PS_DISP 1.0

Guideline
2d/3d displacement generation
using ascending and descending SAR data

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PS_DISP is a bundle script to generate 2D/3D vectors displacement from the LOS InSAR result both ascending and descending data. The output for 2D mode is **the vertical (dU)** and **east-westward (dE)** vectors. 2D mode is appropriate to study cases such as subsidence, crustal deformation, and any other deformation phenomena in which the direction of movement can not predicted easily. The output for 3D mode is the **vertical (dU)**, **east-westward (dE)** and **north-southward (dN)** vectors. 3D *pseudo* mode is computed based on *the elevation downward behavior*. It assumes the movement will be going towards to lower level due to the gravitational effect. It's a pseudo calculation for the third component of 3D vectors using the aspect information. 3D *pseudo* mode could be used to study cases such as landslide (slowly slope movement), glacier monitoring, volcanoes observation, etc.

Requirement

- Default softwares used to create interferogram and PS :

  - GMTSAR

  - STAMPS (TRAIN)

  - If data come from another software, define the process as : "*EXTERNAL"*
- GMT
- Matlab
- ArcGIS → to generate aspect direction; assuming the horizontal movement parallel to aspect direction) for 3d displacement computation.

STAMPS format

Prepare Data

- Make a new directory for mean velocity and time series 2d/3d displacement (example : 3d_disp) → for the mean velocity
- On 3d_disp folder, make a new directory “timeseries”
- Put all of input files in 3d_disp directory for the mean velocity LOS data
- Put all of input files in 3d_disp/timeseries directory for the timeseries LOS data

STAMPS data:

- at ***3d_disp*** directory, copy “ps_plot_v-d*.mat both for asc & dsc
- at ***3d_disp*** directory, copy “ps2*.mat both for asc & dsc
- at ***3d_disp*** directory, copy aspect_val.txt (generated from the third software, e.g. ArcGIS)
- at ***3d_disp/timeseries*** directory, copy (& rename)

  “ps_plot_ts_v-d*_asc.mat” and “ps_plot_ts_v-d*_dsc.mat”
- define the path files at param_PS_DISP.txt

EXTERNAL format

External data option (ignore if you use default processing : STAMPS)

- *input_ex_asc/dsc* contain of LOS ascending result (the mean velocity)

  txt file format : lon,lat,value (comma delimited)

- *TS_asc/dsc_ex* contain of LOS ascending time series result sequentially

  txt file format : value[time01],value[time02],value[time03],...,value[time_end] (comma delimited)

- *lonlat_asc/dsc_ex* contain of longitude (X) and latitude (Y)

  txt file format : lon,lat (comma delimited)

- TS_day_asc/dsc_ex contain of acquisition dates (YYYYMMDD)

  txt file format (per line):

  YYYYMMDD

  YYYYMMDD

  ...

  YYYYMMDD

If there is an error while reading the file txt,
Try to copy paste manually the txt file from windows into **gedit** txt file in linux sytem (ubuntu)

- *azimuth/incidence data asc/dsc* contain of azimuth and incidence angles pixel by pixel

  txt file format : lon,lat,value (comma delimited or space delimited)

How to use PS_DISP

- Set PS_DISP scripts to your shell environment
- Set PS_DISP_matlab.m & pseudo_disp_generate.m to your matlab environment
- Go to your own directory (e.g. 3d_disp)
- Firstly, we will generate 2D and 3D displacement using the mean velocity then going to time series data
- Prepare/set your parameter to be suitable for PS_DISP (*e.g. param_PS_DISP.txt*)
- All of the step are controlled by:

  $ **PS_DISP [mode] [path to param.txt]**

  example : $ PD_DISP 1 /home/isya/3d_disp/param_PS_DISP.txt

PS_DISP mode

Mode:

THE MEAN VELOCITY -->
1 Prepare LOS asc and dsc files using Surface || Nearneighbour method
2 Compute azimuth and incidence angle from the master scene asc & dsc
3 Compute 2d displacement (vertical & west-eastward) components for the mean velocity
4 Compute 3d (psuedo) displacement (vertical & horizontal) components for the mean velocity

TIMESERIES -->
5 Prepare LOS asc and dsc files for time series (TS) using Surface || Nearneighbour method
6 Compute 2d displacement (vertical & west-eastward) components for timeseries
7 Compute 3d (psuedo) displacement (vertical & horizontal) components for timeseries

PLOT -->
8 Plot vertical and horizontal displacement of mean velocity
9 Plot vertical and horizontal displacements for timeseries
10 Plot graphic displacement at a selected location (timeseries)

Standard Statistical Computation -->
11 Compute standard deviation of mean velocity
12 Compute standard deviation for timeseries

13 Retrieve 3D displacements from across- and along- track InSAR

Step 1

InSAR LOS **ascending** + tropospheric correction

InSAR LOS **descending** + tropospheric correction

gridding using surface

gridding using neighbour

select PS scatters based on Amp. Diff. Dispersion from asc/dsc data (only for **surface** method required)

LOS **ascending** (gridding)

LOS **descending** (gridding)

Step 2

LOS **ascending** (gridding)

LOS **descending** (gridding)

compute incidence & heading angle for asc orbit

compute incidence & heading angle for dsc orbit

Aspect from SRTM 30 m

ArcGIS

Step 3 - 7

resample & interpolation
(spasial) (temporal)

compute dU,dE,dN using “3d aspect” method

$$\begin{bmatrix} \cos(\theta_{inc}) & -\sin(\theta_{inc}).\sin(\alpha_h) & -\sin(\theta_{inc}).\cos(\alpha_h) \\ \cos(\theta_{inc}) & -\sin(\theta_{inc}).\sin(\alpha_h) & -\sin(\theta_{inc}).\cos(\alpha_h) \\ 0 & \cos(\theta_{asp}).\cos(90-\theta_{asp}) & -1 \end{bmatrix} \begin{bmatrix} d_U \\ d_E \\ d_N \end{bmatrix} = \begin{bmatrix} dLOS_{asc} \\ dLOS_{dsc} \\ 0 \end{bmatrix}$$

dU , dE, dN

Step 8

vertical displacement using surface gridding

horizontal displacement using vector velocity

script: **PS_DISP**

run PS_DISP ...

```
isya@hermes: ~/APPS/ciloto/Sentinel1_update/3d_disp_update/puncakhighway
isya@hermes:~$ cd APPS/ciloto/Sentinel1_update/3d_disp_update/puncakhighway/
isya@hermes:~/APPS/ciloto/Sentinel1_update/3d_disp_update/puncakhighway$ PS_DISP

Usage: PS_DISP [mode] [PATH_parameter]

  Script to prepare and calculate 2d/3d displacement

  example : PS_DISP 1 /home/isya/3d_disp/param_PS_DISP.txt

  Mode: THE MEAN VELOCITY -->
        1 Prepare LOS asc and dsc files using Surface || Nearneighbour method
        2 Compute azimuth and incidence angle from the master scene asc & dsc
        3 Compute 2d displacement (vertical & west-eastward) components for the mean velocity
        4 Compute 3d (psuedo) displacement (vertical & horizontal) components for the mean velocity

        TIMESERIES -->
        5 Prepare LOS asc and dsc files for time series (TS) using Surface || Nearneighbour method
        6 Compute 2d displacement (vertical & west-eastward) components for timeseries
        7 Compute 3d (psuedo) displacement (vertical & horizontal) components for timeseries

        PLOT -->
        8 Plot vertical and horizontal displacement of mean velocity
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        10 Plot graphic displacement at a selected location (timeseries)

        Standard Statistical Computation -->
        11 Compute standard deviation of mean velocity
        12 Compute standard deviation for timeseries

        3D COMBO -->
        13 Calculate 3d displacement from LOS and Along Track (AZI) ascending and descending data at a single different time

isya@hermes:~/APPS/ciloto/Sentinel1_update/3d_disp_update/puncakhighway$ PS_DISP 1 /home/isya/APPS/ciloto/Sentinel1_update/3d_disp_update/puncakhighway/param_PD_DISP.txt
```

Note:
For **external** process data, PS_DISP can only run using **“neighbour”** method !

param_PS_DISP.txt

If you use 3D mode,
put aspect_val.txt
with a format:
lon,lat,slope_aspect_value

The DEM file
has to be named --> “dem.grd”
in topo_asc or topo_dsc folders.
It can be automatically generated
from the GMTSAR webiste:
https://topex.ucsd.edu/gmtsar/demgen/

```
################## SET PARAMETER ###############################
process = STAMPS
#       * could be STAMPS || EXTERNAL
method = surface
#       * could be surface || neighbour
################################################################
resolution = 0.000046296 (in radian)
radius = 0.000277778 (in radian)
region = 106.99/107.02/-6.73/-6.7 (in degree decimal
longitude_min/longitude_max/latitude_min/latitude_max)
ts_path = timeseries
aspect = aspect_val.txt (aspect information)
################### STAMPS data (mat file) ###################
input_asc = ps_plot_v-d_asc.mat
loc_asc = ps2_asc.mat
input_dsc = ps_plot_v-d_dsc.mat
loc_dsc = ps2_dsc.mat
input_asc = ps_plot_ts_v-d_asc.mat
input_TS_dsc = ps_plot_ts_v-d_dsc.mat
topo_asc = /home/isya/APPS/ciloto/Sentinel1/batch_asc/topo
topo_dsc = /home/isya/APPS/ciloto/Sentinel1/batch_dsc/topo
################## EXTERNAL data (txt file) ################
input_ex_asc =          see param_PS_DISP.txt example
input_ex_dsc =
TS_asc_ex =
TS_dsc_ex =
lonlat_asc_ex =
lonlat_dsc_ex =
TS_day_asc_ex =
TS_day_dsc_ex =
azimuth_data_asc =
incidence_data_asc =
azimuth_data_dsc =
incidence_data_dsc =
################################################################
```

Note:

- if the process is EXTERNAL, topo_asc & topo_dsc will be not used and the method is only **nearneighbour**
- if you only want to calculate 2D displacement, **aspect** is neglected

STAMPS input:

- # for mean velocity, the files must be included:
- - ps_plot_v-d*_asc.mat
- - ps2_asc.mat
- - ps_plot_v-d*_dsc.mat
- - ps2_dsc.mat
- # for timeseries, the files must be included:
- - ps_plot_ts_v-d*_asc.mat
- - ps_plot_ts_v-d*_dsc.mat
- # for 3d pseudo displacement, aspect info is generated from third software (e.g ArcGIS)
- - aspect_val.txt

Output PS_DISP

- The mean velocity output:
  - dE.txt (lon,lat,east-west component)
  - dU.txt (lon,lat,up/down component)
  - dN.txt (lon,lat,north-south component)

2D

3D

- Time series output :
  - dE_ts.txt (east-west component)
  - dU_ts.txt (up/down component)
  - dN_ts.txt (north-south component)
  - lonlat.txt (longitude and latitude information)

2D

3D