

Introduction

This tutorial will guide you through a complete modeling session to become familiar with the main module functionalities. The tutorial starts with the subsampling of a displacement map associated with an M_w 6.6 earthquake that occurred near the city of Bam (Iran) on December 26th, 2003. After importing the geodetic data, the coseismic displacement is modeled via Non-Linear and Linear inversions, to retrieve the geometric parameters of the fault and its related slip distribution. The latter is then used to calculate the change in stress generated by the earthquake on the fault itself; finally, the retrieved model is used in a direct (forward) modeling to generate the raster map of the modeled (predicted) displacement, projected onto the SAR Line-Of-Sight.

Though this tutorial covers the main modeling features, it cannot be considered exhaustive of all the software potentialities. In most cases, only one of the possible processing configurations is presented: we strongly suggest the user to refer to the Help manual for a complete description of all the available options. At the beginning of every paragraph, the keyword to retrieve a topic from the help index is reported.

Since the characterization of a geophysical source is generally non-unique, different solutions can lead to comparable results, equally able to reproduce the observed data. Only experience and the combined analysis of all the available data (e.g. geodetic, geological, seismological) can help to find the most realistic solution.

Tips and notes are also provided to improve the modeling strategy and discover further functionalities.

The Bam event data

This tutorial is based on the displacement map generated with a pair of SAR images acquired by the Envisat satellite from the European Space Agency. This map has been obtained with an interferometric processing carried out with the SARscape interferometric module; the images have been acquired on December 3rd, 2003 and February 11th, 2004 and have a spatial baseline of about 4 m. In this tutorial the displacement is modeled with a single fault with distributed slip.

Refer to the cited literature (Wang et al., 2004; Funning et al, 2005) for a review of the event.

REFER TO YOUR LOCAL DISTRIBUTOR TO GET THE DATA FOR THIS TUTORIAL.

To run the tutorial, you need the following files:

- **Bam_envisat_dsc_disp**: displacement map (m) obtained from a descending Envisat image pair;
- **Bam_envisat_dsc_ALOS**: map of the Line-Of-Sight azimuth angle (deg);
- **Bam_envisat_dsc_ILOS**: map of the Line-Of-Sight incident angle (deg);
- **Bam_SRTM_dem**: SRTM digital elevation model with 90 m resolution;
- **Bam_project_backup.xml**: XML Project File (see next paragraph);
- **Subsampling_areas.shp**: shapefile containing the areas to sample the displacement map.

All the images are in a UTM-WGS84, Zone 40 North, projection.

The XML Project File

Help Index: "XML_Modeling_Project_file"

In the main modeling panel, an XML Project File must be set (see the related page in the help). This file allows to save the input configuration of any processing for a quick restore in any moment. Most of the processing outputs are stored in the XML Project File as well, thus allowing also an efficient project portability.

In the tutorial, an XML Project File created from scratch and named **Bam_project.xml** will be used. Together with the input data, we also provide a project with all the sections already present (the **Bam_project_backup.xml** file). This permits the user to avoid the setting of parameters, which can be directly restored into the panels; however, we suggest the use of a new project file in order to get confident with them.

Image subsampling

Menu: "SARscape"-> "Interferometry"->"Displacement Modeling"->"Tools"->"Image Subsampling"

Help Index: Image subsampling, InSAR_dataset

Image subsampling can be carried out with two different approaches: over areas with equally spaced points or with the Quadtree algorithm. In this tutorial we use the first approach, which needs the definition of the areas to sample and, for every area, the distance between points.

We define the sampling areas through the **Subsampling_areas.shp** file, where two zones are defined, respectively with a 500 m sample spacing close to the fault and 2000 m one far from it (Fig. 1). This file is provided together with the input data.

Tip You can define your own subsampling areas, creating a new shapefile and setting the resolution values in the ".dbf" file. See the "Image_subsampling" help page to know the rules to create a new shapefile for subsampling.

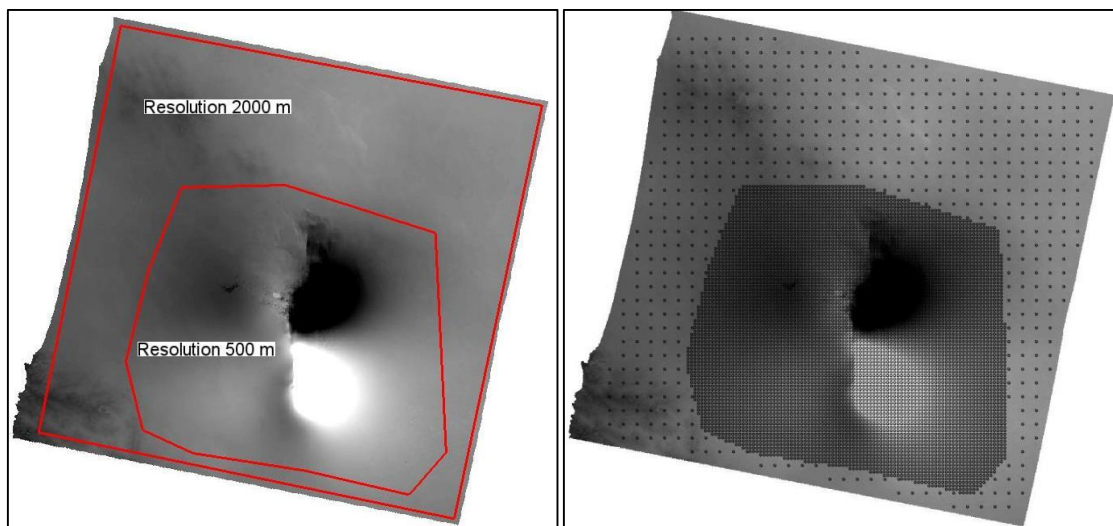


Figure 1. Sampling areas (left) and resulting points (right)

Once the file with the areas to sample has been defined, the subsampling can be carried out:

1. Open the "Image Subsampling" panel;
2. Set the following files:
 - "Subsampling Image": **Bam_envisat_dsc_disp**;
 - "Azimuth LOS image": **Bam_envisat_dsc_ALOS**;
 - "Incidence LOS image": **Bam_envisat_dsc_ILOS**;

- "DEM": Bam_SRTM_dem;
3. Set the "Select subsampling method" to "Mesh from vector file";
 4. Set in "Sampling Areas" the **Subsampling_areas.shp** file (or a newly created one);
 5. Set in "Output Shapefile" the **Bam_sampled_points.shp** name;
 6. Click "Start" and wait for the "END" message.

If you sample the image using the **Subsampling_areas.shp** file provided with this tutorial, the **Bam_sampled_points.shp** will contain 7448 points, shown in Fig. 2 with the related attributes.

To view the image in colors based on displacement, drag the file from the folder in which it was saved into the ENVI environment. Right click and click on 'Properties'. In the pop-up window, under 'Select Attribute' choose 'Observed', and under 'Color Table' choose 'Rainbow'.

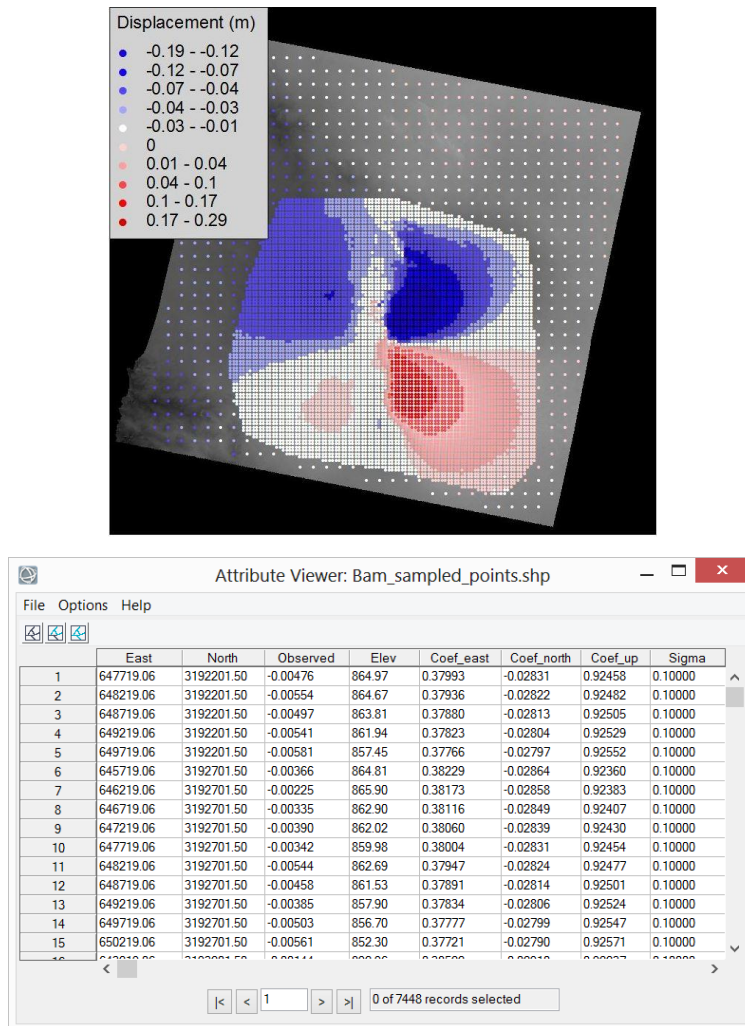


Figure 2. Subsampled points with the observed displacement and related attributes

In addition to the usual shapefile components (.shp, .dbf, .shx, .prj) a further file has been created, the **Bam_sampled_points.shp.xml** file, which contains ancillary information required by the inversion; see the "InSAR_dataset" help page for further details.

Non-Linear Inversion

Menu: "SARscape"->"Interferometry"->"Displacement Modeling"->"Non-Linear and Linear Inversion", "Non-Linear Inversion" tab.

Help Index: NL-Inversion

With the Non-Linear Inversion we try to reproduce the observed displacement by means of a geophysical source. We assume here that nothing is known about the source and all its parameters must be inferred from InSAR data. We model the data by means of a single fault, accounting also for a possible offset that might affect the data, since the reference point in the interferogram could have been set in a deforming area.

Before adding the dataset to invert and initializing the source, the XML Project File must be set:

1. Open the "Non-Linear" panel;
2. Set the "XML Project File" to **Bam_project.xml**.

Dataset setting

Help Index: InSAR_dataset

The dataset to invert, obtained with a subsampling of the displacement map, is added as follows:

1. Click on the "Add..." button in the "Dataset(s)" list and select the **Bam_sampled_points.shp**;
2. Open the Parameter setting panel through the "Set..." button;
3. Flag the "Invert for orbital surface" (default option);
4. Set 0 as "Polynomial degree";
5. Click on "Commit".

By setting 0 as polynomial degree, we let the inversion to assess also a possible offset that might affect the data.

Source setting

Help Index: "Initialize_Values_from_CMT_Cat", "Elastic_dislocation_Okada"

Though the source parameters are assumed to be completely unknown, we must set, for each parameter, a range of allowed values between a minimum and a maximum. Since the elastic dislocation source is characterized by a high number of parameters, we developed a specific tool to initialize these values from the Global Centroid Moment Tensor catalogue. The only thing to know is the CMT event identifier, which for the Bam earthquake can be obtained from the Global CMT website as follows:

1. Go to the <http://www.globalcmt.org/CMTsearch.html> site;
2. Set the following parameters for the:
 - Starting Date - Year: 2003
 - Starting Date - Month: 12"
 - Starting Date - Day: 26"
 - Ending Date - Number of days: 1
 - Moment magnitude range with $6 \leq M_w \leq 7$;
3. Click on "Done";
4. Two events should match these constraints: copy the identifier of the "SOUTHERN IRAN" event (122603B).

Once the CMT event identifier is known, initialize the source to invert as follows:

1. Click on "New...";
2. Select "Elastic dislocation (Okada)" from the pull down menu;
3. Click on the "Initialize from CMT solution..." button;

4. Set the event identifier in the "Insert the CMT identifier" field and click the "Search" button (it could take a while to get the result);
5. From the pull down menu select "Plane 1" then click "Commit";
6. Set "Bam_fault" as "Source name", then click "Commit" to return to the main inversion panel;
7. Click on the "Start" button to run the inversion;
8. Click "Yes" to the "XML Project File updated" dialog box;
9. Wait until the "END" message (it could take few minutes);
10. Click "No" to the "Focal Mechanism" dialog box.

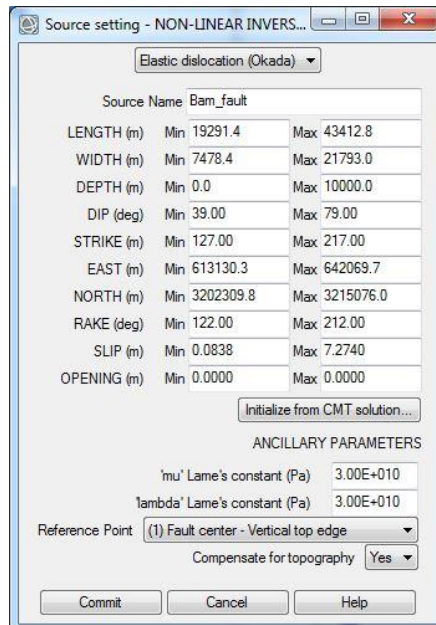


Figure 3. Source Parameters initialized with the CMT solution

Tip The CMT catalogue always provides two alternative solutions, corresponding to the real slipped plane and the auxiliary one. In the case of Bam, the displacement pattern allows to state that the slipped fault is oriented North-South, therefore the "Plane 1" must be selected.

Note When the XML file is updated, the "NLInput" and "NLOptions" sections are created under the "ModelingRoot"- "NonLinearInversion" XML section. If they already exist from a previous processing, they are overwritten. In order to maintain the alignment between input and output, when the "NLInput" and "NLOptions" sections are updated, the "NLOutput" section, if existing from a previous processing, is canceled. The new "NLOutput" section is written at the end of the inversion.

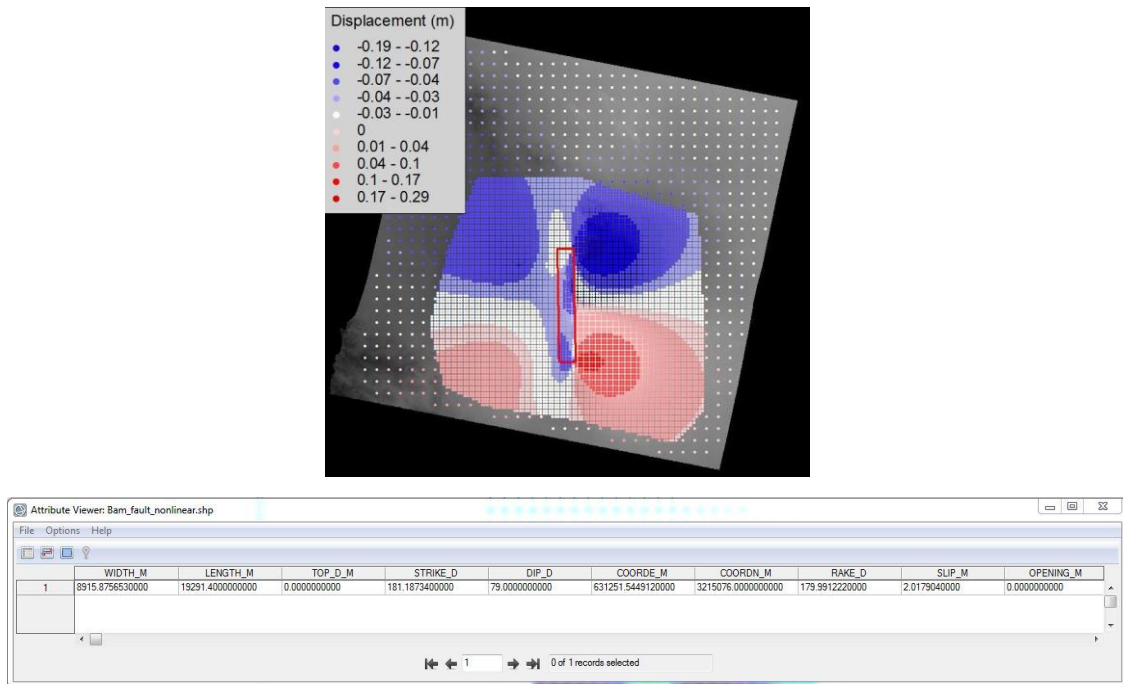
When the Non-Linear Inversion ends, the **Bam_project.xml** file is updated to store the results: source parameters, data offset, RMS of the residuals between observed and modeled data, geodetic moment, moment magnitude, etc... All the information are written in the "ModelingRoot"- "NonLinearInversion"- "NLOutput" section.

Note the Non-Linear Inversion algorithm is based on multiple restarts where every starting configuration is randomly picked within the allowed ranges: this is intended to avoid, as far as possible, to trap the cost function into local minima. At the same time, this can lead to different results for different runs.

Tip We strongly suggest to run the Non-Linear inversion several times and inspect every time the inferred source, in order to understand the reliability and the stability of a result.

Here we show a result obtained with the source initialized as in Fig. 3. If the flags "Generate output shapefile" in the Inversion Settings (accessible through the "Inversion settings..." button in the main panel) are set, the following files have also been created:

- **Bam_fault_nonlinear.shp**, containing the best fit source with its parameters.
- **Bam_sampled_points_nonlinear.shp**, containing the observed and modeled data.



From the XML Project File	
Overall residual RMS	0.028 m
Geodetic Moment	$1.26 \cdot 10^{19}$ N·m
Moment Magnitude	6.7
Data offset	0.014 m

Figure 4. Modeled points, fault parameters and other general parameters after the Non-Linear Inversion automatically initialized with the CMT values.

The results of Fig. 4 show that the source automatic initialization with CMT values already leads to reasonable results. However, at this stage, further improvements are still possible.

Tip When the inverted parameter reaches the upper or the lower limit of the allowed range, this range should be modified to let it find the best fit value. In general, a good result is obtained when all the parameters fall within the specified range without assuming a limit value.

Tip When a parameter is already known and doesn't need to be inverted, set minimum and maximum equal to the desired value.

In Fig. 4 the fault dip corresponds to the upper limit, suggesting that higher values could be preferred; however, since most of the signal is on the eastern side of the fault (see Fig. 1), the fault is likely to dip eastward and not westward, as proposed by the CMT solution. Because of the convention on the strike and dip angles (see "Elastic_dislocation_Okada" in the help), to let the source dipping eastward, also the strike range must be changed. Through the "Edit..." button on the "Source(s)" section, change the "Strike" and "Dip" ranges according to Fig. 5

Note: It is a good idea to delete the already created datasets from ENVI not to confuse the program. This can be done via the "Data Manager" (top left corner of the ENVI environment).

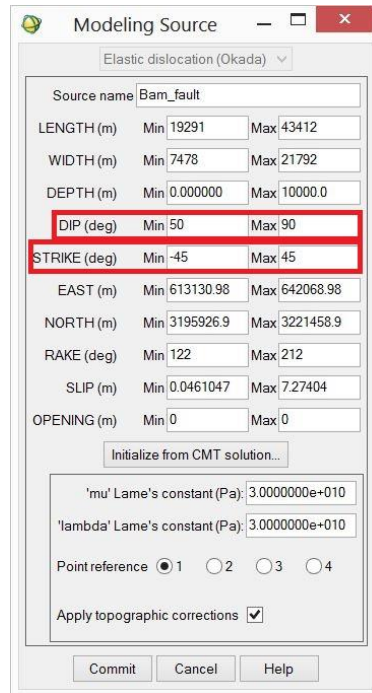
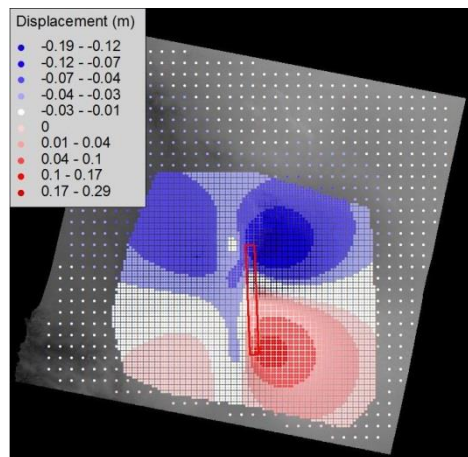


Figure 5. Source parameters modified after the first inversion

After that, rerun the Non-Linear inversion and verify that all the inverted parameters fall within the allowed ranges. You can navigate through the "NLOutput" section of the **Bam_project.xml** file to verify that the RMS of the residuals is slightly lower than before.



	WIDTH_M	LENGTH_M	TOP_D_M	STRIKE_D	DIP_D	COORD_E_M	COORD_N_M	RAKE_D	SLIP_M	OPENING_M
1	7478.4000000000	19291.4000000000	876.3269240000	2.3230750000	80.0514330000	633025.0104190001	3215076.0000000000	178.5201410000	1.6676810000	0.0000000000

From the XML Project File	
Overall residual RMS	0.026 m

Geodetic Moment	0.62 ·10 ¹⁹ N·m
Moment Magnitude	6.5
Data offset	0.017 m

Figure 6. Modeled points, fault parameters and other general parameters after the Non-Linear Inversion with revised ranges for Strike and Dip.

Note Different solutions can fit almost equally the observed data, as visible by comparing the results of Fig. 4 and Fig. 6, which have almost the same RMS for different sources. Only external information and experience allow to judge whether a solution is reliable.

Linear inversion

Menu: "SARscape"->"Interferometry"->"Displacement Modeling"->"Non-Linear and Linear Inversion", "Linear Inversion" tab.

Help Index: "Linear_Inversion"

With the Non-Linear inversion we modeled a source characterized by a unique slip value, which is a mean fault dislocation of 1.44 m (Fig. 6). With the Linear Inversion we retrieve a realistic distribution of slip over the fault plane.

As for the Non-Linear Inversion, this task requires the setting of the XML Project File;

1. Open the "Linear Inversion" panel
2. Set the "XML Project File" to **Bam_project.xml**

Note Through the tutorial, we add every task to the same XML Project File. However, every task is independent from the others and it can be stored in a different XML Project File.

Dataset setting

To load the dataset to invert, follow the same steps of the Non-Linear case, but make sure you switched to the "Linear Inversion" tab, at the top of the main panel:

1. Click on the "Add..." button in the "Dataset(s)" list and select the **Bam_sampled_points.shp**;
2. Open the Parameter setting panel through the "Edit..." button;
3. Flag the "Invert for orbital surface" (default option);
4. Set 0 as "Polynomial degree";
5. Click on "Commit".

Source setting

Help Index: "Fault_patches_Okada", "XML_Modeling_Project_file"

The starting point for the Linear Inversion is the source calculated by the Non-Linear inversion: we do not create a new source with the "New..." button, but we load the Non-Linear inversion results. This can be done in two ways: loading the **Bam_fault_nonlinear.shp** through the "Add from file..." button or retrieving the fault parameters with the "Load from XML..." button, which allow to explore the content of any XML Project File.

Note The "Add from XML..." button allows to access any XML Project File, to inspect and retrieve any stored source (input/output of Non-Linear Inversion, Linear Inversion, CFF Stress Transfer, Forward Modeling). In this tutorial, we access the same **Bam_project.xml** file to get the output of the Non-Linear inversion.

To load the source stored in the XML Project File after the Non-Linear inversion as input for the Linear Inversion, follow these steps:

1. Click on the "Add from XML..." button under the "Source(s)" list;
2. Select the **Bam_project.xml** file;
3. In the XML section, select "Non-Linear Inversion - Output";
4. Select, from the "Bam_fault[Elastic dislocation (Okada)]" item;
5. Click "Commit".

Tip Since the slip retrieved through Non-Linear Inversion is a mean value of the real one, a good strategy in the Linear Inversion setting is to extend that source to let the slip vanish at the fault limits (Fig. 7).

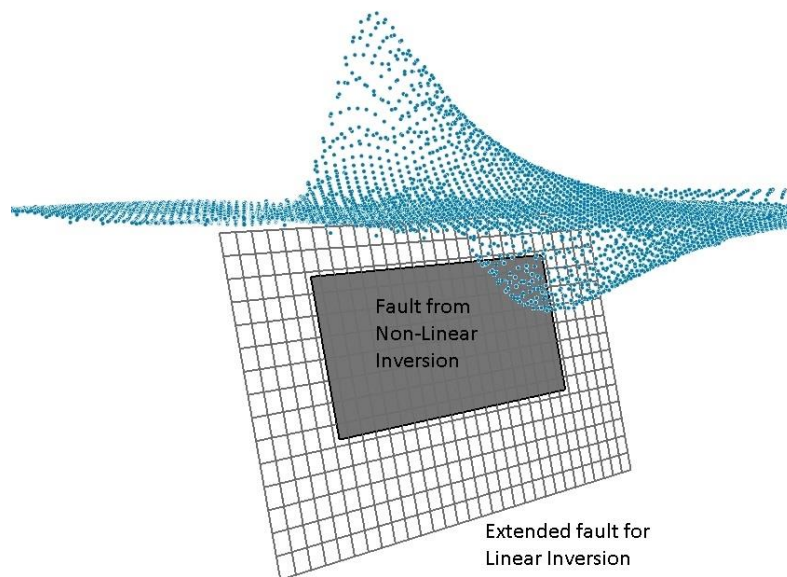


Figure 7. Fault from Non-Linear Inversion (gray rectangle) extended and subdivided into 30x15 patches; blue points represent the observed displacement in the Line-Of-Sight

The source retrieved from the Non-Linear inversion is added to the "Source(s)" list with the flag "***CHECK PARAMETERS ***", notifying that more information must be provided before running the inversion. To check the missing parameters and to change the source dimension:

1. Select the source in the "Source(s)" list and click the "Edit..." button;
2. Set the "Length (m)" field to "30000.";
3. Set the "Width (m)" field to "15000.";
4. Set the "Depth (m)" field to "0.";
5. Set "Fixed rake" under "Invert For";
6. Set "Non-Negative Least Squares" under "Inversion Algorithm";
7. Set the "Patches Along Strike" field to "30" and "Patches Along Dip" field to "15";
8. Set the "Damping value" to 0.05;
9. Change the "Reference Point" to "(4) Fault Trace Center – Along Dip Top Edge";
10. Only for ENVI 5.0 or higher, click the "Draw Source in ENVI 5.x" button to see the source in the ENVI view (a reference layer must be already present);
11. Click the "Commit" button;
12. Start the inversion;
13. Answer "No" to the "Focal Mechanism" dialog box after the inversion ends.

We switched to the Point Reference 4 (see "Elastic_dislocation_Okada" in the help) to change the source length and width without affecting the East and North coordinates.

In this way we extended the initial fault to a 30x15 km source, subdivided into patches of 1 km. After clicking on the "Start" button, the **Bam_project.xml** file is updated by creating, or updating, the "LinInput" and "LinOptions" sections in "ModelingRoot"->"LinearInversion". In Fig. 8 we show the results of the Linear Inversion.

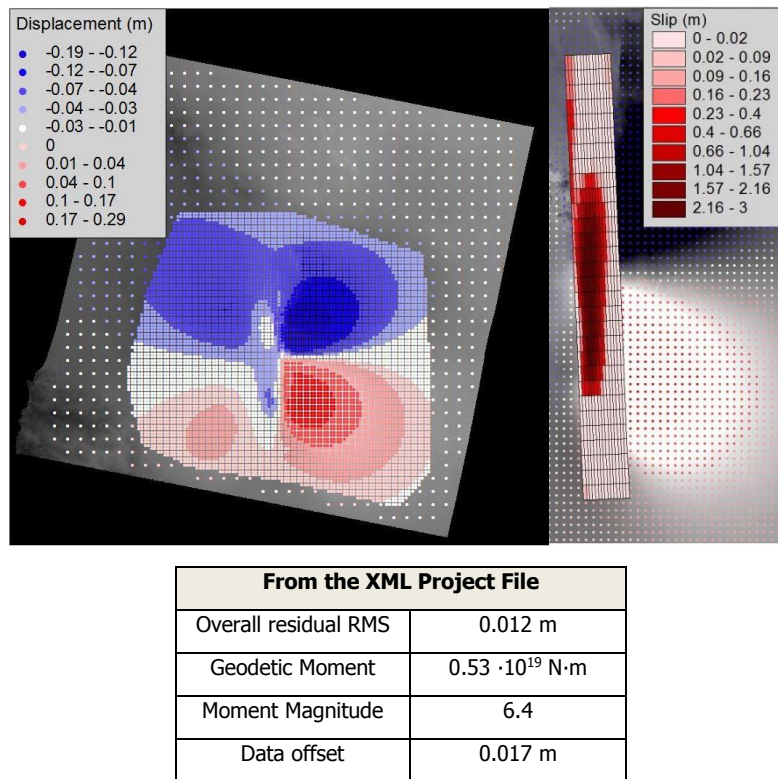


Figure 8. Modeled points, slip distribution and other parameters after the Linear Inversion

Tip The slip distribution strongly depends on the Damping Value: a low damping leads to scattered slip values while a high values to an over-smoothed solution. The best value can be obtained only with a *trial-and-error* approach. Unless you need a complete damping vs. RMS curve, we suggest a *divide-and-conquer* algorithm: start from a low value, then move to a high value, then test a value in between, and so on... checking at every step the result. This is quite fast, if the output shapefile is loaded into a GIS: since the output shapefile, at every step, is overwritten, you just need to refresh the view to check the result for every new damping value.

If the flags "Generate output shapfile" in the Inversion Settings (accessible through the "Inversion settings..." button in the inversion panel) are set, the following files have been created:

- **Bam_fault_linear.shp**: containing the best fit source with its parameters;
- **Bam_sampled_points_linear.shp**: containing the observed and modelled data.

Calculate the moment tensor and draw the "beach ball"

Menu: "SARscape"-> "Interferometry"->"Displacement Modeling"->"Tools"->"Calculate and Draw Focal Mechanism".

Help Index: "Calculate and Draw Focal Mechanism"

After any Non-Linear or Linear Inversion, it is possible to automatically calculate the seismic moment, the moment tensor and draw the beach ball of the focal mechanism, which can be exported to a .pdf file.

This can be also done in any moment, through the “Calculate and Draw Focal Mechanism” panel, loading in the “Source(s)” list the sources for which you want to do the calculation. A source can be created from scratch or loaded from a shapefile or an XML Project File. In this tutorial, we load the results of the Linear Inversion from the **Bam_project.xml** file, where they have been stored after the inversion:

1. Open the “Calculate and Draw Focal Mechanism” panel, under “Modeling Tools”;
2. Click on the “Add from XML...” button;
3. Select the **Bam_project.xml** file;
4. Form the “XML section” pull down menu, select “Linear Inversion – Output”;
5. Select in the source list the “Bam_fault [Fault patches(Okada)]” item and click “Commit”;
6. Click “Start” (Fig. 9).

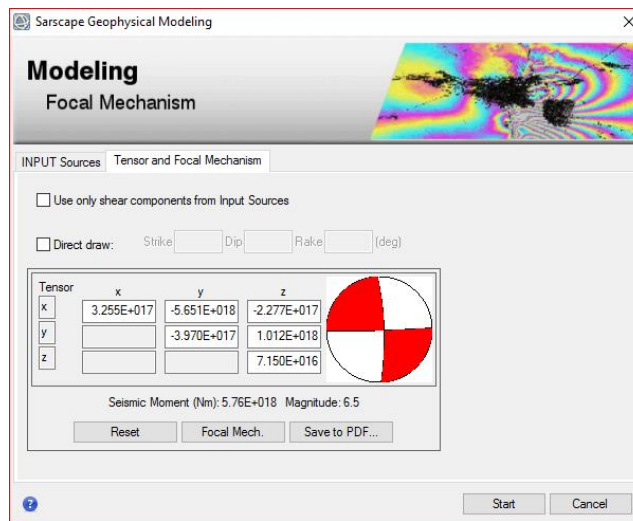


Figure 9. Moment tensor and focal mechanism of the Bam earthquake

Tip You can test, for instance, the effect of changing the shear modulus μ just editing the source, through the “Edit...” button, then setting a different value in the “ μ ’ Lamé’s constant” field.

CFF Stress Transfer

Menu: “SARscape”-> “Interferometry”-> “Displacement Modeling”-> “CFF Stress Transfer”

Help Index: “CalculateCFF”

This tool can be used to calculate the stress change induced by any source, or a list of sources (input sources), into another source, or a list of sources (receiver sources). In the case of Bam, only one source is involved, we therefore calculate here the stress change induced by the Bam fault on the fault itself.

Tip The self-induced stress change can be used to verify if the aftershock distribution over a fault plane is in agreement with that expected, i.e. whether they are located where the stress change has the highest values.

As for the Non-Linear and Linear Inversions, this task requires the setting of the XML Project File, which is the same **Bam_project.xml** file:

1. Open the “CFF Stress Transfer” panel;
2. Set the “XML Project File” to **Bam_project.xml**.

The input and receiver sources are retrieved, as in previous tasks, from an XML file (which is the same Bam_project.xml):

1. Click on the "Add from XML..." button under the "INPUT SOURCE(S)" list;
2. Select the **Bam_project.xml** file;
3. Form the "XML section" pull down menu, select "Linear Inversion – Output";
4. Select in the source list the "Bam_fault [Fault patches(Okada)]" item and click "Commit";
5. Click on the "Add from XML..." button under the "RECEIVER SOURCE(S)" list;
6. Repeat the steps from 2-4;
7. Click on the "Start" button in the main panel and wait for the "END" message.

Unlike the inversion processing, in this case the output (the CFF value) is stored only in the XML Project File, in the "ModelingRoot"->"CFFModeling"->"CFFOutput"->"CFFTarget" section. To inspect the result there it can be saved to a shapefile through the "Create Source Shapefile" as follows:

1. Open the "Create Source Shapefile" panel;
2. Click on the "Add from XML..." button;
3. Select the **Bam_project.xml** file;
4. Form the "XML section" pull down menu, select "CFF Calculation - Output";
5. Select in the source list the "Bam_fault [Fault patches(Okada)]" item and click "Commit";
6. In the main panel, select the "Bam_fault [Fault patches(Okada)]" item and click on the "Edit..." button;
7. Set the output directory;
8. Set a dummy value for the "Slip" and "Opening" fields then "Commit";
9. In the main panel, select the "Bam_fault [Fault patches(Okada)]" item and click on the "Start..." button.

Once the shapefile has been created, it can be loaded into a GIS software, as in Fig. 10.

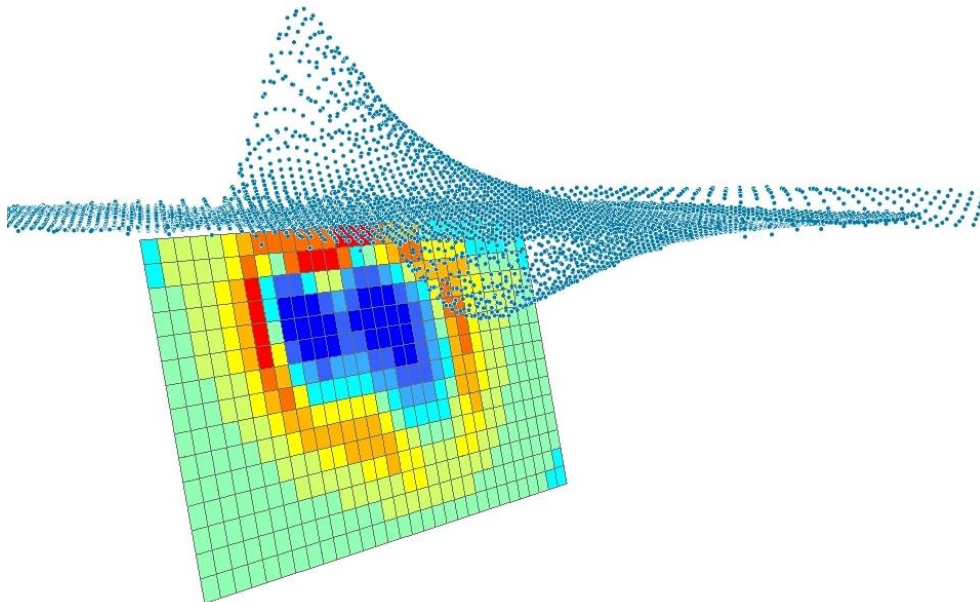


Figure 10. CFF stress change induced by the slip of Fig. 8.

Forward Modeling

Menu: "SARscape"->"Interferometry"->"Displacement Modeling"->"Forward Modeling"

Help Index: "ForwardModeling"

This task requires the setting of the XML Project File:

1. Open the "Forward Modeling" panel;
2. Set the "XML Project File" to **Bam_project.xml**.

In this step we use the results of the Linear Inversion, the distributed slip on the Bam fault, to generate a raster map of the surface displacement. The Forward Modeling can be carried out for a set of points stored in a shapefile or creating three raster files containing the East, North and Up components. We create here a raster output, using the **Bam_envisat_dsc_disp** as a reference for the extent and resolution (i.e. the output of the interferometric processing, used as input for the image subsampling), but with a reduced resolution of 250 m instead 25 m.

Note As explicitly written in the Help, any processing performed with the modeling tools must be carried out in a projected cartographic system; in the case of Bam, data are in the UTM-WGS84, Zone 40 North, projection.

To create the raster maps of the surface displacement:

1. Click on the "Add from XML..." button under the "INPUT SOURCE(S)" list;
2. Select the **Bam_project.xml** file;
3. From the "XML section" pull down menu, select "Linear Inversion – Output";
4. Select in the source list the "Bam_fault [Fault patches(Okada)]" item and click "Commit";
5. In the "Forward Model Output" pull down menu, select "Raster";
6. Click on "Get from image..." and select the **Bam_envisat_dsc_disp** file;
7. Change, if necessary, the "Output File" name and path automatically created;
8. Check on the "Set raster info..." button;
9. Change to 250 the "Cell size";
10. Click on the "Cartographic System" button and set the following parameters:
 - "State": UTM-GLOBAL
 - "Hemisphere": NORTH
 - "Projection": UTM
 - "Zone": 40
 - "Ellipsoid": WGS84
11. Click on "Commit" to close the "Set cartographic system" panel;
12. Click on "Commit" to close the "Raset Parameters";
13. Click on "Start" and wait for the "END" message.

Unless you changed the output name, automatically generated, the processing will create the following files (Fig. 11):

- **Bam_envisat_dsc_disp_forward_east**: with the displacement East component;
- **Bam_envisat_dsc_disp_forward_north**: with the displacement North component;
- **Bam_envisat_dsc_disp_forward_up**: with the displacement Up component.

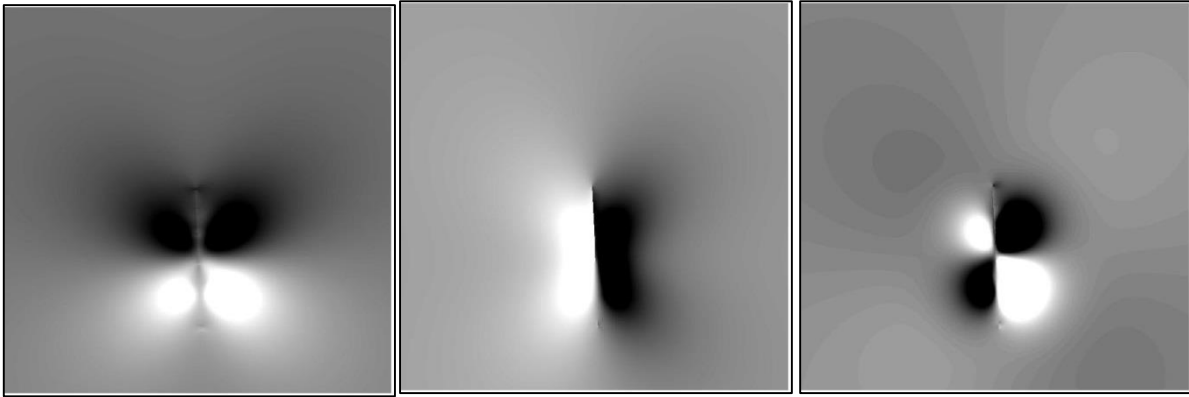


Figure 11. East, North and Up components of the modeled displacement.

Note The displacement measurement unit is always coherent with the input source: when the slip is provided in meters, the output map will be in meters.

As a further information, the **Bam_project.xml** file has been automatically updated and the section "ModelingRoot"->"ForwardModeling" has been created. You can navigate through the XML tags to inspect its content.

Project raster to LOS

Menu: "SARscape"->"Interferometry"->"Displacement Modeling"->"Tools"->"Project raster to LOS"

Help Index: "Project_Raster_to_LOS"

In the last step, the three maps generated with the Forward Modeling panel are combined together to project them into a single Line-Of-Sight. This simple panel just needs the three raster maps and the ALOS (Azimuth Line-Of-Sight) and the ILOS (Incidence Line-Of-Sight) images.

Note The group of the three displacement maps and the ALOS/ILOS pair have in general a different extent and resolution; the extent and resolution of the output raster can be independently set according to any of the two groups.

Tip When several LOSs are available (perhaps Ascending and Descending) the Forward Modeling tool can be used just once, to create the East/North/Up displacement maps; then they can be projected into as many LOSs available.

To run the LOS projection:

1. Open the "Project raster to LOS" panel;
2. Set the following files:
 - "East component": **Bam_envisat_dsc_disp_forward_east**
 - "North component": **Bam_envisat_dsc_disp_forward_north**
 - "Up component": **Bam_envisat_dsc_disp_forward_up**
 - "Azimuth LOS image": **Bam_envisat_dsc_ALOS**
 - "Incidence LOS image": **Bam_envisat_dsc_ILOS**
3. Set the "Output image" to **Bam_envisat_dsc_disp_forward_los**;
4. Set the "Raster extent" to "Same as the ALOS/ILOS components";
5. Set the "Raster resolution" to "Same as the ALOS/ILOS components";
6. Click on the "Start" button and wait for the "END" message.

After that, it is possible to compare the Forward Modeling results projected into the LOS with the original displacement map, as in Fig. 12.

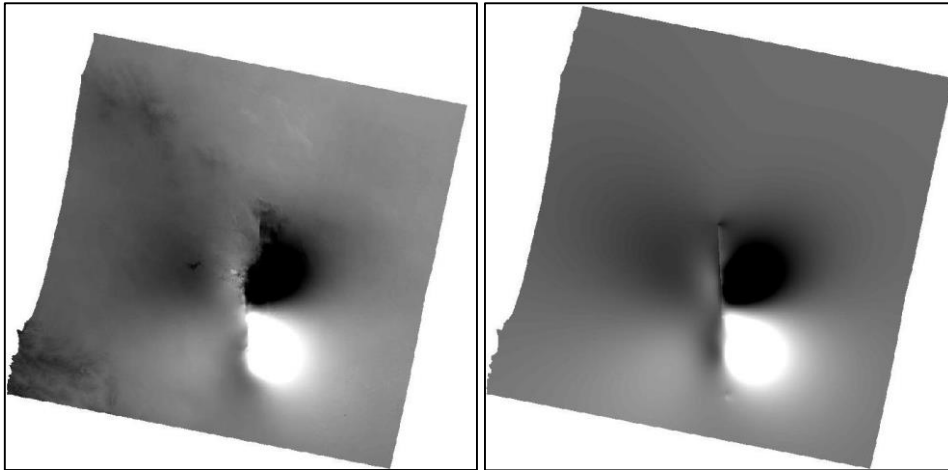


Figure 12. Comparison between the observed (left) and the modelled (right) displacement maps in the Line-Of-Sight

Note To make a correct comparison of the observed and the modeled displacement maps, it must be taken into account that in the inversion an orbital surface might have been calculated.

In this case, we calculated in the Linear Inversion an offset of 0.017 m (see Fig. 8), which must be added to the modeled displacement of Fig. 12 (right) to obtain the complete modeled displacement.

References

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