

Joint Analysis of InSAR and Geodetic Time Series from a Principal Component Analysis-Based Inversion Method

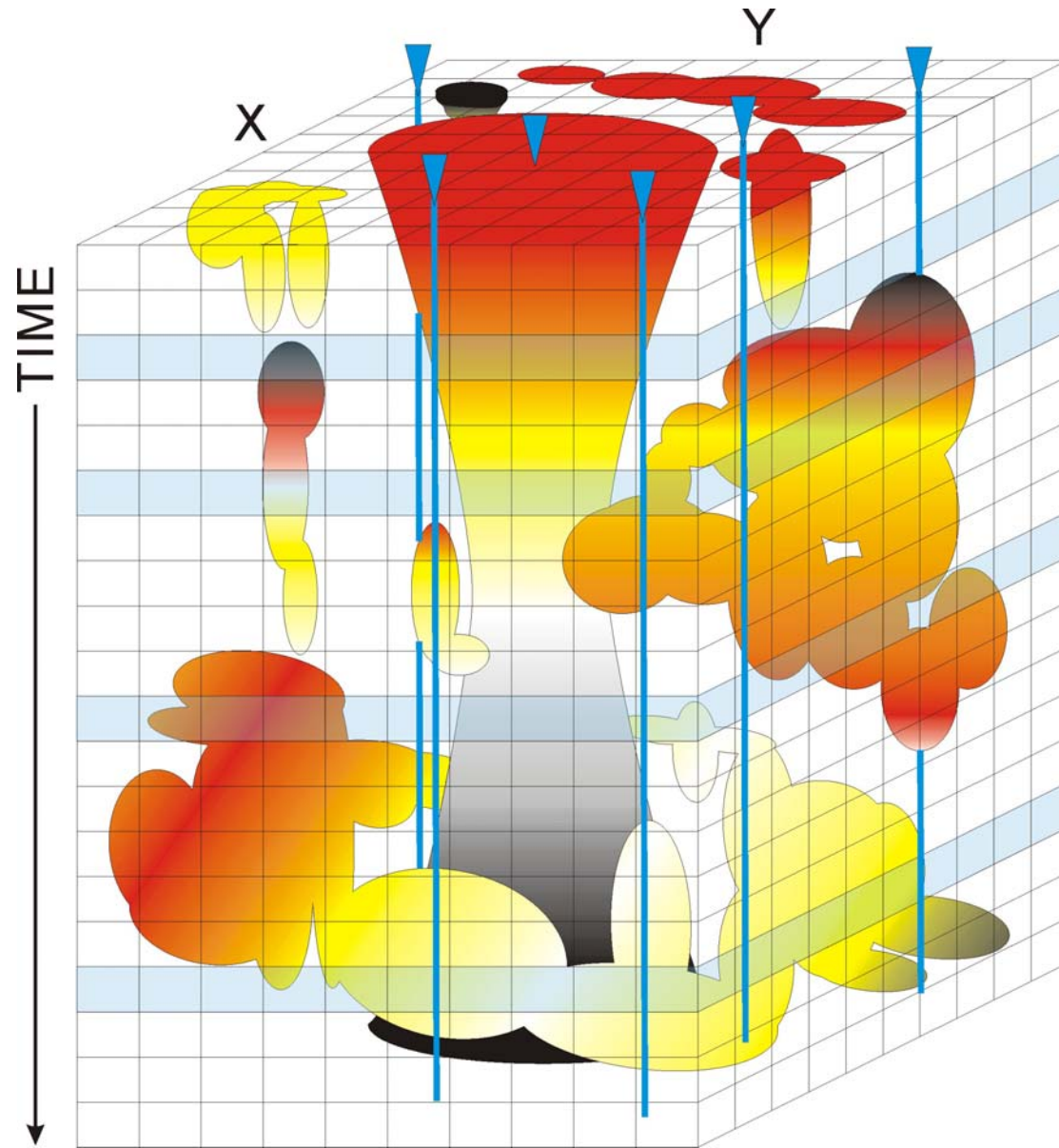


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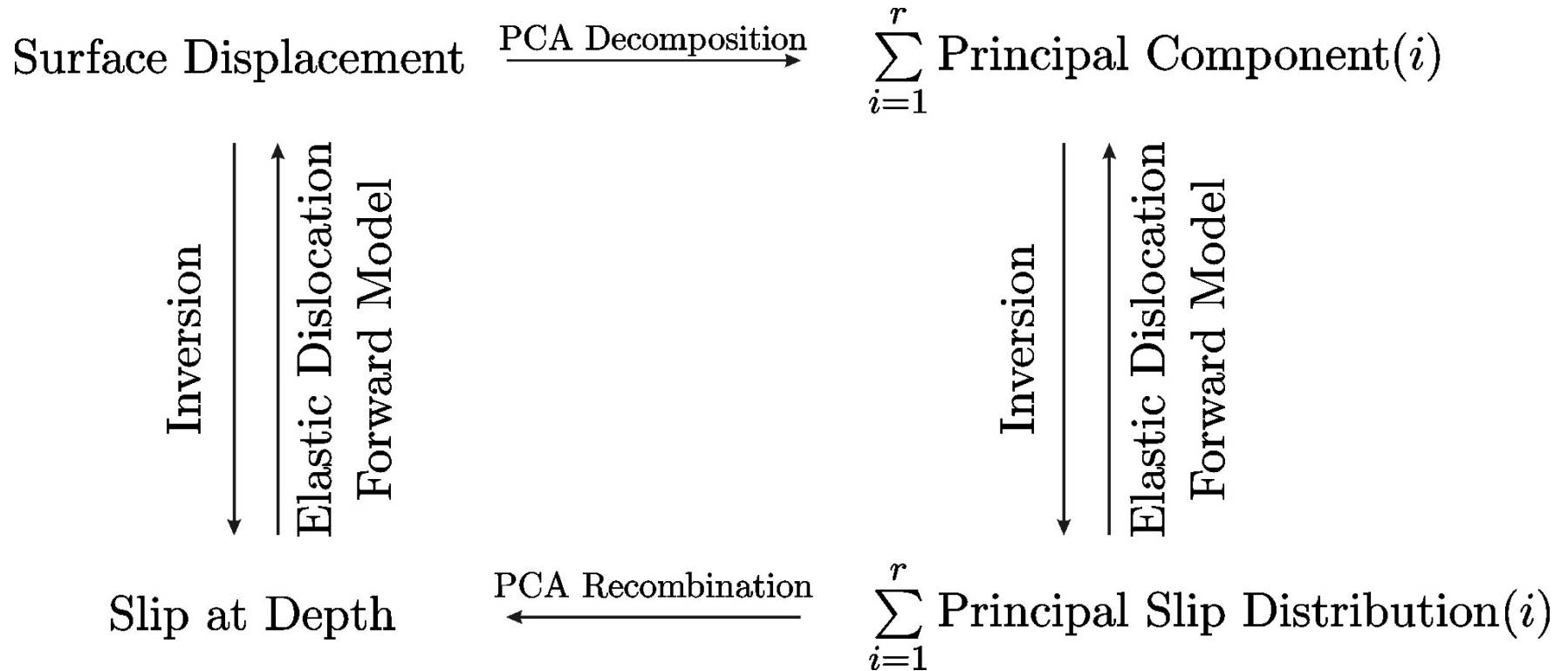
Tectonic Observatory,
California Institute of Technology

PCAIM available on-line at:
<http://www.tectonics.caltech.edu/resources/pcaim>

Q: How do we join InSAR and geodetic time series?



Principal Component Analysis-based Inversion Method (PCAIM)



[Kositsky and Avouac, 2009]

Long Valley Caldera 1997-1998 Inflation Episode

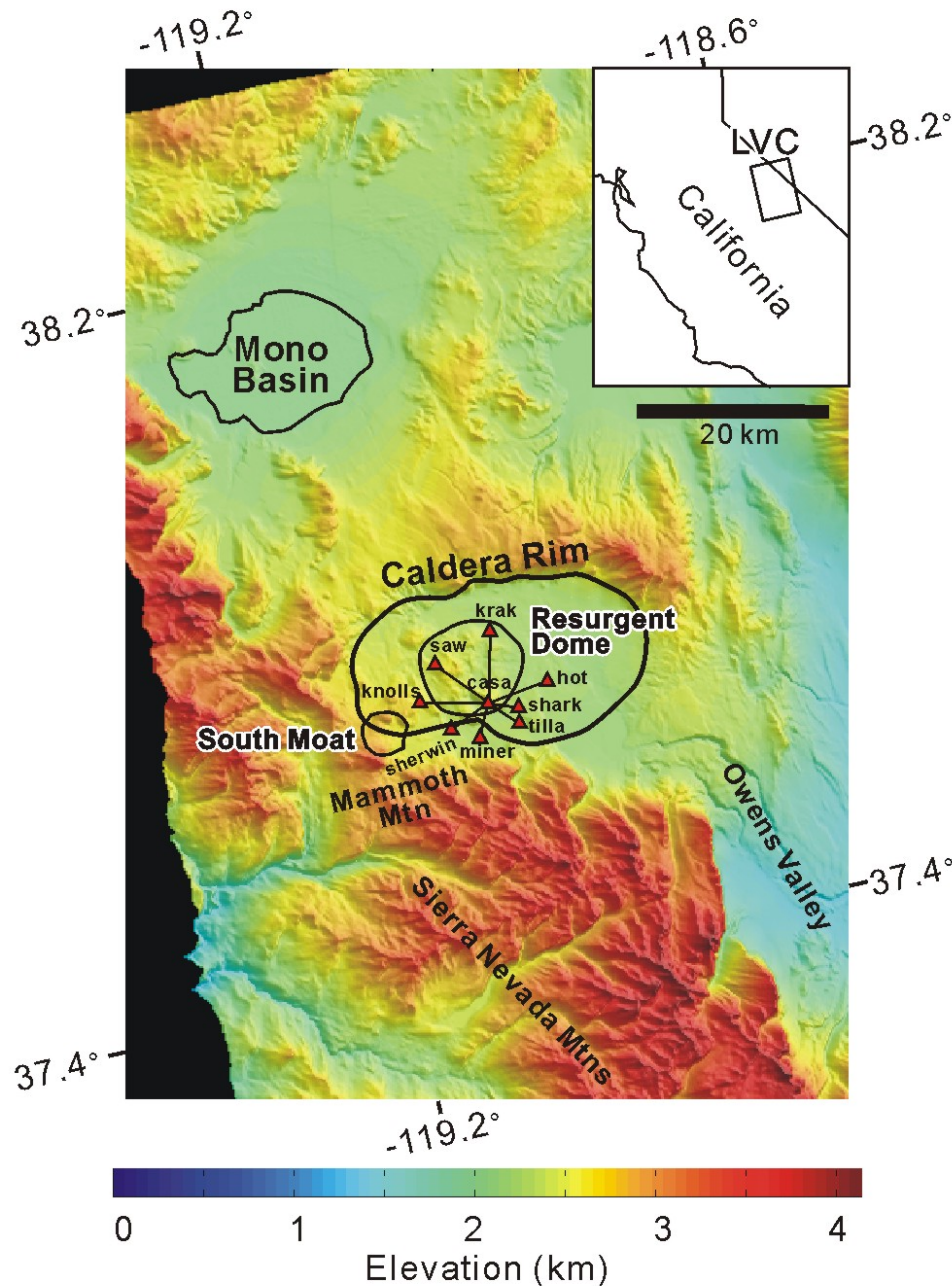
- multiple inflation events since 1980's

- ~10 cm uplift near the resurgent dome during 1997-98 episode

- 8 EDM time series

[Langbein, 2003]

- 24 ERS scene and 65 interferograms

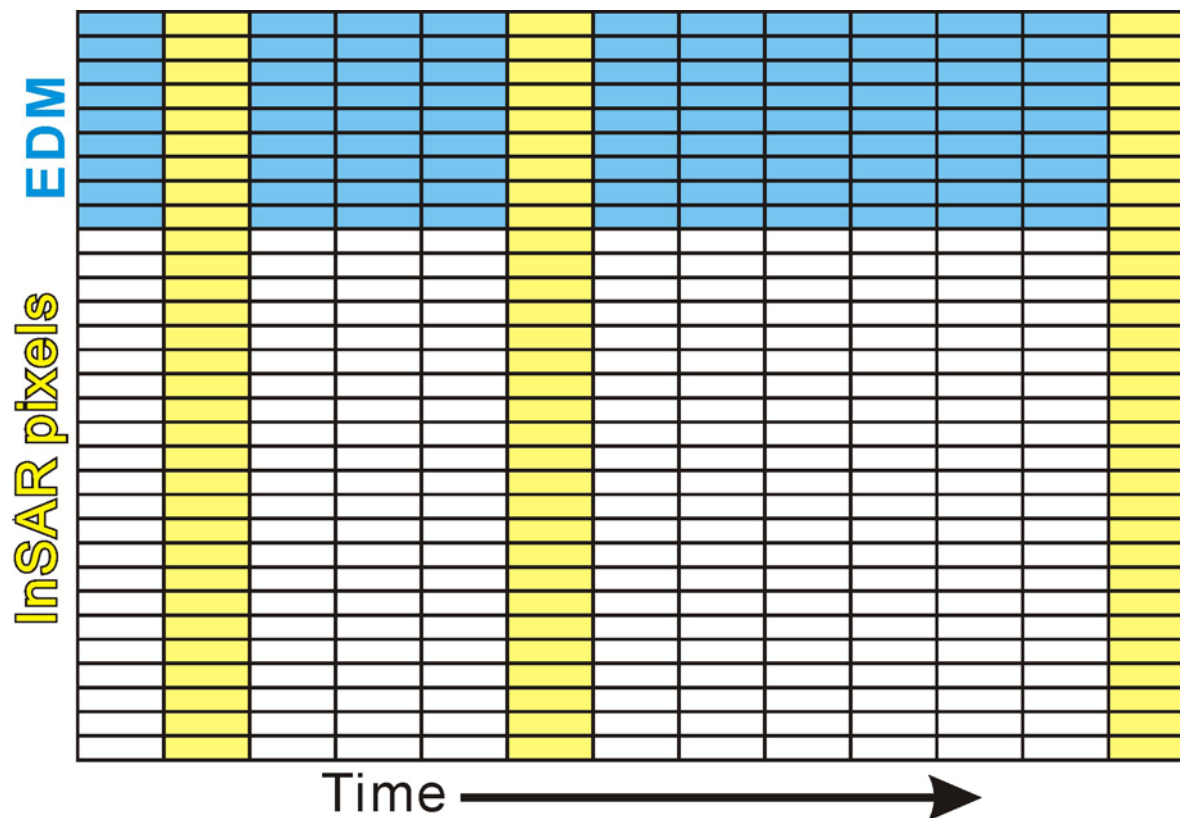


PCAIM Nonlinear Solver

- Sparse matrix \rightarrow weighting matrix and nonlinear solver

[Srebro and Jaakkola, 2003]

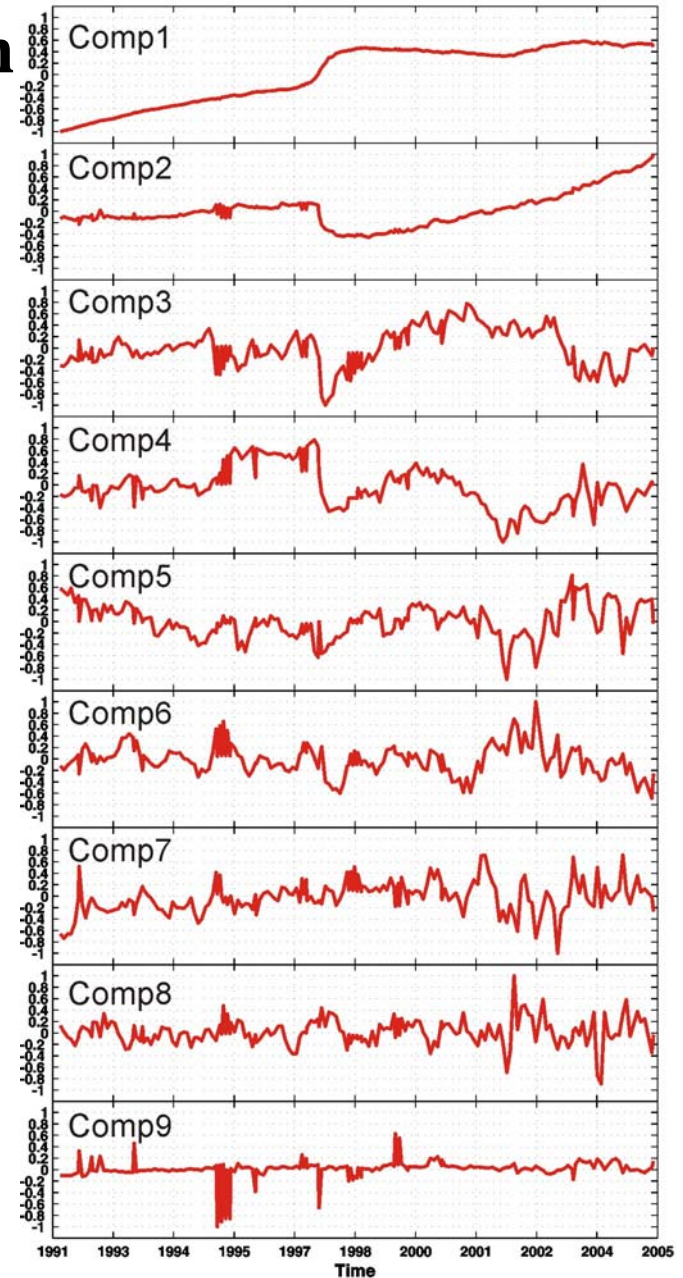
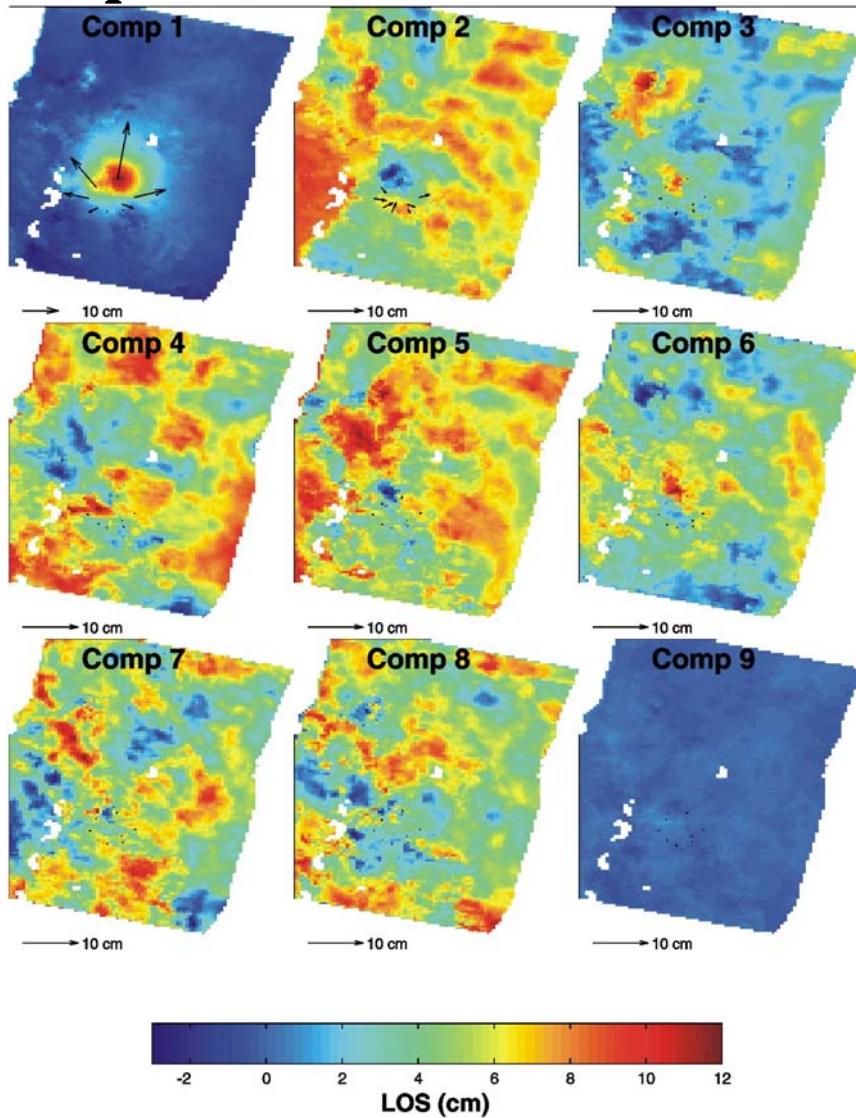
- Iterative decomposition to maintain temporal continuity of the signals



PCA Decomposition

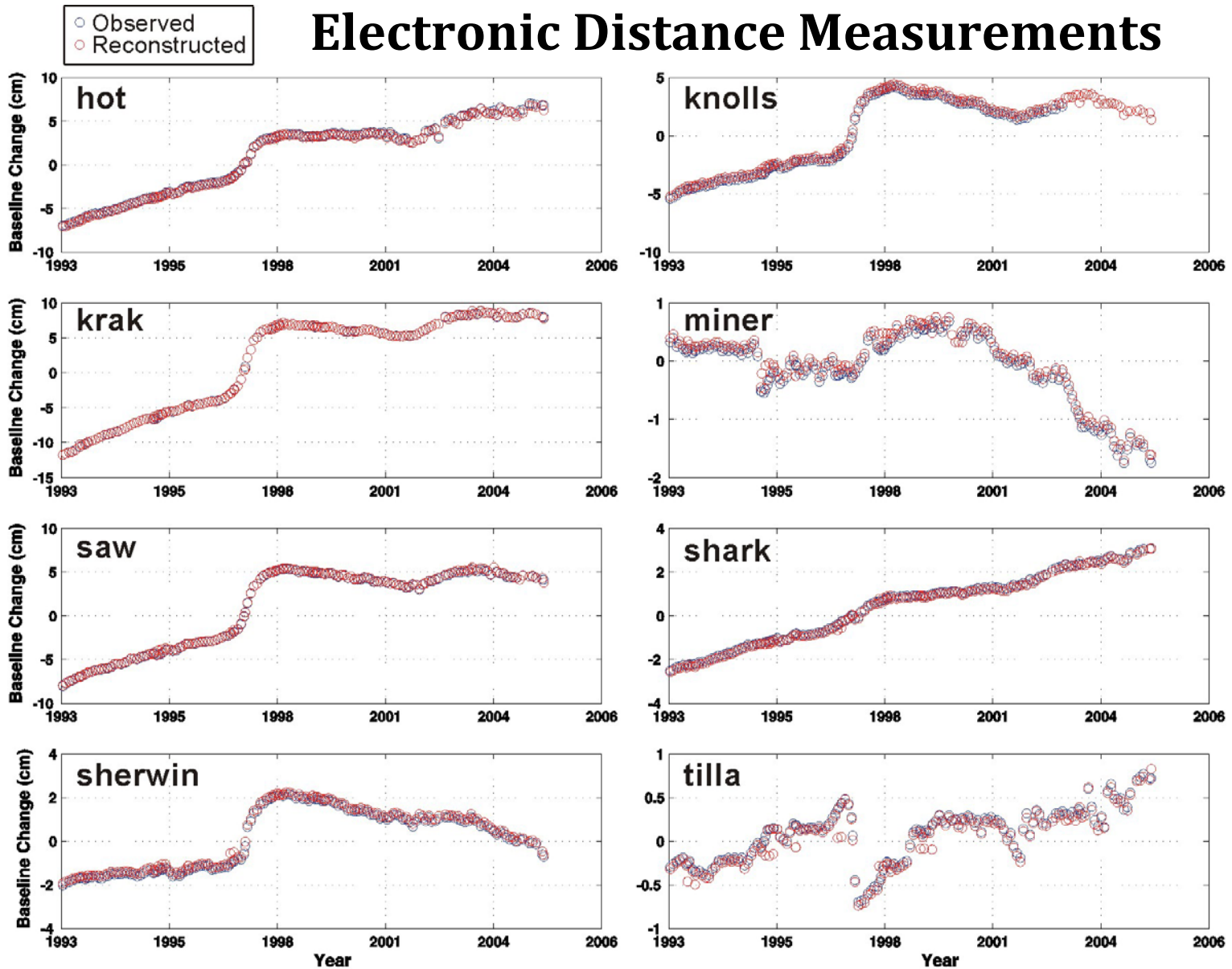
► Time function

▼ Spatial function



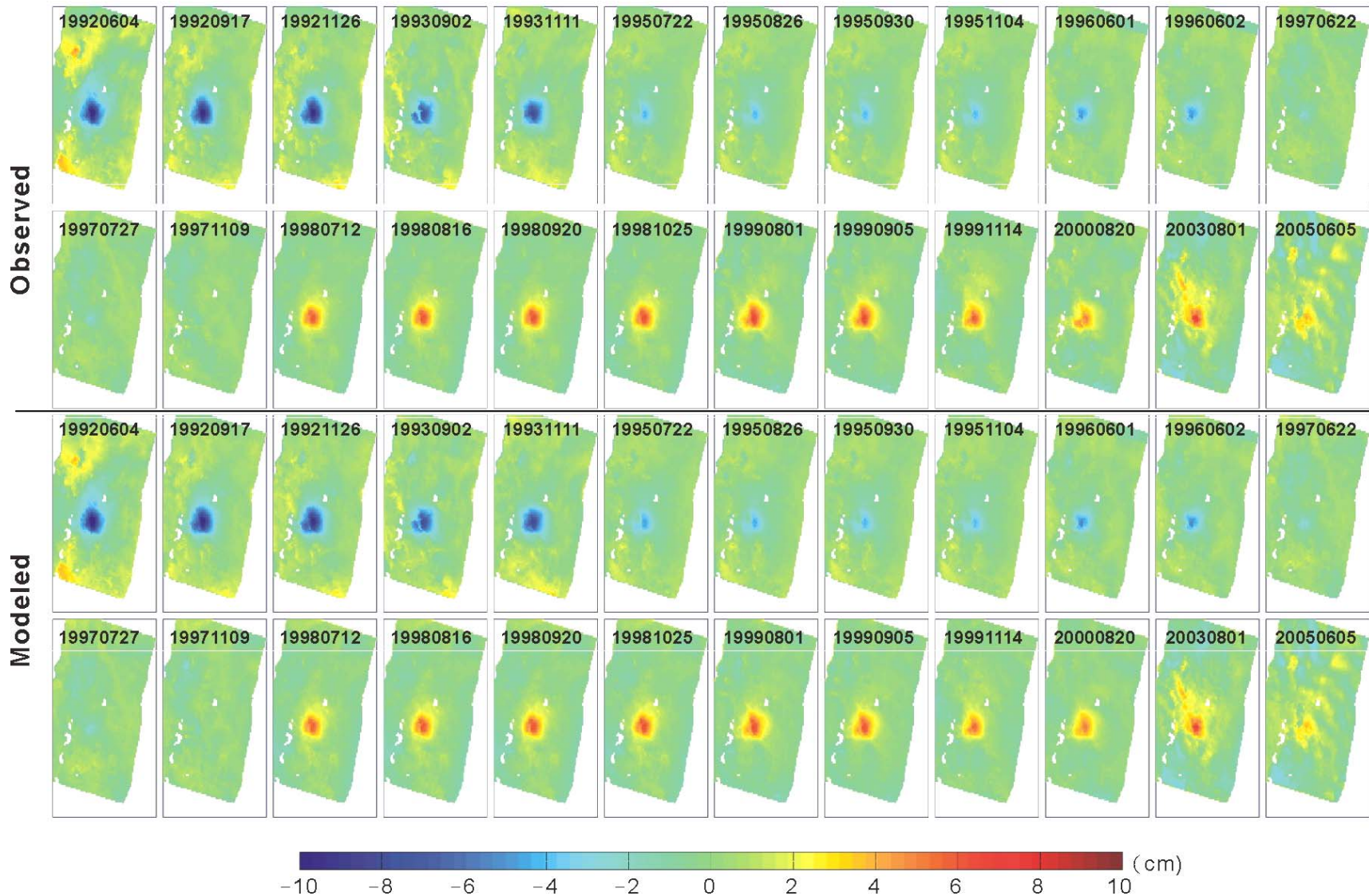
PCA Reconstruction (4 components)

Electronic Distance Measurements

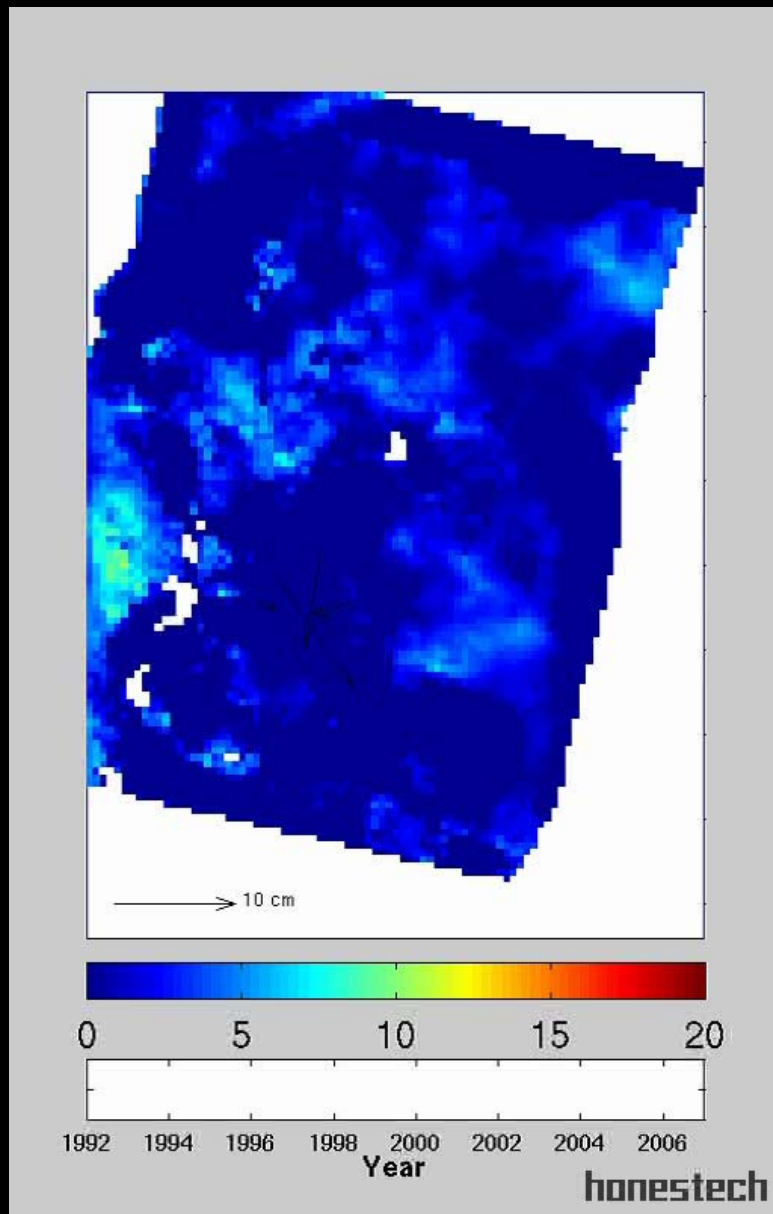


PCA Reconstruction (4 components)

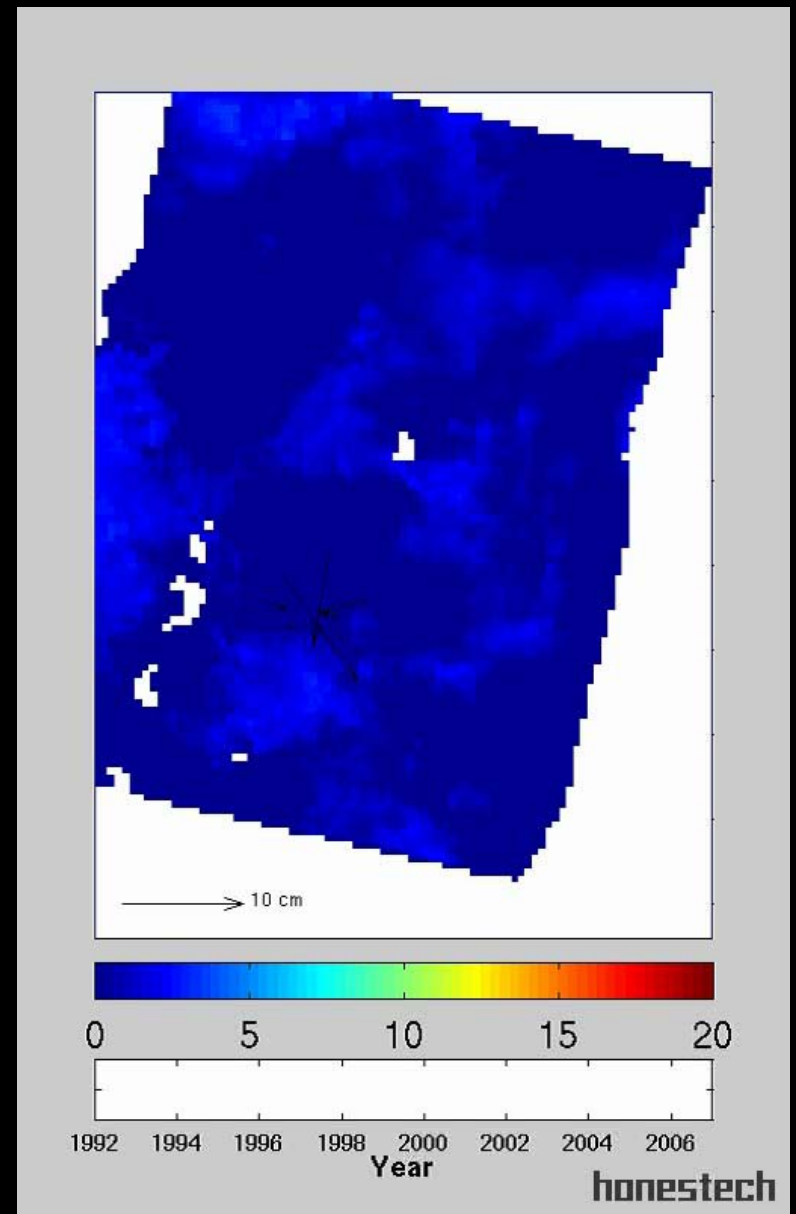
InSAR SBAS Time Series



Displacement Field 9 Components



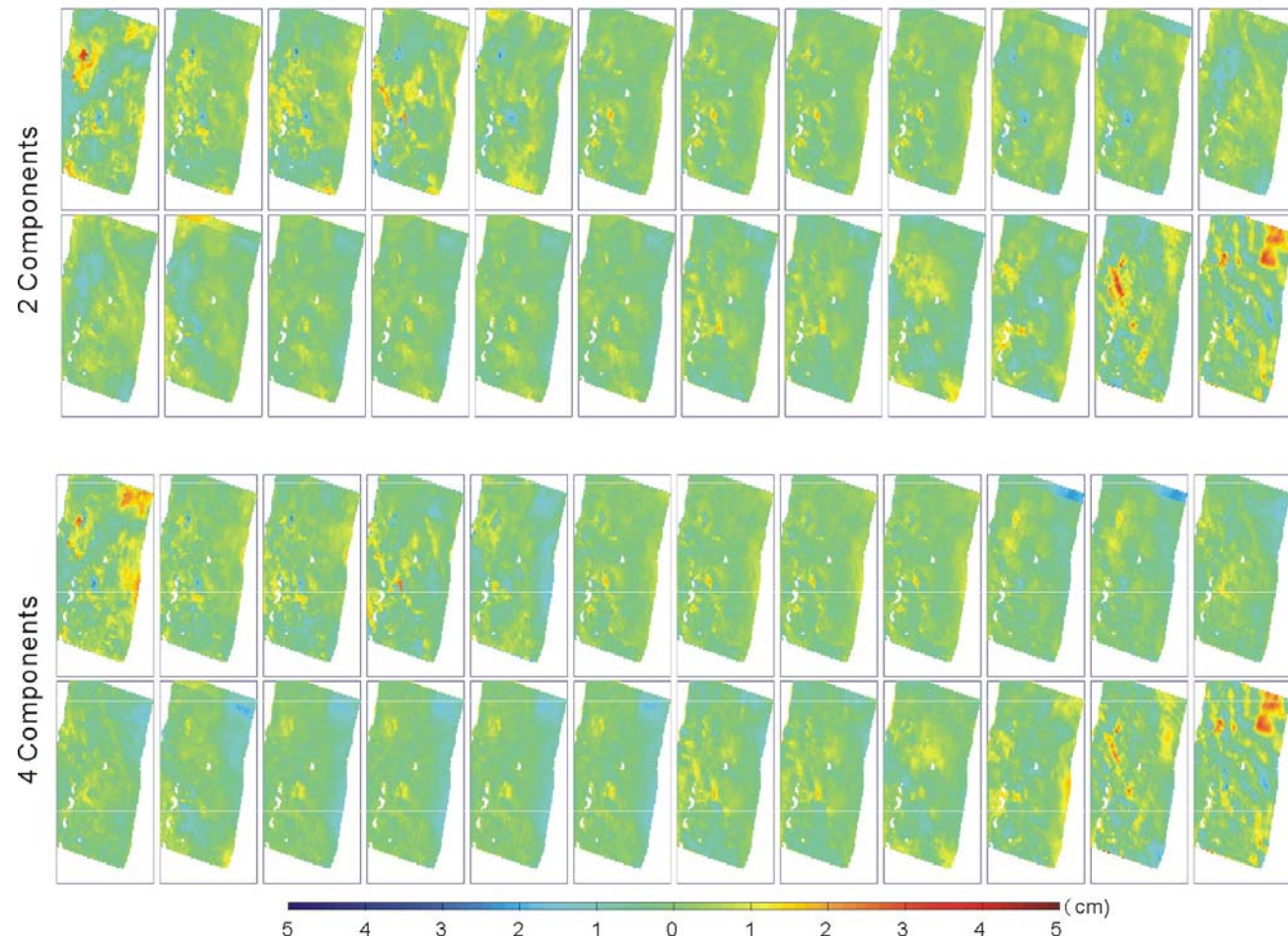
4 Components



PCA Joint Inversion

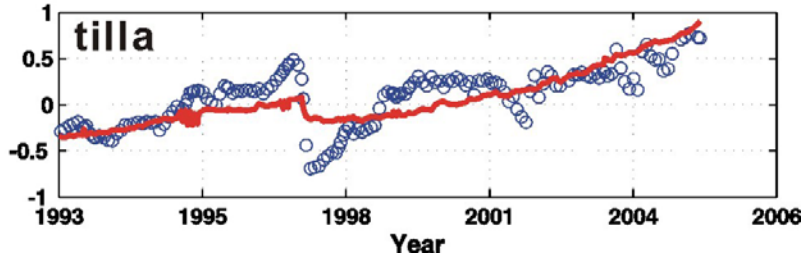
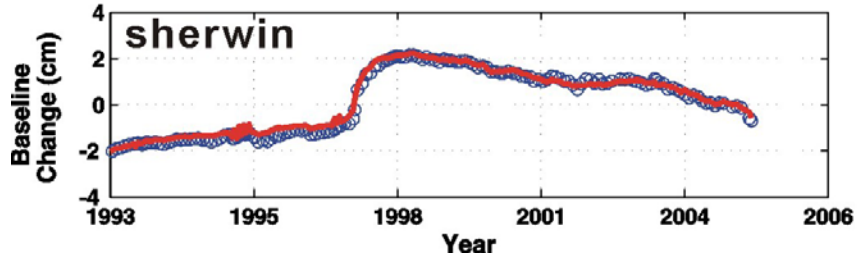
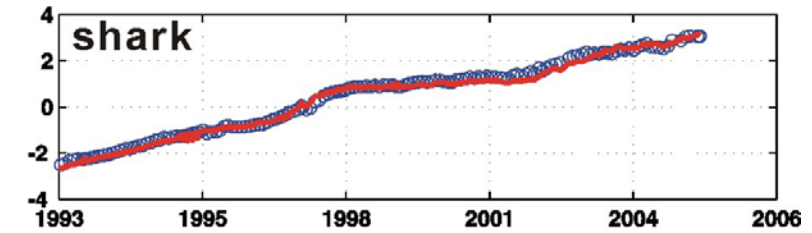
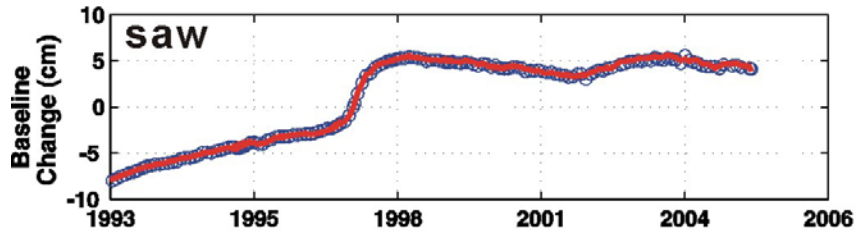
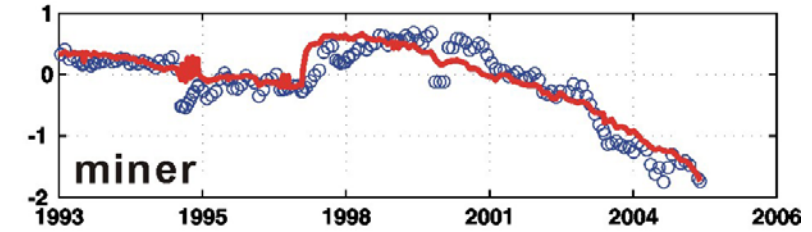
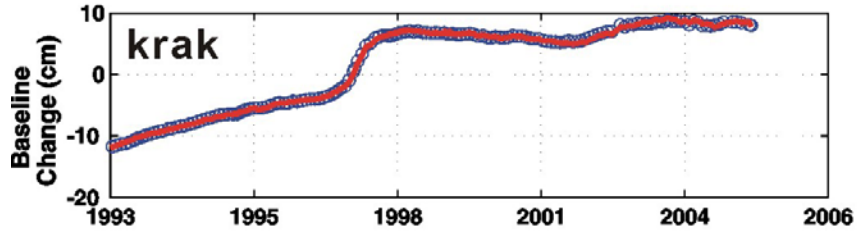
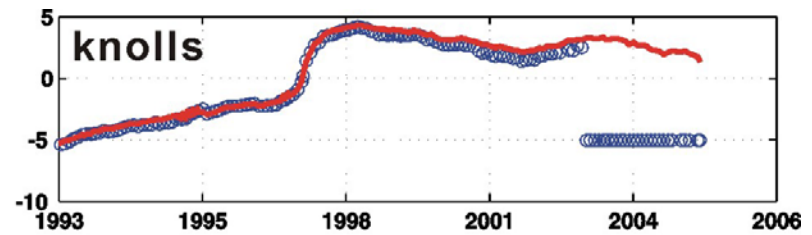
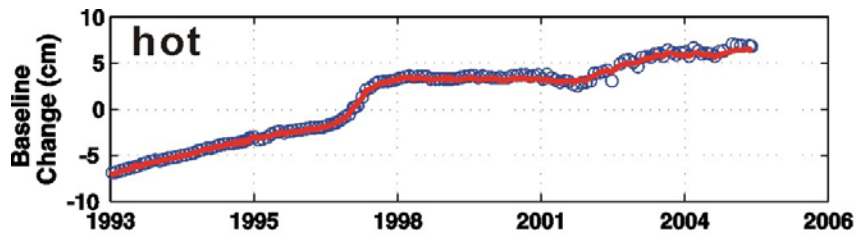
- Gridded Mogi Model [Masterlark and Lu, 2004]
- Apply Laplacian operator and cross validation

**Residuals
between
inversion
result and
observed
data**



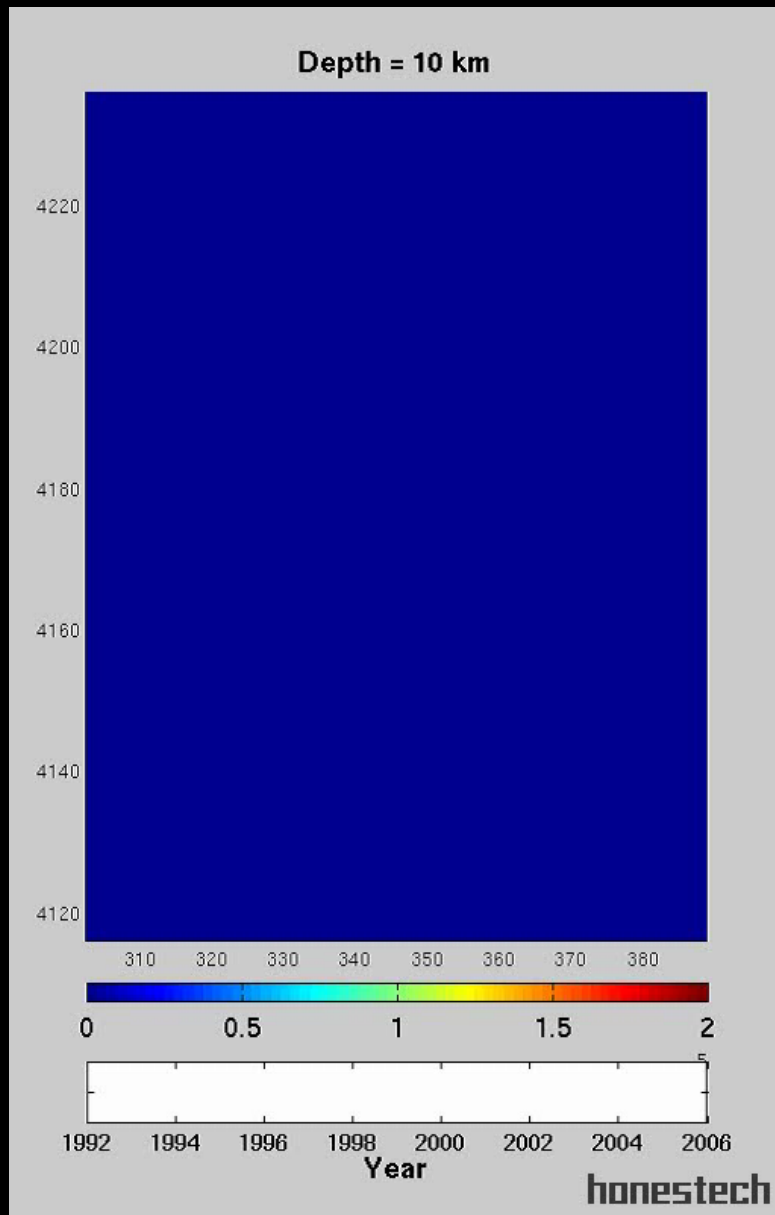
PCA Joint Inversion

2 Components

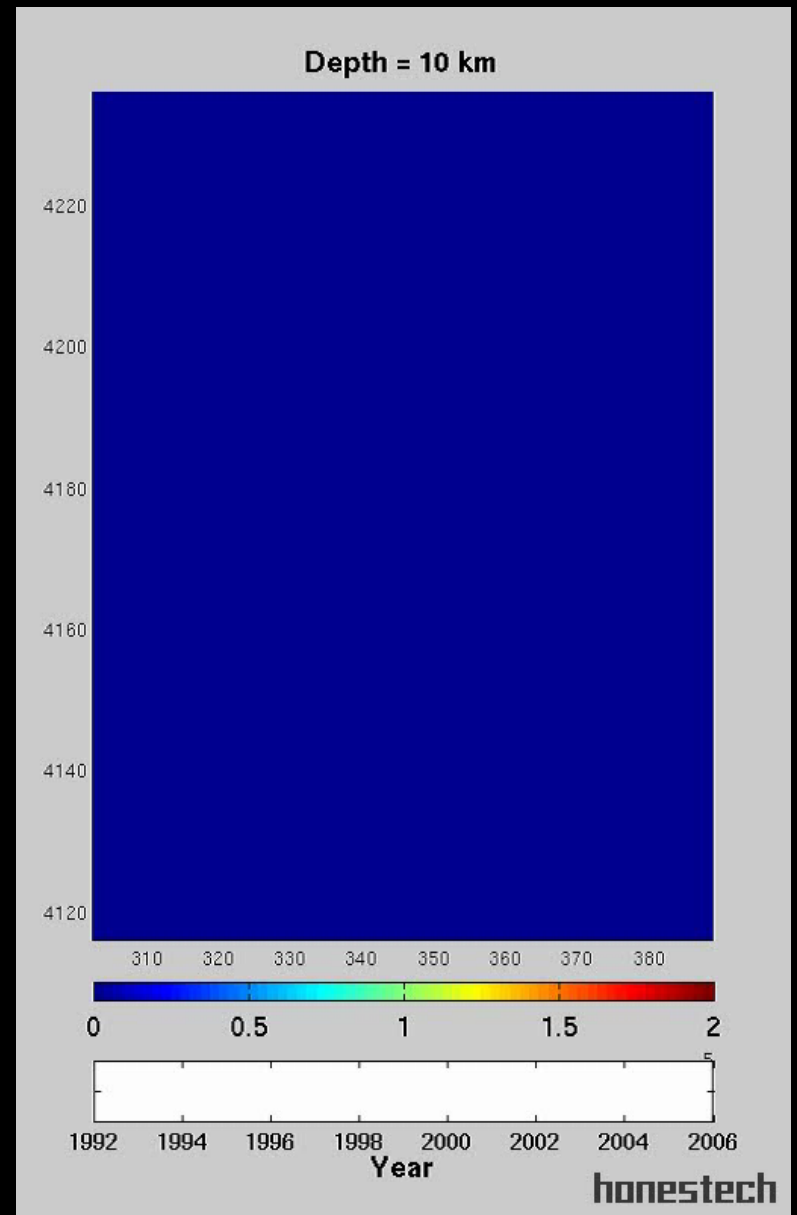


Source Mapping

4 Components

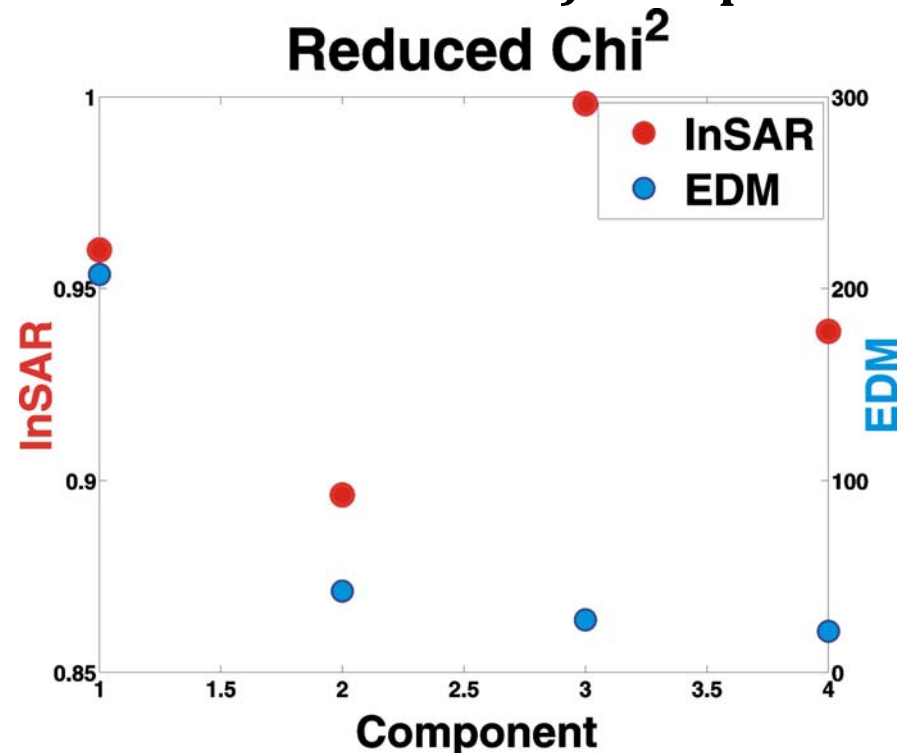


2 Components



PCA Joint Inversion -- Discussion


- We can get better source mapping in time and in space through combining InSAR and EDM
- Some (local) tectonic signals are mixed with noises in higher components
- We may need another source (such as South Moat Fault) to improve the fitting to EDM data
- Noises such as atmospheric signals in InSAR data can be filtered out into higher components
- Atmospheric correction will improve joint inversion by reducing the magnitude of noises



Summary

- PCAIM can produce a detail mapping of the source both in time and in space when combining InSAR and other time series data
- PCA decomposition may filter the unwanted atmospheric signals from InSAR data, but some local low-amplitude signals can also be excluded



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Tectonics Observatory 

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<http://www.tectonics.caltech.edu/resources/pcaim>

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PCAIM - recovering the time-evolution history of surface deformation sources

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Overview

PCAIM (Principal Component Analysis-based inversion Method) software can be used to recover the time-evolution history of the source of surface deformation (e.g., slip on a fault or magmatic

EN F Cumulative Slip Model PCAIM Cumulative Slip Model

