Research within the WinSAR consortium

… and the GeoEarthscope project

… and the Los Angeles and Hawaii Supersite

Falk Amelung, University of Miami (Chair)

and the WinSAR Executive Committee

Roland Burgmann, Yuri Fialko, Eric Fielding and David Schmidt

Outline of talk:

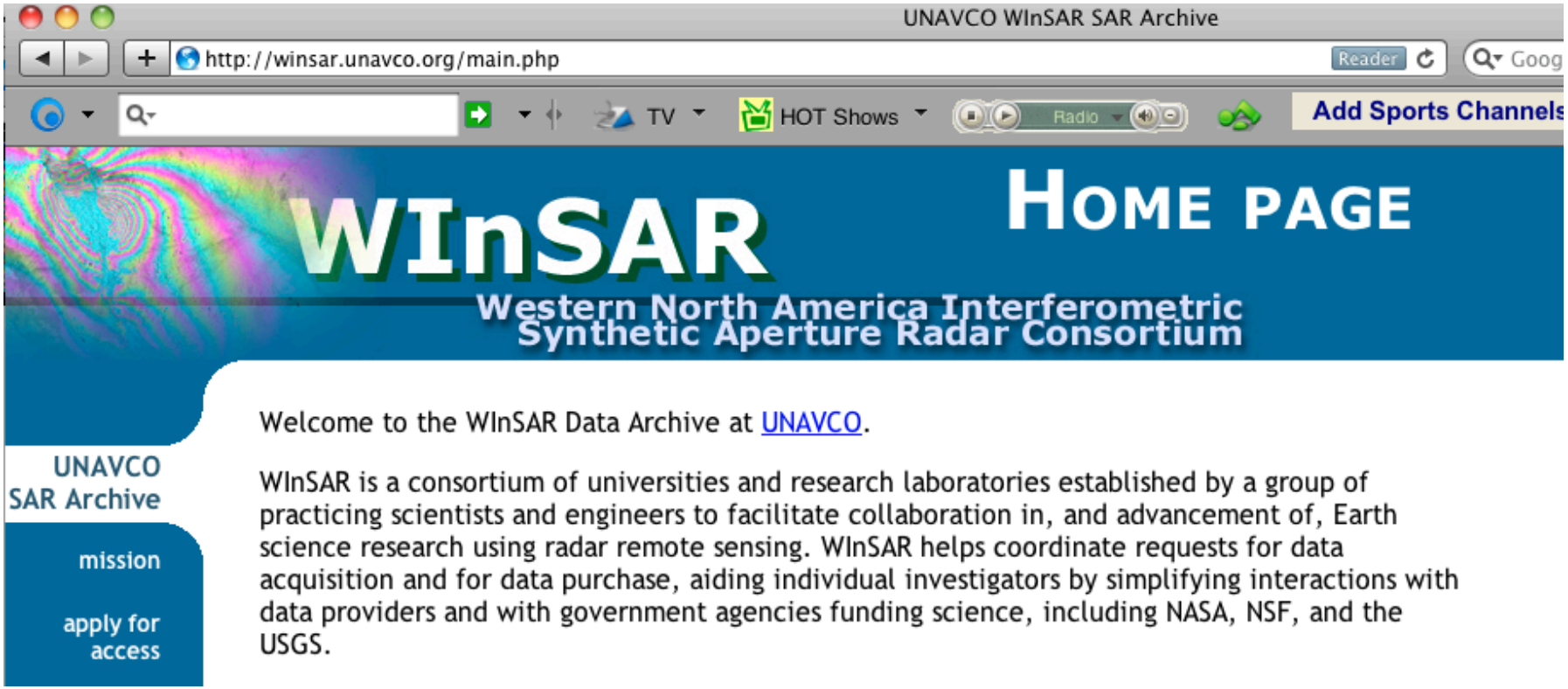
What is WinSAR ?

Research examples:

- Earthquakes
- Inter-seismic
- Volcanoes
- Subsidence
- Others

Recommendations

What is WinSAR ?



Consortium of 83 Universities/ Research Institutions
~20 non U.S.
Executive Committee (elected, 2-year terms)

Funding:

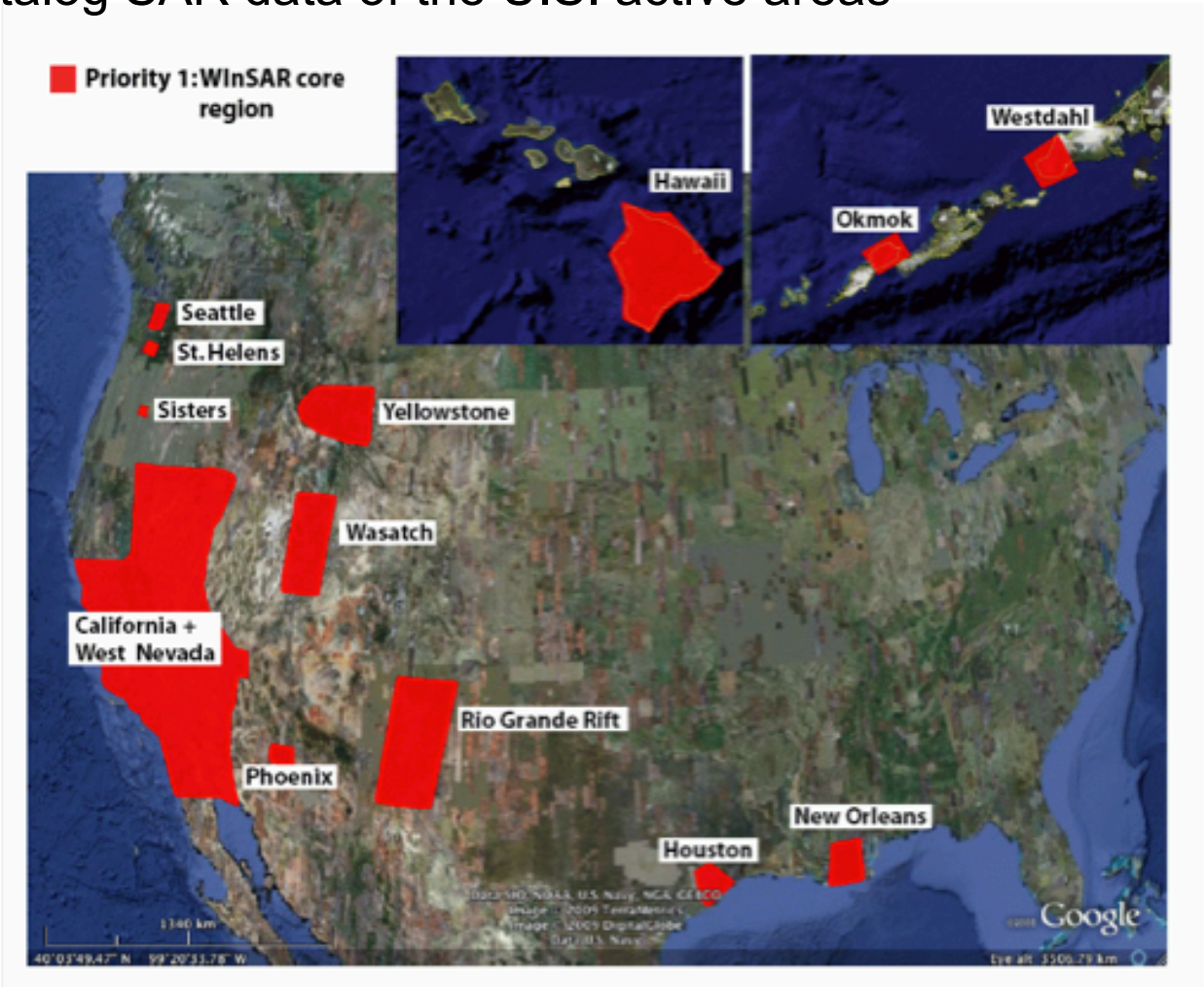
WinSAR objectives

- Promote the use and development of InSAR technology for scientific investigations.
- Promote free and open access to SAR data as allowed by data providers.
- Acquire, archive and catalog SAR data of the U.S. active areas (4 sec. download time)

Complete ERS,Envisat data sets available for WinSAR core area!

	# of scenes	
ERS	22826	8.9 TB
Envisat	7185	1.7 TB

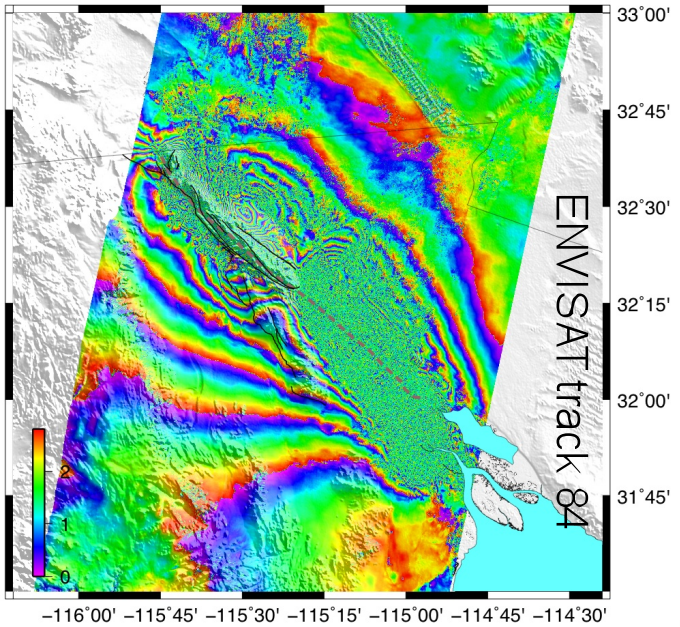
WinSAR successful when it is not needed anymore!

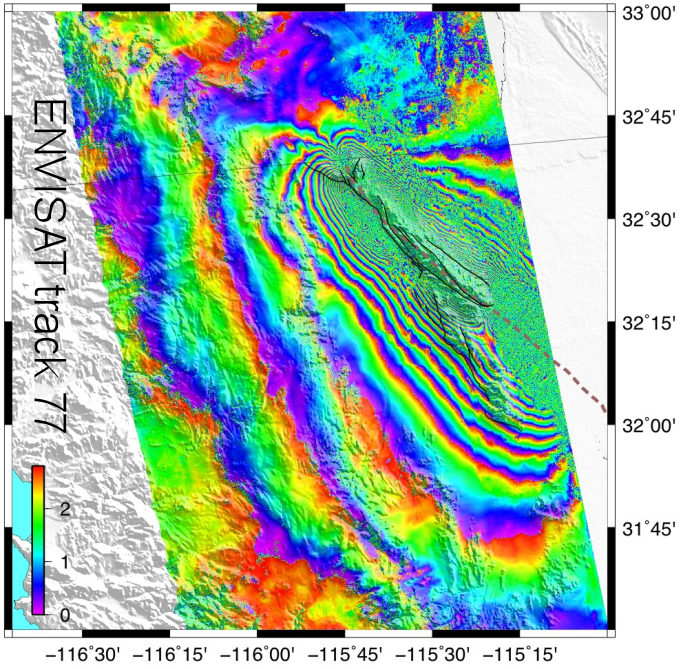


2. Earthquakes

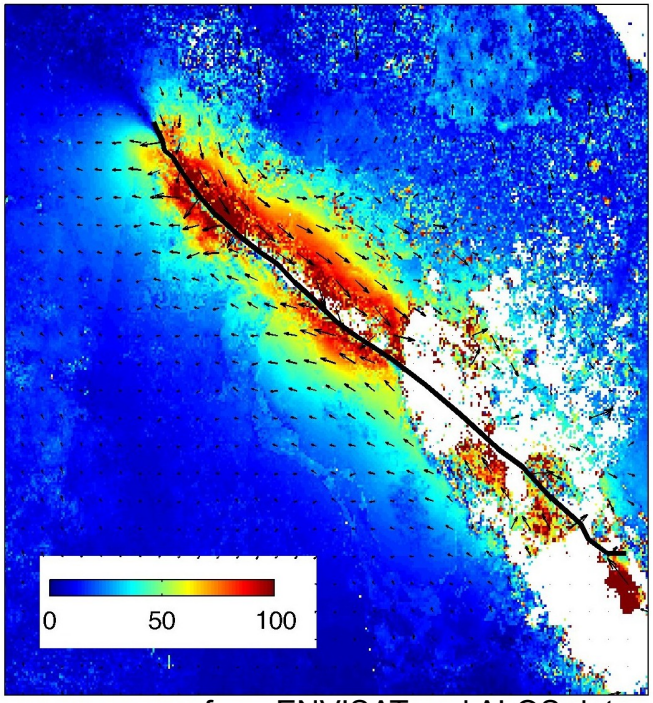
April 4, 2010 M7.2 El Mayor (Mexico) earthquake

Yuri Fialko
SIO/UCSD



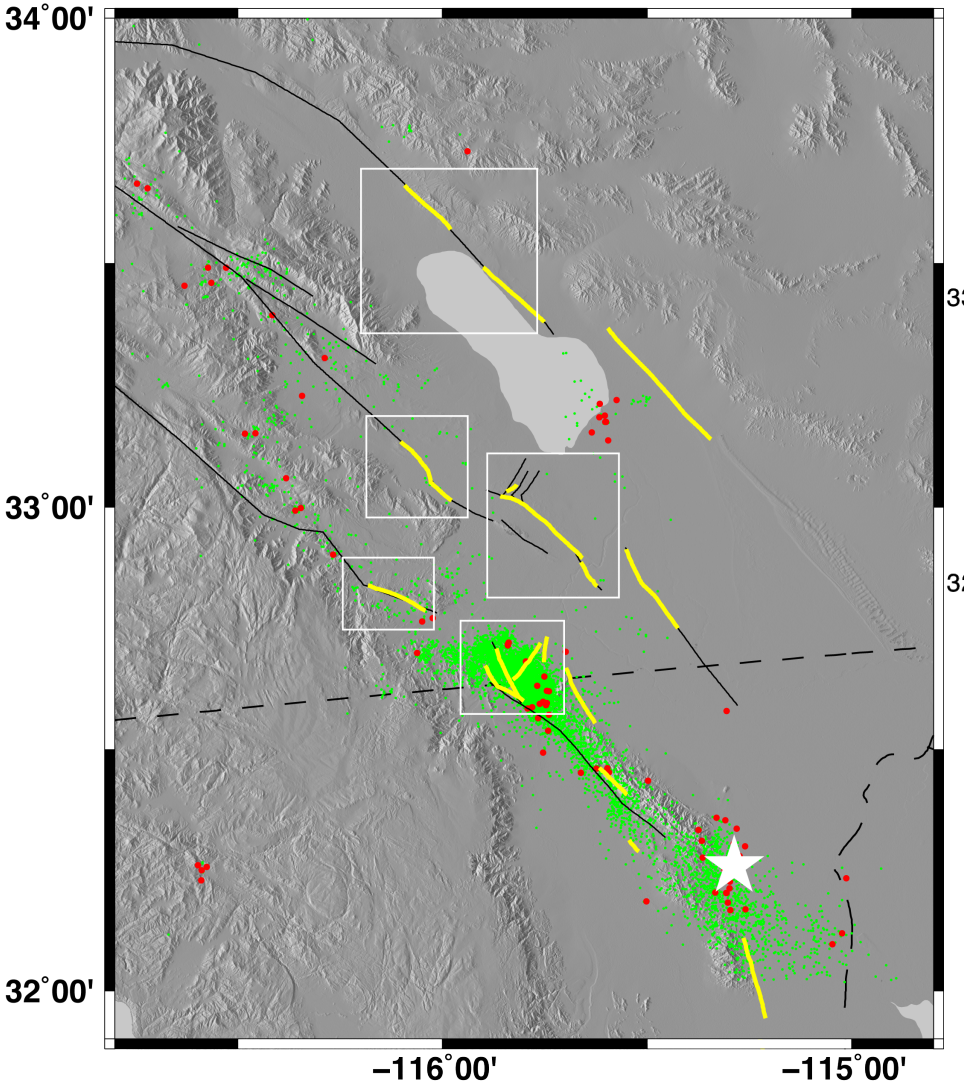


Horizontal displacements, cm

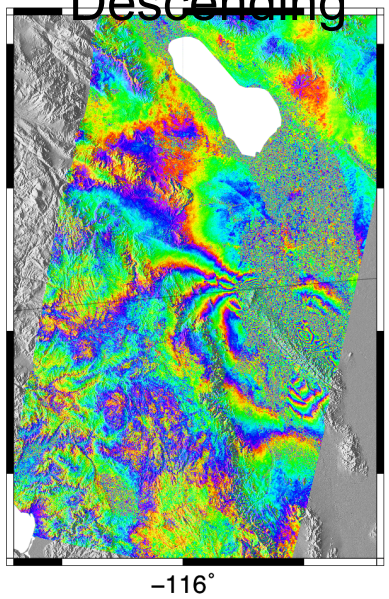


from ENVISAT and ALOS data

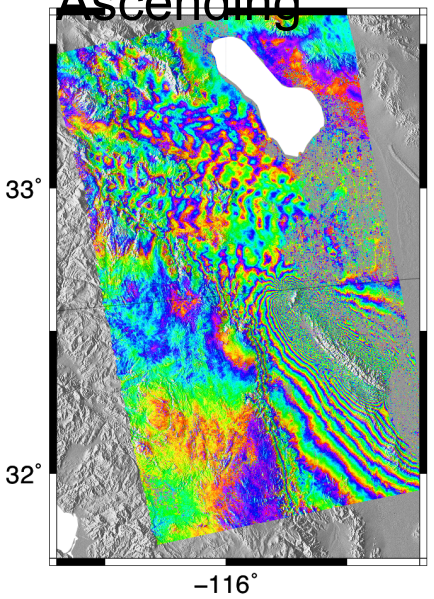
Fault Slip in Southern California triggered by the April 4th, 2010 Baja Earthquake in Mexico, Observed by ENVISAT data



ENVISAT Descending



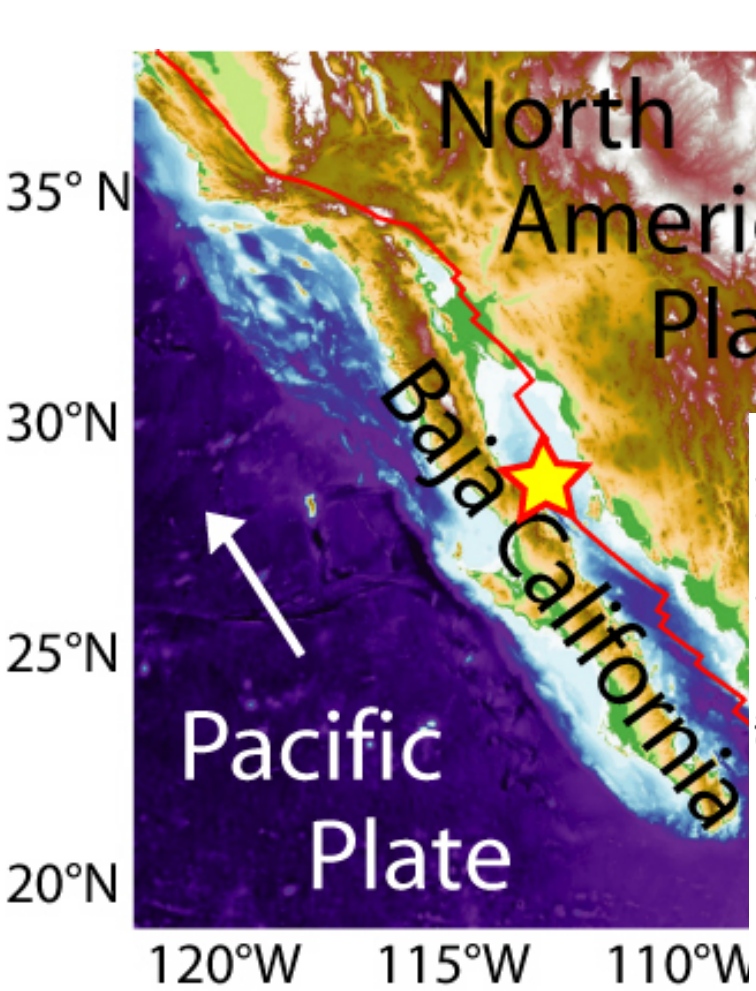
ENVISAT Ascending

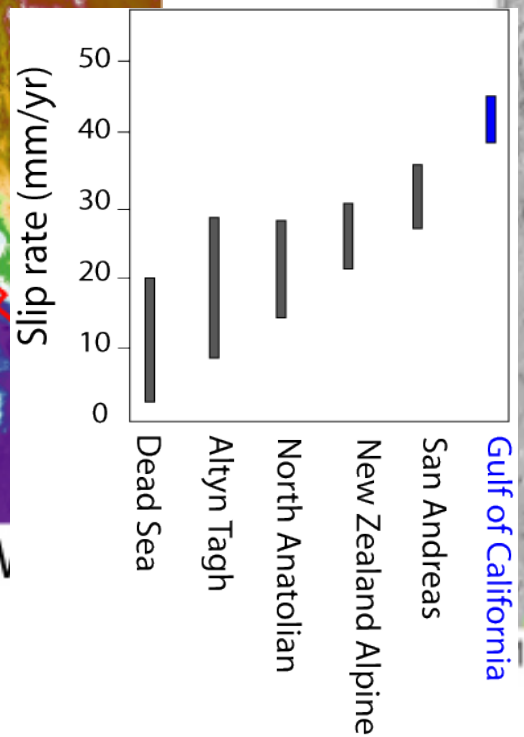


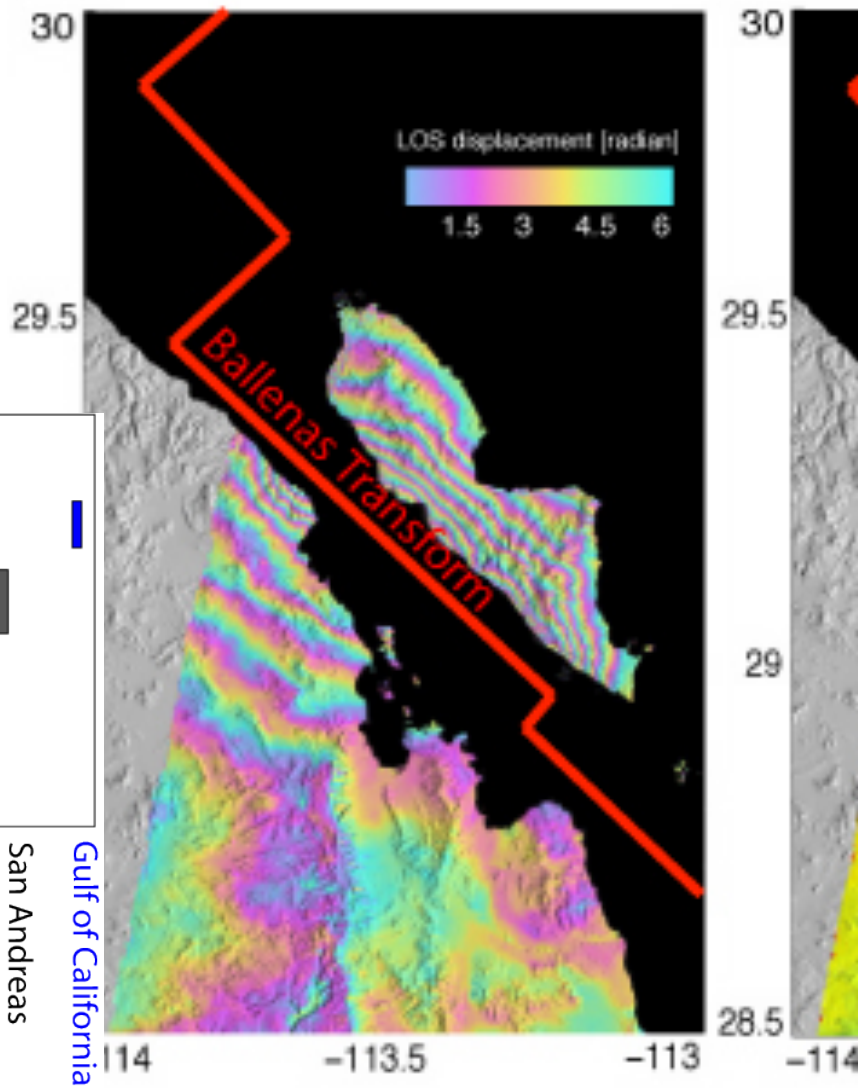
Map of Southern California and Northern Baja California. Black solid lines are major faults. Yellow solid lines are faults observed offset except the one in the bottom is a subsided road.

Wei, Sandwell, SIO/UCSD

August 3rd 2009 Mw 6.9 event in central Gulf of California, Ballenas Transform Fault



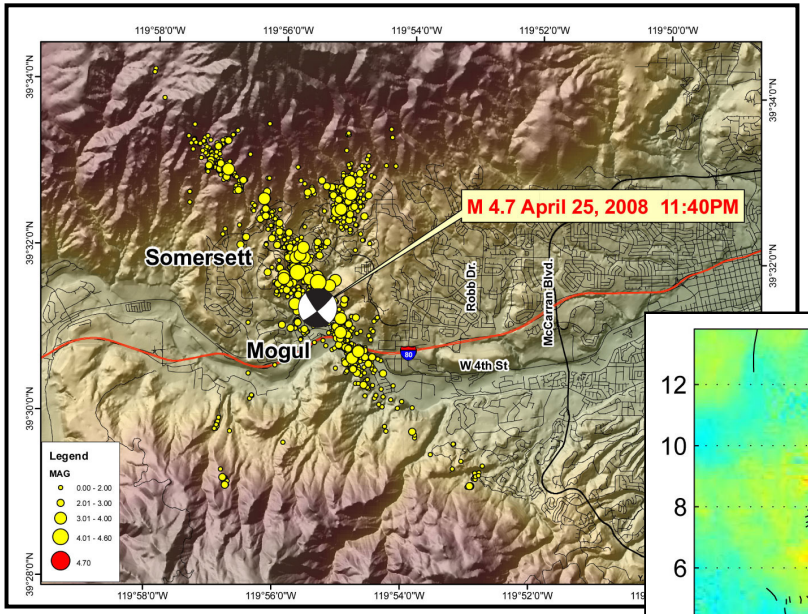


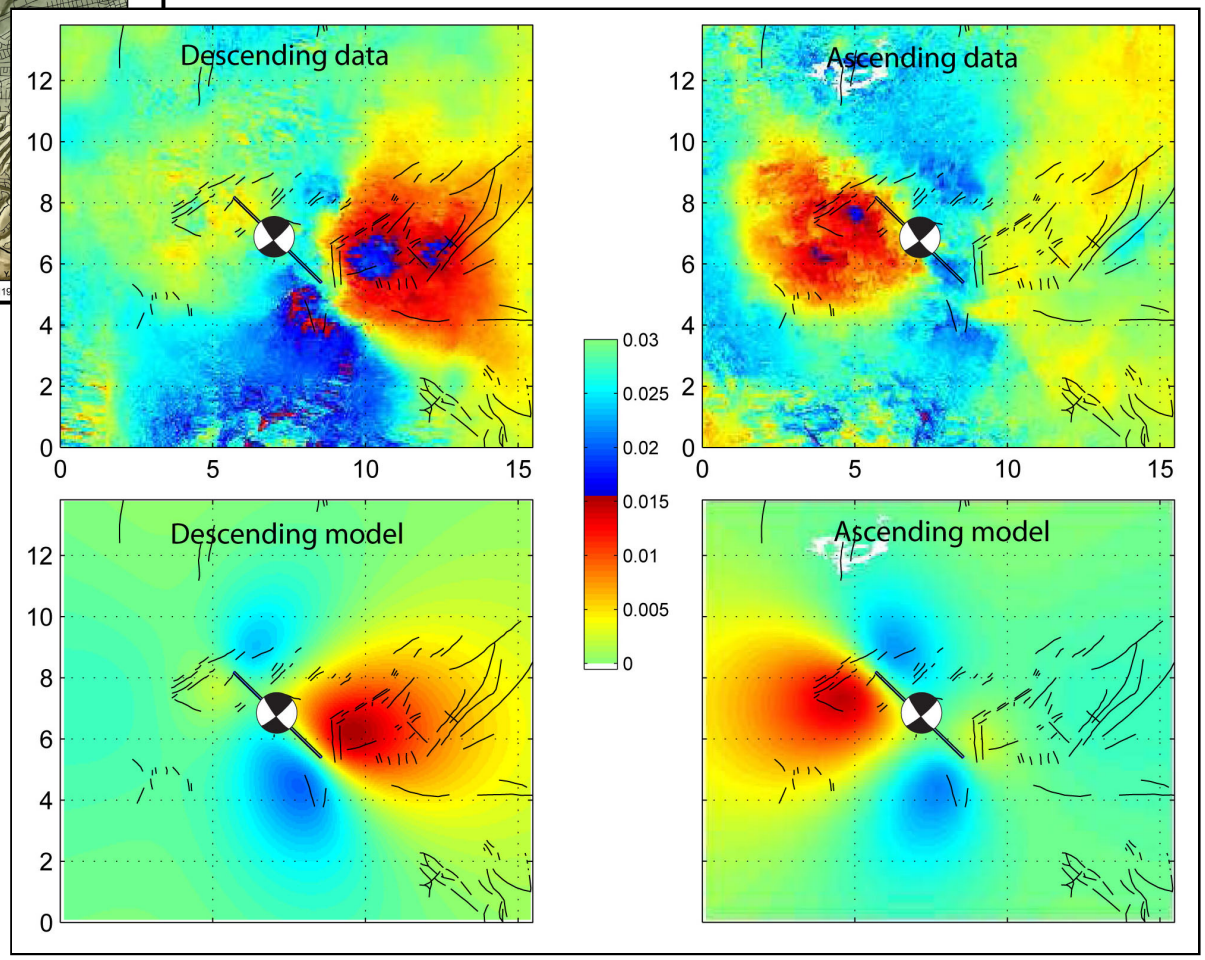


Plattner, Amelung, Dixon, Malservisi et al., U of Miami, U of South Florida

2008 Reno-Mogul earthquake M 4.7

WInSAR 2007-2009 data



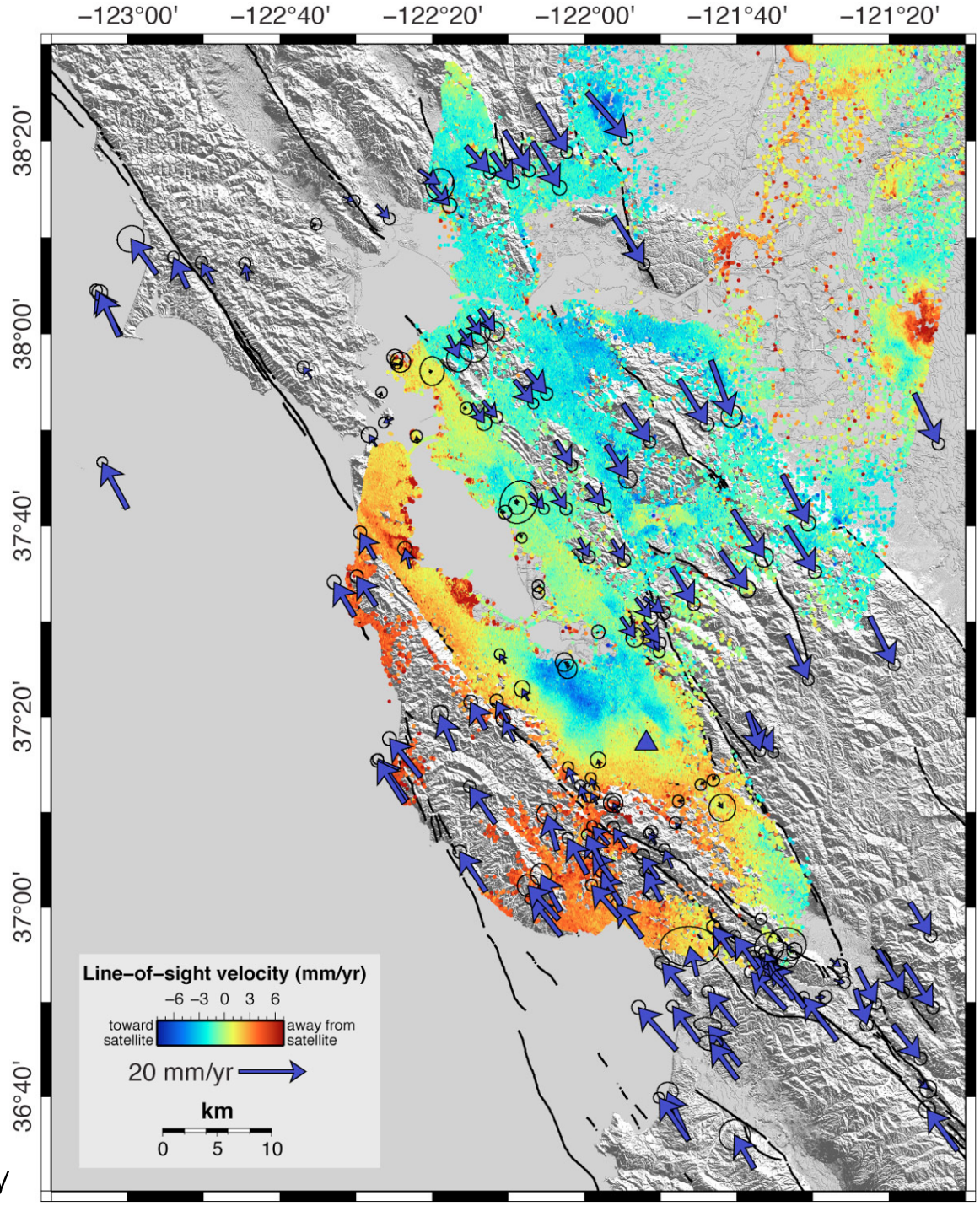


- Smallest magnitude event detected with InSAR in Basin and Range
- Preferred model: 20 cm right-lateral strike-slip motion on N45W fault at 1 km depth
- M_w 5.29

University of Nevada, Reno and University of Miami

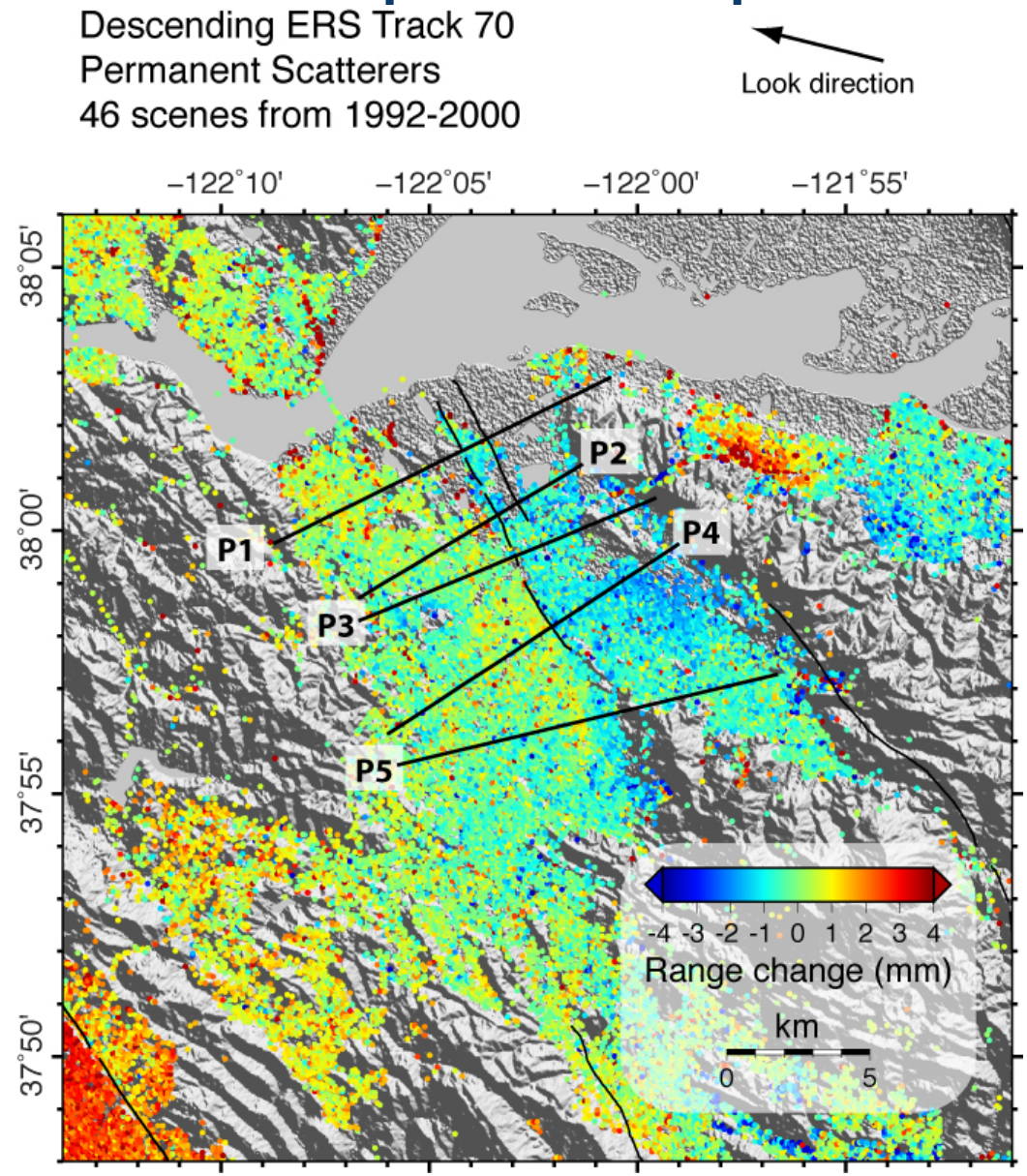
2. Interseismic

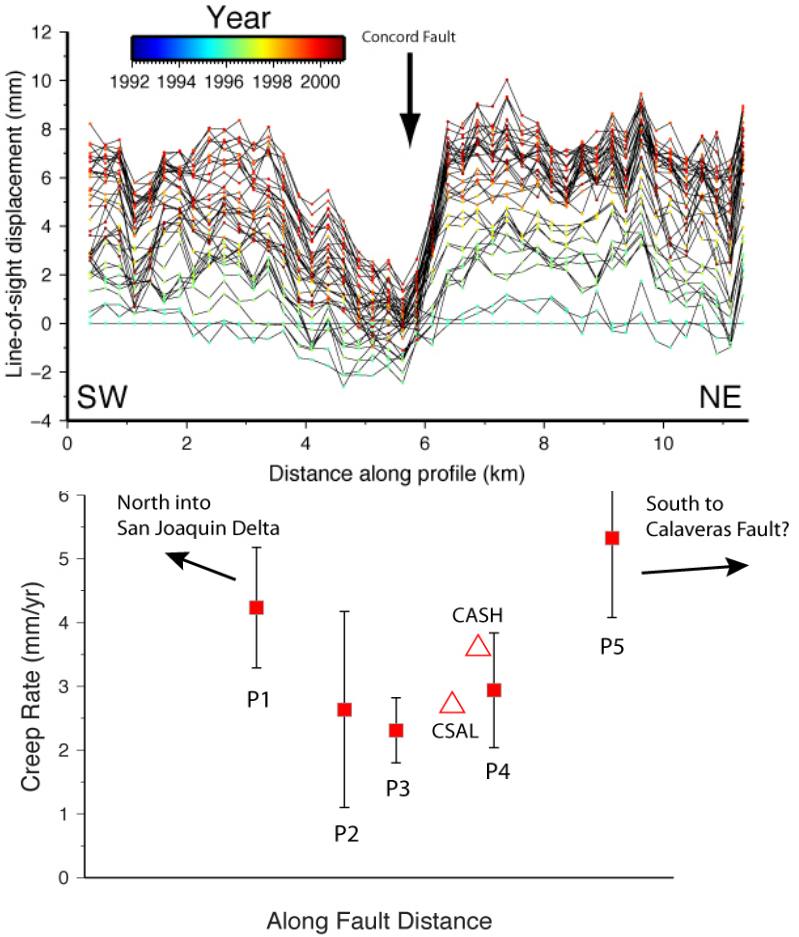
GPS & InSAR Over San Francisco Bay Area



R. Burgmann, G. Funning et al., UC Berkeley

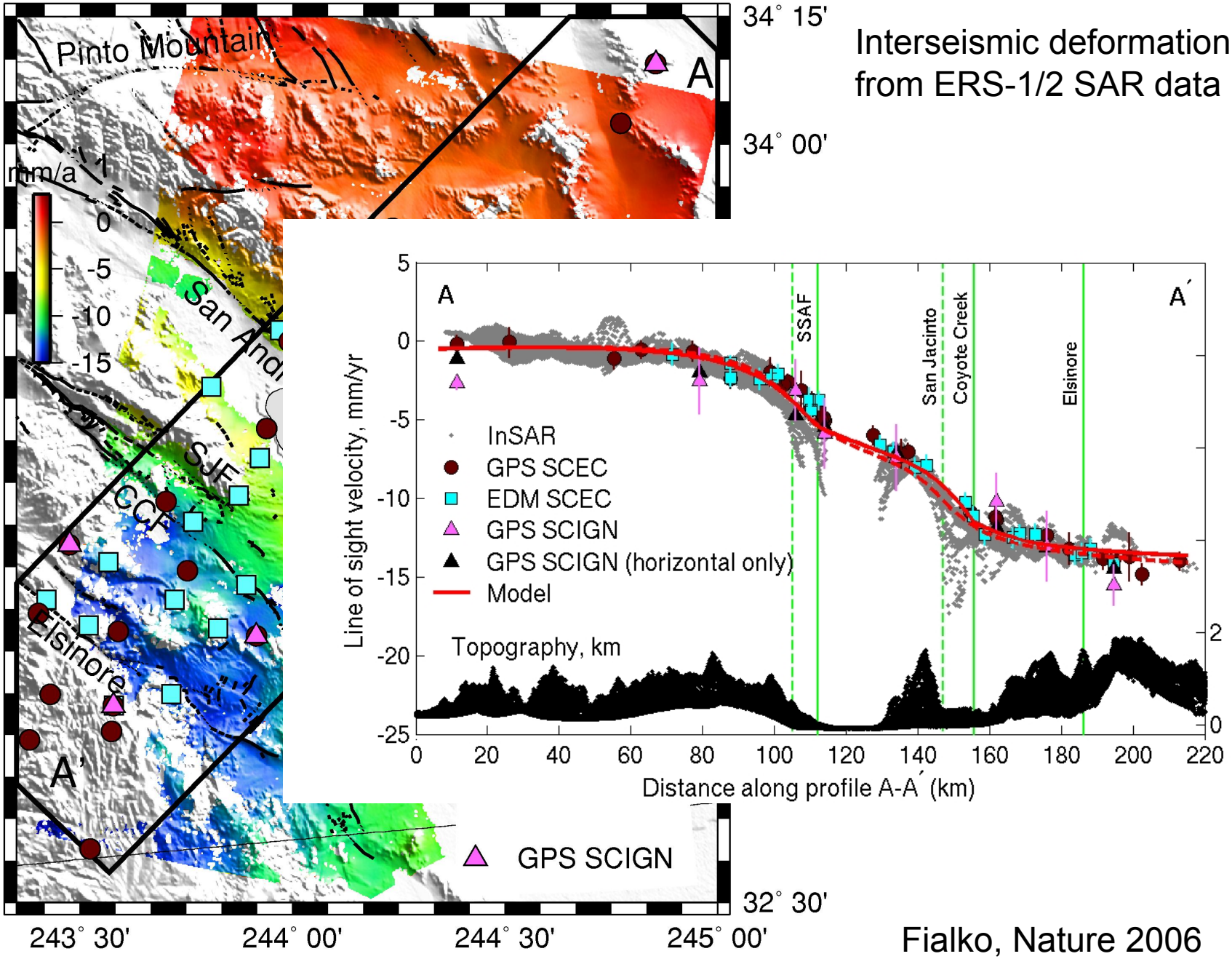
Creep and Asperities on Other Faults





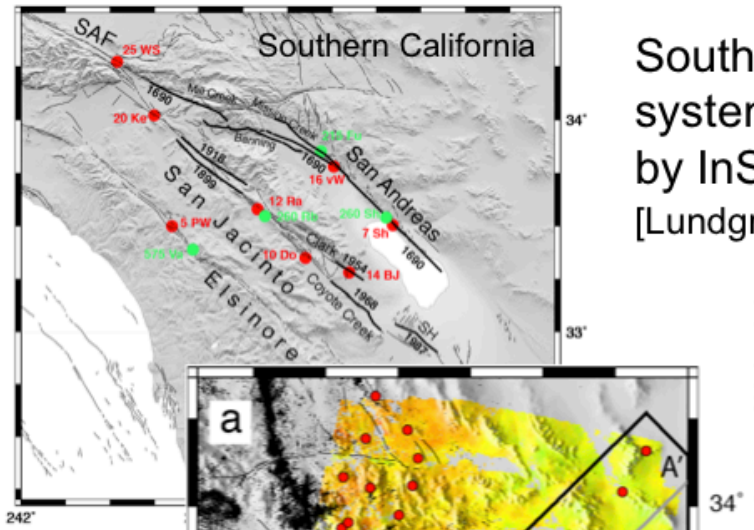
- Constrain subsurface creep and asperities on partially coupled faults
- Calaveras, Rodgers Creek, Concord, Green Valley, San Andreas

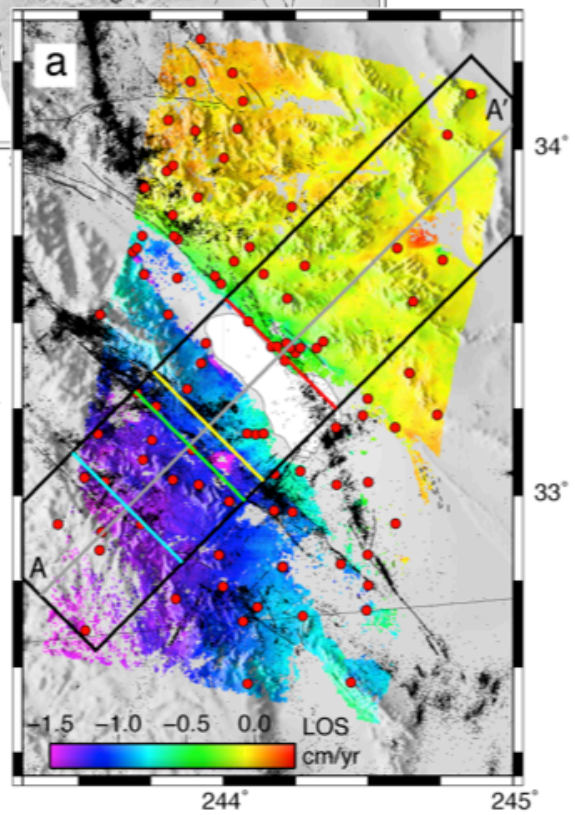
R. Burgmann, G. Funning et al., UC Berkeley


Interseismic deformation
from ERS-1/2 SAR data
Pinto Mountain
San Andreas
SJF
CCF
Elsinore
A
A'
mm/a
1
0
-5
-10
-15
34° 15'
34° 00'
32° 30'
243° 30'
244° 00'
244° 30'
245° 00'
GPS SCIGN
Line of sight velocity, mm/yr
Distance along profile A-A´ (km)
InSAR
GPS SCEC
EDM SCEC
GPS SCIGN
GPS SCIGN (horizontal only)
Model
Topography, km
SSAF
San Jacinto
Coyote Creek
Elsinore
Fialko, Nature 2006

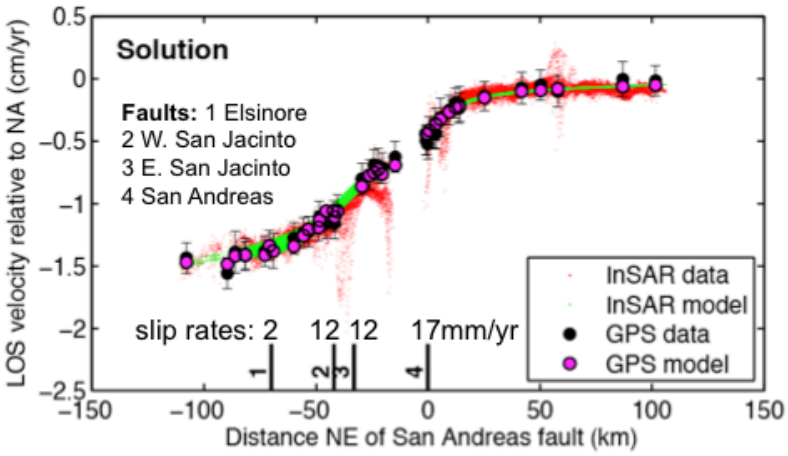
Southern San Andreas - San Jacinto fault system: Earthquake cycle models constrained by InSAR* and GPS data

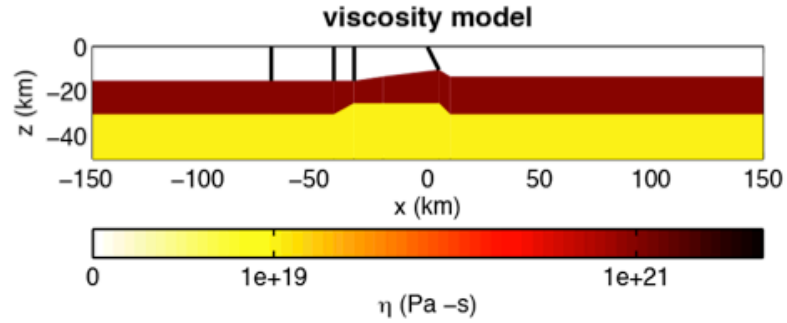
[Lundgren et al., *J. Geophys. Res.*, 2009]





InSAR time series mean line-of-sight velocity map (ERS T356, 1992-1999)



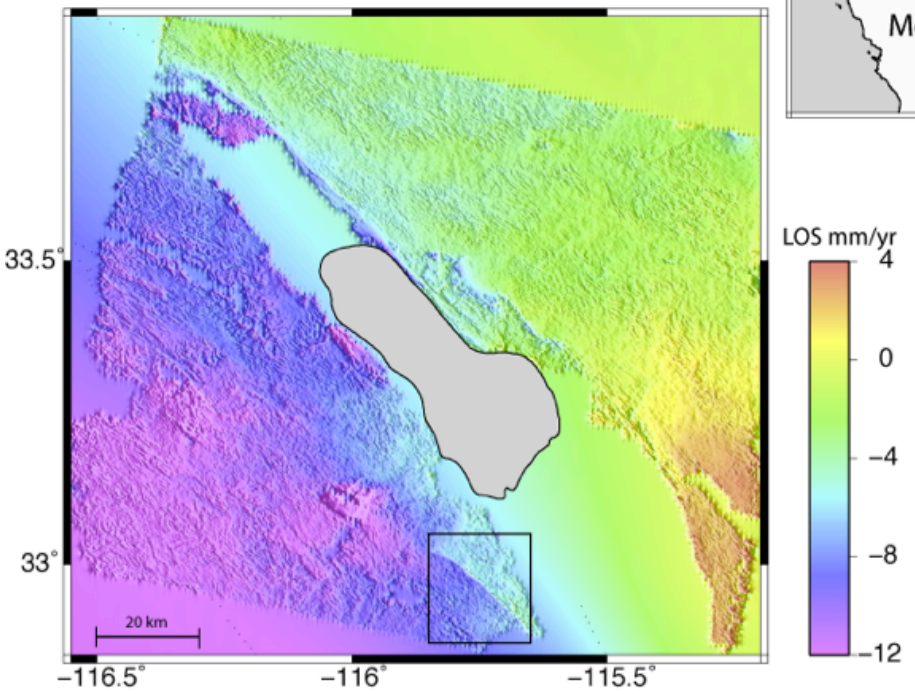


Visco-elastic earthquake cycle, Maxwell solid model, allows for estimation of slip rate, time into earthquake cycle, and lower crust/upper mantle viscosity structure

*ERS data courtesy ESA from WInSAR archive

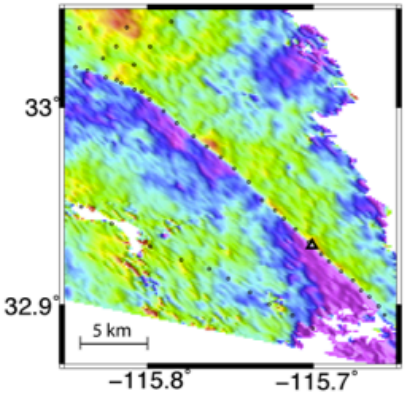
P. Lundgren et al., JPL

1992-2000 ERS (15 interfero-grams stacked)

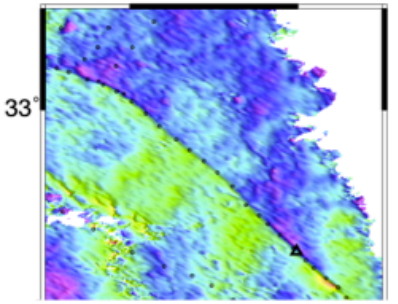


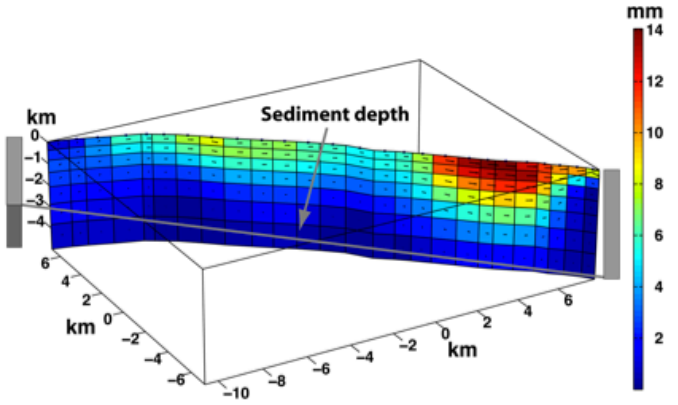
Wei, M., D. Sandwell, and Y. Fialko (2009), A silent Mw 4.7 slip event of October 2006 on the Superstition Hills fault, southern California, J. Geophys. Res., 114, B07402, doi: 10.1029/2008JB006135.

Descending (7 interferograms stacked)

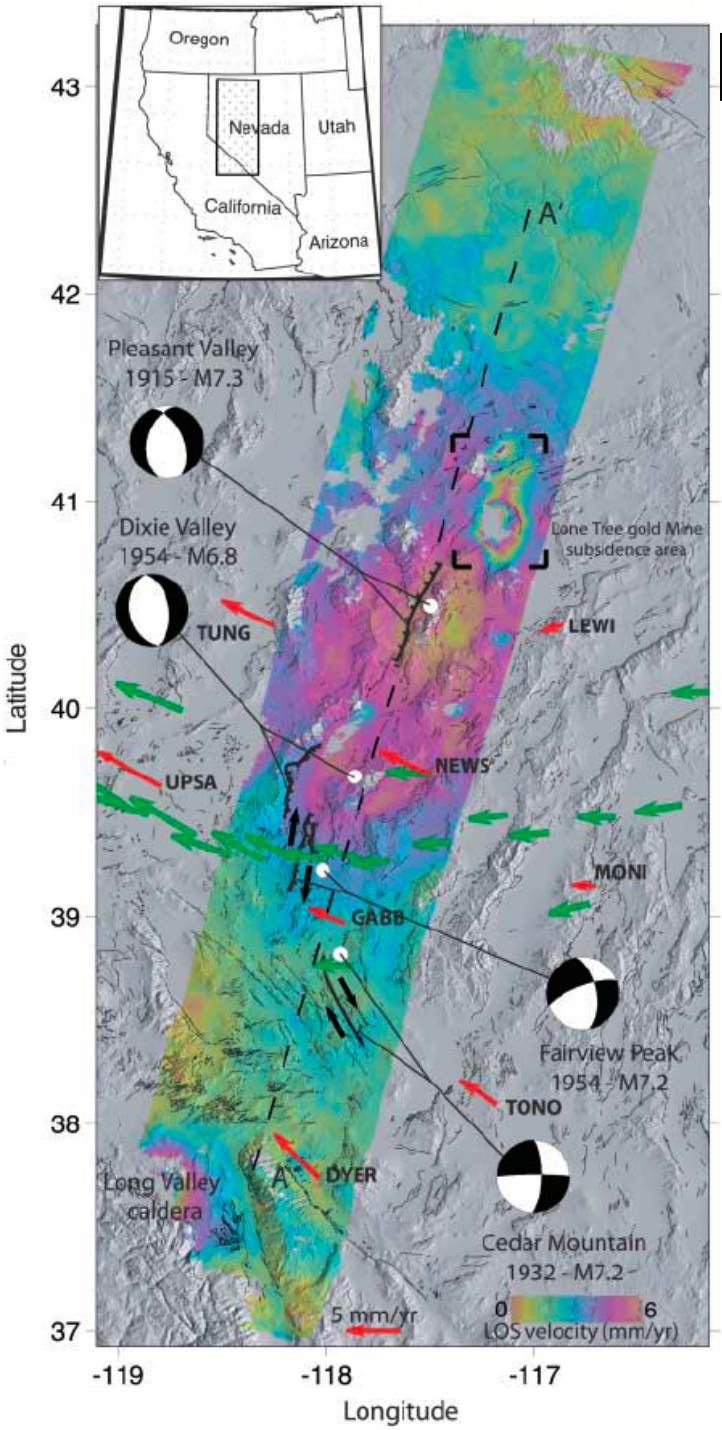


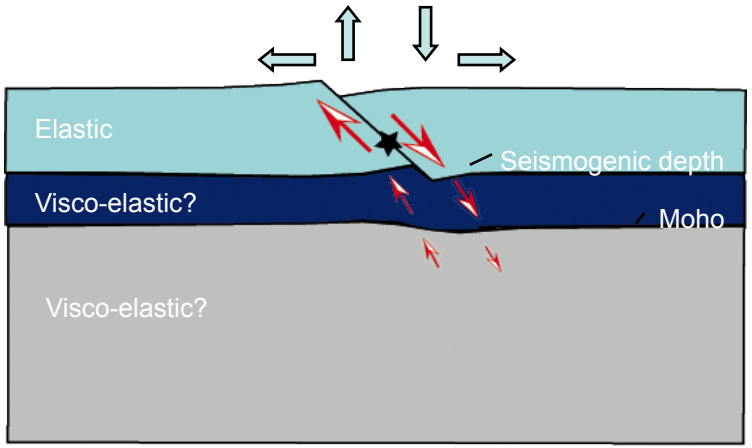
Ascending (8 interferograms stacked)





Post-seismic deformation in Nevada

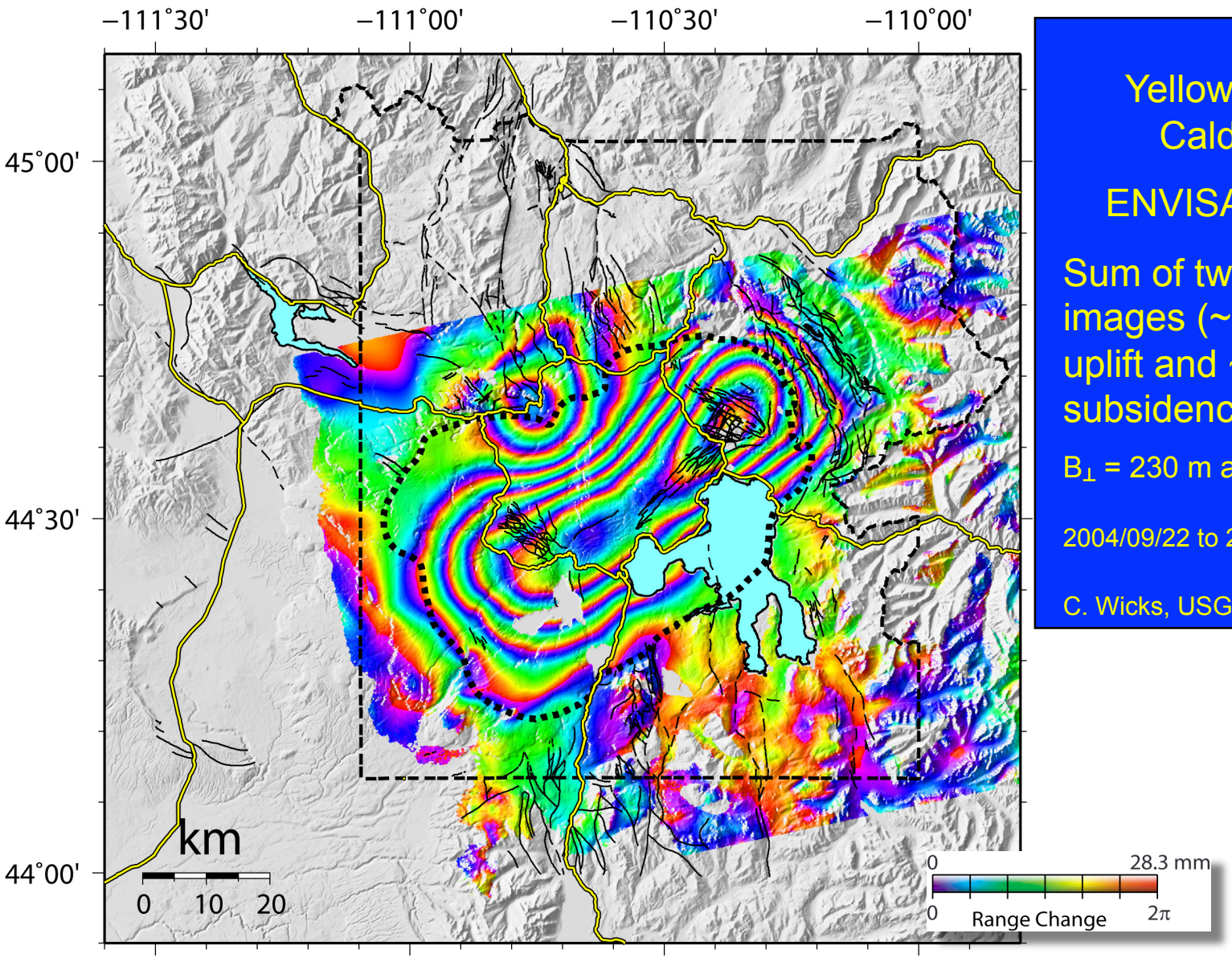




Several 1917-1954 M>7 earthquakes caused viscous flow in the Earth's mantle which is detectable at the Earth's surface.

Gourmelen and Amelung, Science, 2005

3. Magmatic



Yellowstone Caldera

ENVISAT IS2

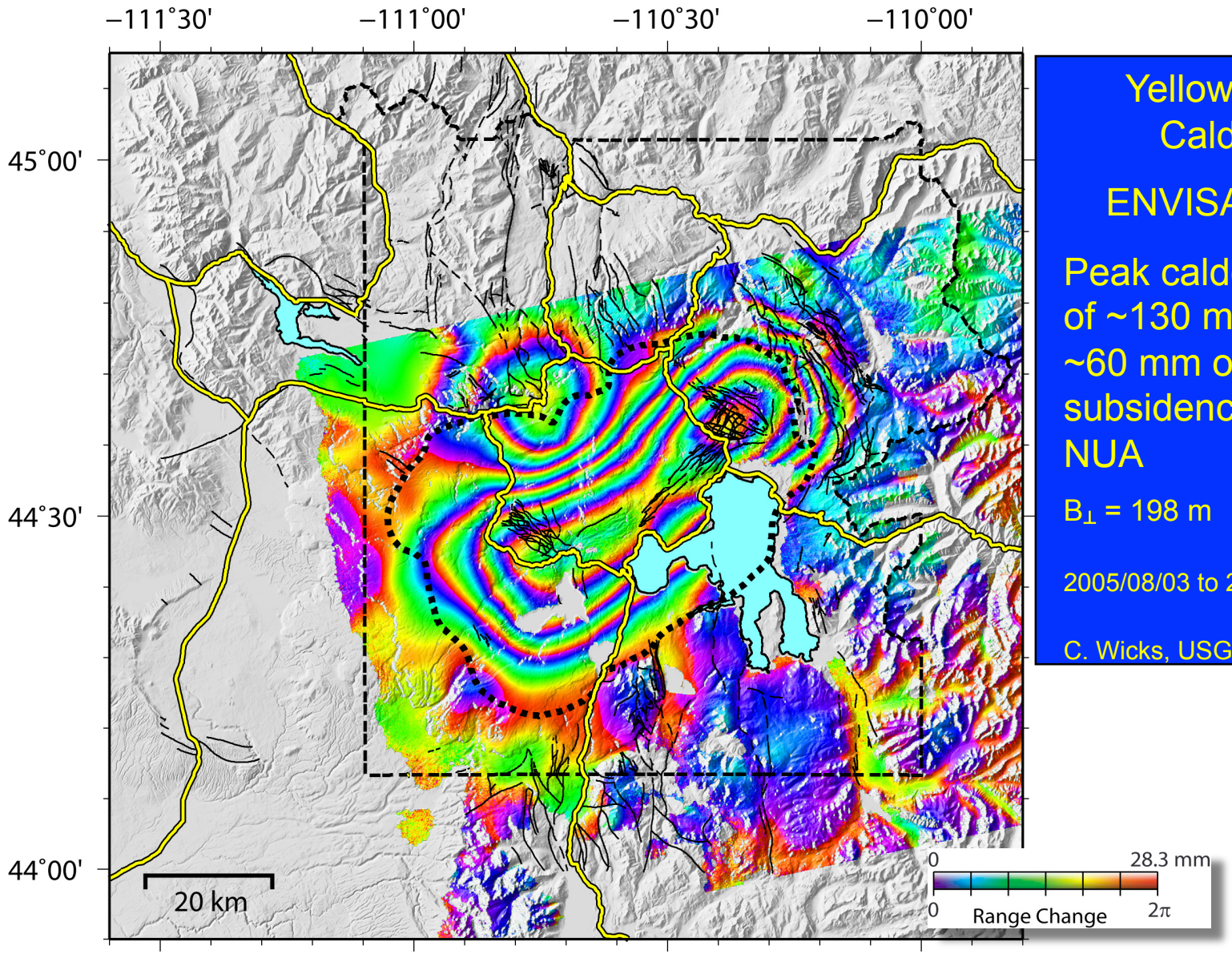
Sum of two images (~150 mm uplift and ~65 mm subsidence)

$B_{\perp}$ = 230 m and 190 m

2004/09/22 to 2006/08/23

C. Wicks, USGS

USGS



Yellowstone Caldera

ENVISAT IS2

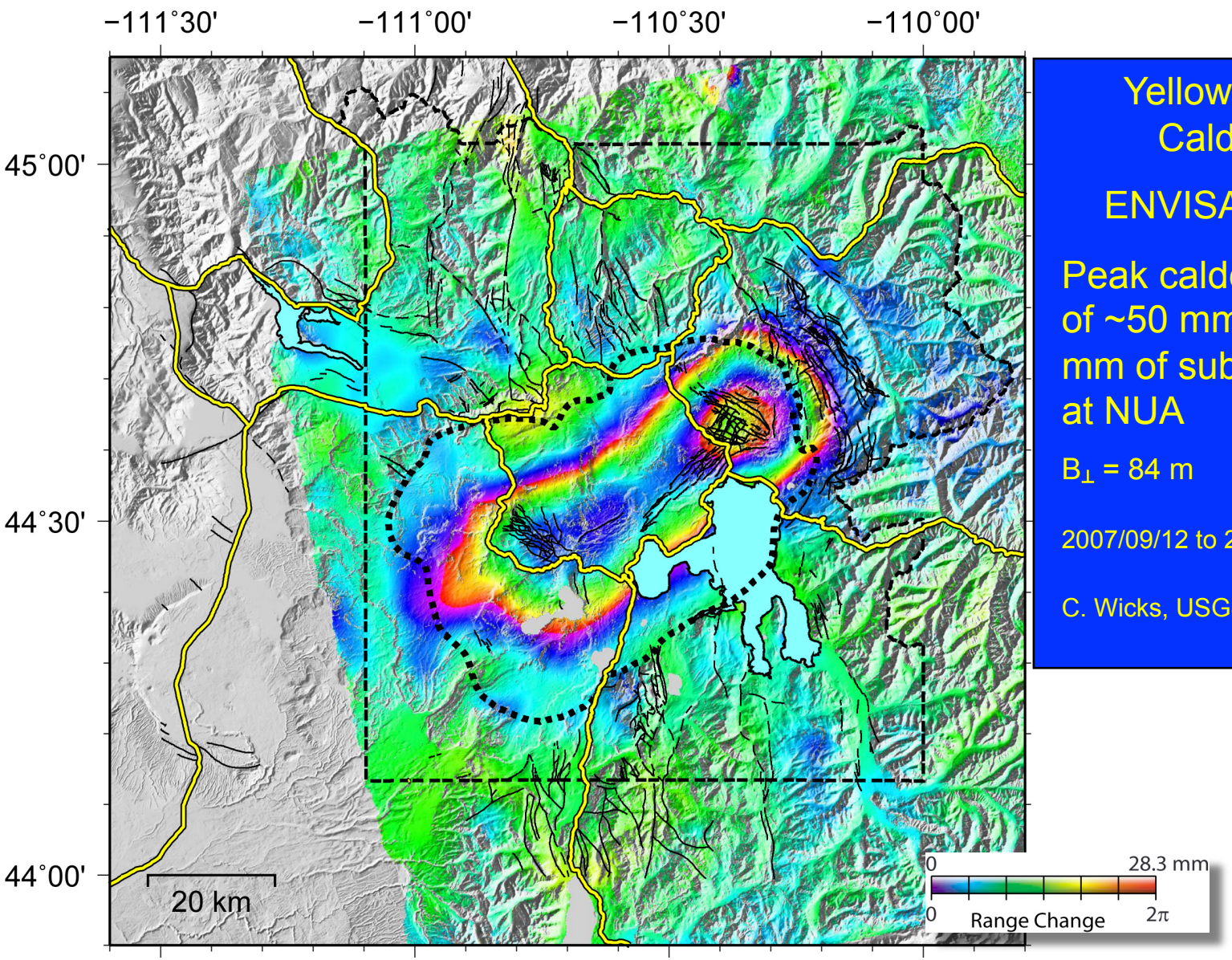
Peak caldera uplift of ~130 mm and ~60 mm of subsidence at NUA

$B_{\perp}$ = 198 m

2005/08/03 to 2007/07/04

C. Wicks, USGS

USGS



Yellowstone Caldera

ENVISAT IS2

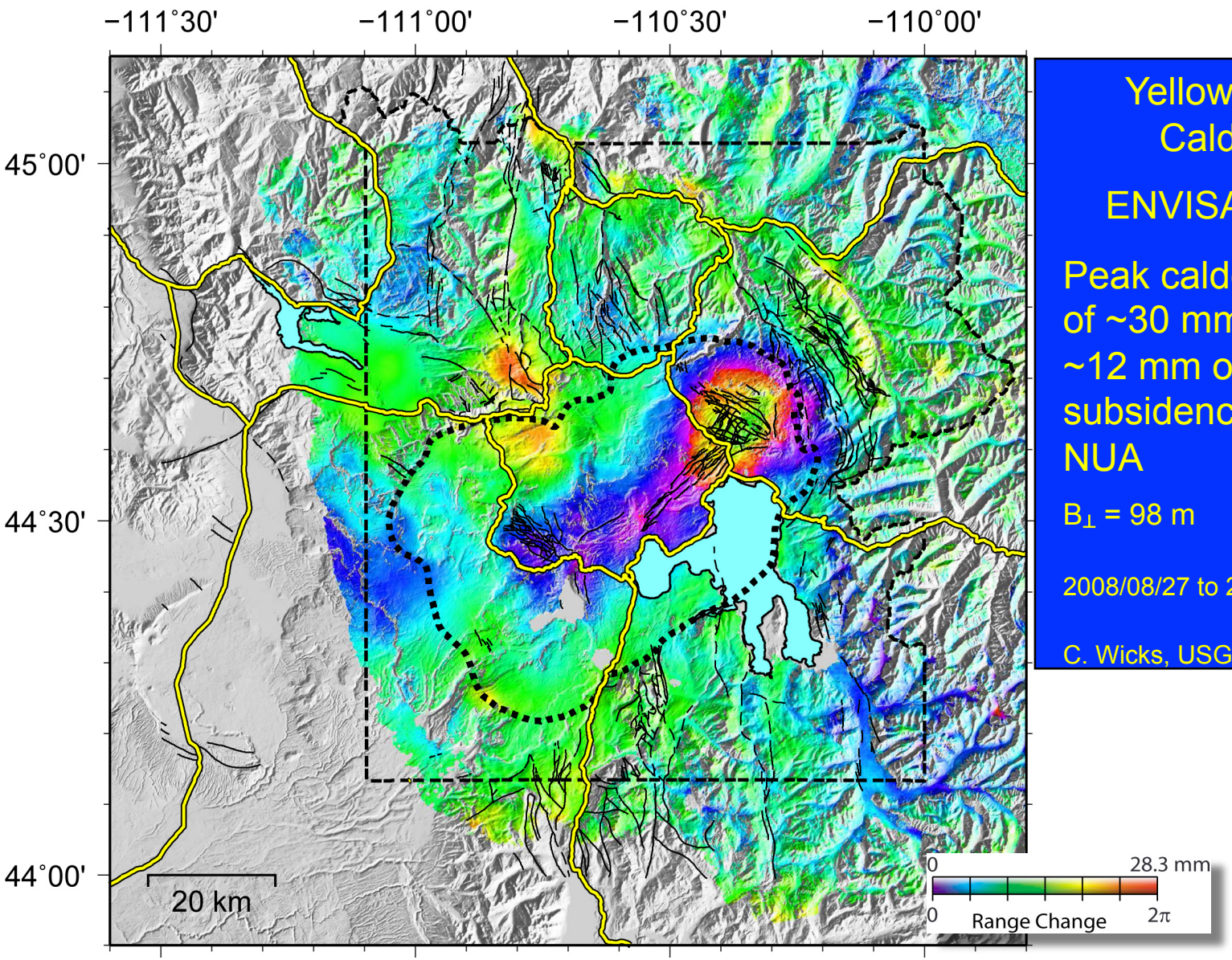
Peak caldera uplift of ~50 mm and ~8 mm of subsidence at NUA

$B_{\perp}$ = 84 m

2007/09/12 to 2008/08/27

C. Wicks, USGS

USGS



Yellowstone Caldera

ENVISAT IS2

Peak caldera uplift of ~30 mm and ~12 mm of subsidence at NUA

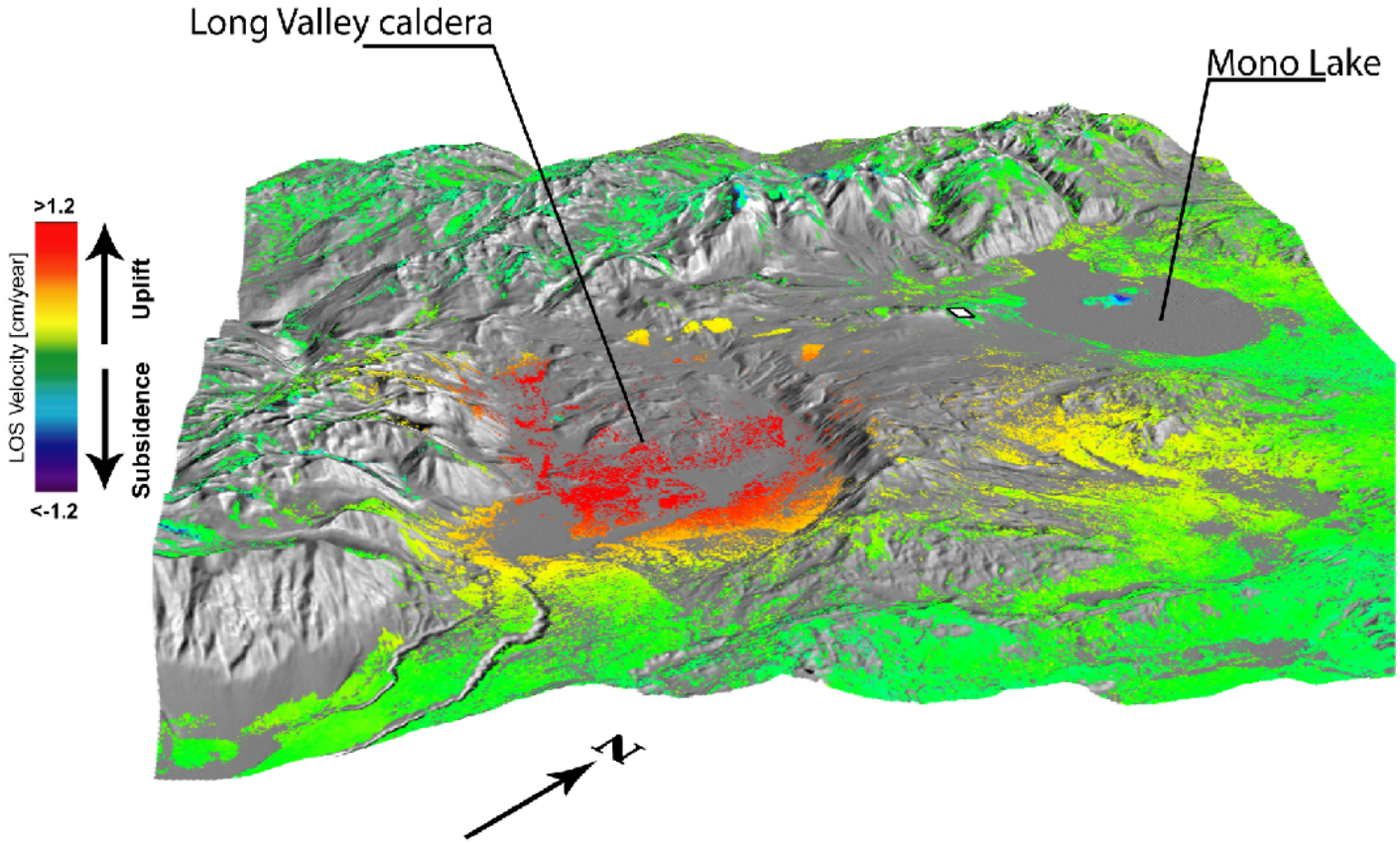
$B_{\perp}$ = 98 m

2008/08/27 to 2009/09/16

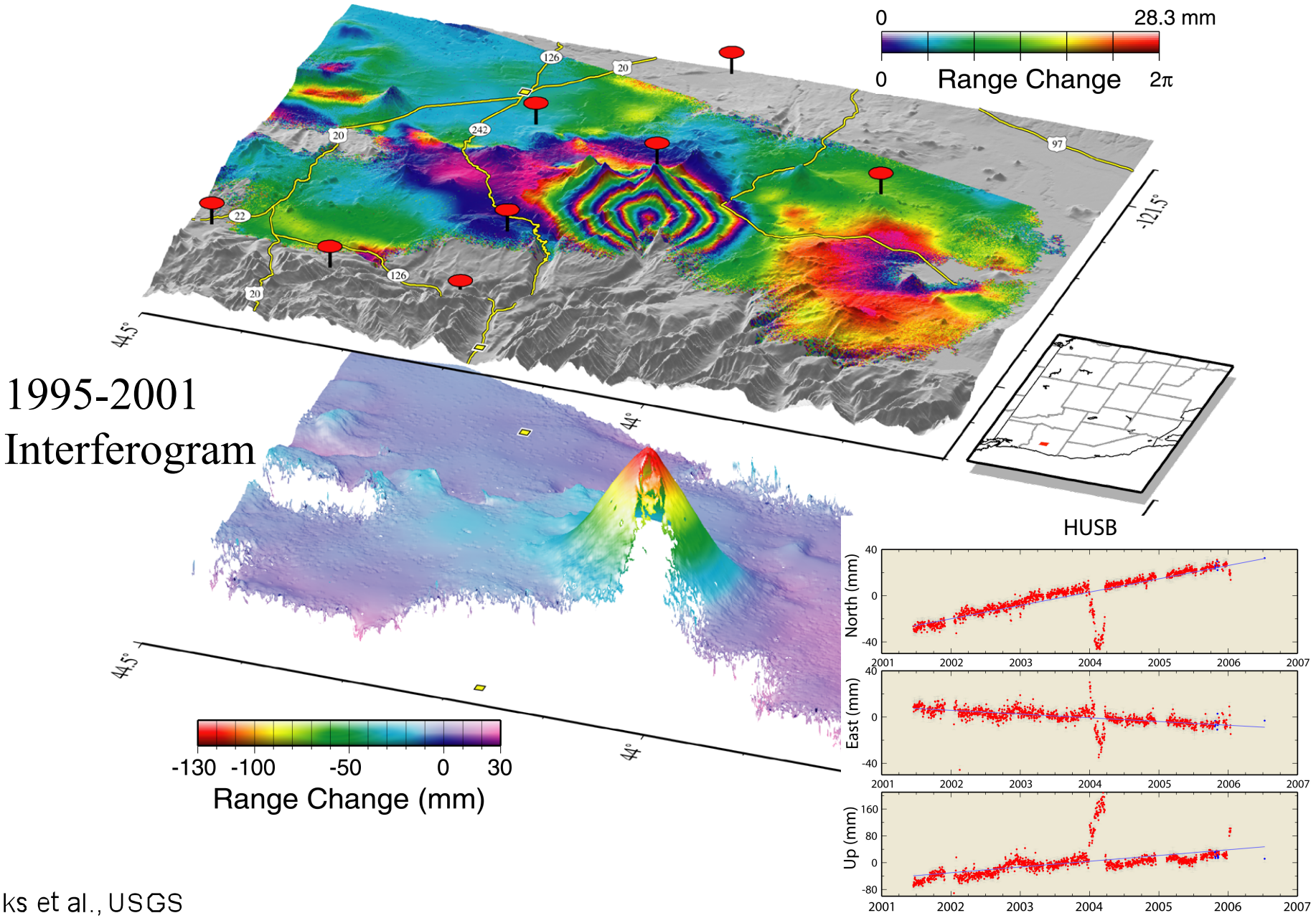
C. Wicks, USGS

USGS

To measure the deformation of the entire caldera floor and its surroundings, we analyze a data set composed by 21 descending orbit SAR images (Track 485, Frame 2845), acquired by the European Space Agency ERS-1/2 satellites spanning the time interval from June 1992 to August 2000. The ERS 1/2 satellite data were processed using the SBAS-DInSAR algorithm. (Tizzani et al., 2007)



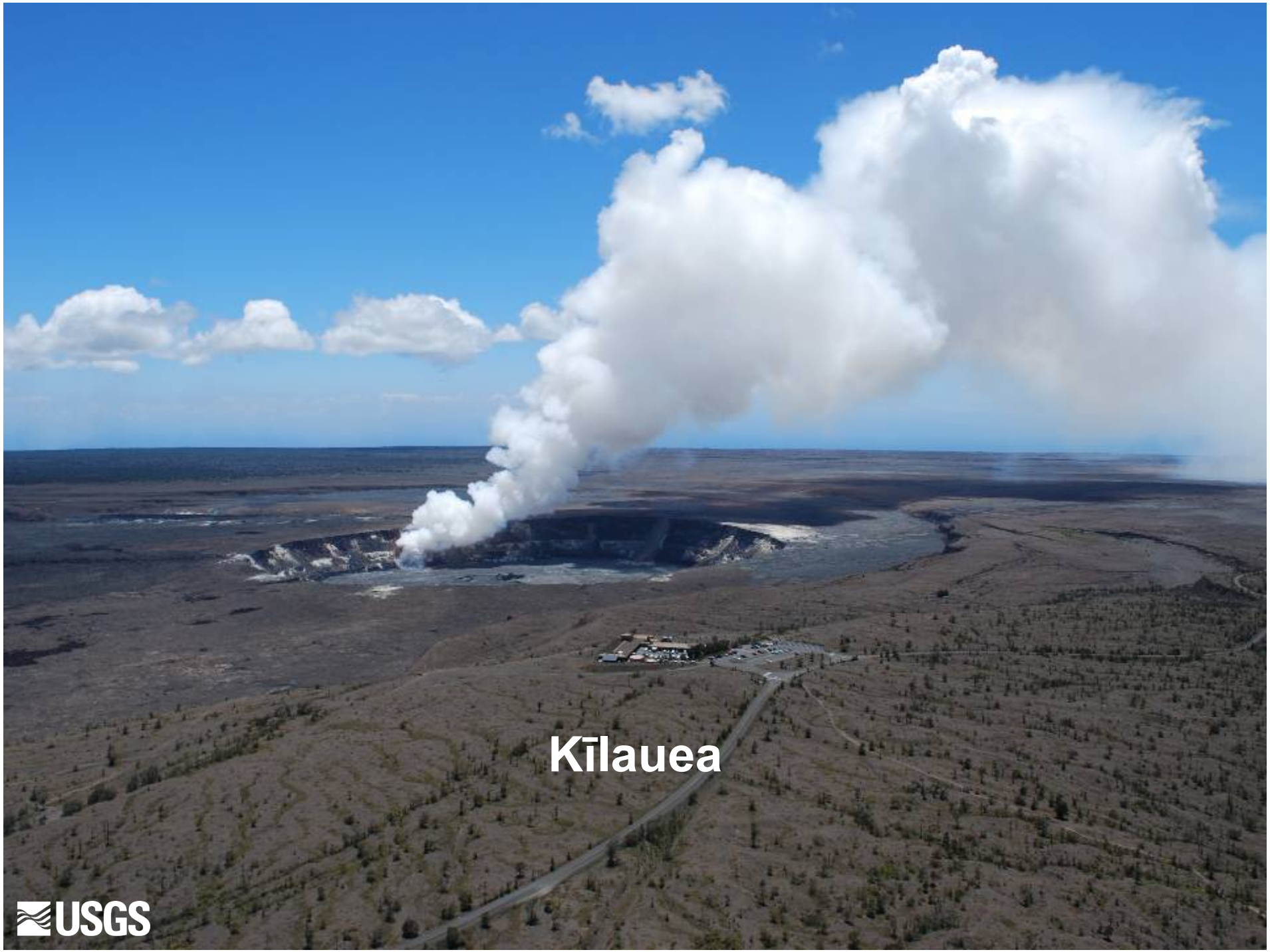
Tizzani, Manunta, Lanari, P. Lundgren et al., IREA,JPL

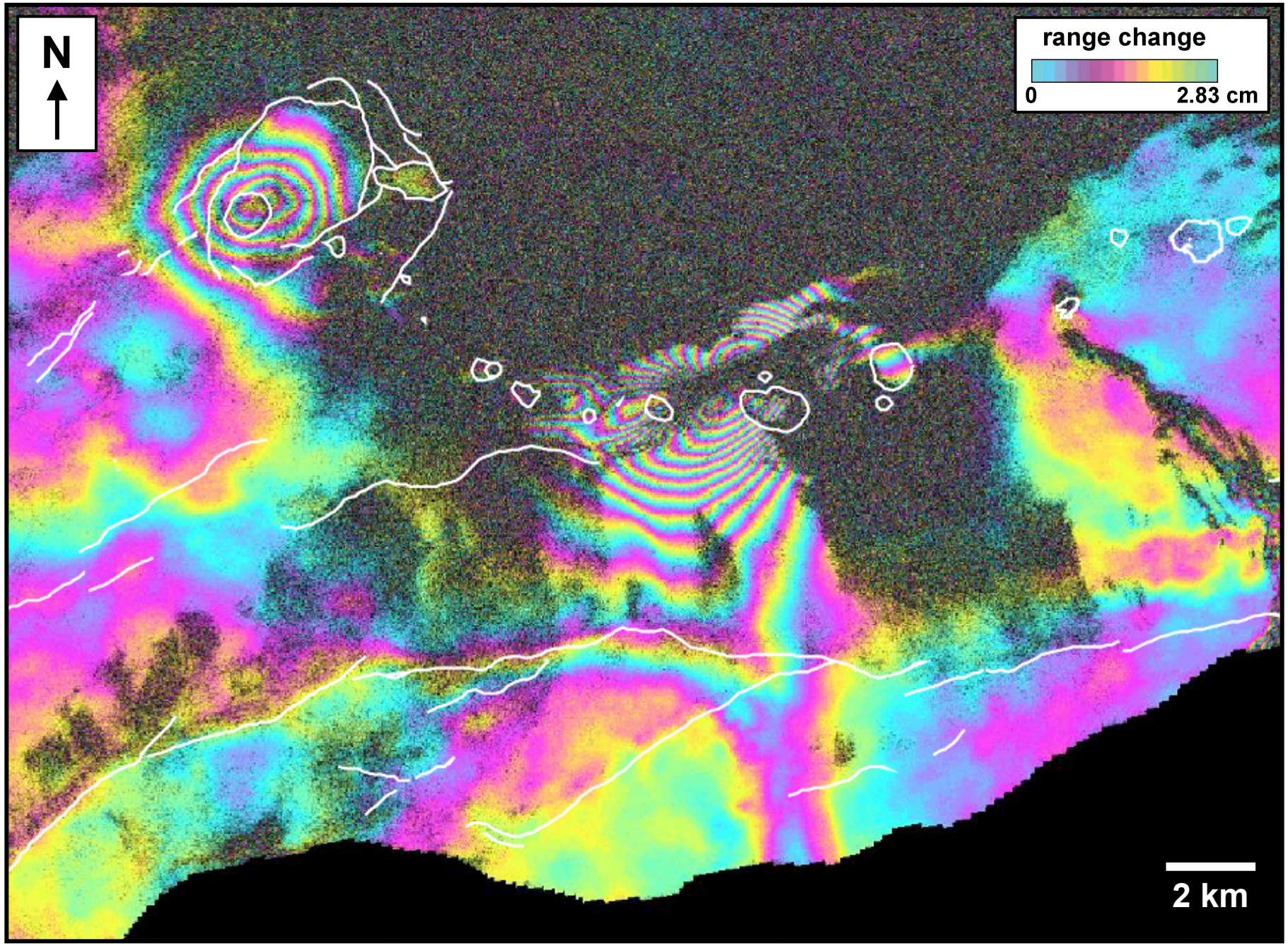


1995-2001
Interferogram

Wicks et al., USGS


Snow Near South Sister on June 30, 2006

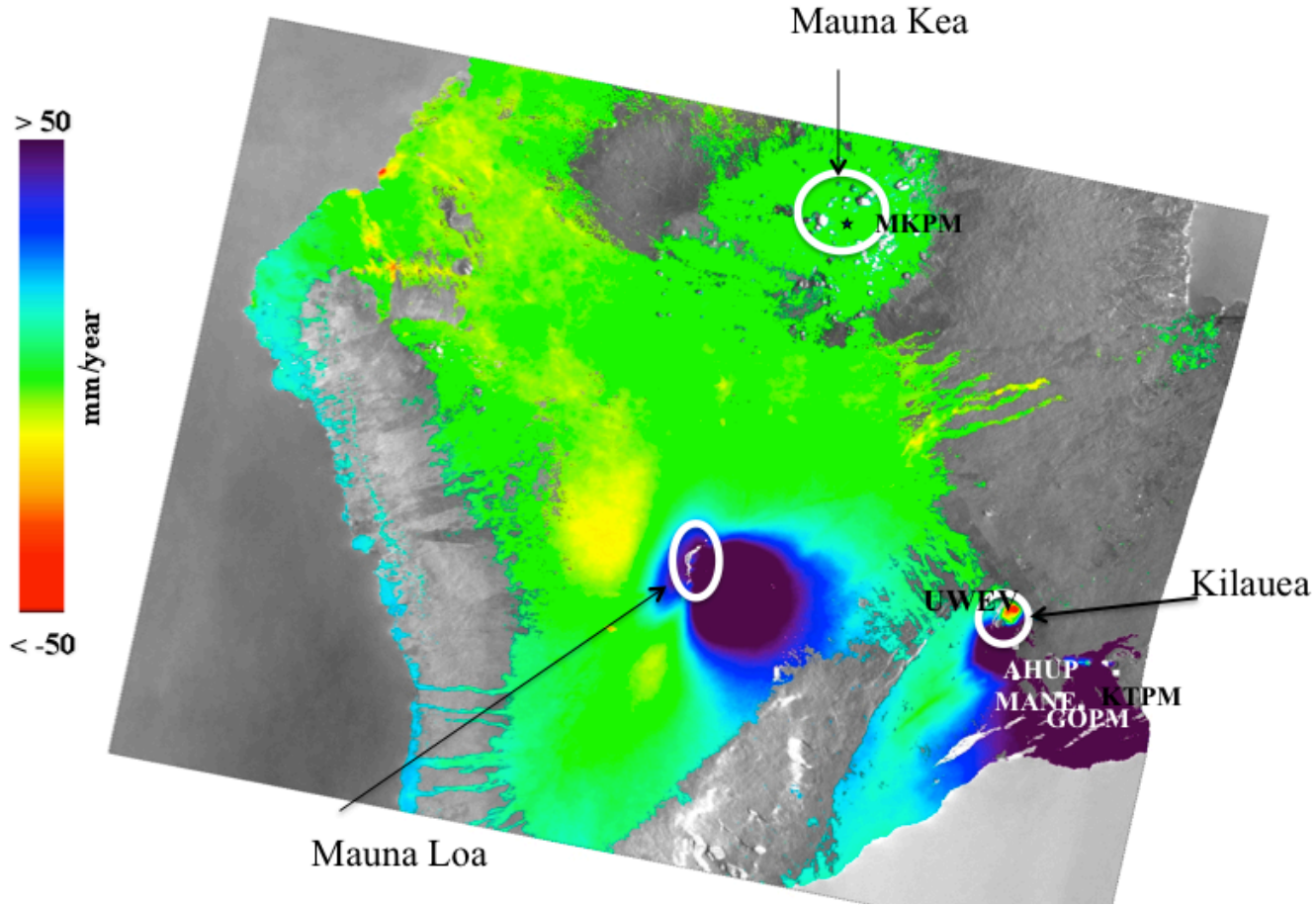

Kīlauea
USGS



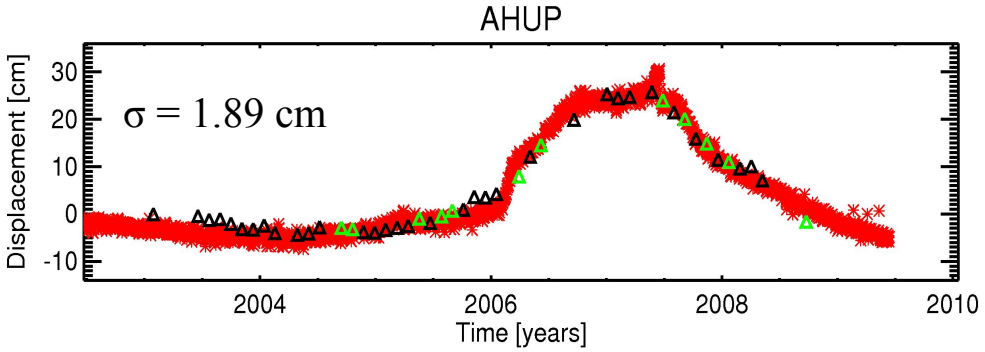
USGS

ASAR, mode 4, track 157, filtered Apr 12 – Jun 21, 2007

Mean deformation velocity maps for 2003 – 2008 from track 200



SBAS time-series
Including
ScanSAR

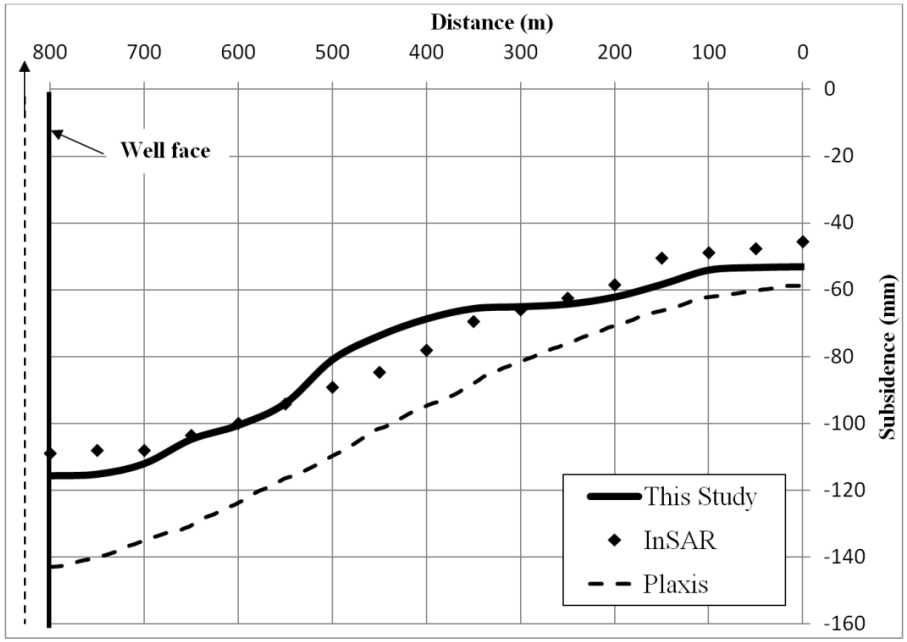


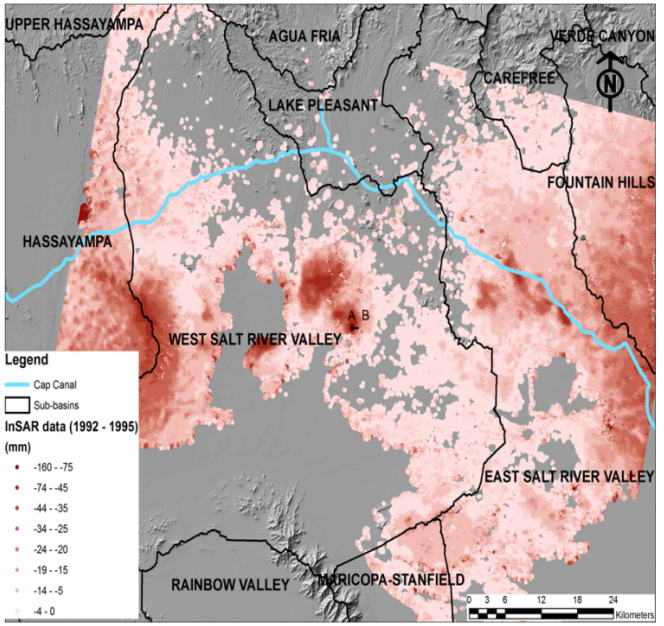
Ana Bertan et al., JPL

4. Subsidence, Permafrost

Using InSAR data to Calibrate Land Subsidence Prediction Model

InSAR data is coupled with a numerical model to predict land subsidence and earth fissure formation from groundwater pumping

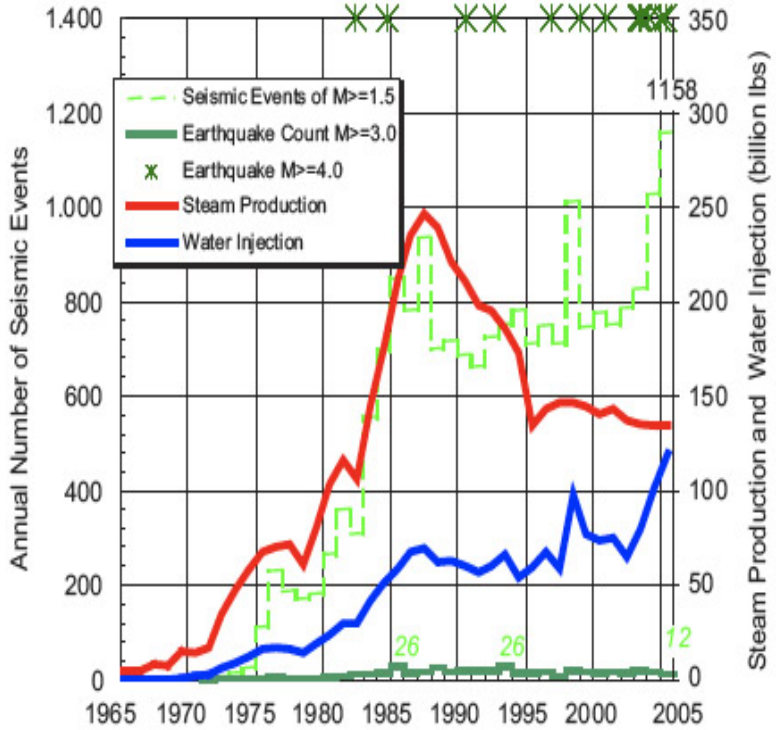




Contact: Professor Muni Budhu
budhu@email.arizona.edu

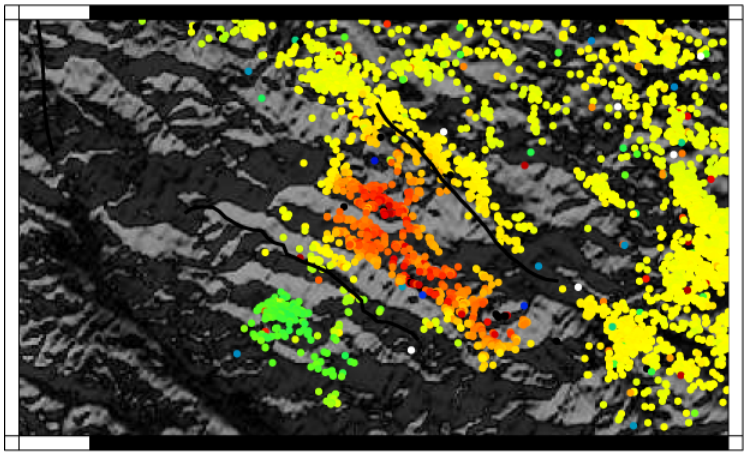
Geysers Geothermal Field

Geysers Annual Steam Production, Water Injection and Seismicity



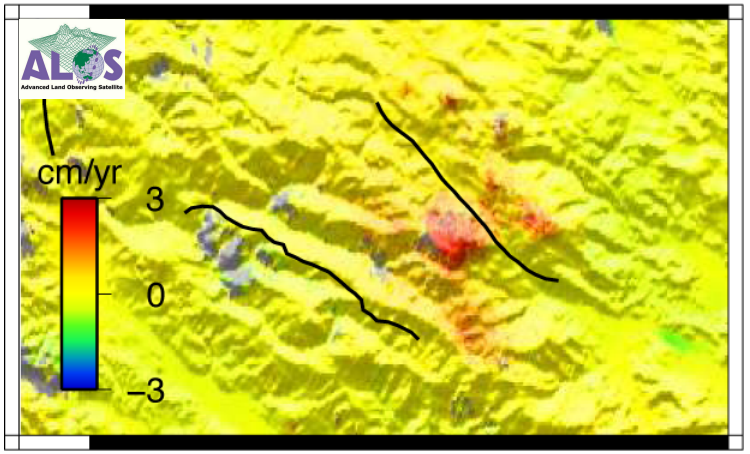
R. Burgmann, et al., UC Berkeley

ERS 1992–1999

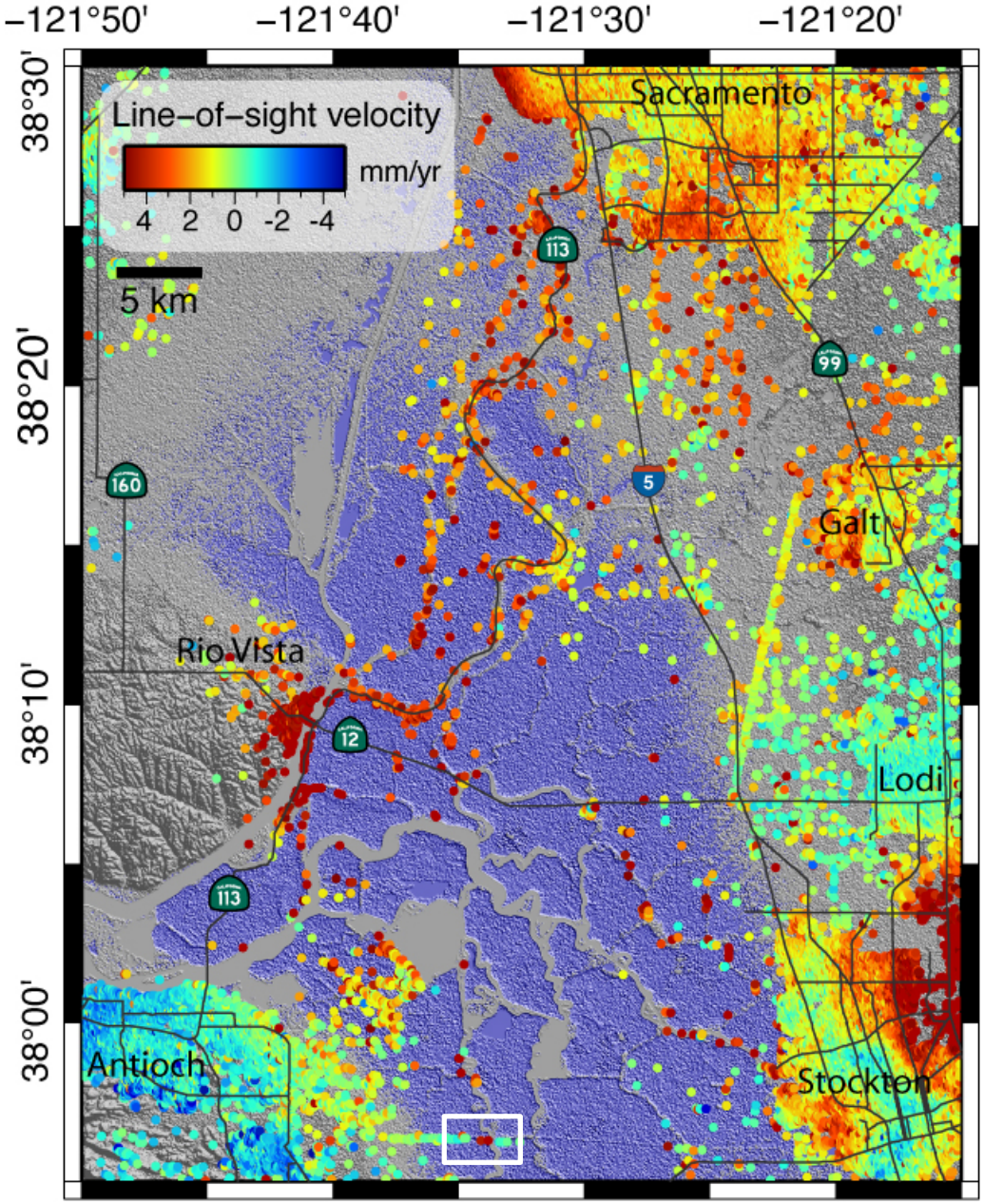


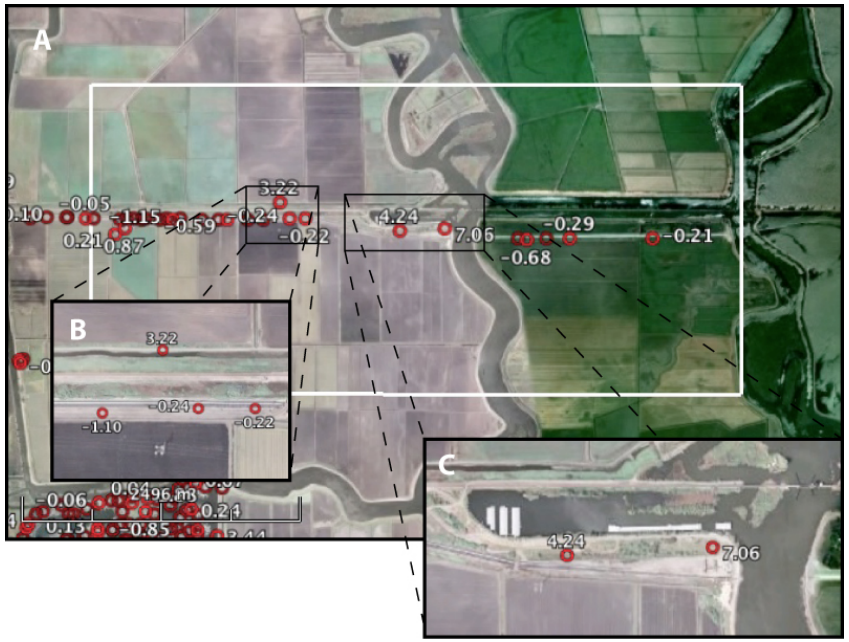
237˚00'

ALOS 2007–2009



San Francisco Bay and Sacramento Delta Subsidence





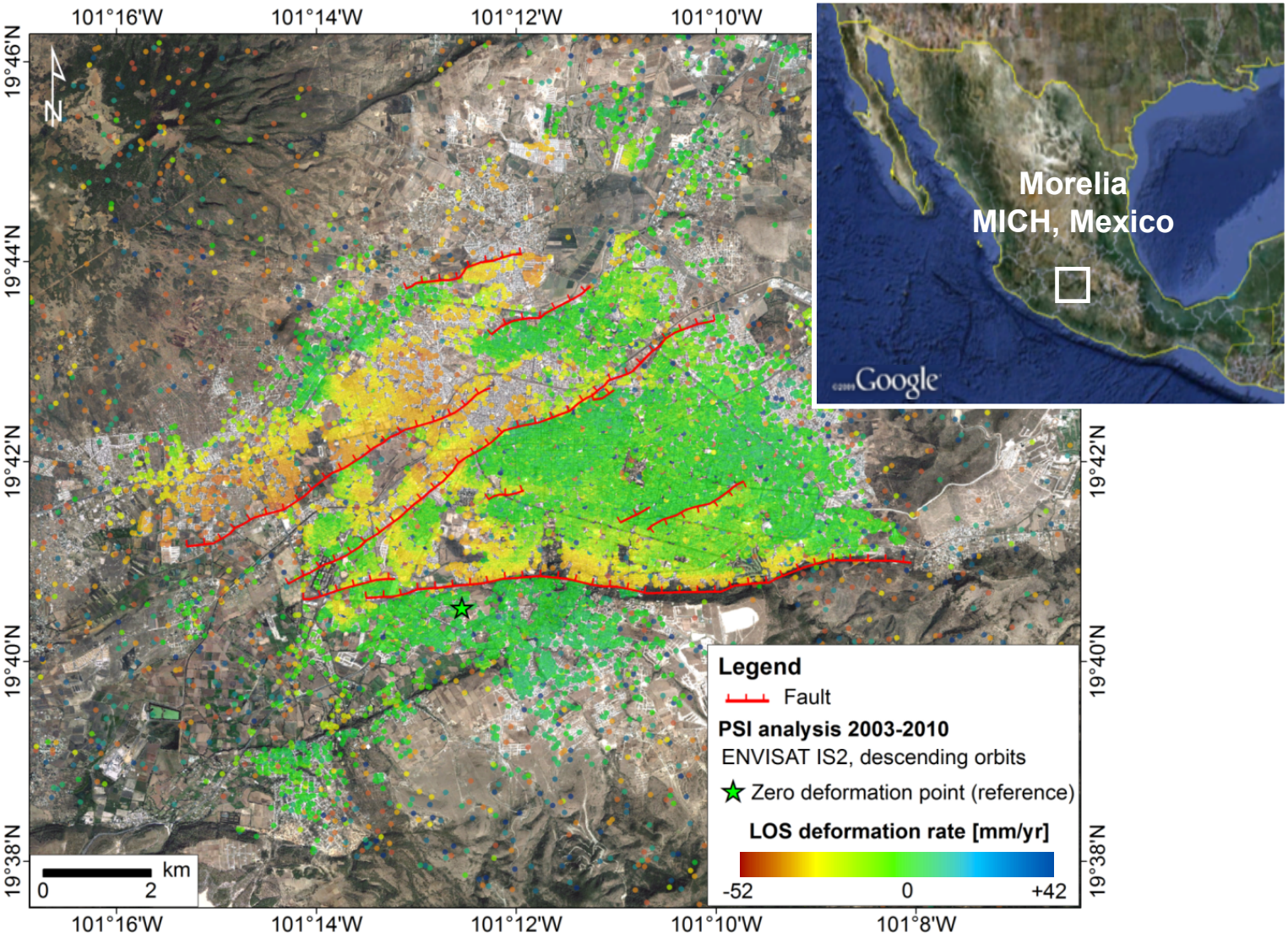
White box in overview is extent of Google Earth image A.

PS points can show precisely where subsidence is occurring, e.g. on levees, and approaching waterways.

C-band ERS 1992-2000

R. Burgmann, et al., UC Berkeley

Morelia (Mexico): PSI analysis 2003-2010



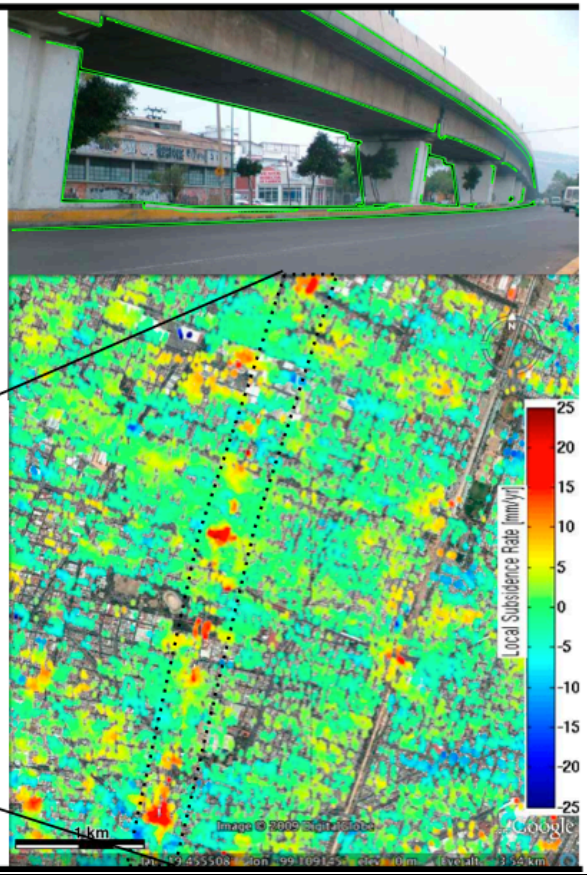
From F. Cigna, T. Dixon, B. Osmanaglu, University of Miami

Measuring Differential Subsidence Rate with Envisat InSAR

Batuhan Osmanoğlu, Timothy H. Dixon, Shimon Wdowinski, Enrique Cabral-Cano, Yan Jiang

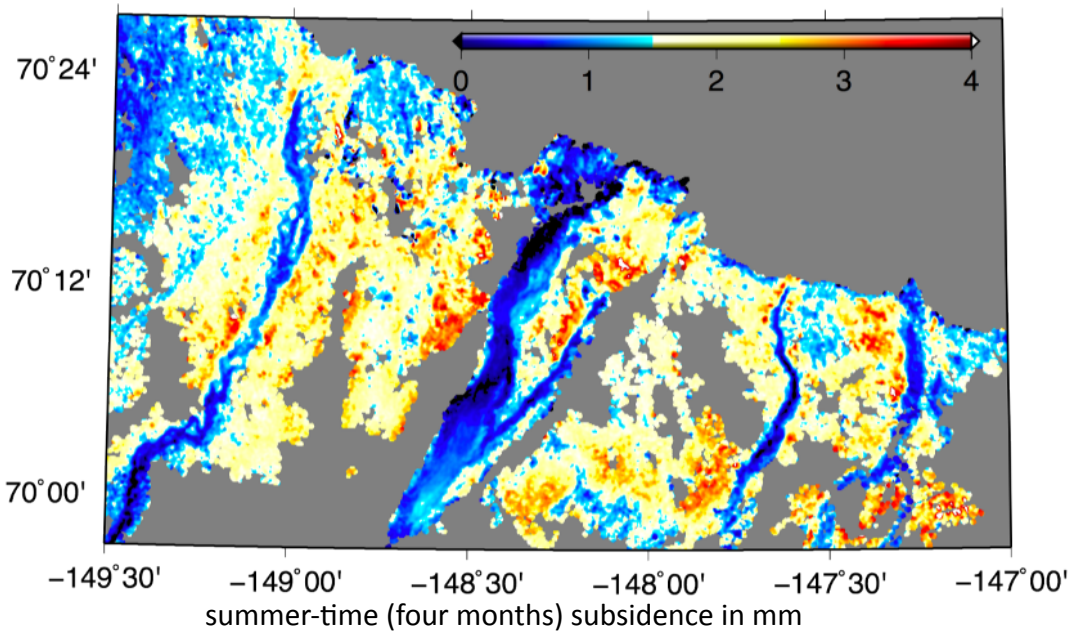
Satellite interferometry can measure surface subsidence due to natural or anthropogenic activities. We analyzed 23 Envisat SAR scenes to study Mexico City subsidence due to water withdrawal in excess of recharge. Measured subsidence rates are over 300 mm/yr during the observation period between January 2004 and July 2006.

In any observation, higher rates can mask finer details, which can be important in daily life. Removal of the general deformation trend from our Mexico City results revealed that several civil structures in the study area are experiencing significant shear stress due to differential subsidence.

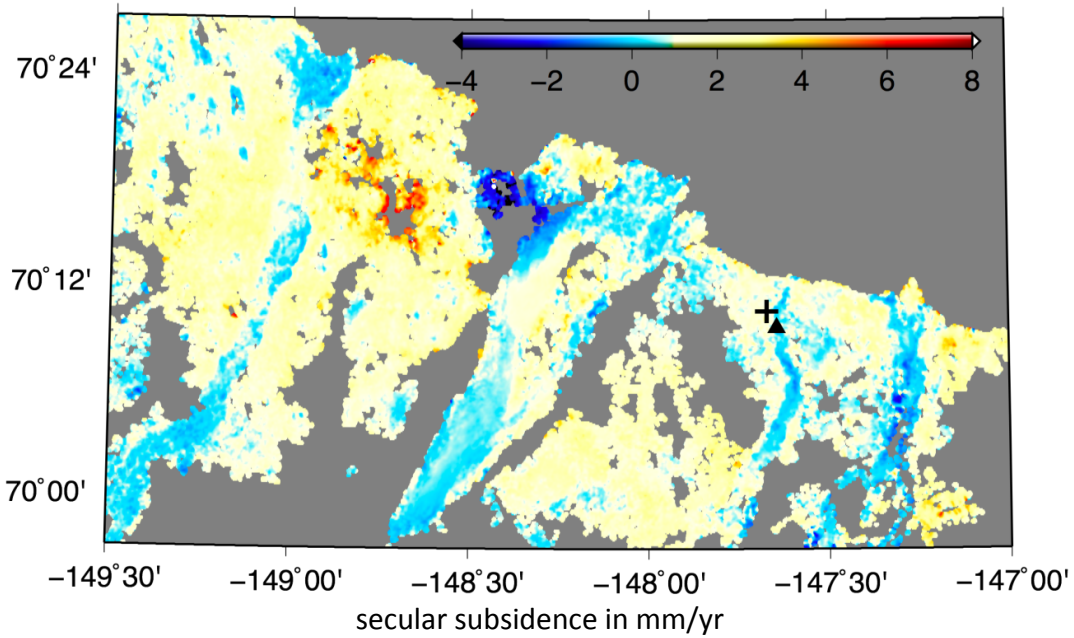


One of the civilian structures was the elevated metro rail line 4. This line runs approximately Northeast-Southwest and is supported by vertical columns on horizontal pads. The rail tracks are subsiding more slowly than the surrounding area as a result of their strong foundation. Our analysis captures the differential deformation along the Metro line, and measures of about 20 mm/yr difference in subsidence rates.

(Photo Courtesy of Edgar Campos Cajero)



1—4 cm of summer-time subsidence, caused by seasonal thaw settlements

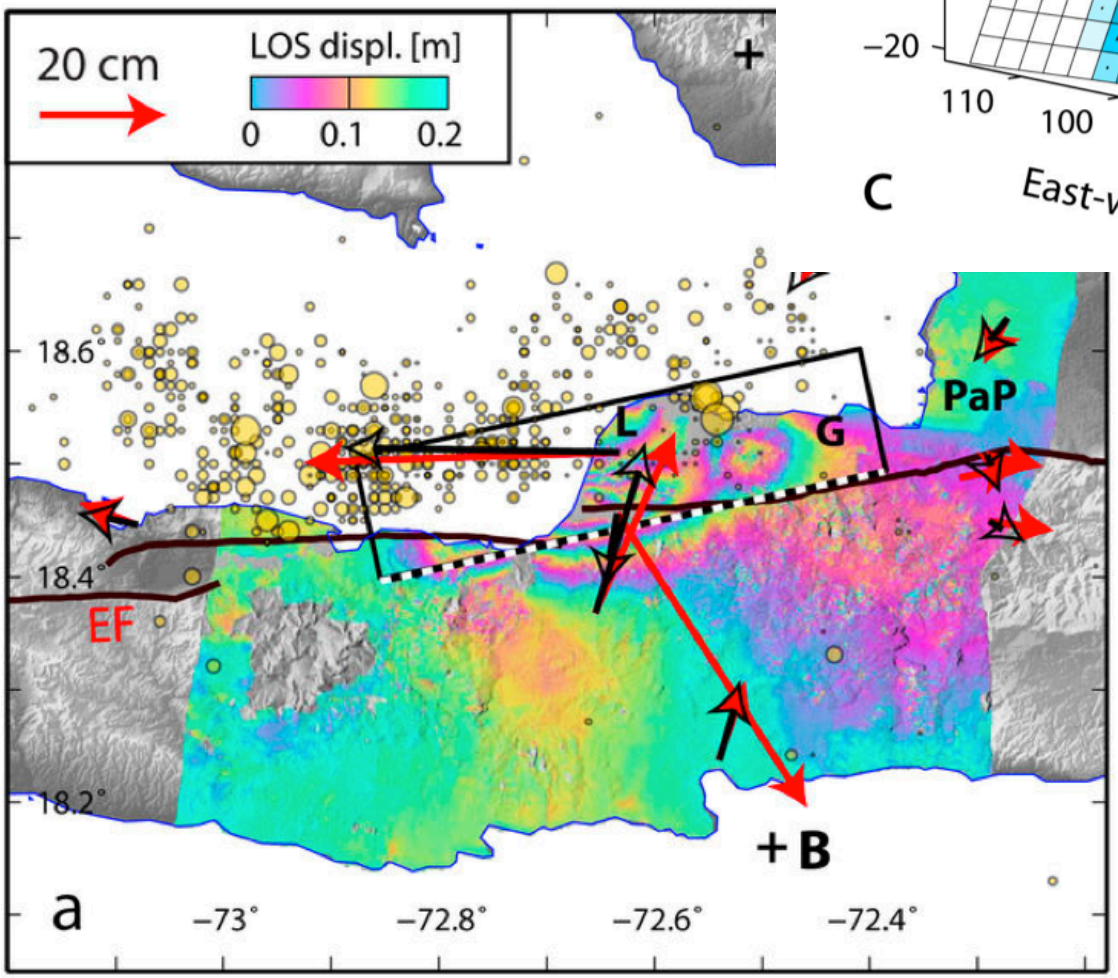


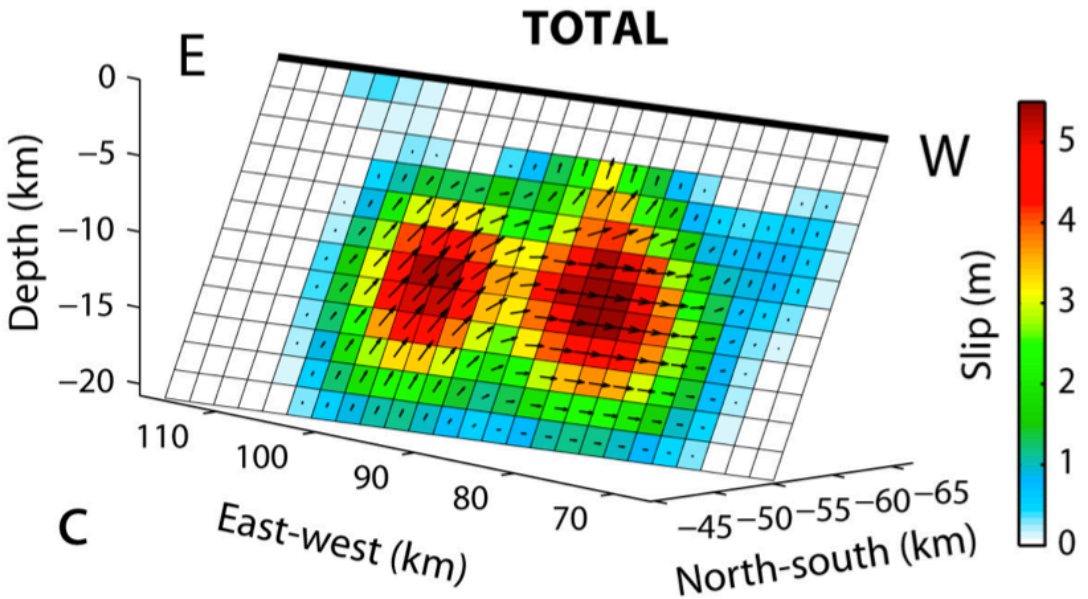
1—8 mm/yr secular subsidence during 1992—2000, by melting of massive ice near the permafrost table.

Liu, Zhang, and Wahr, *JGR* 2010

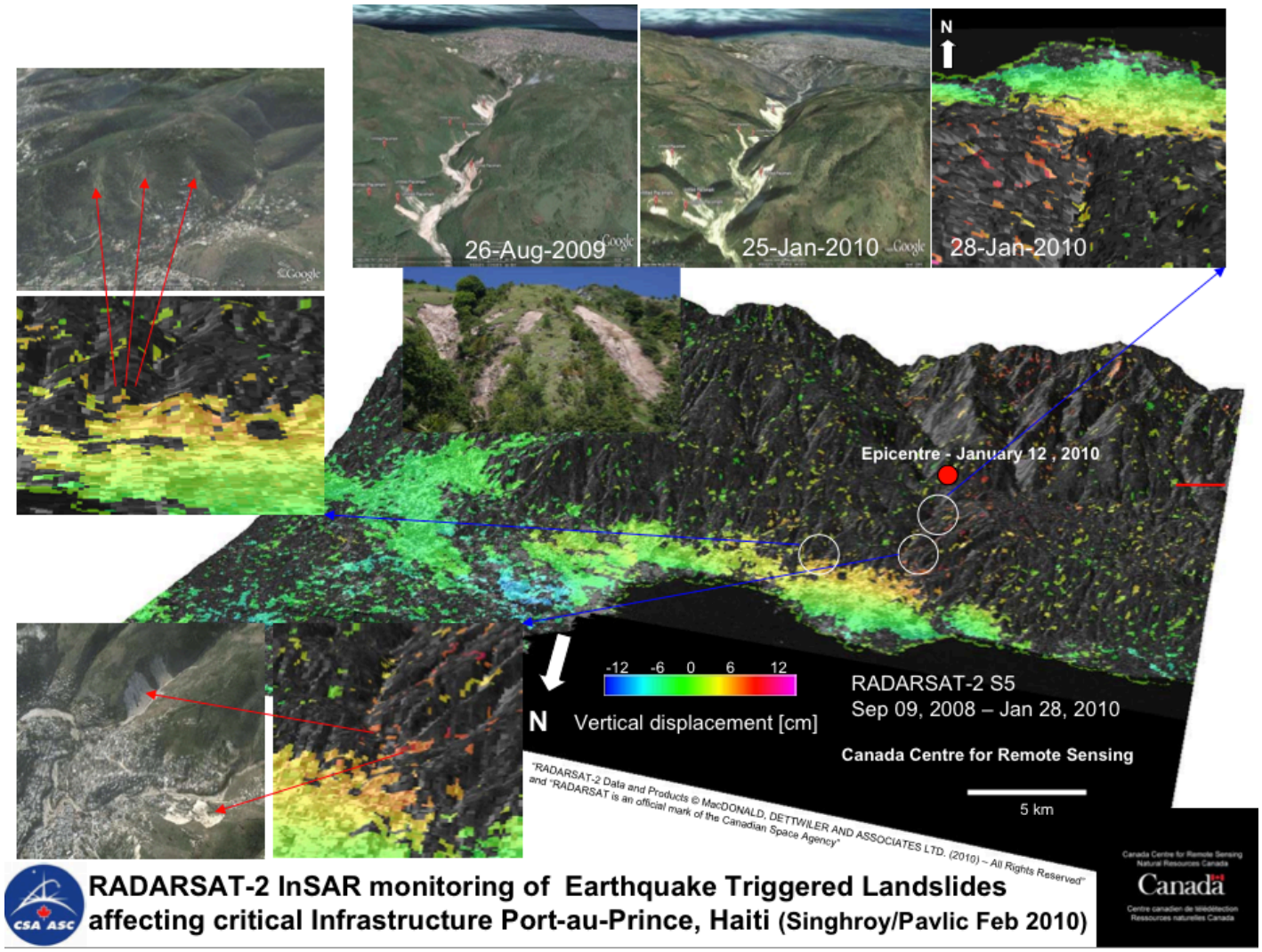
4. Other activities

January 12, 2010
M7.0 Haiti earthquake





Calais, Freed, Mattioli,
Amelung, Jonsson et al.



Vern Singhroy et al, Canada Center of Remote Sensing

(Radarsat-2 data not yet in WinSAR or Supersites)

Summary

Good things:

- Entire ERS/Envisat data set for WinSAR core area supports diverse research endavours and is bedrock for U.S. InSAR activities.
- 143 peer-reviewed articles.
- Excellent Envisat time-series since 2005 (tasking).
- Fast data access within the U.S. (40 MB/s, 4 seconds/scene).
- Technician support available at Unavco.

Not so good things:

- Heterogeneous with frame and swath (Envisat).
- Data at 3 locations (WinSAR, GeoEarthscope, Supersites).
- Complex access rules for non-US WinSAR members:
  - WinSAR ESA data available only to North American members (ESA rule!).
  - Geoearthscope ESA data available through Mini Cat-1.
  - Supersite ESA data available to all Supersite Co-PIs.
  - Geoearthscope Radarsat available to everybody (not online)
  - ALOS data (at ASF) available to US researchers only (JAXA rule!)

Recommendation to Audience

Spell out in ***Recommendations to ESA:***

◆ Need of full access to WinSAR data for European and international scientists.
→ Transfer WinSAR data into ESA's virtual archive.

Recommendation to ESA

◆ Develop WinSAR-like data access for all tectonically active areas (Geohazard Supersites/natural laboratory idea)

◆Define standard product (e.g. framed L0-data) and provide tools to generate higher-order products (SLC processor, frame concatenator).

◆ Provide data access through APIs at 1 frame/second download rate

Thursday's breakout session on Supersites:
10:00 - 13:00, room Samtroll

Thank you, ESA,
for these wonderful data sets !

… and by the way, please think of us when you launch Sentinel …