

INSAR_G2S

An automatic script to export interferograms
generated by GMTSAR into StaMPS/MTI
(suitable for Sentinel1A/B SLC dataset)

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INSAR_G2S is automatic GMTSAR bundled scripts acted as InSAR Processor before running the InSAR time series analysis using StaMPS.

Required Softwares

- GMT
- GMTSAR
- StaMPS/MTI

- When using this program please reference Isya et al., 2020:

Hayati, N.; Niemeier, W.; Sadarviana, V. Ground Deformation in The Ciloto Landslides Area Revealed by Multi-Temporal InSAR. Geosciences 2020, 10, 156. <https://doi.org/10.3390/geosciences10050156>

- Related Publication:

Isya, N. H.; Riedel, A.; Riedel, B. & Niemeier, W. Comparison of Power Law Tropospheric Correction for Time Series InSAR Application Wissenschaftlich-Technische Jahrestagung der DGPF und PFGK18 Tagung in München, Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation e.V., 2018, 483 - 50

How to use INSAR_G2S

- Set INSAR_G2S scripts to your shell environment

```
cd ~
```

```
pico .bashrc
```

- Add these commands on your bashrc and save it

```
export INSAR_G2S=/home/go_to_your_INSAR_G2S_path
```

```
export PATH=$INSAR_G2S:$PATH
```

- Replace or add files from **gmtsar_matlab** to **StaMPS/matlab** directory
 - stamps.m (replace the old file)
 - ps_load_initial_gmtsar.m (add file)
 - sb_load_initial_gmtsar.m (add file)

INSAR_G2S overview

```
isya@hermes:~$ INSAR_G2S.sh
```

```
Usage: INSAR_G2S.sh [step] [parameter_with_path_directory]
```

Script to pre-process SAR data and export to STAMPS format

example : `INSAR_G2S.sh 1 /home/isya/3d_disp/param_INSAR_G2S.txt`

Step: Data Preparation -->

- 1 Prepare the directory arrangement
- 2 Prepare the POE data
- 3 Prepare the EAP data
- 4 Preprocess SAR data: Compute Baseline and Alignment
- 5 Create a configuration of master-slave for SM or SB network

Interferogram Generation -->

- 6 Project DEM to radar coordinates
- 7 Generate Interferogram (Real and Imaginary format) [SM | SB]
- 8 Overview the sample of amplitude and phase file on Google Earth (optional)
- 9 Cut the interferograms based on ROI (optional) [SM | SB]

GMTSAR2STAMPS (PS Method) -->

- 10 Create Amplitude Dispersion Index
- 11 Convert GMTSAR result to be able processed by STAMPS PS
- 12 Fix the result of PS Candidates (PS)

GMTSAR2STAMPS (Small Baseline [SB] Method) -->

- 13 Create Amplitude Difference Dispersion Index
- 14 Convert GMTSAR result to be able processed by STAMPS SB
- 15 Fix the result of PS Candidates (SB)

Guidelines:

Step 0

- Create a main folder which all of the processing will be run.

`$ mkdir yourproject`

- Copy a template of param_INSAR_G2S.txt in the “yourproject” folder

Explanation of param_INSAR_G2S.txt

dataorbit = the orbit direction (could be ascending / descending)
raw_path = the full path directory of your SLC SAR data (ZIP files)
sen_POE = the full path directory of POE Sentinel-1 files, inside this directory S1A and S1B has to be splitted into two folders (S1A and S1B folder)
temp_bl = the maximum limit of temporal baseline
spatial_bl = the maximum limit of spatial baseline
region = the region of interest (radar coordinates)
reg_ll = the region of interest (geographic coordinates)
n_range = number of patches in range
n_azimuth = number of patches in azimuth
ov_range = overlapping pixels between patches in range
ov_azimuth = overlapping pixels patches in azimuth
threshold = threshold of amplitude (difference) dispersion (0.4-0.6 is reasonable)
heading = heading angle or azimuth direction for Sentinel-1, see metadata super master file (default=**auto** or e.g, Asc = -12.00707218611660e ; Dsc = -1.6799e+02)
master_date= date of super master
master_PRM = the name of master PRM
suffix = sub-swath number (e.g F1, F2, F3)
tiff_id = number of tiff (e.g 001, 002, ..)
type_data = type of polarization (could be single | dual | mix)

Use tiff_id from single polarization, if your type_data is "mix"

param_INSAR_G2S.txt
example -->

Note:

For Step 1-7, region and region_ll can be let empty "-"

region_ll will be used on step 8

region will be used on step 9

```
param_INSAR_G2S.txt (4,0 TB Volume /media/isya/649d6fa0-f505-4c78-9eb5-78d4aec5c2f3/Celle) - gedit
Open  [icon] Save

##### set parameters #####
dataorbit = descending
# OPTION: ascending or descending
raw_path  = /media/isya/649d6fa0-f505-4c78-9eb5-78d4aec5c2f3/RAW/Celle/Ascending/DESC_out/no_POE
sen_POE   = /home/isya/APPS/ciloto/sen_orbit/aux_poeorb/
temp_bl   = 50
spatial_bl = 100
region    = 1000/16000/9000/12000
reg_ll    = 9.47916666667/10.9652777778/52.4958333333/53.15
n_range   = 2
n_azimuth = 3
ov_range  = 50
ov_azimuth = 200
threshold = 0.4
heading   = auto # for descending: -164.296, for ascending: -12.00707218611660e
master_date= 20180128
master_PRM = S1_20180128_ALL_F2
suffix    = F2
tiff_id   = 005
type_data  = dual
#####
```

Guidelines:

Step 1 – 5 → a process of “Data Preparation”

(For the data preparation steps, they are suitable for Sentinel-1 dataset. If you want to process other sensors (e.g., ALOS, ERS, etc), You need to manually modify the scripts.)

- Step 1 : Prepare the directory arrangement

Run Step 1 on “yourproject” folder

```
$ INSAR_G2S.sh 1 /home/isya/yourproject/param_INSAR_G2S.txt
```

It will create batch_asc or batch_dsc folder (depends on your orbit direction data)

- Step 2 : Prepare the POE data

Run Step 2 on “yourproject” folder

```
$ INSAR_G2S.sh 2 /home/isya/yourproject/param_INSAR_G2S.txt
```

Just in case, install \$ `sudo apt-get install unzip`

If POE files are located on your local storage, type \$ `yes`

If you don't have POE files, the program will automatically download them, type \$ `no`

- Step 3 : Prepare the EAP data

Save s1a-aux-cal.xml and s1b-aux-cal.xml in **raw_orig** directory.

The aux file is only needed for Elevation Antenna Pattern correction. Please check on the manifest.safe file from your downloaded data. If the processing version is after 2.36 (some early data after March 2015), there is no need to cat the aux file to the xmls. However, it's better to apply the aux file to all xmls.

Run Step 3 on “yourproject” folder

```
$ INSAR_G2S.sh 3 /home/isya/yourproject/param_INSAR_G2S.txt
```

It will create “topo” directory inside batch_”orbit” directory. Please save **dem.grd** file in topo directroy.

dem.grd could be downloaded from <https://topex.ucsd.edu/gmtsar/demgen/>

Guidelines:

- If you do not run step 3, please create “topo” directory inside batch_”orbit” directory.

Put **dem.grd** file in the topo directroy.

dem.grd could be downloaded from: <https://topex.ucsd.edu/gmtsar/demgen/>

- Step 4 ; Preprocess SAR data: Compute Baseline and Alignment

Run Step 4 on “yourproject” folder

```
$ INSAR_G2S.sh 4 /home/isya/yourproject/param_INSAR_G2S.txt
```

PRM, LED and SLC files will be generated in raw directory

- Step 5 ; Create a configuration of master-slave for SM or SB network

Run Step 5 on **batch_”orbit”** folder

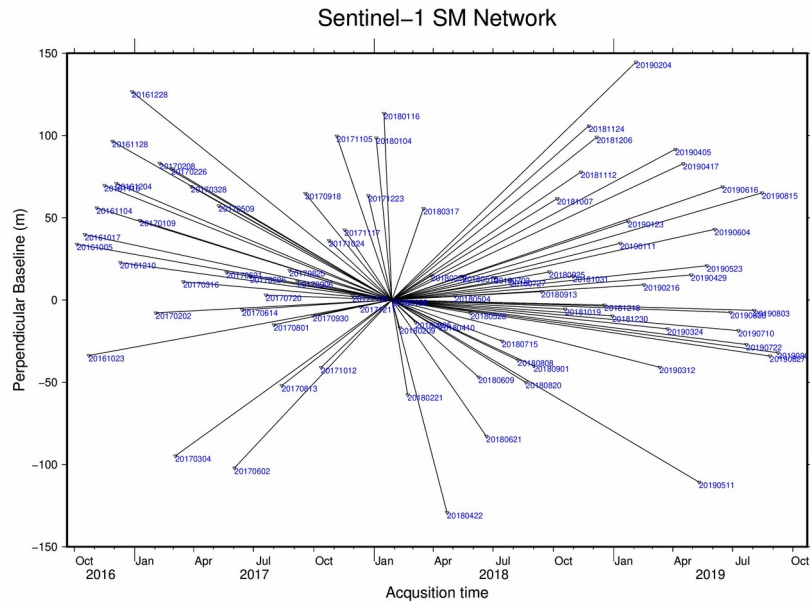
```
$ INSAR_G2S.sh 5 /home/isya/yourproject/param_INSAR_G2S.txt
```

There are two network options : Single Master (SM) or Small Baseline (SB)

If you want to work with PS method, type **\$ SM**

If you want to work with SB method, type **\$ SB**

Example for the generated files from Step 5



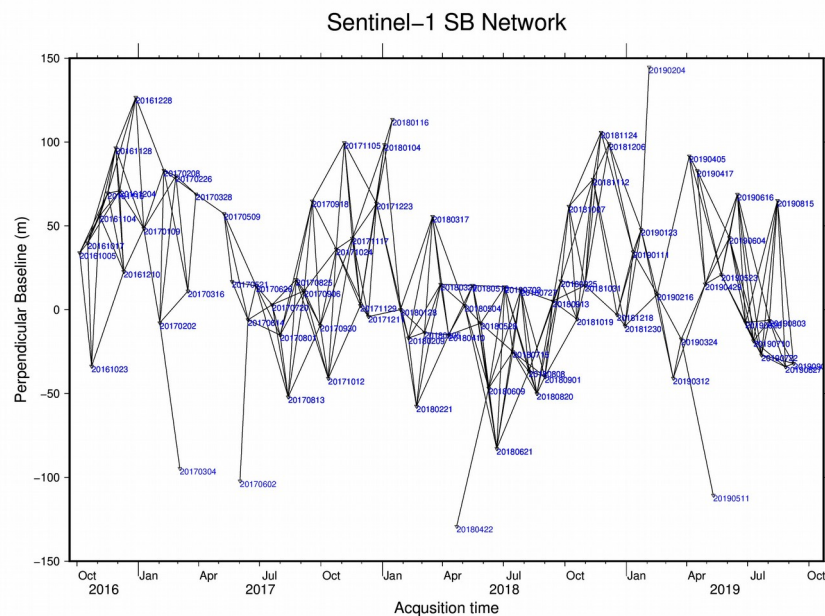
baseline_pair_SM.ps

```
intf_SM.in (4,0 TB Volume /media/isya/649d6fa0-f505-4c78-9eb5-78d4aec5c2f3/Celle/batch_dsc) - gedit
Open [F2] Save

S1_20180128_ALL_F2:S1_20161005_ALL_F2
S1_20180128_ALL_F2:S1_20161017_ALL_F2
S1_20180128_ALL_F2:S1_20161023_ALL_F2
S1_20180128_ALL_F2:S1_20161104_ALL_F2
S1_20180128_ALL_F2:S1_20161116_ALL_F2
S1_20180128_ALL_F2:S1_20161128_ALL_F2
S1_20180128_ALL_F2:S1_20161204_ALL_F2
S1_20180128_ALL_F2:S1_20161210_ALL_F2
S1_20180128_ALL_F2:S1_20161228_ALL_F2
S1_20180128_ALL_F2:S1_20170109_ALL_F2
S1_20180128_ALL_F2:S1_20170202_ALL_F2
S1_20180128_ALL_F2:S1_20170208_ALL_F2
S1_20180128_ALL_F2:S1_20170226_ALL_F2
S1_20180128_ALL_F2:S1_20170304_ALL_F2
S1_20180128_ALL_F2:S1_20170316_ALL_F2
S1_20180128_ALL_F2:S1_20170328_ALL_F2
S1_20180128_ALL_F2:S1_20170509_ALL_F2
S1_20180128_ALL_F2:S1_20170521_ALL_F2
S1_20180128_ALL_F2:S1_20170602_ALL_F2
S1_20180128_ALL_F2:S1_20170614_ALL_F2
S1_20180128_ALL_F2:S1_20170626_ALL_F2
S1_20180128_ALL_F2:S1_20170720_ALL_F2
S1_20180128_ALL_F2:S1_20170801_ALL_F2
S1_20180128_ALL_F2:S1_20170813_ALL_F2
S1_20180128_ALL_F2:S1_20170825_ALL_F2
S1_20180128_ALL_F2:S1_20170906_ALL_F2

Plain Text Tab Width: 8 Ln 85, Col 38 INS
```

intf_SM.in



baseline_pair_50_100.ps

```
intf_SB.in (4,0 TB Volume /media/isya/649d6fa0-f505-4c78-9eb5-78d4aec5c2f3/Celle/batch_dsc) - gedit
Open [F2] Save

S1_20190604_ALL_F2:S1_20190616_ALL_F2
S1_20190604_ALL_F2:S1_20190628_ALL_F2
S1_20190604_ALL_F2:S1_20190710_ALL_F2
S1_20190604_ALL_F2:S1_20190722_ALL_F2
S1_20190616_ALL_F2:S1_20190628_ALL_F2
S1_20190616_ALL_F2:S1_20190710_ALL_F2
S1_20190616_ALL_F2:S1_20190722_ALL_F2
S1_20190616_ALL_F2:S1_20190803_ALL_F2
S1_20190628_ALL_F2:S1_20190710_ALL_F2
S1_20190628_ALL_F2:S1_20190722_ALL_F2
S1_20190628_ALL_F2:S1_20190803_ALL_F2
S1_20190628_ALL_F2:S1_20190815_ALL_F2
S1_20190710_ALL_F2:S1_20190722_ALL_F2
S1_20190710_ALL_F2:S1_20190803_ALL_F2
S1_20190710_ALL_F2:S1_20190815_ALL_F2
S1_20190710_ALL_F2:S1_20190827_ALL_F2
S1_20190722_ALL_F2:S1_20190803_ALL_F2
S1_20190722_ALL_F2:S1_20190815_ALL_F2
S1_20190722_ALL_F2:S1_20190827_ALL_F2
S1_20190722_ALL_F2:S1_20190908_ALL_F2
S1_20190803_ALL_F2:S1_20190815_ALL_F2
S1_20190803_ALL_F2:S1_20190827_ALL_F2
S1_20190803_ALL_F2:S1_20190908_ALL_F2
S1_20190815_ALL_F2:S1_20190827_ALL_F2
S1_20190815_ALL_F2:S1_20190908_ALL_F2
S1_20190827_ALL_F2:S1_20190908_ALL_F2

Plain Text Tab Width: 8 Ln 254, Col 38 INS
```

intf_SB.in

Guidelines:

Step 6 – 9 → a process of “Interferogram Generation”

- Step 6 ; Project DEM to radar coordinates

Run Step 6 on **batch_”orbit”** folder

```
$ INSAR_G2S.sh 6 /home/isya/yourproject/param_INSAR_G2S.txt
```

- Step 7 ; Generate Interferogram (Real and Imaginary format)

Run Step 7 on **batch_”orbit”** folder

```
$ INSAR_G2S.sh 7 /home/isya/yourproject/param_INSAR_G2S.txt
```

There are two network options : Single Master (SM) or Small Baseline (SB), based on your option on Step 5

If you want to work with PS method, type **\$ SM**

If you want to work with SB method, type **\$ SB**

Guidelines:

- Step 8 ; Overview the sample of amplitude and phase file on Google Earth (optional)

Create one pair interferogram and save as **intf_tes.in** in stack directory (An example can be seen in intf_SB.in or intf_SM.in). Run Step 8 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 8 /home/isya/yourproject/param_INSAR_G2S.txt
```

- Step 9 ; Cut the interferograms based on ROI (optional) [SM | SB]

Run Step 9 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 9 /home/isya/yourproject/param_INSAR_G2S.txt
```

There are two network options : Single Master (SM) or Small Baseline (SB), based on your option on Step 5

If you want to work with PS method, type **\$ SM**

If you want to work with SB method, type **\$ SB**

- Step 8 and 9 are optional.

If you want to save your computer storage, run step 8 to define your ROI on radar coordinates and step 9 to cut real and image files based on a certain region. You could delete imag* and real* files in stack directory after Step 9.

You can set **region_II** before running step 8 or let it empty if you want to plot a whole scene.

After you could define radar coordinates based on the KML overview, set **region** before running step 9, 10,

Guidelines:

If on Step 5 you choose SM option, then run step 10 – 12

Step 10 – 12 → a process of “GMTSAR to STAMPS for PS method”

- Step 10 ; Create Amplitude Dispersion (AD) Index

Run Step 10 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 10 /home/isya/yourproject/param_INSAR_G2S.txt
```

In raw folder, scatter_SM.grd (Amplitude Dispersion) is generated.

Threshold of AD is taken from param_INSAR_G2S.txt (e.g 0.4).

- Step 11 ; Convert GMTSAR result to be able processed by STAMPS PS

Run Step 11 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 11 /home/isya/yourproject/param_INSAR_G2S.txt
```

It will create PS directory and generate interferograms result based on StaMPS format.

- Step 12 ; Fix the result of PS Candidates (PS)

Run Step 12 on **batch_”orbit”/stack/PS** folder

```
$ INSAR_G2S.sh 12 /home/isya/yourproject/param_INSAR_G2S.txt
```

This step is to rewrite pscands1.ll and pscands.hgt to have the same size matrix.

GMTSAR to StaMPS result [PS Method]

me Celle batch_dsc stack PS				
Name	Size	Type	Modified	
PATCH_1	32 items	Folder	Okt 10	
PATCH_2	32 items	Folder	Okt 15	
PATCH_3	32 items	Folder	Okt 15	
PATCH_4	32 items	Folder	Okt 15	
PATCH_5	32 items	Folder	Okt 16	
PATCH_6	32 items	Folder	Okt 16	
patch_reg	29 items	Folder	Okt 2	
patch_SM	10 items	Folder	Okt 9	
SMALL_BASELINES	194 items	Folder		
bp2.mat	62,5 MB	File		
bperp.1.in	706 bytes	File		
bperp_20161005.1.in	50,0 kB	File		
bperp_20161017.1.in	50,0 kB	File		

me Celle batch_dsc stack PS PATCH_1				
Name	Size	Type	Modified	
pscands.1.da	6,1 MB	Text	Okt 9	
pscands.1.hgt	1,6 MB	Binary	Okt 10	
pscands.1.ij	7,0 MB	Text	Okt 10	
pscands.1.ll	3,3 MB	Binary	Okt 10	
pscands.1.ph	279,7 MB	Binary	Okt 9	
psver.mat	1,9 kB	Binary	Okt 14	
psweed.1.node	2,2 MB	Text	Okt 14	
psweed.2.edge	5,1 MB	Text	Okt 14	
psweed.2.ele	4,0 MB	Text	Okt 14	
psweed.2.node	3,6 MB	Text	Okt 14	
rc2.mat	27,9 MB	Binary	Okt 18	
select1.mat	270,3 MB	Binary	Okt 14	
STAMPS.log	19,4 kB	Text	Okt 18	

Guidelines:

If on Step 5 you choose SB option, then run step 13 – 15

Step 13 – 15 → a process of “GMTSAR to STAMPS/MTI for SB method”

- Step 13 ; Create Amplitude Difference Dispersion (ADD) Index

Run Step 13 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 13 /home/isya/yourproject/param_INSAR_G2S.txt
```

In raw folder, scatter_SB.grd (Amplitude Difference Dispersion) is generated.

Threshold of ADD is taken from param_INSAR_G2S.txt (e.g 0.6).

- Step 14 ; Convert GMTSAR result to be able processed by STAMPS SB

Run Step 14 on **batch_”orbit”/stack** folder

```
$ INSAR_G2S.sh 14 /home/isya/yourproject/param_INSAR_G2S.txt
```

It will create PS/SMALL_BASELINES directory and generate interferograms result based on StaMPS format.

- Step 15 ; Fix the result of PS Candidates (SB)

Run Step 15 on **batch_”orbit”/stack/PS/SMALL_BASELINES** folder

```
$ INSAR_G2S.sh 15 /home/isya/yourproject/param_INSAR_G2S.txt
```

This step is to rewrite pscands1.ll and pscands.hgt to have the same size matrix.

GMTSAR to StaMPS result [SB Method]

Name	Size	Type	Modified
PATCH_1	29 items	Folder	Okt 7
PATCH_2	29 items	Folder	Okt 9
PATCH_3	29 items	Folder	Okt 11
PATCH_4	29 items	Folder	Okt 12
PATCH_5	29 items	Folder	Okt 12
PATCH_6	29 items	Folder	Okt 12
PATCH_7	29 items	Folder	Okt 12
PATCH_8	29 items	Folder	Okt 12
PATCH_9			
PATCH_10			
PATCH_11			
PATCH_12			
PATCH_13			

Name	Size	Type	Modified
pscands.1.ll	2,7 MB	Binary	Okt 7
pscands.1.ij	5,7 MB	Text	Okt 7
pscands.1.hgt	1,4 MB	Binary	Okt 7
ifgday.1.in	4,6 kB	Link to Text	Okt 3
pscands.1.ph	689,2 MB	Binary	Okt 2
swap_pixels.m	596 bytes	Text	Okt 2
pscands.1.ph0	689,2 MB	Binary	Okt 2
pscands.1.da	5,1 MB	Text	Okt 2
patch_noover_old.in	13 bytes	Text	Okt 2
patch_noover.in	20 bytes	Text	Okt 2
patch.in	13 bytes	Text	Okt 2

StaMPS Processing

- After you successfully convert all of files from GMTSAR to StaMPS format, now you can run the PS/SB InSAR processing on Matlab.

- Run StaMPS step by step

```
>> stamps(1,1)
```

```
>> stamps(1,2)    etc
```

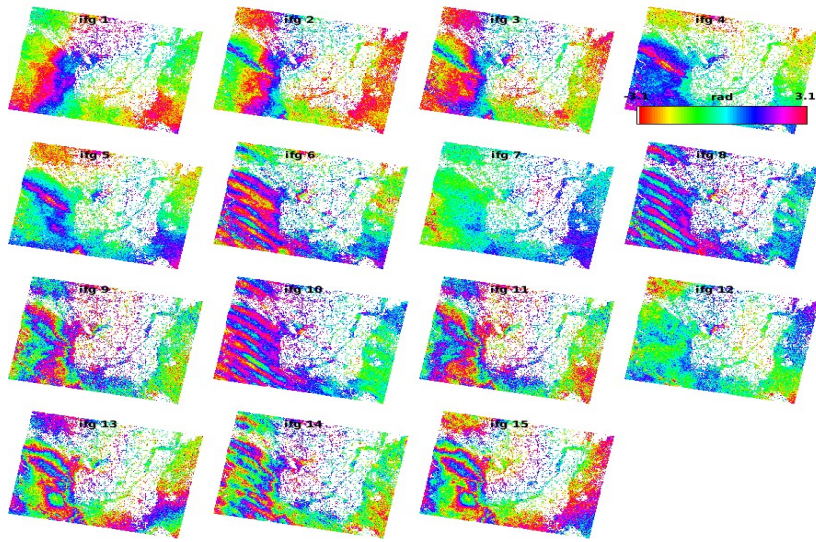
- Or all steps

```
>> stamps(1,5)
```

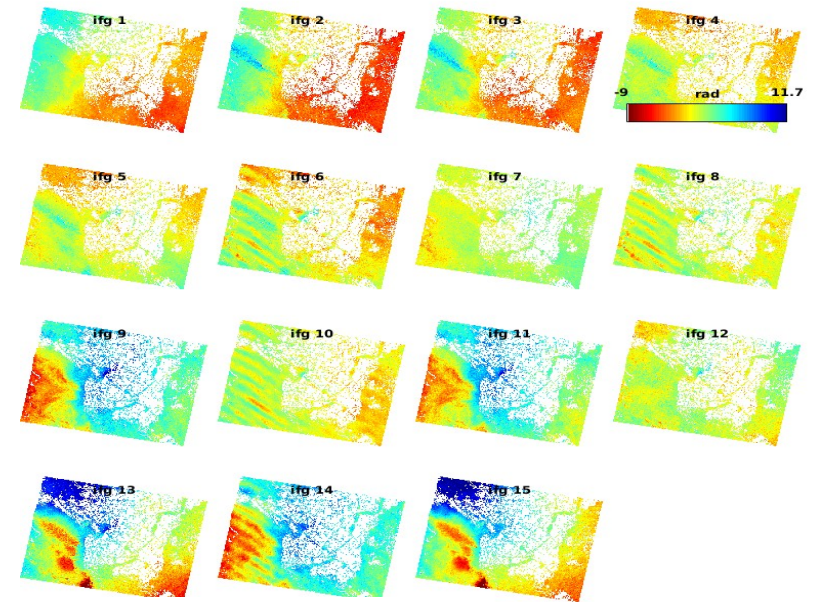
```
>> stamps(6,7)    etc
```


STAMPS result overview (SB method)

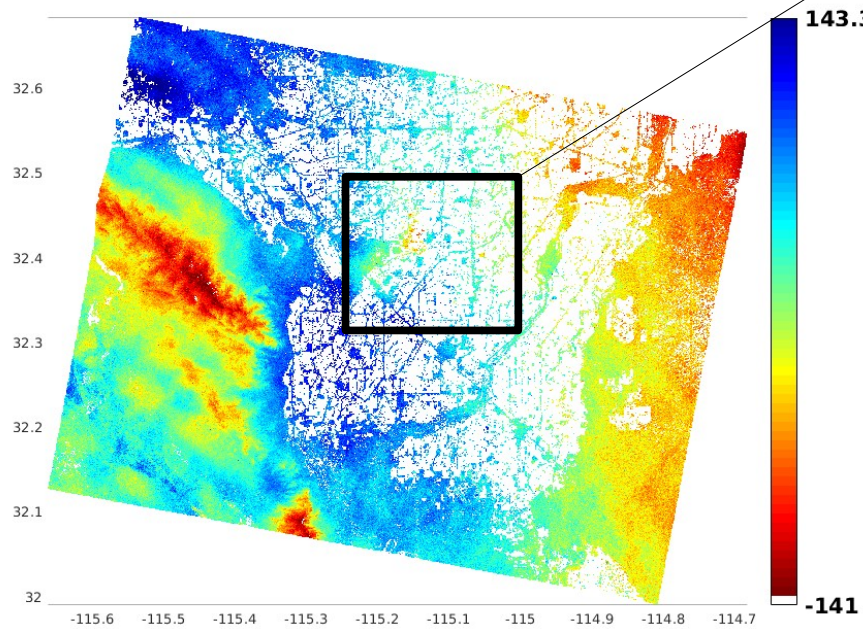
Location: Cerro Prieto, Mexico



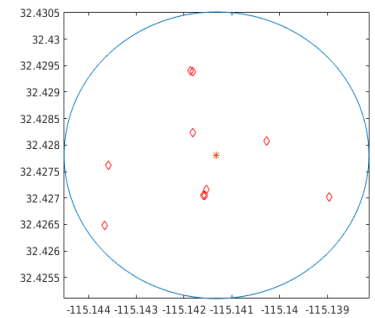
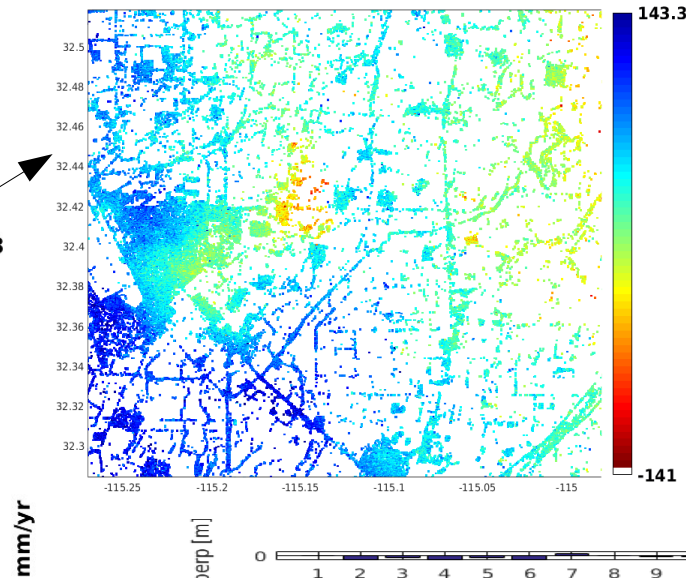
wrapped interferograms



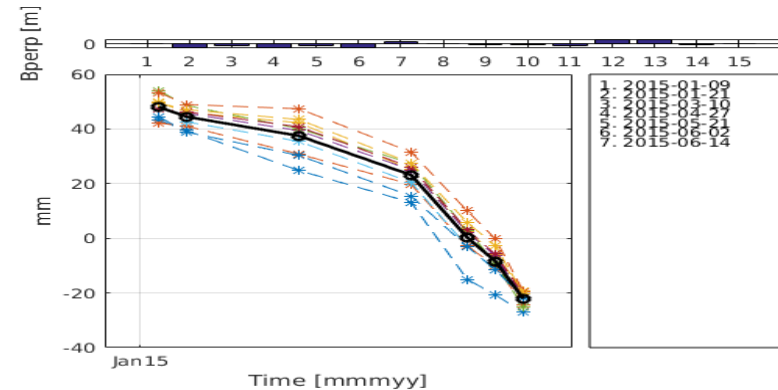
unwrapped interferograms



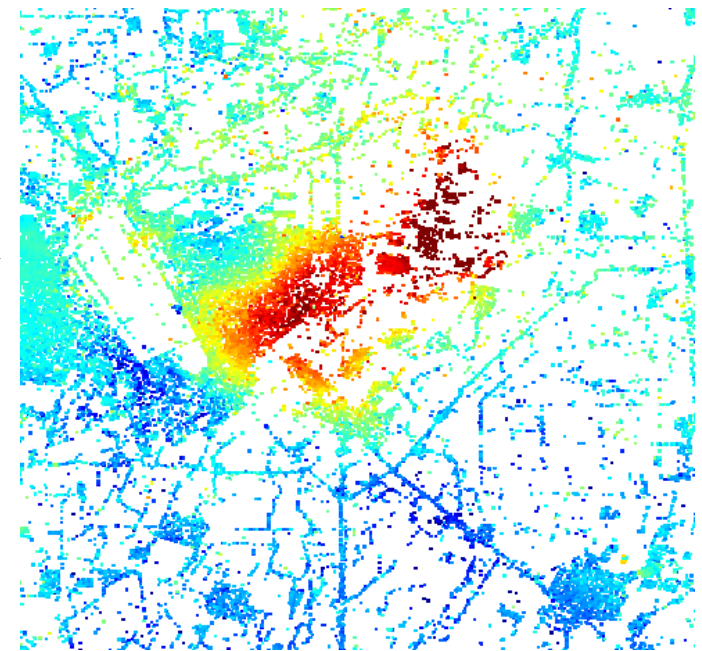
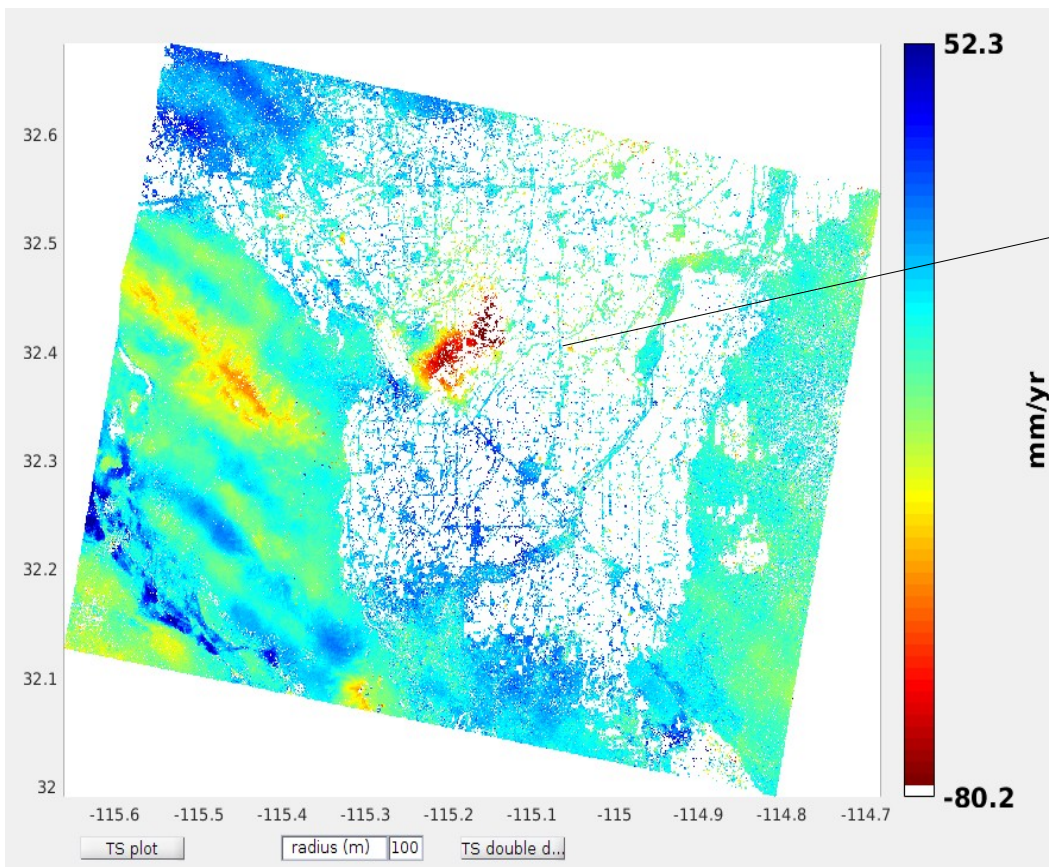
mean velocity (SM network inversion) for V-DO plot



Time series PS scatters



STAMPS result with (set merge_resample_size = 100)



mean velocity (SB network inversion) for v-do plot
(small letters for v-do)

