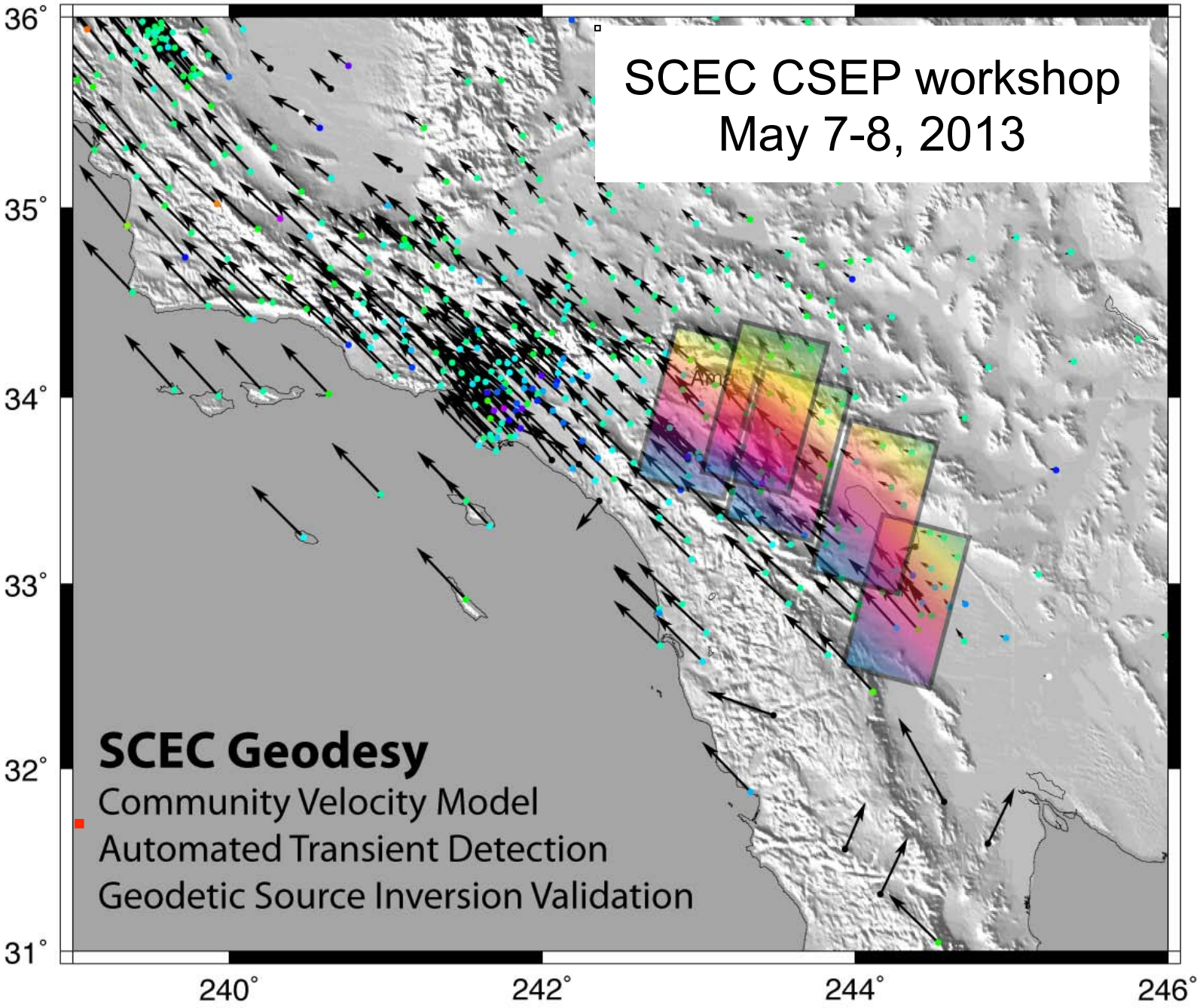

SCEC CSEP workshop
May 7-8, 2013
SCEC Geodesy
Community Velocity Model
Automated Transient Detection
Geodetic Source Inversion Validation
36°
35°
34°
33°
32°
31°
240°
242°
244°
246°

Example Prototype: Geodetic Transient Detection

- Objective: “Develop a geodetic network processing system that will detect anomalous strain transients”
- Observation: Systematic monitoring lagged despite;
  - Growth in permanent GPS and strainmeter networks
  - InSAR time series analysis techniques
  - Growing number of transient events observed world-wide
- Organizers: Rowena Lohman, Jessica Murray, Duncan Agnew

Key issues:

- What is a transient?
  - Why are we interested?
    - Real-time monitoring of transient deformation and associated seismicity
    - Characterization of signals for investigating underlying processes
    - Identification of non-tectonic signals
    - Tracking of data quality
    - Planning future network development to improve detection thresholds

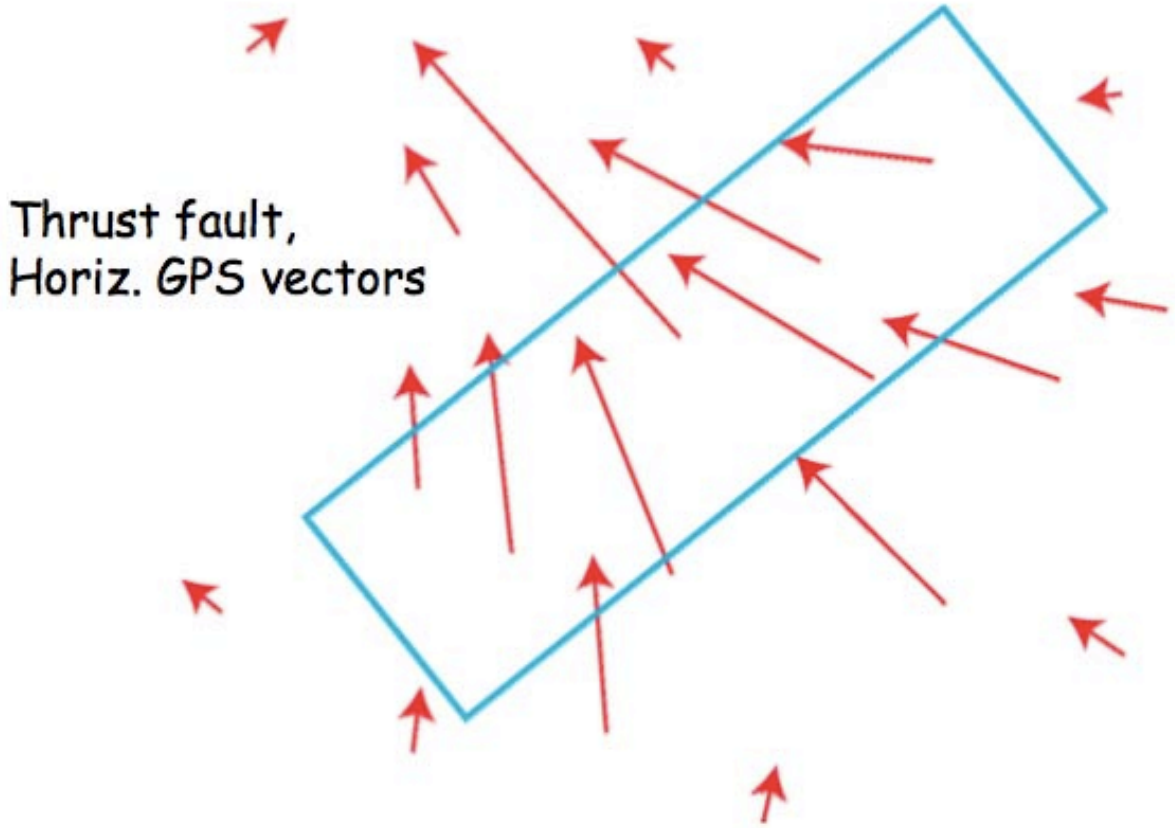
    Previous efforts:
    - Require some spatial, temporal coherence
    - "Characterization" requires treatment of seasonal + new, larger postseismic

  - Real signals:
    - Vastly different temporal scales
    - Propagate spatially
    - Seasonal cycle varies from year to year
    - Instrument issues

Currently: no way of determining if transient is "real"

Phase I: Synthetic Tests

Metrics-Deformation area



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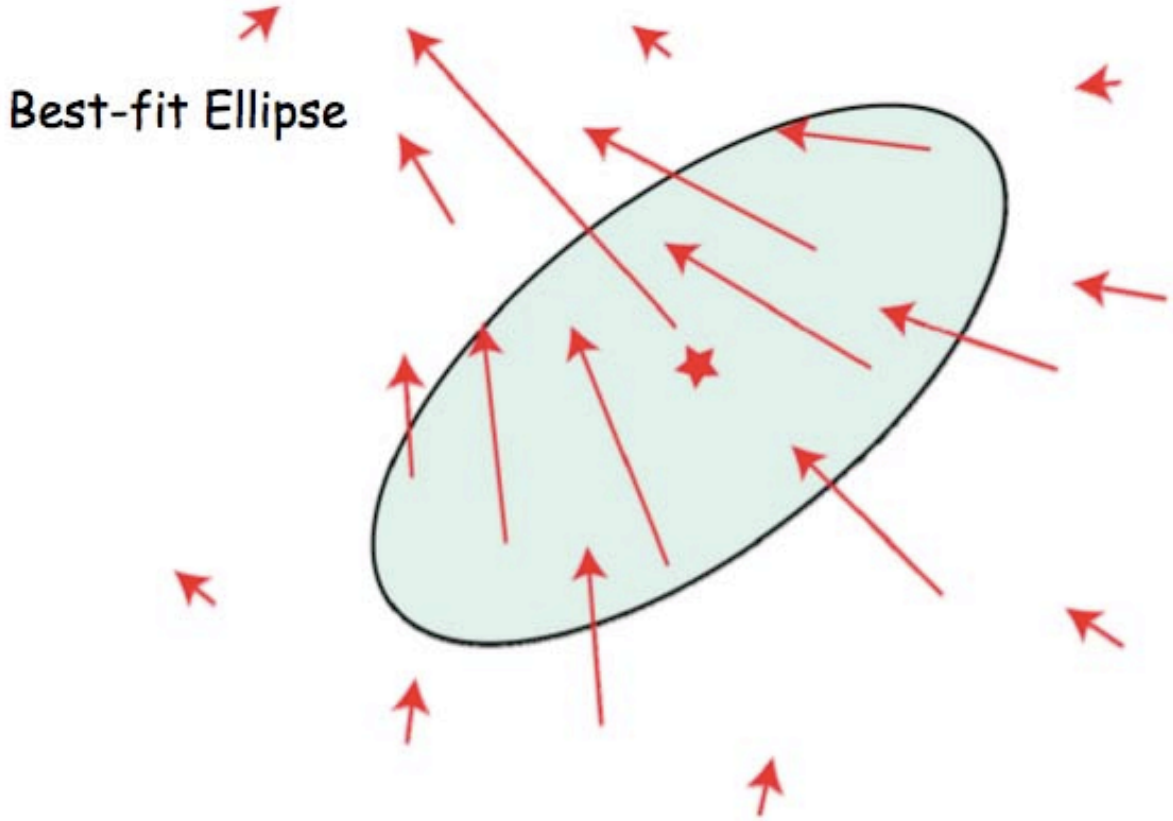
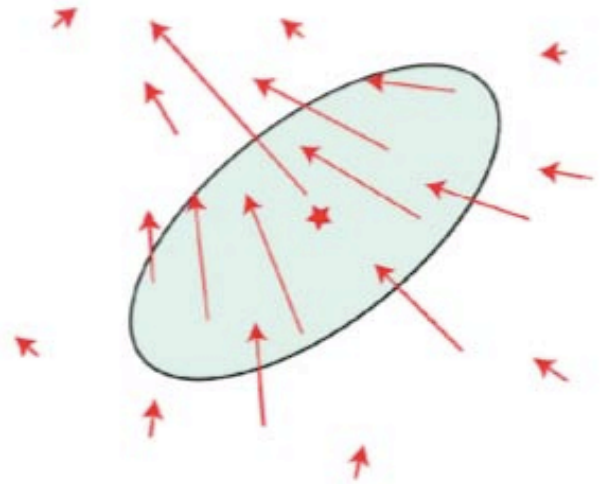


Metrics-Deformation area

Best-fit Ellipse:

Center: $\langle x_i \rangle = \dfrac{\sum x_i A_i}{\sum A}$

X_i = coordinate at site i
A_i = horiz. magnitude at i

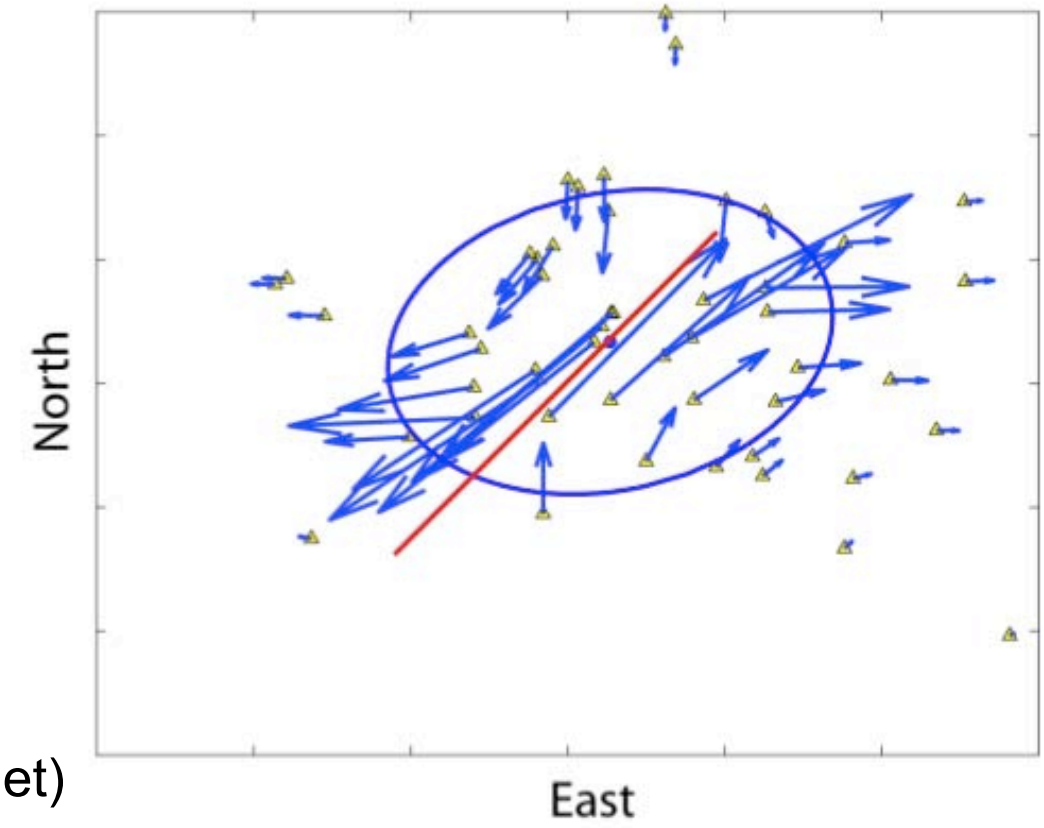


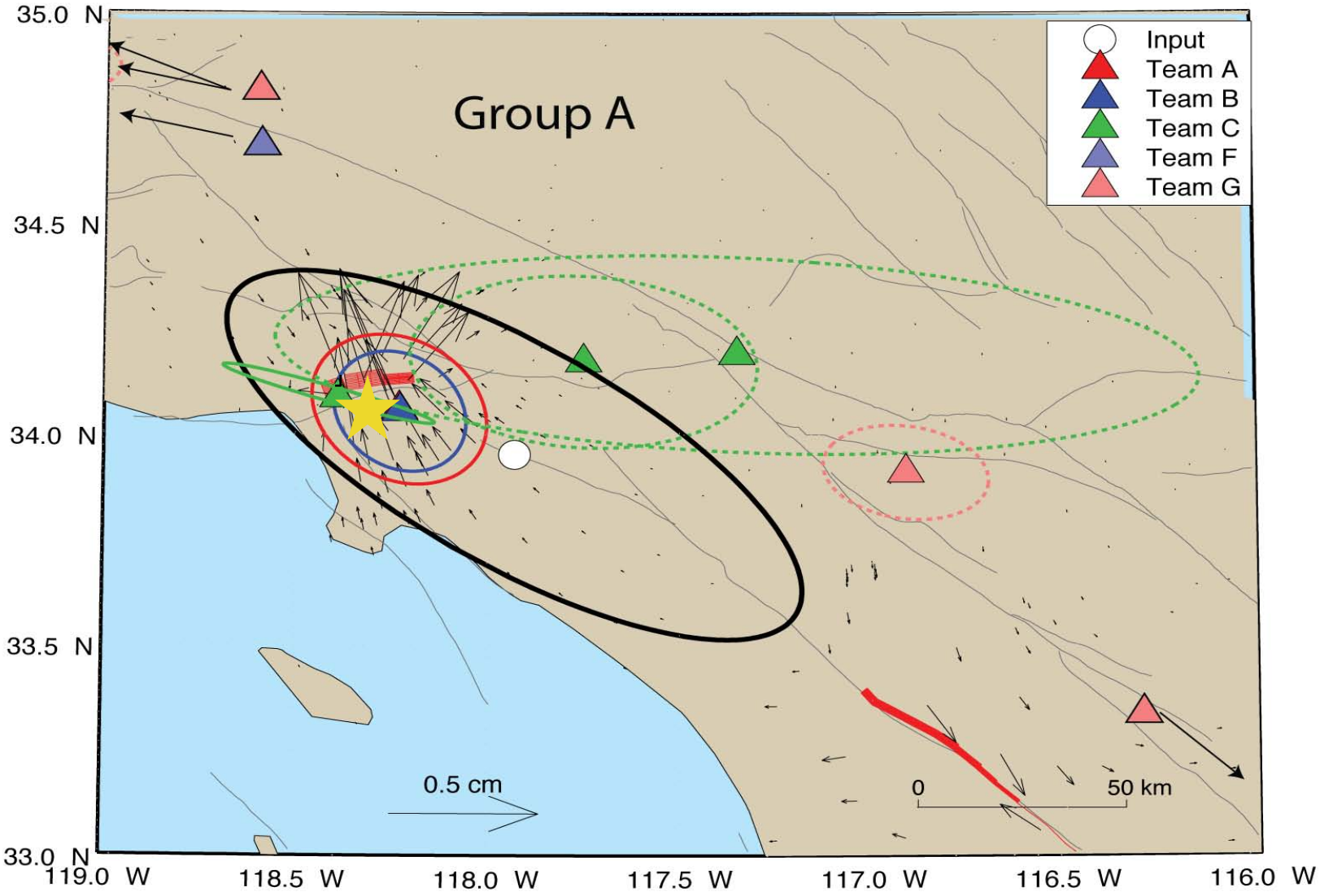
Ellipse:

Vxx	Vxy
Vxy	Vyy

$$V_{xy} = \frac{\sum (x_i - \langle x \rangle)(y_i - \langle y \rangle) A_i}{\sum A}$$

- 4 test phases
  - 4-18 datasets
  - Progressively more realistic noise (Fakenet)
  - Signals - very slow, very small, very broad (and some easy ones!)




Group A
Input
Team A
Team B
Team C
Team F
Team G
35.0 N
34.5 N
34.0 N
33.5 N
33.0 N
119.0 W
118.5 W
118.0 W
117.5 W
117.0 W
116.5 W
116.0 W
0.5 cm
0
50 km

Results from synthetic testing

- Most successful:
  - Kalman filtering, different basis function types
  - PCA of raw or filtered signals
  - Analysis of temporal variations in strain

- Also explored
  - Simple visual inspection of time series and/or SNR over moving time window
  - Fitting of piecewise linear segments
  - Application of image processing techniques

Shared: detect features with spatial and/or temporal coherence

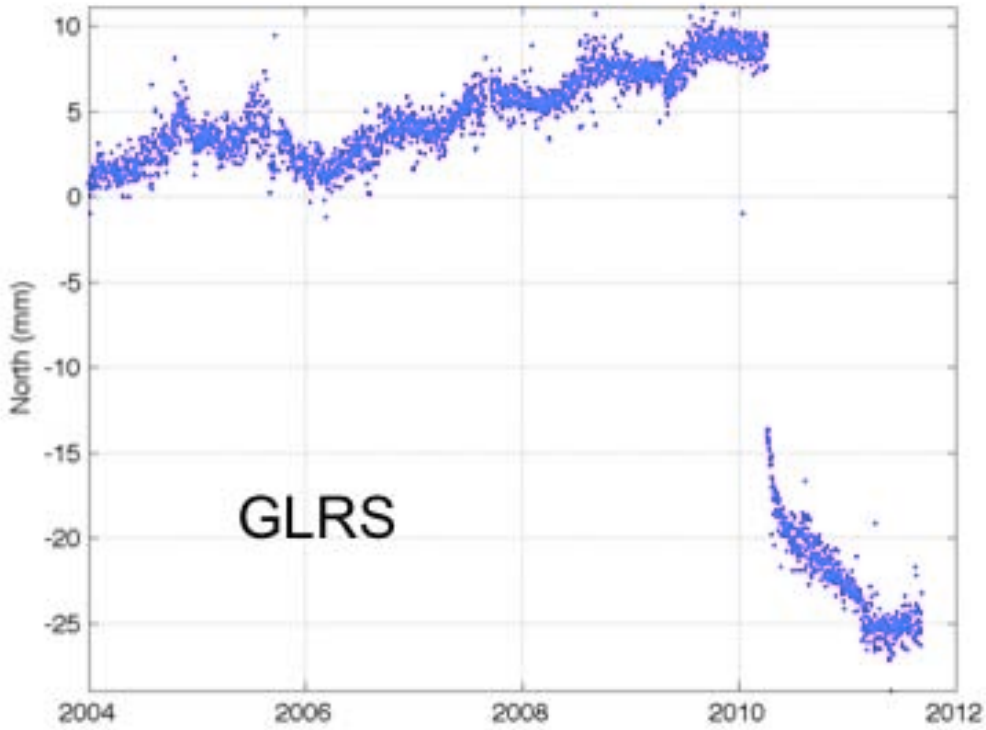
"Automation" remained a challenge

Phase II: Automated application to real data

- Goals for participants:
  - Get code working with input data types (GPS, etc)
    - Provided example scripts for download/sort/write testing center formats
  - Enable automated detection
    - Time-delayed, retrospective detections are fine!
  - Rewrite code so that some key paths, dates are in single input file
  - Send to CSEP (Maria Liukis)

Phase II: Automated application to real data

- "Dummy" algorithm
  - Load data
  - ID coseismic offsets
  - Attempt removal of postseismic, seasonal signals
  - Cull sites (# neighbors, length of data)
  - Fit rates for full time series
  - Identify sites that diverge from long-term trend in "recent" time
  - Produce results file



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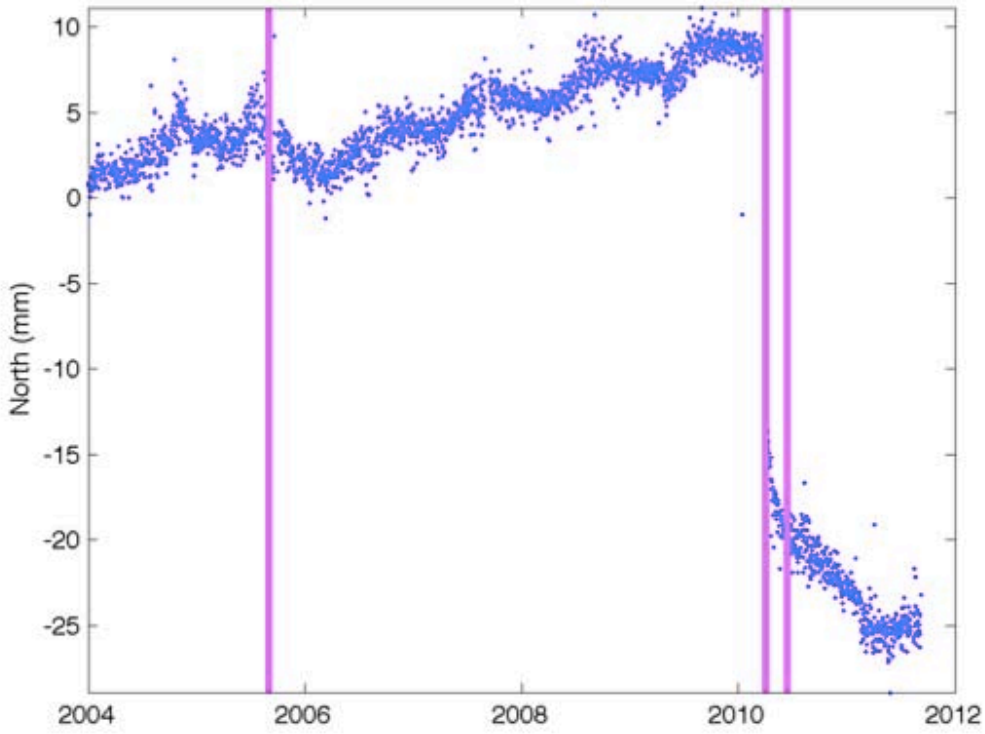

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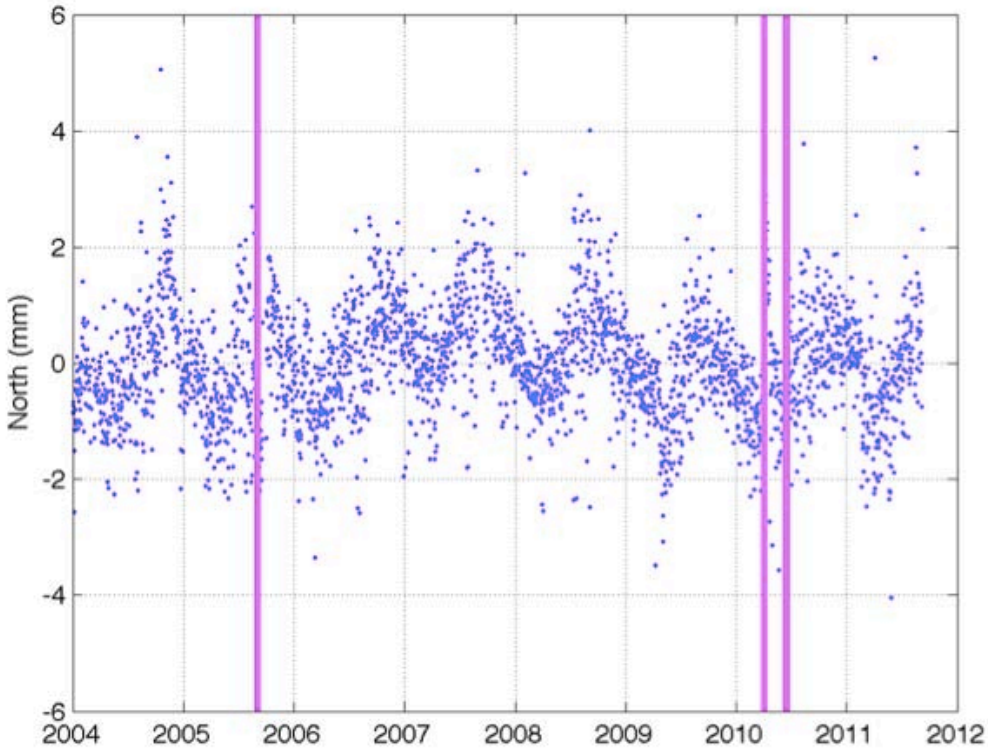

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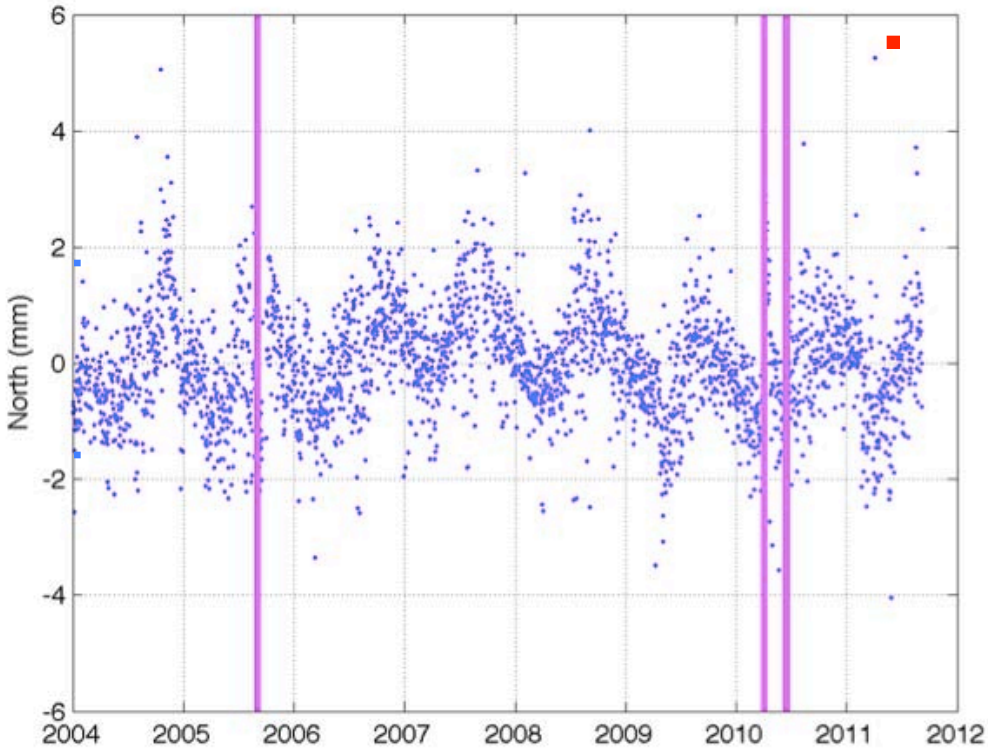
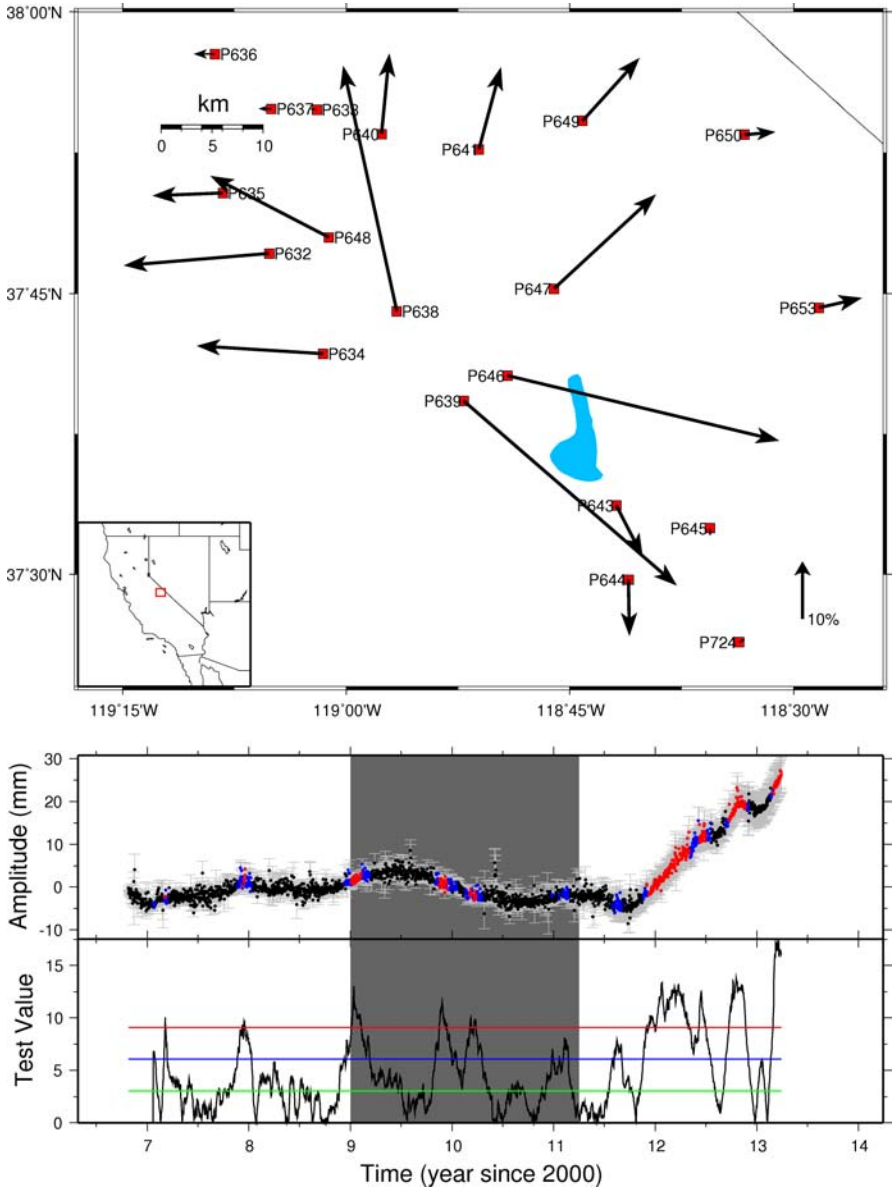


Currently - continued detections near Parkfield

Progress of TAG as a whole

- Last week:
  - Publication of SRL special section on Transient detection
  - (4 papers + intro)
- Herring/Ji
  - Applied approach to:
    - Akutan volcano, Alaska
    - Cascadia, Washington
    - Cascadia, Oregon
    - Cascadia, California
    - Yellowstone (horizontal), Wyoming
    - Yellowstone (vertical), Wyoming
    - Long Valley, California
    - Parkfield (coseismic), California
    - Parkfield (postseismic), California



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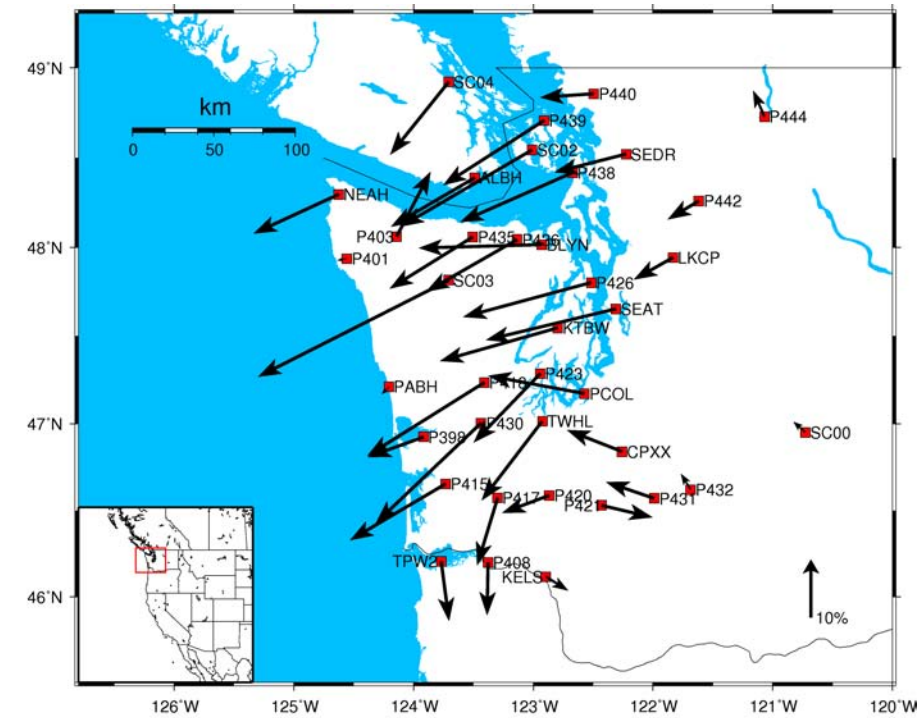

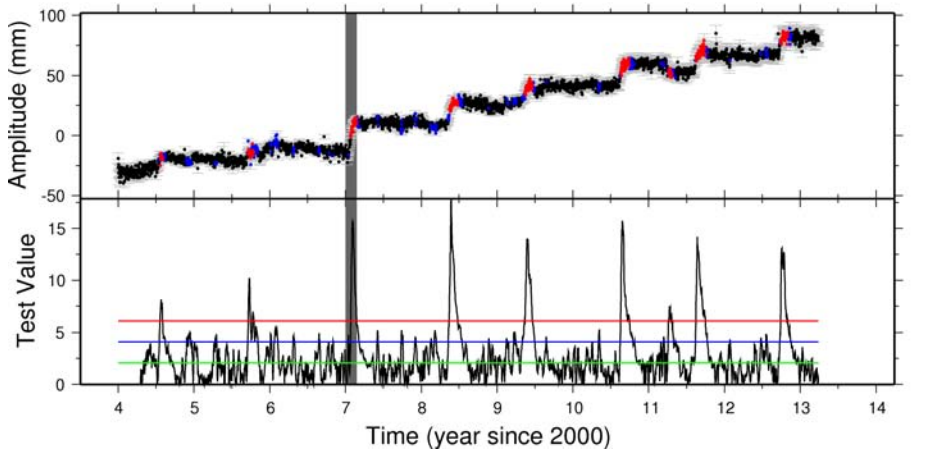

Progress of TAG as a whole

- Last week:
  - Publication of SRL special section on Transient detection
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- Holt
  - Strain-based approach
  - Initial difficulties with use of velocities when stations came in and out of network