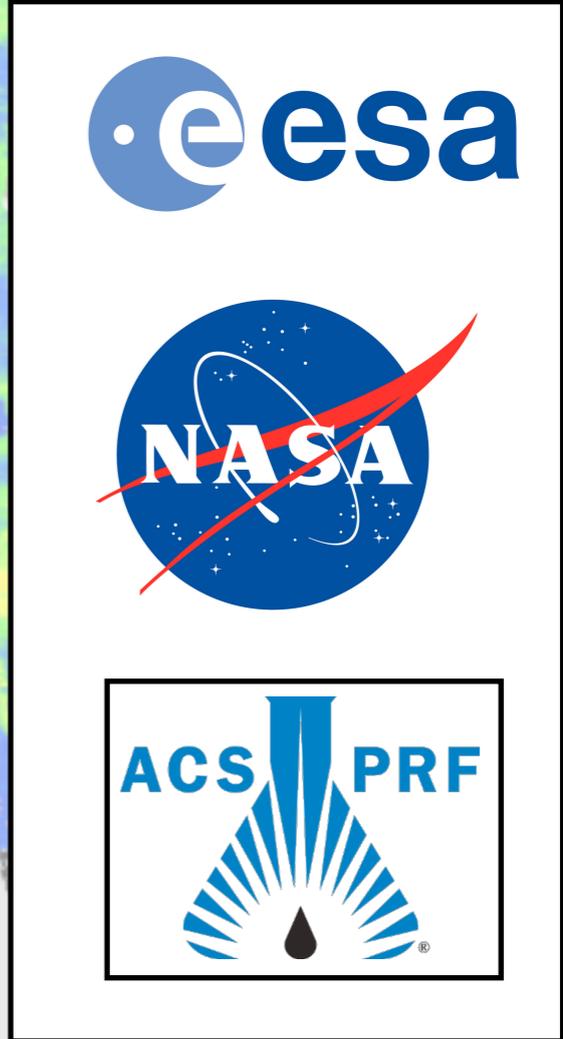




Multi-Track InSAR Time Series of Plate Boundaries: The Zagros Mountains and Makran Subduction Zone Southern Iran

William Barnhart
Rowena Lohman

Cornell University
Ithaca, NY, USA



Orogen-Wide InSAR Time Series

Motivation for generating large-scale time series

- Spatial distribution of strain in broadly deforming zones
- UFOs (Unrecognized Folding/moving/deforming Objects)

Deriving Displacement History

Some Results





Identifying UFOs: The Hazards Perspective

“Our attention should now focus on the threat posed by unanticipated quakes located in the continental interiors”

- England and Jackson, Nature 2011

“...scientific priority should instead lie with identifying regions of the highest hazards where we have ... data on known active faults”

- John McCloskey, Nature 2011

Potential Solution: InSAR Time Series



Zagros Overview

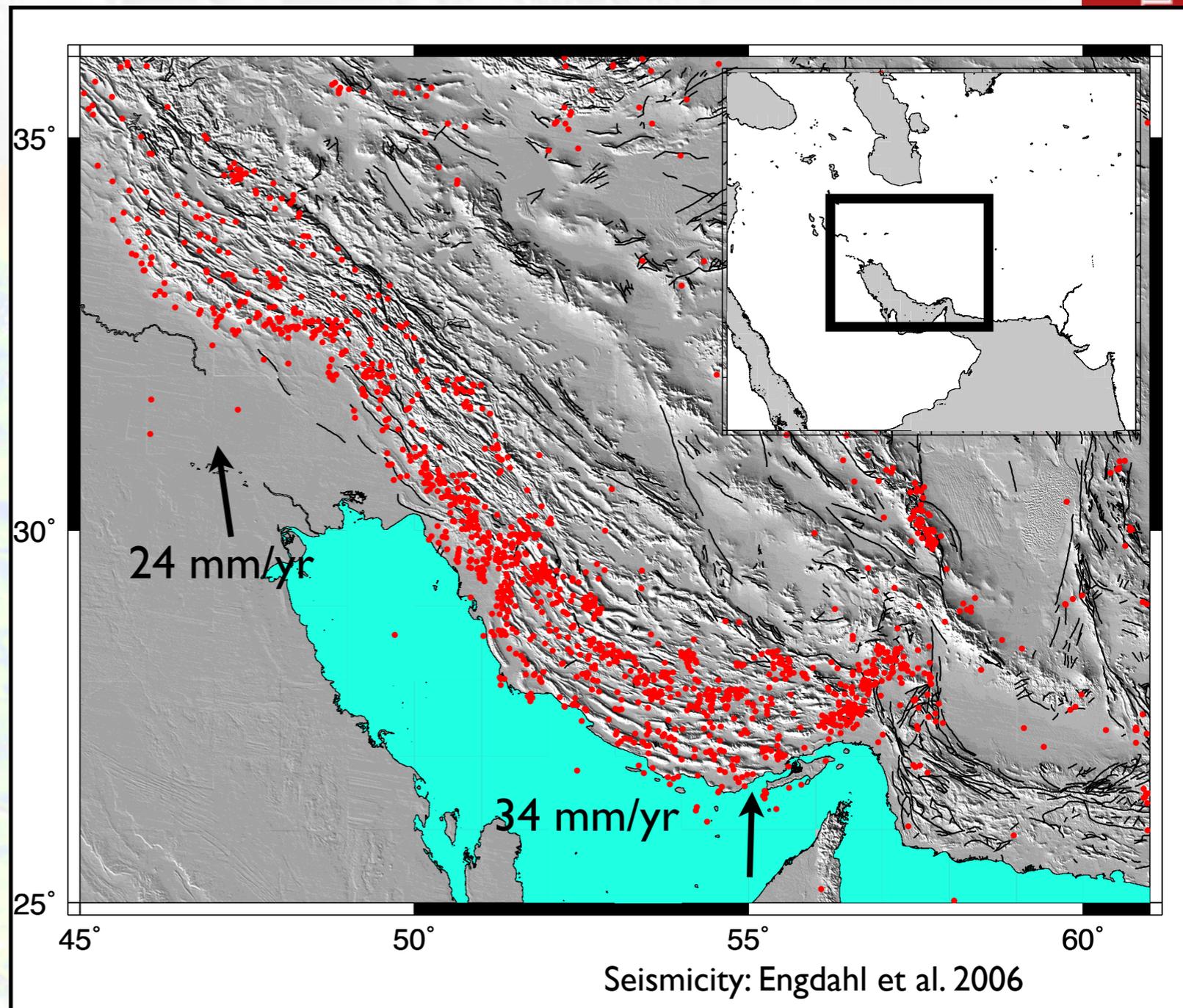
Collision between Arabia and Eurasia

Salt detached fold and thrust belt

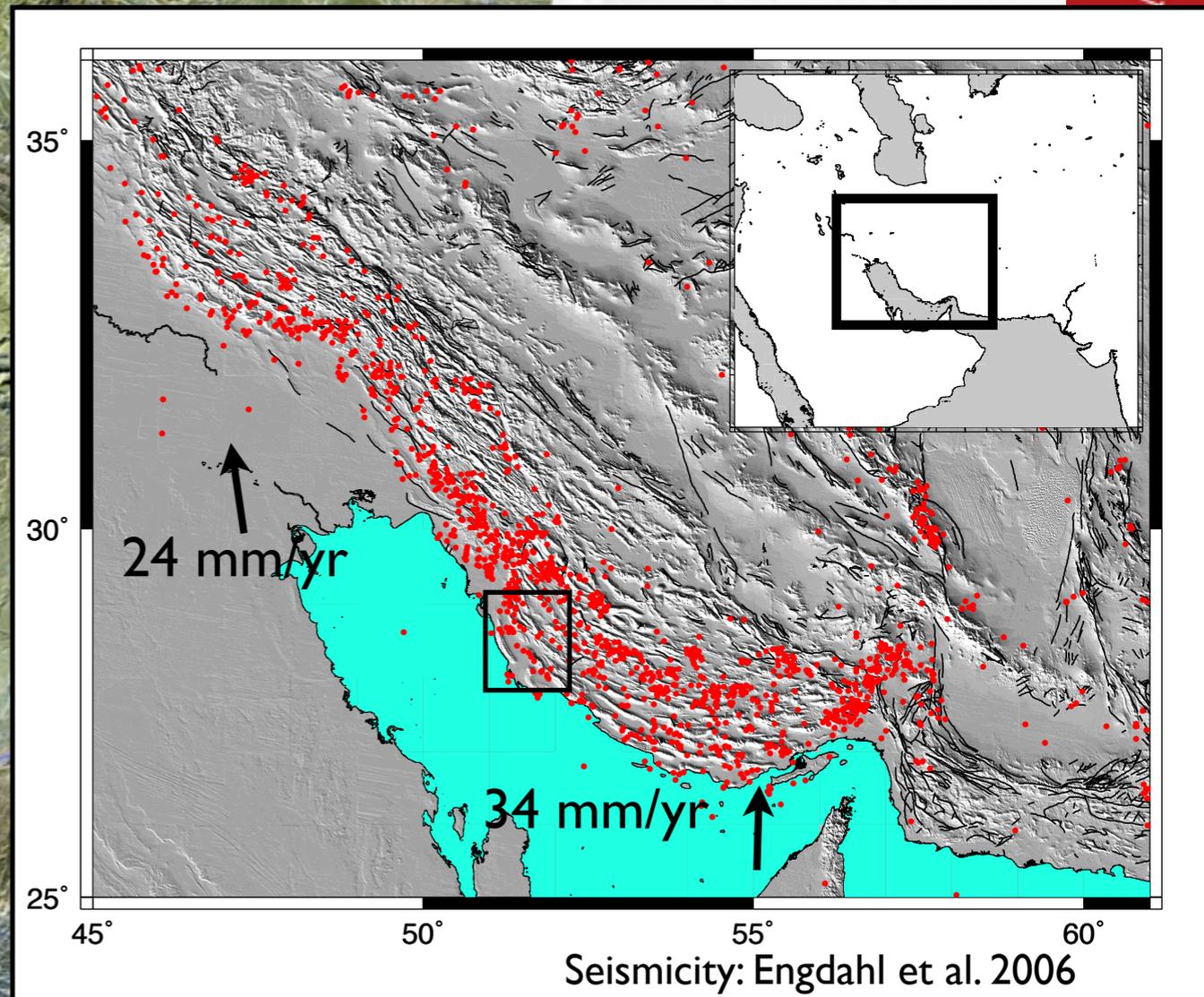
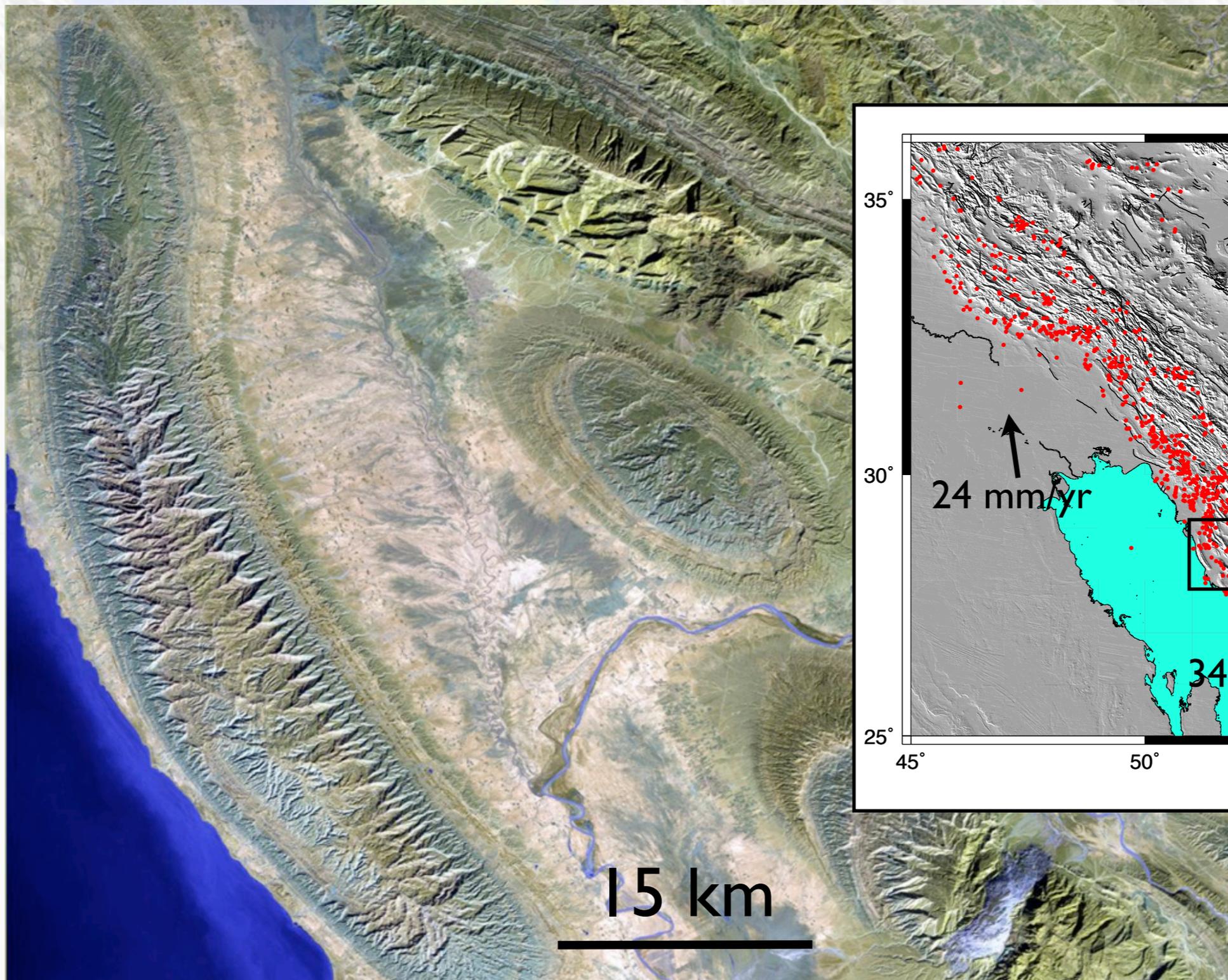
High seismicity rates

80-90% accommodated aseismically

Rare surface rupturing earthquakes



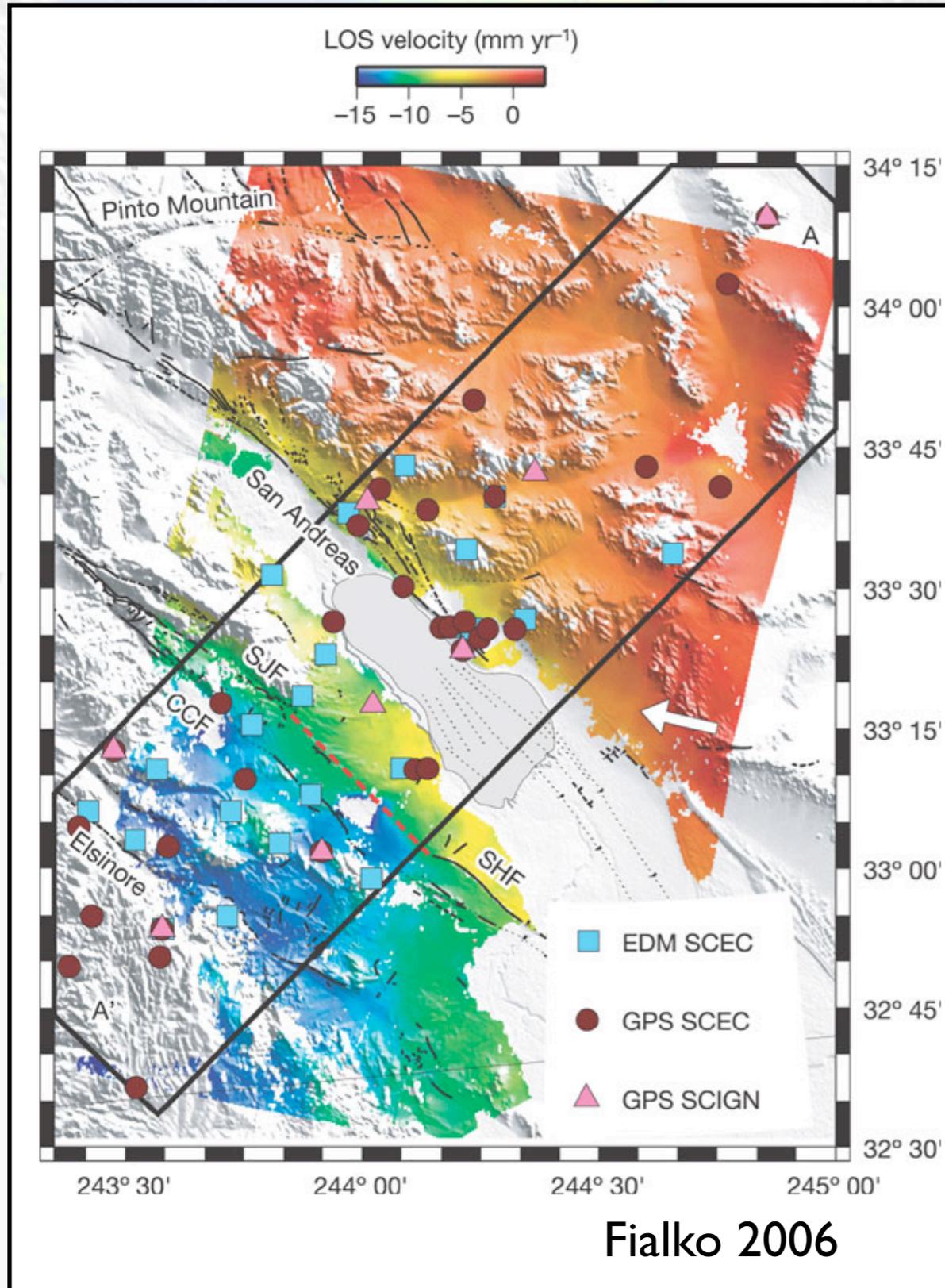
Identifying UFOs: Zagros Anticlinal Uplift



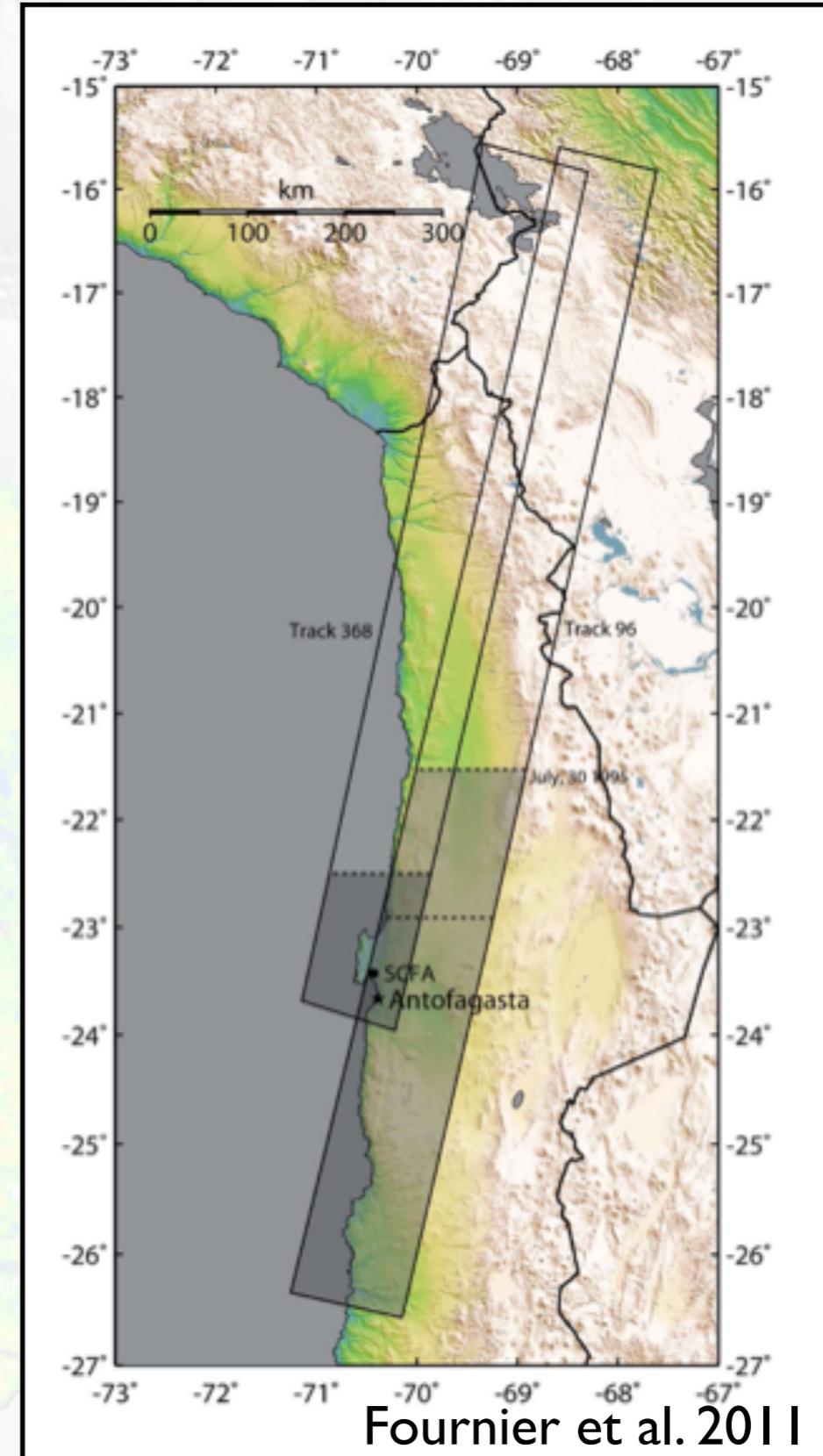
Landsat

Large Spatial Scale InSAR Observations

Southern California



South America

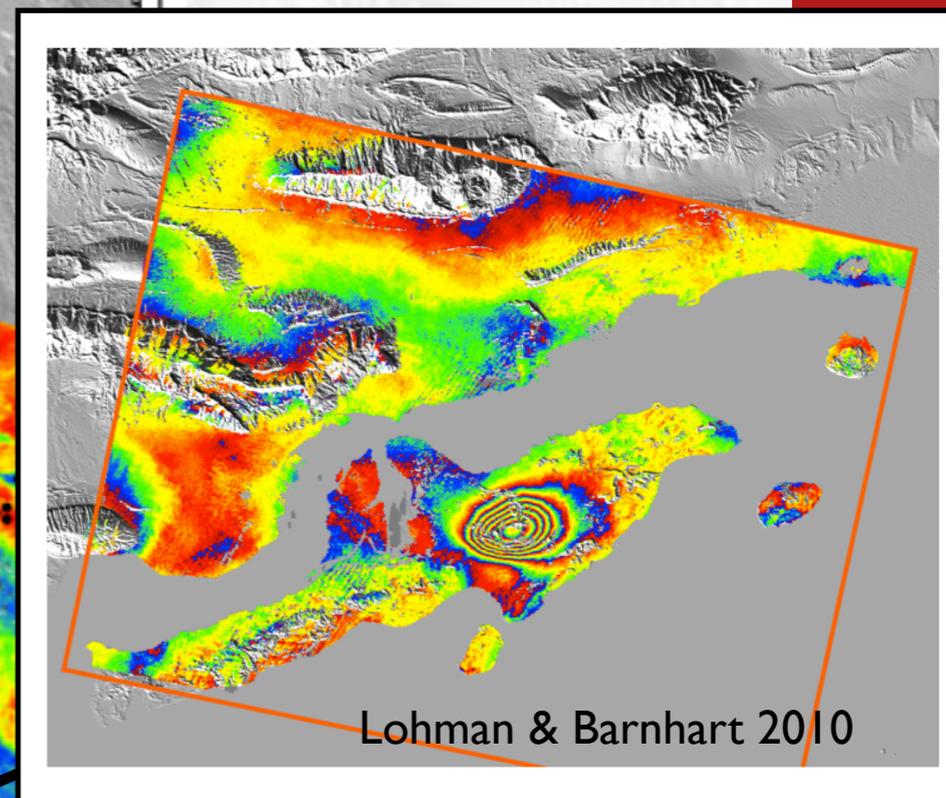
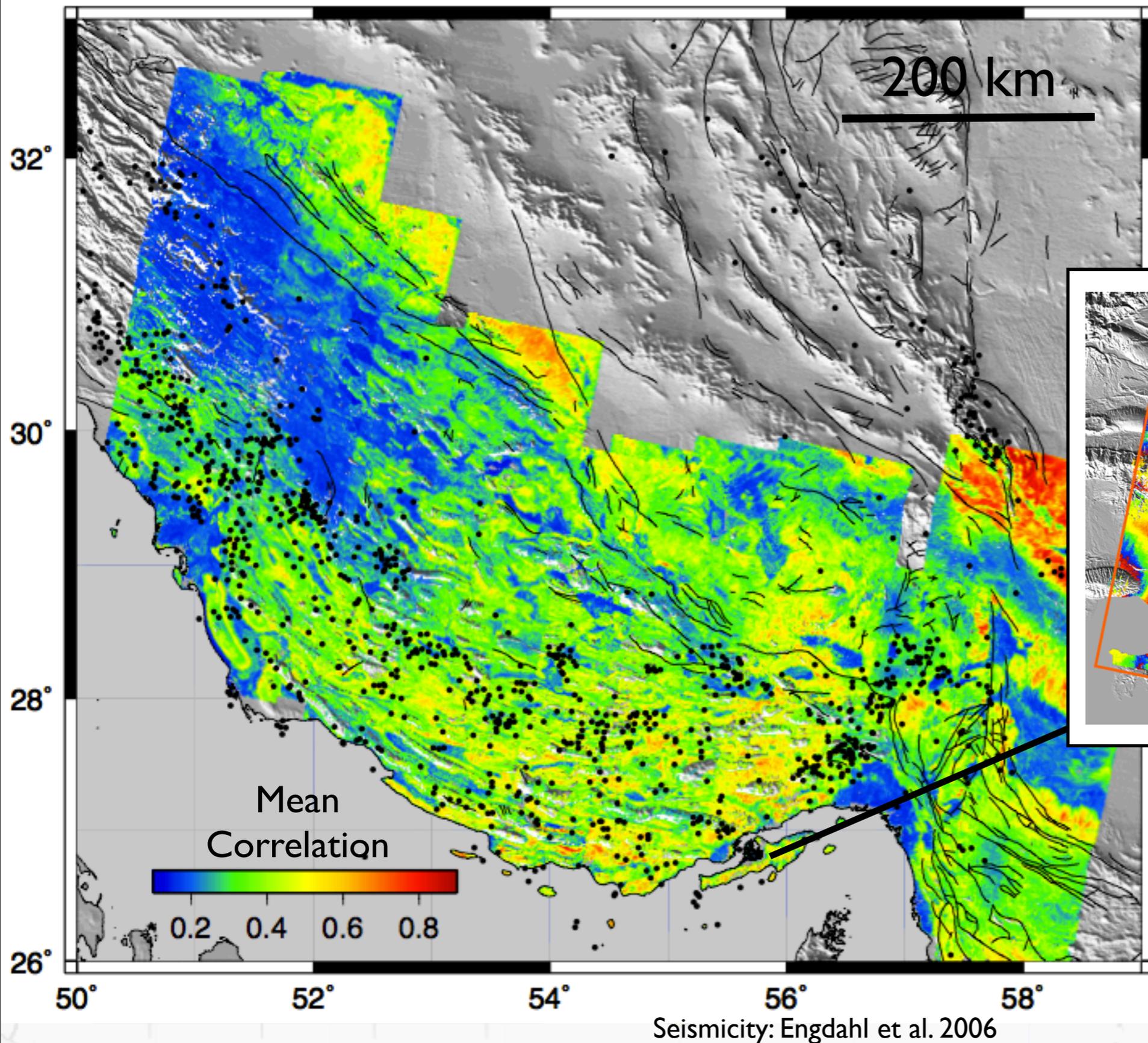




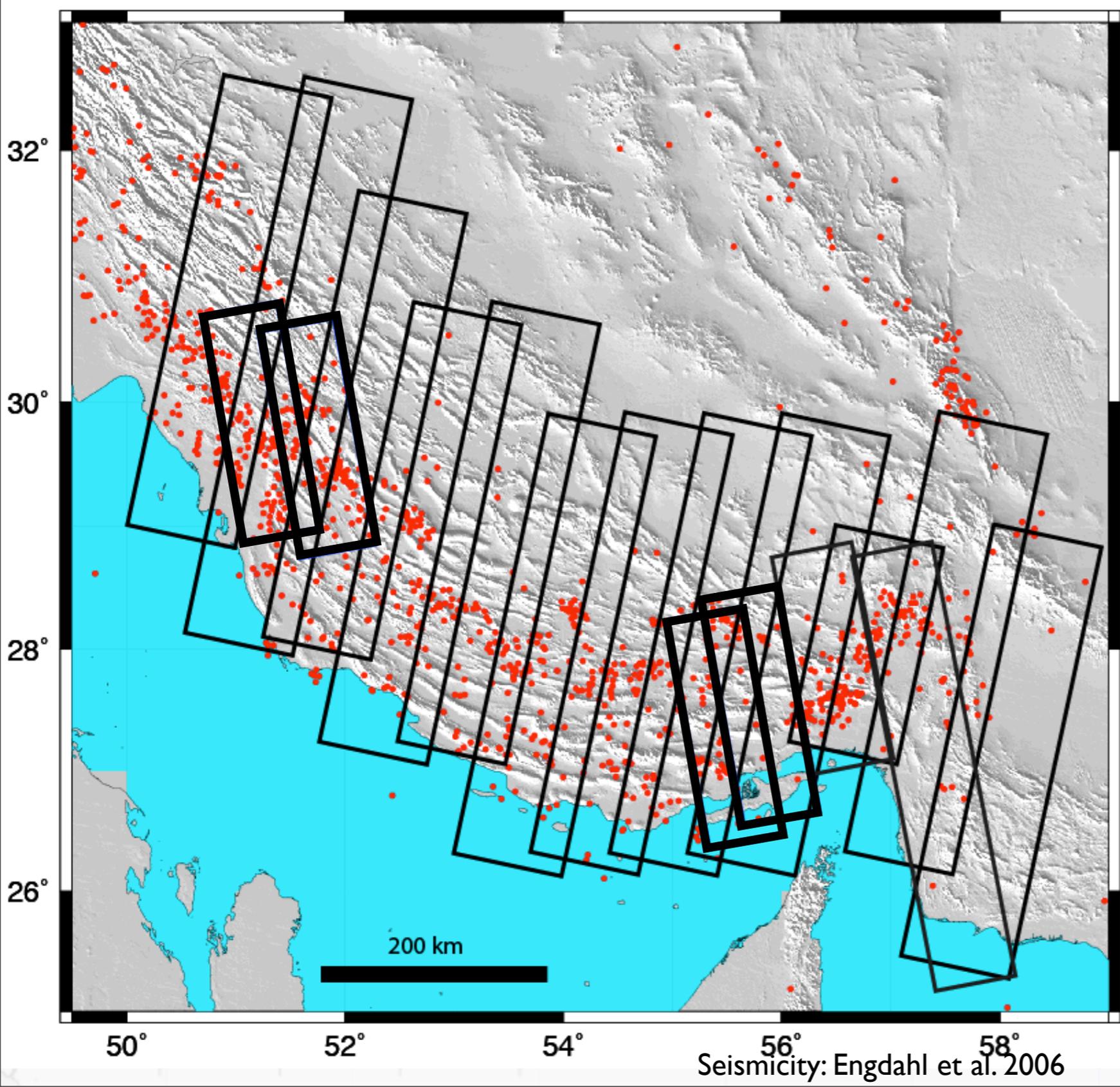
Southern Iran A Natural Laboratory

Descending Envisat Scenes

2005 Qeshm
Island Earthquake



Iran Time Series



2003-2010

18 Tracks

Envisat
and ALOS (bold)

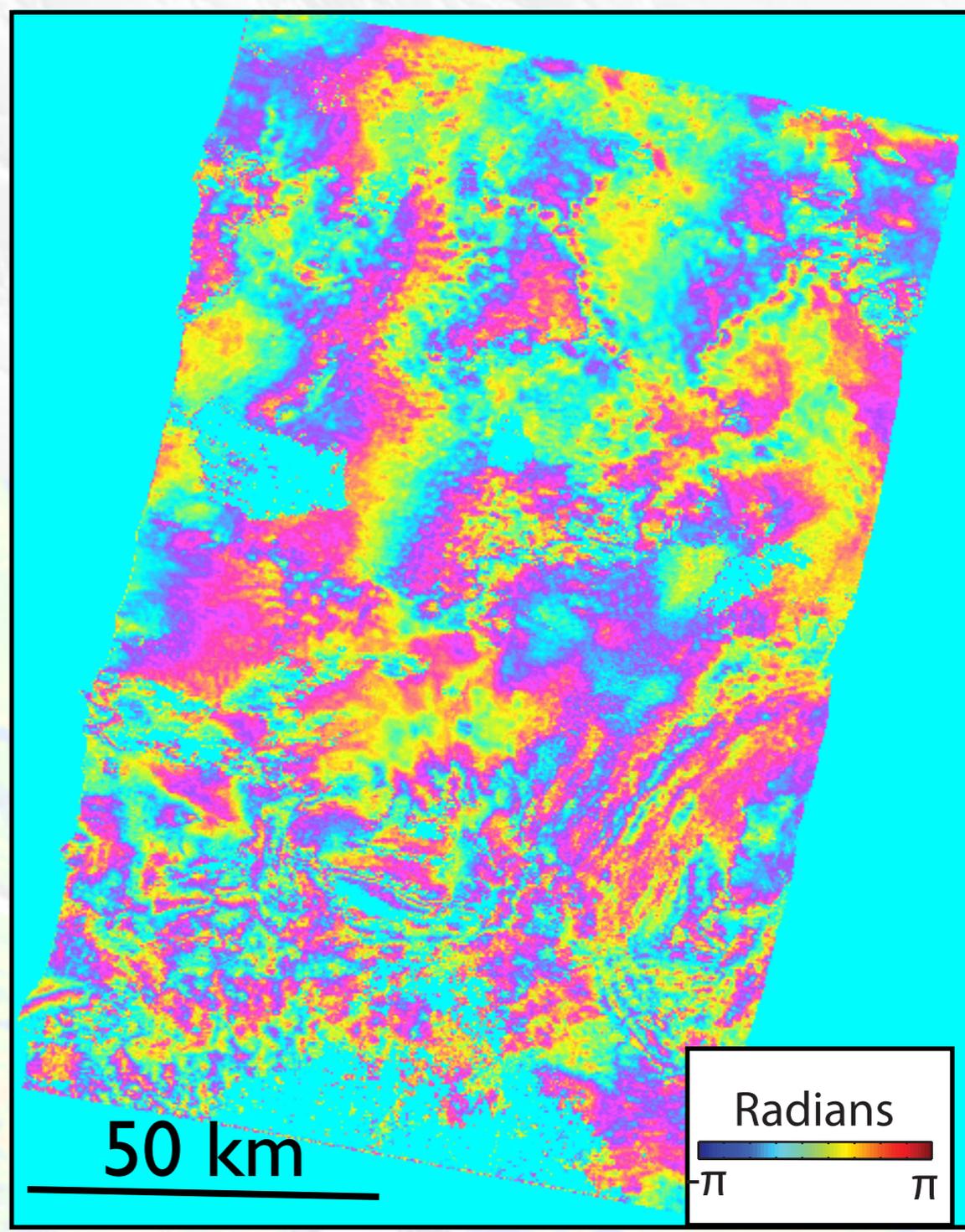
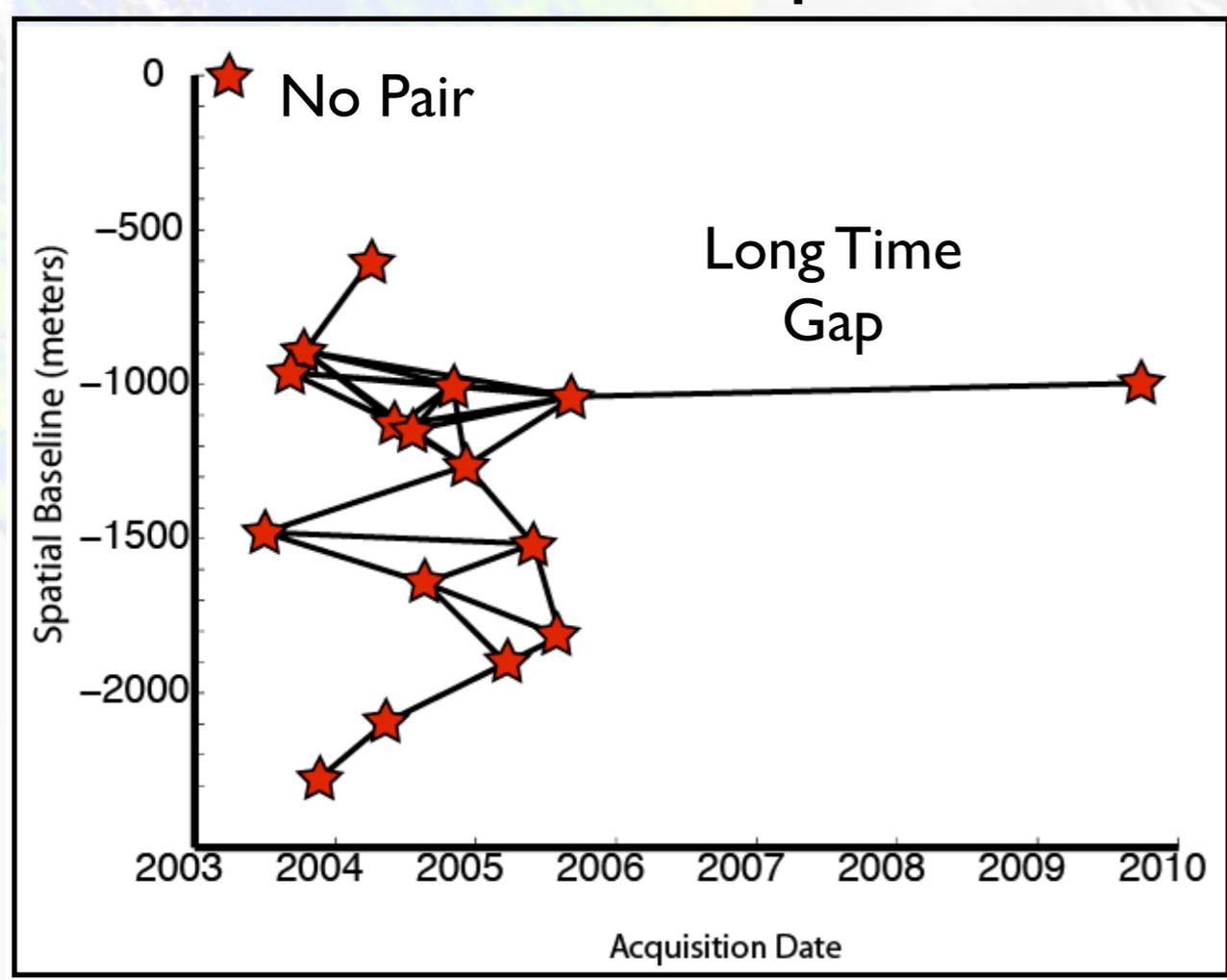
13-38 Acquisitions
per track

948 igrans

Problems

Non Stationary,
Correlated Noise

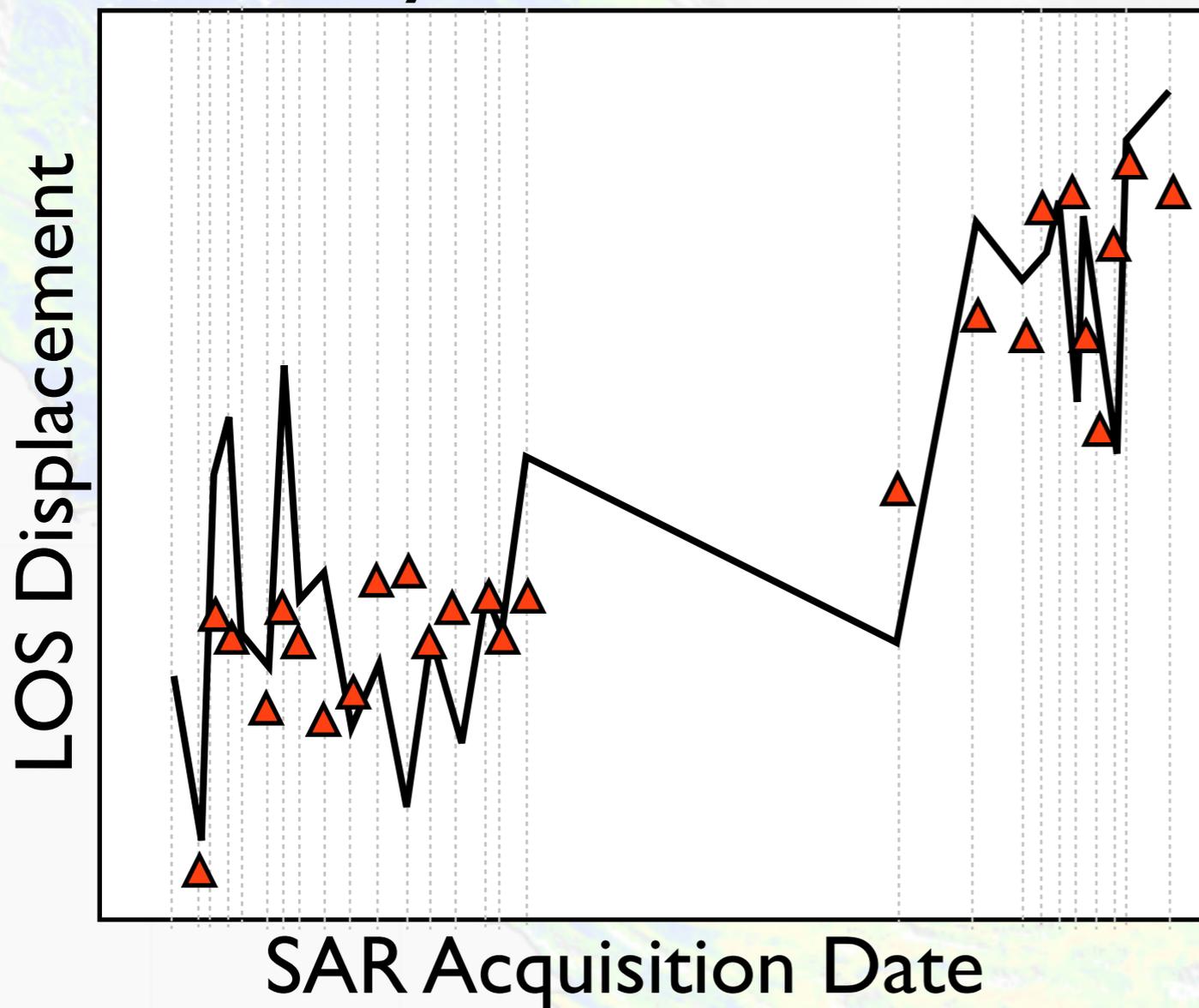
Inconsistent Acquisitions



- Incomplete Tracks
- Unwrapping Errors
- Orbital Errors

Deriving Displacement History From Igram Tree Full-Rank Inversion

Synthetic Test

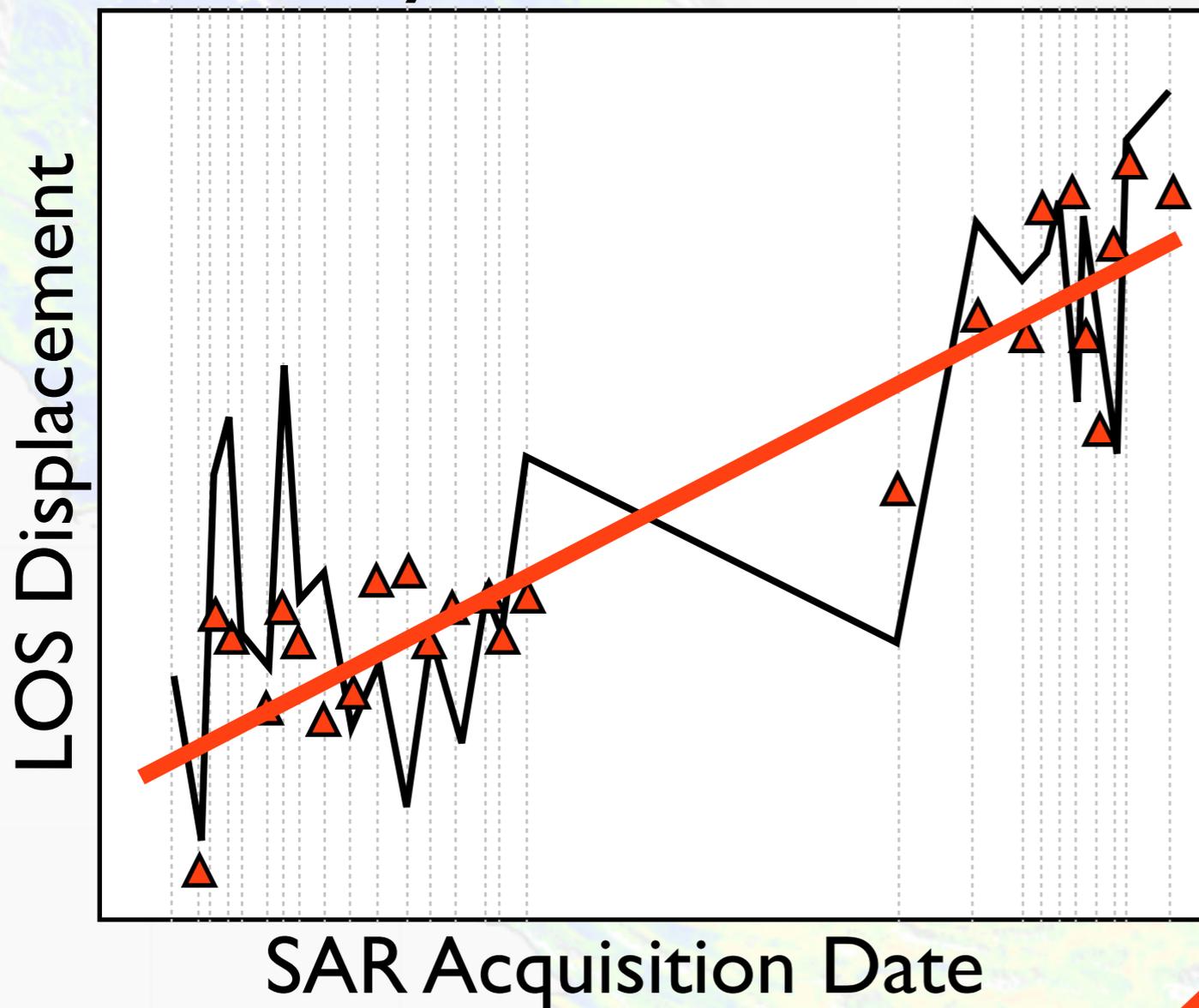


Raw signal =
Noise + ramp + 10 mm/yr

Inverted Displacement =
▲ Noise + 10 mm/yr

Deriving Displacement History From Igram Tree Full-Rank Inversion

Synthetic Test



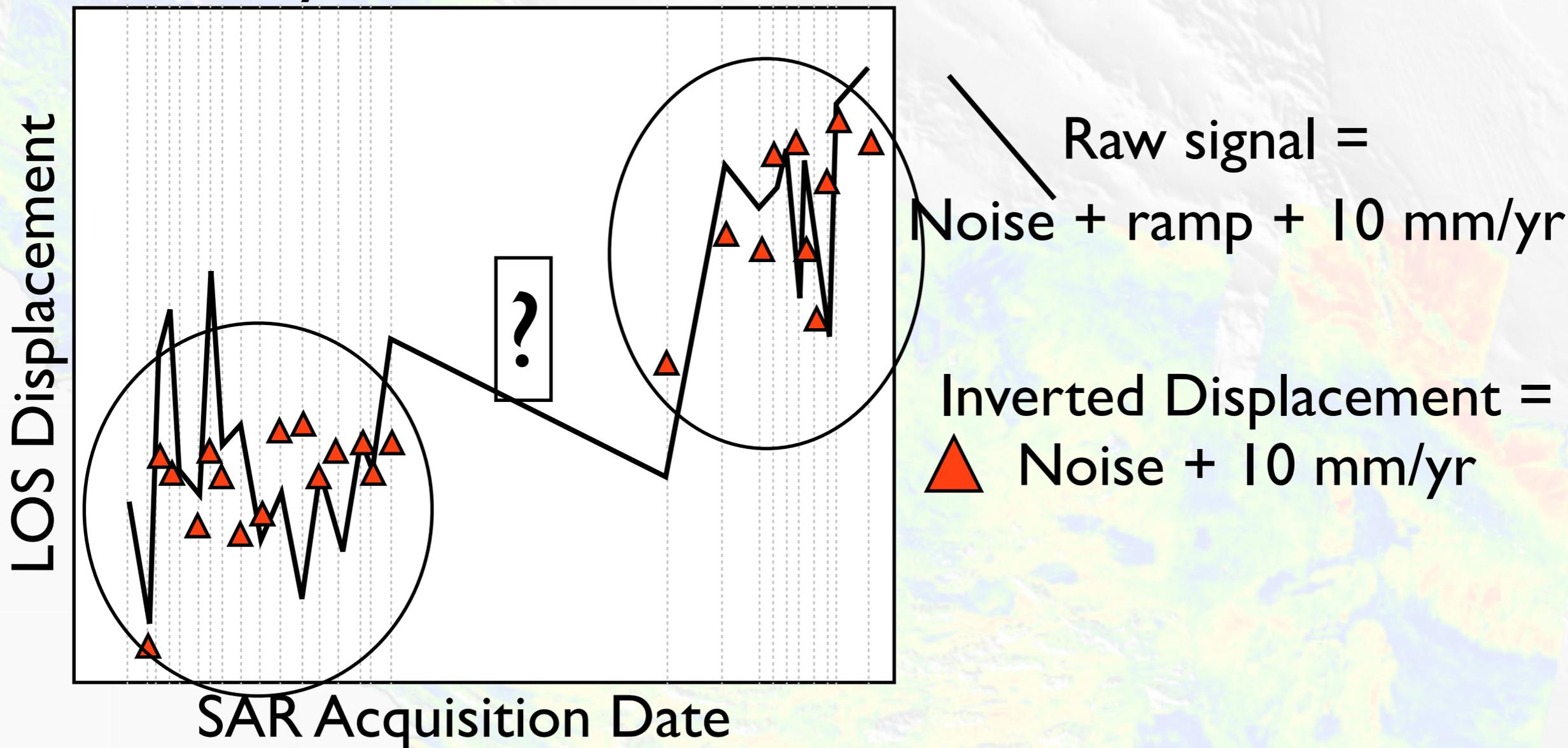
Raw signal =
Noise + ramp + 10 mm/yr

Inverted Displacement =
▲ Noise + 10 mm/yr

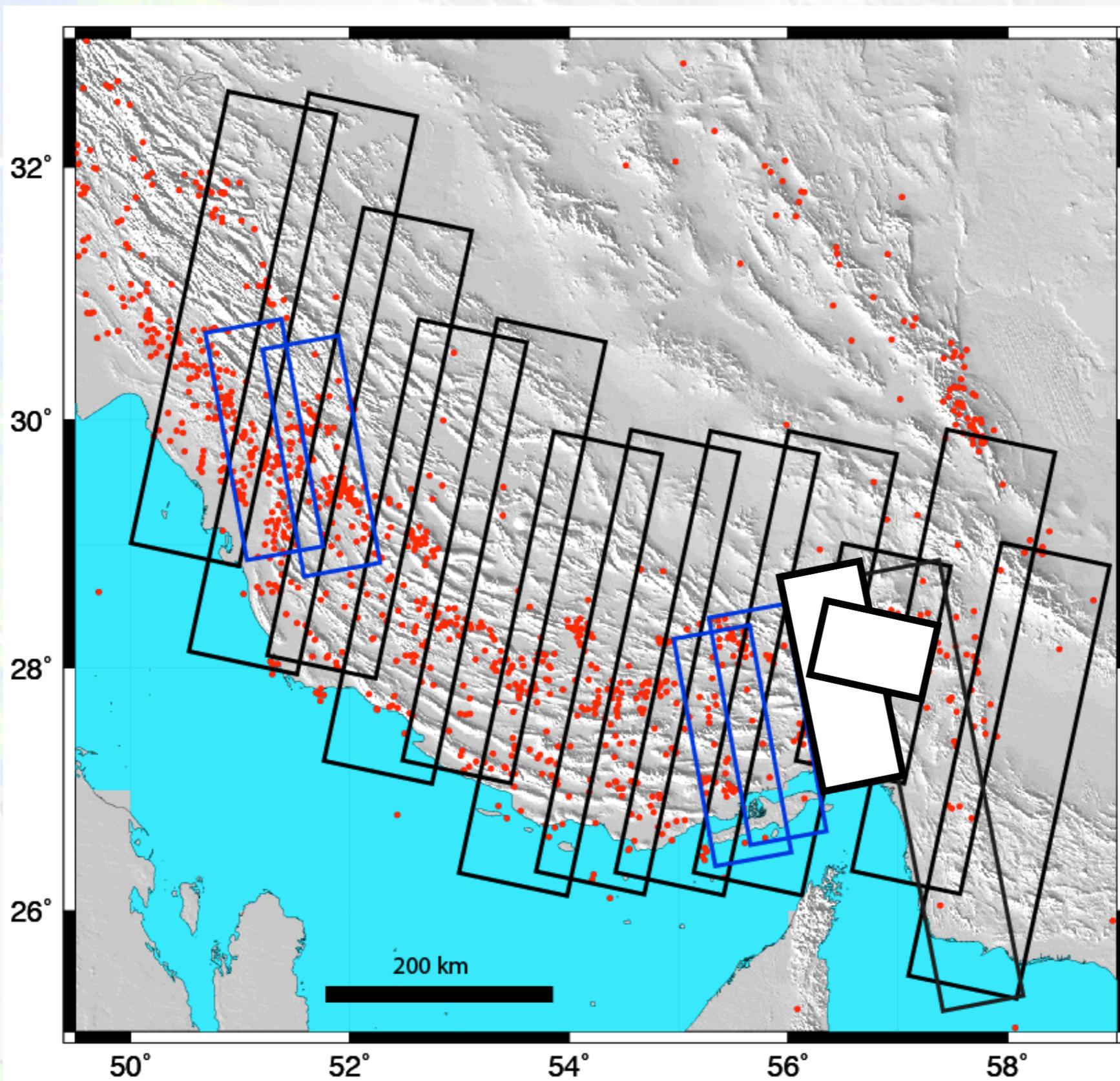
Inverted LOS Rate
~ 10 mm/yr

Deriving Displacement History From Igram Tree Rank Deficient Case

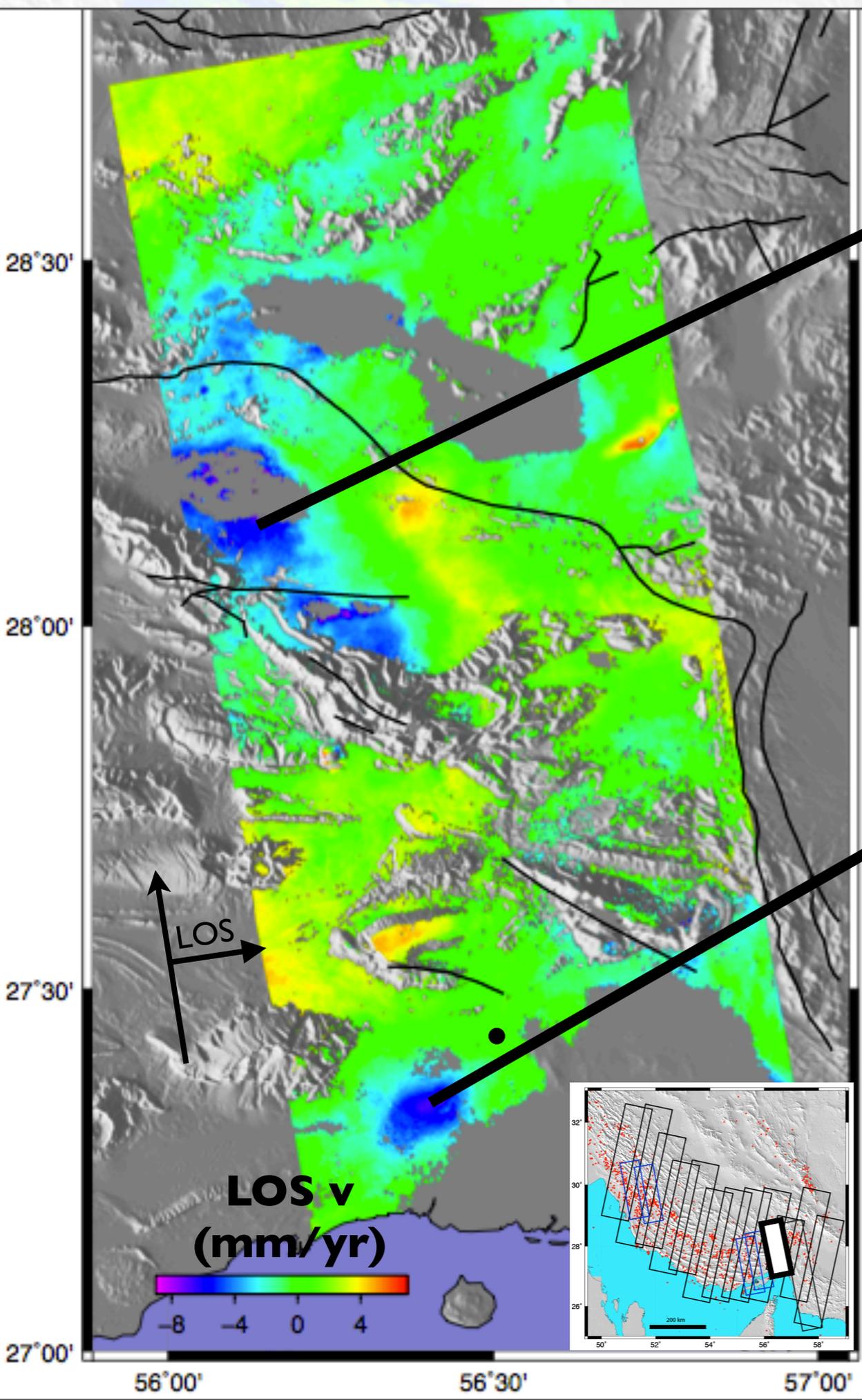
Synthetic Test



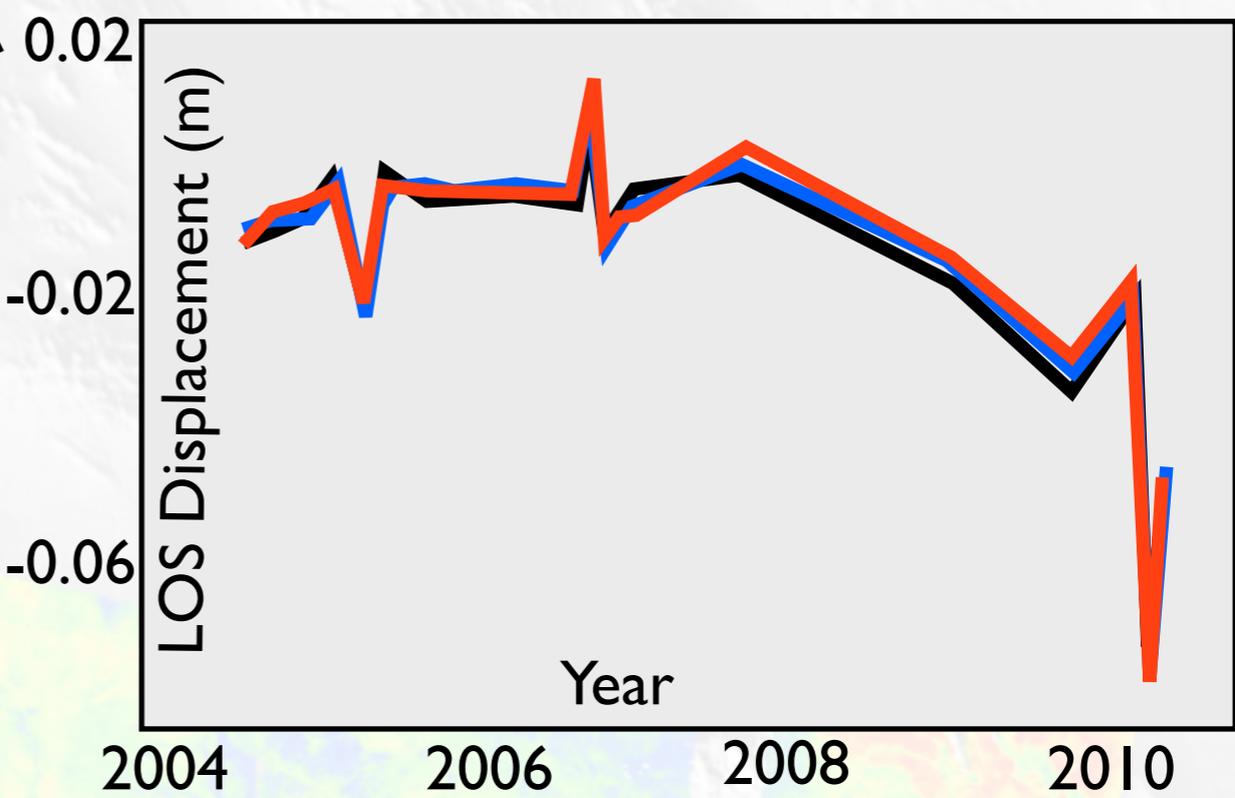
Time Series



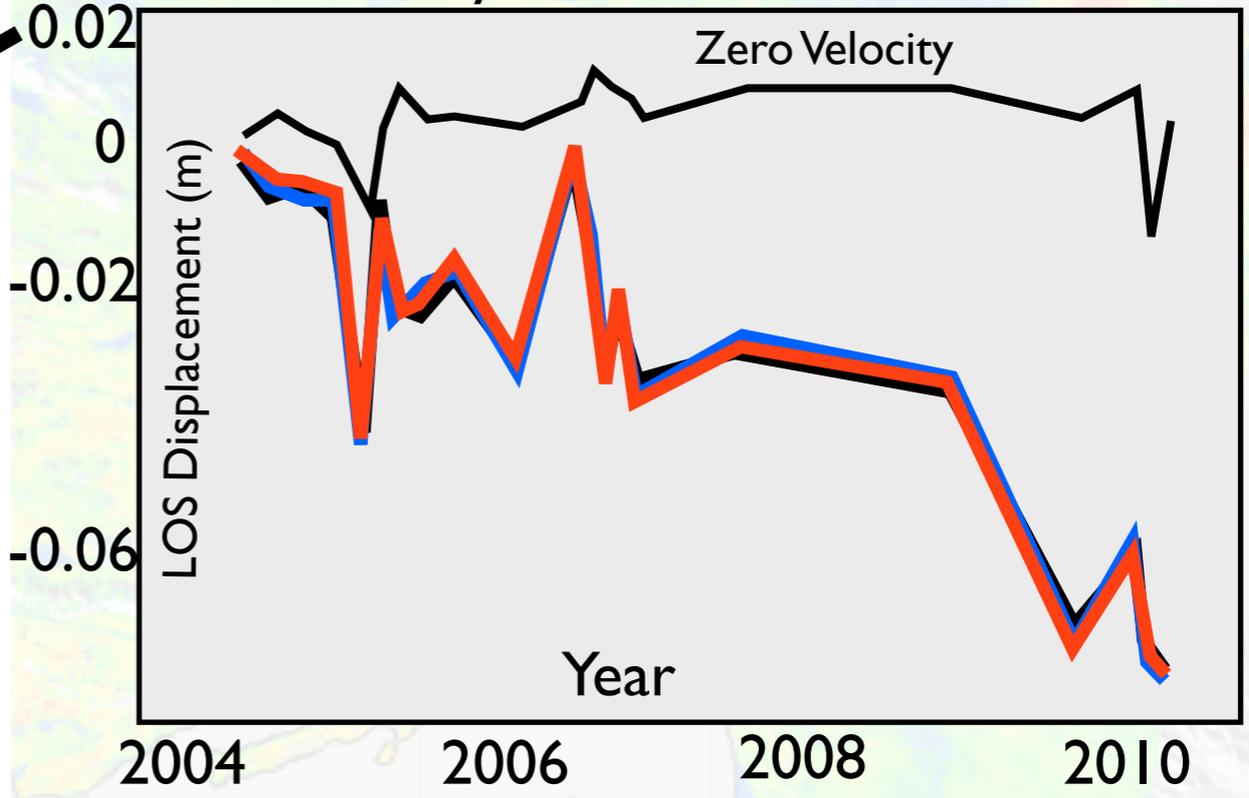
Time Series



Agricultural Subsidence

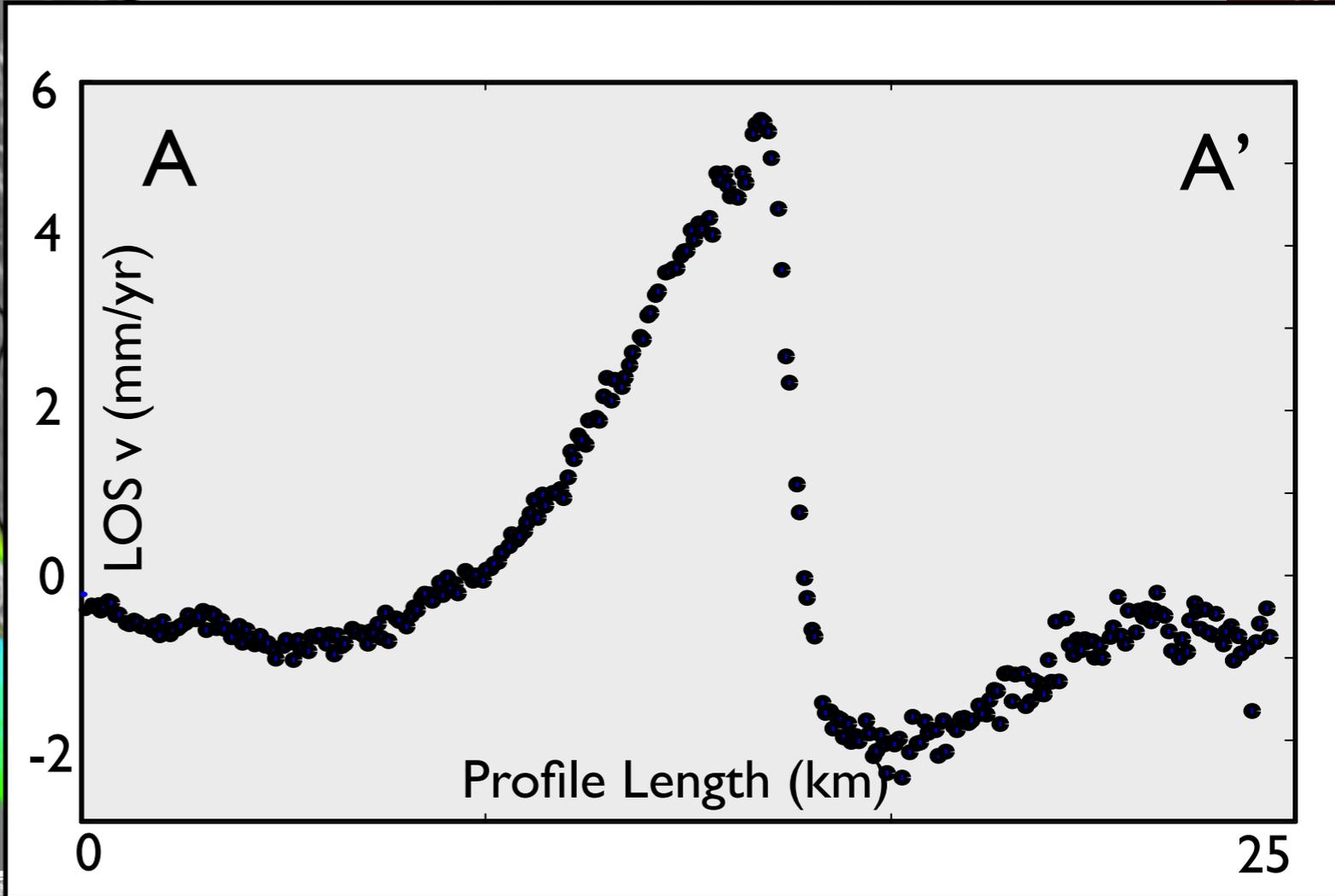
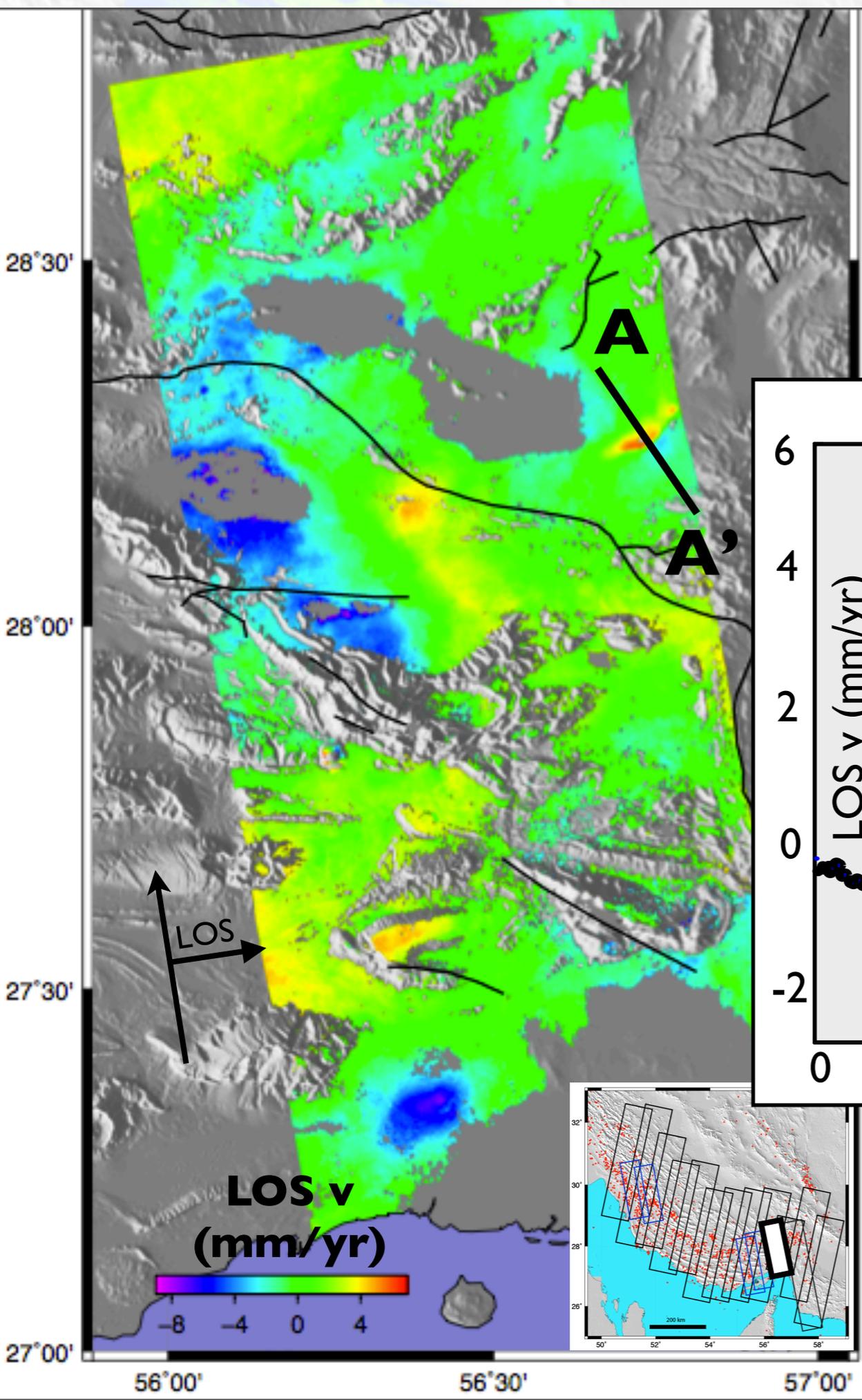


Hydrocarbon Extraction

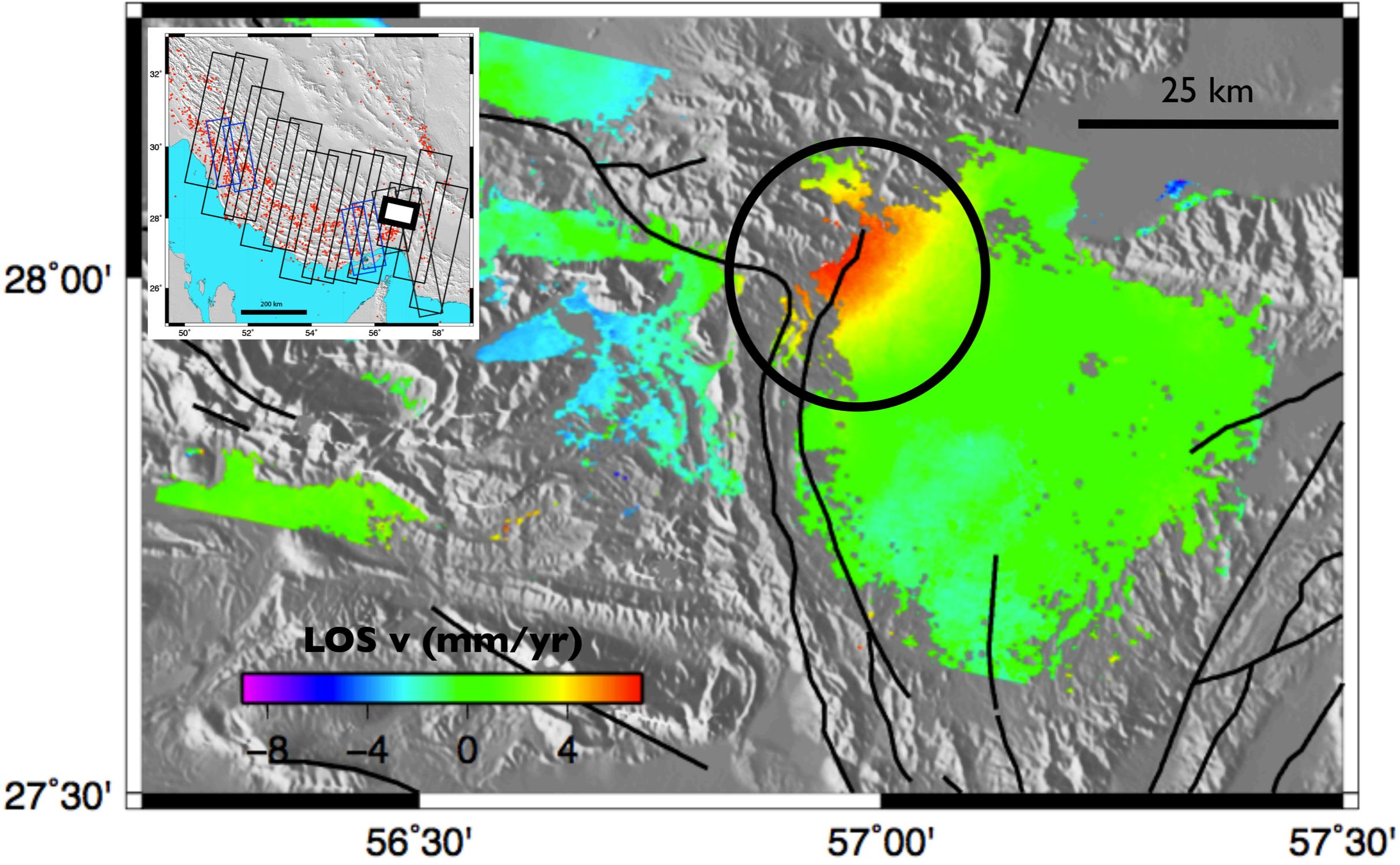


Time Series

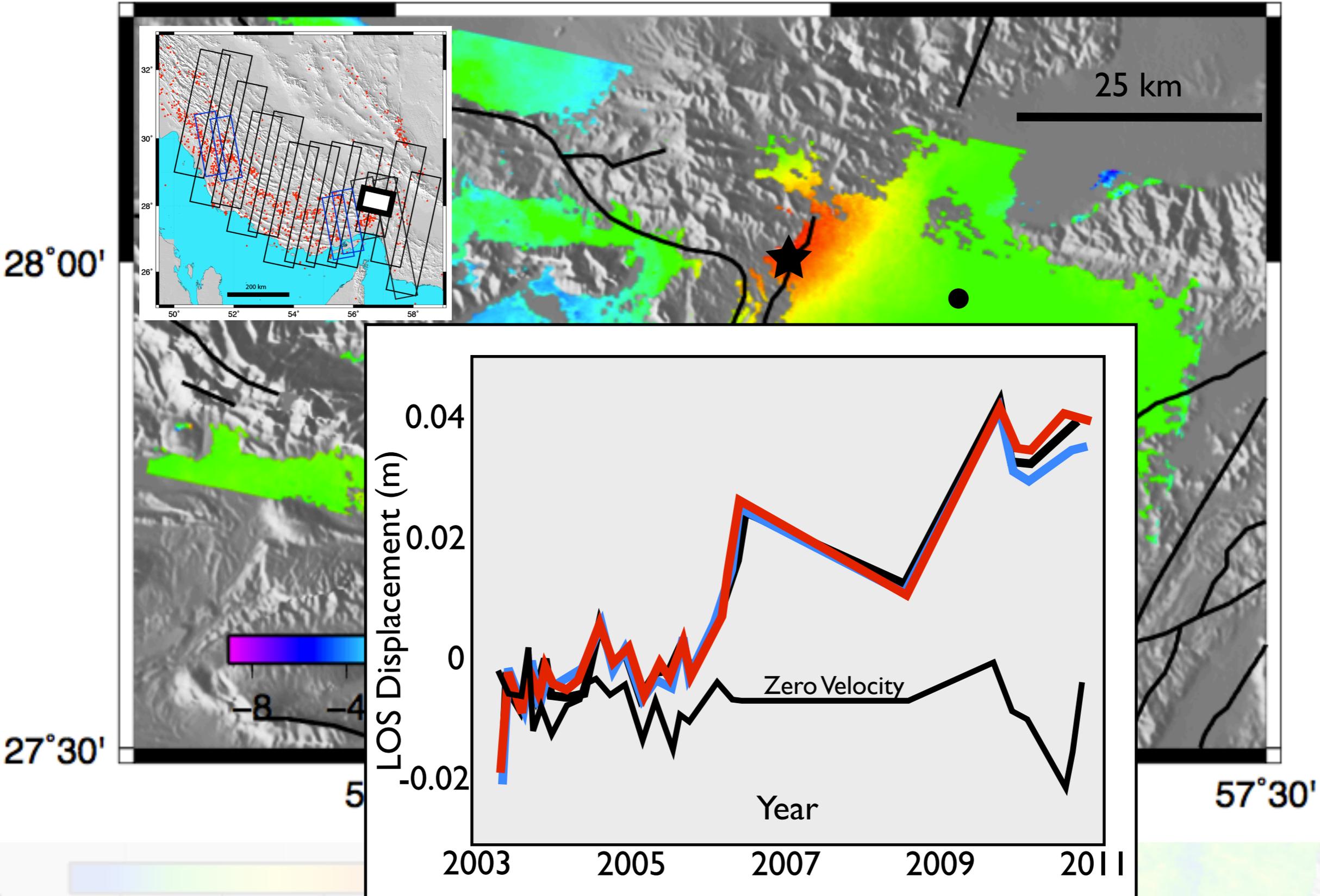
Shallow Earthquake



Unrecognized Folding Object



Unrecognized Folding Object



Conclusions

- InSAR time series analysis allows detection of unrecognized strain features
- Linear aseismic signals with rates of 5 mm/yr are detectable in the Zagros Fold and Thrust Belt
- Unconnected subsets require careful treatment in regions with inconsistent data acquisitions and low correlation

