Consiglio Nazionale delle Ricerche

istituto per il rilevamento elettromagnetico dell'ambiente

esa

→ FRINGE 2015 WORKSHOP

Advances in the Science and Applications of SAR Interferometry and Sentinel-1 InSAR Workshop

Surface Deformation Analysis of 2014 Napa Earthquake Retrieved Through SAR Techniques

G. Solaro[1] , R. Castaldo[1], F. Casu [1], C. De Luca [1,2],M. Manunta [1] ,A. Pepe[1] , S. Samsonov[3]

(1) Istituto per il Rilevamento Elettromagnetico dell'Ambiente, CNR, Napoli

(2) Università degli Studi di Napoli Federico II, DIETI, Napoli

(3) Canada Centre for Mapping and Earth Observation, Ottawa, Canada

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European Space Agency

Summary

We investigate the 24th August South Napa earthquake related deformation by exploiting the *Small BAseline Subset (SBAS)* technique that permits to produce mean deformation maps and time series relevant to large areas.

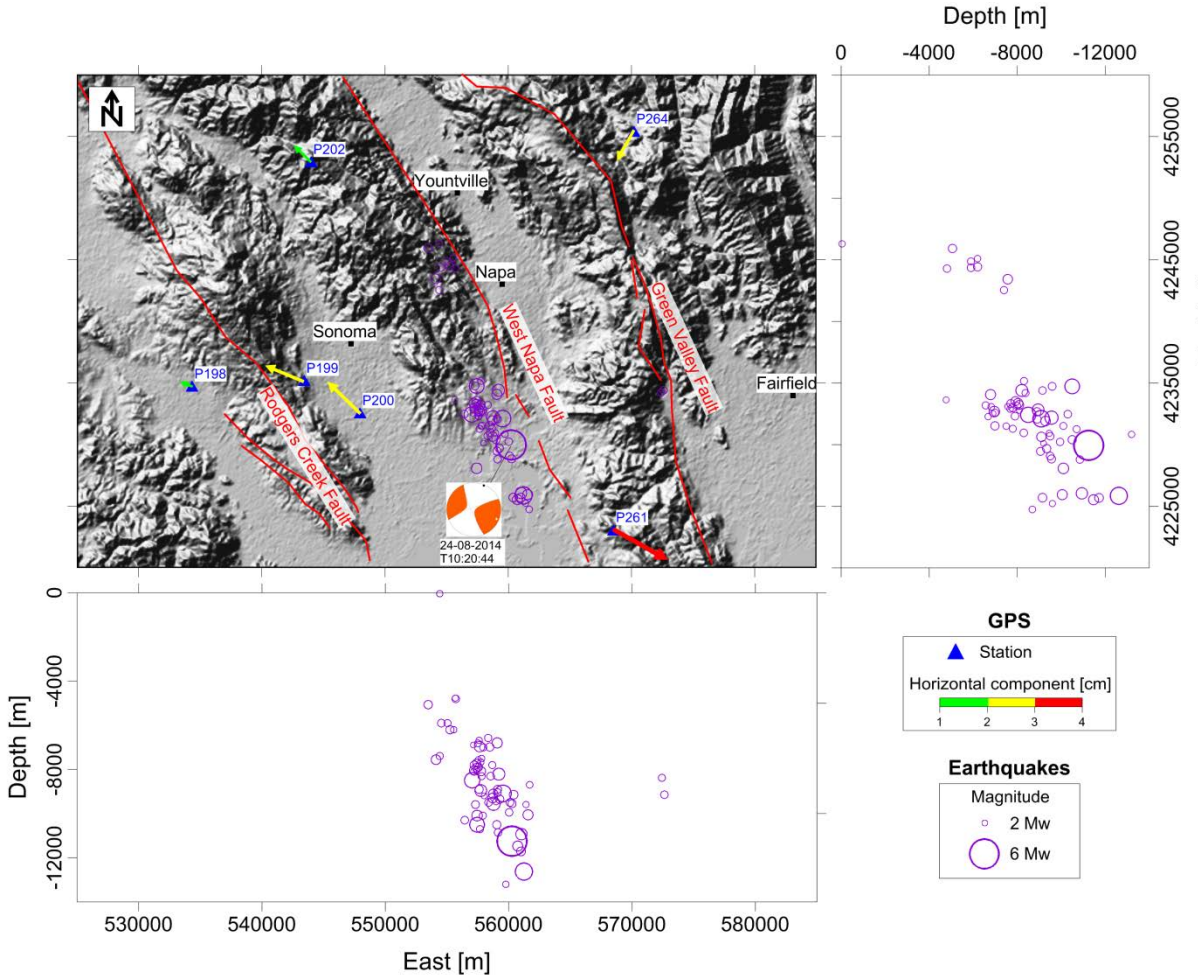
We processed:

- DinSAR interferograms
- SBAS time series
- Pixel offset analysis

We used COSMO-SkyMed (Asc/Desc), RadarSat (Asc) and Sentinel-1 (Desc) data to study co- and post-seismic displacement in space and time

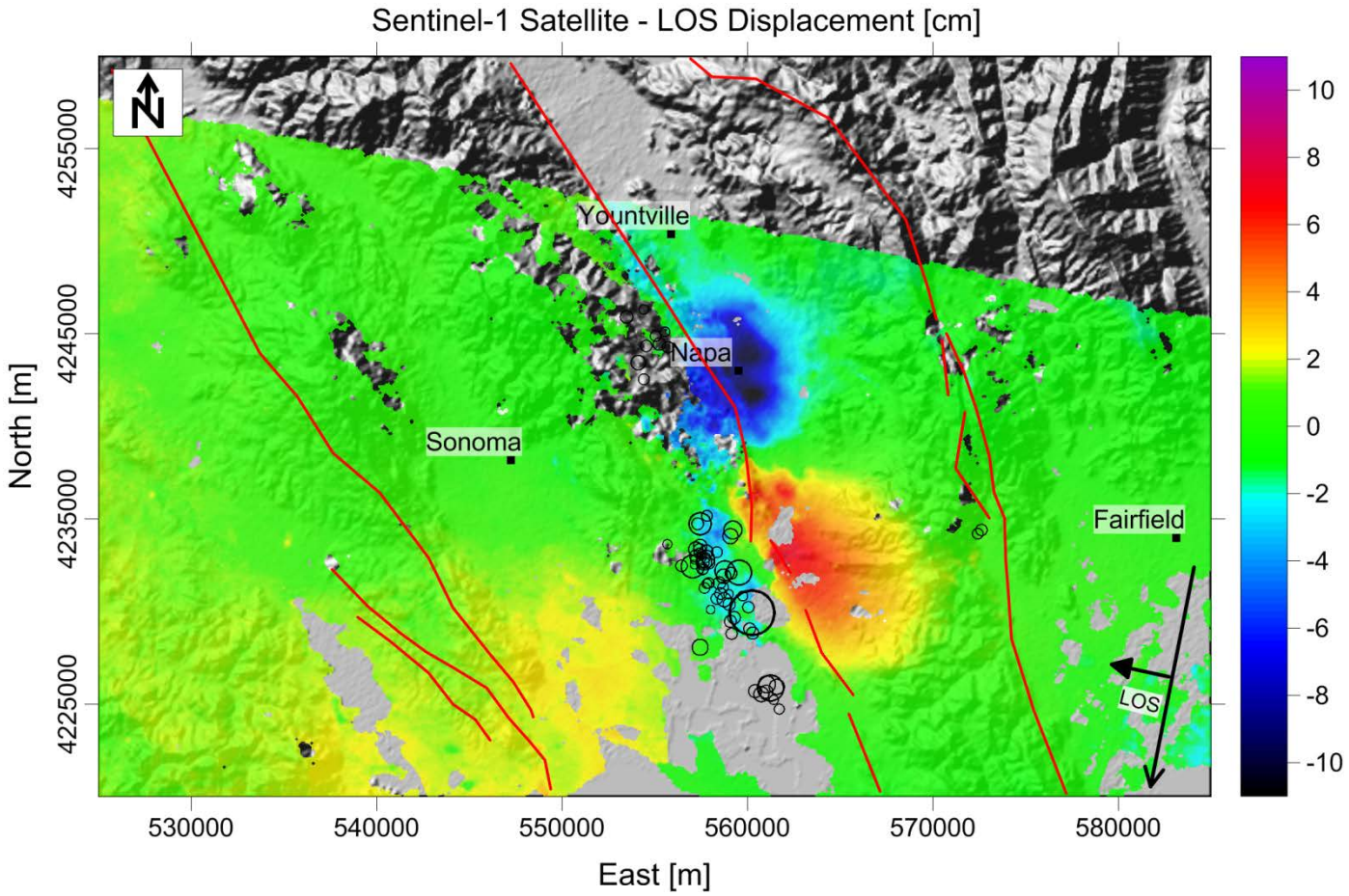
DInSAR data are used to model the causative fault/s

Introduction: Napa Earthquake



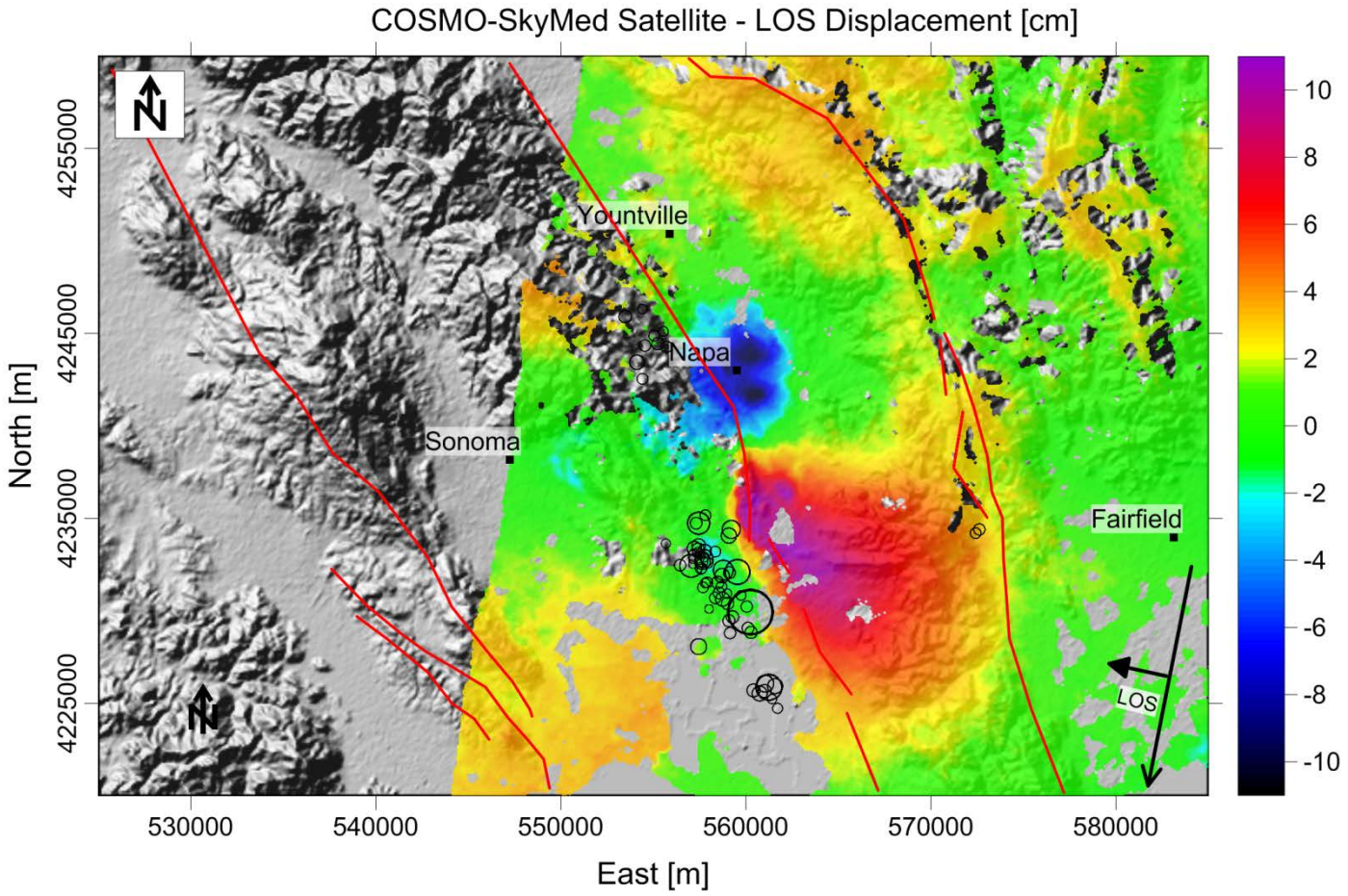
- ✓ The seismic sequence is located between two major active fault systems: the Hayward-Rodgers Creek Fault system on the West and the Concord-Green Valley Fault system on the East.
- ✓ The earthquakes occurred at West of the well-known Napa Fault and they are caused by a right–lateral NNW-SSE oriented fault.
- ✓ There are only four permanent GPS stations in the earthquakes area.

DInSAR Measurements: Sentinel-1 interferogram



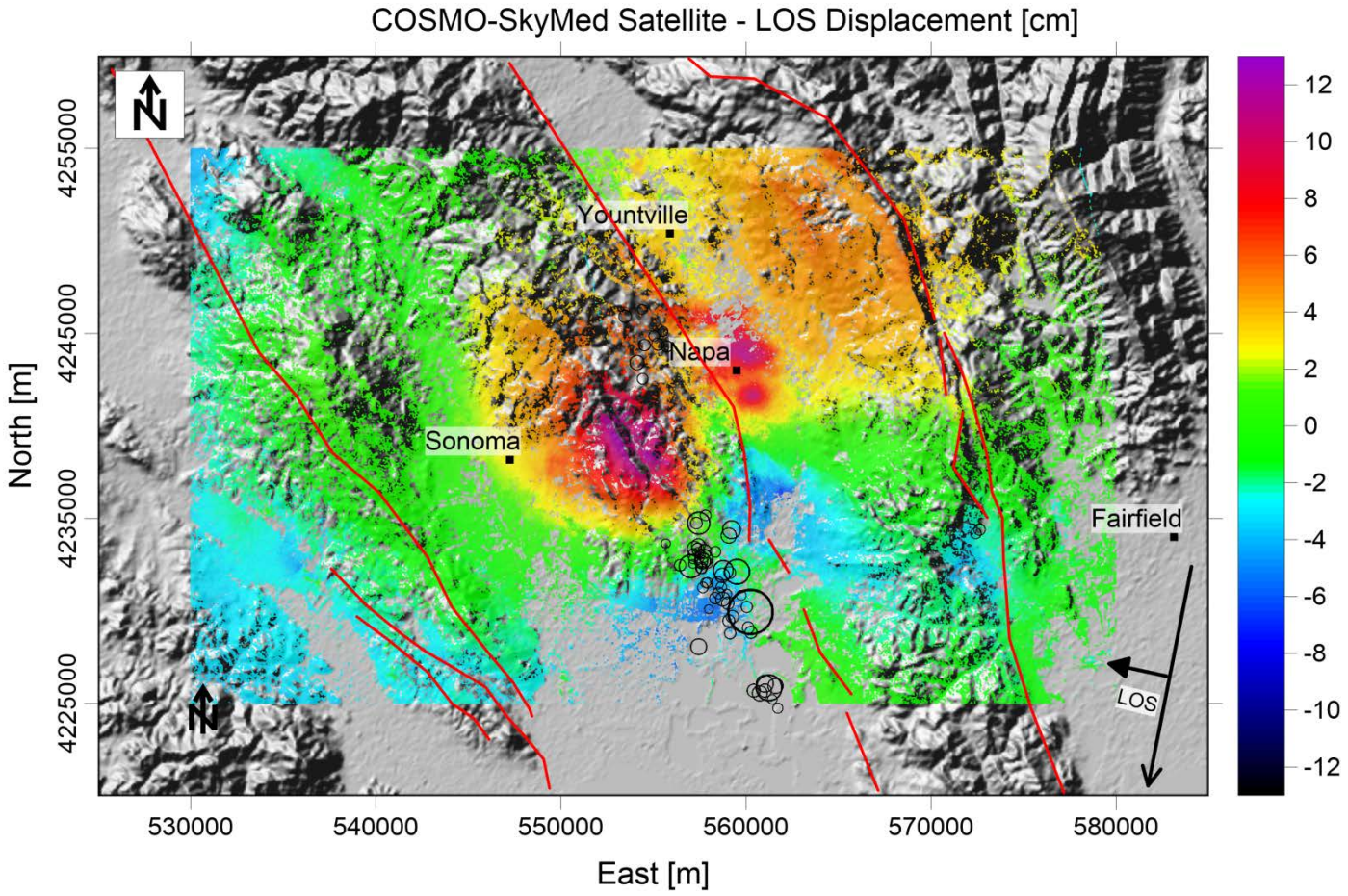
Sensor	Orbit	Interferogram	B_{perp}	Look Angle
Sentinel-1	Descending	07/08/2014 - 31/08/2014	0.3 m	≈ 23°

DInSAR Measurements: COSMO-SkyMed interferogram



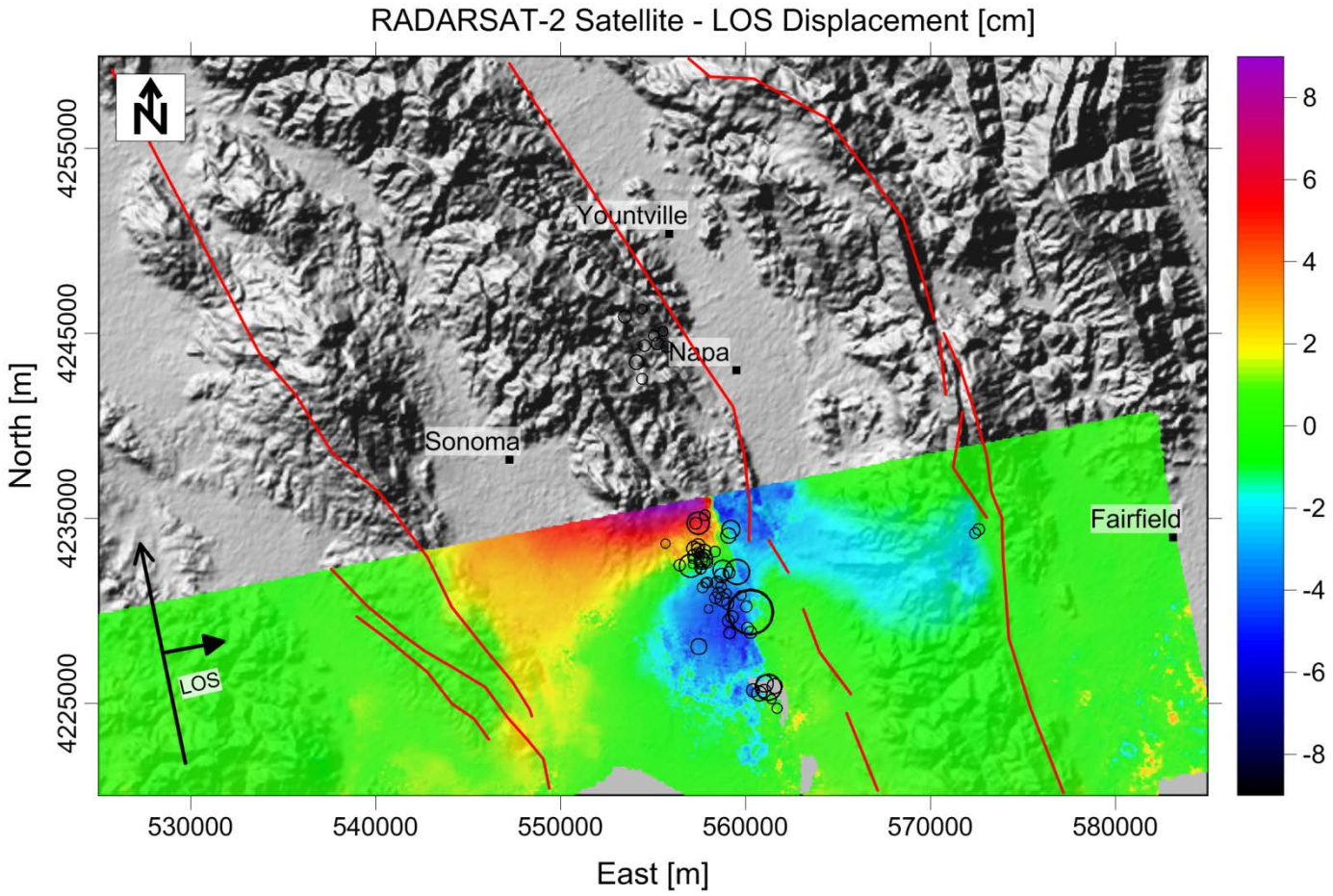
Sensor	Orbit	Interferogram	B_{perp}	Look Angle
COSMO-SkyMed	Descending	26/07/2014 - 27/08/2014	134 m	≈ 29°

DInSAR Measurements: COSMO-SkyMed interferogram



Sensor	Orbit	Interferogram	B_{perp}	Look Angle
COSMO-SkyMed	Ascending	19/06/2014 - 03/09/2014	50 m	≈ 36°

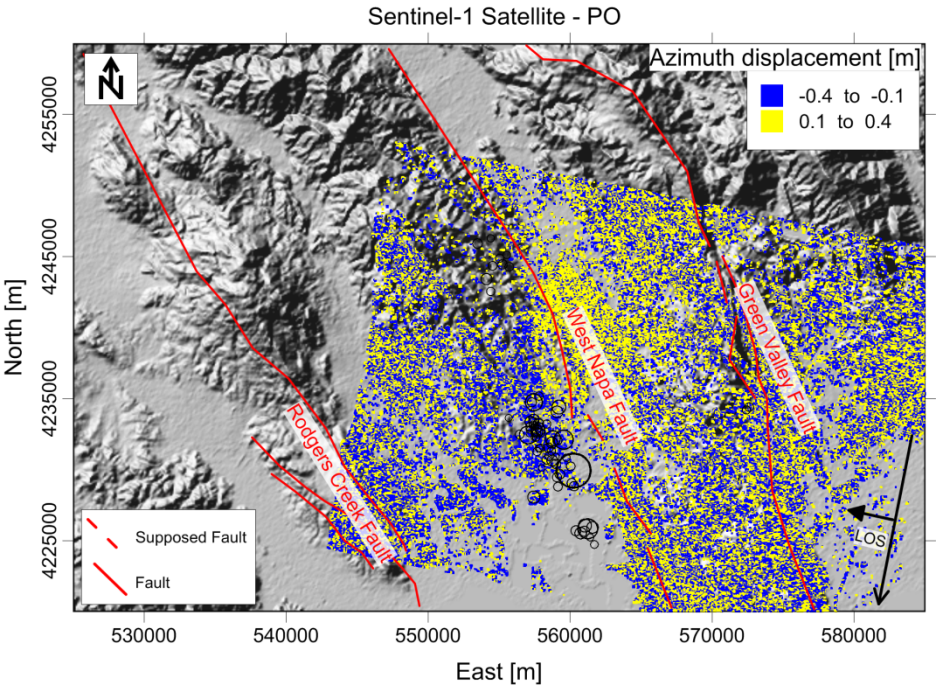
DInSAR Measurements: RADARSAT-2 interferogram

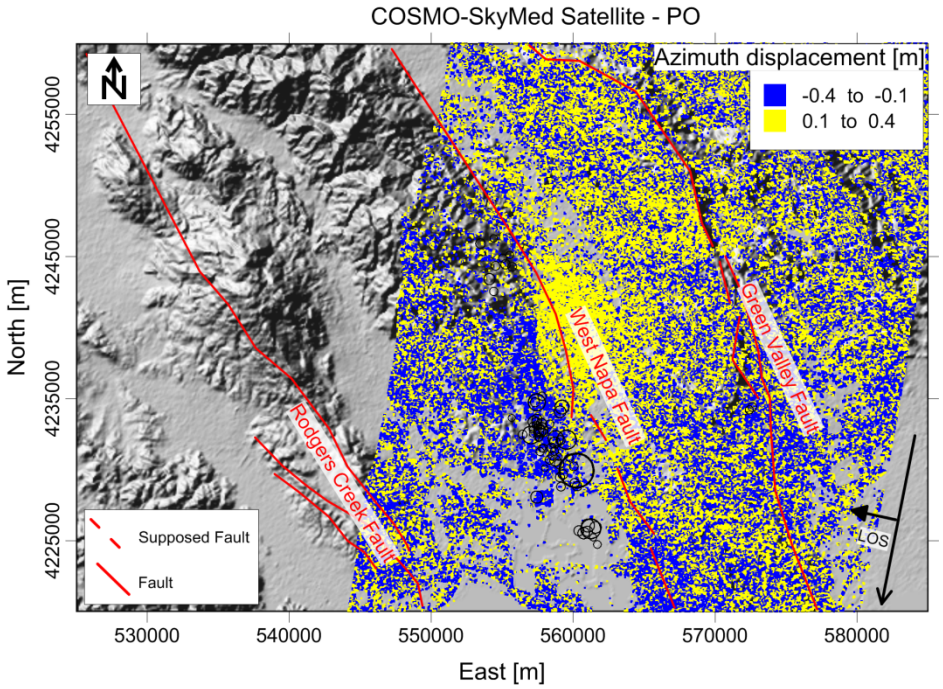


Sensor	Orbit	Interferogram	B_{perp}	Look Angle
RADARSAT-2	Ascending	24/07/2014 - 10/09/2014	40.42 m	≈ 34°

Pixel-Offset analysis: Sentinel-1 and COSMO SkyMed interferograms

By benefiting from the sensor spatial resolutions (down to 3 meters for both CSK and Sentinel-1 satellites), the Pixel-Offset maps of the Sentinel-1 and COSMO-SkyMed data pairs have been computed, thus permitting us to retrieve displacement information along the azimuth direction and better describing the deformation field.

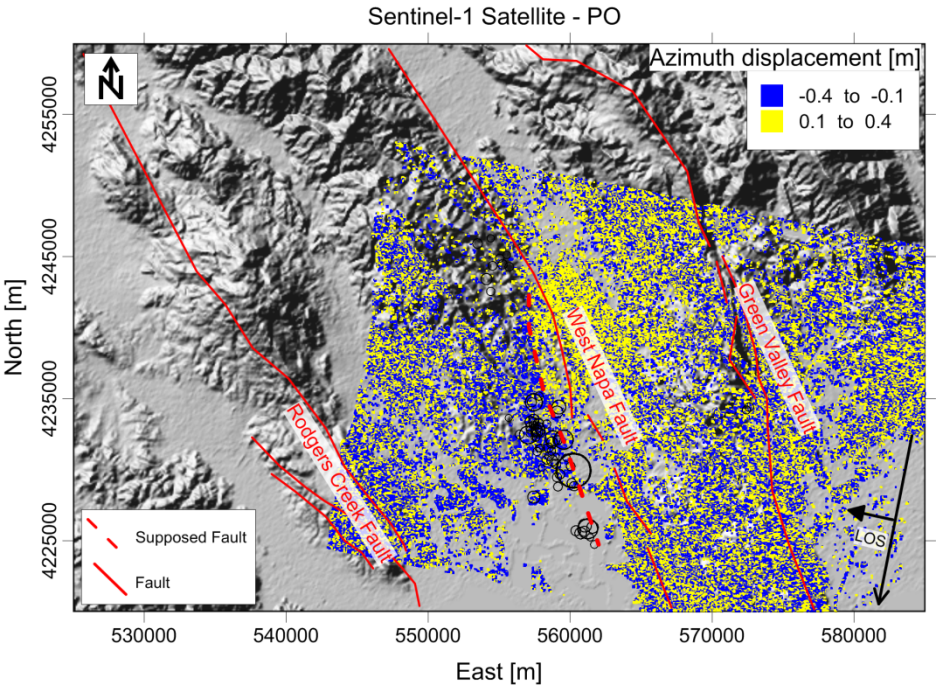


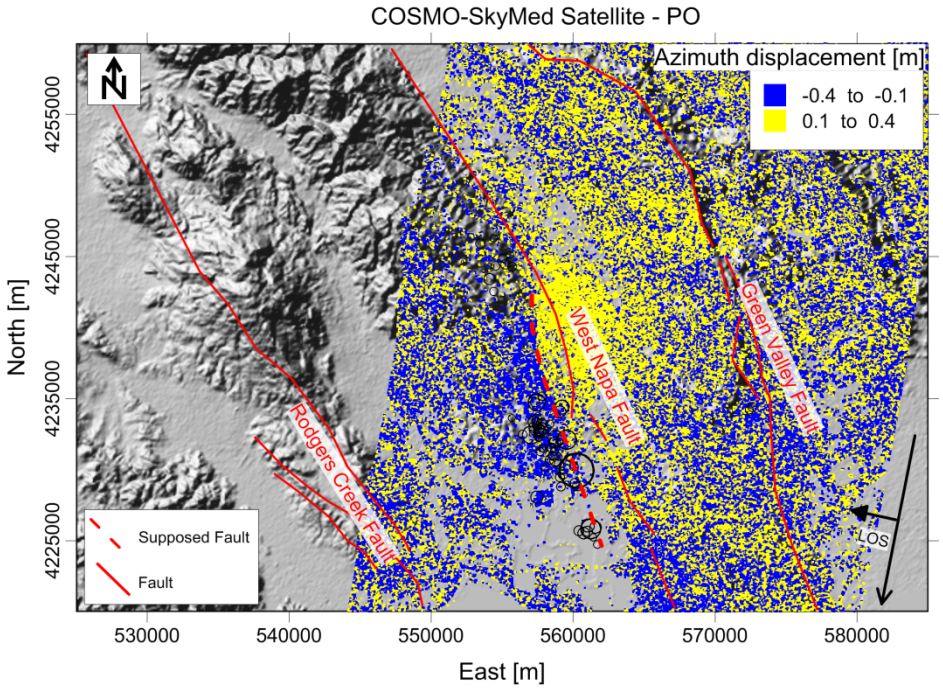


The accuracy is about 1/20 of ground pixel size.

Pixel-Offset analysis: Sentinel-1 and COSMO SkyMed interferograms

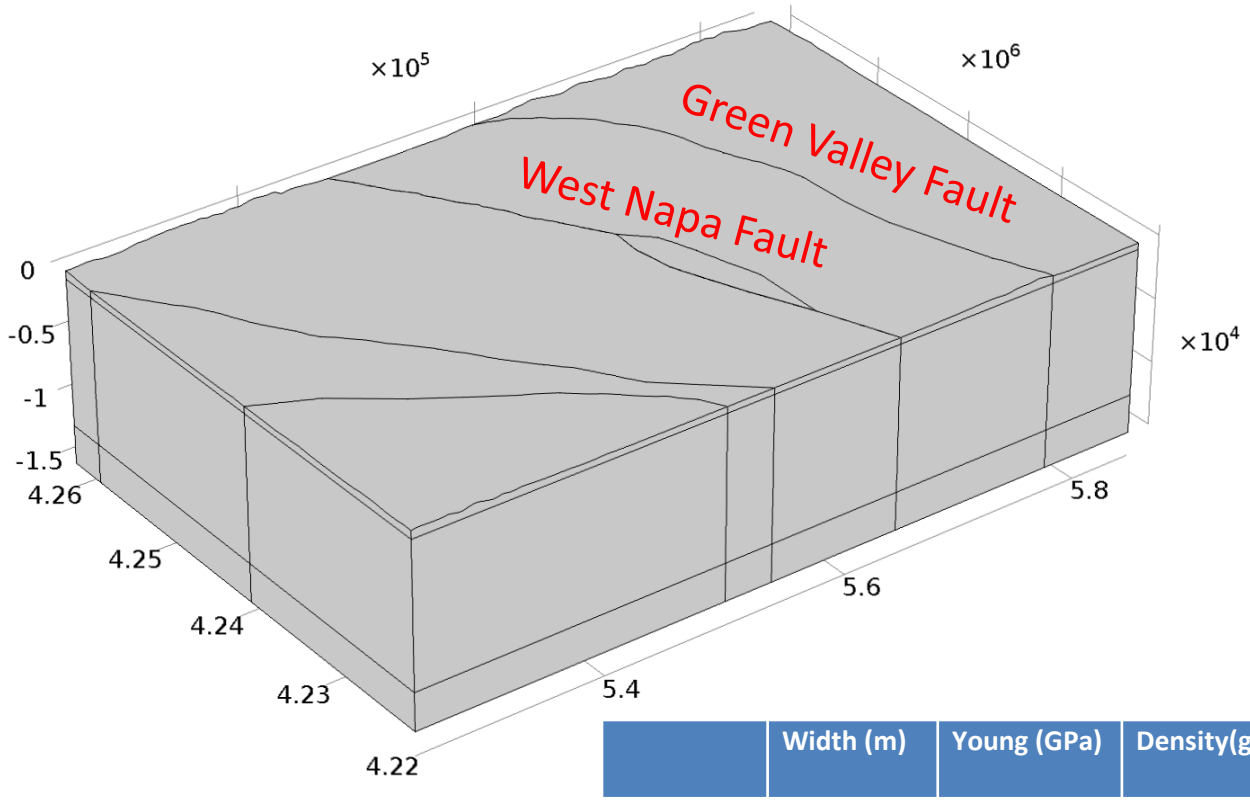
We identify the segment fault responsible of the earthquakes. It is located at West of the well-known West Napa Fault.





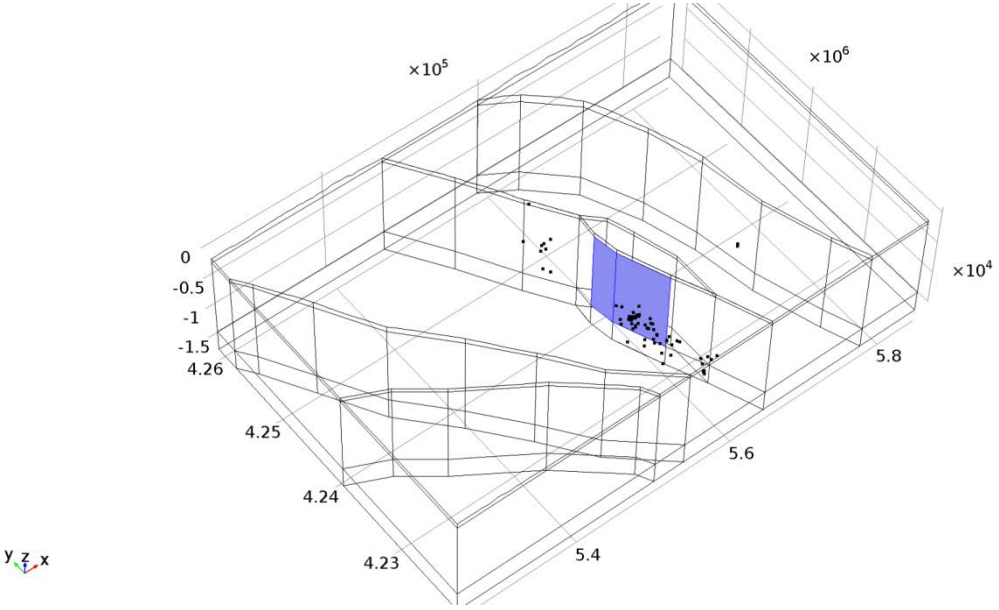
FEM CO-SEISMIC MODEL

Geometry

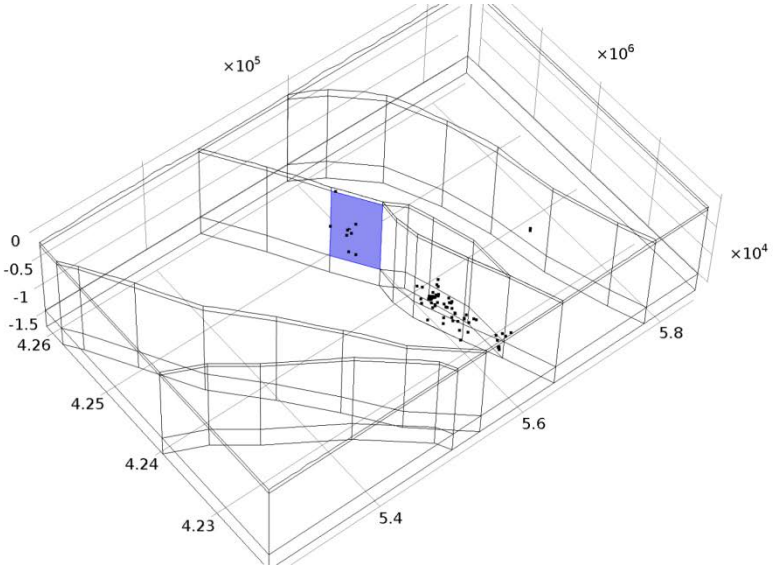


	Width (m)	Young (GPa)	Density(gr/cm³)	Poisson ratio
Layer 1	500	5	2.4	0.25
Layer 2	11.5	10	2.5	0.26
Layer 3	3	15	2.6	0.26

FEM CO-SEISMIC MODEL



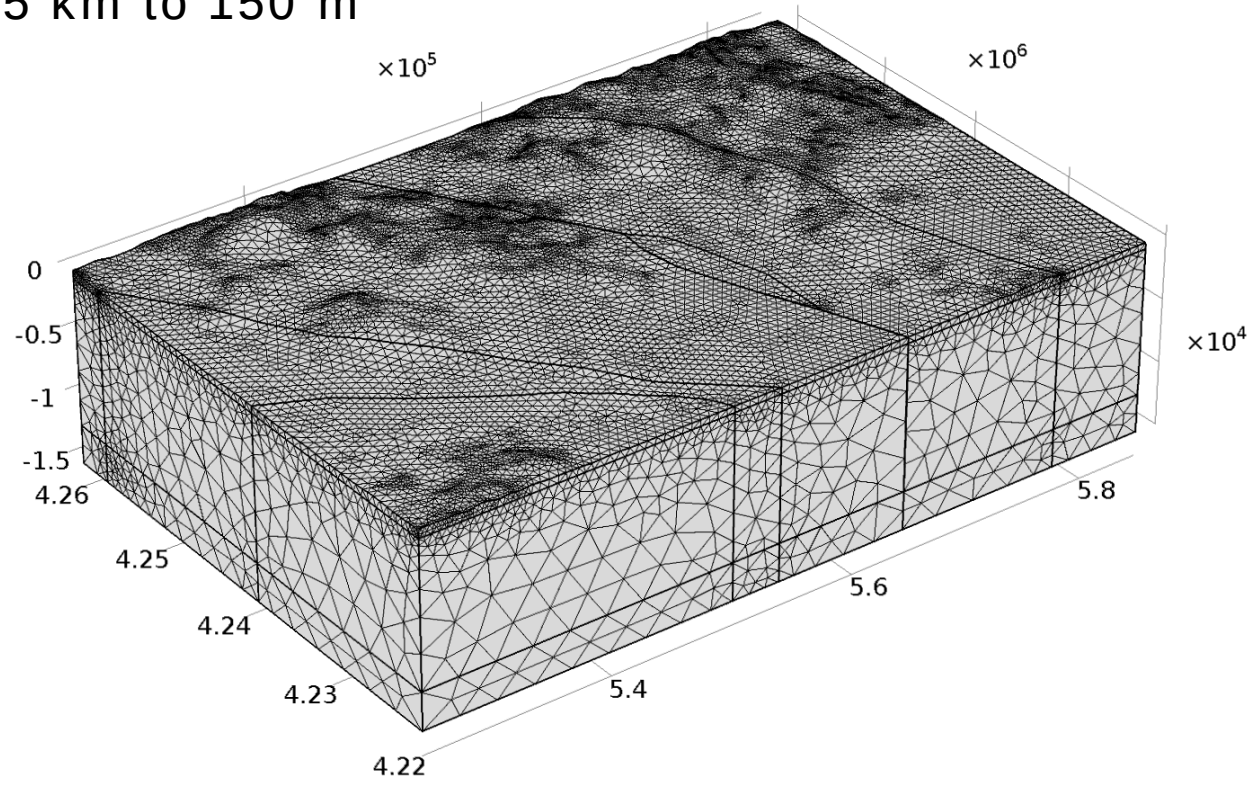
Fault 1
Length:9.5 km
Width:11.5
Dip:83° eastward



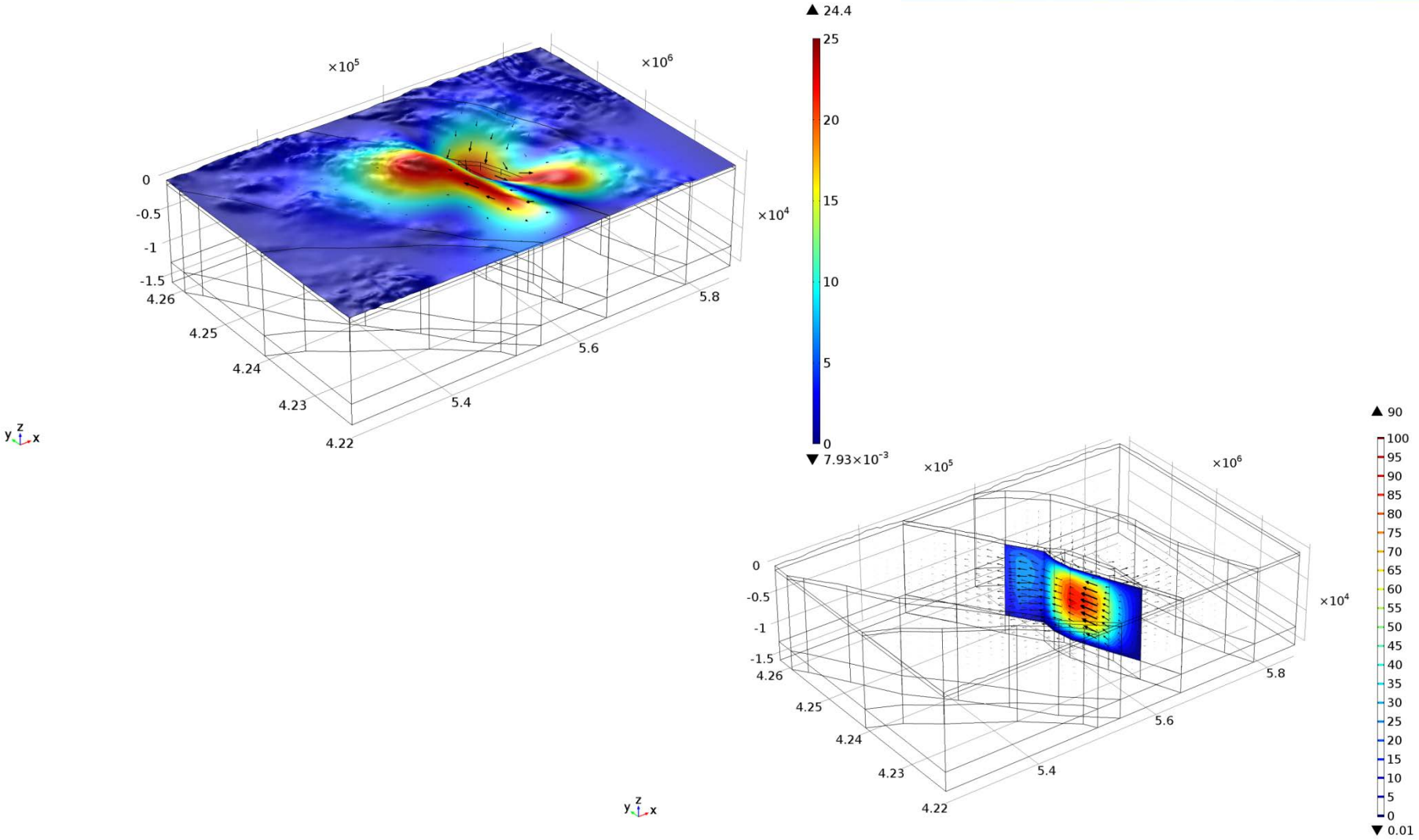
Fault 2
Length:8 km
Width:5.8 km
Dip:85° westward

FEM CO-SEISMIC MODEL

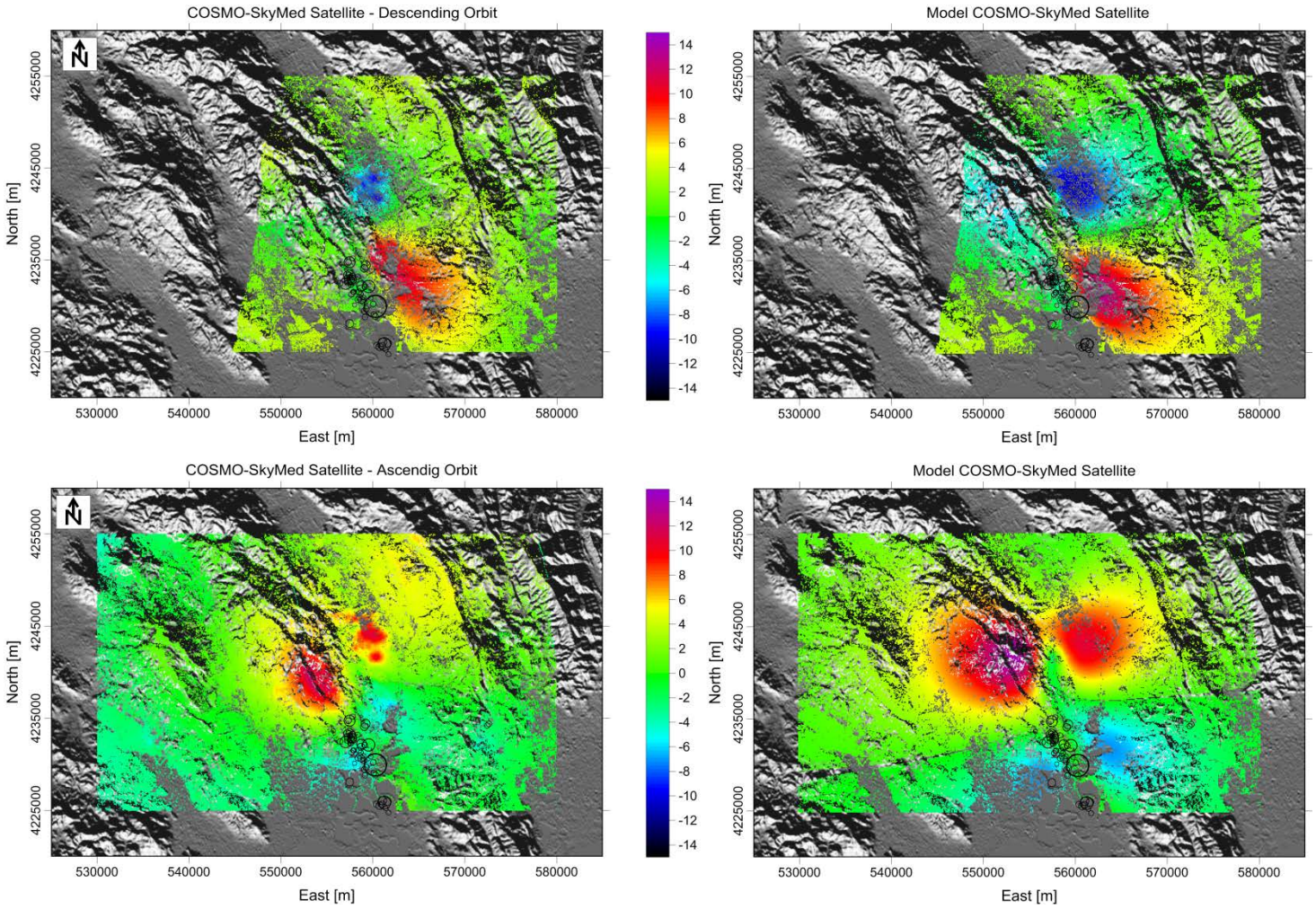
Mesh dimension
From 1.5 km to 150 m



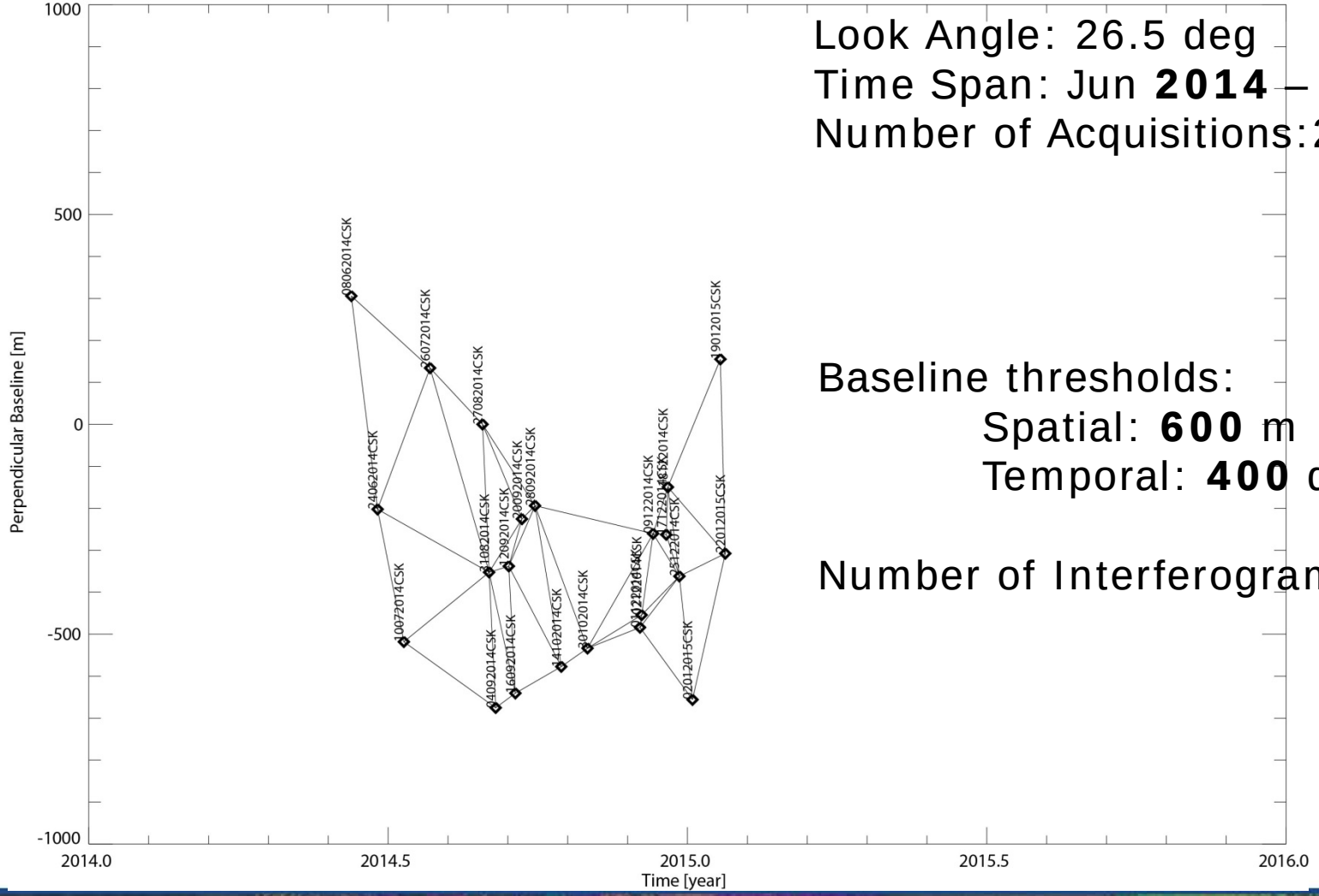
FEM CO-SEISMIC MODEL



Data-Model comparison



CSK Descending time series



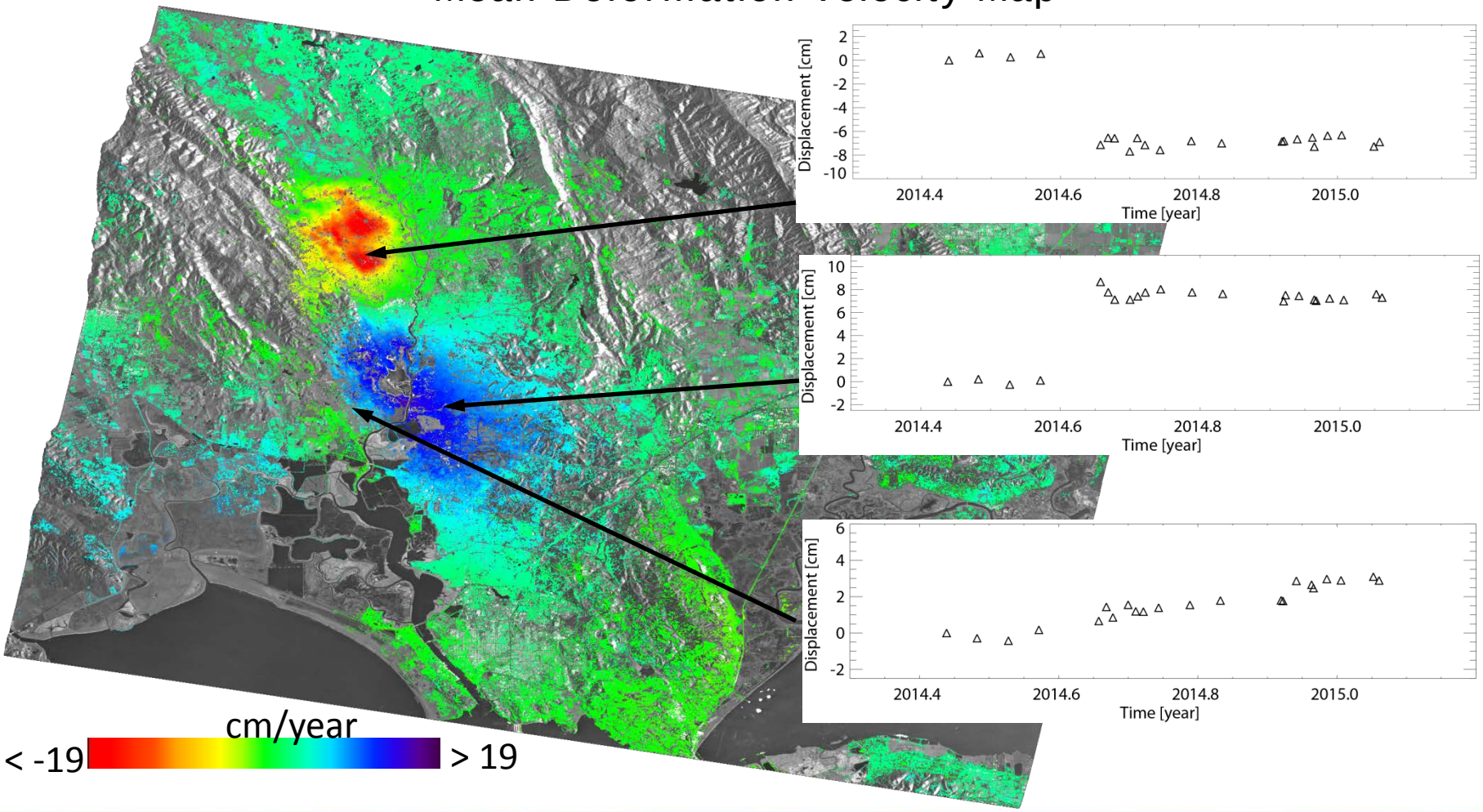
Look Angle: 26.5 deg
Time Span: Jun **2014** – Jan **2015**
Number of Acquisitions: 22

Baseline thresholds:
Spatial: **600** m
Temporal: **400** days

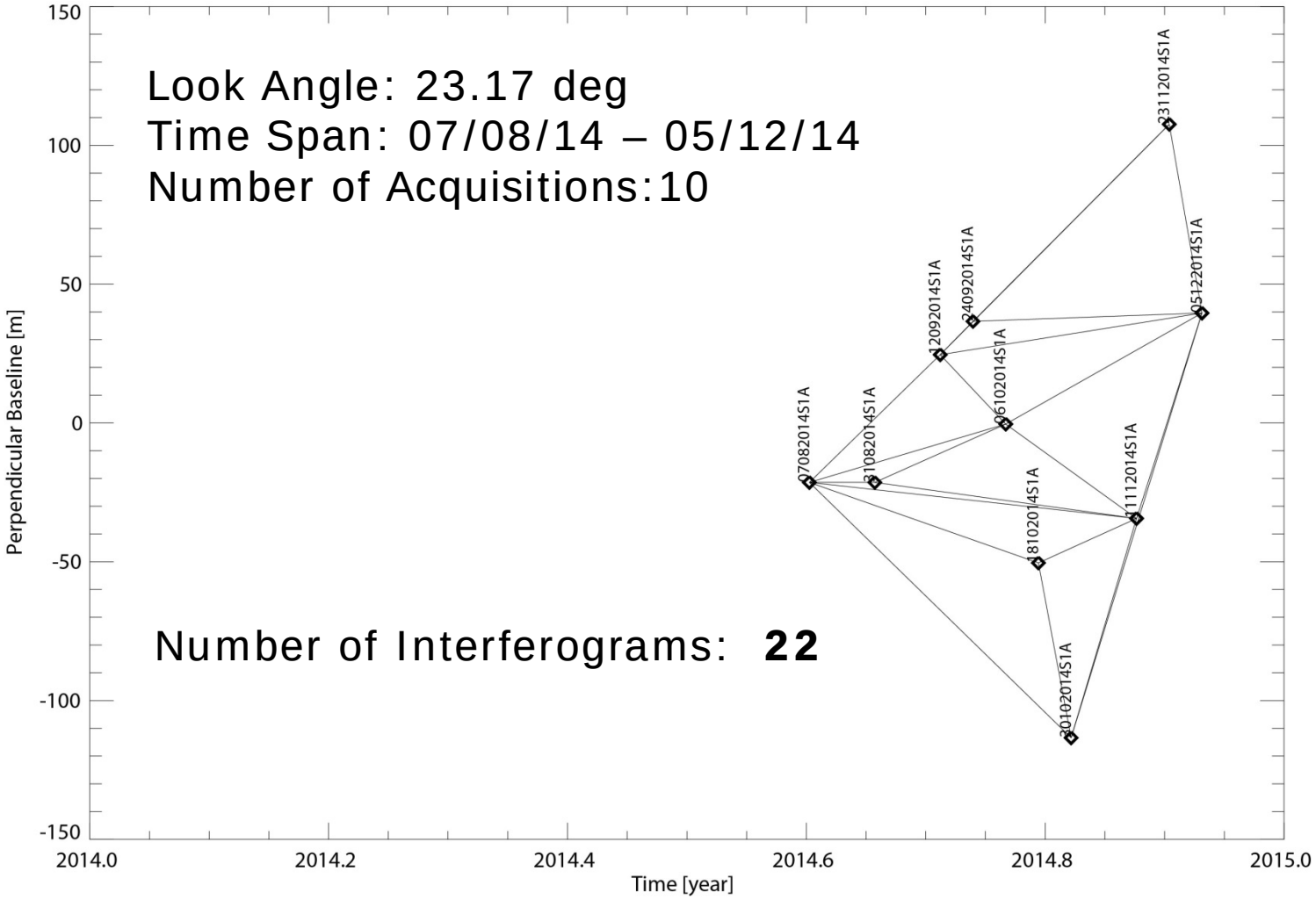
Number of Interferograms: 47

CSK Descending time series

Mean Deformation Velocity Map

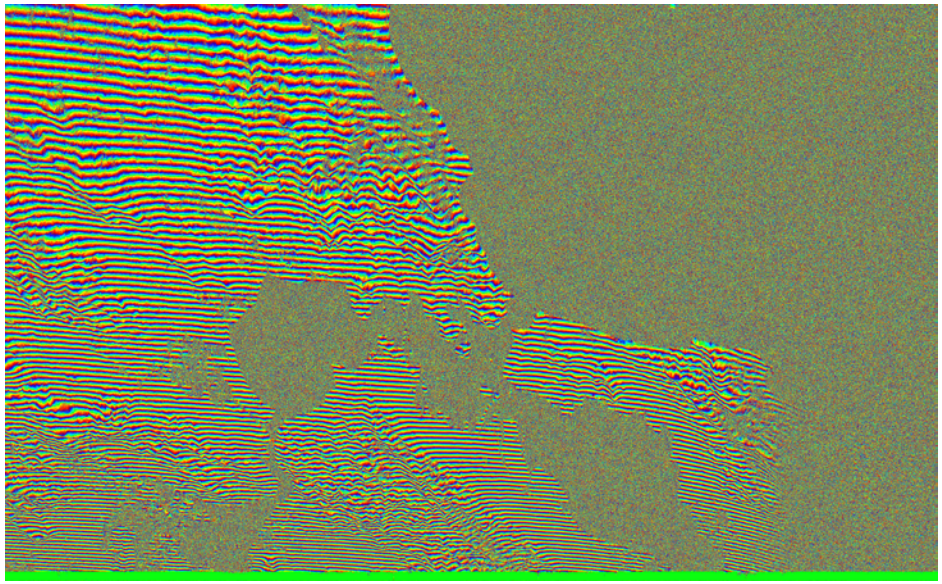


Sentinel-1 Descending time series

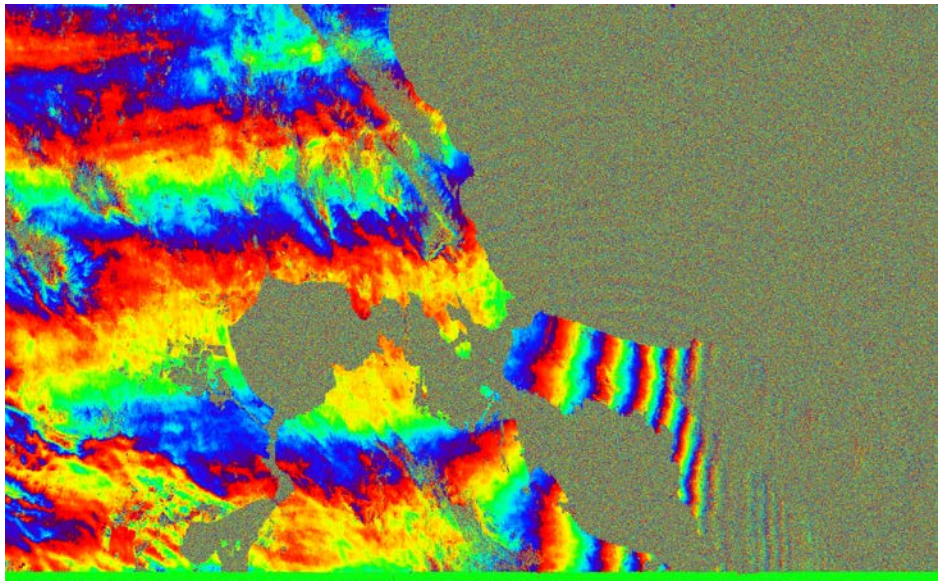


Sentinel-1 orbits comparison

Annotated Orbit



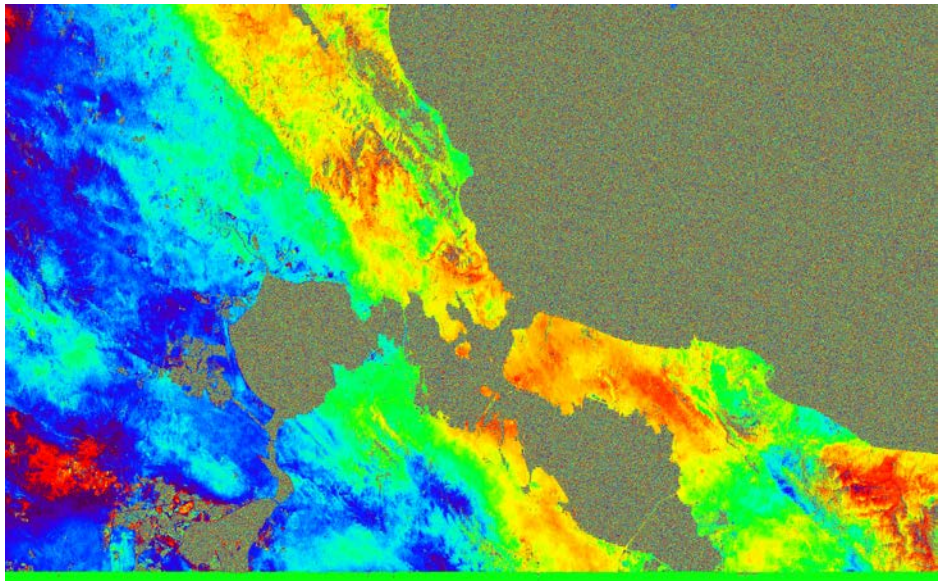
12092014_06102014



12092014_24092014

Sentinel-1 orbits comparison

Precise Orbit (POE)



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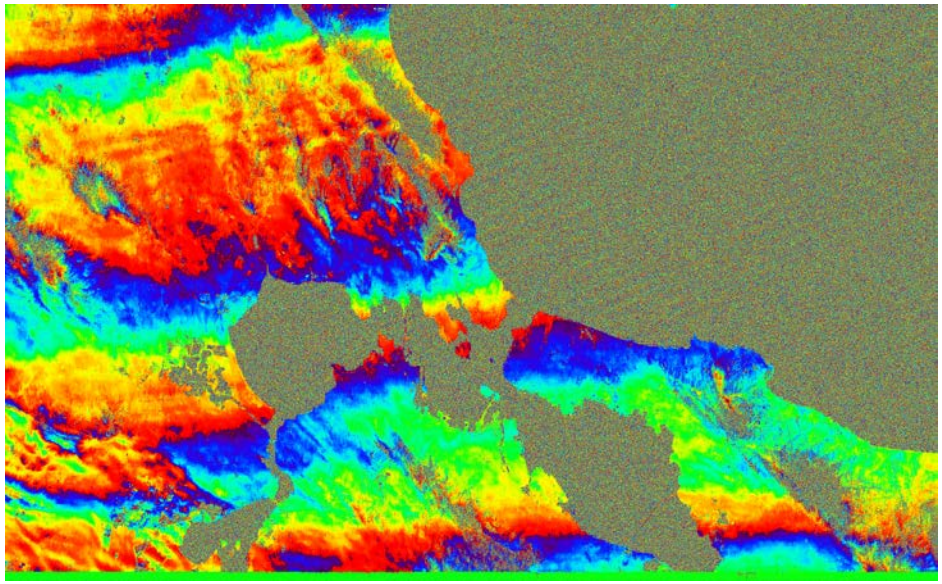
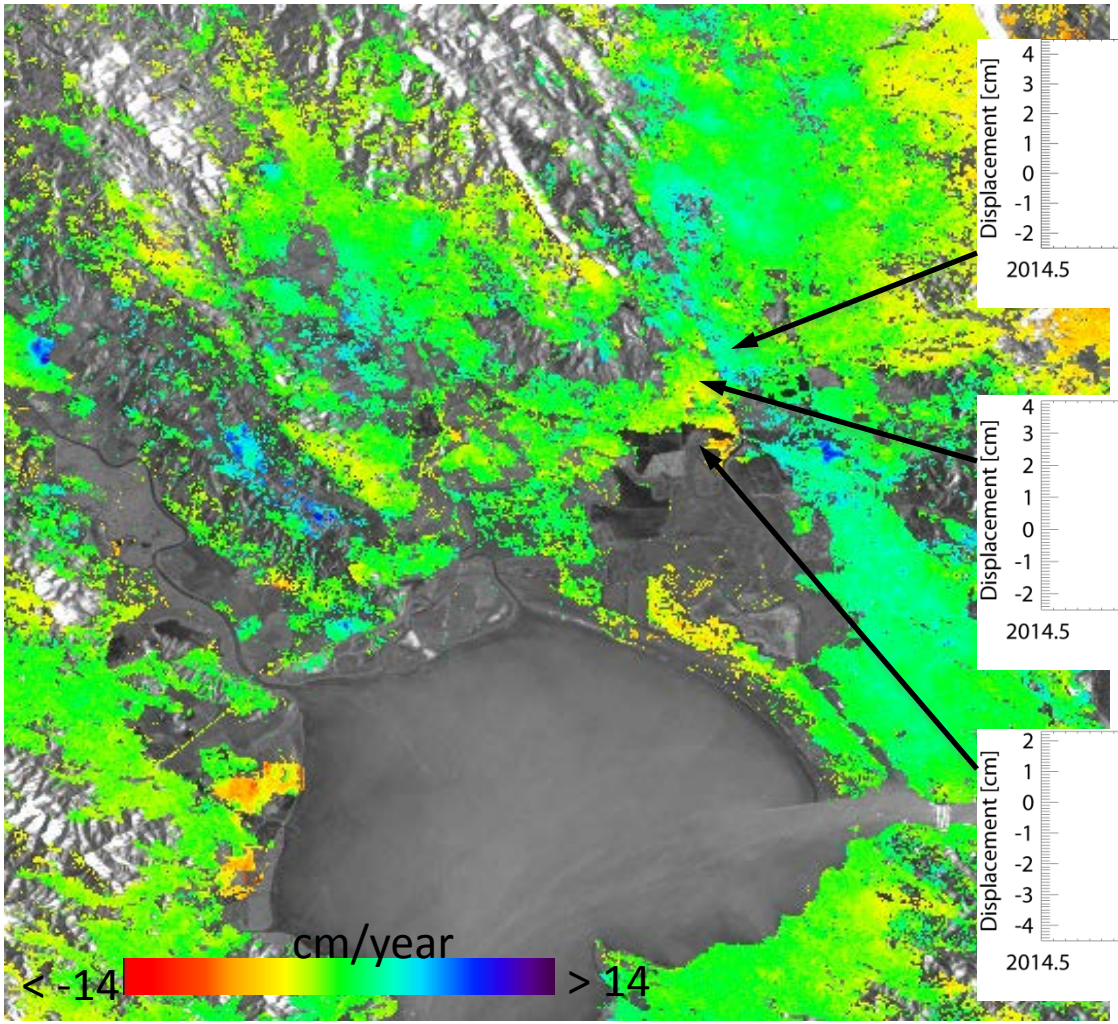
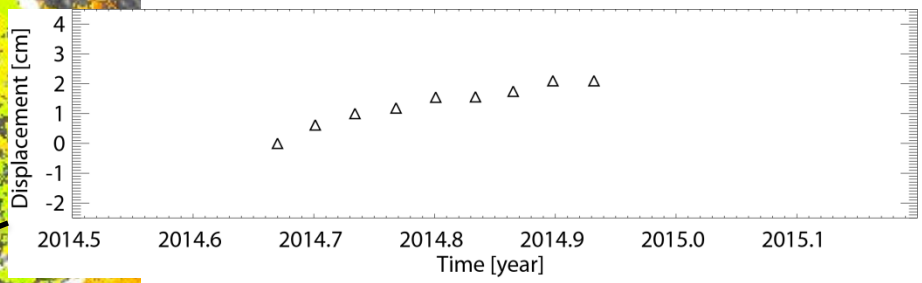


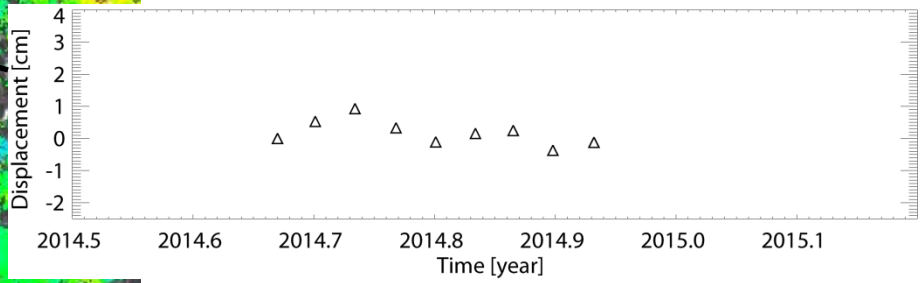
12092014_24092014

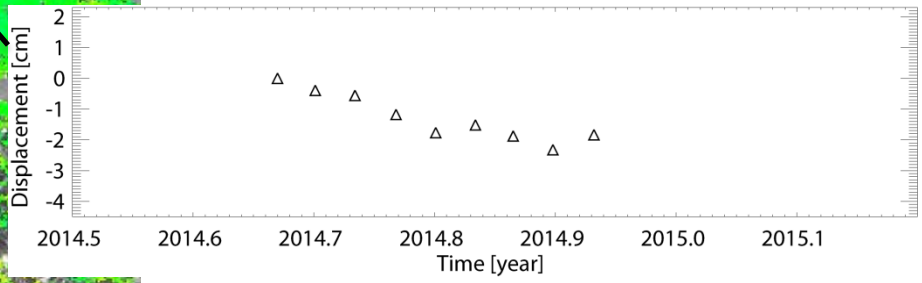
Sentinel-1 Descending time series

Post-seismic Velocity Map









CONCLUSION

- DInSAR and PO analysis reveal a new unmapped segment of West Napa Fault;
- The main kinematics is a right lateral movement and also a westward not negligble component;
- The co-seismic FEM model accounts for 2 segment faults with different dip direction;
- The post-seismic (afterslip) signal is active until the end of October 2014.