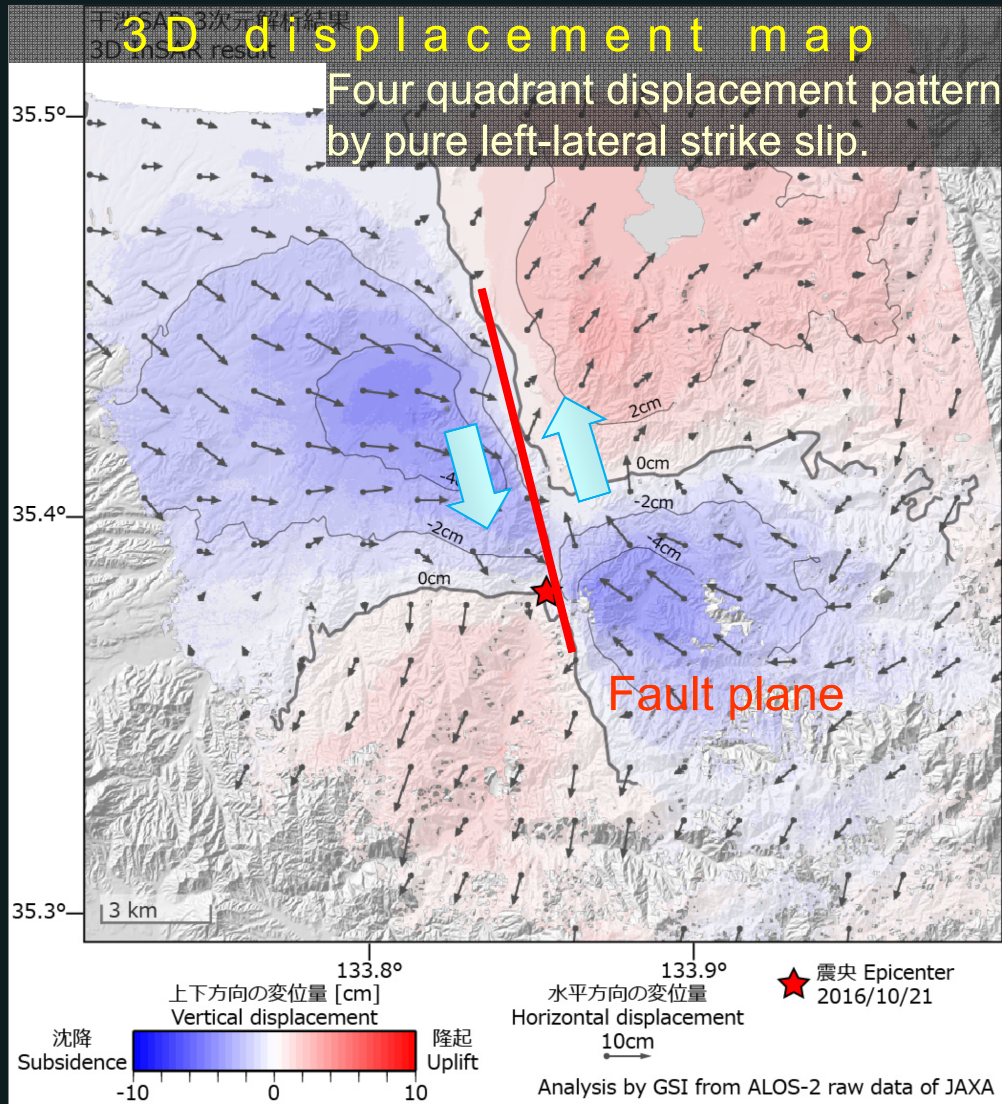
3D displacement map: The 2016 Central Tottori Earthquake

Full 3D coseismic displacement field was retrieved from four independent SAR interferograms with different observing directions

Interferograms



Date: October 21, 2016
Magnitude: Mw6.2
Depth: 11 km
Mechanism: Left-lateral fault slip



http://www.gsi.go.jp/cais/topic161027-index.html

3D displacement map = the 2016 Kumamoto earthquake =

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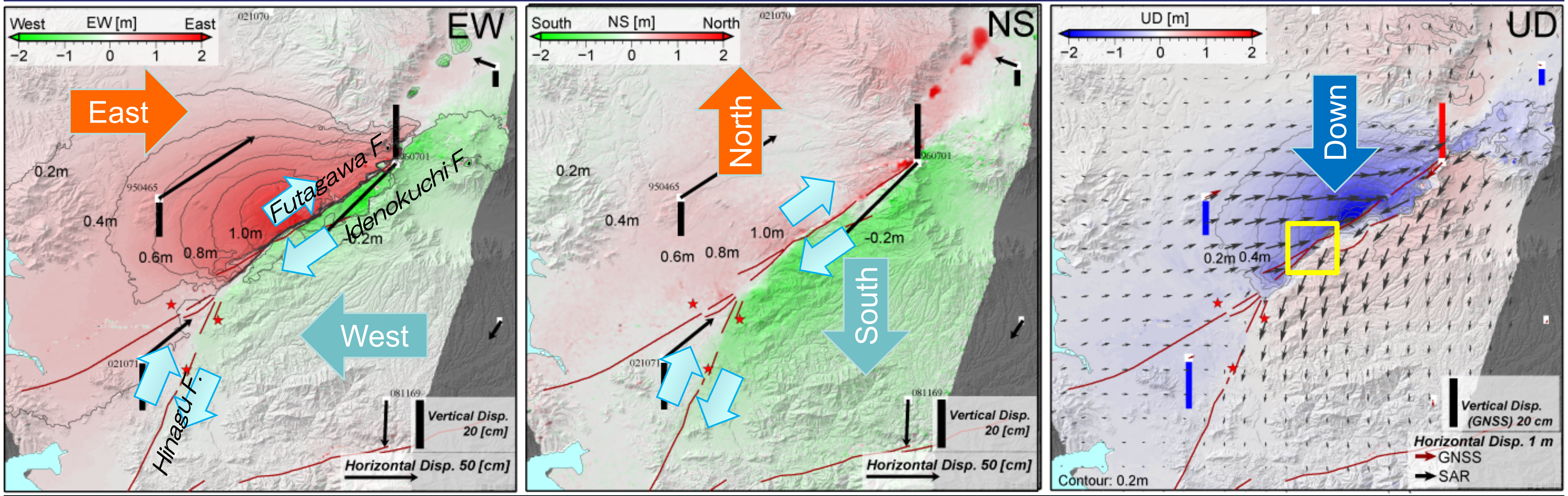
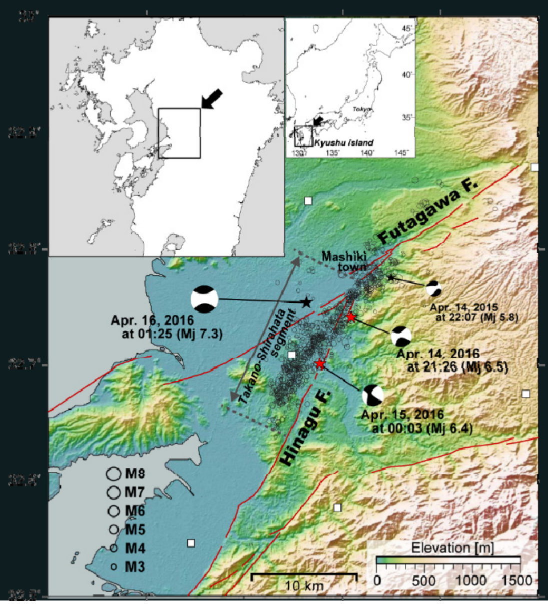
SAR-derived 3D displacement map



Kobayashi (2018)

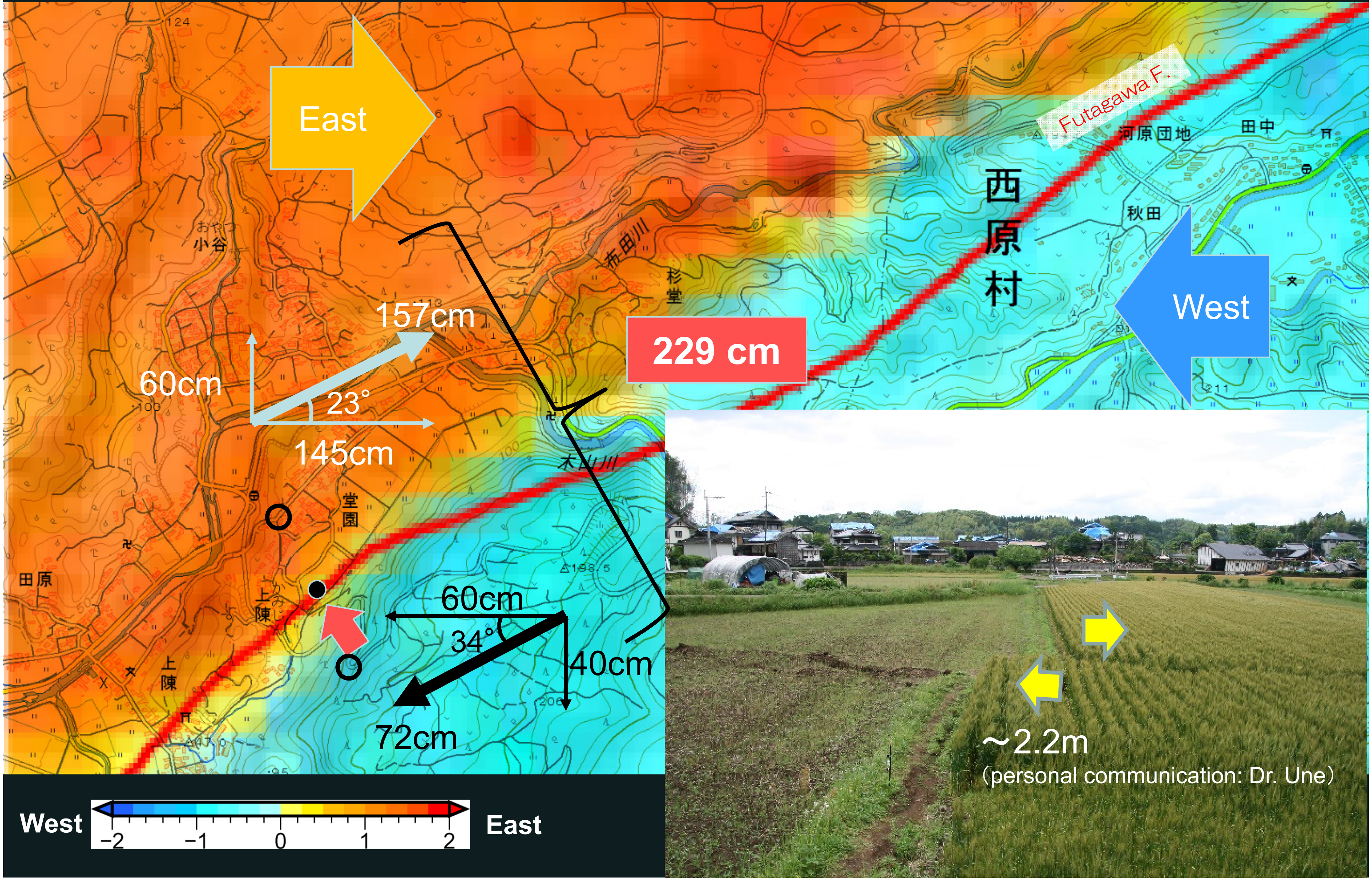


The 2016 Kumamoto earthquake

- Main shock: Mw7.0
- Foreshocks: Mw6.2, 6.0
- Futagawa & Hinagu faults
- Right lateral + normal dip motions

Comparison with field survey result

EW



Summary

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1. We (GSI) are monitoring ground deformation nationwidely with ALOS-2-based InSAR.

2. Once an earthquake occur, we emergently conduct InSAR analysis using ALOS-2, and
   - 2-1. construct fault model to know the fault location and the mechanism.
   - 2-2. report the analysis results to the relevant organizations.
   - 2-3. publish the SAR-derived information on our web site.

3. We retrieve not only LOS component displacement but also full 3-D coseismic displacement field.

   We successfully mapped the 3-D displacement for the 2016 Central Tottori Earthquake and the 2016 Kumamoto earthquake, which are helpful to know the fault-related ground motions.

⇒ Satellite operation/strategy for achievement of observations with different view angles will be more important to improve ground displacement monitoring.