Interferometric processing system (ips)

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This manual describes the functionality of the interferometric processing system (ips). It shows how to generate an ips configuration file and provides an example run that explains the interferometric processing flow in more detail. A completely filled sample configuration file can be taken as reference.

This manual does not give any further introduction into the field of SAR interferometry (InSAR). The user is expected to have a basic understanding of InSAR and to be familiar with the InSAR terminology. For a more detailed introduction the user is referred to the references at the end of this manual.

How to create an ips configuration file

The ips tool is able to process an interferometric image pair from ingesting the individual SAR images to the generation of a digital elevation model and the export to the more user friendly GeoTIFF format. In order to run through this processing flow, a number of parameters need to be defined in a configuration file.

Basic configuration file

A configuration file can be generated from scratch with the following

```
Command line:
 ips -create project.config

Date: 13-Nov-2006, 09:44:30
PID:  15475

   Initialized basic configuration file
```

This generates a configuration with three basic sections: [General], [Master image] and [Slave image].

```
ips configuration file

[General]
mode = DEM
reference dem =
base name =
data type = STF
deskew = 0
doppler = average
lat begin = -99.0
lat end = -99.0
coregistration = PATCH
```

```
maximum offset = 3
default values =
test mode = 0
short configuration file = 1
status = new


[Master image]
path =
data file =
metadata file =


[Slave image]
path =
data file =
metadata file =
```

The first four parameters in the [General] section are the most important ones. The processing mode is by default *DEM* for the generation of a digital elevation model. The alternative *DINSAR* mode is still under development. A lower resolution *reference DEM* is used at various stages in the SAR interferometric processing, e.g. to refine the geolocation of SAR imagery. The *basename* is used in all filenames that are considered worth saving for further analysis. All other intermediate files can be safely deleted. The *data type* determines which strategies are applied for the co-registration of the two SAR images. The Sky Telemetry Format (STF) offers the maximum flexibility as it allows the definition of a latitude range (*lat begin* and *lat end*) that is supposed to be processed.

For a project that requires the processing of a large number of data sets with the same set of parameters it is advisable to define the *default values* in a separate file. More details about the default values file is given in the next section. It should be noted that for this example the *short configuration file* flag was set to 1. By default this value is set to 0 which results in a fully commented basic configuration file.

The remaining two sections [Master image] and [Slave image] define the data sets used in the processing. Each data set consists of a data file and a metadata file that are assumed to be stored in the same location described by its path. The naming schemes for the various supported data types vary.

Further details about the processing parameters can be found in the comments section of the complete example configuration file for each individual parameter.

Default values file

As mentioned before it is advisable for larger project to define default values for essential parameters that are applied throughout the entire project. The following parameters can be predefined.

mode = DEM
reference dem = /data/alaska_dem.img
data type = STF
coregistration = PATCH
doppler = average
deskew = 0
maximum offset = 3
precise master = /data/PRC/ERS2
precise slave = /data/PRC/ERS1
minimum coherence = 0.3
phase unwrapping = snaphu
tiles per degree = 10
tile overlap = 100
projection file = /export/asf_tools/share/asf_tools/projections/
albers_equal_area_conic/albers_equal_area_conic_alaska.proj
projection name = albers
resampling method = bilinear
pixel spacing = 20

Complete configuration file

In order to extend the configuration file to its complete form, the previous command line needs to be repeated.

```
Command line:
 ips -create project.config

Date: 13-Nov-2006, 09:46:49
PID:  18321

   Initialized complete configuration file
```

Running the ips tool

The ips tool can be run with complete configuration file using the following command line:

```
ips project.config
```

Processing flow

The following example shows the processing flow for generating a digital elevation model from ERS tandem data. All processing steps are commented to provide additional information for the command lines.

DEM generation with the ips

```
Command line: ips delta.config
Program: ips
```

```
   Data type: STF
   Processing mode: DEM
```

[Ingest]

```
Command line: asf_import -format STF -log delta.log -quiet -lat 63.500000
64.200000 e2_3919.000 a

Command line: asf_import -format STF -log delta.log -quiet -lat 63.500000
64.200000 e1_23592.000 b
```

Both images are ingested as STF format with the same latitude constraint to focus on the area in Delta Junction where the ASF corner reflectors are deployed.

[Doppler]

```
Command line: avg_in_dop -log delta.log a b reg/avedop
Program: avg_in_dop

   Average: 2.096312e-01 -2.809000e-06 0.000000e+00
```

This program averages the Doppler polynomials in the processing parameter files of the master and slave images.

[Coregister first patch]

```
Command line: ardop -log delta.log -quiet -p 1 -v 3300 -l 0 -debug 1 -c a.dop
a reg/a_p1

Command line: ardop -log delta.log -quiet -p 1 -v 3300 -l 0 -debug 1 -c b.dop
b reg/b_p1
```

The first patch of the master and the slave image are processed using the average Doppler values.

```
Command line: coregister_coarse -log delta.log -quiet reg/a_p1 reg/b_p1
base.00 reg/ctrl1

   Baseline: Bn = -60.680820, dBn = 3.959511, Bp = 19.325935, dBp = -
1.459707, Btemp = -1.000020
   Offset slave image: dx = -2.875183, dy = -37.051548
   Certainty: 59.477118%
   Complex image offset is -185 rows, -2 columns
```

The first estimate for the offset is derived from the state vectors. This offset is then refined using a correlation match in the frequency domain. A first estimate of the baseline is stored as well as a parameter file used for the fine coregistration.

[Coregister last patch]

```
Command line: ardop -log delta.log -quiet -p 1 -v 3300 -l 16461 -debug 1 -c
a.dop a reg/a_pL

Command line: ardop -log delta.log -quiet -p 1 -v 3300 -l 16461 -debug 1 -c
b.dop b reg/b_pL

Command line: coregister_coarse -log delta.log -quiet reg/a_pL reg/b_pL
base.00 reg/ctrlL

   Baseline: Bn = -60.680820, dBn = 3.959511, Bp = 19.325935, dBp = -
1.459707, Btemp = -1.000020
   Offset slave image: dx = -2.814972, dy = -37.055672
   Certainty: 69.128597%
   Complex image offset is -185 rows, -2 columns
```

The same procedure as for coregistering the first patch is applied over here.

[ardop - Master image]

```
Command line: coregister_fine -log delta.log -quiet -g 20 -f reg/a_p1
reg/b_p1 reg/ctrl1 reg/fico1
Program: coregister_fine

   Using Complex FFT instead of coherence for matching
   coregister_fine attempted 400 correlations, 376 succeeded.
```

The correlation technique uses by default an approach based on the coherence values. The quality of the offset points is evaluated by comparing forward and backward correlation. The grid size of the correlation points can be increased. This will lead to a better defined offset grid at the expense of processing time. Empirical studies show that a complex FFT approach for the correlation generally leads to a significant improvement in the coherence level.

```
Command line: coregister_fine -log delta.log -quiet -g 20 -f reg/a_pL
reg/b_pL reg/ctrlL reg/ficoL
Program: coregister_fine

   Using Complex FFT instead of coherence for matching
   coregister_fine attempted 400 correlations, 377 succeeded.
```

The fine coregistration is performed on both the first and the last patch.

```
Command line: fit_line -log delta.log -quiet reg/fico1 reg/line1
Program: fit_line

   Fit_line with 376 points:
   <img 2>.x=<img 1>.x+  0.0001440237249546*<img 1>.x+  2.5474446693804804
   <img 2>.y=<img 1>.y+  0.0002295734311467*<img 1>.x+185.1400117169461339

   x linear, x offset, y linear, y offset:
     0.0001340049717504   2.5836781231447490   0.0002244494772772
185.1628024106335886 301
```

This program performs a least-squares regression on the offset grid points calculated during the forward and backward correlation in the fine coregistration. From the weighted linear first-order least-squares fit a regression line is stored that serves as input to the creation of an offset file for SAR image processing.

```
Command line: fit_line -log delta.log -quiet reg/ficoL reg/lineL
Stopwatch started on date: Tue Jun 28 15:00:43 2005
Program: fit_line

   Fit_line with 377 points:
   <img 2>.x=<img 1>.x+  0.0001604277038263*<img 1>.x+  2.3673973103340575
   <img 2>.y=<img 1>.y+  0.0002304019004998*<img 1>.x+185.1183467629651034

   x linear, x offset, y linear, y offset:
     0.0001489173666843   2.4077702272425725   0.0002254558304249
185.1352615899909608 302
```

The same procedure is carried out for the last patch.

```
Command line: ardop -log delta.log -quiet -p 6 -v 3300 -l 0 -debug 1 -c a.dop
-power a a

   Calculating power image
```

The whole master image is processed in the average Doppler geometry. No other transformations are applied. The master image remains unchanged during the entire coregistration process.

[ardop - Slave image]

```
Command line: calc_deltas reg/line1 reg/lineL 16461 reg/deltas
```

The linear regression coefficients are converted to an offset file that can be used as an input for the SAR image processing.

```
Command line: ardop -log delta.log -quiet -p 6 -v 3300 -l 0 -o reg/deltas -
debug 1 -c b.dop -power b b_corr

   Calculating power image
```

The slave image is processed applying the offsets determined by the linear regression. This approach eliminates an otherwise required resampling step outside the SAR processor.

[Interferogram/coherence]

```
Command line: igram -log delta.log a_cpx.img b_corr_cpx.img delta_igram
```

The generation of an interferogram is the result of the complex multiplication of the master and the slave image, i.e. the master image is multiplied with the complex conjugate of the slave image. The resulting interferogram is not deramped yet. Therefore, the phase values are still not corrected for earth curvature. For the interferogram an amplitude image as well as a phase image is created.

```
Command line: coh -log delta.log a_cpx.img b_corr_cpx.img coh.img
Program: coh

   Coherence     :  Occurances  :  Percent
   ---------------------------------------
    0.00 -> 0.10 :   00039713       0.209
    0.10 -> 0.20 :   00114789       0.604
    0.20 -> 0.30 :   00225746       1.188
    0.30 -> 0.40 :   00400386       2.106
    0.40 -> 0.50 :   00688465       3.622
    0.50 -> 0.60 :   01177413       6.194
    0.60 -> 0.70 :   02187634       11.509
    0.70 -> 0.80 :   04907175       25.816
    0.80 -> 0.90 :   08261494       43.463
    0.90 -> 1.00 :   01005185       5.288
   Maximum Coherence: 0.995
   Average Coherence: 0.750  (14264888.2 / 19008000) 100.000000
```

The coherence image is calculated for the two coregistered SAR images. It reads the number of looks from the metadata file unless another step interval or window size is given. The default look area is 5x1 and default step area is 15x3.

```
Command line: multilook -log delta.log -meta a_cpx.meta delta_igram
delta_igram_ml

   Input is 19800 lines by 4800 samples
   Ouput is 3960 lines by 4800 samples
```

The interferogram is multilooked using coherent summation. The multilooking of an interferogram results in an output that has square pixels. An RGB representation of the interferometric phase with the amplitude as background is created as well.

[Offset matching]

```
Command line: asf_check_geolocation -log delta.log delta_igram_ml_amp.img
delta_fixed.img offset dem_sim.img dem_slant.img
   Detected slant range SAR image
   Generating 30x30 DEM grid ...
   Fitting order 5 polynomial to DEM ...
   Maximum error in polynomial fit: 0.00268944.
   Clipping DEM to 3960x5200 LxS using polynomial fit ...
   Generating slant range DEM and simulating amplitude image ...
```

This program creates a mapping grid which can be used to extract a portion of a DEM to fit a given SAR image. The mapping grid points are used to fit a fifth-order polynomial. A subset of the reference DEM is created covering a slightly larger area than the SAR image. An additional 400 sample wide buffer is applied to ensure the complete mapping of the map projected image into slant range geometry.The program remaps a ground range elevation model into a slant range elevation model and creates a slant range simulated amplitude.

[Simulated phase]

```
Command line: dem2phase -log delta.log dem_slant.img delta.base.00
out_dem_phase.img
```

The phase image is derived from the slant range elevation using the image geometry and baseline.

```
Command line: dem2seeds -log delta.log dem_slant.img delta_igram_ml_amp.img
delta.seeds
Program: dem2seeds

   Potential seed points: 10000
   Final number of seed points: 3034

   Seed point distribution:
```

```
            X   X
        X X   X  XX
   X    XX  XX  XX
     X   XXXXXXXXX
     XX     XXXXXX
    X X XXXXXXXXXX
      XXXXXXXXXXXX
      XXXXXXXXXXXX
   XX   XXXXXXXXXX
    XXXXXXXXXXXXXX
   XXXXXXXXXXXXXXX
   XXXXXXXXXXXXXXX
   XXXXXXXXX  XXXX
   X XXXXXX   XXXX
   XX XXX X    XXX
```

This program searches for good seed point locations in a slant range digital elevation model. The algorithm first uses a dense regular grid of points to calculate the local slope. The points are sorted by local slope and the list is searched for the best points in a less dense grid to ensure a good spatial distribution. These seed point locations are used for refining the interferometric baseline. Good seed points are defined as those having minimal local slope.

[Deramp/multilook]

```
Command line: deramp -log delta.log delta_igram delta.base.00 igramd
   Baseline:   Normal: -60.680820, delta: 3.959511
               Parallel: 19.325935, delta: -1.459707
               Temporal: -1.000020 days
```

The interferogram is corrected for the earth curvature by removing the baseline induced phase shift.

```
Command line: multilook -log delta.log -meta a_cpx.meta igramd ml
Program: multilook

   Input is 19800 lines by 4800 samples
   Ouput is 3960 lines by 4800 samples
```

The deramped interferogram is multilooked to have phase values for square pixels.

[Phase unwrapping]

```
Command line: raster_calc -log delta.log ml_dem_phase.img '(a-b)%6.2831853-
3.14159265' ml_phase.img out_dem_phase.img
```

In order to simplify the phase unwrapping problem the topographic phase part derived the slant range DEM is subtracted from the multilooked interferogram.

```
Command line: phase_filter -log delta.log ml_dem_phase.img 1.6 filtered_phase
```

In this step, the Goldstein phase filter is applied to the interferogram. The filter raises the fast Fourier transformed phase in the frequency domain to some power and transforms the scaled image back into the time domain. This way the signal (topography or motion) in a phase image is preferentially amplified over the noise (decorrelation).

```
Command line: zeroify -log delta.log filtered_phase ml_phase.img
escher_in_phase.img
```

This program is used to set the phase values in the filtered phase image to zero that are zero in the phase simulated from the reference DEM.

```
Command line: escher -log delta.log escher_in_phase.img unwrap_dem
```

This program uses the Goldstein branch-cut phase unwrapping algorithm to unwrap the given [-π,π) input file into the phase unwrapped output file.

```
Command line: raster_calc -log delta.log unwrap_phase.img '(a+b)*(a/a)*(b/b)'
unwrap_dem.img out_dem_phase.img
```

The topographic phase that had been removed to simplify the phase unwrapping problem needs now to be added in again.

```
Command line: convert2ppm -mask unwrap_dem_phase.mask unwrap_mask.ppm
```

A phase unwrapping mask is created that contains detailed information about the phase unwrapping process.

```
Command line: deramp -log delta.log -backward unwrap delta.base.00 unwrap_nod
```

```
   Baseline:   Normal: -60.680820, delta: 3.959511
               Parallel: 19.325935, delta: -1.459707
               Temporal: -1.000020 days
```

In order to do the baseline refinement the unwrapped phase needs to be reramped, i.e. the flat earth phase term is added again.

[Baseline refinement]

```
Command line: refine_base -log delta.log -quiet unwrap_nod_phase.img
delta.seeds delta.base.00 delta.base.01

   Baseline:   Normal: -60.680820, delta: 3.959511
               Parallel: 19.325935, delta: -1.459707
               Temporal: -1.000020 days

   New Baseline:  Normal: -60.383602, delta: 4.371972
                  Parallel: 19.308496, delta: -1.759689


Command line: refine_base -log delta.log -quiet unwrap_nod_phase.img
delta.seeds delta.base.01 delta.base.02

   Baseline:   Normal: -60.383602, delta: 4.371972
               Parallel: 19.308497, delta: -1.759689
               Temporal: 1.000000 days

   New Baseline:  Normal: -60.381916, delta: 4.374791
                  Parallel: 19.308531, delta: -1.758919


Command line: refine_base -log delta.log -quiet unwrap_nod_phase.img
delta.seeds delta.base.02 delta.base.03

   Baseline:   Normal: -60.381916, delta: 4.374791
               Parallel: 19.308531, delta: -1.758919
               Temporal: 1.000000 days

   New Baseline:  Normal: -60.381912, delta: 4.374810
                  Parallel: 19.308533, delta: -1.758914
```

The baseline is refined in an iterative fashion using the reramped unwrapped phase and the seeds file derived the reference slant range DEM. The iteration usually converges in three steps.

```
Command line: deramp -log delta.log delta_igram delta.base.03 igramd
   Baseline:   Normal: -60.381912, delta: 4.374810
               Parallel: 19.308533, delta: -1.758914
               Temporal: 1.000000 days
```

The newly refined baseline is now applied to the original interferogram, removing the baseline induced phase shift.

```
Command line: multilook -log delta.log -meta a_cpx.meta igramd delta_igram_ml
Program: multilook

   Input is 19800 lines by 4800 samples
   Ouput is 3960 lines by 4800 samples
```

The resulting interferogram is multilooked again. This multilooked interferogram can now be analyzed to verify that there are no residual phase shifts are present that are caused by the baseline.

[Elevation]

```
Command line: deramp -log delta.log unwrap_nod delta.base.03 unwrap
   Baseline:   Normal: -60.381912, delta: 4.374810
               Parallel: 19.308533, delta: -1.758914
               Temporal: 1.000000 days
```

In order to convert the unwrapped phase into elevation it needs to be deramped with the refined baseline.

```
Command line: elev -log delta.log -quiet unwrap_phase.img delta.base.03
delta_ht.img delta.seeds
```

In this step the unwrapped phase is finally converted into a digital elevation model in slant range geometry.

```
Command line: eleverr -log delta.log -mask unwrap_dem_phase.mask coh.img
delta.base.03 delta_err_ht.img
```

A slant range DEM error map is generated from the phase unwrapping mask, coherence image and baseline information.

[Ground range DEM]

```
Command line: deskew_dem -log delta.log delta_ht.img elevation.img
Date: Program: deskew_dem
```

```
DEM in slant range, but will be corrected.
Correcting DEM geometrically.
```

The slant range DEM is converted to ground range and interpolates across areas that could not be unwrapped. This is done using a first order linear approximation to map slant ranges to ground ranges.

```
Command line: deskew_dem -i a_amp.img 1 elevation.img amplitude.img

Command line: deskew_dem -i delta_err_ht.img 1 elevation.img error.img

Command line: deskew_dem -i coh.img 0 elevation.img coh_gr.img
```

The amplitude, error map and coherence image are converted to ground range as well.

[Geocoding]

```
Command line: asf_geocode -read-proj-file
/share/asf_tools/projections/utm/utm.proj -resample-method bilinear -pixel-
size 20.0 -log delta.log -quiet elevation delta_dem

Determining input image extent in projection coordinate space... done.

Performing analytical projection of a spatially distributed
subset of input image pixels... done.

For the differences between spline model values and projected values
for the analytically projected control points:
Mean: 0.0415724
Standard deviation: 0.0373593
Maximum (Worst observed error in pixel index distance): 0.210217
Maximum x error (worst observed error in x pixel index): 0.167267
Maximum y error (worst observed error in y pixel index): -0.176808
Upper left x corner error: 0.054716
Upper left y corner error: 0.113214
Lower right x corner error: 0.004211
Lower right y corner error: 0.002705

Resampling input image into output image coordinate space...

Storing geocoded image...


Command line: asf_geocode -read-proj-file
/share/asf_tools/projections/utm/utm.proj -resample-method bilinear -pixel-
size 20.0 -log delta.log -quiet amplitude delta_amp
```

```
Command line: asf_geocode -read-proj-file
/share/asf_tools/projections/utm/utm.proj -resample-method bilinear -pixel-
size 20.0 -log delta.log -quiet error delta_error

Command line: asf_geocode -read-proj-file
/share/asf_tools/projections/utm/utm.proj -resample-method bilinear -pixel-
size 20.0 -log delta.log -quiet coh_gr delta_coh
```

In a final step the newly generated digital elevation model, the amplitude image, the error map and the coherence image are geocoded to a map projection. This is the link from the SAR geometry to the real world as it allows the use of the DEM in other application such as GIS etc.

[Export]

```
Command line: asf_export -format geotiff -log delta.log -quiet delta_dem
delta_dem

Command line: asf_export -format geotiff -log delta.log -quiet delta_amp
delta_amp

Command line: asf_export -format geotiff -log delta.log -quiet delta_error
delta_error

Command line: asf_export -format geotiff -log delta.log -quiet delta_coh
delta_coh
```

In order to use the results outside the ASF software tool environment all final results are exported to GeoTIFF format. This ensures that all the common commercial remote sensing and image processing packages can handle the results and keep the reference frame defined by the map projection.

Example: Complete configuration file

This completely filled configuration file serves as a reference and example what values can be expected for the individual parameters can be expected. This configuration is ready to be run using the ips tool.

ips configuration file

[General]

The interferometric processing system 'ips' can be run in two
different modes. The main mode is DEM for the generation of digital elevation
models. The DINSAR mode for differential interferometry is still under
development.

mode = DEM

```
# This parameter looks for the location of the reference DEM file
# The reference DEM is used in various parts of the SAR interferometric
# processing flow, mostly prominently for the phase unwrapping.

reference dem = /export/apd/rgens/ips/dem/alaska_fixed.img

# The ips saves a large number of intermediate and final results.
# All the files relevant for further analysis will start with this basename

base name = delta

# The ips handles three different data types. The most flexible type
# is the level zero Sky Telemetry Format (STF). This swath data type allows for
# variable area sizes that are processed. The second data type is RAW for CEOS
# level zero data. The third supported data type is single look complex data(SLC)

data type = STF

# The deskew flag indicates whether the raw data is SAR processed in
# in zero Doppler geometry or not (1 for deskewing, 0 for regular processing)

deskew = 0

# For the SAR processing, two different schemes for chosing the
# Doppler values have been considered. Currently only the processing to the
# 'average' Doppler values of the image pair is used. The alternative approach
# that uses 'updated' Doppler values has not been implemented.

doppler = average

# For effectively using swath data the user can define latitude
# constraints to select a subset of the swath data (-99 indicates that no
# latitude constraint is chosen).

lat begin = 63.650
lat end = 64.250

# Matching up the first and last patches of an image pair leads to
# the best results. For this approach use the 'PATCH' option. Once this method
# fails you can use the 'FRAME' option to match up master and slave image in
# its entirety.

coregistration = PATCH

# This parameter defines the maximum allowed pixel offset in range
# or azimuth after the initial co-registration has been performed. Three pixels
# is an empirical value that worked in most cases.

maximum offset = 3

# The default values file is used to define the user's preferred
# parameter settings. In most cases, you will work on a study where your area
# of interest is geographically well defined. You want the data for the entire
# project in the same projection, with the same pixel spacing and the same
# output format.
```

A sample of a default values file can be located in
/export/home/rgens/svnbuild/asf_tools//share/asf_tools/ips.

default values =

The test mode is for internal use only (1 for test mode on, 0 for
test mode off).

test mode = 0

The short configuration file flag allows the experienced user to
generate configuration files without the verbose comments that explain all
entries for the parameters in the configuration file (1 for a configuration
without comments, 0 for a configuration file with verbose comments)

short configuration file = 0

The general status field indicates the progress of the processing.
The status 'new' indicates that the configuration has only been initialized
but not run yet. For each new run the status needs to be set back to 'new'
before running a data set again. Once the processing starts the status changes
to 'processing'. When the processing is complete it is changed to 'success'

status = new

[Master image]

This parameter gives the path of the master image data.

path = /export/apd/rgens/ips/stf

This parameter gives the name of the master data file.
Swath data has usually an extension .000, whereas CEOS data has an extension
.D

data file = e1_23592.000

This parameter gives the name of the master metadata file.
Swath data has usually an extension .par, whereas CEOS data has an extension
.D

metadata file = e1_23592.000.par

[Slave image]

This parameter gives the path of the slave image data.

path = /export/apd/rgens/ips/stf

This parameter gives the name of the slave data file.
Swath data has usually an extension .000, whereas CEOS data has an extension
.D

data file = e2_3919.000

This parameter gives the name of the slave metadata file.
Swath data has usually an extension .par, whereas CEOS data has an extension
.D

metadata file = e2_3919.000.par

[Ingest]

This parameter defines the location of the precision state
vectors provided by the German Aerospace Center (DLR) for the master image

precise master =

This parameter defines the location of the precision state
vectors provided by the German Aerospace Center (DLR) for the slave image

precise slave =

This flag defines whether precision state vectors should be used
or not (1 for using precision state vectors, 0 for not using precision
state vectors). This funcionality is not fully implemented yet.

precise orbits = 0

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Doppler]

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Coregister first patch]

This parameter defines the number of patches that are used
during the co-registration of the upper part of the images. Ideally the
images correlate with one patch. At times, two patches might be required

patches = 1

This parameter indicates at which line number the processing
of the first patch of the master image is started. This can be changed
when the initial co-registration does not succeed.

start master = 0

This parameter indicates at which line number the processing
of the first patch of the slave image is started. This can be changed
when the initial co-registration does not succeed.

start slave = 0

This parameter determines the number of pixels that define the
grid that is used for the FFT match

grid = 20

This parameters defines whether a complex FFT is used for the
fine co-registration instead of the coherence (1 for complex FFT match,
0 for FFT match using coherence). Complex FFT matches usually lead to
better matching results.

fft = 1

This parameter indicates the pixel offset in azimuth direction
the matching algorithm determined.

offset azimuth = 0

This parameter indicates the pixel offset in range direction
the matching algorithm determined.

offset range = 0

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Coregister last patch]

This parameter defines the number of patches that are used
during the co-registration of the lower part of the images. Ideally the
images correlate with one patch. At times, two patches might be required

patches = 1

This parameter indicates at which line number the processing
of the last patch of the master image is started. This can be changed
when the initial co-registration does not succeed.

start master = 0

This parameter indicates at which line number the processing
of the last patch of the slave image is started. This can be changed
when the initial co-registration does not succeed.

start slave = 0

This parameter determines the number of pixels that define the
grid that is used for the FFT match

grid = 20

This parameters defines whether a complex FFT is used for the
fine co-registration instead of the coherence (1 for complex FFT match,
0 for FFT match using coherence). Complex FFT matches usually lead to
better matching results.

fft = 1

This parameter indicates the pixel offset in azimuth direction
the matching algorithm determined.

offset azimuth = 0

This parameter indicates the pixel offset in range direction
the matching algorithm determined.

offset range = 0

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[ardop - Master image]

This parameter indicates the start offset determined by the
the first patch co-registration for the master image.

start offset = 0

This parameter indicates the end offset determined by the
the last patch co-registration for the master image.

end offset = 0

This parameter indicates how many patches of data have been
for the master image.

patches = 1

This flag defines whether a power image is created while
processing the master image (1 for generating a power image, 0 for not
generating a power image).

power flag = 1

This parameter defines the file name of the master power image.

power image = delta_a_pwr.img

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[ardop - Slave image]

This parameter indicates the start offset determined by the
the first patch co-registration for the slave image.

start offset = 0

This parameter indicates the end offset determined by the
the last patch co-registration for the slave image.

end offset = 0

This parameter indicates how many patches of data have been
for the slave image.

patches = 1

This flag defines whether a power image is created while
processing the slave image (1 for generating a power image, 0 for not
generating a power image.

power flag = 1

This parameter defines the file name of the slave power image.

power image = delta_b_pwr.img

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Interferogram/coherence]

This parameter defines the file name of the interferogram

interferogram = delta_igram

This parameter defines the file name of the coherence image

coherence image = coh.img

The minimum coherence level defines the threshold for the
interferometric processing flow to interrupt the processing. In case the
average of an image pair is below this threshold the ips automatically
aborts any further processing. This way the low average coherence is used
as an indicator for co-registration problems.

minimum coherence = 0.3

This indicates whether a multilooked version of the interferogram
is stored (1 for generating a multilooked interferogram, 0 for not generating
one).

multilook = 1

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Offset matching]

Maximum pixel offset allowed during matching with reference
DEM.

max = 1.0

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Simulated phase]

Name of the file containing seed points used in the phase
unwrapping process. Seed points are selected on a regular grid and represent
points with minimum slope.

seeds = delta.seeds

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Deramp/multilook]

The status field indicates the progress of the processing.

The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Phase unwrapping]

Name of the phase unwrapping algorithm used.
Currently two phase unwrapping algorithms are supported. 'escher' is an
implementation of Goldstein's branch cut algorithm. 'snaphu' has been
developed and is distributed by Stanford University. It uses a minimum
cost flow network.

algorithm = escher

This parameters defines whether a topographic phase based on
an ellipsoidal approximation is subtracted from the phase before the
phase unwrapping

flattening = 1

This parameter sets the number of processors used for the
phase unwrapping (only valid for using 'snaphu').

processors = 8

This parameter defines the number of tiles in azimuth direction
used by the 'snaphu' phase unwrapping algorithm.

tiles azimuth = 0

This parameter defines the number of tiles in range direction
used by the 'snaphu' phase unwrapping algorithm.

tiles range = 0

Alternatively, the number of tiles used by 'snaphu' in azimuth
direction can defined per degree.

tiles per degree = 0

This parameter defines the overlap between tiles in azimuth
direction (only valid for using 'snaphu').

overlap azimuth = 400

This parameter defines the overlap between tiles in range
direction (only valid for using 'snaphu').

overlap range = 400

This parameter defines the weighting factor used for the
phase filtering (default value: 1.6).

filter = 1.6

Name of the quality control file generated when using the
snaphu phase unwrapping algorithm.

quality control = delta_qc.phase

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Baseline refinement]
Number of iterations used in the baseline refinement.

iterations = 0
This parameter defines the maxiumum number of iterations allowed
for the iterative determination of the interferometric baseline.

max iterations = 15

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Elevation]

File name of the elevation model in slant range.

dem = delta_ht.img

File name of the error map generated in slant range.

error map = delta_err_ht.img

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Ground range DEM]

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Geocoding]

File name of the geocoded digital elevation model.

dem = delta_dem

File name of the geocoded error map.

error map = delta_error

File name of the geocoded amplitude image.

amplitude = delta_amp

File name of the geocoded coherence image.

coherence = delta_coh

Name of the projection used for the geocoding.
There are currently five projections supported: UTM, Polar Stereographic,
Albers Conic Equal-Area, Lambert Conformal Conic and Lambert Azimuthal
Equal-Area projection.

projection name = utm

Name of the projection parameter file.

projection file = /export/home/rgens/svnbuild/asf_tools//share/asf_tools/projections/utm/utm.proj

Resampling method used for the geocoding of data.
Currently three resampling method are supported: nearest neighbor,
bilinear (default) and bicuc.

resampling method = bilinear

This parameter defines the pixel spacing for the geocoded
products.

pixel spacing = 20.0

The status field indicates the progress of the processing.
The status 'new' indicates that this processing step has not been
performed. When the processing is complete it is changed to 'success'
The processing flow can be interrupted by setting the status to 'stop'

status = new

[Export]

The name of the format all geocoded results are exported to.
For using the geocoded results in any commerical image processing and GIS

```
# the 'geotiff' is the most reliable. For simple visualization 'jpeg' or
# 'tiff' do just fine.

format = geotiff

# The status field indicates the progress of the processing.
# The status 'new' indicates that this processing step has not been
# performed. When the processing is complete it is changed to 'success'
# The processing flow can be interrupted by setting the status to 'stop'

status = new
```

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