Package for A Spatially Varying Scaling Method (ASVS) for InSAR Tropospheric Corrections

Lin Shen

University of Leeds

1. Introduction

A spatially varying scaling method (ASVS) for InSAR tropospheric corrections is developed to address a major limiting factor in Interferometric Synthetic Aperture Radar (InSAR) measurements, that of variable delay through the troposphere. This approach combines the use of both external weather model data and the interferometric phase, which has overcome the limitations of using either approach individually.

The distributed ASVS package consists matlab scripts only and is compatible with the StaMPS software and the TRAIN.

We request users to reference our publication of this approach:

Shen, L., Hooper, A., & Elliott, J. (2019). A spatially varying scaling method for InSAR tropospheric corrections using a high-resolution weather model. *Journal of Geophysical Research: Solid Earth*, **124**, 4051–4068. https://doi.org/10.1029/2018JB016189.

Any feedback is welcomed by sending emails to lshen@ldeo.columbia.edu.

2. Configuration

2.1 Matlab

The ASVS package has been developed based on Matlab 2018, whereas it is expected to run without large problems with other versions.

2.2 StaMPS

The ASVS package is compatible with the StaMPS software version 4.0 and could recognize the StaMPS structure to extract required parameters of interferograms.

2.3 TRAIN

The ASVS package is integrated with the TRAIN version 1beta and could extract tropospheric delays computed from the external weather model data using the TRAIN automatically.

3. Data preparation

As the ASVS package is independent of any processor of InSAR and InSAR tropospheric correction, interferometric phase and tropospheric delay phase estimated from the external weather model data should be provided in advance. A DEM file, a Lon-Lat coordinates file, and other required parameters should be prepared by users as well. If users process the InSAR with the StaMPS software and use the TRAIN to compute tropospheric delays from the external weather model data, most of the required processing parameters can be automatically extracted based on the files of the StaMPS and the TRAIN.

All required parameters should be stored in a Matlab matrix named as **parms_ASVS.mat**, which an example of this matrix is included in the package. The following table shows detailed information about each processing parameters.

Parameter	**Description**	**Interferograms**		**Tropospheric delays**	
		StaMPS structure	Non-StaMPS structure	TRAIN structure	Non-TRAIN structure
stamps_processed	StaMPS structure	‘y’	‘n’	-	-

train_processed	TRAIN structure	-	-	'y'	'n'
phuw_file	Full file path of unwrapped interferograms stored as a matrix of size [n_points n_ifgs] in radian units, variable 'ph_uw'	Automatically loading from the StaMPS processed phuw_sb2.mat	Loading the file path given by users	-	-
ph_tropo_era_file	Full file path of tropospheric delays stored as a matrix of size [n_points n_ifgs] in radian units, variable 'ph_tropo_era'	-	-	Automatically loading from the TRAIN processed tca_sb2.mat	Loading the file path given by users
hgt_file	Full file path of the topography stored as a matrix of size [n_points,1] in meter units, variable 'hgt'	Automatically loading from the StaMPS processed hgt2.mat	Loading the file path given by users	-	-
ll_file	Full file path of the Lon-Lat geocoordinates, stored as a matrix of size [n_points, 2] in the longitude and latitude, variable 'lonlat'	Automatically loading from the StaMPS processed ps2.mat	Loading the file path given by users	-	-
utm_zone	The utm zone of the ROI	From users			
heading_InSAR	The azimuth direction of the satellite in degree units				
win_size	The grid size in kilometer units				
x_min	The grid corners in kilometer units				
x_max					
y_min					
y_max					
sm_std	The Gaussian smoothing width in kilometer units	Default value is 71 km			
n_ifg	The number of interferograms	Automatically loading from the StaMPS	From users	-	-
n_image	The number of images				

ifgday_ix_file	Full path of the design matrix relating the relevant observation epochs for each interferogram,	processed ps2.mat			
	stored with name ‘ifgday_ix’				

4. Programs

4.1 Installation

After unzipping the zipfile of the ASVS package at YOURPATH, to source functions in the sub-folder named ‘functions’, users should be able to run the following command in Matlab. This takes a few seconds to build on a "normal" desktop computer.

```
>> addpath(‘YOURPATH/ASVS/functions’);
```

4.2 Step 1 - getting a grid overlapped with the ROI

A grid overlapped with the ROI is generated in step 1 as ‘step1_get_grid.m’. Users may need to run this step for multiple times to adjust the geometry of the grid until it is well-overlapped with the ROI (e.g., figure 3a in Shen et al., 2019). Results of this step are saved in a matlab matrix named as **scaling_grid.mat** and will be used in the following step 2.

4.3 Step 2 - estimating spatially varying scaling factors

Spatially varying scaling factors are derived in step 2 as ‘step2_run_ASVS.m’. Outputs of this step are the scaled tropospheric phase delay anomaly of each single epoch and the estimated smoothed spatially varying scaling factors of every point in the ROI. These final results are saved in a matlab matrix as **ASVS_results.mat**. Please refer to the paper (Shen et al., 2019) for more details about the methodology. Users then could compute the scaled interferometric tropospheric delays and subtract them from interferometric phase to derive tropospheric corrected interferograms.

5. Demo

The demo included in this package comprises:

- a Matlab matrix with interferometric phase, 'phuw_sb2', derived from Sentinel-1 data spanning the period between October 2014 to December 2016, covering the Nevados de Chillán Volcano in central Chile.
- a Matlab matrix with tropospheric delay phase, 'tca_sb2', estimated from HRES-ECMWF weather model data.
- a Matlab matrix of DEM, 'hgt'.
- a Matlab matrix of Lon-Lat coordinates, 'll'.
- a Matlab matrix with all required parameters, 'parms_ASVS'.

Running this demo on a "normal" desktop computer typically takes a few seconds.