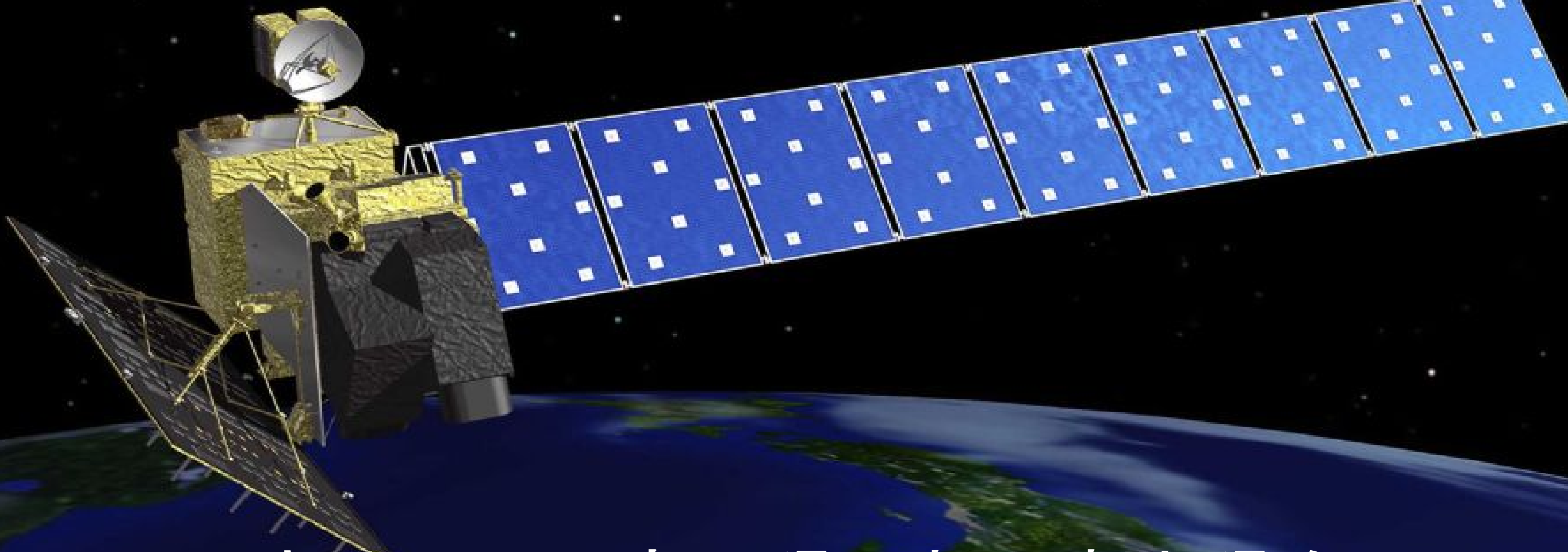
InSARによる2007年中越沖地震に伴う地殻変動の観測と断層モデル



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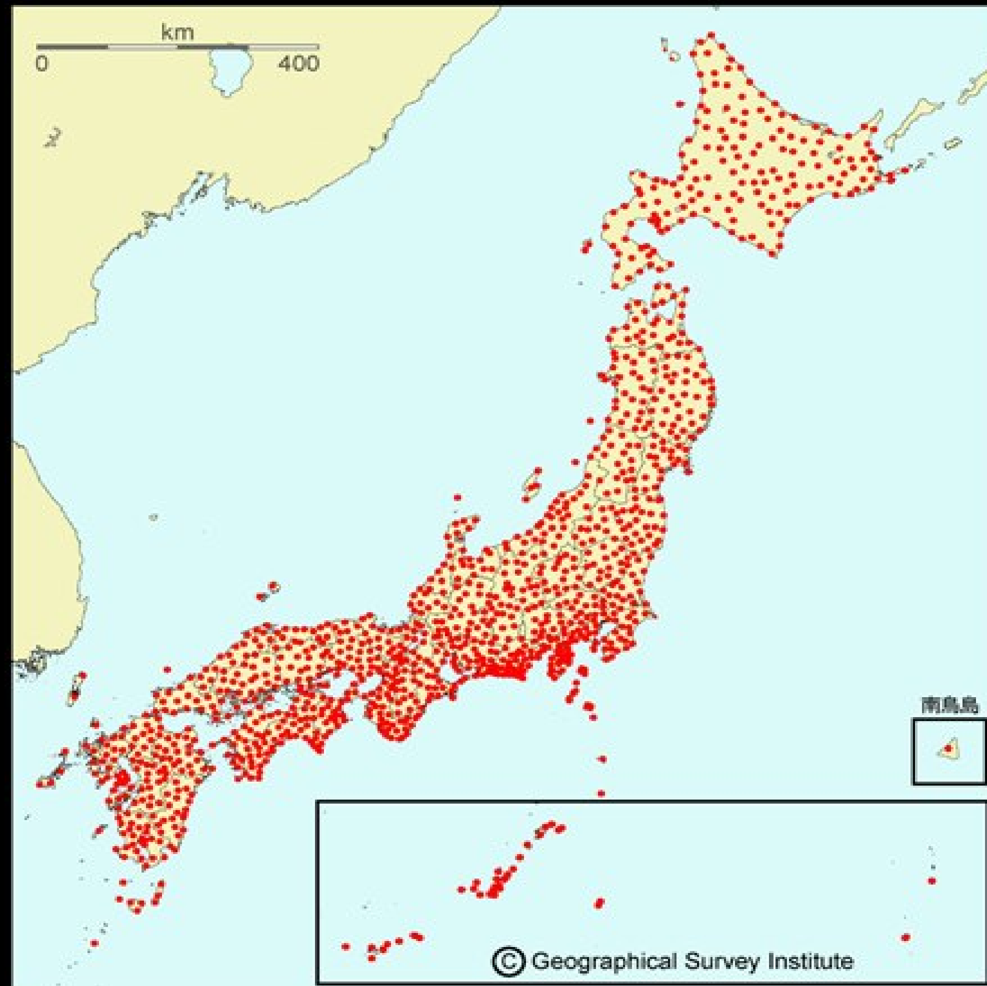
2. 東京大学 地震研究所

Dense GPS network, “GEONET”

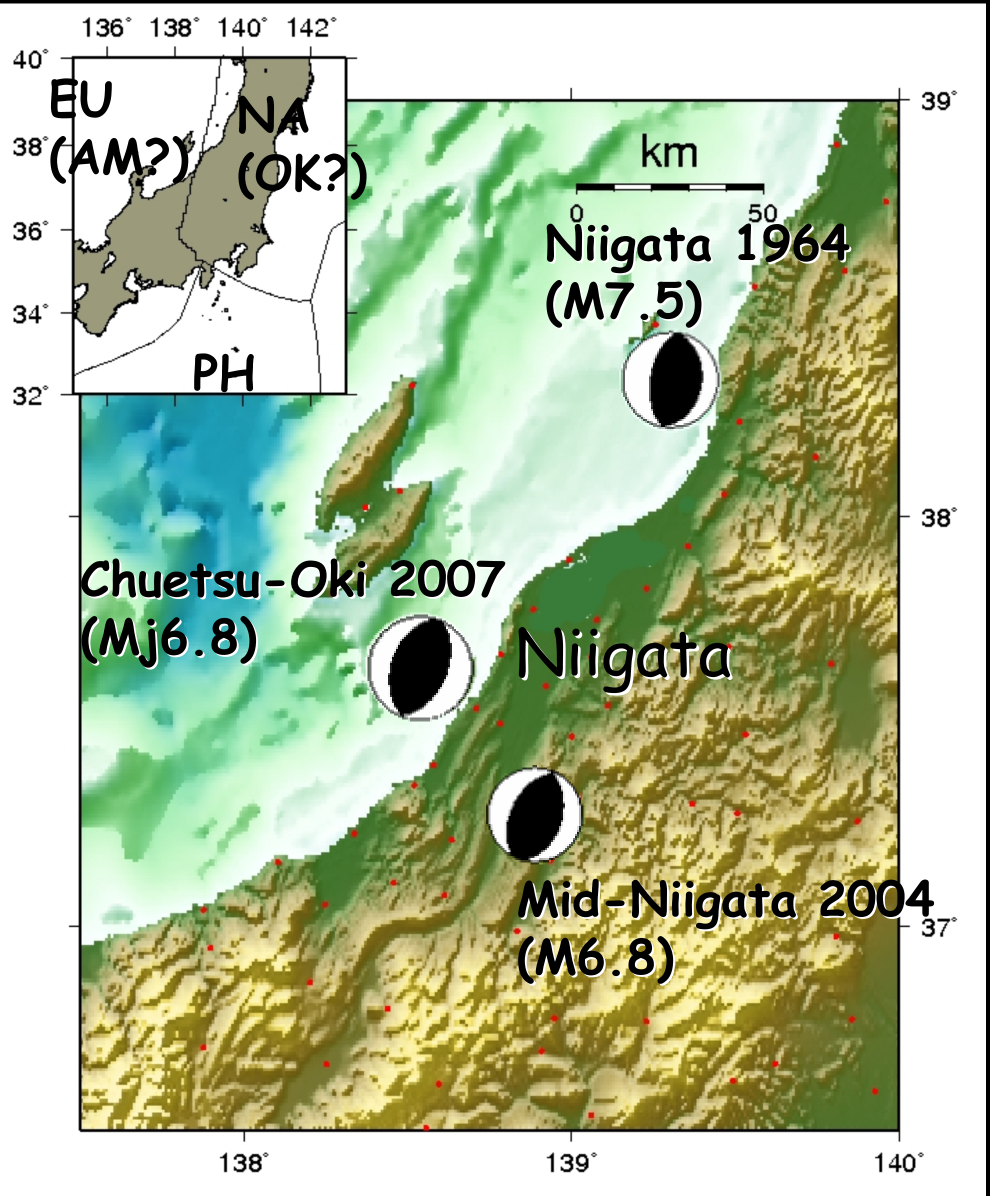
>1200 stations

Monitoring earthquakes and volcanoes.



Is InSAR necessary? Absolutely, yes!!

Tectonic Setting



1. A "diffuse" plate boundary between EU (AM?) and NA (OK?).
2. Strain concentration (Niigata Kobe Tectonic Zone Sagiya et al., 2000)
3. Large inland earthquakes .. 1964, 2004, 2007 (July 16)
4. Active folding and thick Sedimentary layer (Ikeda, 2002; Sato and Kato, 2005; Okamura et al., 2007)

ALOS/PALSAR Observation

Ascending

2006/09/11

2007/06/14

2007/07/16 (EQK)

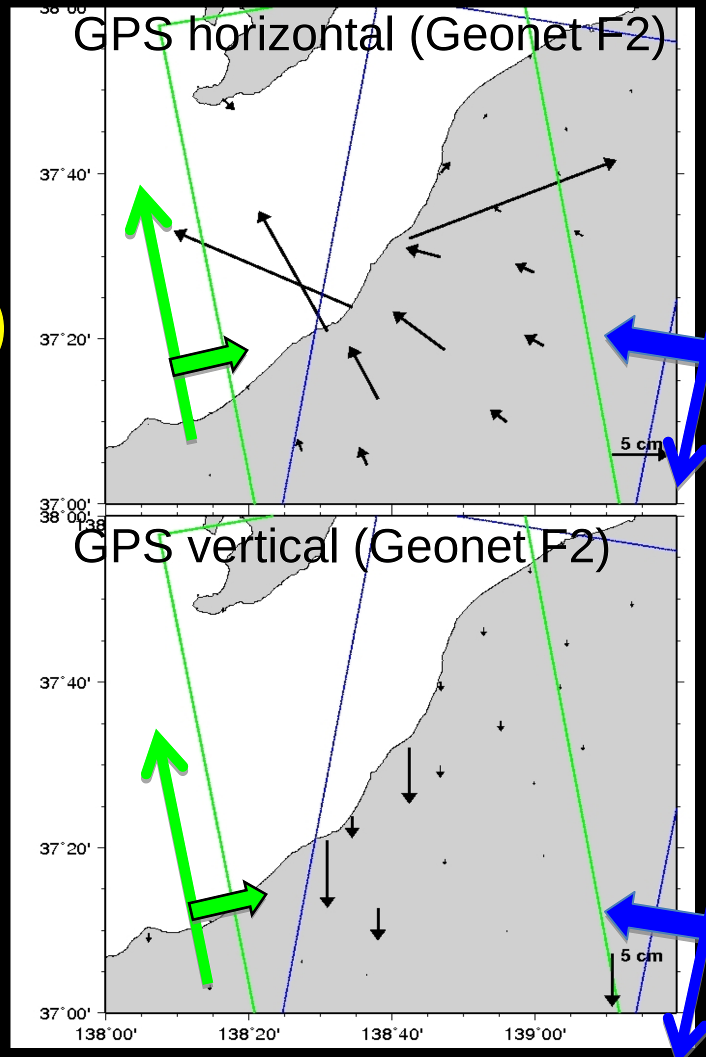
2007/09/14

2007/10/30

Ascending+

2007/07/13

2007/08/28



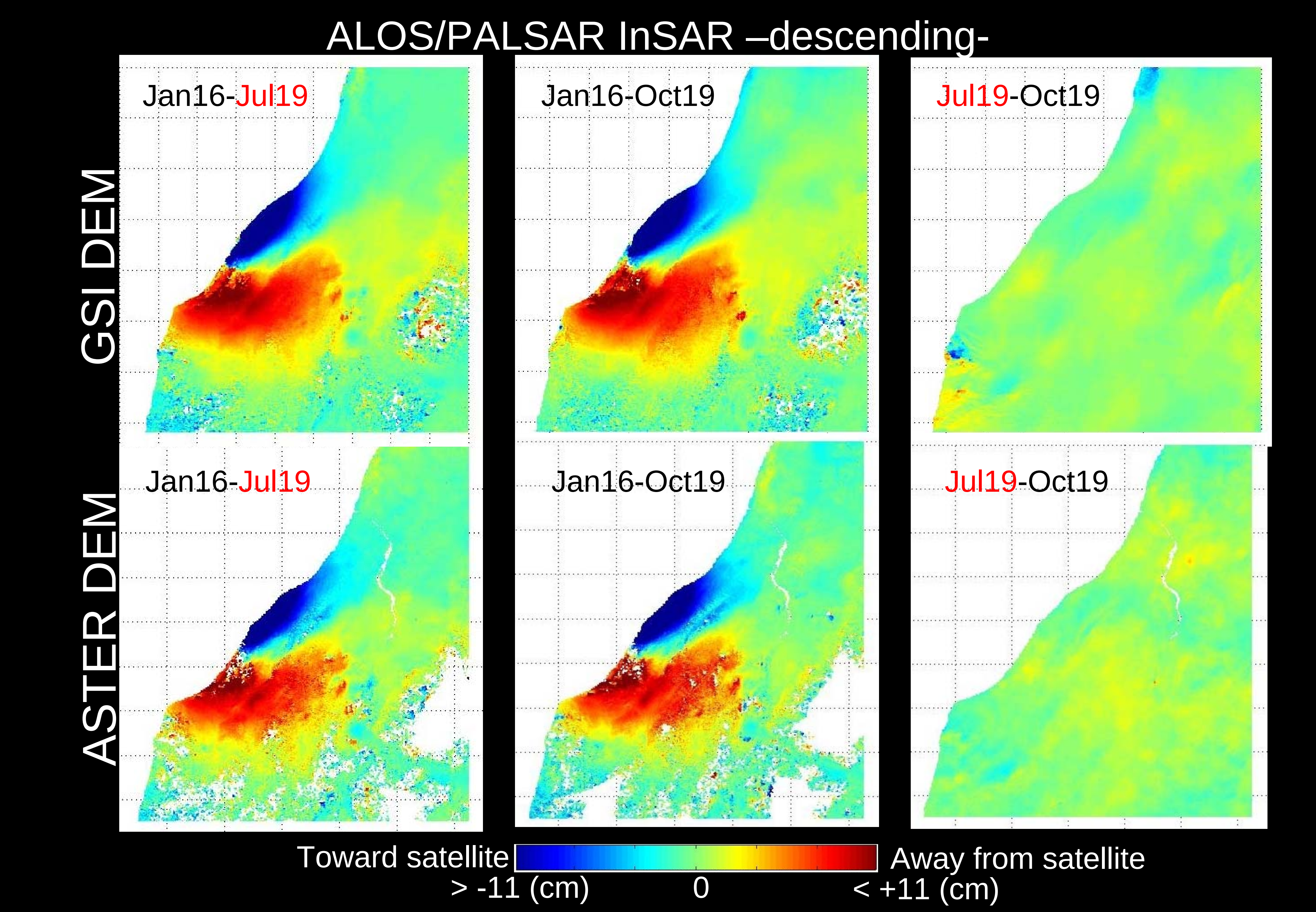
Descending

2007/01/16

2007/07/16 (EQK)

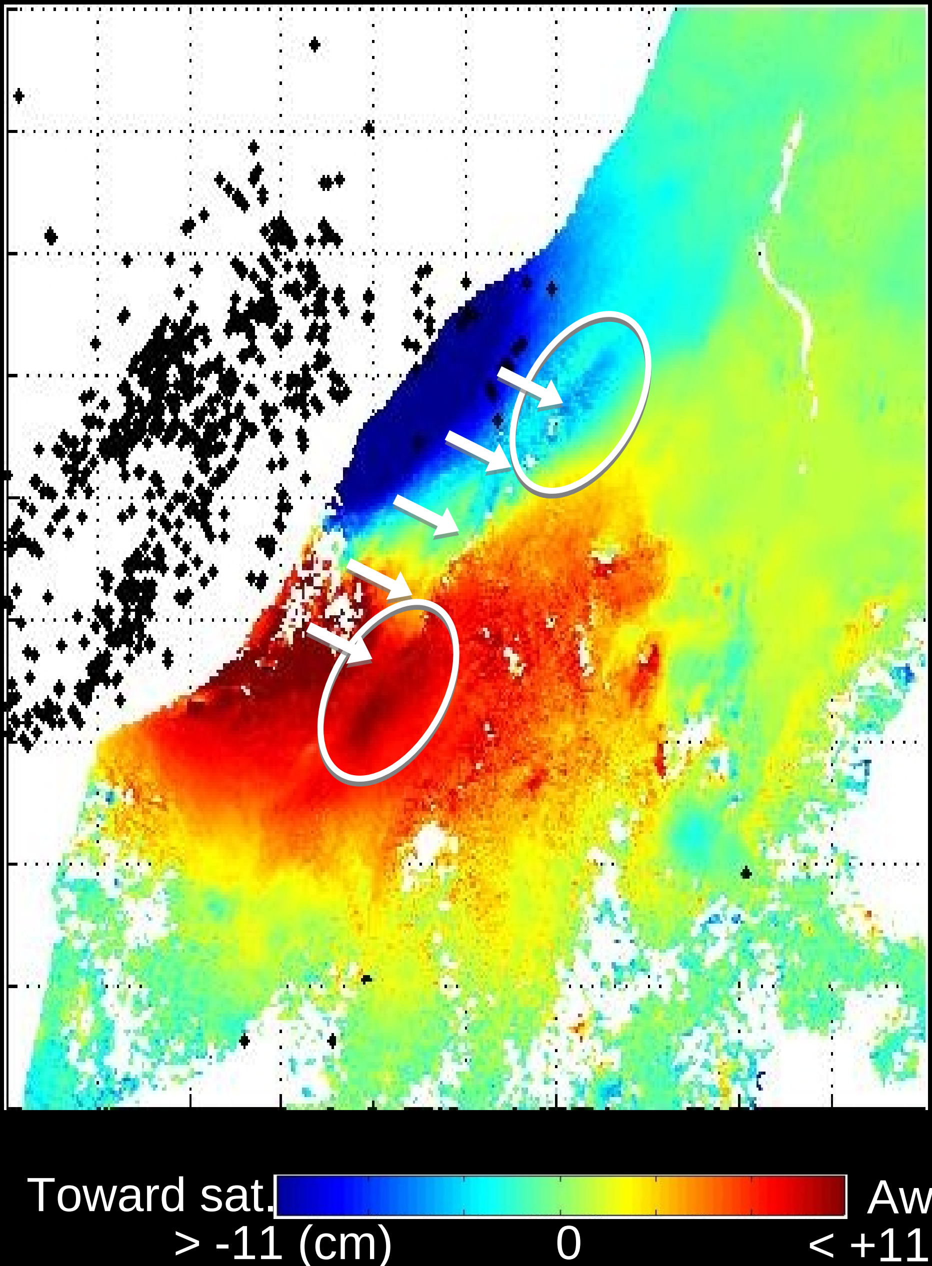
2007/07/19

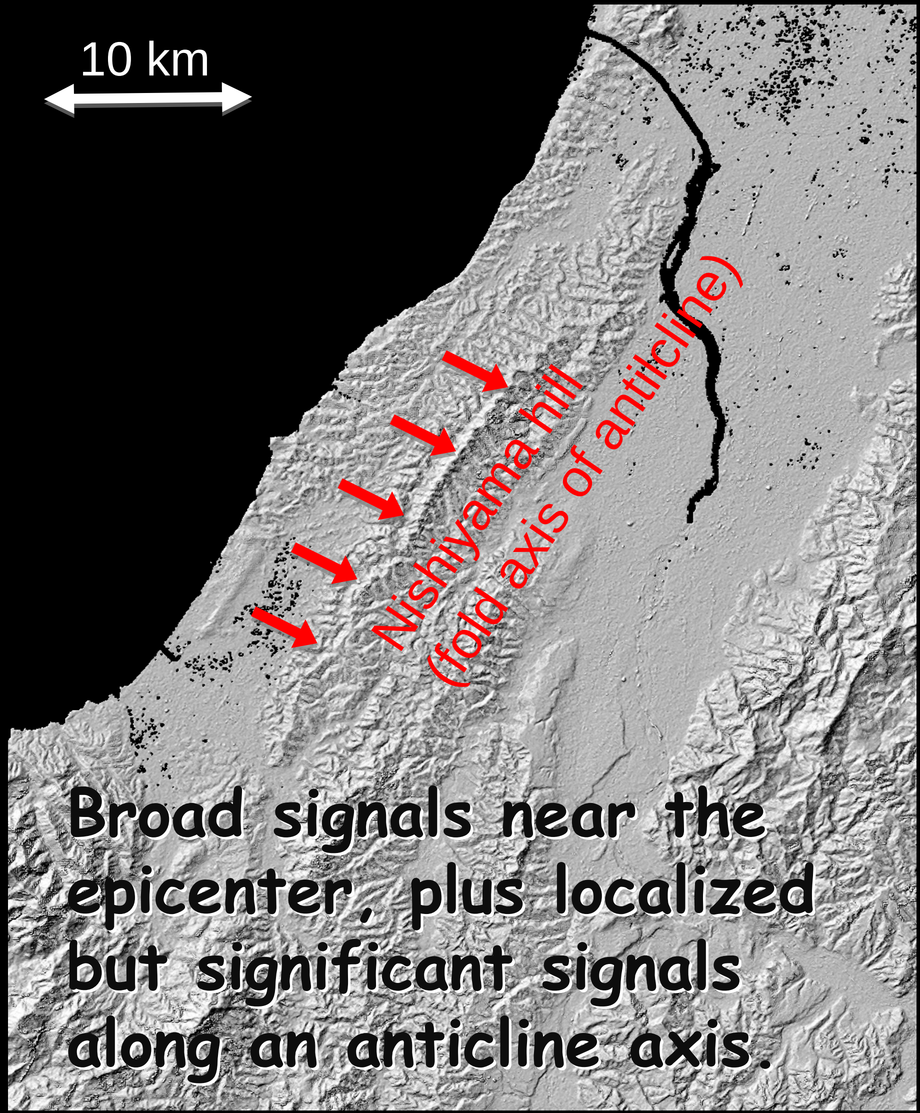
2007/10/19

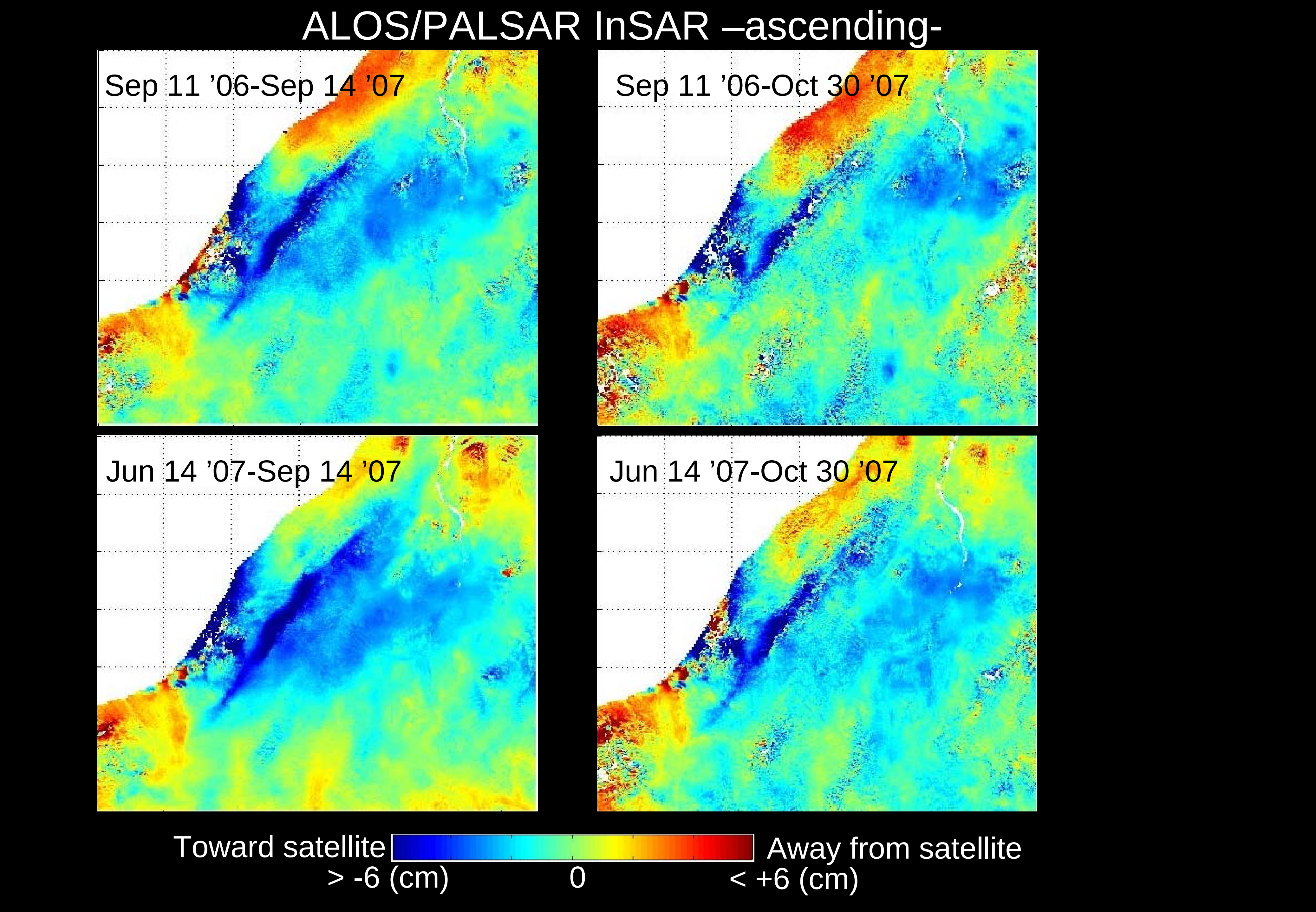


ALOS/PALSAR InSAR –descending-
GSI DEM
ASTER DEM
Jan16-Jul19
Jan16-Oct19
Jul19-Oct19
Jan16-Jul19
Jan16-Oct19
Jul19-Oct19
Toward satellite
Away from satellite
> -11 (cm)
0
< +11 (cm)

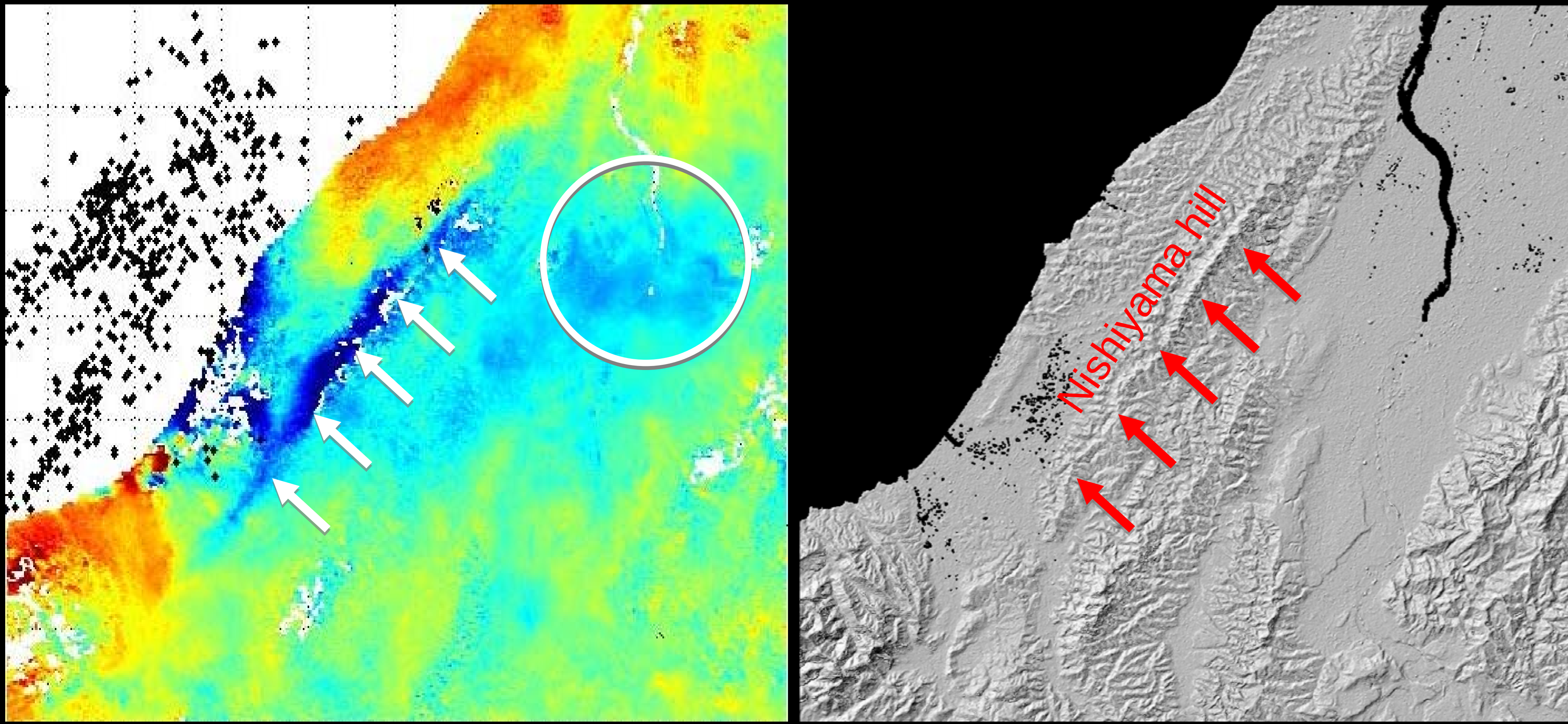
ALOS/PALSAR InSAR –descending stack-






ALOS/PALSAR InSAR –ascending-
Sep 11 '06-Sep 14 '07
Sep 11 '06-Oct 30 '07
Jun 14 '07-Sep 14 '07
Jun 14 '07-Oct 30 '07
Toward satellite
Away from satellite
> -6 (cm)
0
< +6 (cm)

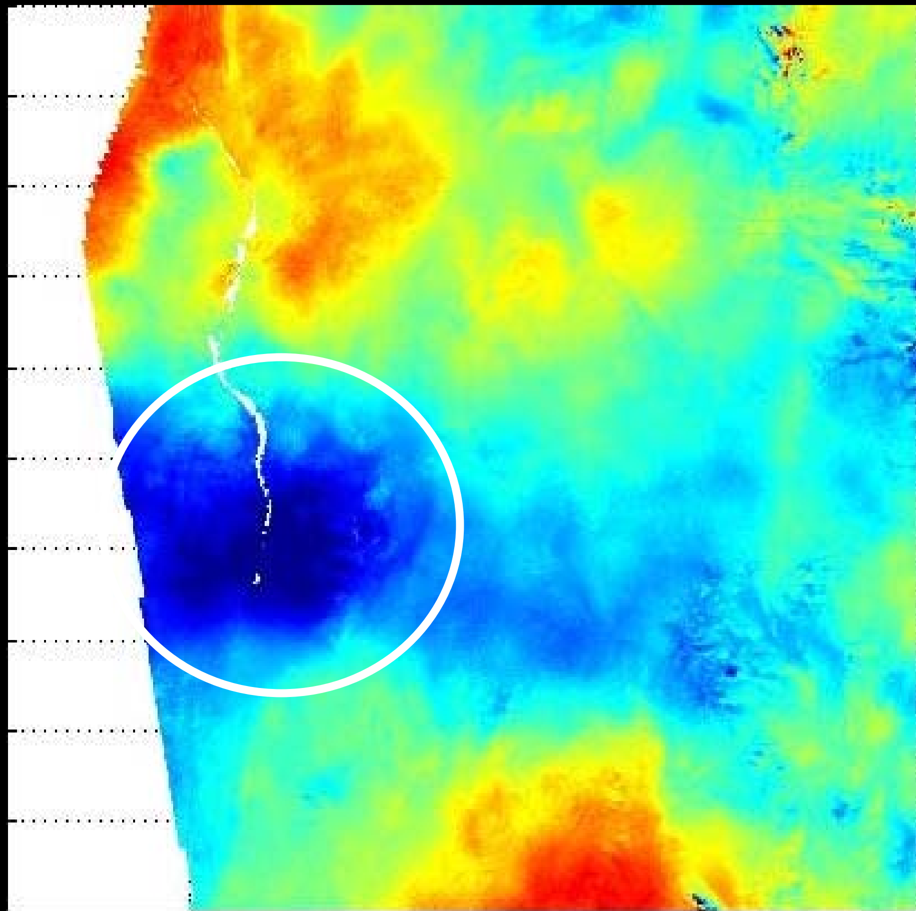
ALOS/PALSAR InSAR –ascending stack-

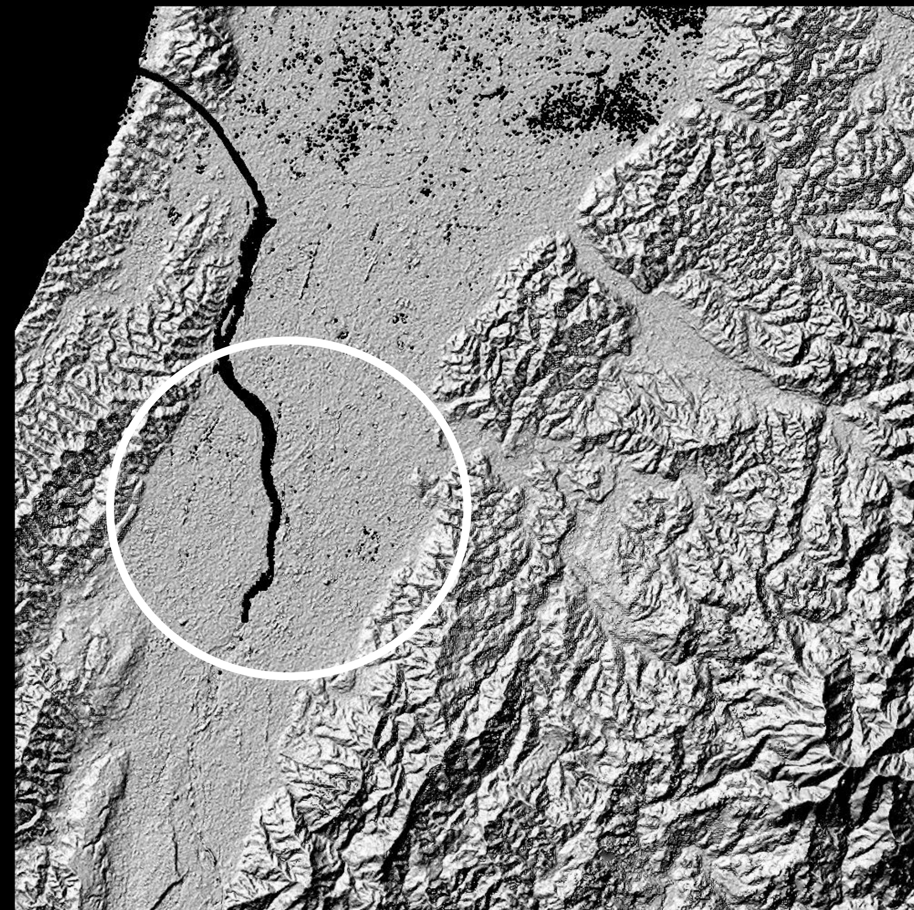


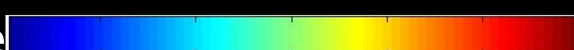
Toward satellite > -6 (cm) 0 < +6 (cm) Away from satellite

ALOS/PALSAR InSAR –another ascending track-

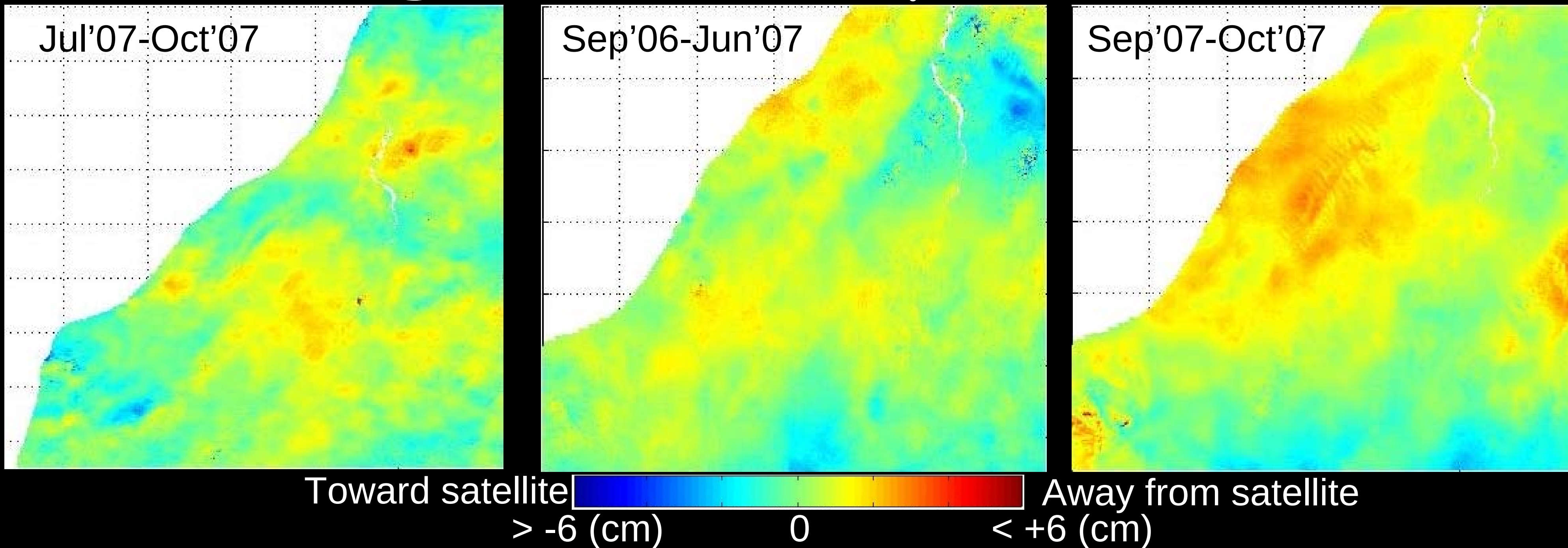
Jul 13 ‘07 - Aug 28 ‘07







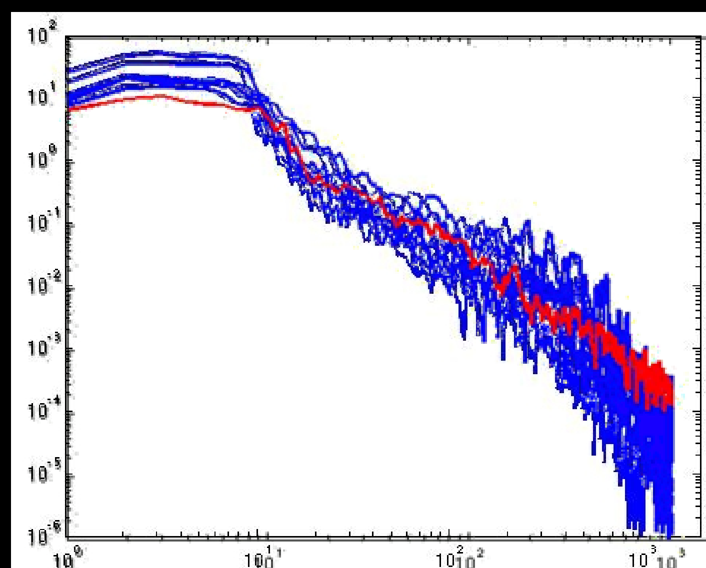
How large are atmospheric “noises”?

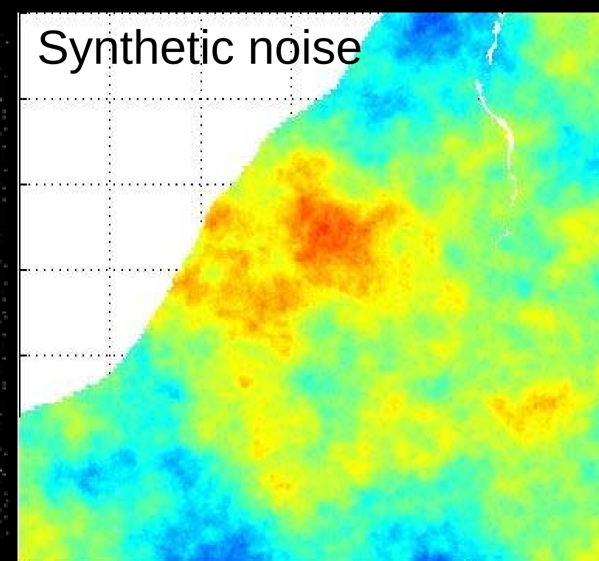


~ +/- 2 cm in radar LOS

They depend on a spatial scale.

“2-D correlated noise”





How do we interpret the observation?

Broad signals near the epicenter

- Main shock fault
  - A simple SE dipping fault
  - Constrained by aftershock data

Localized but significant signals near an anticline axis

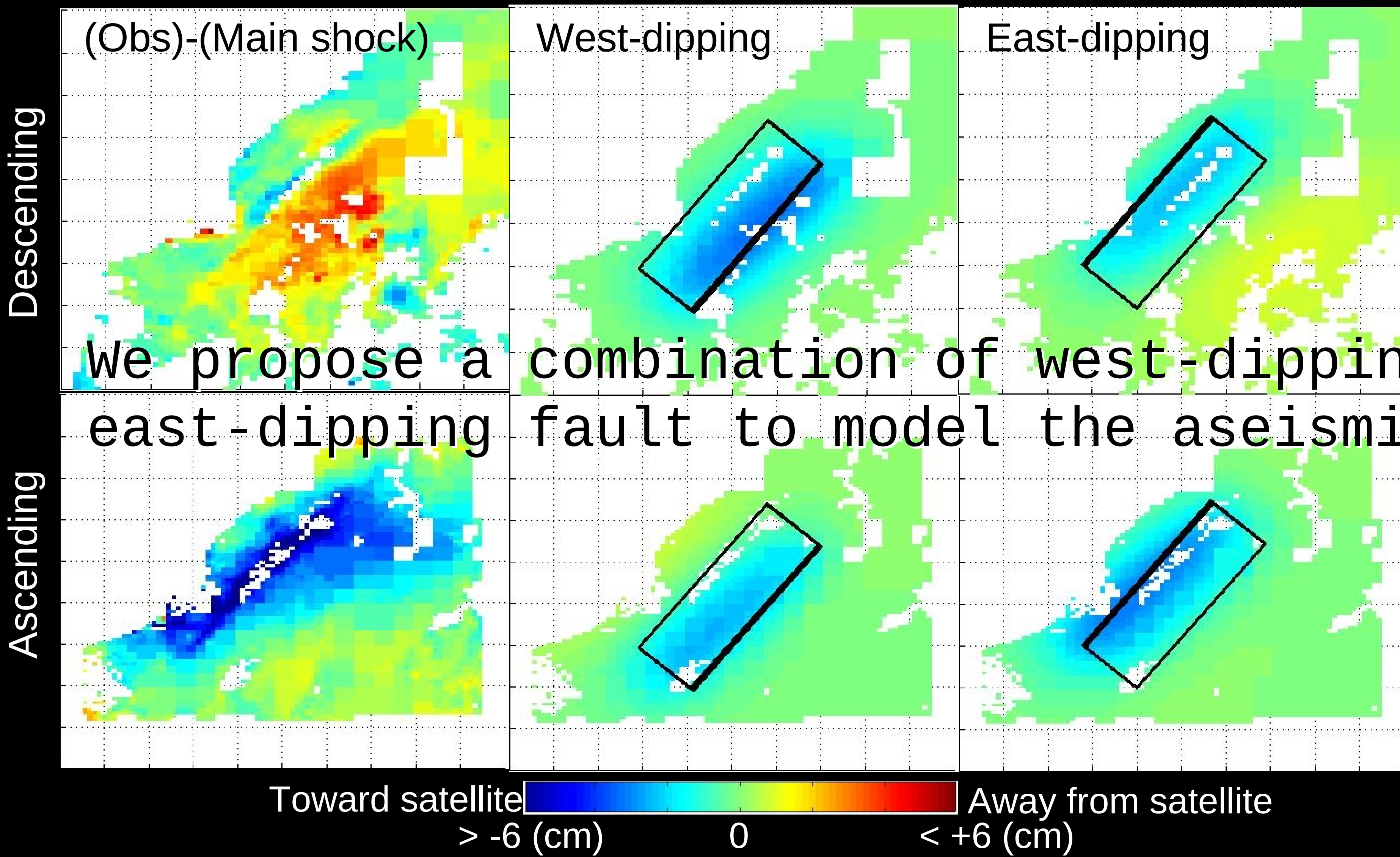
- Aseismic faults around the fold

(Nishiyama hill).

>> Goal: To infer these faults location, geometry and slip distribution

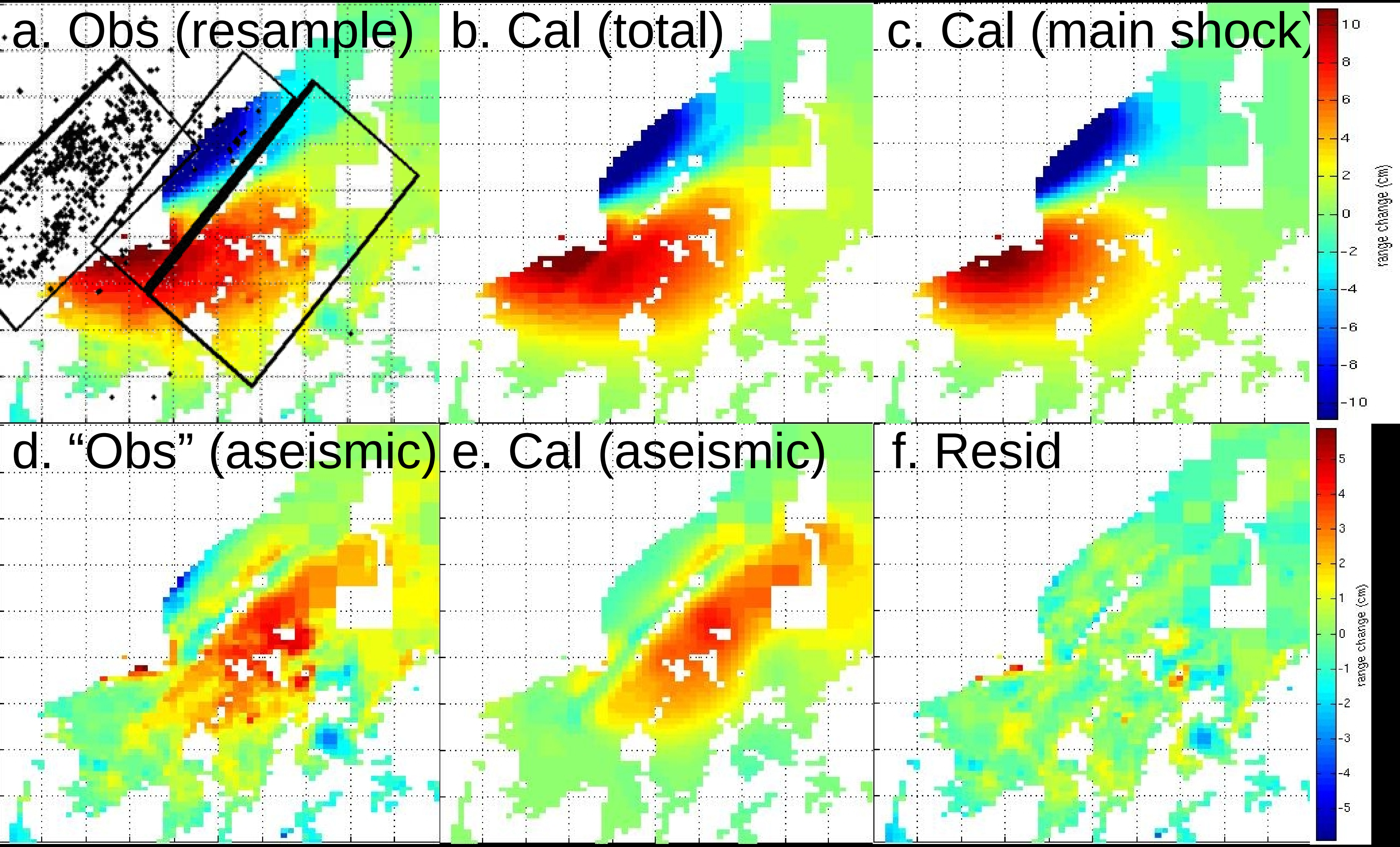
Aseismic slip: West-dipping, or East-dipping?

Simple forward modeling: L=25 km, W=10 km, dep.=10 km, slip=0.1 m, dip=30 deg.

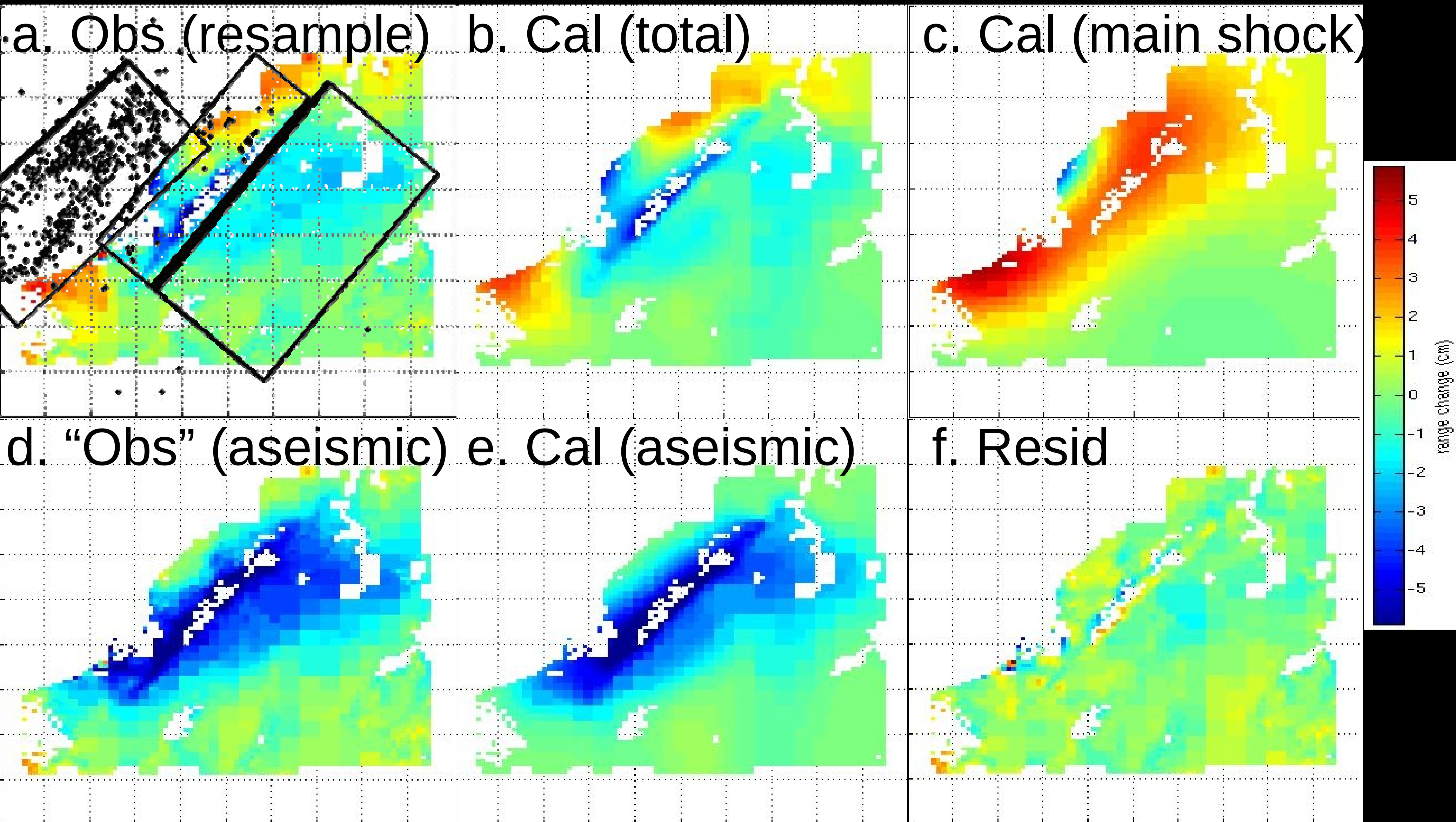


We propose a combination of west-dipping a
east-dipping fault to model the aseismic s

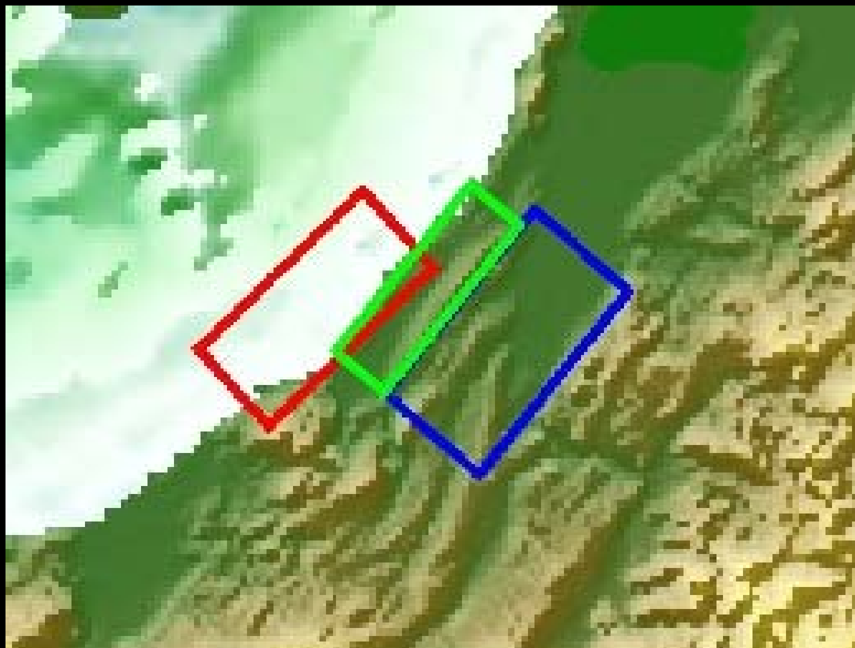
Modeling (1) : InSAR descending

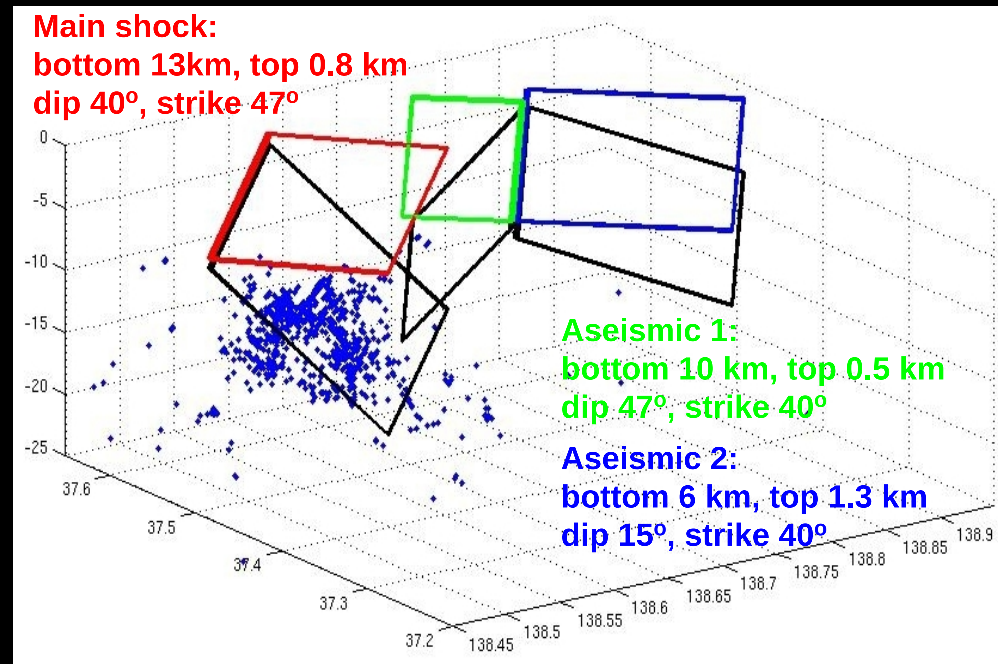


Modeling (2): InSAR ascending



Fault location and geometry



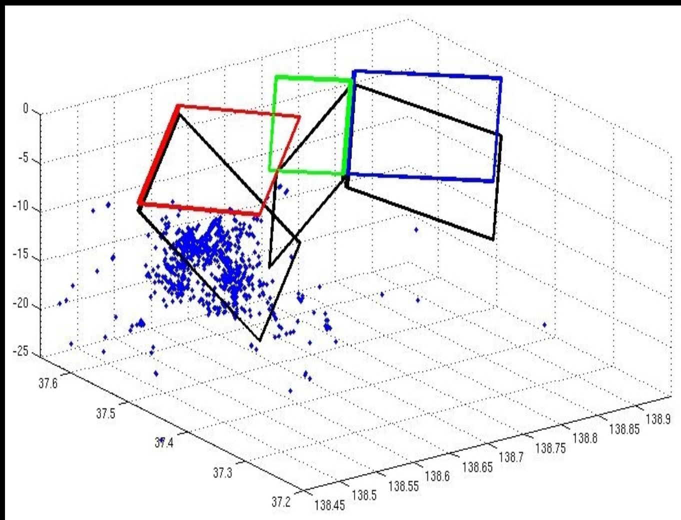


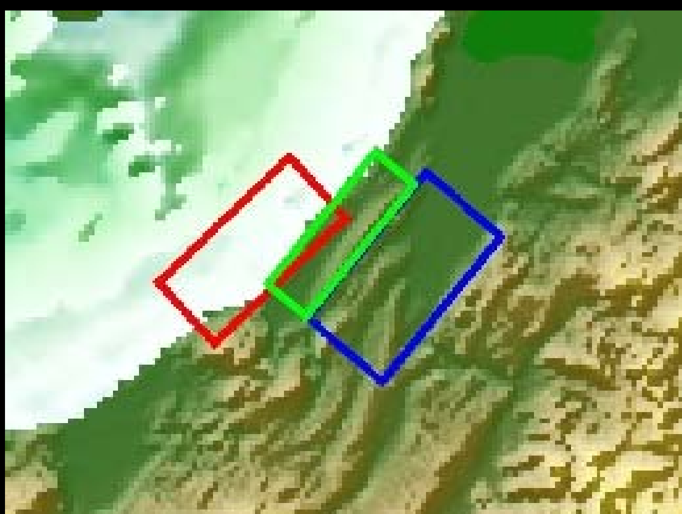
Main shock: bottom 13km, top 0.8 km
dip 40º, strike 47º

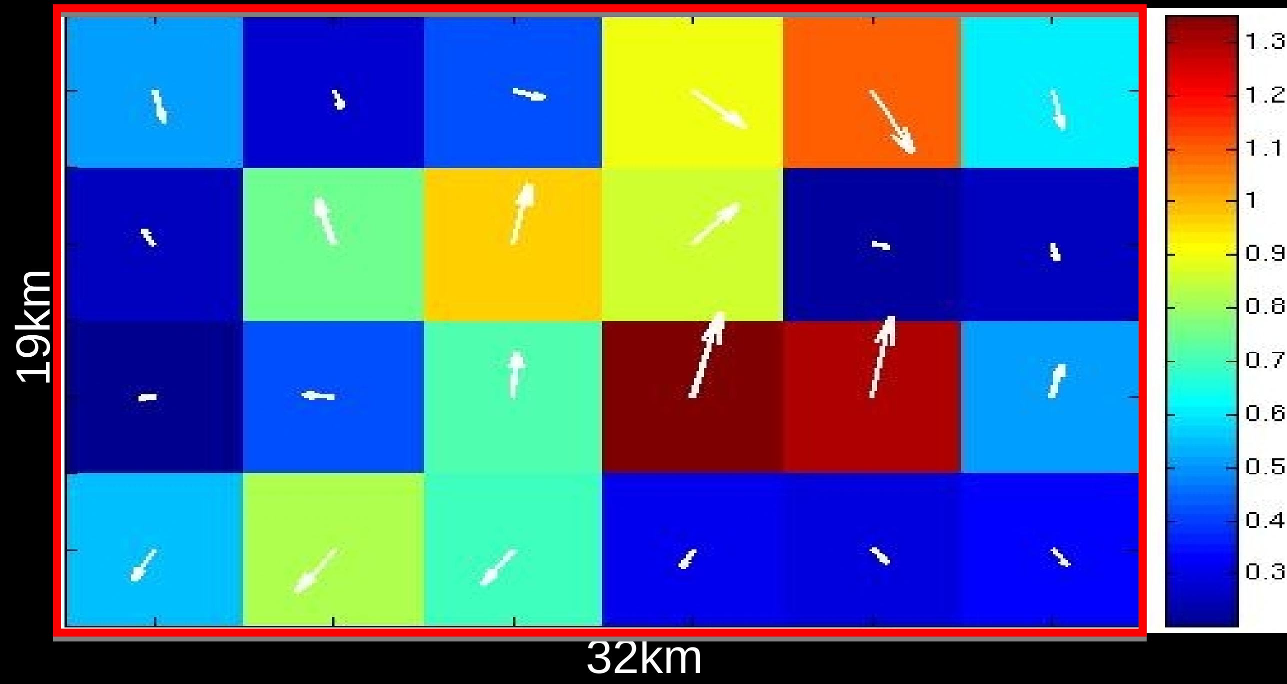
Aseismic(?) 1: bottom 10 km, top 0.5 km
dip 47º, strike 40º

Aseismic 2: bottom 6 km, top 1.3 km
dip 15º, strike 40º

Slip distribution: Main shock fault





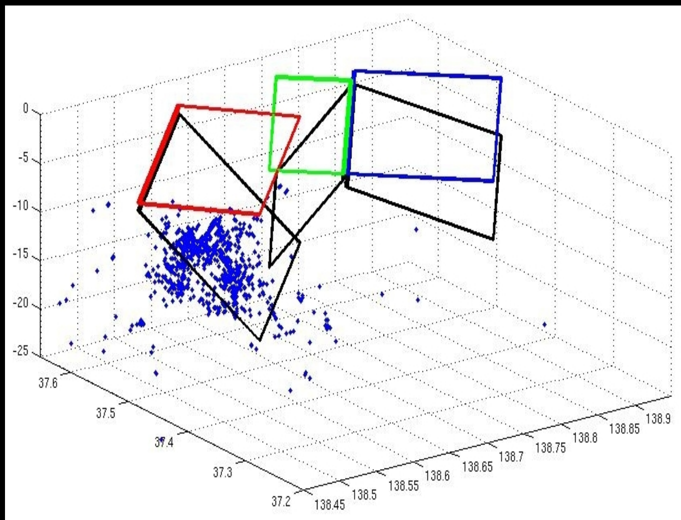


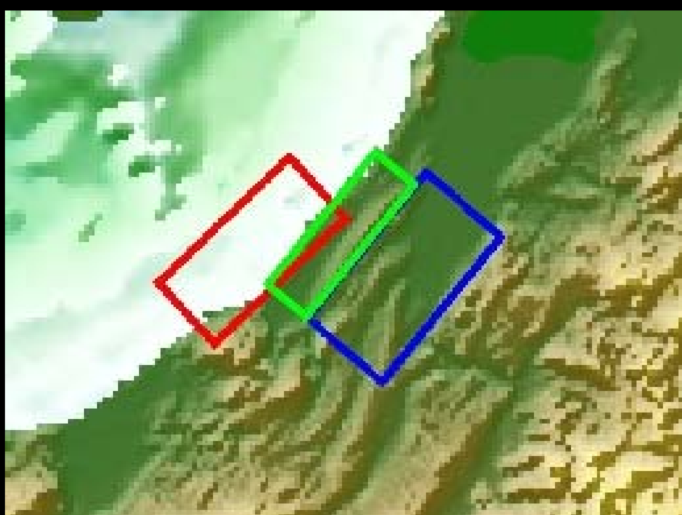
Mw 6.62 (30 GPa)

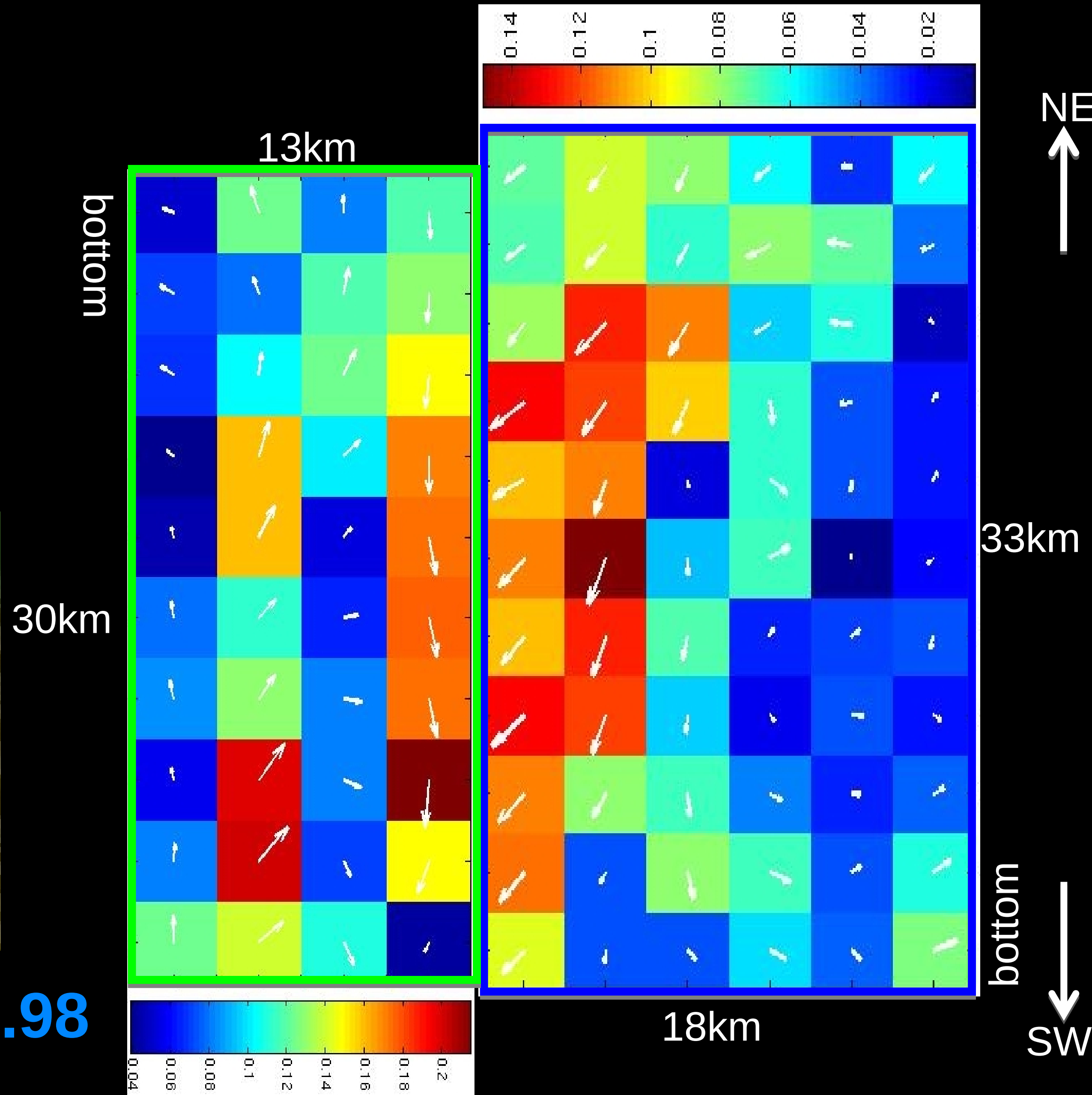
Seismological estimates

Mw 6.7 (Aoi et al., 2007, NIED HP.)
Mw 6.6 (Hikima and Koketsu, 2007, ERI HP.)
Mw 6.7 (Yamanaka, 2007, NGY HP.)
Mw 6.6 (Yagi, 2007, Tsukuba U HP.)

Slip distribution: Aseismic faults

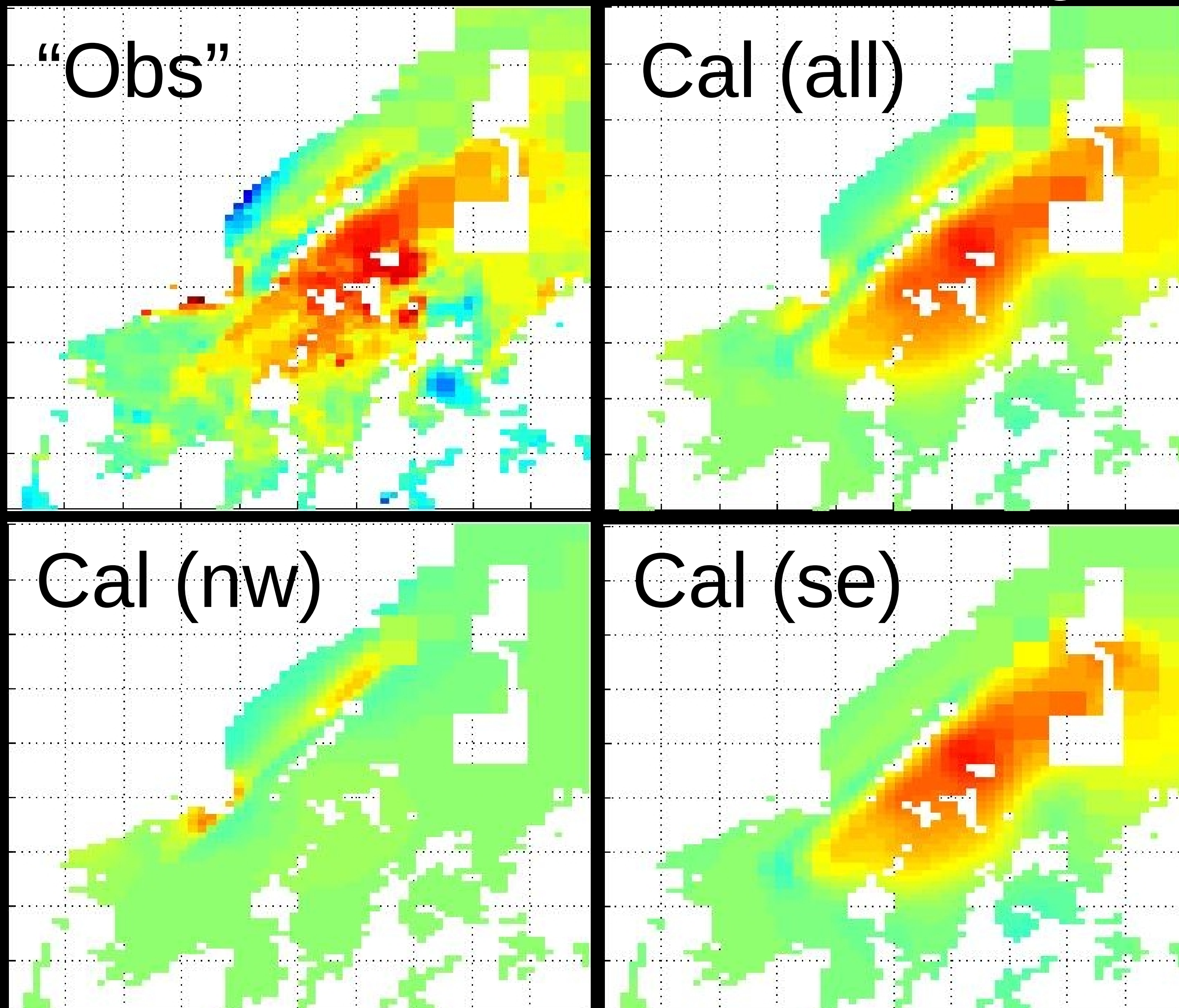




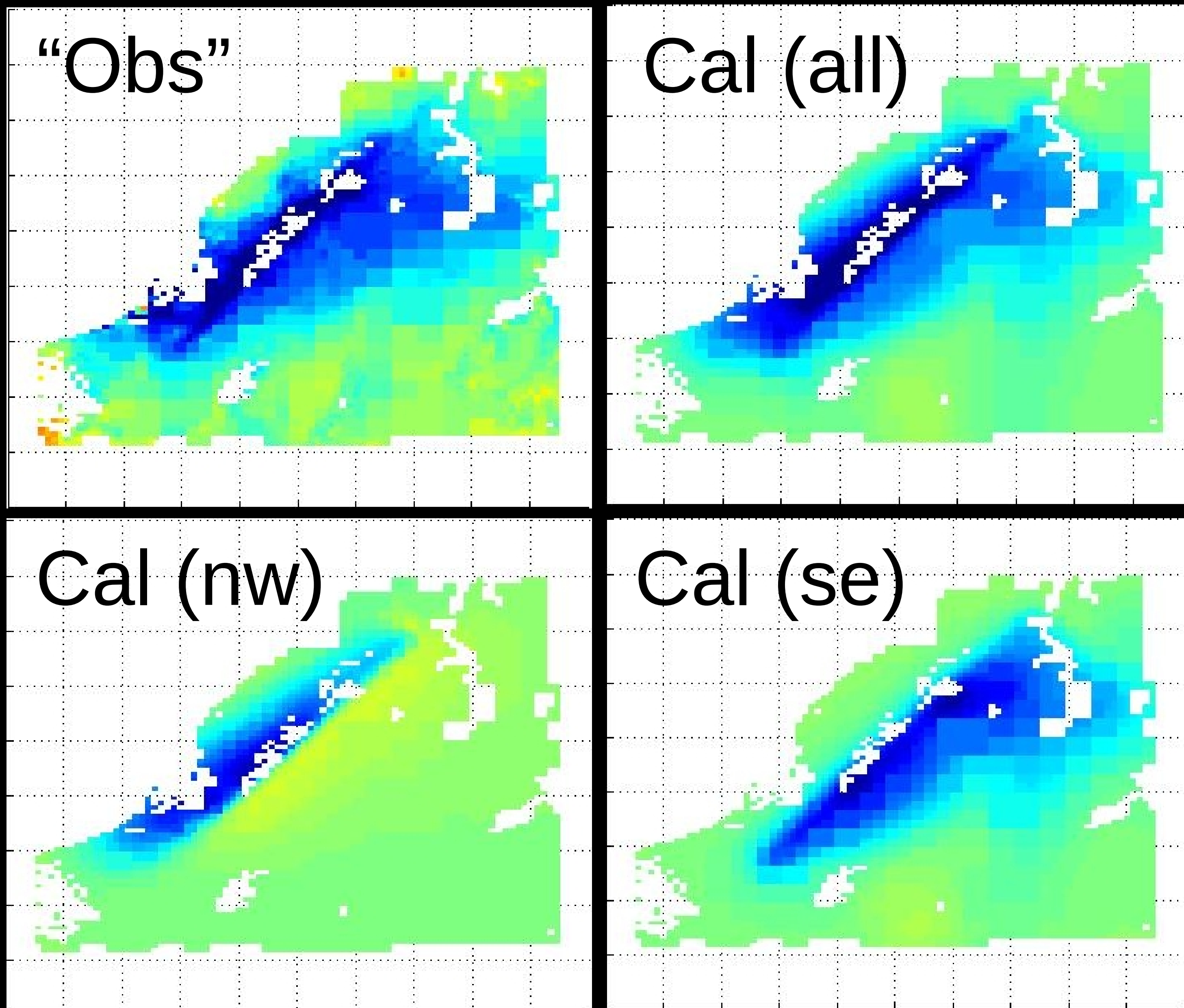


Mw 5.96 and **Mw 5.98**

“Aseismic” effects -Descending-

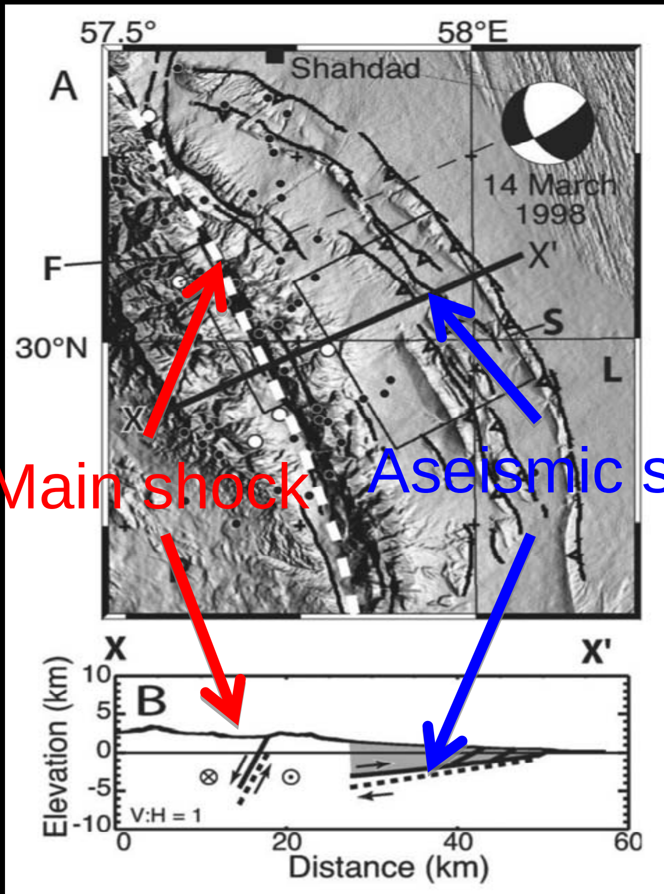


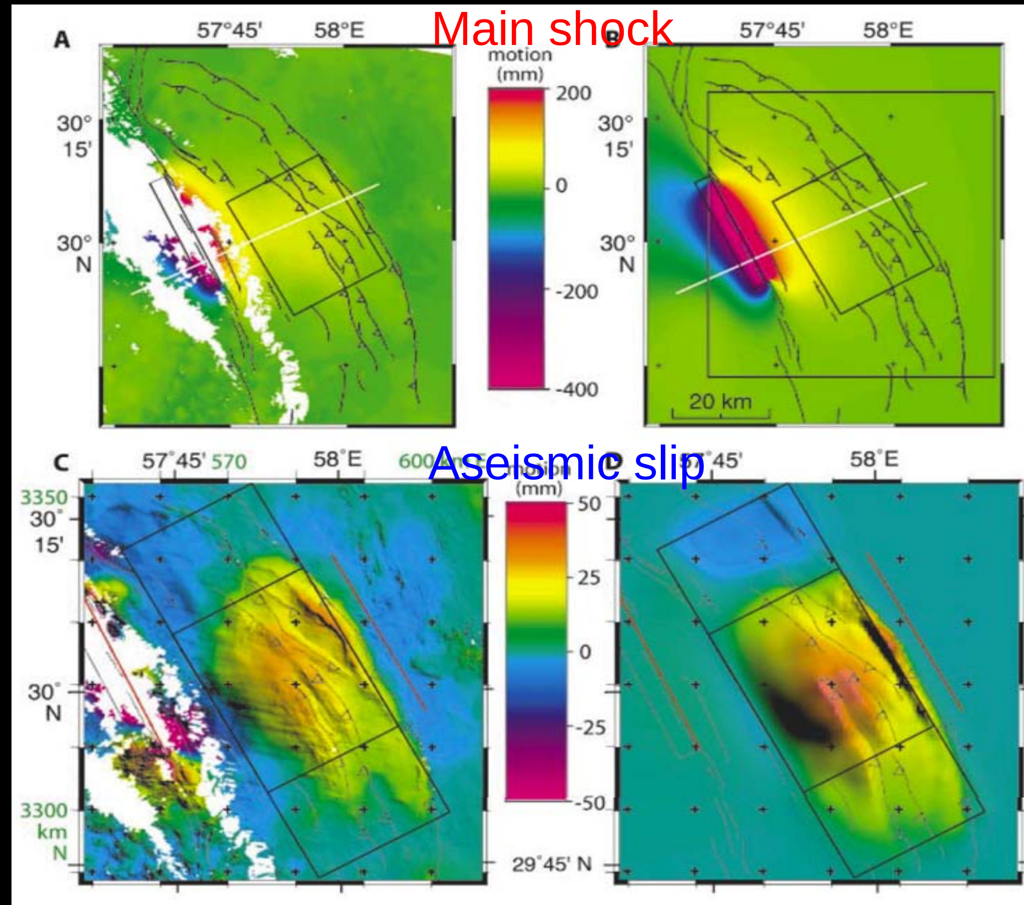
“Aseismic” effects -Ascending-



Aseismic deformation of a fold-and-thrust belt

Fielding et al. (2004), Geology, 32(7), 577-580.

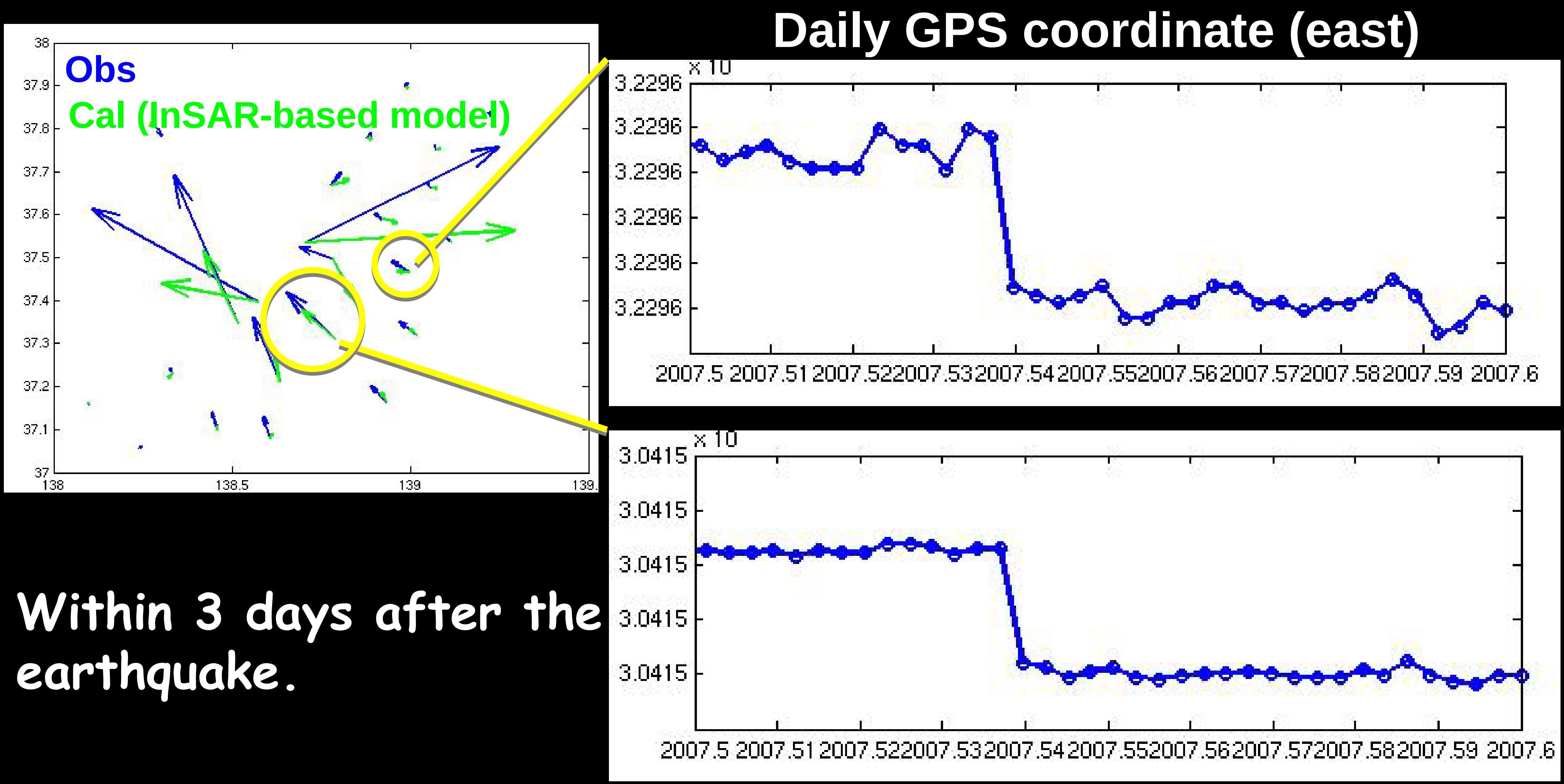




SAR image was acquired 6 months after the earthquake.
When did the aseismic slip take place?

When did the aseismic slip take place?

The earliest post-earthquake image was acquired 3 days after the quake.



Within 3 days after the earthquake.

Conclusion & implications

- Besides the coseismic deformation due to the main shock fault, significant aseismic deformation was observed near a fold axis, ~15 km away from the epicenter, and turned out to terminate mostly within 3 days. …This data is only detectable by InSAR.
- The aseismic slip was modeled as a combination of west-dipping fault (Mw5.96) to the NW and east-dipping fault to the SE (Mw5.98).
- Aseismic growth of a fold -> Low “seismic hazard”
- Inland areas need to be monitored even during an absence of earthquake.

Acknowledgement

- The ownership of PALSAR data belongs to JAXA/METI. PALSAR level 1.0 data are shared among PIXEL, and provided from JAXA under a cooperative research contract with ERI, Univ. Tokyo.
- GEONET F2-solutions were provided from GSI.
- Hypocenter data was provided from Dr. A. Kato@ERI.
- ASTER DEM is based on ASTER Data beta processed by the AIST GEO Grid from ASTER Data owned by METI.
- MF and YT are supported from the grant-in-aid for scientific research, JSPS (19340123).