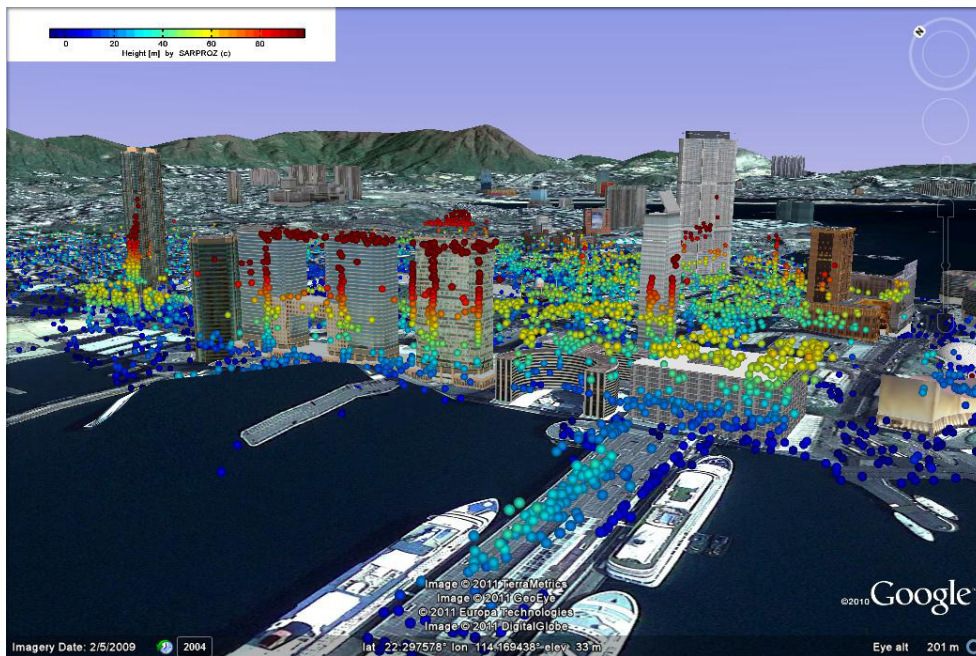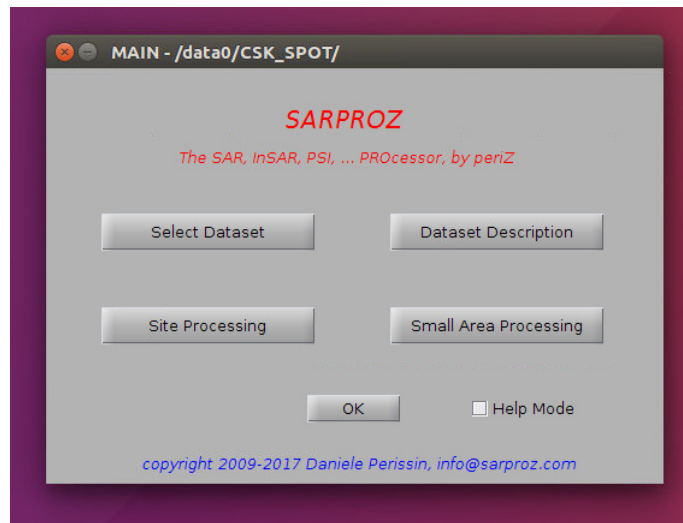# SARPROZ © 2009-2021,

The SAR PROcessor by periZ

### RASER Limited

www.sarproz.com

TerraSAR-X Persistent Scatterers in the Hong Kong harbor.

SARPROZ is a very powerful and versatile tool that implements a wide range of Synthetic Aperture Radar (SAR) processing techniques.

Main characteristics of SARPROZ:

- User friendly Graphical **Interface**: no other language knowledge is required for standard uses
- Based on **Matlab**: advanced users can very easily develop their own software extensions. Data and parameters are very easily imported/exported using Matlab.
- It can be compiled and it runs independently from Matlab on **any platform** (Unix, PC, Mac).
- Completely **parallelized**: SARPROZ can run on multiple CPU cores or computer clusters automatically.
- Command Line execution without Graphic Interface for fully automated processing.
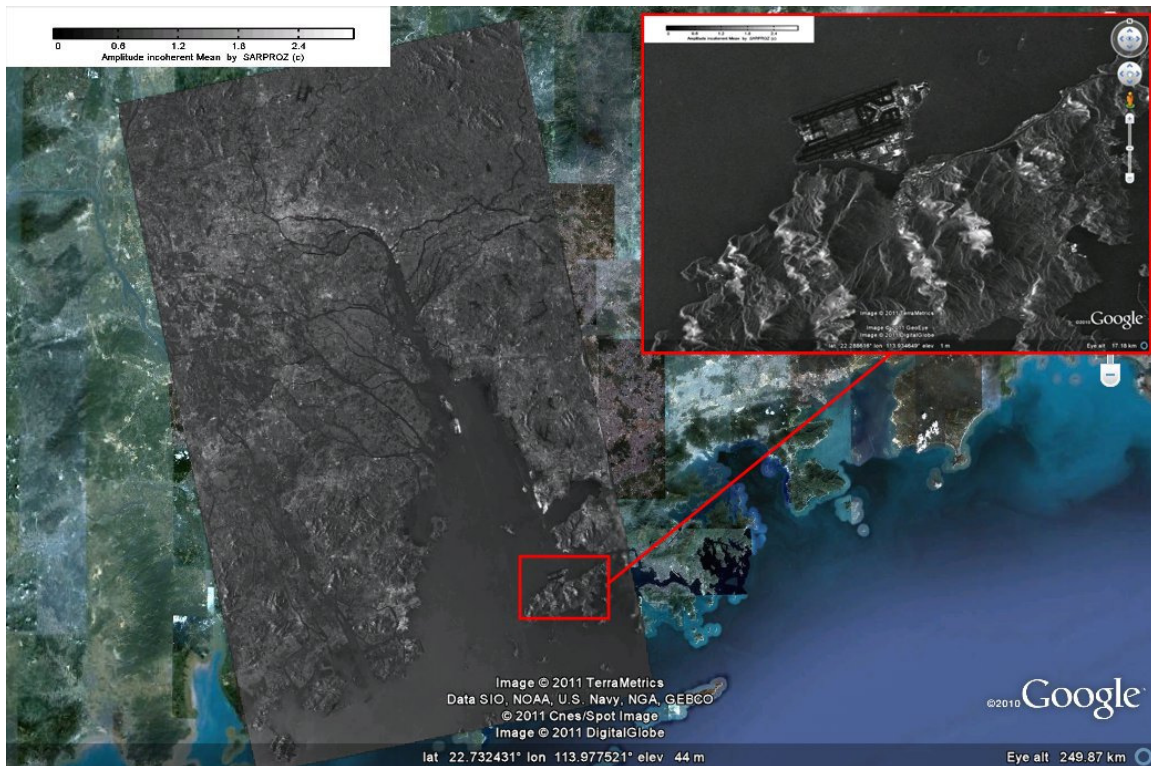
Envisat image of Pearl River Delta, China in Google Earth. The close up shows the details of the image

Processing options/modules included in SARPROZ:

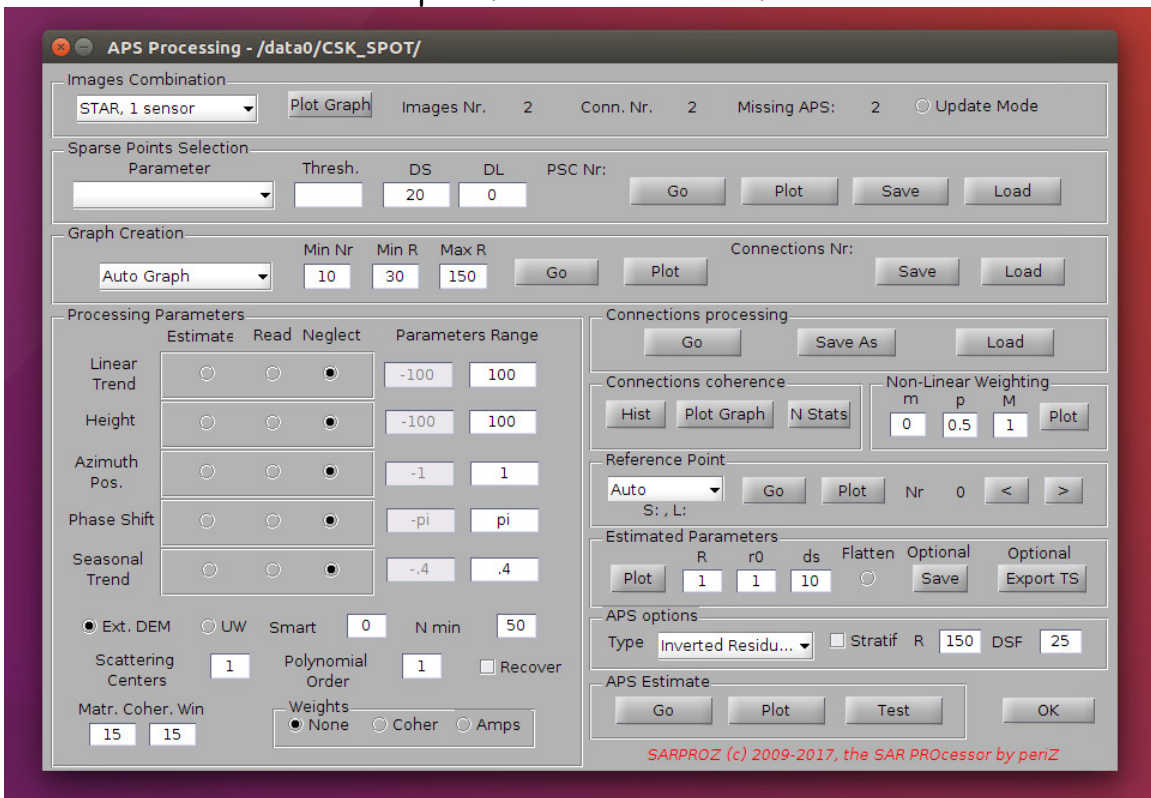- Synthetic Aperture Radar (**SAR**) image processing: SLC coregistration, SLC equalization and calibration, Reflectivity Map calculation, extraction of pointwise targets.
- SAR Interferometry (**InSAR**): orbital data processing, interferogram calculation, interferogram flattening, interferogram filtering, phase unwrapping.
- Differential SAR Interferometry (**DInSAR**): DEM conversion and resampling, topographic phase removal, residual phase processing, motion estimation.
- Stacking of Differential Interferograms (**SDInSAR**): processing of series of interferograms for atmospheric delay suppression and motion estimation.
- Persistent Scatterers InSAR (**PSI**): full-processing chain for ground average deformation trend, ground elevation and atmospheric delay estimation.
- **Urban** Advanced PSI: PS real targets identification and classification (roofs, poles, dihedrals, trihedrals, fences, floor gratings, …).
- **Temporary** PSI: estimation of temporary targets (new constructions, demolitions, short-time structures)
- **Multiple scattering** centers PSI: estimation of double or multiple scattering centers per resolution cell in urban sites.
- **Non-Linear** PSI: estimation of non-linear trends (seasonal polynomial and non-parametric) in target displacement.
- **Quasi-PSI**: an advanced technique to estimate ground average deformation and ground elevation in areas where no PS targets can be detected.
- **Unwrapped-PSI**: time series analysis of unwrapped interferograms.
- **Multi-Sensor** analysis: combination (coherent or un-coherent) of data acquired by different sensors, with different characteristics (frequency, polarization, …) under different geometries
- **DEM** processing based on InSAR/Multi-Temporal InSAR results for DTM and/or DSM extraction
- **Change** detection exploiting pairs of images (coherent/uncoherent).
- **RGB** composite image generation
- **Change** detection exploiting image time series.
- Image **classification** based on results of previous modules.

SITE PROCESSING - /data0/CSK_SPOT/

Current Images Graph
One-sensor STAR

Preliminary analysis
Reflectivity map and amplitude stability index — Go
Mask for sparse points selection — Go

Preliminary geocoding
External DEM selection Current: SRTM — Go
DEM visualization — Go
GCP selection — Go
External DEM and synthetic amplitude in SAR coordinates — Go
Coregistration Refinement (optional) — Go

Sub-dataset extraction
Selection and extraction — Go

Auxiliary analysis
Change detection — Go
Coherent Change detection — Go
Image classification — Go
Multi-Temporal Adaptive Mask — Go

InSAR processing
InSAR Params — Go
Reset flat/height constants — Go
MST estimation — Go
Residual fringes estimation and removal — Go
Interferograms processing — Go
Coherence map generation — Go
Single interferogram processing — Go

Sparse points selection
Load Mask — Go
Custom Mask Generation — Go

Amplitude processing
Images fine equalization — Go
Amplitude time series analysis — Go
Sub-pixel positions analysis — Go
Flat Cartesian coordinates estimation — Go

Multi Image InSAR processing
APS estimation — Go
Sparse Points processing — Go

Results exporting
Extended geocoding (kml-geotiff) — Go
Sparse geocoding (kml-csv) — Go

Post-analysis
Geographic Corrections — Go
DEM post-analysis — Go
PS classification — Go
Time Series Module — Go
Multi-sensor analysis — Go

Visualization tools
Histograms — Go
Scatter Plots — Go
View parameters — Go
View interferograms — Go

SARPROZ (c) 2009-2017, the SAR PROcessor by periZ   ☐ NO security prompt   Running in Normal Mode   Refresh   OK

Example of SARPROZ Interface

APS Processing - /data0/CSK_SPOT/

Images Combination
STAR, 1 sensor   Plot Graph   Images Nr. 2   Conn. Nr. 2   Missing APS: 2   ○ Update Mode

Sparse Points Selection
Parameter   Thresh.   DS 20   DL 0   PSC Nr: Go   Plot   Save   Load

Graph Creation
Auto Graph   Min Nr 10   Min R 30   Max R 150   Go   Plot   Connections Nr: Save   Load

Processing Parameters

	Estimate	Read	Neglect	Parameters Range	
Linear Trend	○	○	●	-100	100
Height	○	○	●	-100	100
Azimuth Pos.	○	○	●	-1	1
Phase Shift	○	○	●	-pi	pi
Seasonal Trend	○	○	●	-.4	.4

● Ext. DEM ○ UW Smart 0   N min 50
Scattering Centers 1   Polynomial Order 1   ☐ Recover
Matr. Coher. Win 15 15   Weights: ● None ○ Coher ○ Amps

Connections processing
Go   Save As   Load

Connections coherence
Hist   Plot Graph   N Stats

Non-Linear Weighting
m 0   p 0.5   M 1   Plot

Reference Point
Auto   Go   Plot   Nr 0   < >
S: , L:

Estimated Parameters
R 1   r0 1   ds 10   Flatten ○   Optional Save   Optional Export TS
Plot

APS options
Type Inverted Residu... ☐ Stratif R 150 DSF 25

APS Estimate
Go   Plot   Test   OK

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Example of Atmospheric delay estimation Module in SARPROZ

Auxiliary features of SARPROZ:

- Results/Data visualization and analysis
    1. Histograms generation with any of the data/results processed by the software, for any selection of pixels.
    2. Plots generation in 2D, 3D, with colors or densities with any of the data/results processed by the software, for any selection of pixels.
    3. Images generation with any of the data/results processed by the software.
- Results/Data exportation in three main forms:
    1. Geocoded raster images (geocoded or orthorectified) in different formats (binary, geotiff, google earth kml).
    2. Geocoded point-information, in 2D or 3D, with detailed information for each point (for GIS or Google Earth).
    3. Hierarchical kmz files for a very efficient visualization in Google Earth.
- Small area analysis with a threefold purpose:
    1. Test processing of any of the techniques previously listed to quickly check the best approach (that depends on available data, area to analyze, aim of the estimate).
    2. Browsing of final results on georeferenced optical layers, with possibility of displaying in colors any processing results and selecting point targets for characteristics listing and time series plotting.
    3. Training of neophytes': new users can learn SAR, InSAR, PSI thanks to the full-featured analysis over a small area through a step-by-step processing path.
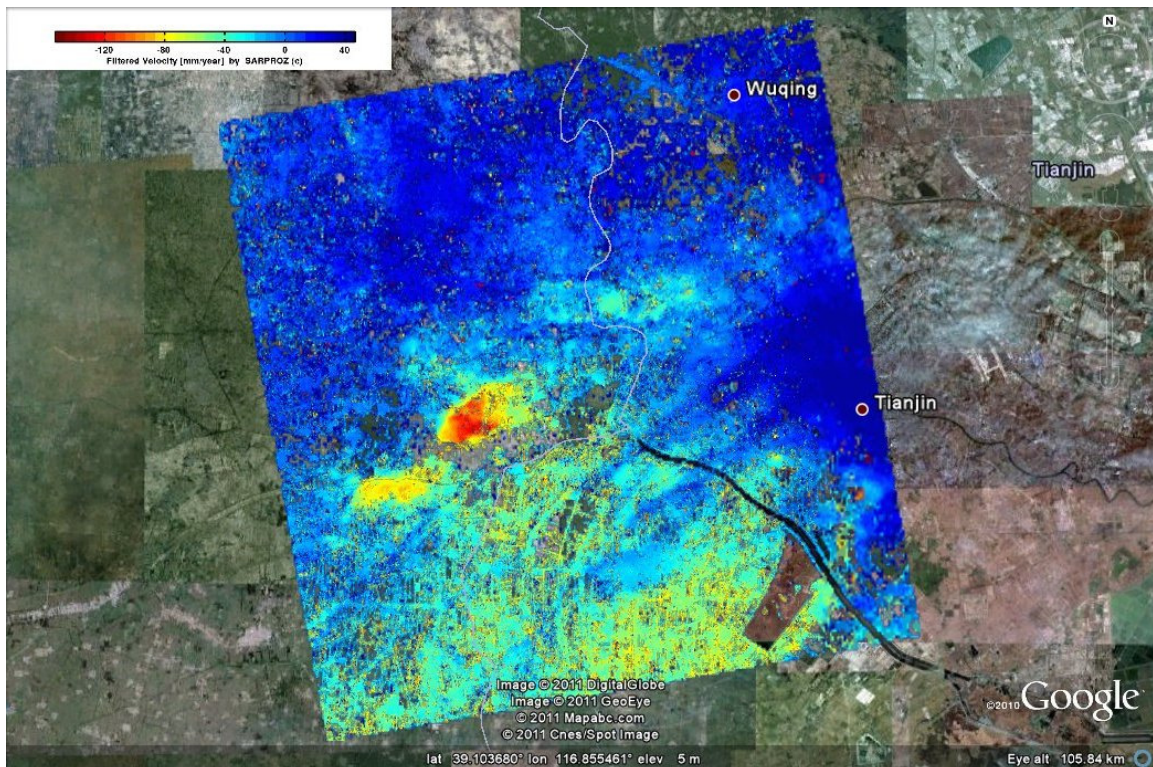
SARPROZ

The SAR, InSAR, PSI, … PROcessor by periZ

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SARPROZ online documentation: www.sarproz.com
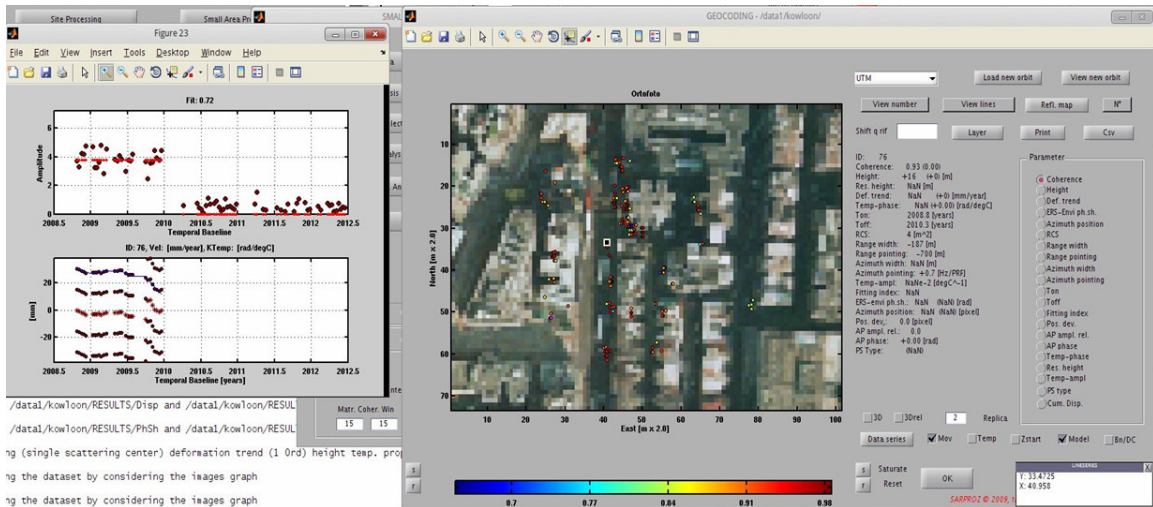
Example of small area geocoding module. PS's are displayed on an optical image, with a color scale according to any of the estimated parameters. Each PS point can be selected and its parameters are listed. Time series (amplitude and displacement) can be plotted as well. On the left: a non-linear movement detected from a subset of images (temporary target).

Example of average deformation trend in Tianjin estimated from ALOS data.

Sensors and imaging modes supported by SARPROZ (SLC):

- ERS-1 and ERS-2 (CEOS format)
- ERS-1 and ERS-2 (Envisat format)
- Envisat (stripmap, Scansar)
- Sentinel-1A/B (stripmap, TOPS)
- Cosmo SkyMed (1,2,3,4) (stripmap, spotlight)
- Cosmo SkyMed Second Generation
- TerraSAR-X (stripmap, spotlight, scansar, staring spotlight)
- Tandem-X
- Tandem-X bistatic pairs
- PAZ
- RadarSAT 1
- RadarSAT 2
- ALOS (ERSDAC)
- ALOS (JAXA)
- ALOS-2
- SAOCOM-1A
- SAOCOM-1B
- Kompsat-5
- Gaofen-3
- Risat-1
- HiSea-1
- Iceye
- Capella
- Multiple polarizations/selection of polarization are supported

Many more data formats can be imported in Sarproz. Further details are available in the software documentation.