Session 1: Target applications for CGM

CGM as a time-dependent reference frame for transient detection

SCEC Community Geodetic Model (CGM) workshop
May 30-31
Menlo Park, CA
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”
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
Progress of TAG as a whole

• Last month:
  – 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
Progress of TAG as a whole

- Last month:
  - 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
Progress of TAG as a whole

- Last month:
  - Publication of SRL special section on Transient detection
  - (4 papers + intro)

- Holt
  - Strain-based approach
  - Initial difficulties with use of velocities when stations came in and out of network
Challenges w/ real data

• Common procedures to most algorithms:
  – Load data
  – Remove trend
    • Either directly estimated from data, or with PBO/SCEC solutions
  – Remove seasonal sinusoids (1 to several)
  – Remove coseismic/postseismic
  – Filter/PCA/etc. on result
Challenges w/ real data

coseismic/postseismic, seasonal

SCEC Geodesy
Community Velocity Model
Automated Transient Detection
Geodetic Source Inversion Validation
Challenges w/ real data
coseismic/postseismic, seasonal
Challenges w/ real data
coseismic/postseismic, seasonal
Challenges w/ real data

coseismic/postseismic, seasonal
Challenges w/ real data
coseismic/postseismic, seasonal

SCEC Geodesy
Community Velocity Model
Automated Transient Detection
Geodetic Source Inversion Validation
Challenges w/ real data

coseismic/postseismic, seasonal
Challenges w/ real data
coseismic/postseismic, seasonal
Challenges w/ real data

coseismic/postseismic, seasonal
Challenges w/ real data

coseismic/postseismic, seasonal
Challenges w/ real data

coseismic/postseismic, seasonal

Detrended

Seasonal removed
Challenges w/ real data
coseismic/postseismic, seasonal
• Are seasonal signals interesting “transients”
  – Or at least, divergences from sinusoids? *(yes, particularly inter-annual)*
  – How many years of data do we need?

• Errors on secular rates allow assessment of divergences

• Treatment of coseismic/postseismic
  – For many Salton trough sites, does S.E.M contamination mean rates can only be defined using pre-2010 data?
  – Smaller events – choosing cutoff/modeling approach