GIAnT - Generic InSAR Analysis Toolbox

Piyush Agram, Romain Jolivet, Mark Simons and Bryan Riel
Seismological Laboratory, Caltech

Introduction

GIAnT is a suite of commonly used time-series synthetic aperture radar interferometry (InSAR) algorithms in a common Python framework. Development of GIAnT was motivated by the need for

1. A toolbox that makes cutting-edge algorithms in InSAR time-series analysis readily available to non-radar specialists.

2. Rapid generation of time-series InSAR products in emergency response situations.

3. Reliable, consistent, efficient and accurate implementations of various InSAR analysis algorithms.

4. Distribution of time-series InSAR products in a standard format, including uncertainties.

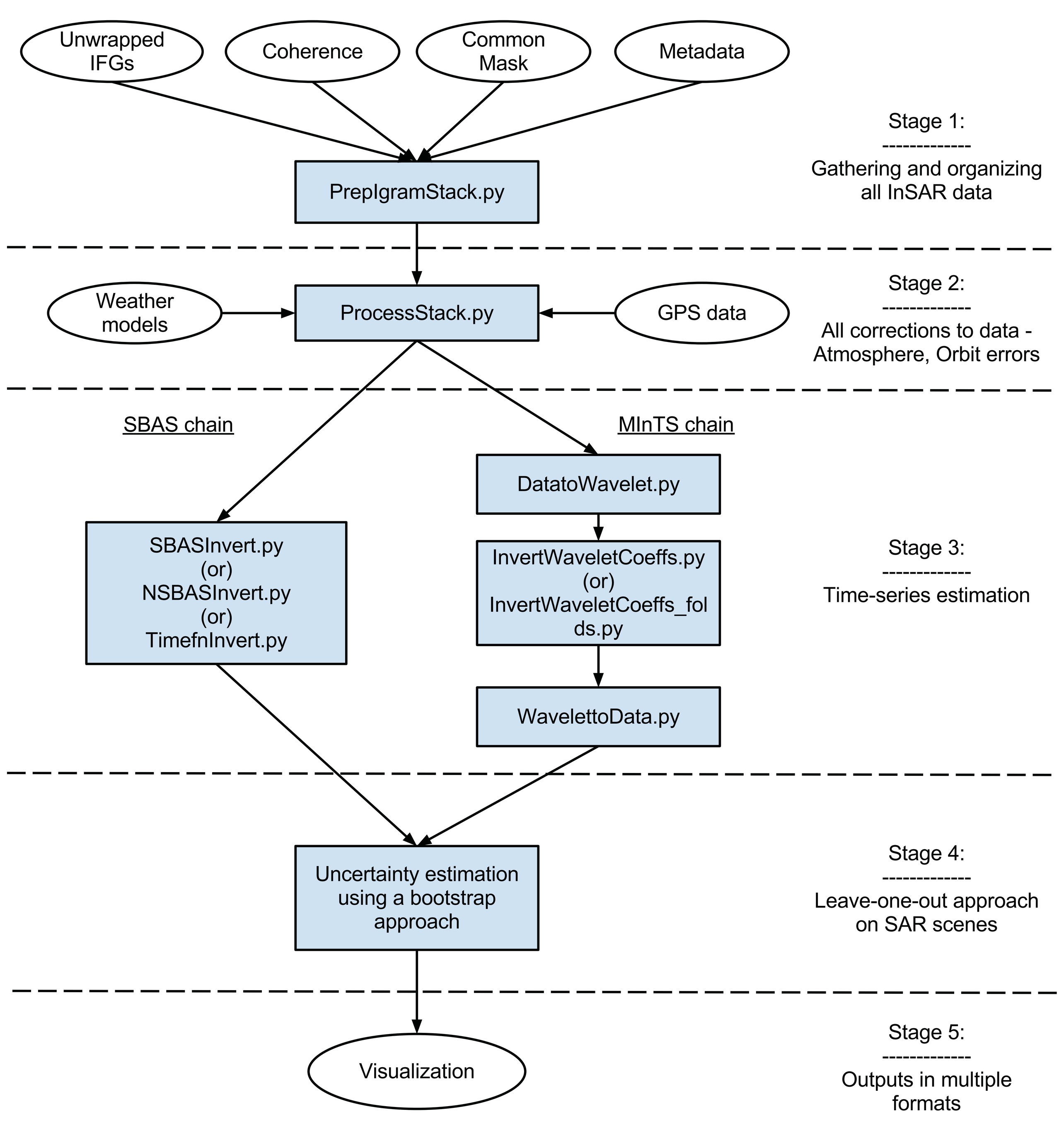
5. Ability to compare the performance of various time-series techniques on a single dataset.

6. Benchmarking and calibration-validation of generated time-series InSAR products.

7. A modular framework to aid development of optimized time-series analysis algorithms in the future.

GIAnT has been developed in collaboration with Marie-Pierre Doin and Cecile Lassere from UJF, Grenoble, France and Eric Hetland from Univ of Michigan.

Workflow and Features



1. Can ingest data from four different InSAR processors - ROI_PAC, ISCE, GMTSAR and DORIS.

2. XML files for user-defined processing parameter inputs and memory mapped HDF5 files for storing large datasets.

3. Automatic download of ECMWF, NARR and MERRA weather model data. Uses the PyAPS python module for estimating phase corrections due to the stratified atmosphere (Jolivet et al., 2011).

4. GPS daily solutions or velocities, when available, to model and correct orbital errors in interferograms.

5. Implements multiple time-series inversion algorithms - SBAS, N-SBAS and MInTS. Analysis in image coordinates or in wavelet domain.

6. Collection of L_1 and L_2 norm, including constrained and regularized, solvers included in the distribution.

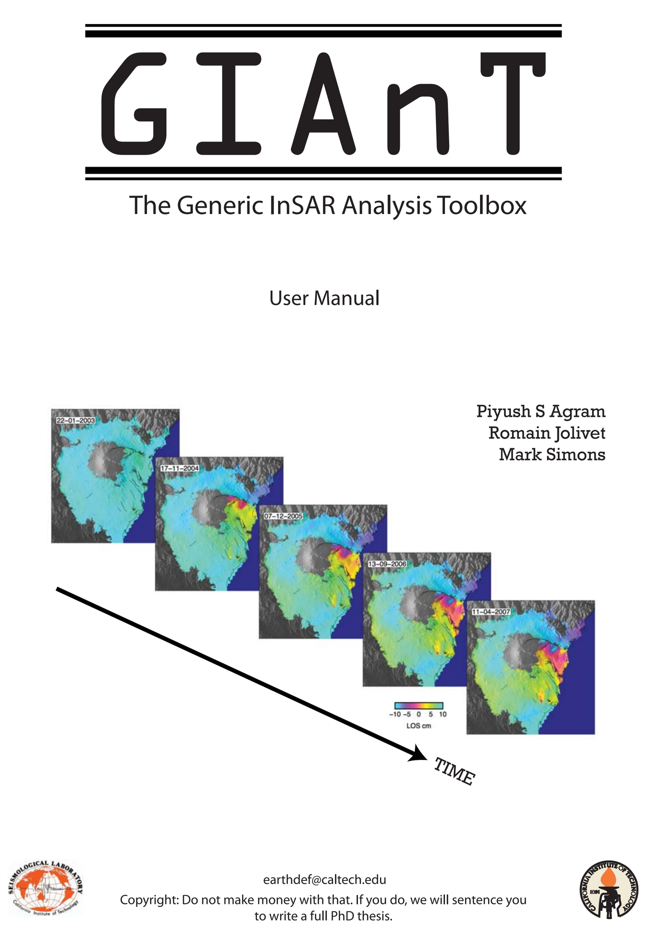
7. Estimates uncertainties using a bootstrap approach from the data itself. Important product for geophysical modeling.

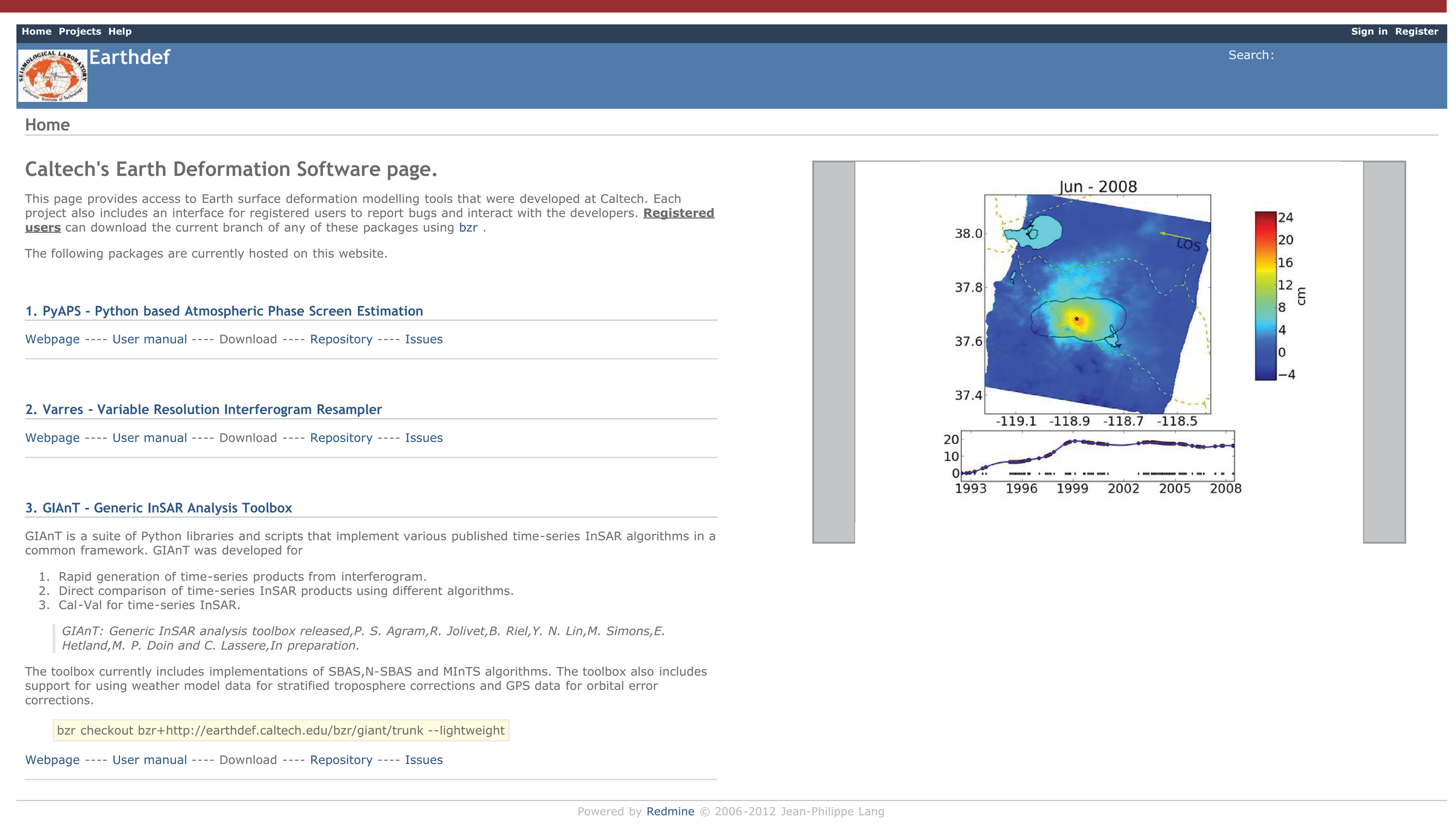
8. Uses fast Python libraries to convert data from radar image domain (range and azimuth) to geocoded domain and vice-versa.

9. High quality visualization scripts. Exports data to multiple formats include GDAL's VRT, KML and GMT netcdf.

10. Computationally intensive routines have been parallelized using Python's multiprocessing module for performance on multi-core machines.

Obtaining GIAnT





GIAnT will be distributed through http://earthdef.caltech.edu . The distribution includes the source code and is available for free for non-commercial applications. The website also includes a bug-tracker and a user forum for reporting issues.

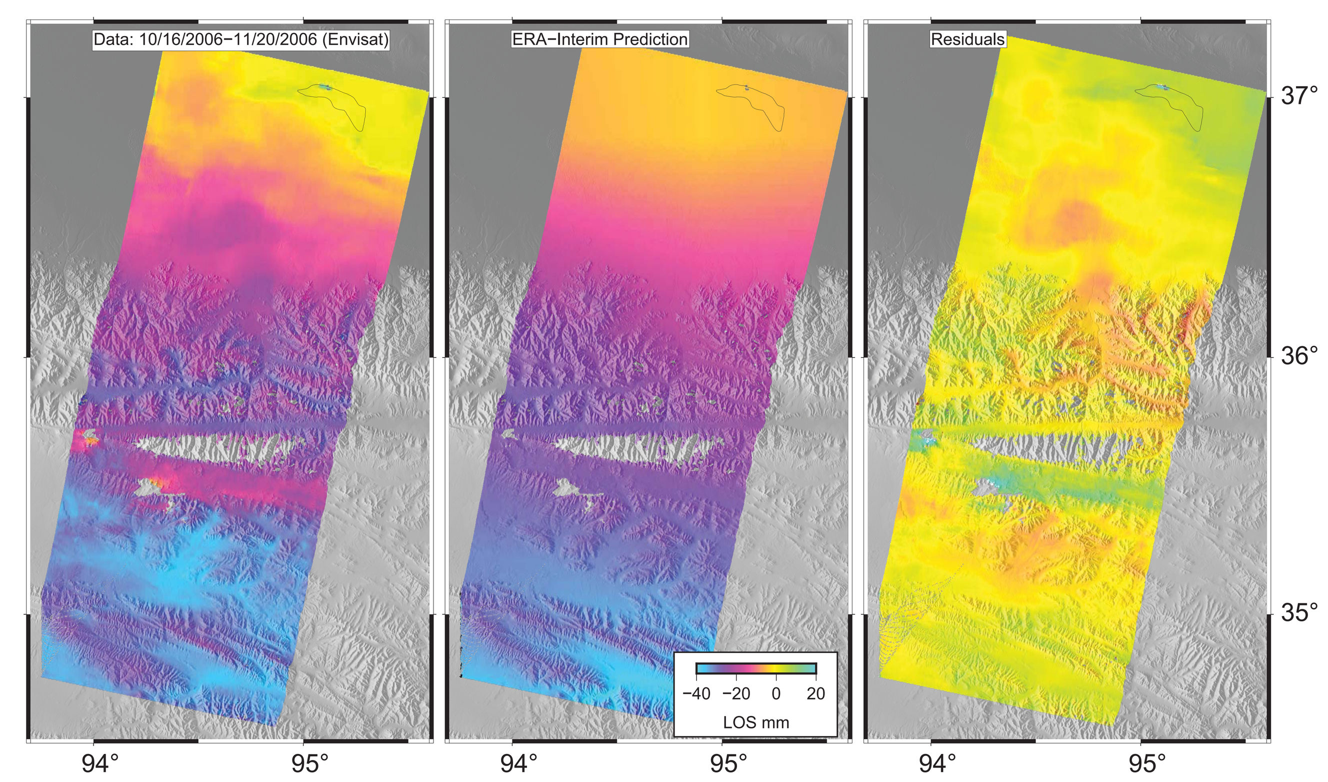
Corrections to InSAR data

The current version of GIAnT includes algorithms for

a) estimating phase contributions due to the stratified troposphere either empirically or using using weather models

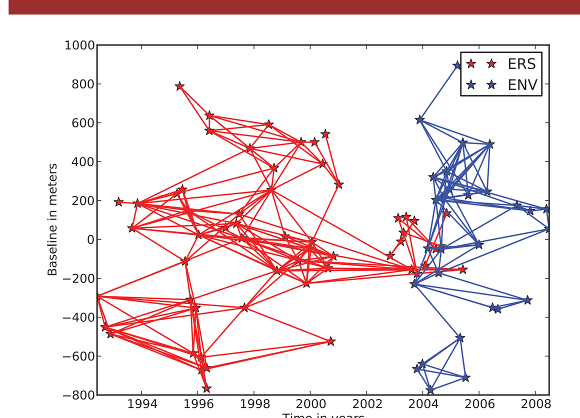
b) estimating satellite orbit errors either empirically or using GPS time-series when available.

Future versions of GIAnT are expected to include corrections for deformation associated with tidal loading.

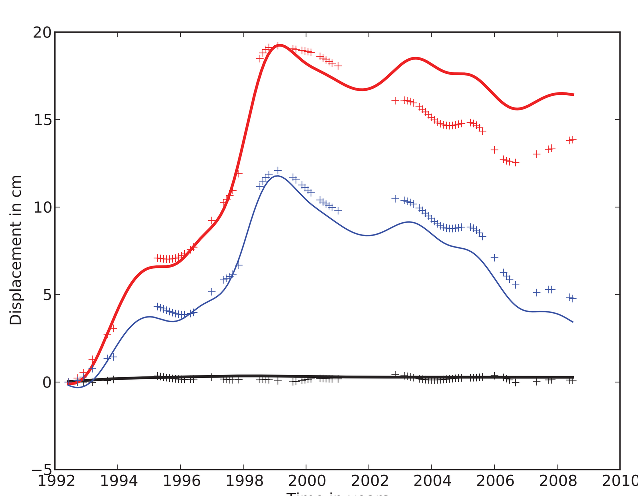


Example of interferogram phase correction using the ECMWF ERA-Interim global atmosphere model over Kunlun in Tibet. In this case, almost all of the observed interferometric phase can be attributed to differential path delay through the troposphere.

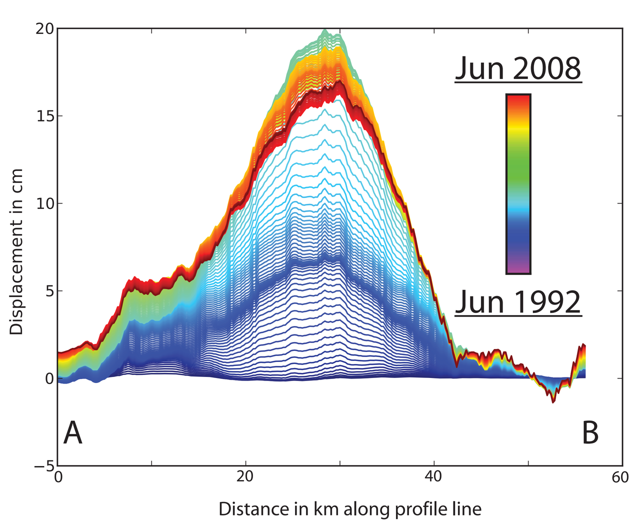
Example: Time-dependent deformation at Long Valley Caldera, California



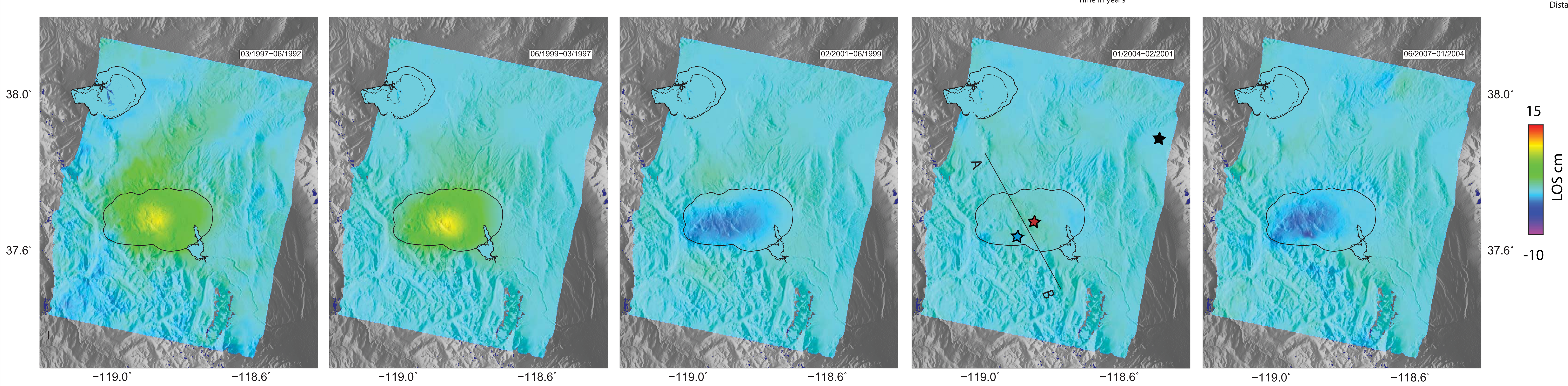
We present results for a large dataset of ERS and ENVISAT SAR images acquired over the Long Valley Caldera in California. We used 85 SAR acquisitions and processed 263 interferograms at a spatial resolution of 160 m using the ROI_PAC software for analysis. NARR weather model data was used to correct the interferograms. Starting with interferograms from ROI_PAC, GIAnT could estimate and compare results from multiple time-series algorithms within 6 hours using 8 cores.



Comparison of MInTS time-series for 3 different pixels in the region - (Red) Center of the Caldera, (Blue) Casa Diablo geothermal station and (Black) near the NE corner. The SBAS time series (+) is also shown.



Temporal evolution of profile line AB as estimated using MInTS. The time-series was estimated using 48 I-splines.



Differential displacements for various time intervals in our 16-year dataset. The deformation pattern associated with the uplift and subsidence processes are different, suggesting different mechanisms at work. The time-series techniques also clearly capture the localized subsidence signal around the Casa Diablo geothermal plant, located within the caldera.