Contribution of ALOS/PALSAR to the Earthquake Hazard Mitigation: Example from the 2008 Wenchuan, China, Earthquake

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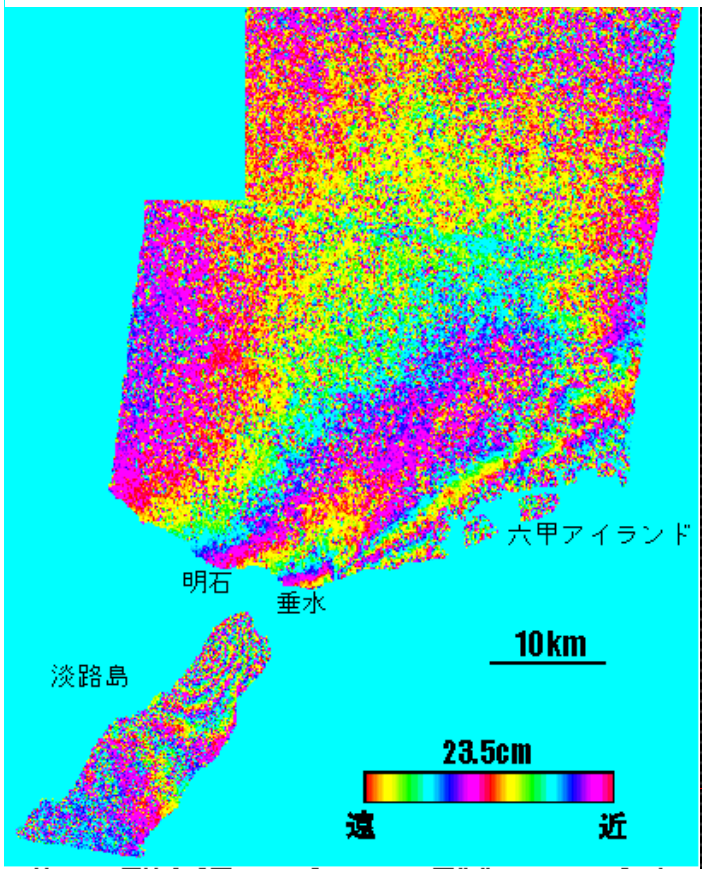
- PALSAR level 1.0 data are shared among *PIXEL* (coordinator: Prof. Masato Furuya), Earthquake WG (Geographical Survey Inst.) and provided from JAXA under cooperative research contract with ERI, Univ. Tokyo. The ownership of PALSAR data belongs to METI (Ministry of Economy, Trade and Industry) and JAXA.
- Special thanks to Taku Ozawa, Masanobu Shimada, Masato Furuya, Mikio Tobita and Pixel members.

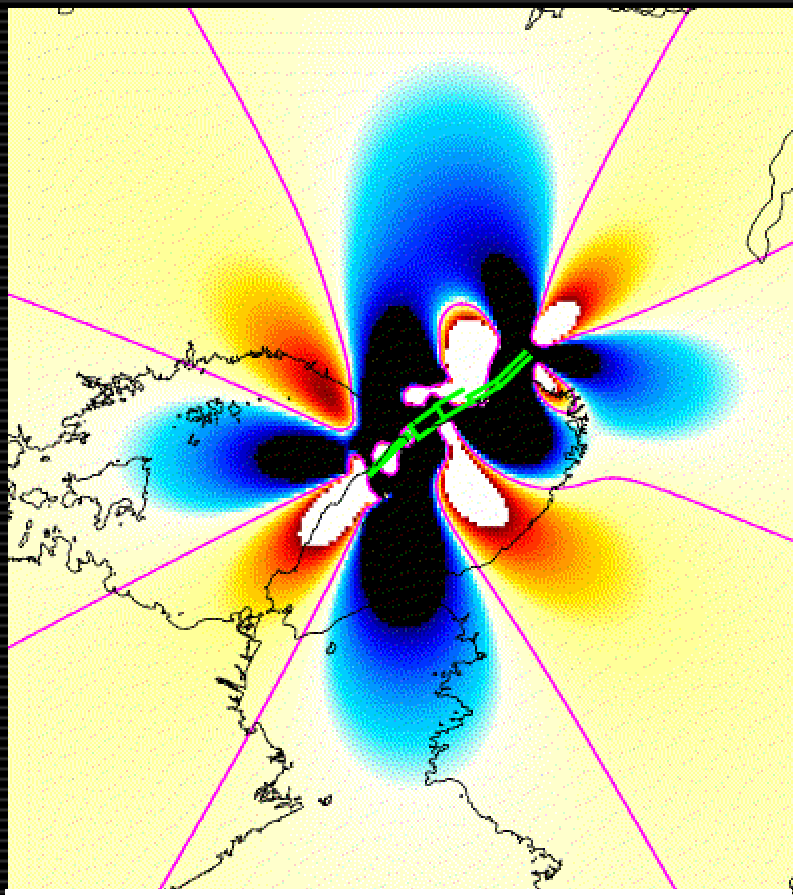
Purpose of InSAR Study of Earthquake

Precise Observation of Crustal Deformation



口絵ー1　干渉合成開口レーダーによって画像化された、平成7年兵庫県南部地震による地殻変動

Precise Model



Precise Evaluation of Seismic Hazard

Outline

- Wenchuan, China, Earthquake
  - May 12, 2008, M8.0
  - Casualties & missed > 80,000
- Crustal deformation ⇒ Fault motion
  - GPS data is unavailable.
  - We can rely only on ALOS/PALSAR.
- Analyses by Earthquake WG
  - Interferometry
  - Pixel Matching

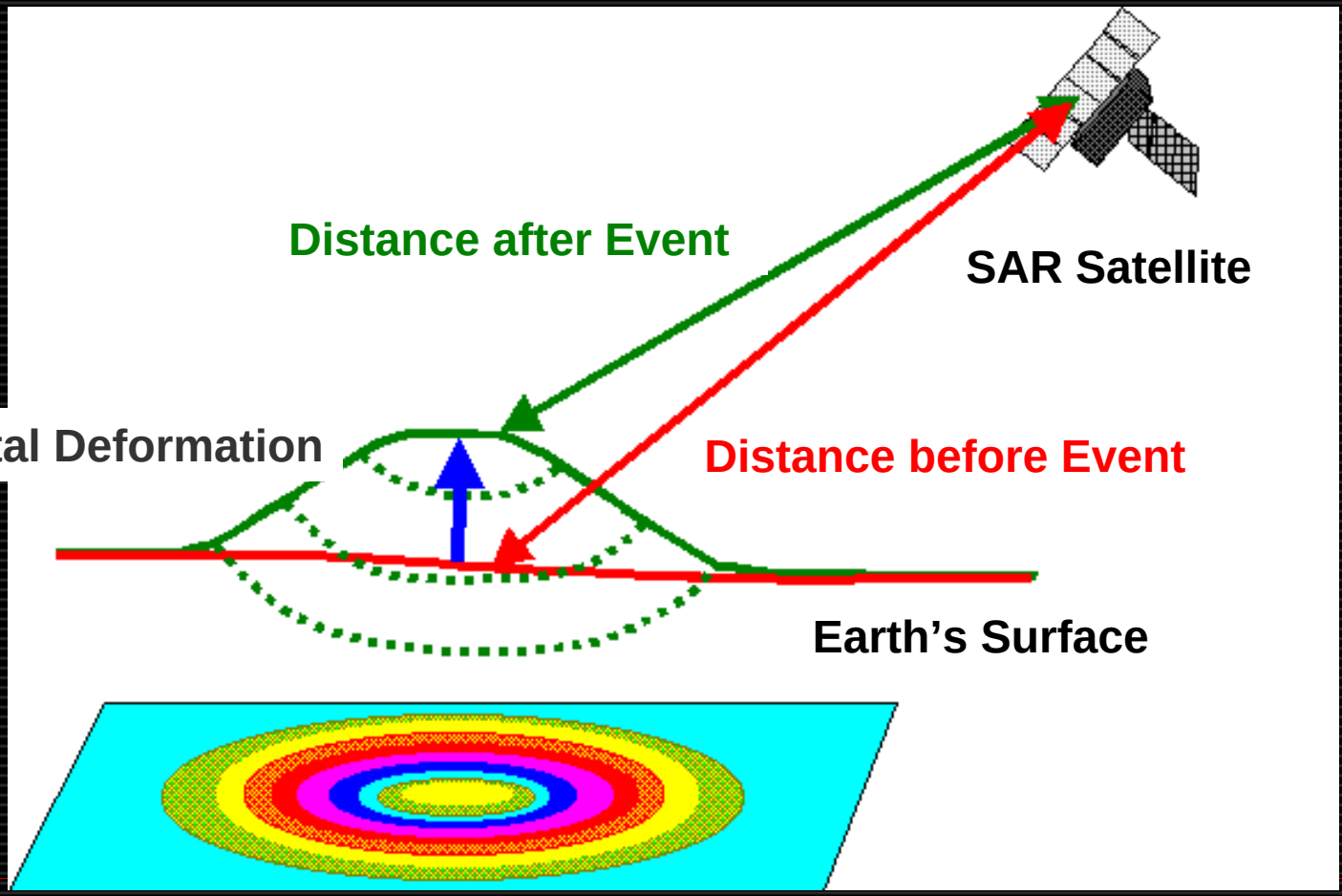
ALOS/PALSAR

Lauch of ALOS

From the website of JAXA

Phased Array type L-band SAR
L-band Radar (λ = 23.6cm)
High coherence in vegetated area

Principle of InSAR

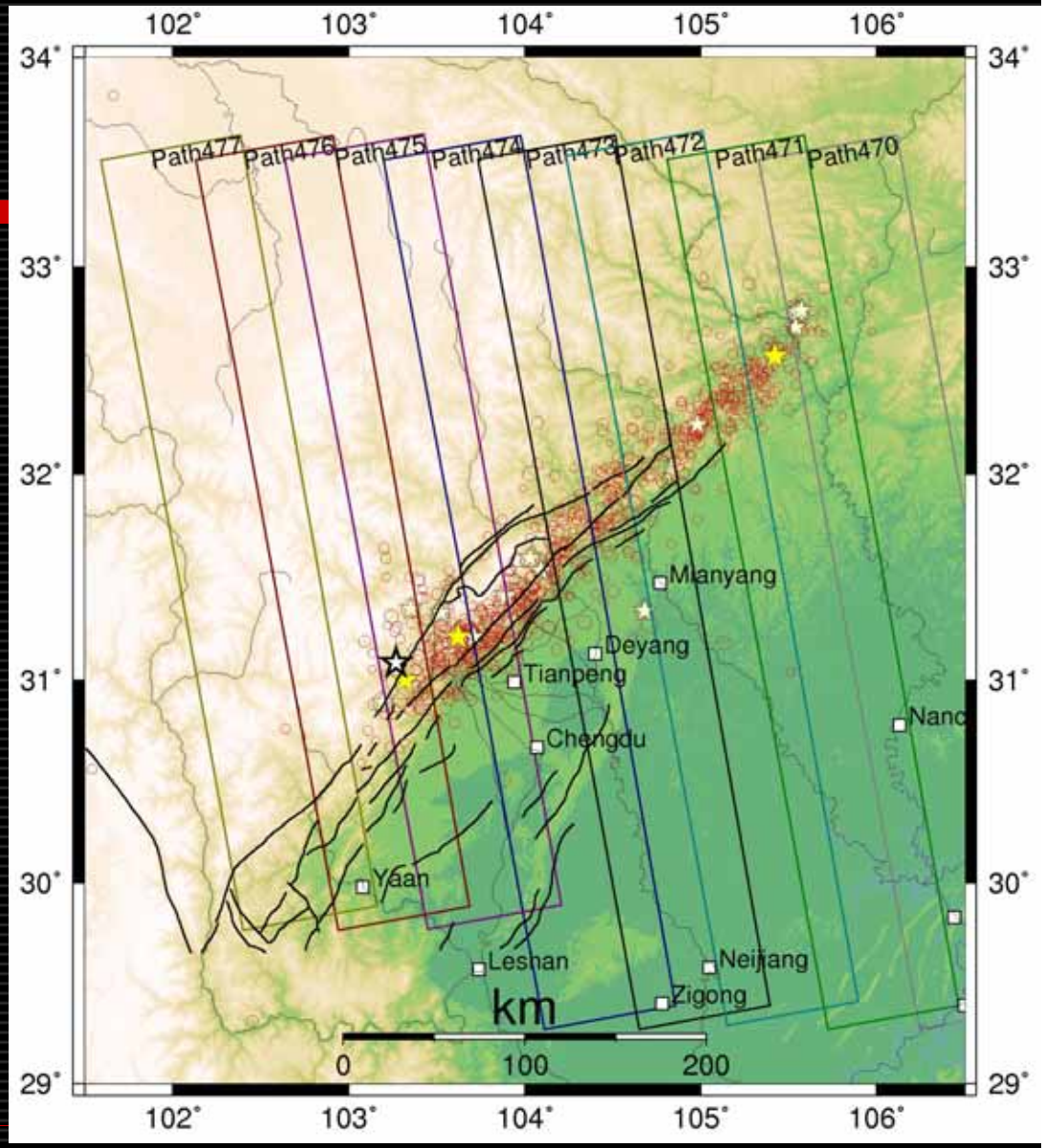


From the website of GSI

Path of ALOS

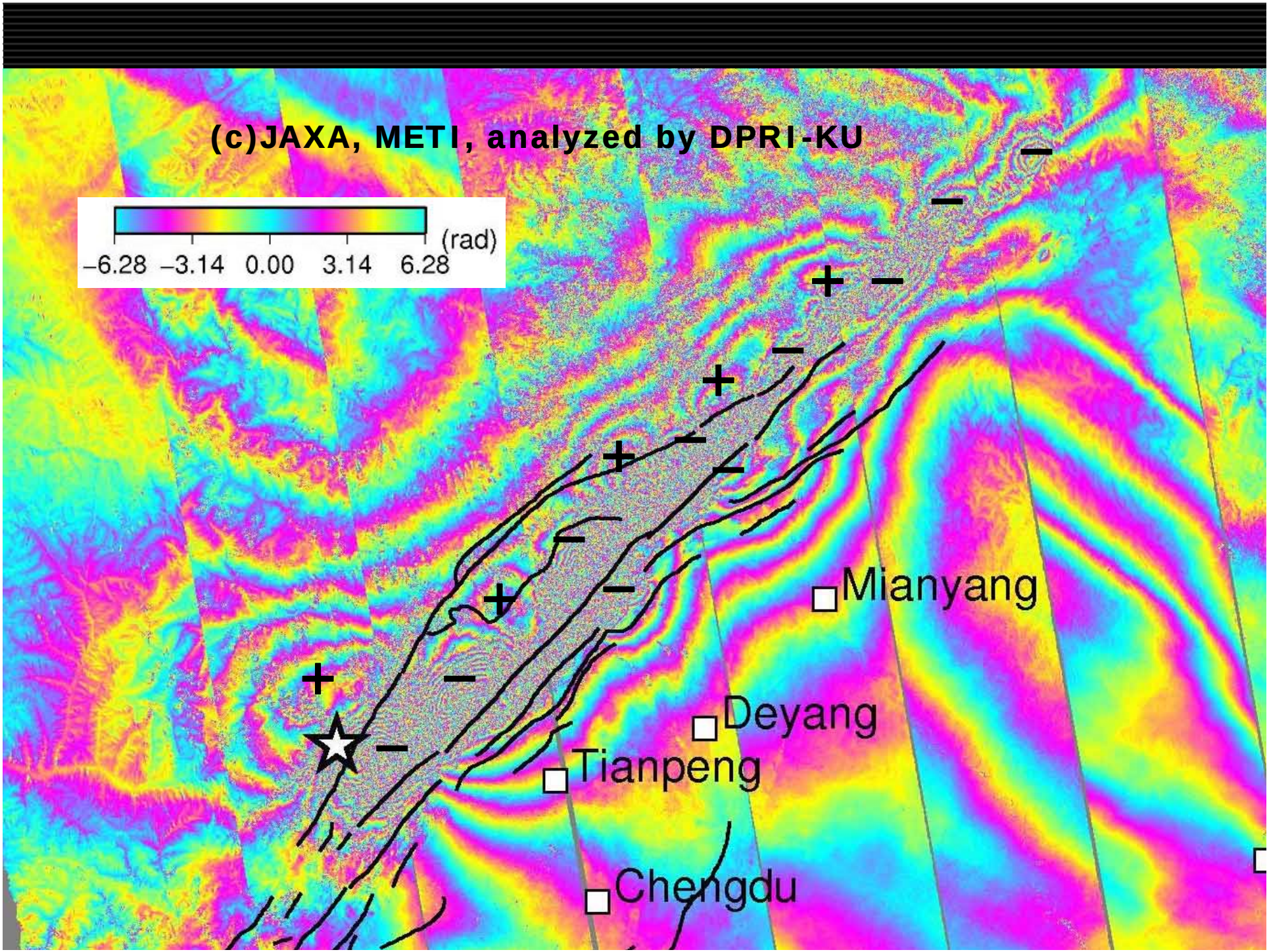
- Ascending orbits
- Look direction: EWE
- Off-nadir: 34.3°
- 7~8 frames/path
- Swath width ~70km
- Precise state vector (except 477)
- DEM: Hole-filled Seamless SRTM3 by CGAIR

Aftershock data from USGS(2008)



Acquisition of ALOS/PALSAR Images

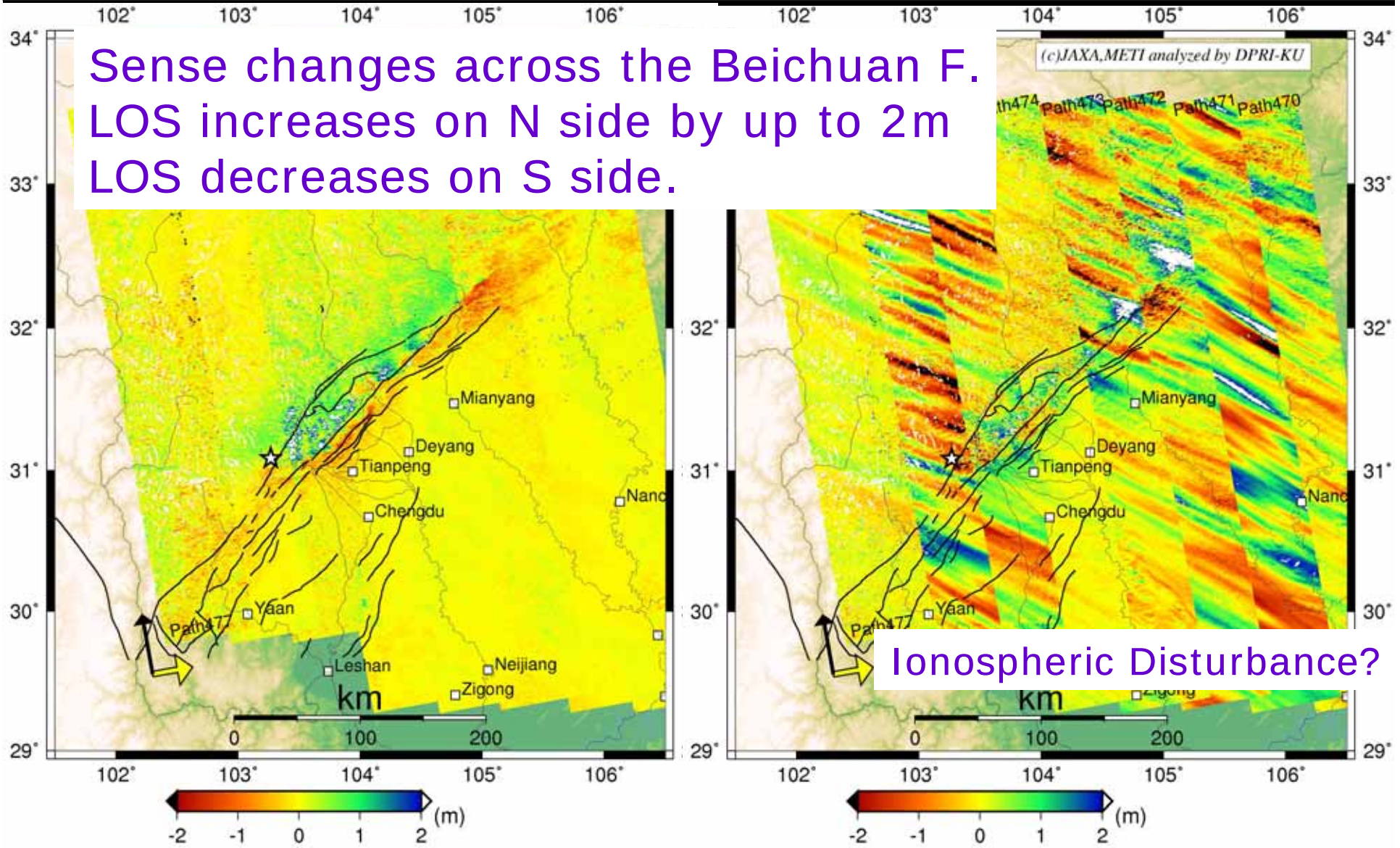
Path	Preseismic Acquisition	Postseismic Acquisition	Bperp
470	Dec. 28, 2007	Jun. 29, 2008	-1143m
471	Feb. 29, 2008	May 31, 2008	78m
472	Jan. 28, 2007	Jun. 17, 2008	205m
473	Feb. 17, 2008	May 19, 2008	220m
474	Mar. 5, 2008	Jun. 5, 2008	283m
475	Jun. 20, 2007	Jun. 22, 2008	-41m
476	Apr. 8, 2008	May 24, 2008	-188m
477	Apr. 25, 2008	Jun. 10, 2008	-74m


(c)JAXA, METI, analyzed by DPRI-KU
(rad)
−6.28 −3.14 0.00 3.14 6.28
Mianyang
Deyang
Tianpeng
Chengdu

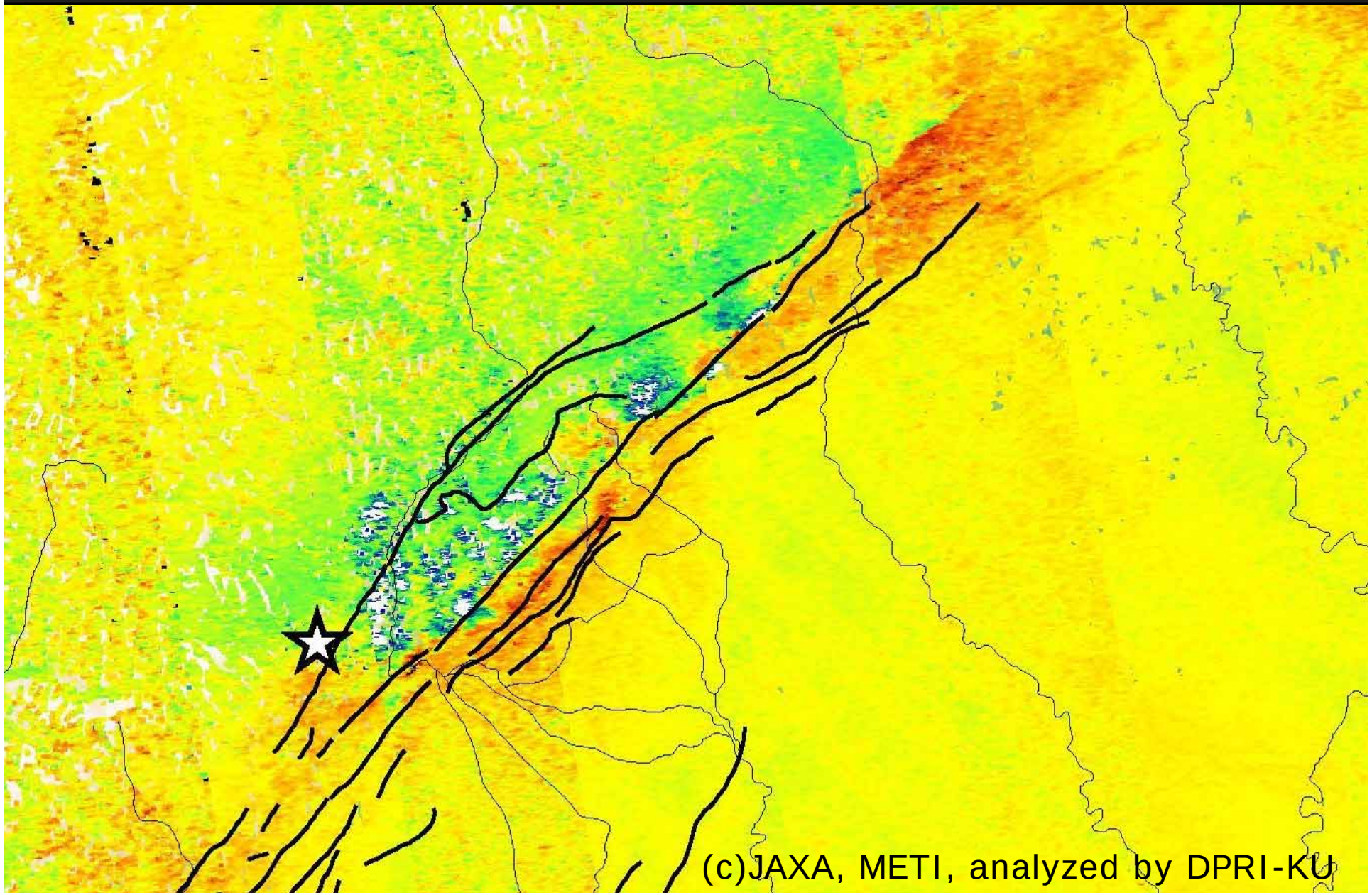
Detection of Deformation with Pixel Matching

- Interferometry cannot get high correlation in regions with large gradient ($>10^{-4}$) .
- Pixel matching can estimate displacements through coregistraion of intensity images.

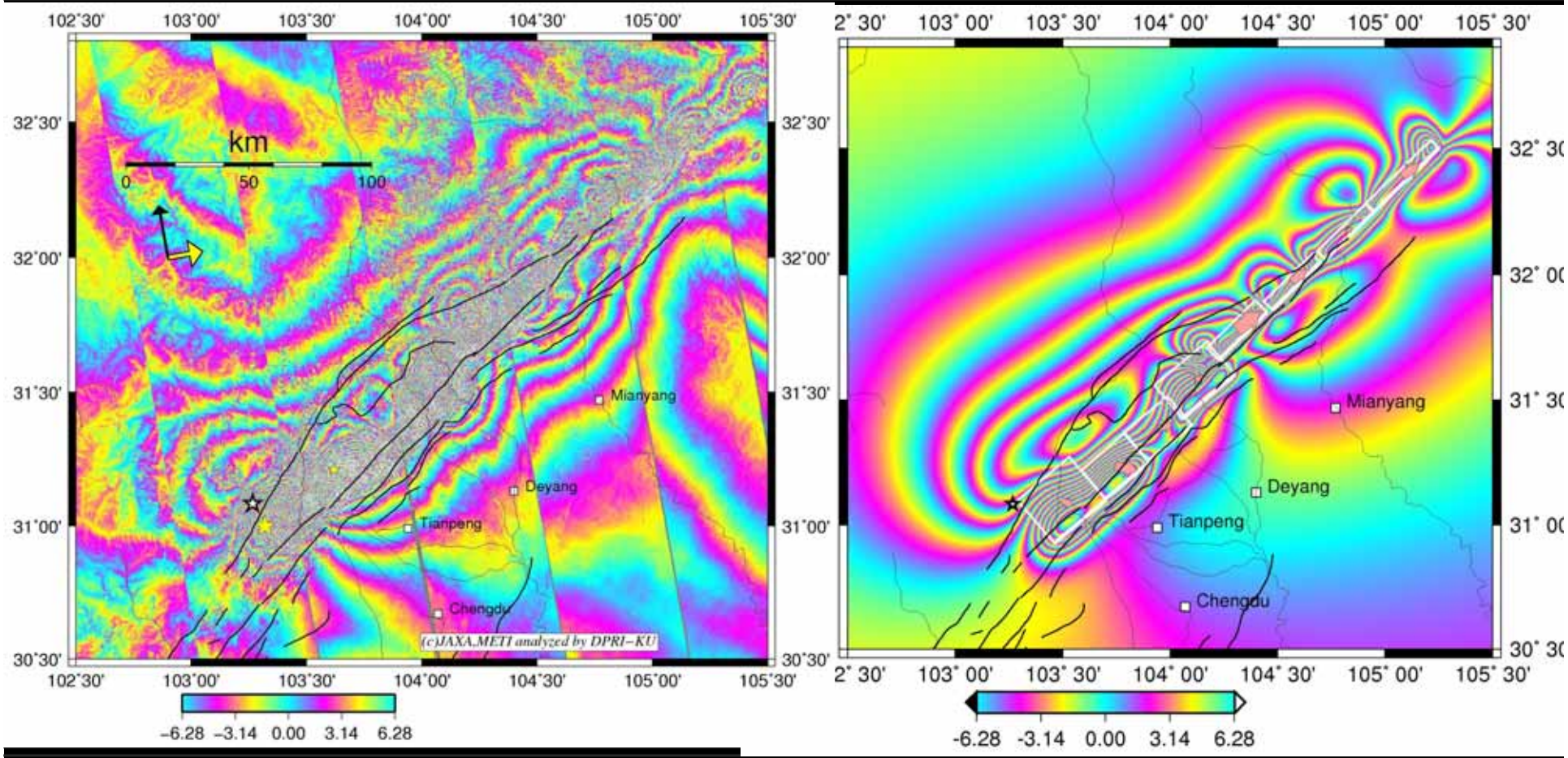
Offsets Estimated With Pixel Matching



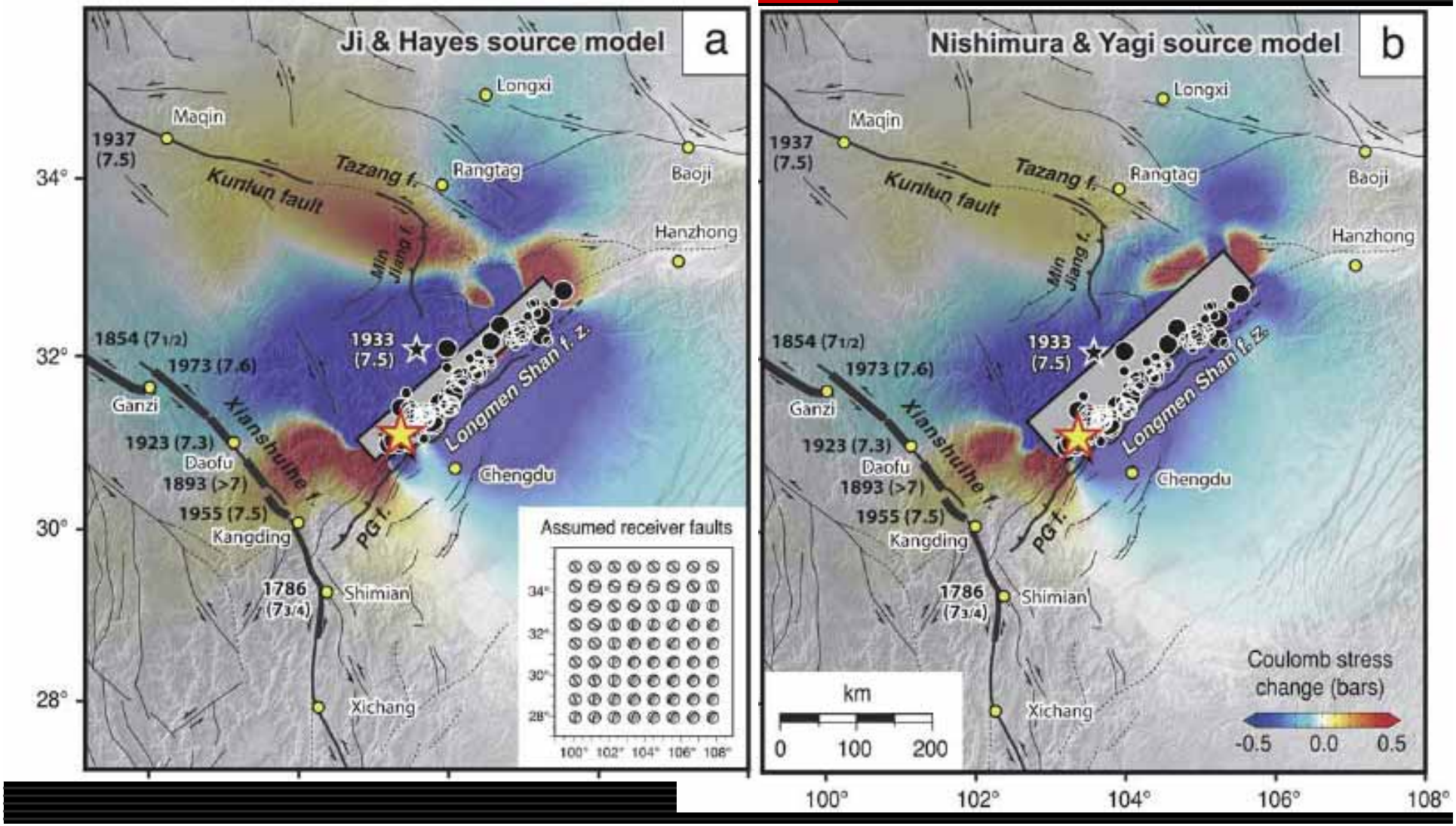
Close-up of Range-offset Map



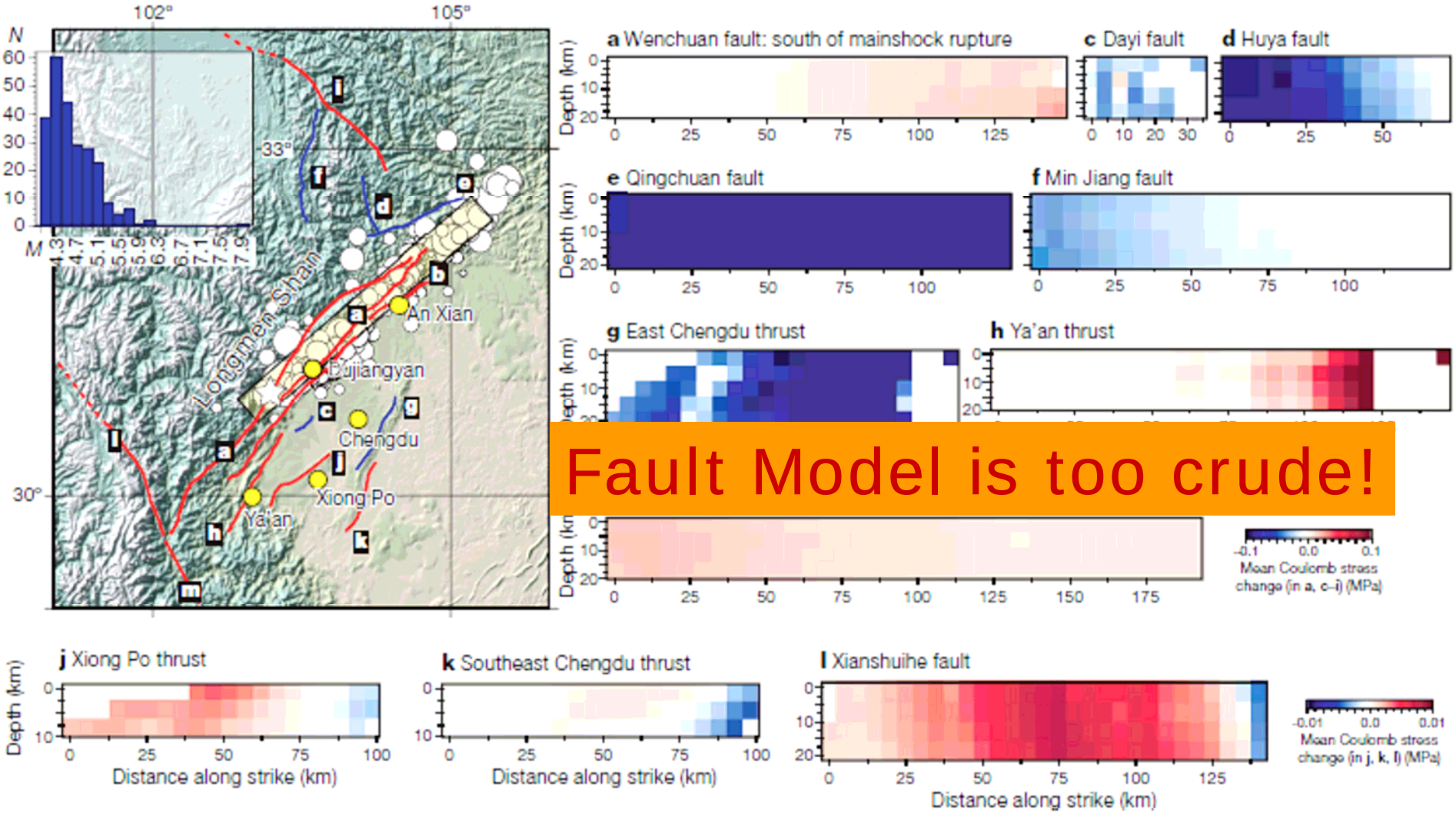
Modeled Interferogram (8 Segment Model)



Theoretical Stress Changes (Toda et al., 2008)



Theoretical Stress Changes (Parsons et al., 2008)

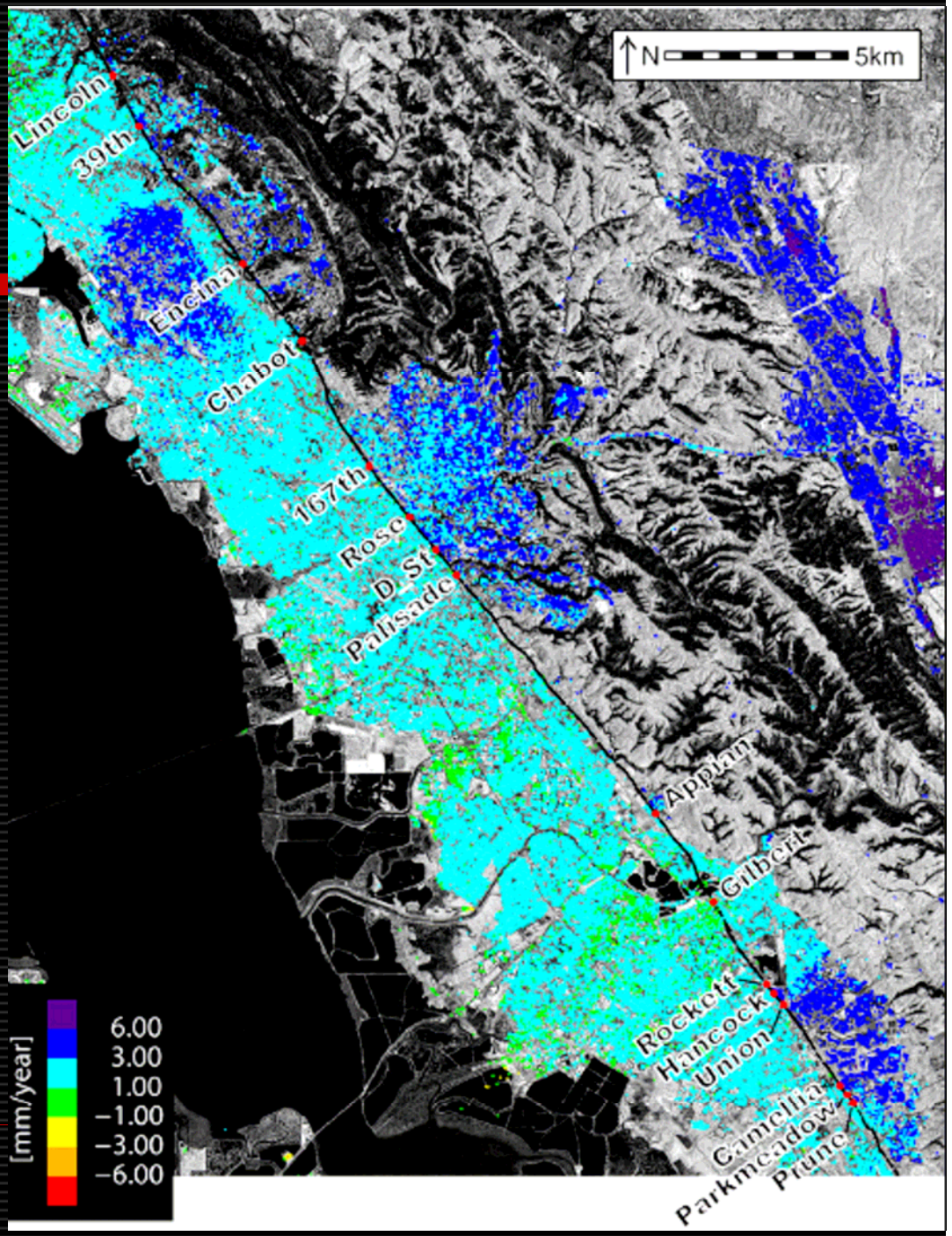


Advantage vs Disadvantage

- Advantage
  - High-resolution image of deformation without observations on ground
  - Available in case of heavy storm
  - Detection of displacements with pixel matching in a region of high gradient
- Disadvantage
  - First postseismic observation on May 19
  - Swath width of only 70km
  - Ionospheric or tropospheric disturbances
  - Wide-Swath ScanSAR
  - Multi-satellites (tandem etc.)

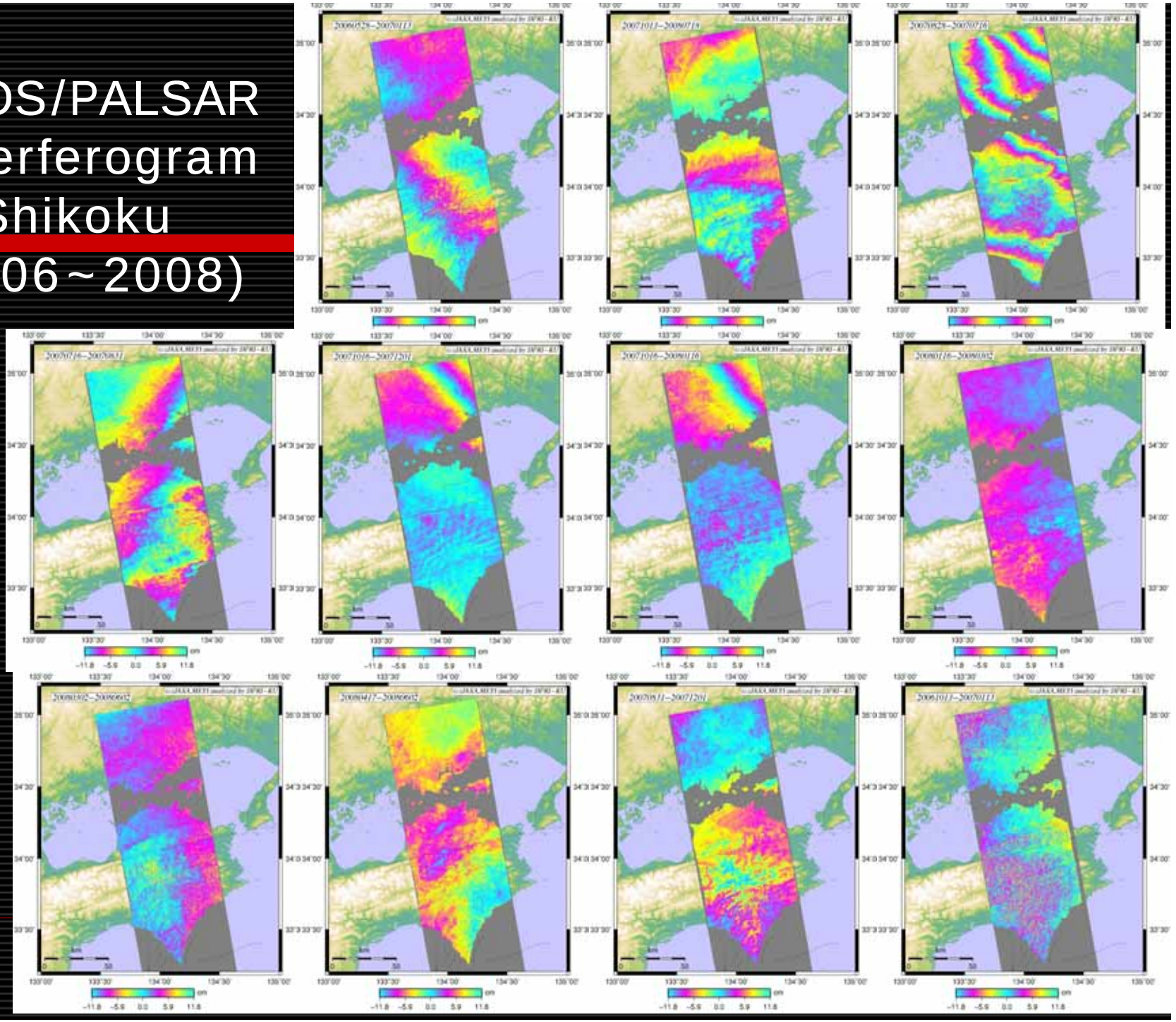
Time Series Analysis

- Spatial distribution of secular slow fault motion
- Stuck patch of fault
- Basis of strong ground motion computation/hazard evaluation



Lanari et al.(2006)

ALOS/PALSAR Interferogram in Shikoku (2006~2008)



Summary

- Interferometry
  - Complicated rupture process
    - 8 or more segments
  - Thrust on SW side, while dextral motion is prevailing on NE side.
  - Max. LOS displacement > 1m (except close vicinity of the fault)
  - Fault length > 240km
- Pixel Matching
  - Discontinuity across the Beichuan Fault
  - Max. LOS displacement > 2m
- High resolution images of deformation
- ➢ Detailed fault model -> Precise estimate future seismic hazard estimate