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 analyis 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)

- Make sure awk has been installed properly $ sudo apt-get install gawk

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

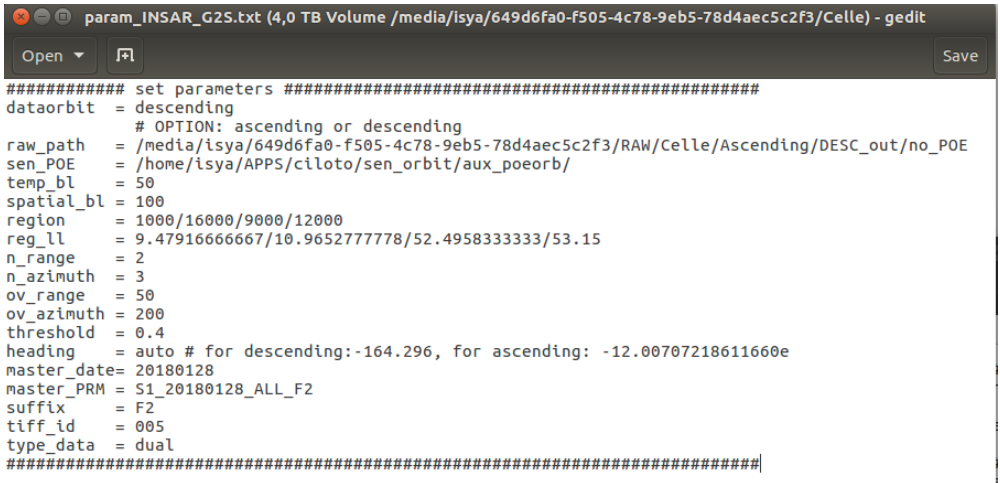
- Copy a template of param_INSAR_G2S.txt in the “yourproject” folder

Explanation of param_INSAR_G2S.txt

dataorbit = the orbit direction (could be ascending / desecending)
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 coodinates)
reg_ll = the region of interest (geographic coodinates)
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, 10-15

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

  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.

  If you want to add EAP, type type $ yes and save *s1a-aux-cal.xml* and *s1b-aux-cal.xml* in **raw_orig** directory.

  If you do not need EAP correction, type $ no

  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:

- 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

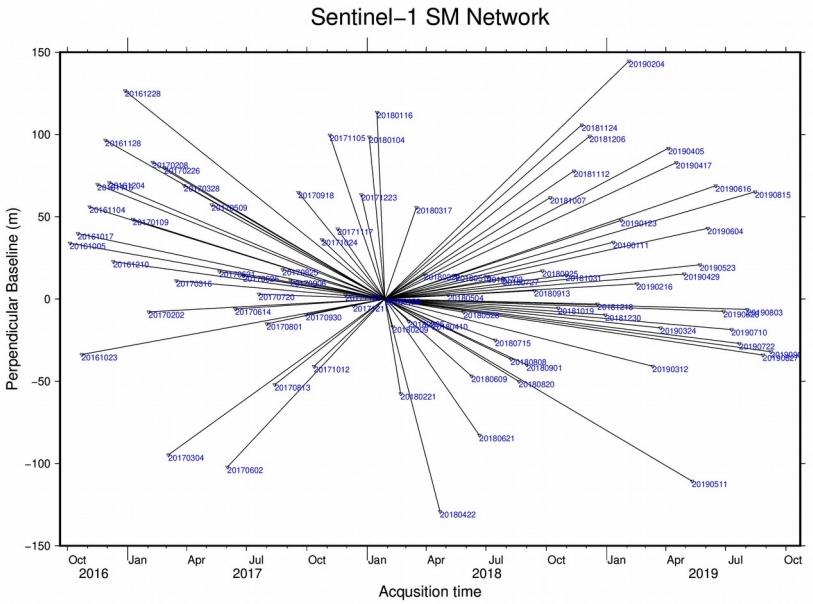
  $ INSAR_G2S.sh 5 /home/isya/yourproject/param_INSAR_G2S.txt

  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 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
```

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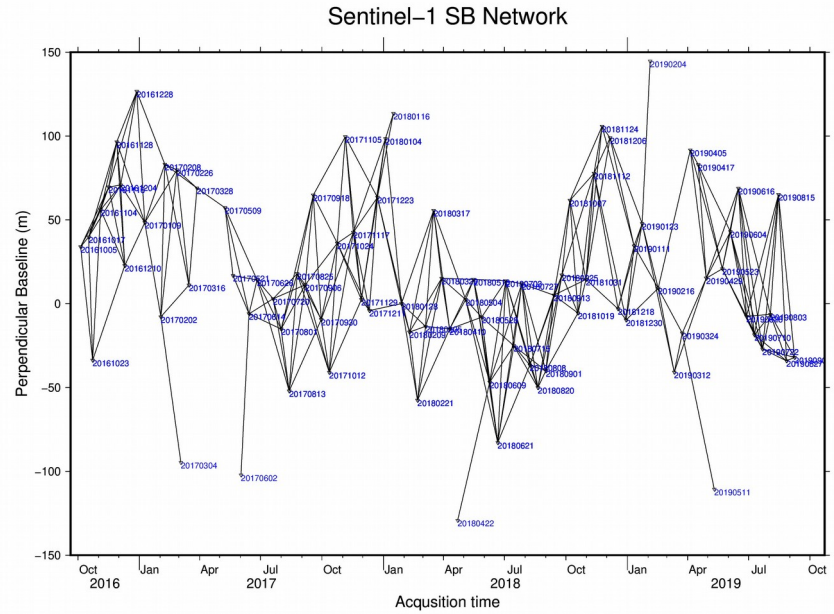
intf_SM.in



baseline_pair_50_100.ps

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

Open 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
```

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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_ll** 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, ….

- If you skip step 8 and 9, you still need to define **region** manually, you can get the information of radar coordinate for a whole scene from imag_xxx_xxx.grd or real_xxx_xxx.grd in stack folder. Use command $ gmt grdinfo imag_xxx__xxx.grd. See the values of x_min x_max y_min y_max.

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.

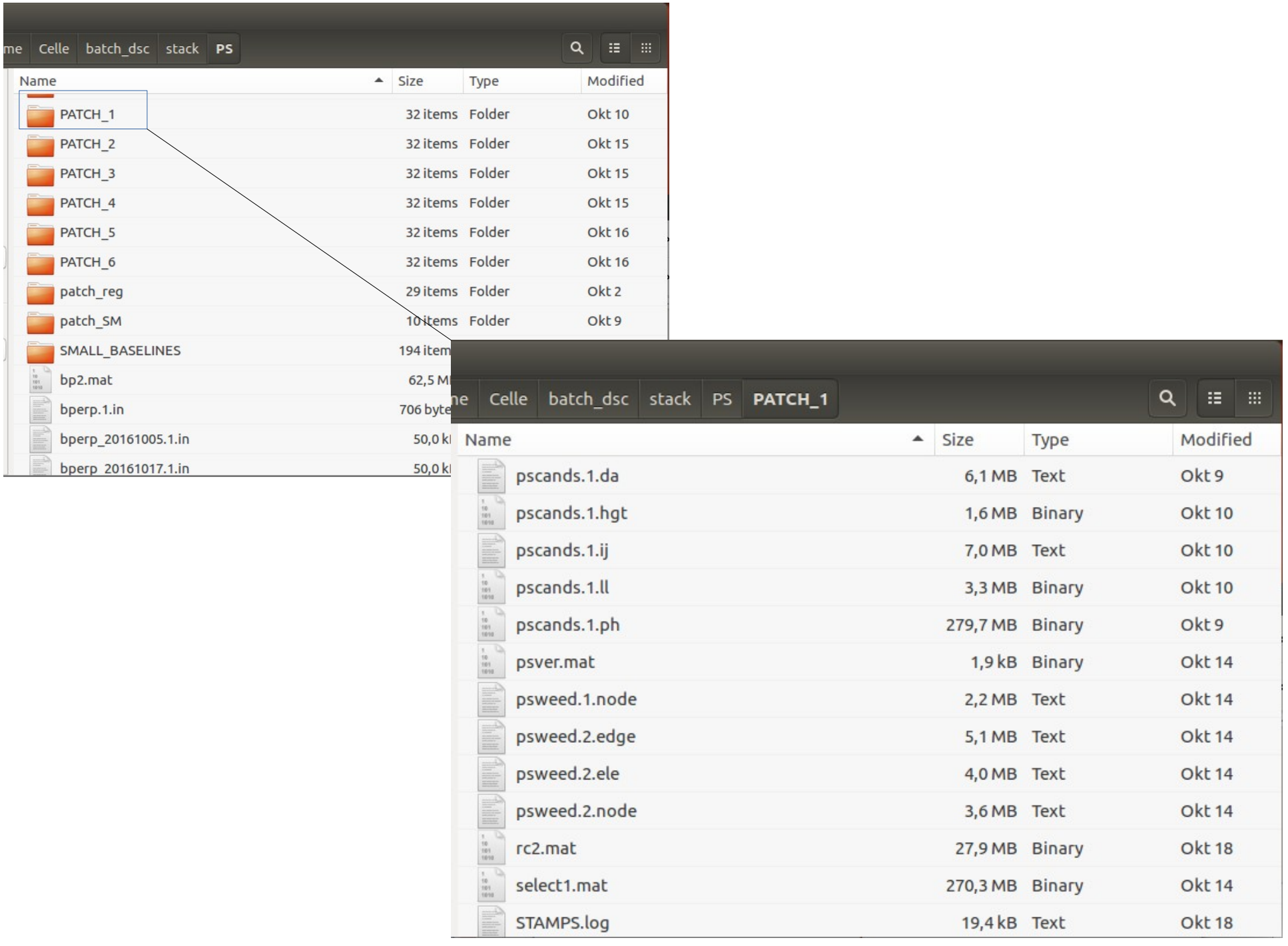
- Step 12 ; Fix the result of PS Candidates (PS)

  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]



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.

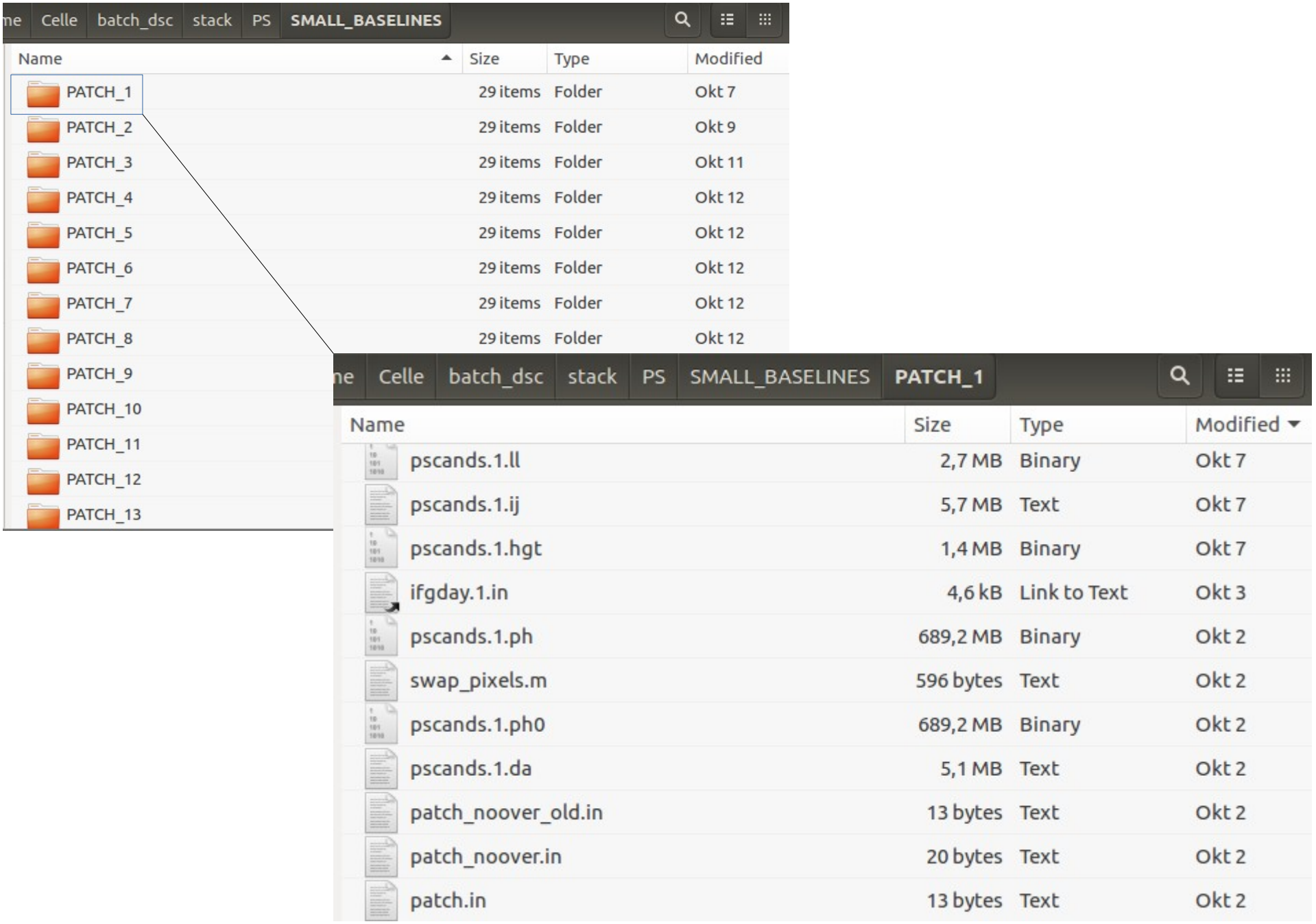
- Step 15 ; Fix the result of PS Candidates (SB)

  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]



StaMPS Processing

- After you sucessfully 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

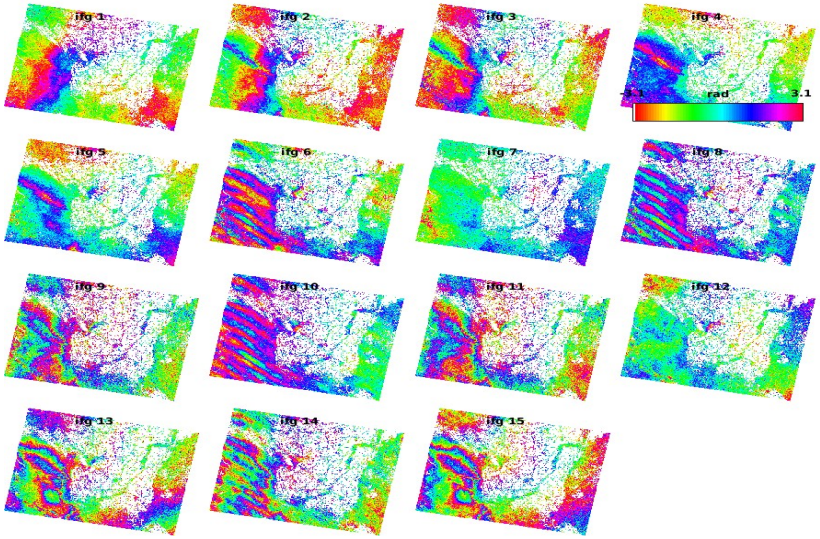
  >> stamps(1,1)

  >> stamps(1,2) etc
- Or all steps

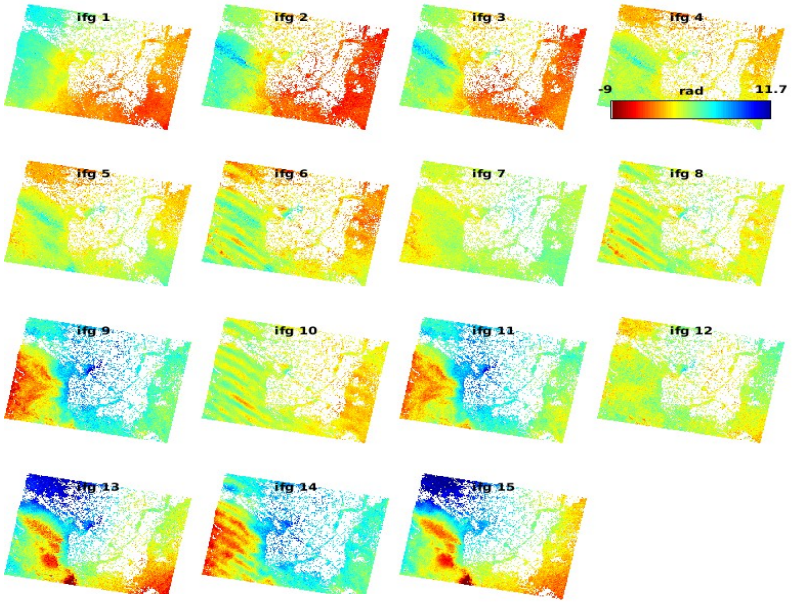
  >> stamps(1,5)

  >> stamps(6,7) etc

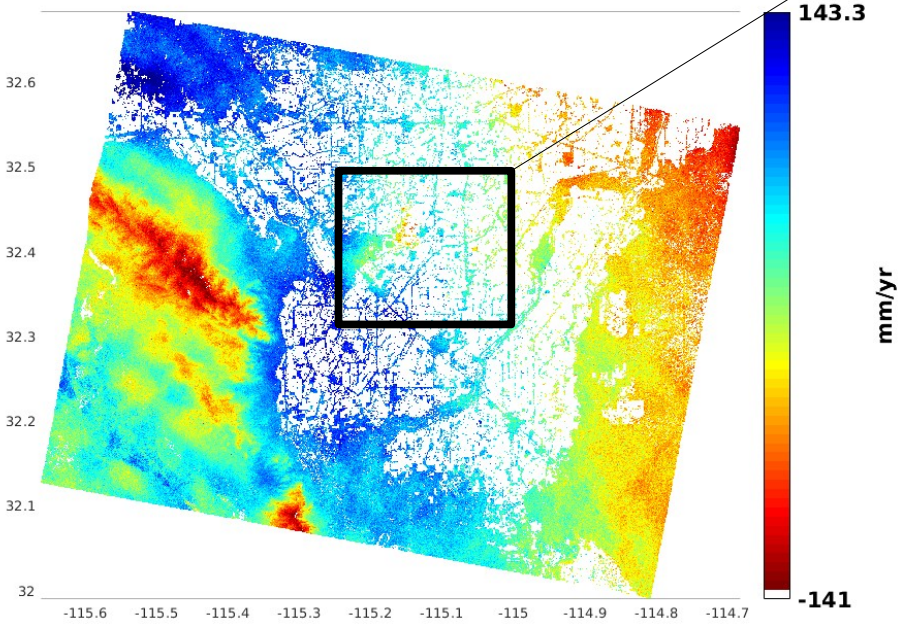
STAMPS result overview (SB method)
Location: Cerro Prieto, Mexico



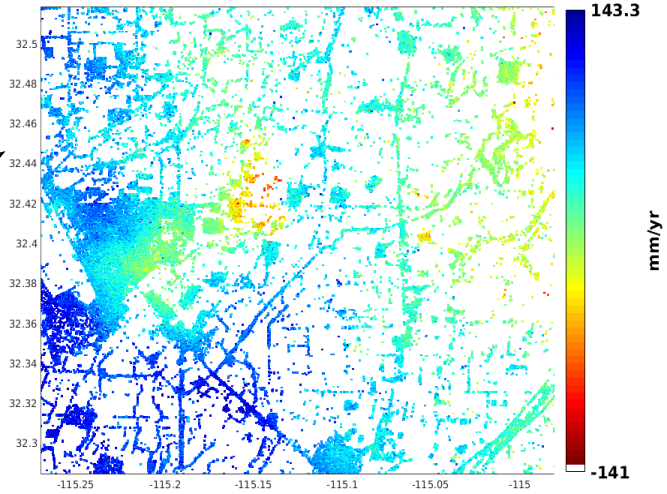
wrapped interferograms

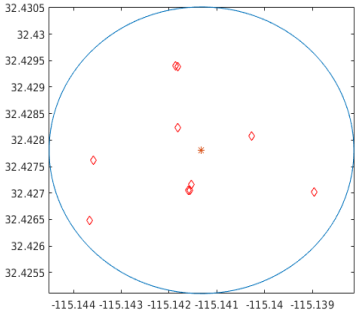


unwrapped interferograms

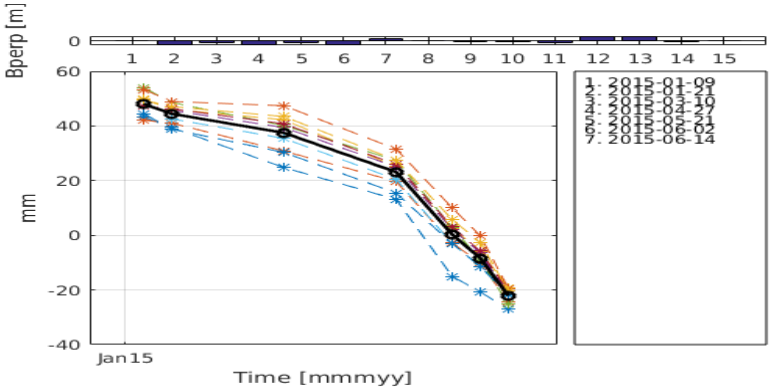


mean velocity (SM network inversion) for V-DO plot

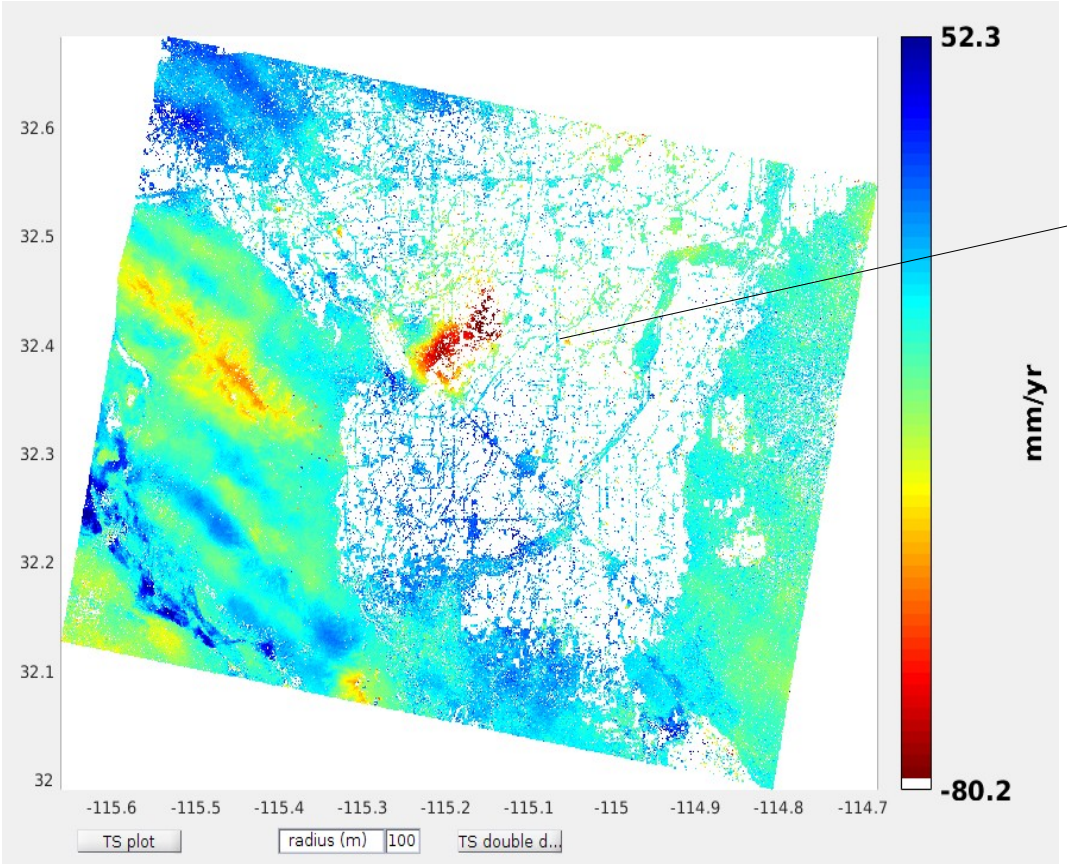


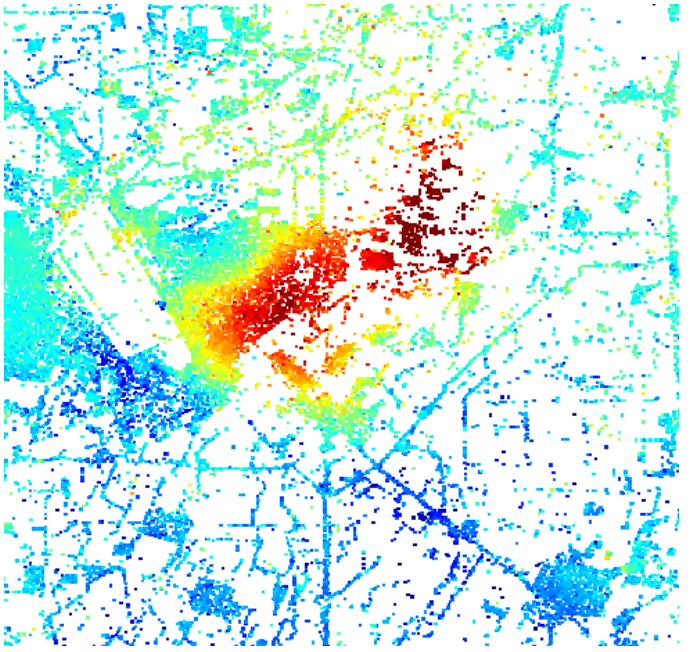


Time series PS scatters



STAMPS result with (set merge_resample_size = 100)





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