INTEGRATED InSAR AND GPS STUDIES OF CRUSTAL DEFORMATION IN THE WESTERN GREAT BASIN, WESTERN UNITED STATES

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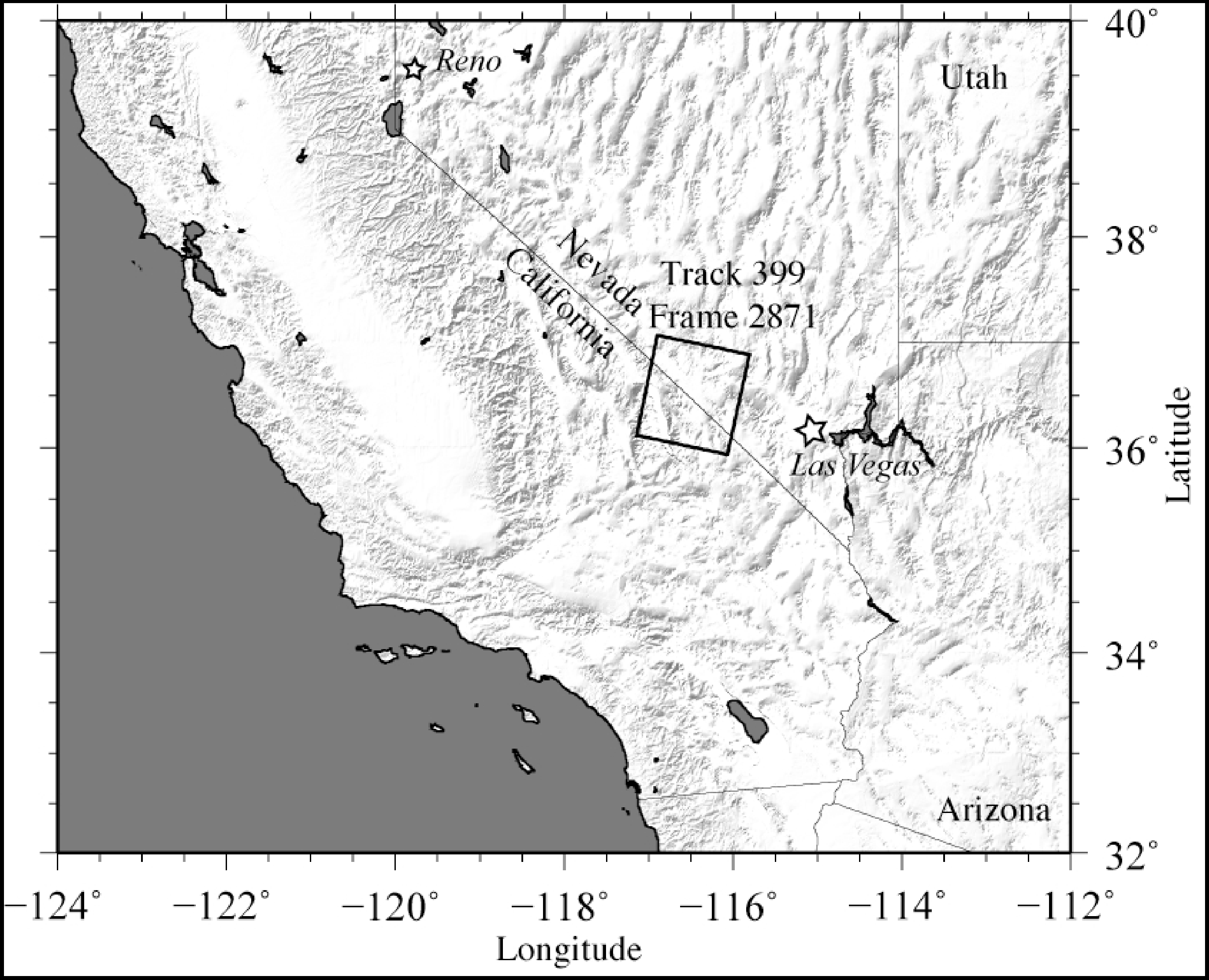
- Introduction: Where and Why
- The Goal
- Available Data
- Analysis Methods
- Improved Velocity Field
- Conclusions

Introduction: Where?

Area on the border between Nevada & California, SW U.S.

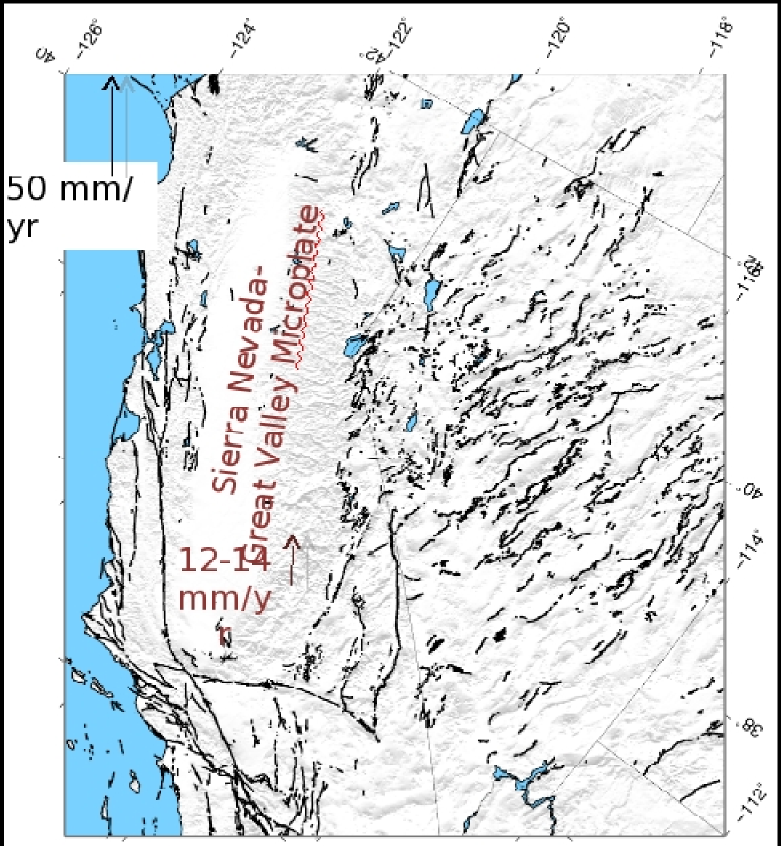


- Former candidate site for national Nuclear Waste Deposit
- High-quality set of continuous GPS sites
- Large number of hydrological, tectonic, and geological studies
- Perfect test site for new approaches and methodologies

Introduction: Why?

Target:
Understanding tectonic and earthquake-related processes, with relevance to urban areas such as Reno, Las Vegas and other similar urban areas

Walker Lane and Sierra Nevada:
A diffuse plate boundary, system with 100s of fault systems.



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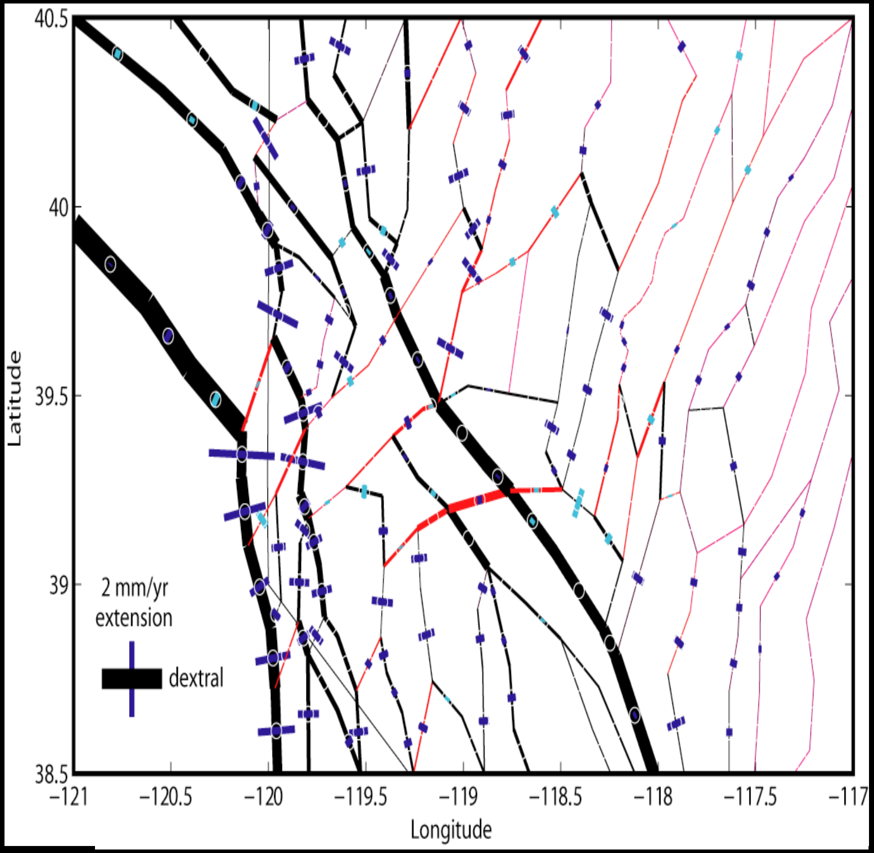

Sierra Nevada/Great Valley microplate moves as (mostly) rigid unit (almost) parallel to PA plate; 10 of 50 mm/yr expressed in Walker Lane, between Sierra Crest and Basin and Range.

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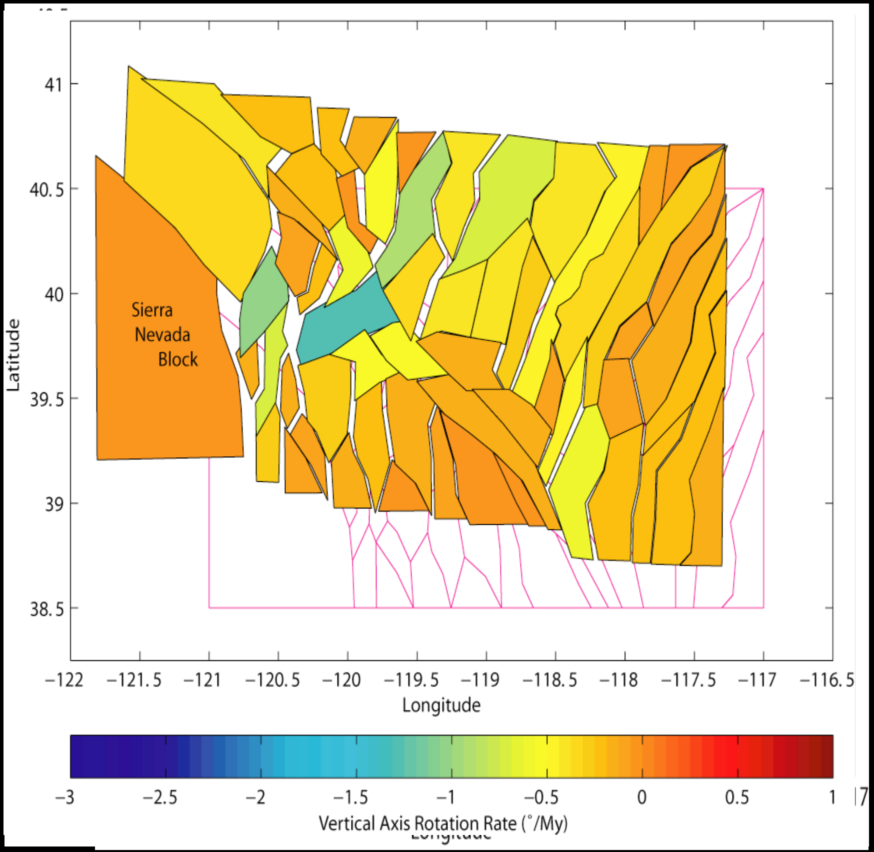

Many small scale features requiring high spatial resolution to constrain models

Introduction: Why?

Target:
Understanding tectonic
earthquake-related proc
with relevance to urban
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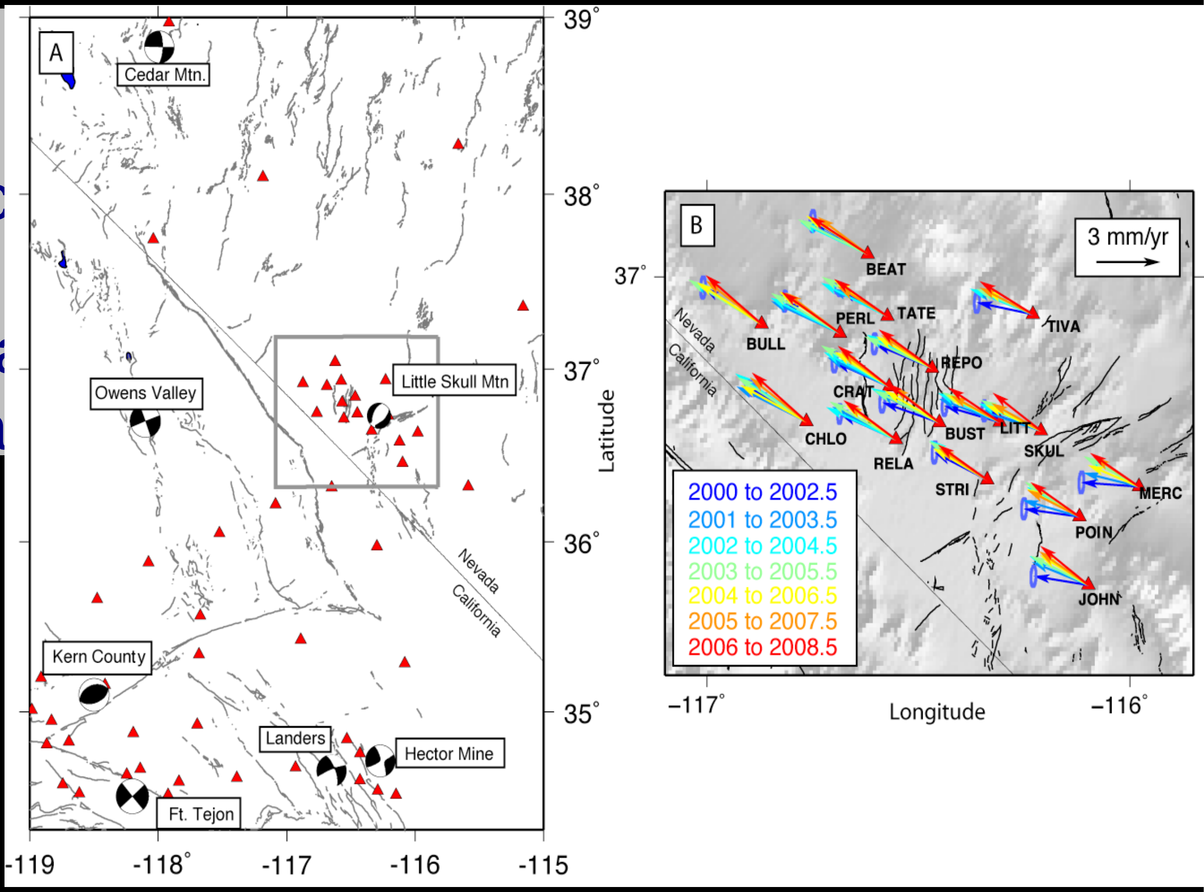
other similar urban area



Postseismic relaxation introduces non-linear variations;
separation of tectonic and hydrological signals (e.g., droughts) is an issue

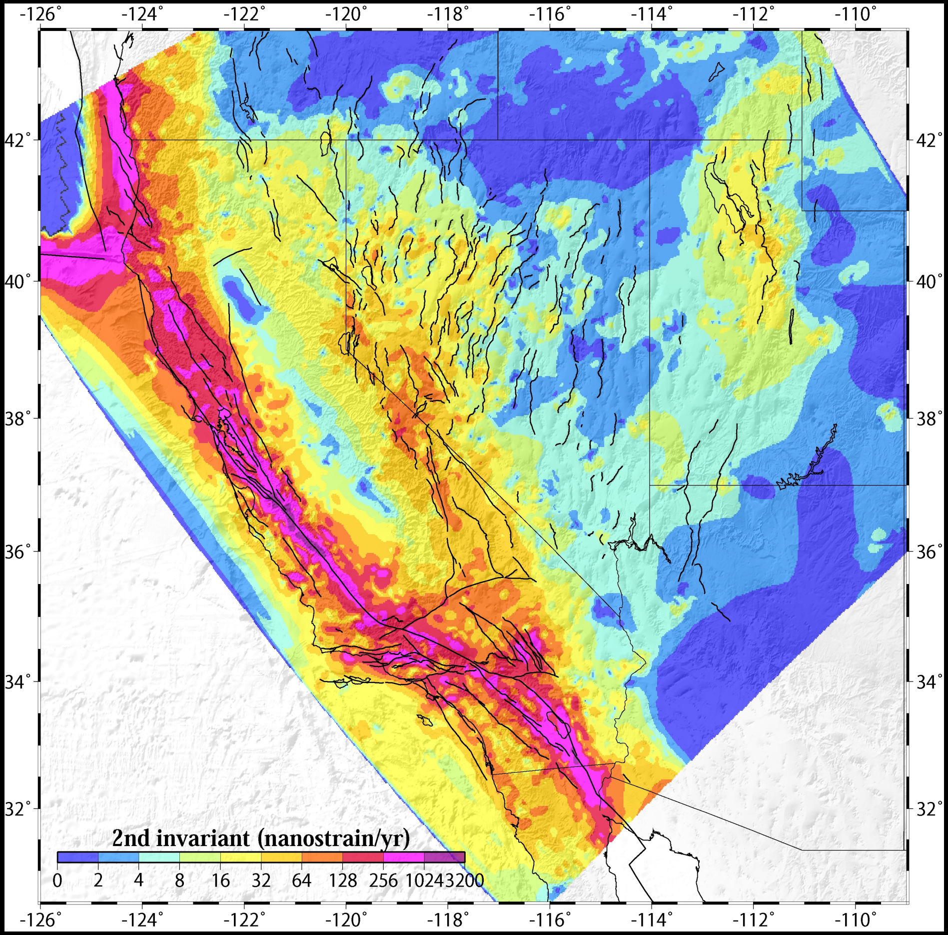
Many small scale features requiring high spatial resolution to constrain models

The Goal

Show that the combination of GPS and InSAR can be used to derive a high resolution velocity and strain field

Velocity field based on high-quality set of continuous and episodic GPS sites

Strain rate field based on GPS velocities and geological information



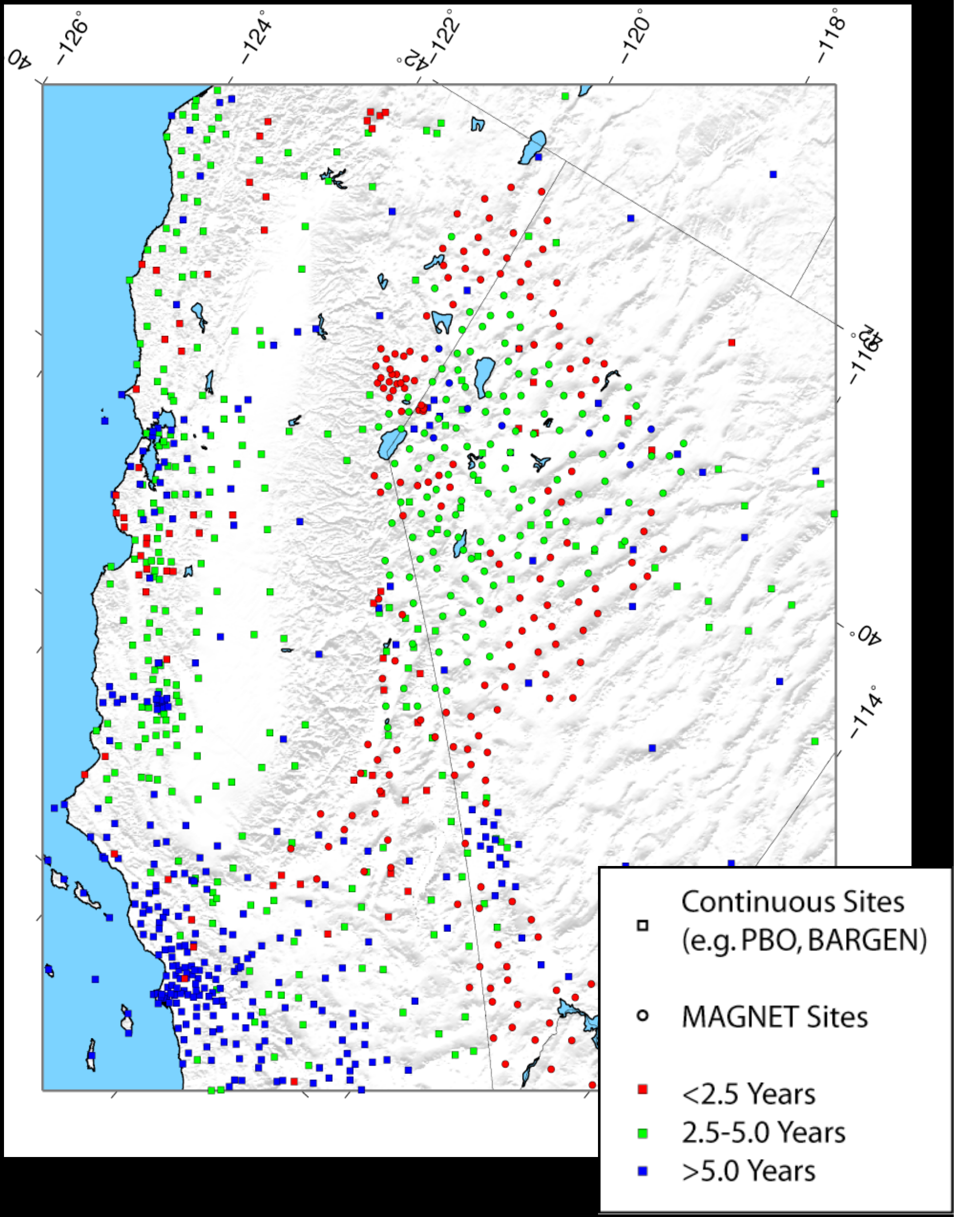
Start to see temporal variations in strain rates

The Data

GPS Data

High-quality set of continuous and episodic GPS sites from several networks (including BARGEN EarthScope PBO, MAGNET, NEARNET)

Data processed uniformly as part of a ~4,000 station global network; GIPSY/Ambizap



The Data

InSAR Data

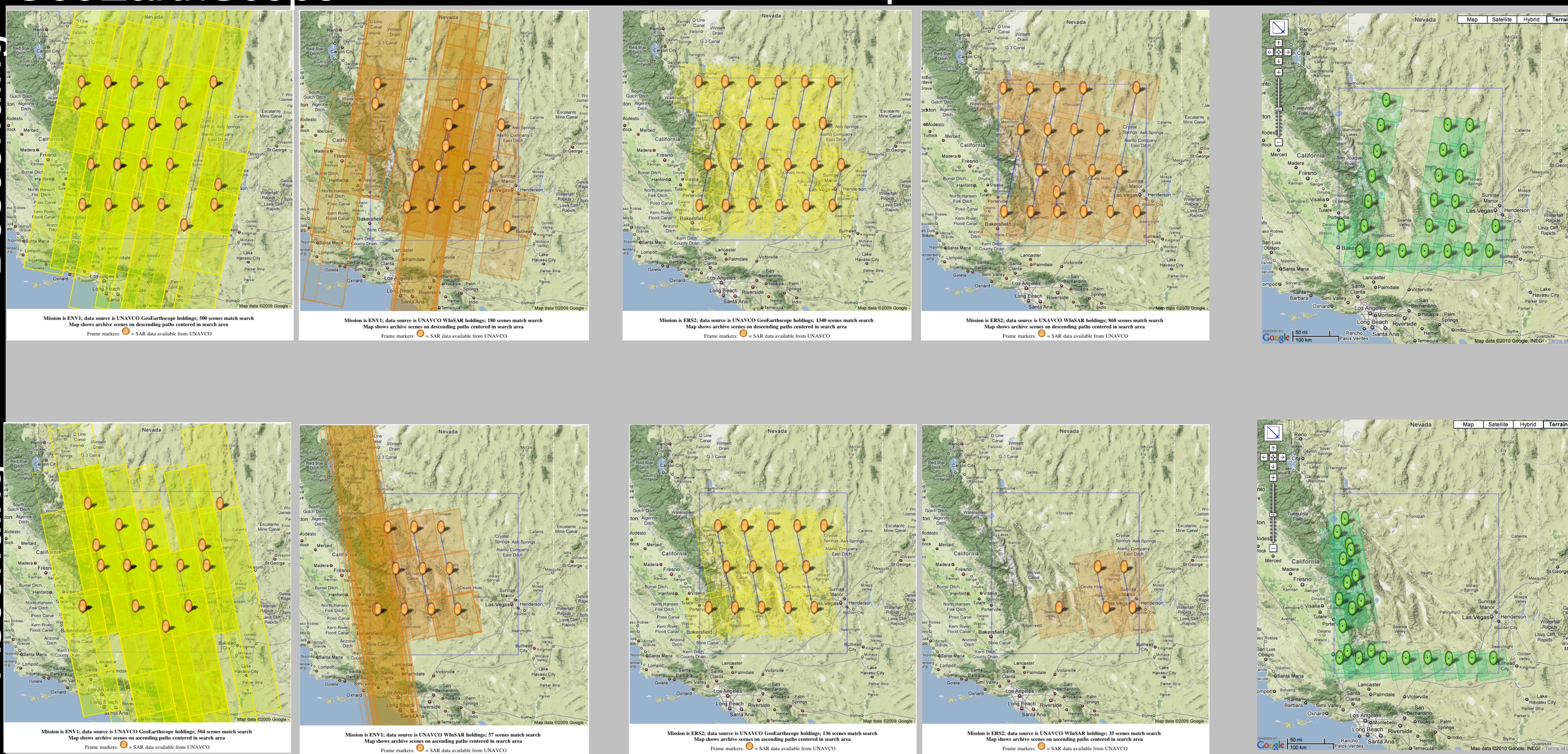
Envisat: GeoEarthScope, WinSAR

ERS: GeoEarthScope, WinSAR

ALOS PALSAR: ASF Data Pool

Descending

Ascending



Data obtained from UNAVCO, Inc.: http://geoes-insar.unavco.org/sasi/sasi.php

Analysis Method

Form all possible interferograms using traditional interferometry

Time series method, modified from *Berardino et al*., 2002; *Lundgren et al*., 2009 (*Li et al.*, 2009)

- Identifies signal from secular, linear motion
- Separates non-linear motion and partitions into orbit error and atmospheric effects.

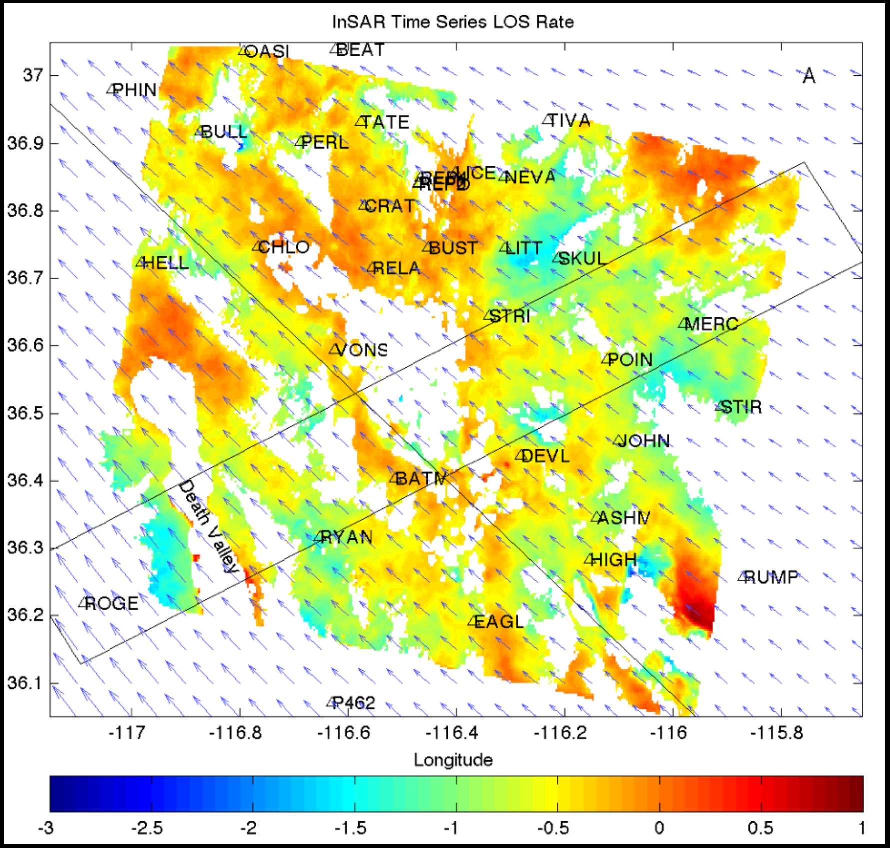
Transform InSAR line-of-sight (LOS) velocity field to conform to GPS strain map velocity field projected into LOS (provisionally assumes that vertical tectonics are zero)

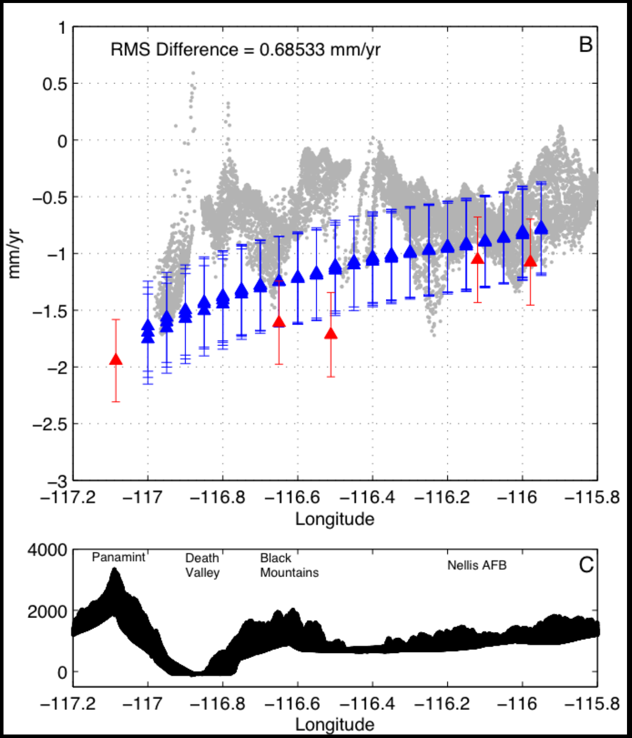
Remove “flat” areas with phase screen since these are more often affected by non-tectonic signals

Topography correction estimates (linear model) and removes signal correlated with topographic height.

Improved Velocity Field

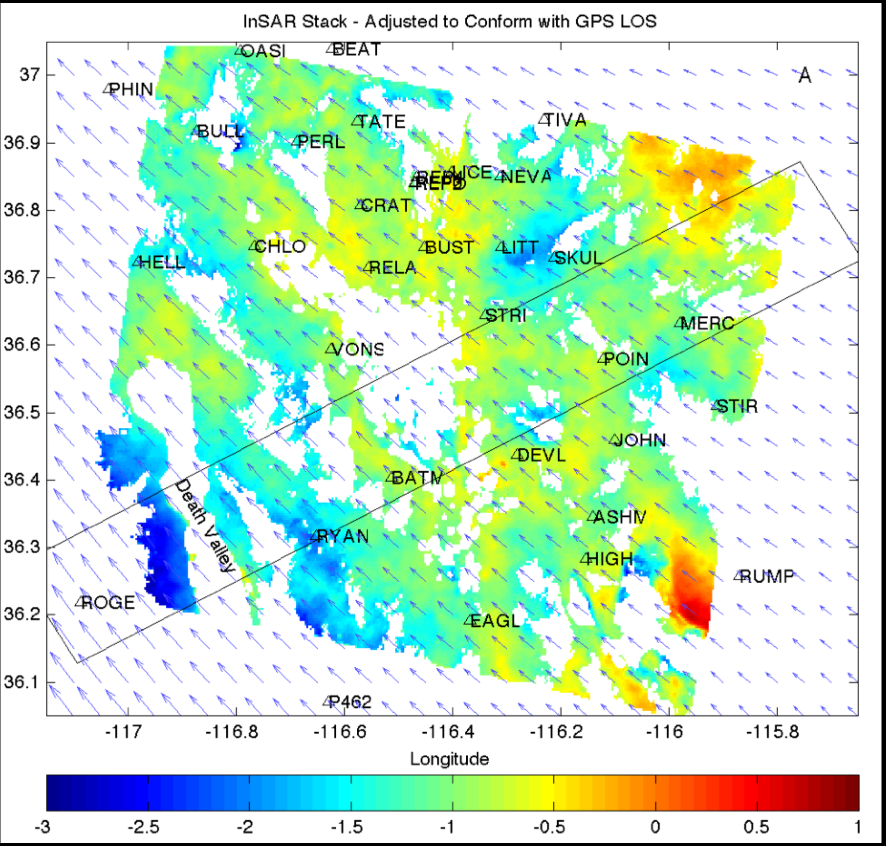
LOS velocity from GPS and InSAR before alignment

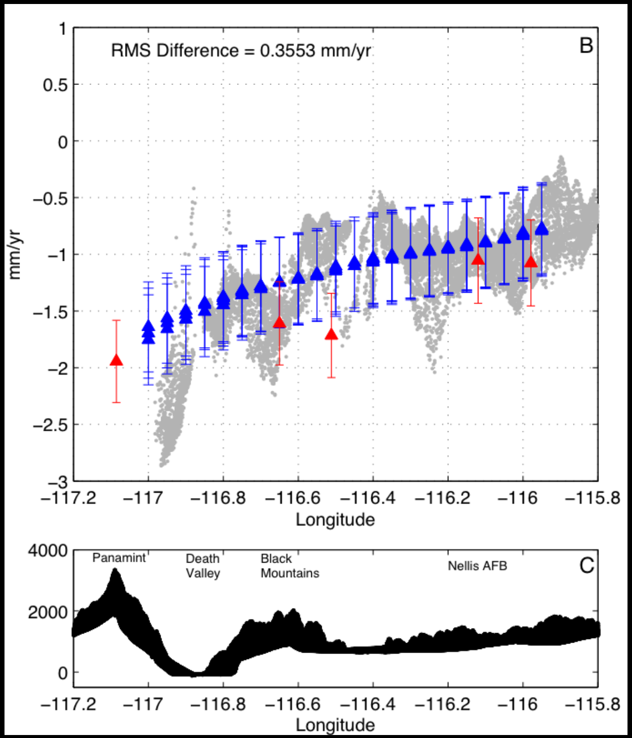




Improved Velocity Field

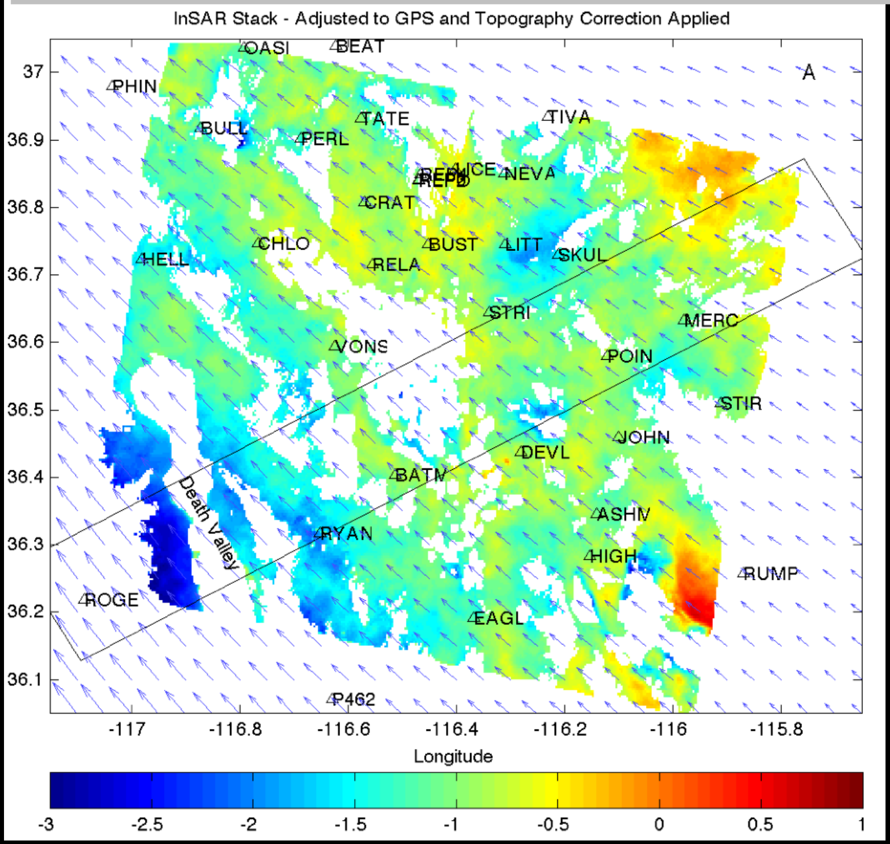
LOS velocity from GPS and InSAR aligned

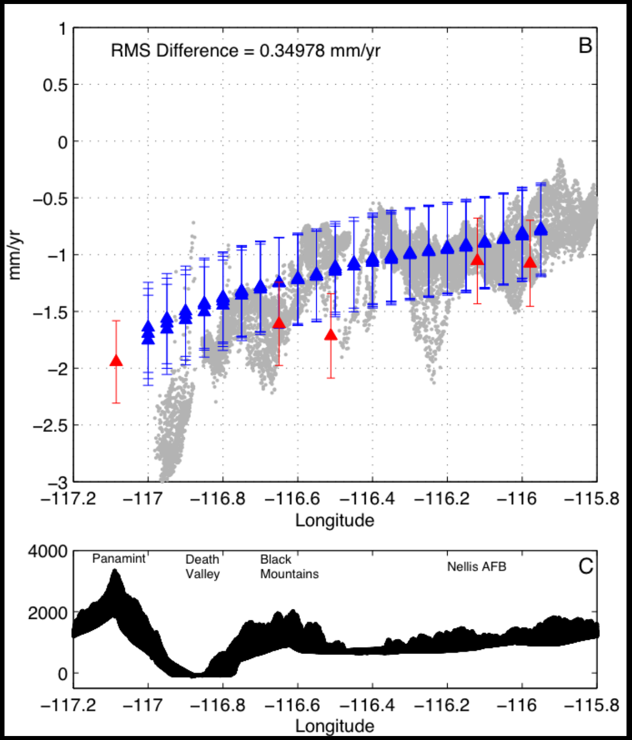




Improved Velocity Field

LOS velocity from GPS and InSAR aligned plus topographic correction





Conclusions

0.35 mm/yr RMS agreement between InSAR-derived LOS rate map and GPS, similar to agreement between GPS and strain rate map interpolations.

Sufficient to improve constraint on crustal deformation, and identify shallow creep (if it slips rapidly enough).

Topography correction does not help much, atmosphere effects are complex with wide range of wavelengths and displaced from topography.

Combination links InSAR results to global geodetic reference frame

These results bode well for the utility of present and future satellite missions (e.g. ALOS, Sentinel, DESDynI) that promise to acquire long time-series of radar images for two-pass interferometry.

Next: Inclusion of ALOS/Palsar data

And ...

Conclusions

Methodology development: combination of GPS and InSAR at time series level, not for linear velocity field

Goal: low-latency surface displacements and detection of "anomalous" displacements for geohazards and other applications as a contribution to the Geohazards Community of Practice of GEO

Importance to use all available InSAR sources;

challenge: low latency