

Tutorial on SAR, InSAR, PSInSAR

SARPROZ

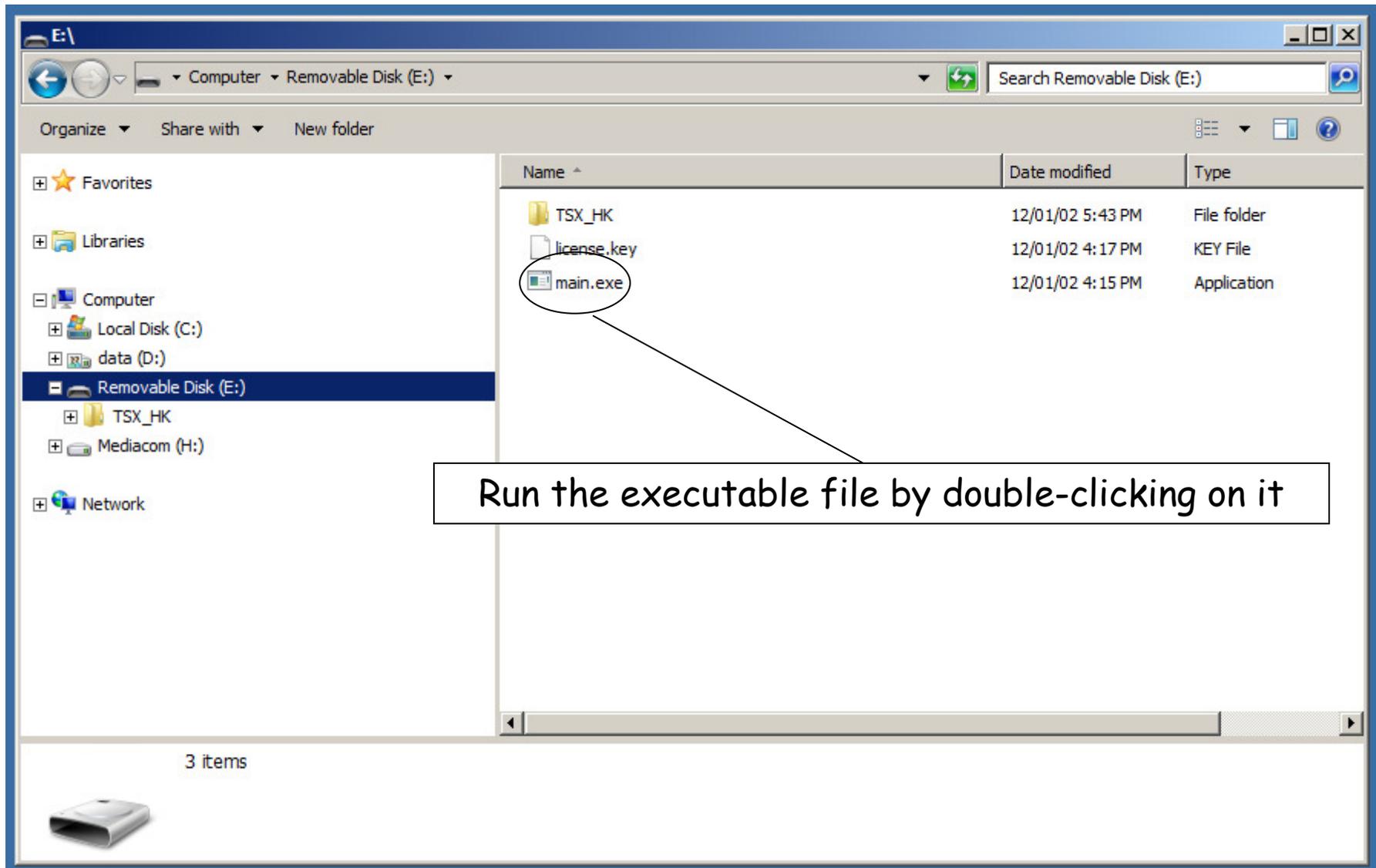
The SAR processing tool by Periz

http://ihome.cuhk.edu.hk/~b122066/index_files/download.htm

Part I

Petronas University of Technology UTP

Windows explorer



Proxy settings



Proxy Settings

Proxy Name: 10.77.170.35

Proxy Port: 8080

User Name:

Authentication

OK Cancel

*SARPROZ © 2009
the SAR PROCessor by periz*



password required

Fill in the user/classroom settings

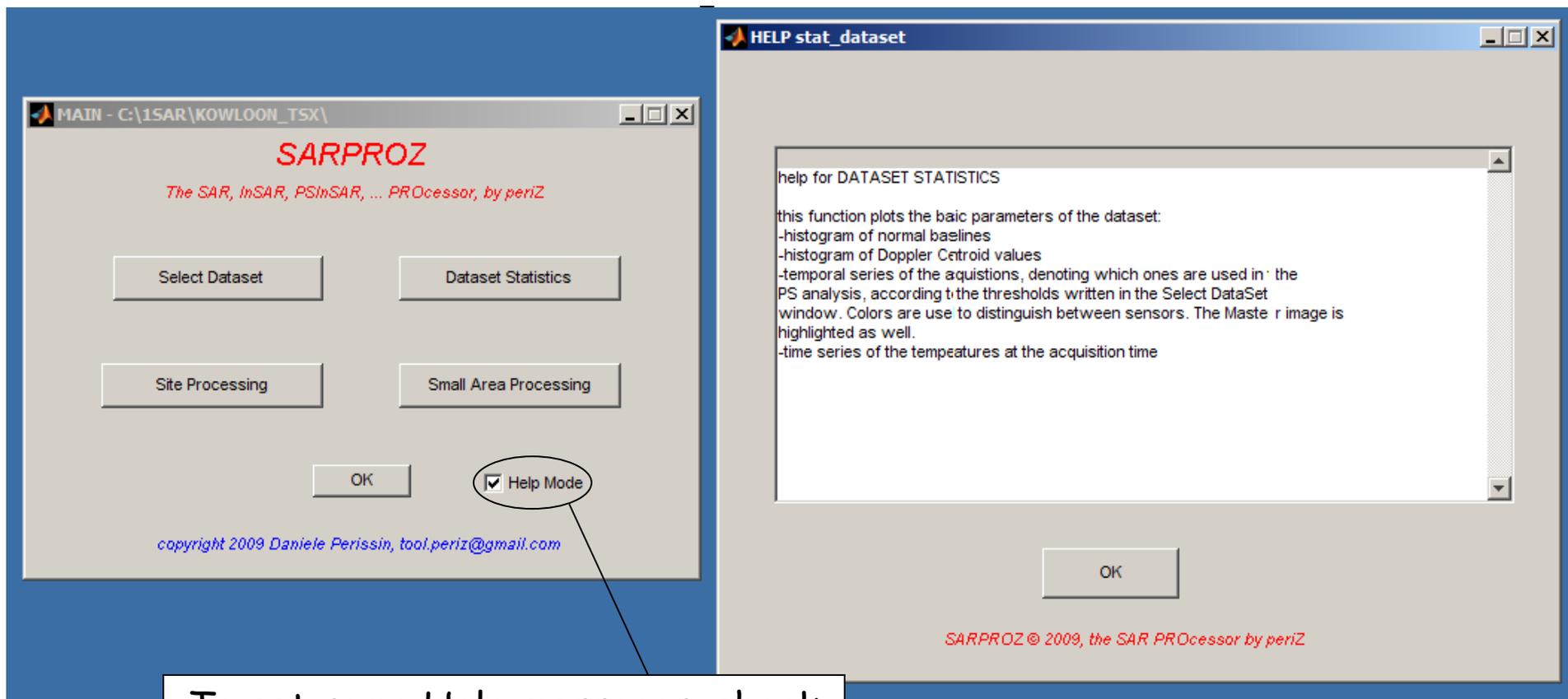


```
E:\main.exe
Welcome to SARPROZ
by Daniele Perissin, copyright 2009
Messages from this session are written in file 02-Jan-2012_18_00_39_sarproz.log
directory E:\
compiled on 02-Jan-2012 16:11:52
```

Keep the command prompt visible for messages

SARPROZ main window

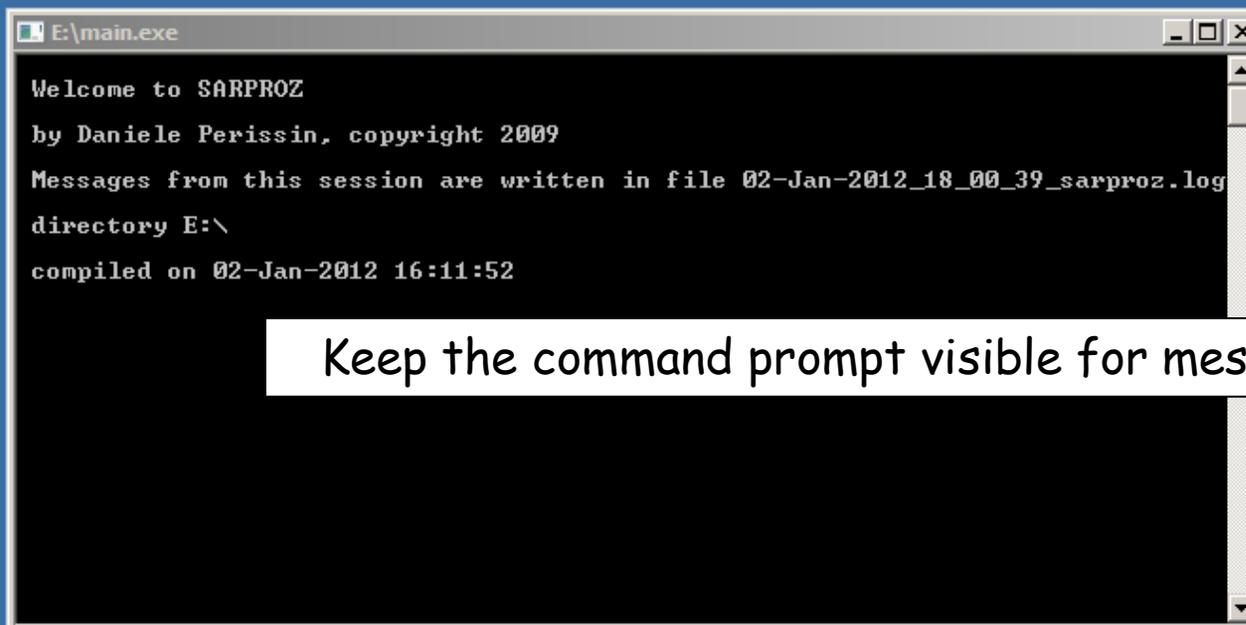
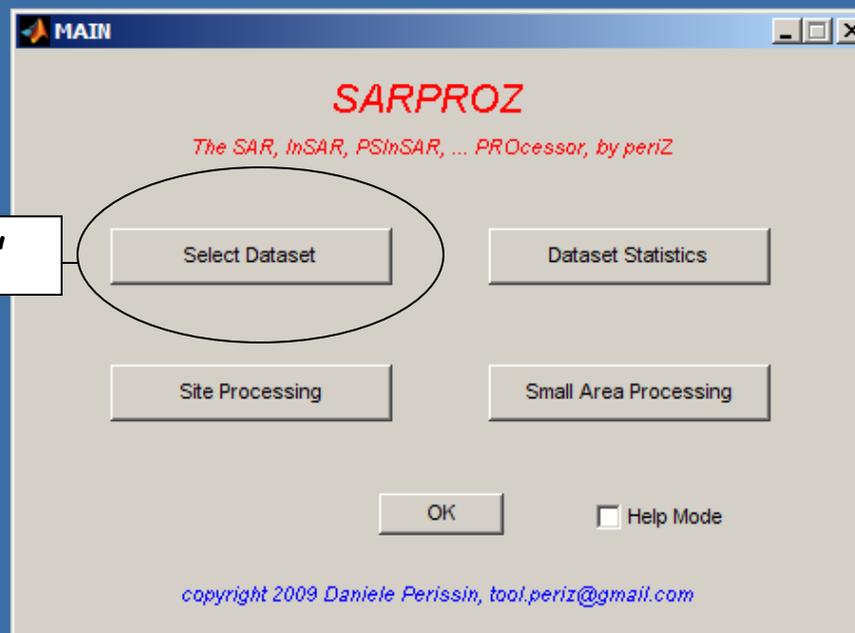
Help for "Dataset Statistics"



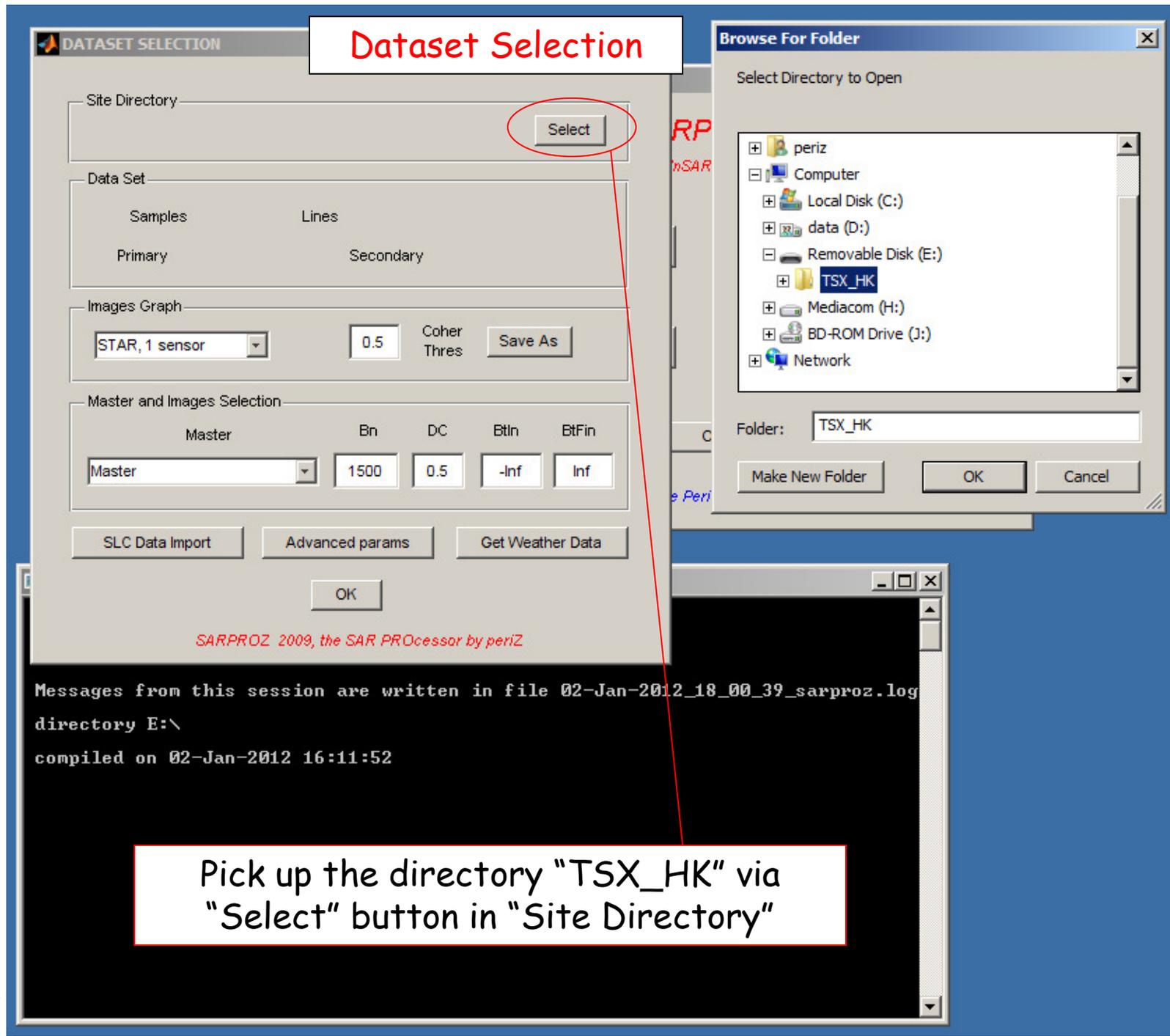
To get some Help messages, check "Help Mode" and press the button you want to receive help about

SARPROZ main window

Load data with "Select Dataset"



Keep the command prompt visible for messages



Dataset Selection

Pick up the directory "TSX_HK" via "Select" button in "Site Directory"

SLC data import

1. Uncheck "Untar" and "Del Tar" options
2. Press "Get Contents" button to get the directory contents
3. Press "Set Orbits" to read all the data in the directory
4. Press "View footprints" to see the footprints in Google Earth

Raw Data List

Get Contents

Untar

Del tar

Sensor: TerraSAR-X, Images Nr: 2

Data Selection

Single Image

All Update

Set Orbits

View Footprints

View Parameters

Master Selection

20110324

Area Selection

Latitude	Longitude	Radius [km]	Max Area
22.406	114.1382	20	<input type="checkbox"/>
Samples	Lines	OVS	
20930	22450	1	View
20930	Samp OVS		

Data Processing

Data Extraction

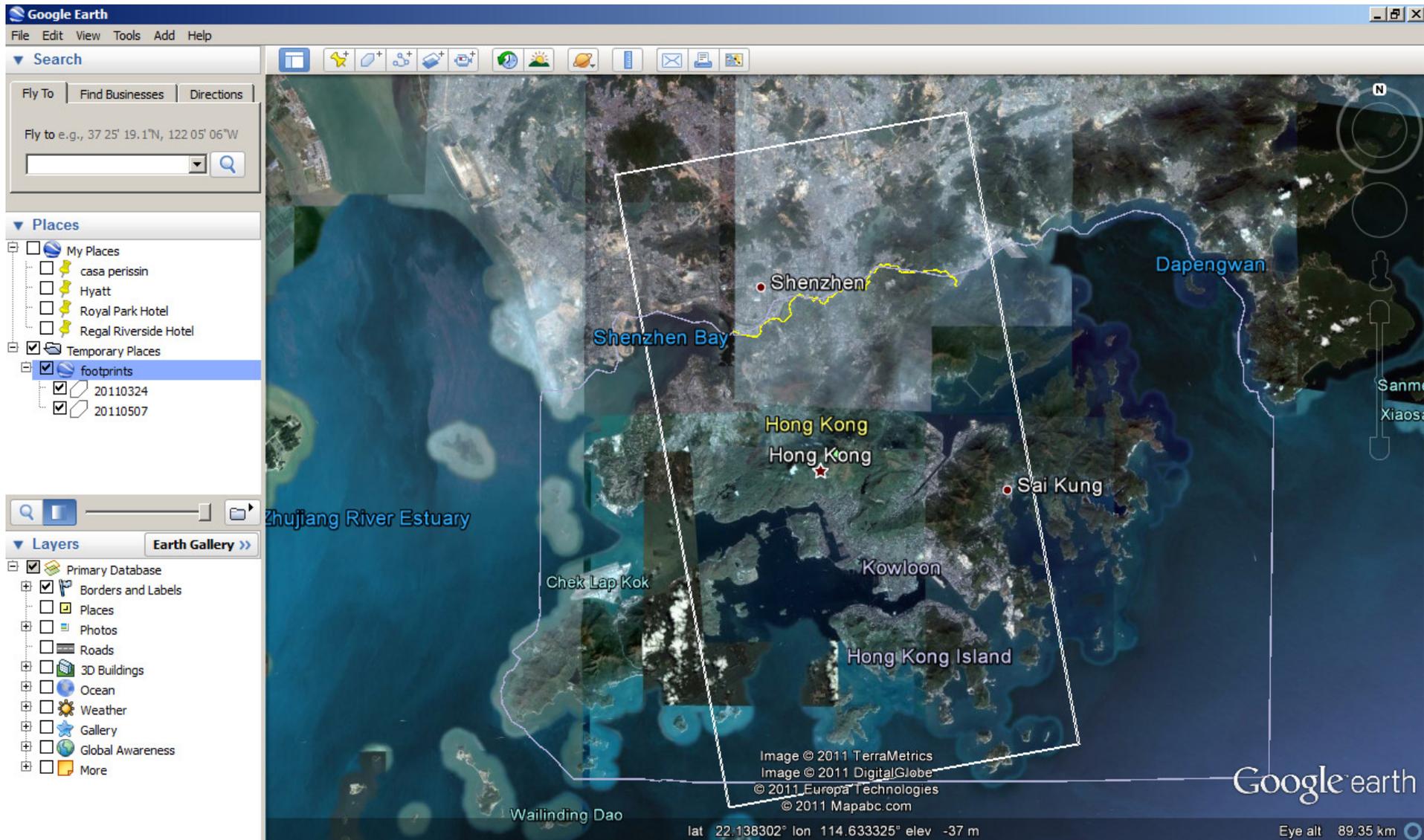
Co-registration

View Images

OK

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Footprints in Google Earth



Choose the Area to process

1. Set the area center (lat and lon in decimal degrees)
2. Set the area size (samples and lines in pixels)
3. Press the "View" button to see the area in GE

Raw Data List

Get Contents Untar Del tar Sensor: TerraSAR-X, Images Nr: 2

Data Selection

Single Image

All Update [Dropdown]

Set Orbits View Footprints View Parameters

Master Selection

20110324 [Dropdown]

Area Selection

Latitude	Longitude	Radius [km]	Max Area
22.4198	114.2039	20	<input type="checkbox"/>
Samples	Lines	OVS	
3000	3000	1	View
3000	Samp OVS		

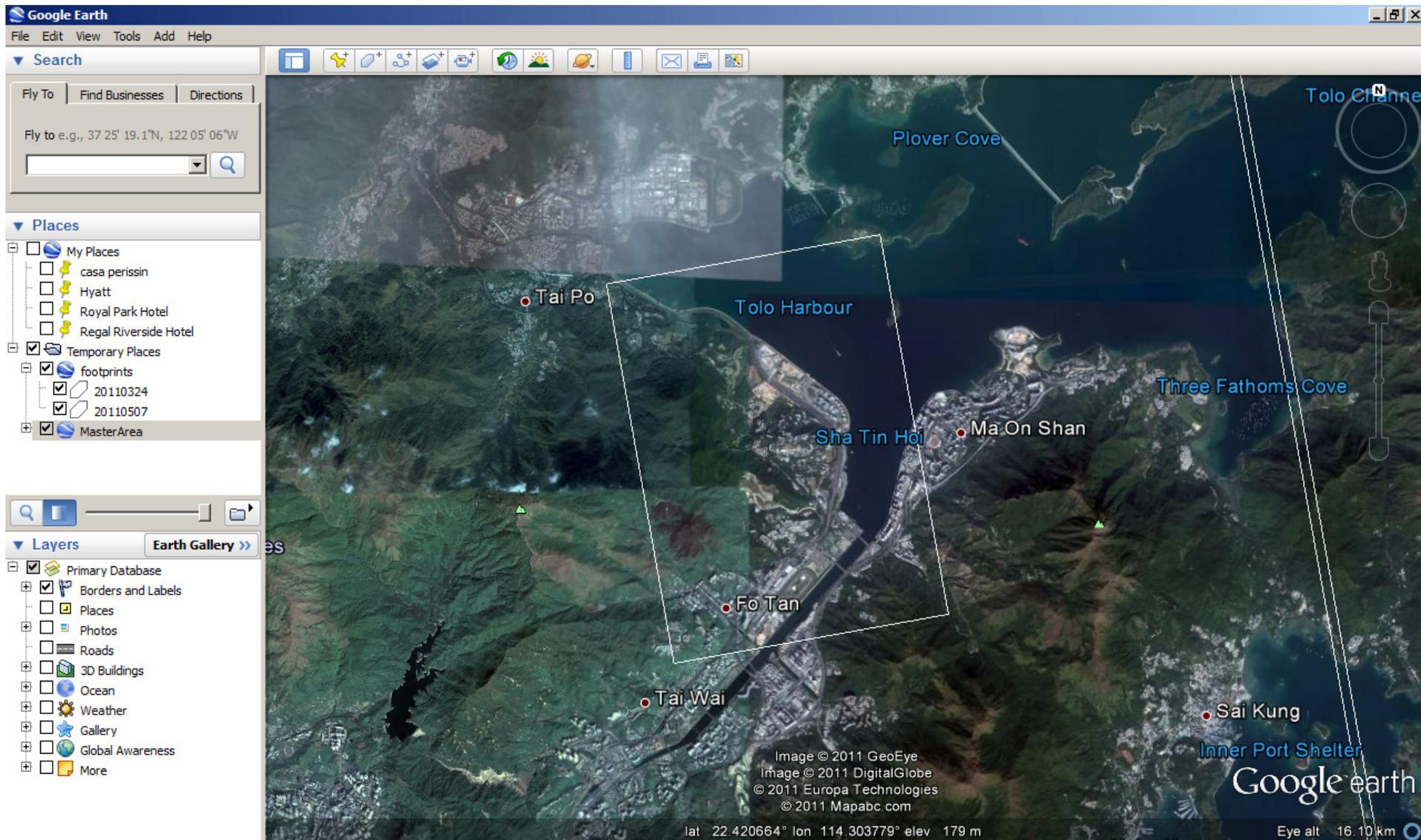
Data Processing

Data Extraction Co-registration View Images

OK

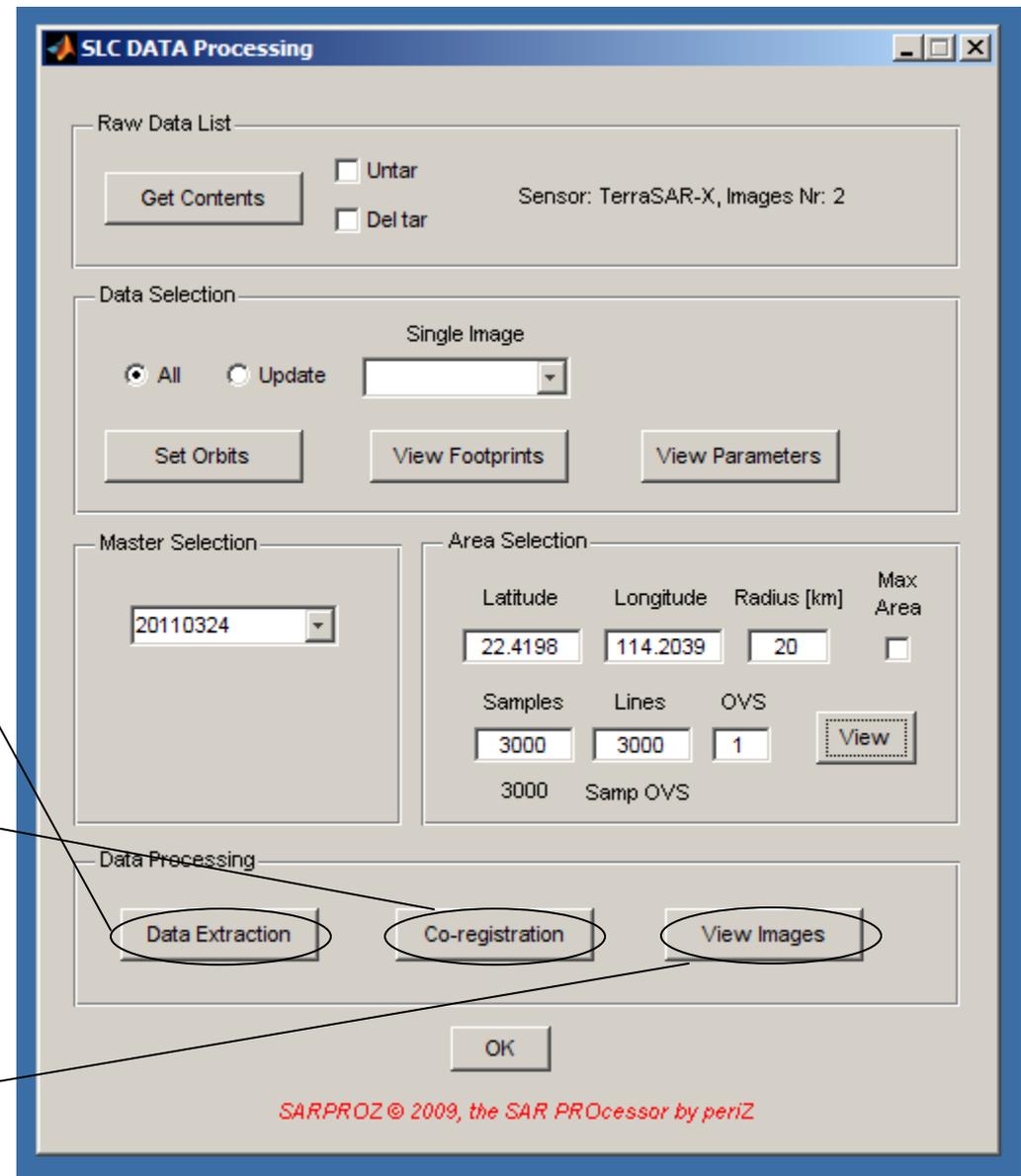
SARPROZ © 2009, the SAR PROCessor by perIZ

Selected Area



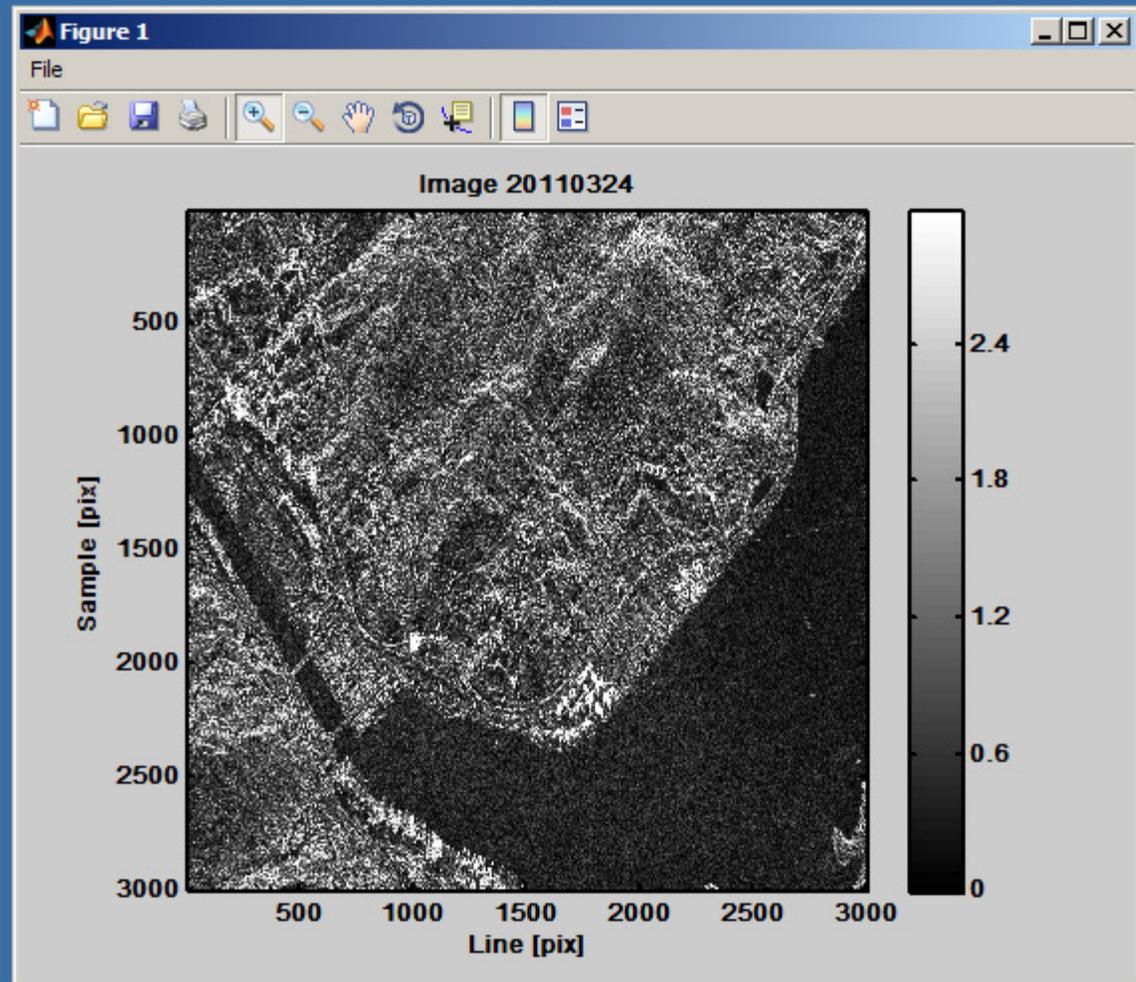
Extract and co-register the data

1. Press the "Data Extraction" button
2. When the previous step is successfully terminated, Press the "Co-registration" button
3. Check the result with "View Images"



Co-registered images visualization

Press "Go" to view the next image or "Stop" to exit



When ready, press "OK" in "SLC Data Processing" window to close it

3-7 September 2012

Dataset Selection

After data have been imported and co-registered, info like Samples, Lines, Sensor are displayed in "Dataset Selection"

Site Directory: E:\TSX_HK/

Data Set: Samples 3000 Lines 3000 Primary TanDEM-X Secondary

Images Graph: STAR, 1 sensor 0.5 Cohes Thres Save As

Master and Images Selection: Master 20110324 0 0 0 7 -9 Bn 1500 DC 0.5 BtIn -Inf BtFin Inf

Buttons: SLC Data Import, Advanced params, Get Weather Data, OK

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Use the button "Get Weather Data" to retrieve weather info from the web

Dataset Selection

When ready, press "OK"
to close the "Dataset
Selection" window

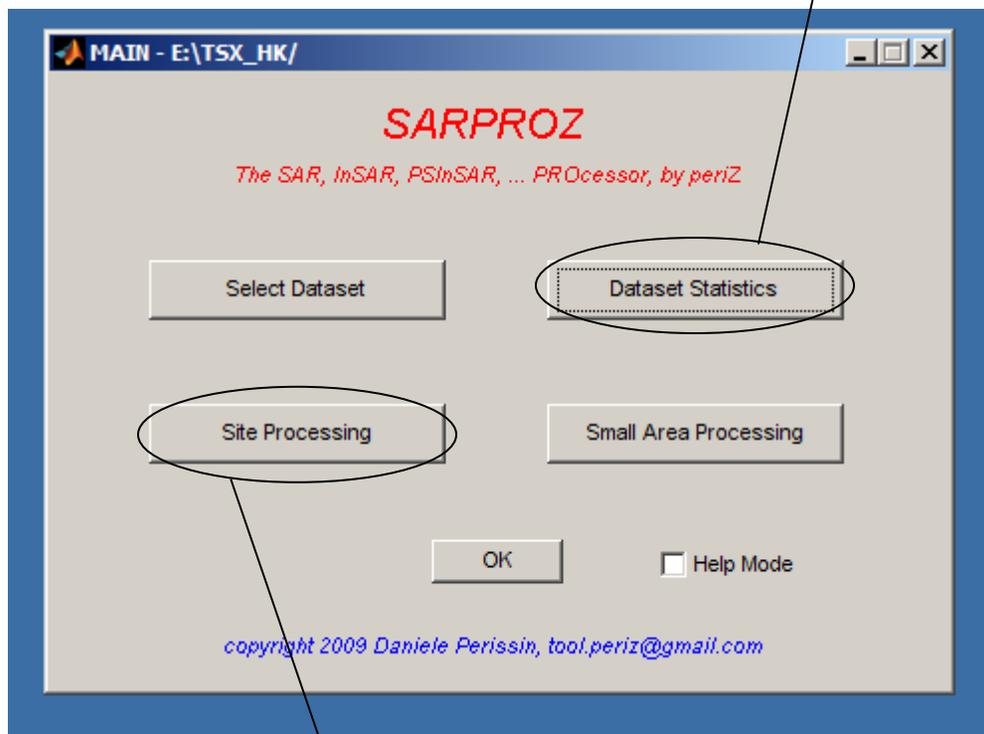
Completed operations and messages are
displayed in the command prompt

The image shows two windows side-by-side. The left window is titled "DATASET SELECTION - E:\TSX_HK/" and contains several sections: "Site Directory" with a text box containing "E:\TSX_HK/" and a "Select" button; "Data Set" with fields for "Samples" (3000), "Lines" (3000), "Primary" (TanDEM-X), and "Secondary"; "Images Graph" with a dropdown menu set to "STAR, 1 sensor", a "0.5" input field, and a "Cohor Thres" label with a "Save As" button; and "Master and Images Selection" with a "Master" dropdown set to "20110324 0 0 0 7 -9", a "Bn" input field set to "1500", a "DC" input field set to "0.5", and "BtIn" and "BtFin" buttons set to "-Inf" and "Inf" respectively. At the bottom of this window are buttons for "SLC Data Import", "Advanced params", "Get Weather Data", and "OK" (which is circled). A red line points from the "OK" button to the text box above. The right window is a command prompt titled "E:\main.exe" showing the following output:

```
directories of other sensors not found
get_temper: file E:\TSX_HK\RESULTS\MATLAB\WeatherData not found: aborting
one-sensor STAR graph
get_temper: file E:\TSX_HK\RESULTS\MATLAB\WeatherData not found: aborting
directories of other sensors not found
get_temper: file E:\TSX_HK\RESULTS\MATLAB\WeatherData not found: aborting
one-sensor STAR graph
Looking for METAR information near the location: <lat 22.4196 lon 114.2031>...
Task for date 20110324 finished...
Looking for METAR information near the location: <lat 22.4196 lon 114.2031>...
Task for date 20110507 finished...
Reading Locations...
Task Finished.
```

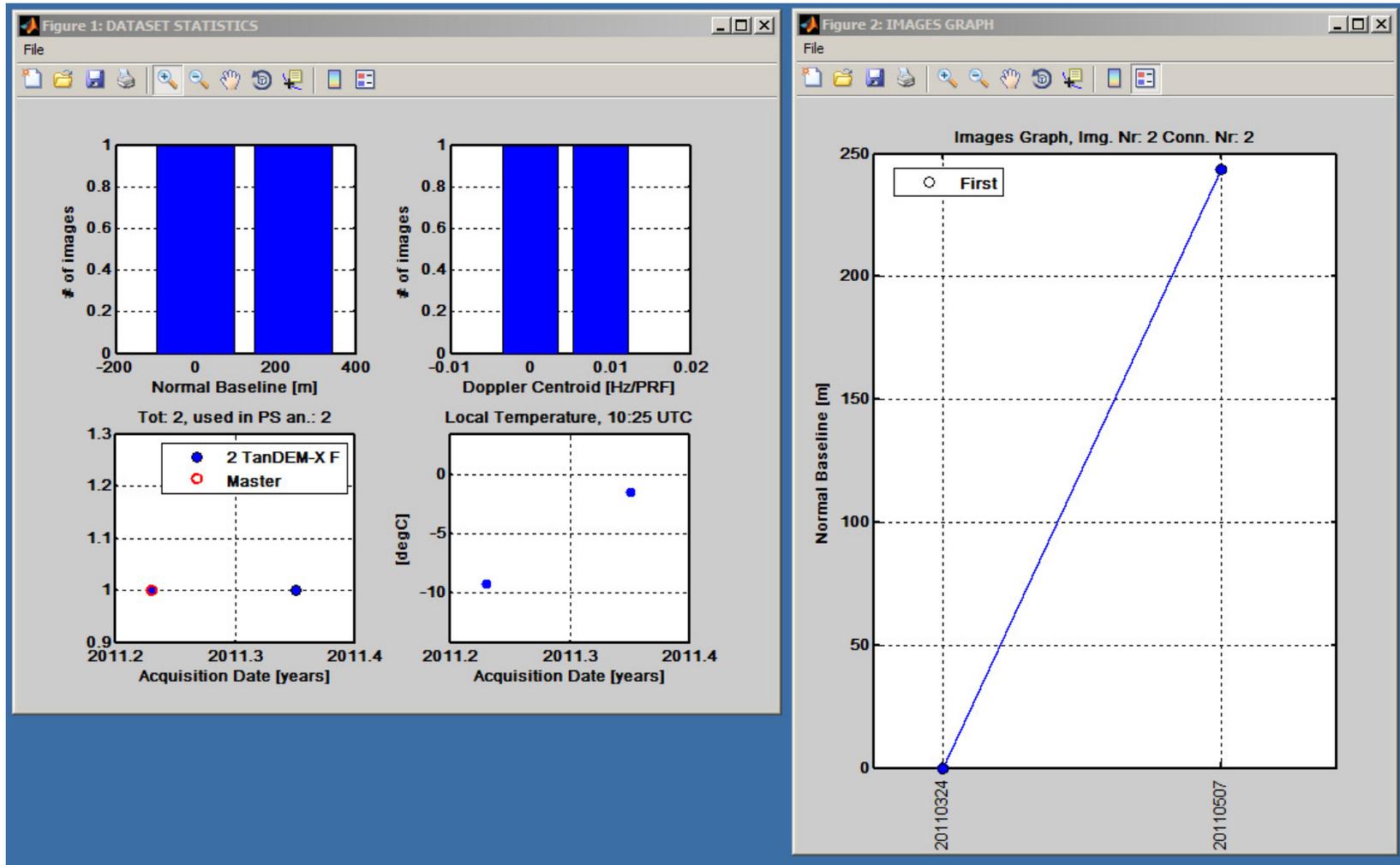
SARPROZ main window

Display the dataset parameters via button "Dataset Statistics"



Processing modules are accessed through "Site Processing"

Dataset Parameters



Generating the Reflectivity map

Site Processing

Press this button to generate the reflectivity map

SITE PROCESSING - E:\TSX_HK/

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**
- Geocoding through external DEM **Go**
- Geocoding through manual GCP selection **Go**
- External DEM and synthetic amplitude in SAR coordinates **Go**

Auxiliary analysis

- Change detection **Go**
- Image classification **Go**

InSAR processing

- Update new images only
- Phase to height constants generation **Go**
- Phase to flat constants generation **Go**
- MST estimation **Go**
- Residual fringes estimation and removal **Go**
- Second order fringes removal **Go**
- Interferograms processing **Go**
- Coherence map generation **Go**
- Synthetic coherence map generation **Go**
- Single interferogram processing **Go**

Sub-dataset extraction

- Selection and extraction **Go**

Sparse points selection

- Load mask **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 (googleearth kml) **Go**
- Sparse geocoding (kml-dbf) **Go**

Post-analysis

- Geographic coordinates estimation **Go**
- UTM coordinates estimation **Go**
- DEM post-analysis **Go**
- PS classification **Go**
- Multi-sensor analysis **Go**
- Tests **Go**

Visualization tools

- Histograms **Go**
- Scatter Plots **Go**
- View parameters **Go**
- View interferograms **Go**

SARPROZ 2009, the SAR PROCessor by periz NO security prompt **OK**

Security prompt

The tool asks for a confirm (to avoid possible mistakes)



```
E:\main.exe
directories of other sensors not found
get_temper: file E:\TSX_HK/RESULTS/MATLAB/WeatherData not found: aborting
one-sensor STAR graph
Looking for METAR information near the location: <lat 22.4196 lon 114.2031>...
Task for date 20110324 finished...
Looking for METAR information near the location: <lat 22.4196 lon 114.2031>...
Task for date 20110507 finished...
Reading Locations...
Task Finished.
directories of other sensors not found
one-sensor STAR graph
the tool is going to process the reflectivity map. is it ok to proceed (no is default) ?
```

Site Processing

When a task is completed, the corresponding button becomes green

The screenshot displays the SARPROZ software interface with the following sections and tasks:

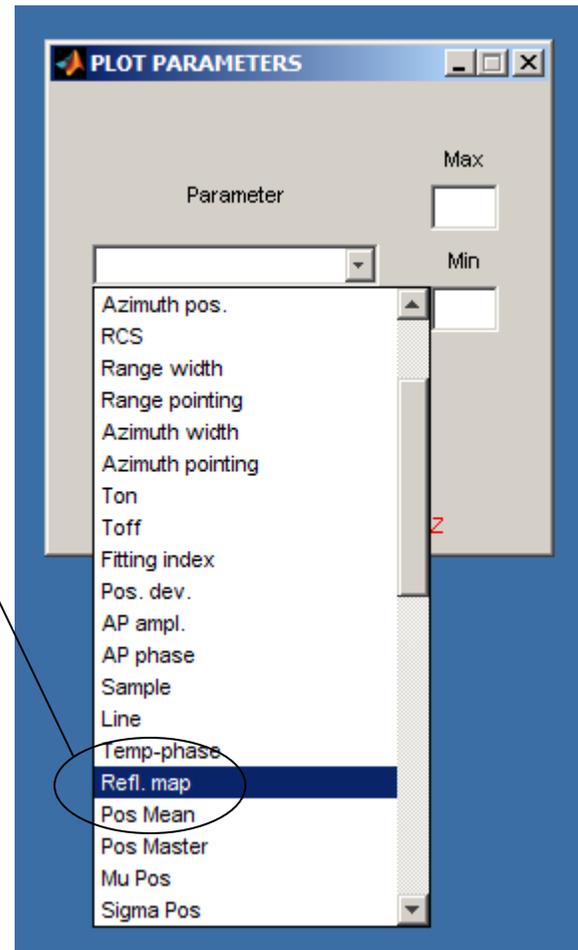
- Preliminary analysis:**
 - Reflectivity map and amplitude stability index: **Go** (green)
 - Mask for sparse points selection: **Go** (red)
- Preliminary geocoding:**
 - External DEM selection (Current: SRTM): **Go** (green)
 - DEM visualization: **Go** (grey)
 - Geocoding through external DEM: **Go** (red)
 - Geocoding through manual GCP selection: **Go** (red)
 - External DEM and synthetic amplitude in SAR coordinates: **Go** (grey)
- Auxiliary analysis:**
 - Change detection: **Go** (grey)
 - Image classification: **Go** (grey)
- InSAR processing:**
 - Update new images only
 - Phase to height constants generation: **Go** (red)
 - Phase to flat constants generation: **Go** (red)
 - MST estimation: **Go** (red)
 - Residual fringes estimation and removal: **Go** (grey)
 - Second order fringes removal: **Go** (grey)
 - Interferograms processing: **Go** (red)
 - Coherence map generation: **Go** (red)
- Single interferogram processing:** **Go** (grey)
- Sub-dataset extraction:**
 - Selection and extraction: **Go** (grey)
- Sparse points selection:**
 - Load mask: **Go** (grey)
- Amplitude processing:**
 - Images fine equalization: **Go** (grey)
 - Amplitude time series analysis: **Go** (grey)
 - Sub-pixel positions analysis: **Go** (grey)
 - Flat Cartesian coordinates estimation: **Go** (grey)
- Multi Image InSAR processing:**
 - APS estimation: **Go** (red)
- Results exporting:**
 - Extended geocoding (googleearth kml): **Go** (grey)
 - Sparse geocoding (kml-dbf): **Go** (grey)
- Post-analysis:**
 - Geographic coordinates estimation: **Go** (grey)
 - UTM coordinates estimation: **Go** (grey)
 - DEM post-analysis: **Go** (grey)
 - PS classification: **Go** (grey)
 - Multi-sensor analysis: **Go** (grey)
 - Tests: **Go** (grey)
- Visualization tools:**
 - Histograms: **Go** (grey)
 - Scatter Plots: **Go** (grey)
 - View parameters: **Go** (green)
 - View interferograms: **Go** (grey)

At the bottom of the interface, there is a footer with the text "SARPROZ 2009, the SAR PROCessor by periz", a checkbox for "NO security prompt", and an "OK" button.

To check the result, press "View Parameters" in "Visualization Tools"

View Parameters

Select "Reflectivity Map" from the menu



View Parameters

The image shows a software interface with two main windows. On the left is the 'PLOT PARAMETERS' dialog box. It has a 'Parameter' dropdown menu currently set to 'Refl. map'. To the right of this menu are two empty input fields labeled 'Max' and 'Min'. Below the dropdown is a 'Plot' button, which is circled in red. At the bottom of the dialog is an 'OK' button and a copyright notice: 'SARPROZ © 2009 the SAR PROCessor by periz'. On the right is a plot window titled 'Figure 1' with a toolbar. The plot itself is titled 'Amplitude incoherent Mean' and shows a grayscale image of a terrain. The y-axis is labeled 'Sample [pix]' and ranges from 500 to 3000. The x-axis is labeled 'Line [pix]' and ranges from 500 to 3000. A vertical color bar on the right of the plot indicates intensity values from 0 to 3.

Press the button "Plot"

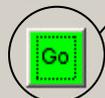
Site Processing

The screenshot shows the 'SITE PROCESSING' software interface with the following sections and buttons:

- Preliminary analysis:**
 - Reflectivity map and amplitude stability index: Go (green)
 - Mask for sparse points selection: Go (green, circled)
- Preliminary geocoding:**
 - External DEM selection (Current: SRTM): Go (green)
 - DEM visualization: Go (grey)
 - Geocoding through external DEM: Go (red)
 - Geocoding through manual GCP selection: Go (red)
 - External DEM and synthetic amplitude in SAR coordinates: Go (red)
- Auxiliary analysis:**
 - Change detection: Go (grey)
 - Image classification: Go (grey)
- constants generation:**
 - Phase to flat constants generation: Go (red)
 - MST estimation: Go (red)
 - Residual fringes estimation and removal: Go (grey)
 - Second order fringes removal: Go (grey)
 - Interferograms processing: Go (red)
 - Coherence map generation: Go (red)
 - Synthetic coherence map generation: Go (grey)
 - Single interferogram processing: Go (grey)
- Amplitude processing:**
 - Images fine equalization: Go (grey)
 - Amplitude time series analysis: Go (grey)
 - Sub-pixel positions analysis: Go (grey)
 - Flat Cartesian coordinates estimation: Go (grey)
- Multi Image InSAR processing:**
 - APS estimation: Go (red)
 - Sparse Points processing: Go (red)
- Results exporting:**
 - Extended geocoding (googleearth kml): Go (grey)
 - Sparse geocoding (kml-dbf): Go (grey)
- Sub-dataset extraction:**
 - Selection and extraction: Go (grey)
- Visualization tools:**
 - Histograms: Go (grey)
 - Scatter Plots: Go (grey)
 - View parameters: Go (grey)
 - View interferograms: Go (grey)
- Other buttons:** UTM coordinates estimation (Go), DEM post-analysis (Go), PS classification (Go), Multi-sensor analysis (Go), Tests (Go).

At the bottom, there is a checkbox labeled 'NO security prompt' which is checked, and an 'OK' button.

Press this button to generate the mask for sparse points selection



Check this box to avoid security prompt

The external DEM

Site Processing

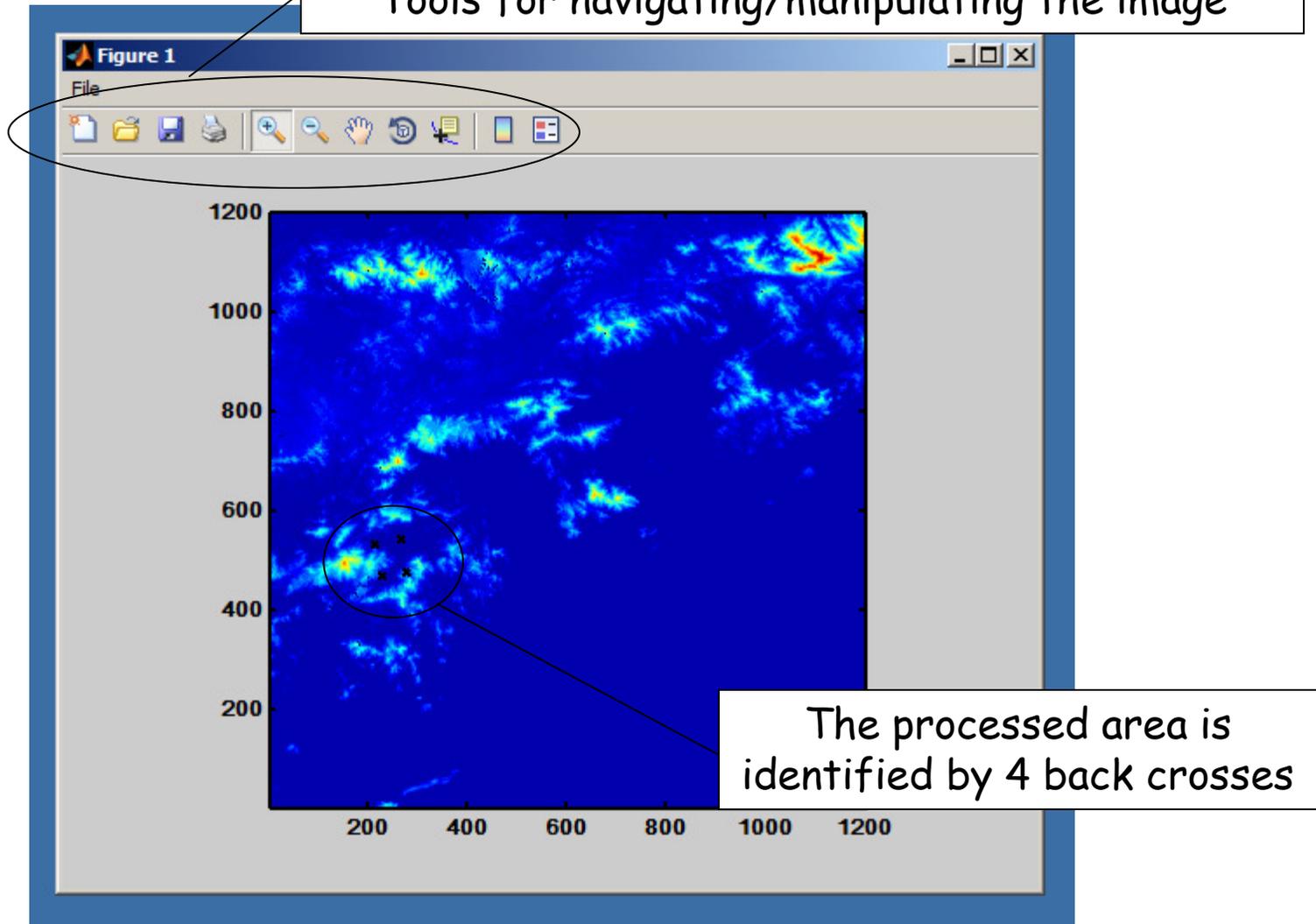
The screenshot displays the SARPROZ software interface for site processing. The window title is "SITE PROCESSING - E:\TSX_HK/". The interface is organized into several panels, each containing a list of processing steps and "Go" buttons. The "Preliminary analysis" panel includes "Reflectivity map and amplitude stability index" and "Mask for sparse points selection". The "Preliminary geocoding" panel includes "External DEM selection" (Current: SRTM), "DEM visualization", "Geocoding through external DEM", "Geocoding through manual GCP selection", and "External DEM and synthetic amplitude in SAR coordinates". The "Auxiliary analysis" panel includes "Change detection" and "Image classification". The "InSAR processing" panel includes "Update new images only", "Phase to height constants generation", "MST estimation", "Residual fringes estimation and", "Second order fringes removal", "Interferograms processing", "Coherence map generation", "Synthetic coherence map generation", "Single interferogram processing", and "Sub-dataset extraction". The "Sparse points selection" panel includes "Load mask". The "Multi Image InSAR processing" panel includes "APS estimation" and "Sparse Points processing". The "Results exporting" panel includes "Extended geocoding (googleearth kml)" and "Sparse geocoding (kml-dbf)". The "Post-analysis" panel includes "Geographic coordinates estimation", "M coordinates estimation", "M post-analysis", "PS classification", "Multi-sensor analysis", and "Tests". The "Visualization tools" panel includes "Histograms", "Scatter Plots", "View parameters", and "View interferograms". At the bottom, there is a copyright notice "SARPROZ 2009, the SAR PROcessor by periz", a checked checkbox for "NO security prompt", and an "OK" button.

SRTM DEM is the default option, and automatically downloaded

Press this button to visualize the DEM

DEM visualization

Tools for navigating/manipulating the image



Site Processing

The screenshot displays the SARPROZ software interface, titled "SITE PROCESSING - E:\TSX_HK/". The interface is organized into several functional panels, each containing a list of processing tasks and a "Go" button to execute them. The panels are:

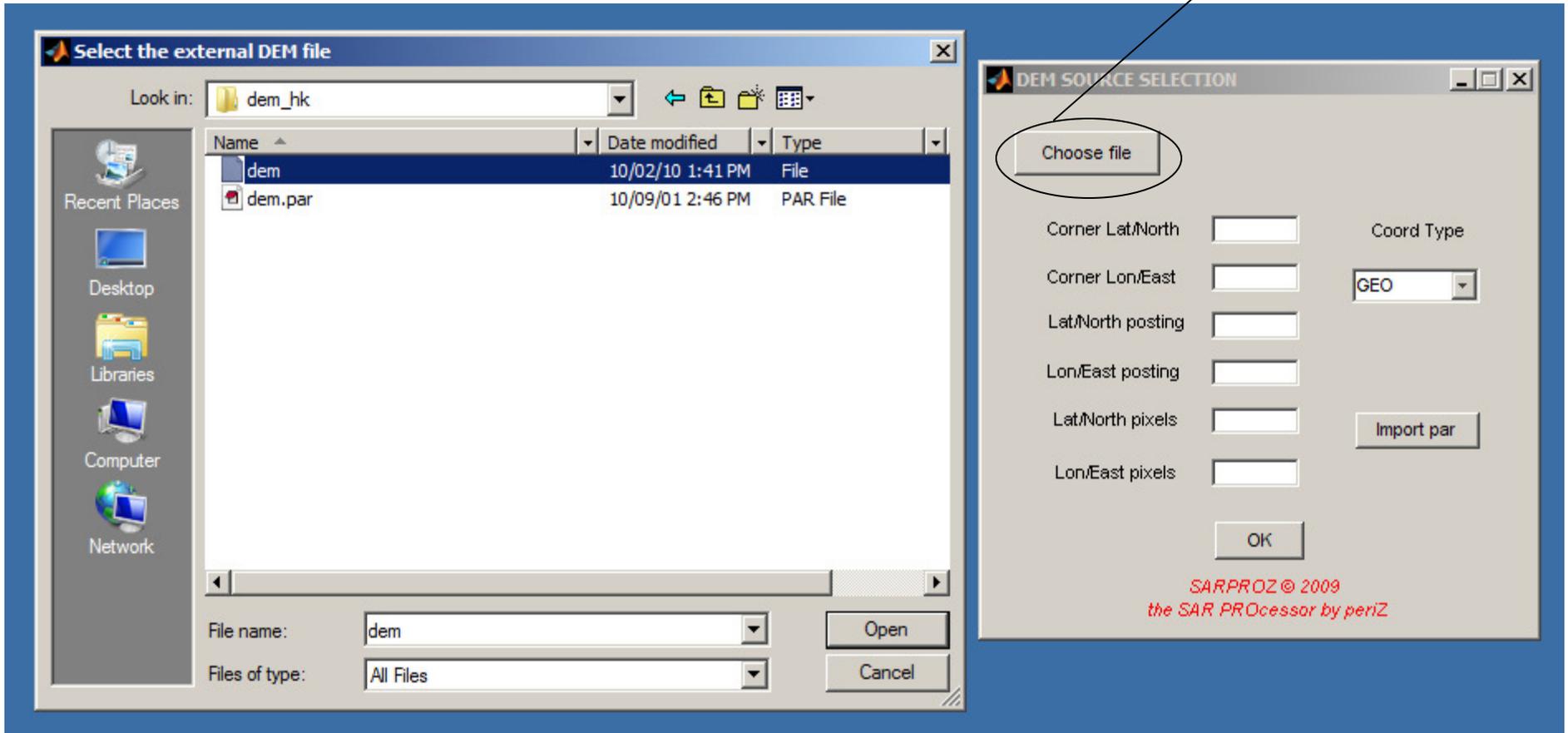
- Preliminary analysis:** Reflectivity map and amplitude stability index (Go), Mask for sparse points selection (Go).
- Preliminary geocoding:** External DEM selection (Current: SRTM) (Go), DEM visualization (Go), Geocoding through external DEM (Go), Geocoding through manual GCP selection (Go), External DEM and synthetic amplitude in SAR coordinates (Go).
- Auxiliary analysis:** Change detection (Go), Image classification (Go).
- InSAR processing:** Update new images only, Phase to height constants generation (Go), Phase to constants generation (Go), MST estimation (Go), Residual fringes estimation and removal (Go), Second order fringes removal (Go), Interferograms processing (Go), Coherence map generation (Go), Synthetic coherence map generation (Go), Single interferogram processing (Go).
- Sub-dataset extraction:** Selection and extraction (Go).
- Sparse points selection:** Load mask (Go).
- Amplitude processing:** 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 (googleearth kml) (Go), Sparse geocoding (kml-dbf) (Go).
- Post-analysis:** Geographic coordinates estimation (Go), PS classification (Go), Multi-sensor analysis (Go), Tests (Go).
- Visualization tools:** Histograms (Go), Scatter Plots (Go), View parameters (Go), View interferograms (Go).

A callout box with a white background and black border points to the "External DEM selection" button. The text inside the callout box reads: "Use this button to select an other DEM source".

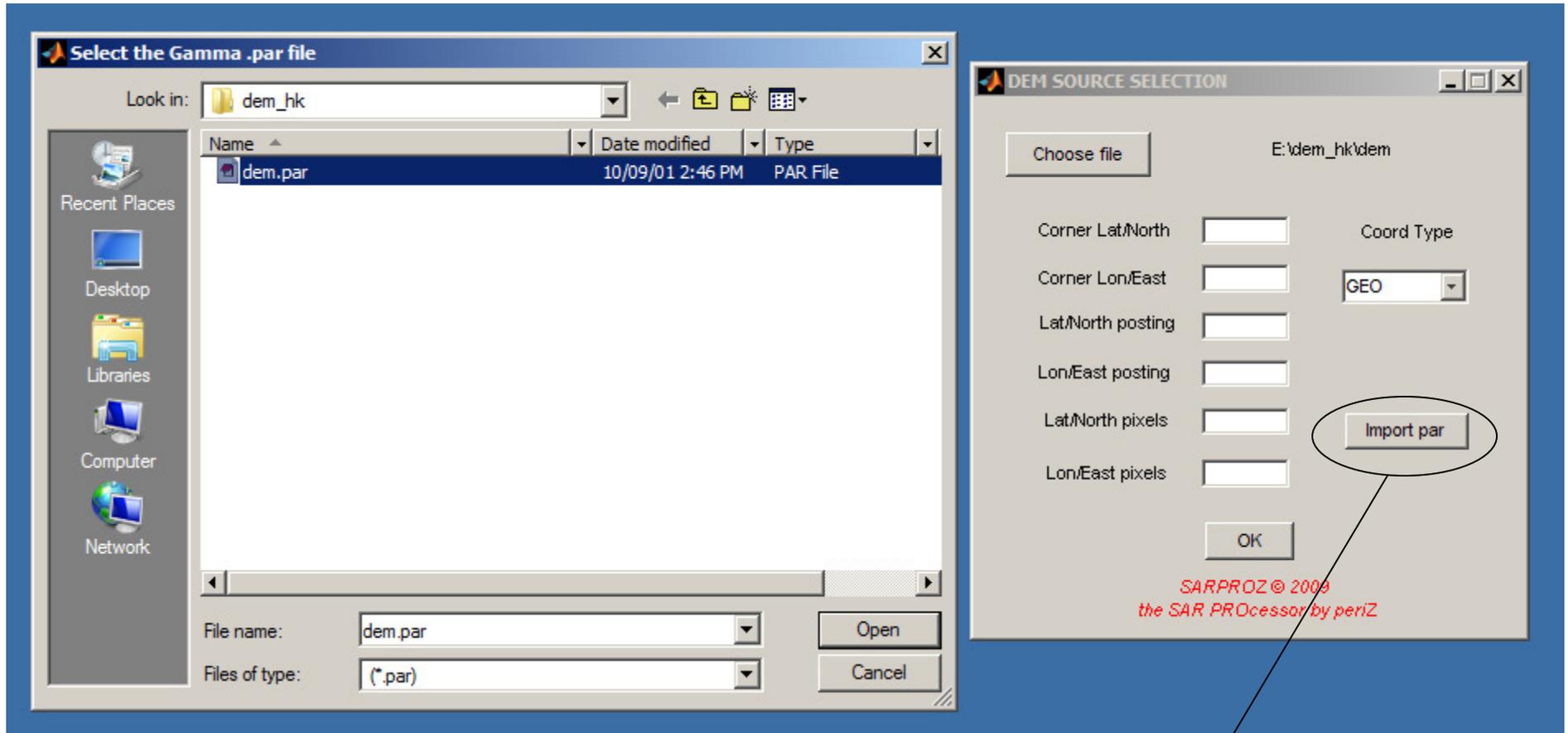
At the bottom of the interface, there is a footer area containing the text "SARPROZ 2009, the SAR PROcessor by periz", a checked checkbox for "NO security prompt", and an "OK" button.

External DEM selection

Select a file containing the DEM data



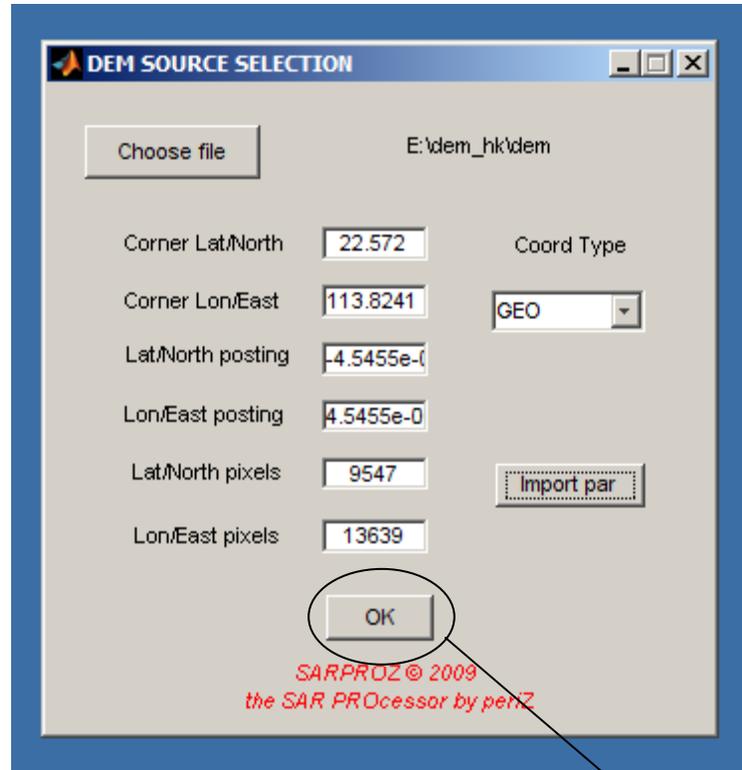
External DEM selection



Import a parameter file for reading the DEM data

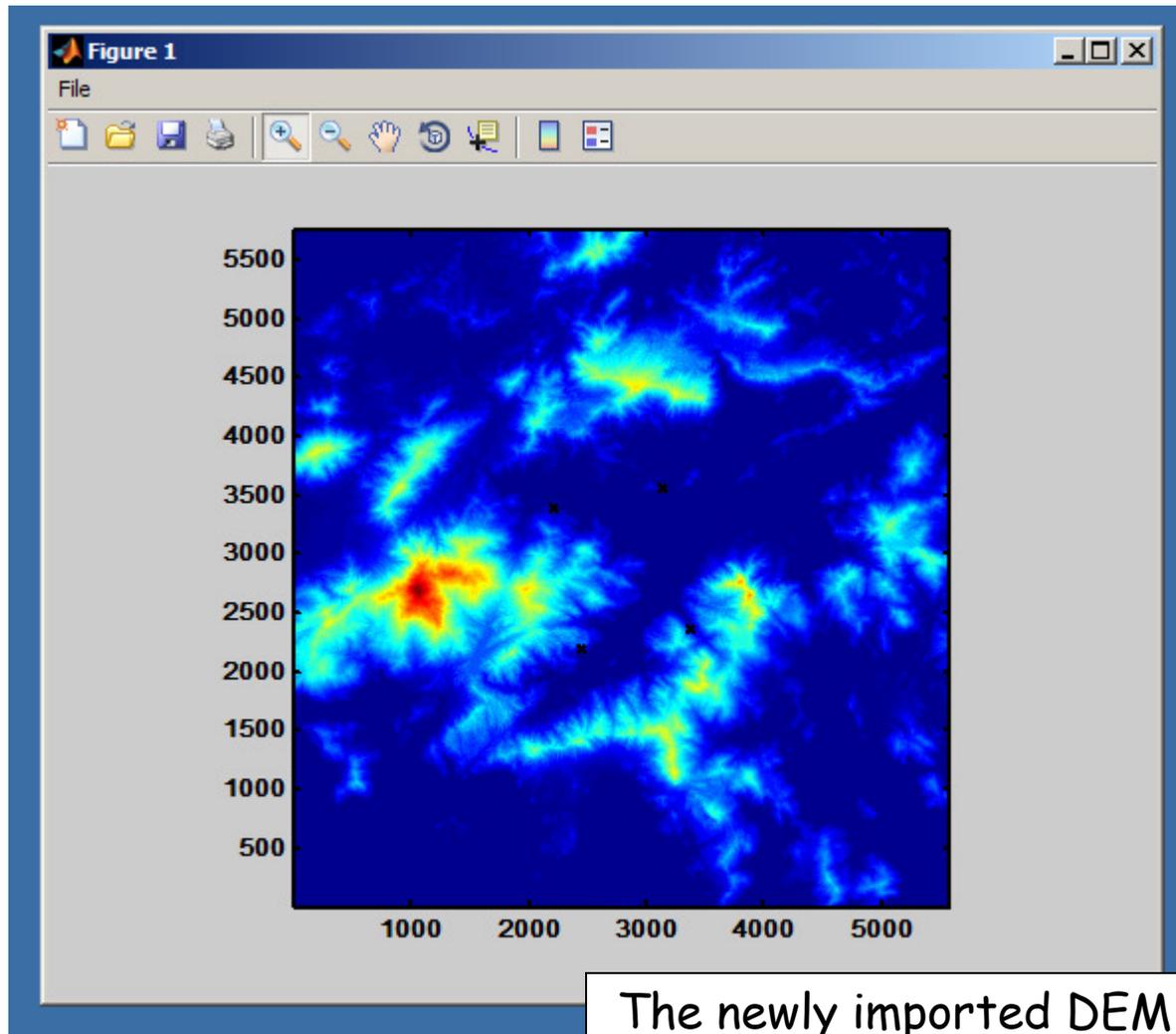
External DEM selection

Alternatively, fill in manually the DEM parameters



When completed, press the "OK" button

DEM visualization



The newly imported DEM has a better resolution than SRTM

Preliminary geocoding

Site Processing

The screenshot displays the SARPROZ software interface with the following sections and options:

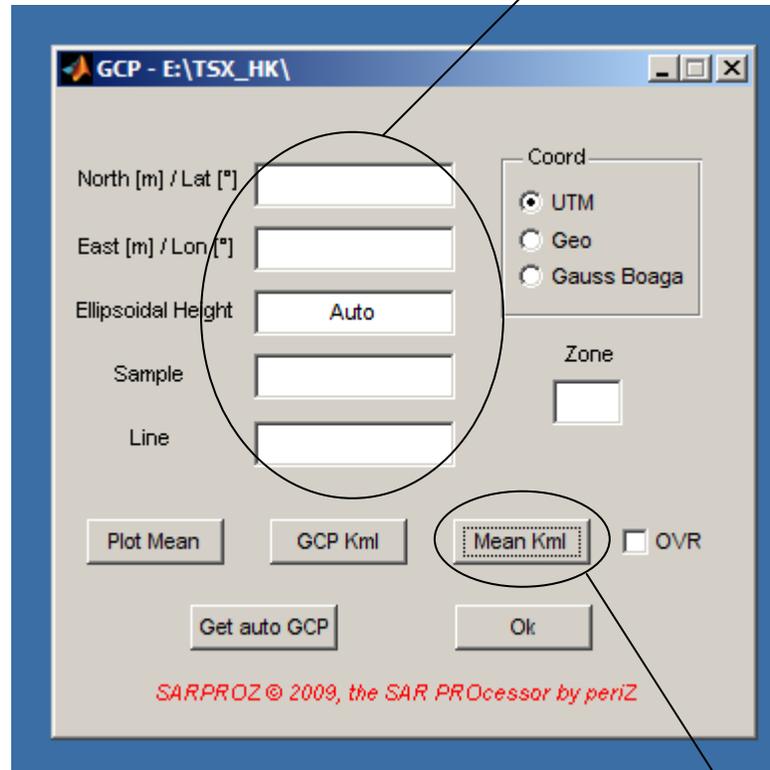
- Preliminary analysis:** Reflectivity map and amplitude stability index (Go), Mask for sparse points selection (Go).
- Preliminary geocoding:** External DEM selection (Current: SRTM, Go), DEM visualization (Go), Geocoding through external DEM (Go), Geocoding through manual GCP selection (Go), External DEM and synthetic amplitude in SAR coordinates (Go).
- Auxiliary analysis:** Change detection (Go), Image classification (Go).
- InSAR processing:** Update new images only, Phase to height constants generation (Go), Phase to flat constants generation (Go), MST estimation (Go), Residual fringes estimation and removal (Go), Second order fringes removal (Go), Interferogram processing (Go), Coherence map generation (Go), Synthetic coherence map generation (Go), Single interferogram processing (Go), Sub-dataset extraction: Selection and extraction (Go).
- Sparse points selection:** Load mask (Go).
- Amplitude processing:** Images fine equalization (Go), Amplitude time series analysis (Go), Sub-pixel positions analysis (Go).
- Multi Image InSAR processing:** APS estimation (Go), Sparse Points processing (Go).
- Results exporting:** Extended geocoding (googleearth kml) (Go), Sparse geocoding (kml-dbf) (Go).
- Post-analysis:** Geographic coordinates estimation (Go), UTM coordinates estimation (Go), DEM post-analysis (Go), PS classification (Go), Multi-sensor (Go).
- Visualization tools:** Histograms (Go), Scatter Plots (Go), View parameters (Go), View interferograms (Go).

A callout box points to the 'Go' button for 'Geocoding through manual GCP selection' with the text: "Click this button to have a first evaluation of the quality of geocoding".

SARPROZ 2009, the SAR PROCessor by periz NO security prompt

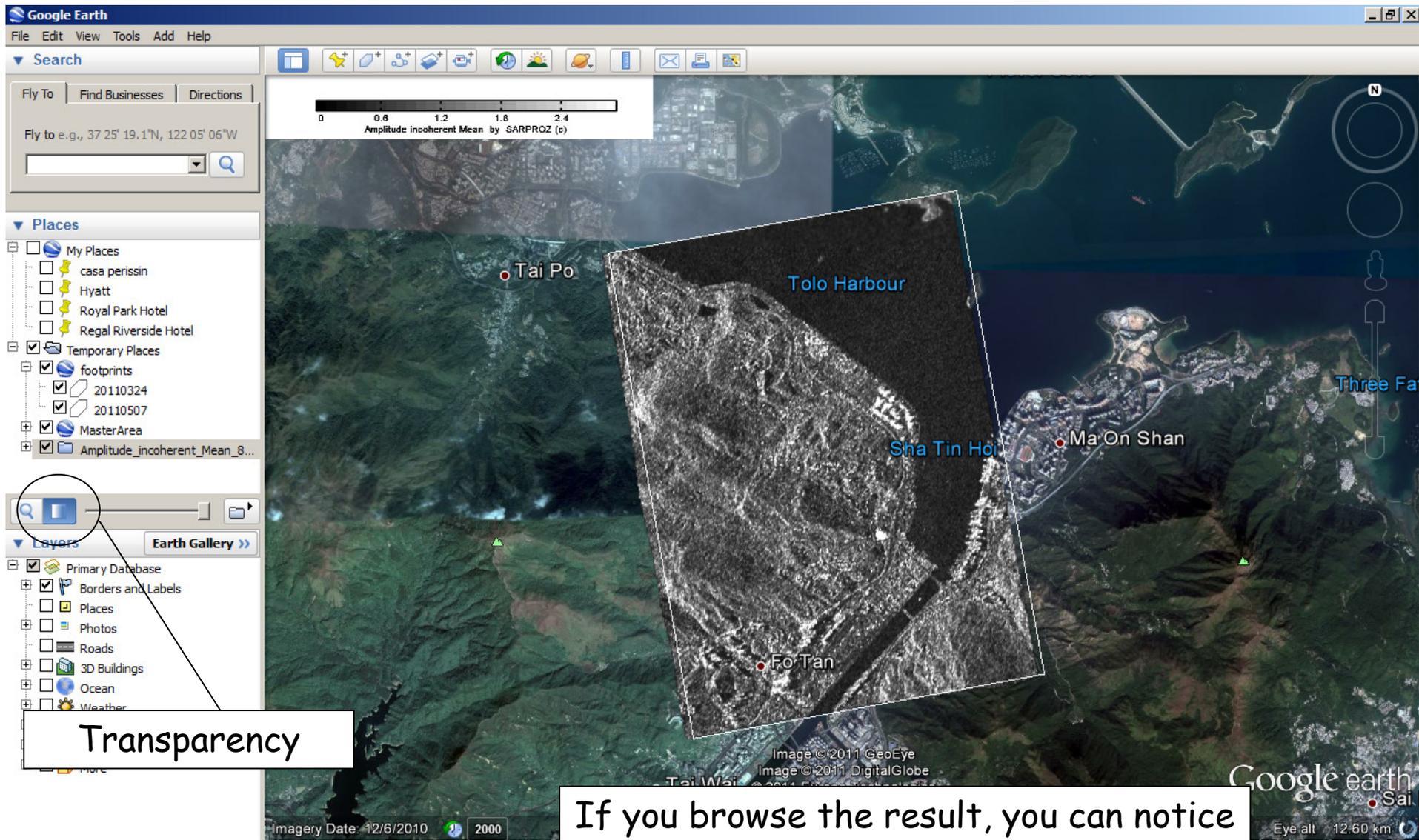
Geocoding through a GCP

No GCP has been inserted yet



Use this button to display the Reflectivity map in Google Earth

The Reflectivity Map in GE



Transparency

If you browse the result, you can notice a low quality geocoding

Site Processing

The screenshot displays the SARPROZ software interface with the following sections and options:

- Preliminary analysis:** Reflectivity map and amplitude stability index (Go), Mask for sparse points selection (Go).
- Preliminary geocoding:** External DEM selection (Go), Current: User defined (Go), DEM visualization (Go), Geocoding through external DEM (Go), Geocoding through manual GCP selection (Go), External DEM and synthetic amplitude in SAR coordinates (Go).
- Auxiliary analysis:** Change detection (Go), Image classification (Go).
- InSAR processing:** Update new images only (checkbox), Phase to height constants generation (Go), Phase to flat constants generation (Go), MST estimation (Go), Residual fringes estimation and removal (Go), Second order fringes removal (Go), Interferograms processing (Go), Coherence map generation (Go), Synthetic coherence map generation (Go), Single interferogram processing (Go), Sub-dataset extraction: Selection and extraction (Go).
- Sparse points selection:** Load mask (Go).
- Amplitude processing:** Images fine equalization (Go), Amplitude time (Go).
- Results exporting:** Extended geocoding (googleearth kml) (Go), Sparse geocoding (kml-dbf) (Go).
- Post-analysis:** Geographic coordinates estimation (Go), UTM coordinates estimation (Go), DEM post-analysis (Go), Tests (Go), Scatter Plots (Go), View parameters (Go), View interferograms (Go).
- Buttons:** Sparse Points processing (Go), Sparse geocoding (kml-dbf) (Go).

Callout 1: Use this button to geocode by means of the external DEM (points to the 'Go' button for 'Geocoding through external DEM').

Callout 2: When the processing is concluded, click again the manual GCP selection (points to the 'Go' button for 'Geocoding through manual GCP selection').

Footer: SARPROZ 2009, the SAR PROCessor by periz. NO security prompt. OK

Geocoding through a GCP

After the automatic geocoding, a GCP is shown here

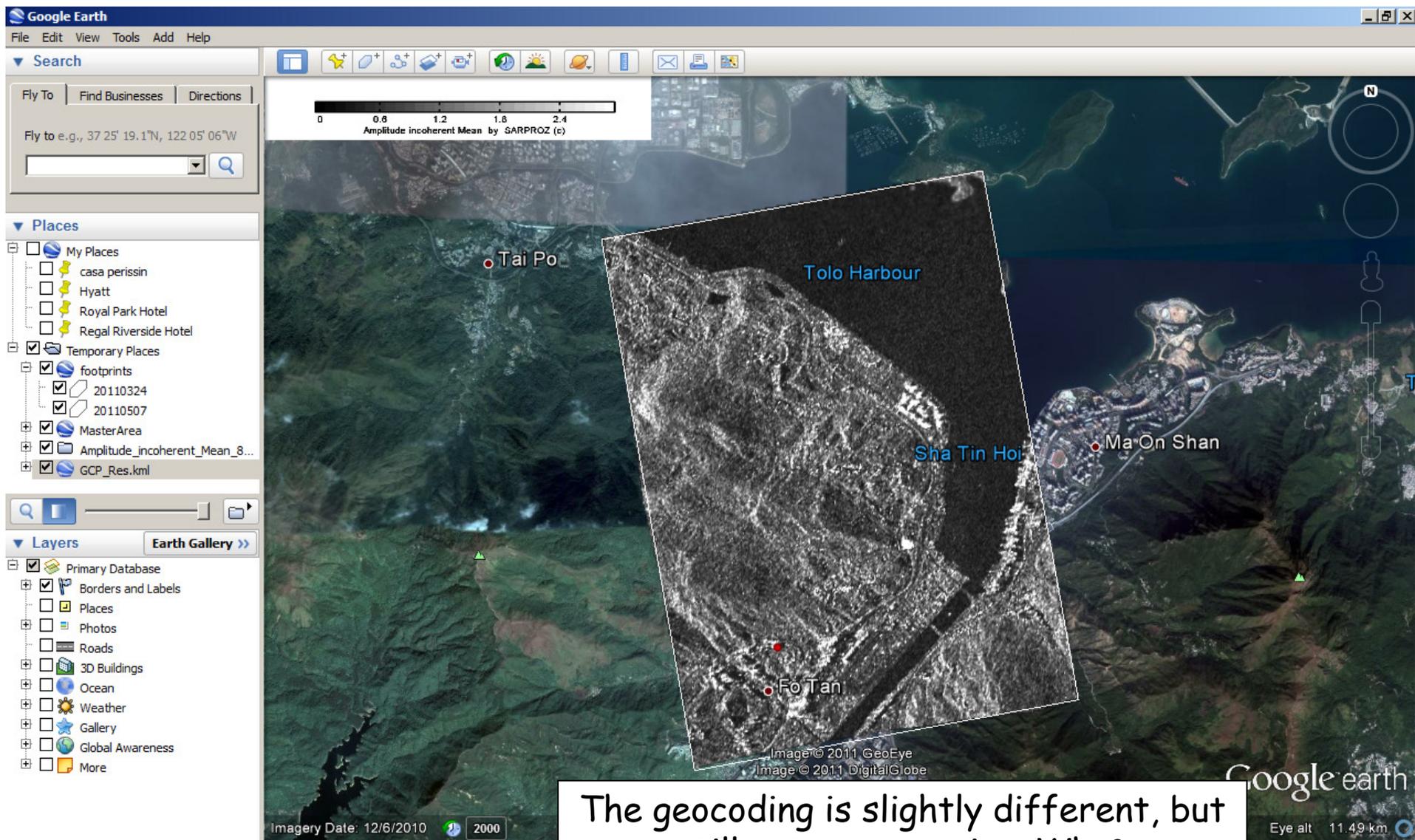
The screenshot shows a dialog box titled "GCP - E:\TSX_HK\" with the following fields and controls:

- North [m] / Lat [°]: 2479957.0339
- East [m] / Lon [°]: 211408.4668
- Ellipsoidal Height: 78
- Sample: 779
- Line: 571
- Coord: UTM, Geo, Gauss Boaga
- Zone: 50
- Buttons: Plot Mean, GCP Kml, Mean Kml, Get auto GCP, Ok
- Checkbox: OVR

Red text at the bottom: SARPROZ © 2009, the SAR PROcessor by periz

We can display again the reflectivity map in GE, but we need to check "OVR" to overwrite the previous result

The Reflectivity Map in GE



The geocoding is slightly different, but still not very precise. Why?

Site Processing

The screenshot displays the SARPROZ software interface with the following sections and buttons:

- Preliminary analysis:** Reflectivity map and amplitude stability index (Go), Mask for sparse points selection (Go).
- Preliminary geocoding:** External DEM selection (Go), Current: User defined (Go), DEM visualization (Go), Geocoding through external DEM (Go), Geocoding through manual GCP selection (Go), External DEM and synthetic amplitude in SAR coordinates (Go).
- Auxiliary analysis:** Change detection (Go), Image classification (Go).
- InSAR processing:** Update new images only (checkbox), Phase to height constants generation (Go), Phase to flat constants generation (Go), MST estimation (Go), Residual fringes estimation and removal (Go), Second order fringes removal (Go), Interferogram processing (Go), Coherence map generation (Go), Synthetic coherence map generation (Go), Single interferogram processing (Go), Sub-dataset extraction (Go), Selection and (Go).
- Sparse points selection:** Load mask (Go).
- Amplitude processing:** Images fine equalization (Go), Amplitude time series analysis (Go), Sub-pixel positions analysis (Go), Flat Cartesian coordinates estimation (Go).
- Results exporting:** Extended geocoding (googleearth kml) (Go), Sparse geocoding (Go).
- Post-analysis:** Geographic coordinates estimation (Go), UTM coordinates estimation (Go), DEM post-analysis (Go), PS classification (Go), Multi-sensor analysis (Go), Tests (Go).
- Histograms:** Histograms (Go), Scatter Plots (Go).
- View parameters:** View parameters (Go), View interferograms (Go).

Annotations:

- A callout box points to the "Go" button for "External DEM and synthetic amplitude in SAR coordinates" with the text: "We need to project the DEM data into the SAR coordinates".
- Another callout box points to the "Go" button for "View parameters" with the text: "When the processing is completed we can check the results with 'View Parameters'".