
pyroSAR Documentation

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Contents

1 Drivers	1
2 SNAP Processing	15
3 GAMMA Processing	17
3.1 GAMMA Command API	20
4 Sentinel-1 Tools	81
5 Datacube Tools	85
6 Ancillary Functions	87
7 Indices and tables	89
Python Module Index	91

Drivers

This is the core module of package pyroSAR. It contains the drivers for the different SAR image formats and offers functionality for retrieving metadata, unpacking images, downloading ancillary files like DEMs and Orbit State Vector files as well as archiving scenes in a database. The *ID* class and its subclasses allow easy and standardized access to the metadata of images from different SAR sensors.

classes

<i>ID</i>	Abstract class for SAR meta data handlers
<i>CEOS_PSR</i>	Handler class for ALOS-PALSAR data in CEOS format
<i>CEOS_ERS</i>	Handler class for ERS data in CEOS format
<i>ESA</i>	Handler class for SAR data in ESA format (Envisat ASAR, ERS-1/2)
<i>SAFE</i>	Handler class for Sentinel-1 data
<i>TSX</i>	Handler class for TerraSAR-X and TanDEM-X data
<i>Archive</i>	Utility for storing SAR image metadata in a spatialite database

functions

<i>identify</i>	identify a SAR scene and return the appropriate meta-data handler object
<i>identify_many</i>	wrapper function for returning metadata handlers of all valid scenes in a list, similar to function <i>identify()</i> .
<i>filter_processed</i>	Filter a list of pyroSAR objects to those that have not yet been processed and stored in the defined directory.
<i>findfiles</i>	find files in a scene archive, which match a pattern
<i>getFileObj</i>	Load a file in a SAR scene archive into a readable file object.

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Table 2 – continued from previous page

<code>parse_date</code>	this function gathers known time formats provided in the different SAR products and converts them to a common standard of the form YYYYMMDDTHHMMSS
-------------------------	--

class `pyroSAR.drivers.Archive` (*dbfile*, *custom_fields=None*)

Bases: `object`

Utility for storing SAR image metadata in a spatialite database

Parameters

- **dbfile** (*str*) – the database file. This file might either point to an existing database or will be created otherwise.
- **custom_fields** (*dict*) – a dictionary containing additional non-standard database column names and data types; the names must be attributes of the SAR scenes to be inserted (i.e. `id.attr`) or keys in their meta attribute (i.e. `id.meta['attr']`)

Examples

select all Sentinel-1 A/B scenes stored in the database, which

- overlap with a test site
- were acquired in Ground-Range-Detected (GRD) Interferometric Wide Swath (IW) mode before 2018
- contain a VV polarization image
- have not been processed to directory *outdir* before

```
>>> from pyroSAR import Archive
>>> from pyroSAR.spatial import Vector
>>> archive = Archive('/path/to/dbfile.db')
>>> site = Vector('/path/to/site.shp')
>>> outdir = '/path/to/processed/results'
>>> maxdate = '20171231T235959'
>>> selection_proc = archive.select(vectorobject=site,
>>>                                processdir=outdir,
>>>                                maxdate=maxdate,
>>>                                sensor=('S1A', 'S1B'),
>>>                                product='GRD',
>>>                                acquisition_mode='IW',
>>>                                vv=1)
>>> archive.close()
```

Alternatively, the *with* statement can be used. In this case to just check whether one particular scene is already registered in the database:

```
>>> from pyroSAR import identify, Archive
>>> scene = identify('S1A_IW_SLC__1SDV_20150330T170734_20150330T170801_005264_
→ 006A6C_DA69.zip')
>>> with Archive('/path/to/dbfile.db') as archive:
>>>     print(archive.is_registered(scene))
```

close()

close the database connection

export2shp (*shp*)

export the database to a shapefile

Parameters **shp** (*str*) – the name of the shapefile to be written

filter_scenelist (*scenelist*)

Filter a list of scenes by file names already registered in the database.

Parameters **scenelist** (*list* of *str* or *pyroSAR.drivers.ID*) – the scenes to be filtered

Returns the file names of the scenes whose basename is not yet registered in the database

Return type *list*

get_colnames ()

Return the names of the database table.

Returns the column names of the data table

Return type *list*

get_tablenames ()

Return the names of all tables in the database

Returns the table names

Return type *list*

get_unique_directories ()

Get a list of directories containing registered scenes

Returns the directory names

Return type *list*

import_outdated (*dbfile*, *verbose=False*)

import an older data base in csv format

Parameters

- **dbfile** (*str*) – the file name of the old data base
- **verbose** (*bool*) – should status information and a progress bar be printed into the console?

insert (*scene_in*, *verbose=False*, *test=False*)

Insert one or many scenes into the database

Parameters

- **scene_in** (*str* or *list*) – a SAR scene or a list of scenes to be inserted
- **verbose** (*bool*) – should status information and a progress bar be printed into the console?
- **test** (*bool*) – should the insertion only be tested or directly be committed to the database?

is_registered (*scene*)

Simple check if a scene is already registered in the database.

Parameters **scene** (*str*) – the SAR scene

Returns is the scene already registered?

Return type *bool*

move (*scenelist*, *directory*)

Move a list of files while keeping the database entries up to date. If a scene is registered in the database (in either the data or duplicates table), the scene entry is directly changed to the new location.

Parameters

- **scenelist** (*list*) – the file locations
- **directory** (*str*) – a folder to which the files are moved

select (*vectorobject=None*, *mindate=None*, *maxdate=None*, *processdir=None*, *recursive=False*, *polarizations=None*, *verbose=False*, ***args*)
select scenes from the database

Parameters

- **vectorobject** (*Vector*) – a geometry with which the scenes need to overlap
- **mindate** (*str*) – the minimum acquisition date in format YYYYmmddTHHMMSS
- **maxdate** (*str*) – the maximum acquisition date in format YYYYmmddTHHMMSS
- **processdir** (*str*) – a directory to be scanned for already processed scenes; the selected scenes will be filtered to those that have not yet been processed
- **recursive** (*bool*) – should also the subdirectories of the processdir be scanned?
- **polarizations** (*list*) – a list of polarization strings, e.g. ['HH', 'VV']
- **verbose** (*bool*) – print details about the selection including the SQL query?
- ****args** – any further arguments (columns), which are registered in the database. See [`get_colnames\(\)`](#)

Returns the file names pointing to the selected scenes

Return type *list*

select_duplicates (*outname_base=None*, *scene=None*)

Select scenes from the duplicates table. In case both *outname_base* and *scene* are set to None all scenes in the table are returned, otherwise only those that match the attributes *outname_base* and *scene* if they are not None.

Parameters

- **outname_base** (*str*) – the basename of the scene
- **scene** (*str*) – the scene name

Returns the selected scene(s)

Return type *list*

size

get the number of scenes registered in the database

Returns the number of scenes in (1) the main table and (2) the duplicates table

Return type *tuple*

class `pyroSAR.drivers.CEOS_ERS` (*scene*)

Bases: `pyroSAR.drivers.ID`

Handler class for ERS data in CEOS format

Sensors:

- ERS1

- ERS2

Reference: ER-IS-EPO-GS-5902-3: Annex C. ERS SAR.SLC/SLC-I. CCT and EXABYTE (ESA 1998)

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

unpack (*directory*, *overwrite=False*)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

class `pyroSAR.drivers.CEOS_PSR` (*scene*)

Bases: `pyroSAR.drivers.ID`

Handler class for ALOS-PALSAR data in CEOS format

Sensors:

- PSR1
- PSR2

PALSAR-1:

Reference: NEB-070062B: ALOS/PALSAR Level 1.1/1.5 product Format description (JAXA 2009)

Products / processing levels:

- 1.0
- 1.1
- 1.5

Acquisition modes:

- AB: [SP][HWDPC]
- **A: supplemental remarks of the sensor type:**
 - S: Wide observation mode
 - P: all other modes
- **B: observation mode**
 - H: Fine mode
 - W: ScanSAR mode
 - D: Direct downlink mode

- P: Polarimetry mode
- C: Calibration mode

PALSAR-2:

Reference: ALOS-2/PALSAR-2 Level 1.1/1.5/2.1/3.1 CEOS SAR Product Format Description ([JAXA 2014](#)).

Products / processing levels:

- 1.0
- 1.1
- 1.5

Acquisition modes:

- SBS: Spotlight mode
- UBS: Ultra-fine mode Single polarization
- UBD: Ultra-fine mode Dual polarization
- HBS: High-sensitive mode Single polarization
- HBD: High-sensitive mode Dual polarization
- HBQ: High-sensitive mode Full (Quad.) polarimetry
- FBS: Fine mode Single polarization
- FBD: Fine mode Dual polarization
- FBQ: Fine mode Full (Quad.) polarimetry
- WBS: Scan SAR nominal [14MHz] mode Single polarization
- WBD: Scan SAR nominal [14MHz] mode Dual polarization
- WWS: Scan SAR nominal [28MHz] mode Single polarization
- WWD: Scan SAR nominal [28MHz] mode Dual polarization
- VBS: Scan SAR wide mode Single polarization
- VBD: Scan SAR wide mode Dual polarization

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

led_filename

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

unpack (directory, overwrite=False)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

class pyroSAR.drivers.ESA(*scene*)

Bases: `pyroSAR.drivers.ID`

Handler class for SAR data in ESA format (Envisat ASAR, ERS-1/2)

Sensors:

- ASAR
- ERS1
- ERS2

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

unpack (*directory*, *overwrite=False*)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

class pyroSAR.drivers.ID(*metadict*)

Bases: `object`

Abstract class for SAR meta data handlers

bbox (*outname=None*, *overwrite=True*)

get the bounding box of a scene either as a vector object or written to a shapefile

Parameters

- **outname** (*str*) – the name of the shapefile to be written
- **overwrite** (*bool*) – overwrite an existing shapefile?

Returns the vector object if *outname* is None, None otherwise

Return type `Vector` or `None`

compression

check whether a scene is compressed into an tarfile or zipfile or not at all

Returns either 'zip', 'tar' or None

Return type `str` or `None`

examine (*include_folders=False*)

check whether any items in the SAR scene structure (i.e. files/folders) match the regular expression pattern defined by the class. On success the item is registered in the object as attribute *file*.

Parameters **include_folders** (*bool*) – also match folder (or just files)?

Raises `IOError`

export2dict ()

Return the uuid and the metadata that is defined in self.locals as a dictionary

export2sqlite (*dbfile*)

Export relevant metadata to a sqlite database

Parameters **dbfile** (*str*) – the database file

findfiles (*pattern, include_folders=False*)

find files in the scene archive, which match a pattern; see *findfiles()*

Parameters

- **pattern** (*str*) – the regular expression to match
- **include_folders** (*bool*) – also match folders (or just files)?

Returns the matched file names

Return type `list`

gdalinfo ()

read metadata directly from the GDAL SAR image drivers

Parameters **scene** (*str*) – an archive containing a SAR scene

Returns the metadata attributes

Return type `dict`

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

getFileObj (*filename*)

Load a file into a readable file object.

Parameters **filename** (*str*) – the name of a file in the scene archive, easiest to get with method *findfiles()*

Returns a file pointer object

Return type `BytesIO`

getGammaImages (*directory=None*)

list all files processed by GAMMA

Parameters **directory** (*str*) – the directory to be scanned; if left empty the object attribute *gammadir* is scanned

Returns the file names of the images processed by GAMMA

Return type `list`

Raises `IOError`

getHGT ()

get the names of all SRTM HGT tiles overlapping with the SAR scene

Returns names of the SRTM HGT tiles

Return type `list`

is_processed (*outdir*, *recursive=False*)

check whether a scene has already been processed and stored in the defined output directory (and subdirectories if scanned recursively)

Parameters **outdir** (*str*) – the directory to be checked

Returns does an image matching the scene pattern exist?

Return type `bool`

outname_base (*extensions=None*)

parse a string containing basic information about the scene in standardized format. Currently this id contains the sensor (4 digits), acquisition mode (4 digits), orbit (1 digit) and acquisition start time (15 digits), e.g. *SIA_IW__A_20150523T122350*

Parameters **extensions** (*list of str*) – the names of additional parameters to append to the basename, e.g. ['orbitNumber_rel']

Returns a standardized name unique to the scene

Return type `str`

static parse_date (*x*)

this function gathers known time formats provided in the different SAR products and converts them to a common standard of the form *YYYYMMDDTHHMMSS*.

Parameters **x** (*str*) – the time stamp

Returns the converted time stamp in format *YYYYmmddTHHMMSS*

Return type `str`

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

summary ()

print the set of standardized scene metadata attributes

unpack (*directory*, *overwrite=False*)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

class `pyroSAR.drivers.SAFE` (*scene*)

Bases: `pyroSAR.drivers.ID`

Handler class for Sentinel-1 data

Sensors:

- S1A
- S1B

References:

- S1-RS-MDA-52-7443 Sentinel-1 IPF Auxiliary Product Specification
- MPC-0243 Masking “No-value” Pixels on GRD Products generated by the Sentinel-1 ESA IPF

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

getOSV (outdir, osvType='POE')

download Orbit State Vector files for the scene

Parameters

- **outdir** (*str*) – the directory of OSV files; subdirectories POEORB and RESORB are created automatically
- **osvType** (`{ 'POE ', 'RES ' }`) – the type of orbit file either ‘POE’, ‘RES’ or a list of both

See also:

`pyroSAR.S1.auxil.OSV()`

removeGRDBorderNoise ()

mask out Sentinel-1 image border noise

Reference: Masking “No-value” Pixels on GRD Products generated by the Sentinel-1 ESA IPF’ (issue 1, June 2015; issue 2.1 Jan 29 2018) available online under <https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/document-library>

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

unpack (directory, overwrite=False)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

class pyroSAR.drivers.TSX (scene)

Bases: `pyroSAR.drivers.ID`

Handler class for TerraSAR-X and TanDEM-X data

Sensors:

- TSX1
- TDX1

References:

- TX-GS-DD-3302 TerraSAR-X Basic Product Specification Document
- TX-GS-DD-3303 TerraSAR-X Experimental Product Description
- TD-GS-PS-3028 TanDEM-X Experimental Product Description
- TerraSAR-X Image Product Guide (Airbus Defence and Space)

Acquisition modes:

- ST: Staring Spotlight
- HS: High Resolution SpotLight
- HS300: High Resolution SpotLight 300 MHz
- SL: SpotLight
- SM: StripMap
- SC: ScanSAR
- WS: Wide ScanSAR

Polarisation modes:

- Single (S): all acquisition modes
- Dual (D): High Resolution SpotLight (HS), SpotLight (SL) and StripMap (SM)
- Twin (T): StripMap (SM) (experimental)
- Quad (Q): StripMap (SM) (experimental)

Products:

- SSC: Single Look Slant Range Complex
- MGD: Multi Look Ground Range Detected
- GEC: Geocoded Ellipsoid Corrected
- EEC: Enhanced Ellipsoid Corrected

getCorners ()

derive the corner coordinates from a SAR scene

Returns dictionary with keys *xmin*, *xmax*, *ymin* and *ymax*

Return type `dict`

scanMetadata ()

scan SAR scenes for metadata attributes. The returned dictionary is registered as attribute *meta* by the class upon object initialization. This dictionary furthermore needs to return a set of standardized attribute keys, which are directly registered as object attributes.

Returns the derived attributes

Return type `dict`

unpack (directory, overwrite=False)

Unpack the SAR scene into a defined directory.

Parameters

- **directory** (*str*) – the base directory into which the scene is unpacked
- **overwrite** (*bool*) – overwrite an existing unpacked scene?

`pyroSAR.drivers.filter_processed(scenelist, outdir, recursive=False)`

Filter a list of pyroSAR objects to those that have not yet been processed and stored in the defined directory. The search for processed scenes is either done in the directory only or recursively into subdirectories. The scenes must have been processed with pyroSAR in order to follow the right naming scheme.

Parameters

- **scenelist** (*list*) – a list of pyroSAR objects
- **outdir** (*str*) – the processing directory
- **recursive** (*bool*) – scan *outdir* recursively into subdirectories?

Returns a list of those scenes, which have not been processed yet

Return type *list*

`pyroSAR.drivers.findfiles(scene, pattern, include_folders=False)`

find files in a scene archive, which match a pattern

Parameters

- **scene** (*str*) – the SAR scene to be scanned, can be a directory, a zip or tar.gz archive
- **pattern** (*str*) – the regular expression to match
- **include_folders** (*bool*) – also match folders (or just files)?

Returns the matched file names

Return type *list*

`pyroSAR.drivers.getFileObj(scene, filename)`

Load a file in a SAR scene archive into a readable file object.

Parameters

- **scene** (*str*) – the scene archive. Can be either a directory or a compressed archive of type *zip* or *tar.gz*.
- **filename** (*str*) – the name of a file in the scene archive, easiest to get with method *findfiles()*

Returns a file object

Return type *BytesIO*

`pyroSAR.drivers.identify(scene)`

identify a SAR scene and return the appropriate metadata handler object

Parameters **scene** (*str*) – a file or directory name

Returns a pyroSAR metadata handler

Return type a subclass object of *ID*

`pyroSAR.drivers.identify_many(scenes)`

wrapper function for returning metadata handlers of all valid scenes in a list, similar to function *identify()*. Prints a progressbar.

Parameters **scenes** (*list*) – the file names of the scenes to be identified

Returns a list of pyroSAR metadata handlers

Return type *list*

`pyroSAR.drivers.parse_date(x)`

this function gathers known time formats provided in the different SAR products and converts them to a common standard of the form `YYYYMMDDTHHMMSS`

Parameters `x` (*str* or *datetime*) – the time stamp to be converted

Returns the converted time stamp in format `YYYYmmddTHHMMSS`

Return type *str*

SNAP Processing

```
pyroSAR.snap.util.geocode(infile, outdir, t_srs=4326, tr=20, polarizations='all', shape-
                           file=None, scaling='dB', geocoding_type='Range-Doppler', re-
                           moveS1BoderNoise=True, offset=None, externalDEMFile=None,
                           externalDEMNoDataValue=None, externalDEMAppliesEGM=True,
                           basename_extensions=None, test=False)
```

wrapper function for geocoding SAR images using ESA SNAP

Parameters

- **infile** (*str* or *ID*) – the SAR scene to be processed
- **outdir** (*str*) – The directory to write the final files to.
- **t_srs** (*int*, *str* or *osr.SpatialReference*) – A target geographic reference system in WKT, EPSG, PROJ4 or OPENGIS format. See function `spatialist.auxil.crsConvert()` for details. Default: 4326.
- **tr** (*int* or *float*, *optional*) – The target resolution in meters. Default is 20
- **polarizations** (*list* or {'VV', 'HH', 'VH', 'HV', 'all'}, *optional*) – The polarizations to be processed; can be a string for a single polarization e.g. 'VV' or a list of several polarizations e.g. ['VV', 'VH']. Default is 'all'.
- **shapefile** (*str* or *Vector*, *optional*) – A vector geometry for subsetting the SAR scene to a test site. Default is None.
- **scaling** ({'dB', 'db', 'linear'}, *optional*) – Should the output be in linear or decibel scaling? Default is 'dB'.
- **geocoding_type** ({'Range-Doppler', 'SAR simulation cross correlation'}, *optional*) – The type of geocoding applied; can be either 'Range-Doppler' (default) or 'SAR simulation cross correlation'
- **removeS1BoderNoise** (*bool*, *optional*) – Enables removal of S1 GRD border noise (default).

- **offset** (*tuple, optional*) – A tuple defining offsets for left, right, top and bottom in pixels, e.g. (100, 100, 0, 0); this variable is overridden if a shapefile is defined. Default is None.
- **externalDEMFile** (*str or None, optional*) – The absolute path to an external DEM file. Default is None.
- **externalDEMNoDataValue** (*int, float or None, optional*) – The no data value of the external DEM. If not specified (default) the function will try to read it from the specified external DEM.
- **externalDEMApplyEGM** (*bool, optional*) – Apply Earth Gravitational Model to external DEM? Default is True.
- **basename_extensions** (*list of str*) – names of additional parameters to append to the basename, e.g. ['orbitNumber_rel']
- **test** (*bool, optional*) – If set to True the workflow xml file is only written and not executed. Default is False.

Note: If only one polarization is selected the results are directly written to GeoTiff. Otherwise the results are first written to a folder containing ENVI files and then transformed to GeoTiff files (one for each polarization). If GeoTiff would directly be selected as output format for multiple polarizations then a multilayer GeoTiff is written by SNAP which is considered an unfavorable format

See also:

`pyroSAR.drivers.ID, spatialist.vector.Vector, spatialist.auxil.crsConvert()`

GAMMA Processing

`pyroSAR.gamma.geocode(scene, dem, tempdir, outdir, targetres, scaling='linear', func_geoback=2, func_interp=0, nodata=(0, -99), sarSimCC=False, osvdir=None, alow_RES_OSV=False, cleanup=True)`
 general function for geocoding SAR images with GAMMA

Parameters

- **scene** (*str* or *ID*) – the SAR scene to be processed
- **dem** (*str*) – the reference DEM in GAMMA format
- **tempdir** (*str*) – a temporary directory for writing intermediate files
- **outdir** (*str*) – the directory for the final GeoTiff output files
- **targetres** (*int*) – the target resolution in meters
- **scaling** (*{'linear', 'db'}* or *list*) – the value scaling of the backscatter values; either 'linear', 'db' or a list of both, i.e. ['linear', 'db']
- **func_geoback** (*{0, 1, 2, 3}*) –

backward geocoding interpolation mode (see GAMMA command geocode_back)

- 0: nearest-neighbor
- 1: bicubic spline
- 2: bicubic-log spline, interpolates log(data)
- 3: bicubic-sqrt spline, interpolates sqrt(data)

NOTE: bicubic-log spline and bicubic-sqrt spline modes should only be used with non-negative data!

- **func_interp** (*{0, 1, 2, 3}*) –

output lookup table values in regions of layover, shadow, or DEM gaps (see GAMMA command gc_map)

- 0: set to (0., 0.)

- 1: linear interpolation across these regions
- 2: actual value
- 3: nn-thinned
- **nodata** (*tuple*) – the nodata values for the output files; defined as a tuple with two values, the first for linear, the second for logarithmic scaling
- **sarSimCC** (*bool*) – perform geocoding with SAR simulation cross correlation? If False, geocoding is performed with the Range-Doppler approach using orbit state vectors
- **osvdir** (*str*) – a directory for Orbit State Vector files; this is currently only used by for Sentinel-1 where two subdirectories POEORB and RESORB are created; if set to None, a subdirectory OSV is created in the directory of the unpacked scene.
- **allow_RES_OSV** (*bool*) – also allow the less accurate RES orbit files to be used? Otherwise the function will raise an error if no POE file exists
- **cleanup** (*bool*) – should all files written to the temporary directory during function execution be deleted after processing?

Note:**intermediate output files (named <master_MLI>_<suffix>):**

- dem_seg: dem subsetting to the extent of the SAR image
- lut: rough geocoding lookup table
- lut_fine: fine geocoding lookup table
- sim_map: simulated SAR backscatter image in DEM geometry
- sim_sar: simulated SAR backscatter image in SAR geometry
- u: zenith angle of surface normal vector n (angle between z and n)
- v: orientation angle of n (between x and projection of n in xy plane)
- inc: local incidence angle (between surface normal and look vector)
- psi: projection angle (between surface normal and image plane normal)
- pix: pixel area normalization factor
- ls_map: layover and shadow map (in map projection)
- diffpar: ISP offset/interferogram parameter file
- offs: offset estimates (fcomplex)
- coffs: culled range and azimuth offset estimates (fcomplex)
- coffsets: culled offset estimates and cross correlation values (text format)
- ccp: cross-correlation of each patch (0.0->1.0) (float)

`pyroSAR.gamma.convert2gamma` (*id*, *directory*, *SI_noiseremoval=True*)
general function for converting SAR images to GAMMA format

Parameters

- **id** (*ID*) – an SAR scene object of type `pyroSAR.ID` or any subclass
- **directory** (*str*) – the output directory for the converted images

- **S1_noiseremoval** (*bool*) – only Sentinel-1: should noise removal be applied to the image?

class pyroSAR.gamma.ISPPar (*filename*)

Bases: *object*

Reader for ISP parameter files of the GAMMA software package.

This class allows to read all information from files in GAMMA's parameter file format. Each key-value pair is parsed and added as attribute. For instance if the parameter file contains the pair 'sensor: TSX-1' an attribute named 'sensor' with the value 'TSX-1' will be available.

The values are converted to native Python types, while unit identifiers like 'dB' or 'Hz' are removed. Please see the GAMMA reference manual for further information on the actual file format.

Parameters *filename* (*str*) – the Gamma parameter file

Examples

```
>>> from pyroSAR.gamma import ISPPar
>>> with ISPPar('S1A_IW__A_20141115T181801_VH_grd.par') as par:
...     print(par) # print an overview of all available metadata
...     print(par.keys) # print all parameter names
...     for key, value in par.envidict().items():
...         print('{0}: {1}'.format(key, value)) # print the ENVI HDR compliant_
↪ metadata
```

keys

the names of all parameters

Type *list*

envidict ()

export relevant metadata to a ENVI HDR file compliant format

Returns

Return type *dict*

pyroSAR.gamma.**process** (*cmd*, *outdir=None*, *logpath=None*, *inlist=None*, *void=True*)

wrapper function to execute GAMMA commands via module *subprocess*

Parameters

- **cmd** (*list*) – the command line arguments
- **outdir** (*str*) – the directory to execute the command in
- **logpath** (*str*) – a directory to write logfiles to; the file will be named {GAMMA command}.log, e.g. gc_map.log
- **inlist** (*list*) – a list of values, which is passed as interactive inputs via stdin
- **void** (*bool*) – return the stdout and stderr messages?

Returns the stdout and stderr messages if void is False, otherwise None

Return type tuple of str or None

pyroSAR.gamma.**ovs** (*parfile*, *targetres*)

compute DEM oversampling factors for a target resolution in meters

Parameters

- **parfile** (*str*) – a GAMMA DEM parameter file
- **targetres** (*int* or *float*) – the target resolution in meters

Returns the oversampling factors for latitude and longitude

Return type tuple of float

`pyroSAR.gamma.S1_deburst` (*burst1*, *burst2*, *burst3*, *name_out*, *rlks*=5, *azlks*=1, *replace*=False, *path_log*=None)

Debursting of Sentinel-1 SLC imagery in GAMMA. The procedure consists of two steps. First antenna pattern deramping and then mosaicing of the single deramped bursts. For mosaicing, the burst boundaries are calculated from the number of looks in range (*rlks*) and azimuth (*azlks*), in this case 5 range looks and 1 azimuth looks. Alternately 10 range looks and 2 azimuth looks could be used.

Parameters

- **burst1** (*str*) – burst image 1
- **burst2** (*str*) – burst image 2
- **burst3** (*str*) – burst image 3
- **name_out** (*str*) – the name of the output file
- **rlks** (*int*) – the number of looks in range
- **azlks** (*int*) – the number of looks in azimuth
- **replace** (*bool*) – replace the burst images by the new file? If True, the three burst images will be deleted.
- **path_log** (*str*) – the directory to write the logfiles to

`pyroSAR.gamma.correctOSV` (*id*, *osvdir*=None, *logpath*=None, *osvType*='POE')

correct GAMMA parameter files with orbit state vector information from dedicated OSV files

Parameters

- **id** (*ID*) – the scene to be corrected
- **osvdir** (*str*) – the directory of OSV files; subdirectories POEORB and RESORB are created automatically
- **logpath** (*str*) – a path to write logfiles to
- **osvType** (*str* or *list*) – the type of orbit file either 'POE', 'RES' or a list of both

3.1 GAMMA Command API

This is an attempt to make it easier to execute Gamma commands by offering automatically parsed Python functions. Thus, instead of executing the command via shell:

```
offset_fit offs ccp off.par coeffs - 0.15 3 0 > offset_fit.log
```

one can wrap it in a Python script:

```
import os
from pyroSAR.gamma.api import isp

workdir = '/data/gamma_workdir'
```

(continues on next page)

(continued from previous page)

```
parameters = {'offs': os.path.join(workdir, 'offs'),
              'ccp': os.path.join(workdir, 'ccp'),
              'OFF_par': os.path.join(workdir, 'off.par'),
              'coffs': os.path.join(workdir, 'coffs'),
              'thres': 0.15,
              'npoly': 3,
              'interact_flag': 0}

isp.offset_fit(**parameters, logpath=workdir)
```

A file *offset_fit.log* containing the output of the command is written in both cases. Any parameters, which should not be written and need to be set to - in the shell can be omitted in the Python call since all optional parameters of the functions are already defined with '-' as a default. The documentation can be called like with any Python function:

```
from pyroSAR.gamma.api import isp
help(isp.offset_fit)
```

3.1.1 Parser Documentation

`pyroSAR.gamma.parser.autoparse()`

automatic parsing of Gamma commands. This function will detect the Gamma installation via environment variable `GAMMA_HOME`, detect all available modules (e.g. ISP, DIFF) and parse all of the module's commands via function `parse_module()`. A new Python module will be created called *gammaparse*, which is stored under `$HOME/pyrosar`. Upon importing the *pyroSAR.gamma* submodule, this function is run automatically and module *gammaparse* is imported as *api*.

Examples

```
>>> from pyroSAR.gamma.api import diff
>>> print('create_dem_par' in dir(diff))
True
```

`pyroSAR.gamma.parser.parse_command(command)`

Parse the help text of a Gamma command to a Python function including a docstring. The docstring is in rst format and can thus be parsed by e.g. sphinx. This function is not intended to be used by itself, but rather within function `parse_module()`.

Parameters `command` (*str*) – the name of the gamma command

Returns the full Python function text

Return type *str*

`pyroSAR.gamma.parser.parse_module(bindir, outfile)`

parse all Gamma commands of a module to functions and save them to a Python script.

Parameters

- **bindir** (*str*) – the *bin* directory of a module containing the commands
- **outfile** (*str*) – the name of the Python file to write

Examples

```
>>> import os
>>> from pyroSAR.gamma.parser import parse_module
>>> outname = os.path.join(os.environ['HOME'], 'isp.py')
>>> parse_module('/cluster/GAMMA_SOFTWARE-20161207/ISP/bin', outname)
```

3.1.2 API Demo

This is a demonstration of an output script as generated automatically by function `parse_module()` for the Gamma module *ISP*. Within each function, the command name and all parameters are passed to function `process()`, which converts all input to str and then calls the command via the `subprocess` module.

```
pyroSAR.gamma.parser_demo.ASAR_LO_phase_drift(SLC1_par, SLC2_par, OFF_par,
                                              ph_drift, logpath=None)
```

Calculate interferometric phase correction due to drift of the ASAR local oscillator

Copyright 2015, Gamma Remote Sensing, v1.1 3-Dec-2015 clw

Parameters

- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **ph_drift** – (output) interferometric phase correction due to drift of the ASAR LO (radians)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ASAR_XCA(ASA_XCA, antenna, swath='-', pol='-', logpath=None)
```

Interpretation of ASAR external calibration data file (ASA_XCA)

Copyright 2006, Gamma Remote Sensing, v1.1 7-June-2006 awi/uw/clw

Parameters

- **ASA_XCA** – (input) ASAR external calibration data file (binary)
- **antenna** –
(output) 1-way antenna gain pattern file or ‘-’ (if not provided) or ‘all’ to generate all ASAR antenna diagrams
- **swath** – ASAR swath (IS1,IS2,... IS7;SS1,SS2,... SS5)
- **pol** – polarization (HH,VV,HV,VH)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.DELFT_vec2(SLC_par, DELFT_dir, nstate='-', interval='-',
                                       ODR='-', logpath=None)
```

Extract and interpolate DELFT ERS-1, ERS-2, and ENVISAT state vectors

Copyright 2012, Gamma Remote Sensing, v2.6 clw 24-Oct-2012

Parameters

- **SLC_par** – (input) ISP image parameter file
- **DELFT_dir** –
directory containing Delft orbit arclist and ODR files for ERS-1, ERS-2 or ENVISAT

– NOTE: enter . for current directory
- **nstate** – number of state vectors to generate (enter - for default (>= 15))
- **interval** – time interval between state vectors in the ISP image parameter file (s) (default: 10.0)
- **ODR** – ODR file to use (include path) rather than ODR file determined from the Delft orbit arclist
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.DORIS_vec (SLC_PAR, DOR, nstate='-', logpath=None)
```

Extract ENVISAT DORIS state vectors and write to an ISP image parameter file

Copyright 2008, Gamma Remote Sensing, v1.4 11-Jun-2008 clw

Parameters

- **SLC_PAR** – (input/output)ISP SLC/MLI image parameter file
- **DOR** – (input) ASAR DORIS data file (DOR_VOR_AXVF)
- **nstate** – number of state vectors to extract (enter - for default: 11)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.MLI_cat (MLI_1, MLI_2, MLI1_par, MLI2_par, MLI_3, MLI3_par,
                                     logpath=None)
```

Concatenate two MLI images using bicubic spline interpolation

Copyright 2015, Gamma Remote Sensing, v1.0 23-Jul-2015 awi

Parameters

- **MLI-1** – (input) MLI-1 image (single-look)
- **MLI-2** – (input) MLI-2 image to be appended to MLI-1
- **MLI1_par** – (input) MLI-1 ISP image parameter file
- **MLI2_par** – (input) MLI-2 ISP image parameter file
- **MLI-3** – (output) concatenated MLI image
- **MLI3_par** – (output) ISP image parameter file for concatenated image
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.MLI_copy (MLI_in, MLI_in_par, MLI_out, MLI_out_par, roff='-',
                                     nr='-', loff='-', nl='-', logpath=None)
```

Copy MLI data file with options for segment extraction

Copyright 2013, Gamma Remote Sensing, v4.4 10-Jan-2013 uw/clw

Parameters

- **MLI_in** – (input) multi-look intensity image (float format)
- **MLI_in_par** – (input) ISP image parameter file for input MLI
- **MLI_out** – (output) selected MLI section (float format)
- **MLI_out_par** – (output) ISP image parameter file for output MLI
- **roff** – offset to starting range sample (enter - for default: 0)
- **nr** – number of range samples (enter - for default: to end of line)
- **loff** – offset to starting line (enter - for default: 0)
- **nl** – number of lines to copy (enter - for default: to end of file)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ORB_prop_SLC(SLC_par, nstate='-', interval='-', extra='-',  
                                         mode='-', logpath=None)
```

Calculate state vectors using orbit propagation and interpolation

Copyright 2008, Gamma Remote Sensing, v1.8 11-Jun-2008 clw/awi

Parameters

- **SLC_par** – (input) ISP image parameter file with at least 1 state vector
- **nstate** – number of state vectors to calculate (enter - for default: nstate from image duration + extra)
- **interval** – time interval between state vectors (enter - for default: state vector time interval in SLC_par)
- **extra** – extra time for state vectors at start and end of image (sec.) (enter - for default: 30.0)
- **mode** –
 - orbit propagation mode:**
 - 0: polynomial interpolation (default, if 3 or more state vectors available)
 - 1: integration of the equations of motion (default, if less than 3 state vectors available)
 - 2: interpolate between state vectors, minimum of 3 state vectors; interpolation of the equations of motion outside of the time span of the existing state vectors

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ORRM_vec(SLC_par, ORRM, nstate='-', logpath=None)
```

Calculate state vectors extraction from ORRM file

Copyright 2008, Gamma Remote Sensing, v1.4 15-Nov-2004 clw

Parameters

- **SLC_par** – (input/output) ISP SLC/MLI image parameter file
- **ORRM** – (input) ORRM state vector file
- **nstate** – number of state vectors (default=5, maximum=64)

- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.PRC_vec(SLC_par, PRC, nstate='-', logpath=None)`

State vectors from ERS PRC orbit data for ISP processing clw/uw
Copyright 2008, Gamma Remote Sensing, v1.7 clw 11-Jun-2008

Parameters

- **SLC_par** – (input/output) ISP SLC/MLI image parameter file
- **PRC** – (input) PRC state vector file
- **nstate** – number of state vectors (default=5, maximum=64)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.RSAT2_vec(SLC_par, RSAT2_orb, nstate='-', logpath=None)`

Extract Radarsat-2 state vectors from a definitive orbit file
Copyright 2010, Gamma Remote Sensing, v1.0 clw 13-May-2010

Parameters

- **SLC_par** – (input) ISP image parameter file
- **RSAT2_orb** – Radarsat-2 definitive orbit data file available from MDA. (orbit_number_def.orb)
- **nstate** – number of state vectors to extract (enter - for default: 9)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.S1_OPOD_vec(SLC_PAR, OPOD, nstate='-', logpath=None)`

Extract Sentinel-1 OPOD state vectors and copy into the ISP image parameter file
Copyright 2015, Gamma Remote Sensing, v1.3 17-Aug-2016 awi/clw

Parameters

- **SLC_PAR** – (input/output)ISP SLC/MLI image parameter file
- **OPOD** –
(input) Sentinel-1 OPOD orbit data file (**AUX_POEORB** or **AUX_RESORB**)
https://qc.sentinel1.eo.esa.int/aux_resorb/
- **nstate** – number of state vectors to extract (default: include 60 sec extention at the start and end of the SLC data)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.S1_burstloc(annotation_XML, logpath=None)`

Print Burst information found in the Sentinel-1 annotation file
Copyright 2016, Gamma Remote Sensing, v1.0 22-Jan-2016 awi

Parameters

- **annotation_XML** – (input) Sentinel-1 L1 XML annotation file
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_burst_copy(SLC, SLC_par, TOPS_par, SLC_out,  
                                           SLC_out_par, burst_num, drflg='- ',  
                                           SLC_par2='- ', logpath=None)
```

Copy selected burst from Sentinel-1 TOPS SLC to a file

Copyright 2014, Gamma Remote Sensing, v1.3 21-Oct-2014 awi/clw

Parameters

- **SLC** – (input) Sentinel-1 TOPS mode burst SLC
- **SLC_par** – (input) SLC parameter file for the TOPS burst SLC
- **TOPS_par** – (input) TOPS parameter file for the TOPS burst SLC
- **SLC_out** – (output) SLC file containing a single burst
- **SLC_out_par** – (output) SLC parameter file for the single burst SLC
- **burst_num** – burst number of selected burst (1->number of bursts in the SLC)
- **drflg** –
 deramp phase flag:
 - 0: no modification of the burst SLC phase (default)
 - 1: subtract TOPS Doppler phase ramp (deramp)
- **SLC_par2** – (output) SLC parameter file for the single burst SLC with deramped phase (drflg: 1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_burst_corners(SLC_par, TOPS_par, logpath=None)
```

Calculate corner geographic coordinates of Sentinel-1 TOPS SLC bursts

Copyright 2016, Gamma Remote Sensing, v1.1 14-Apr-2016 awi/rc/cw

Parameters

- **SLC_par** – (input) SLC parameter file for the TOPS burst SLC
- **TOPS_par** – (input) TOPS parameter file for the TOPS burst SLC
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_cat(SLC_1, SLC_2, SLC1_par, SLC2_par, OFF_par, SLC_3,  
                                   SLC3_par, dopflg='- ', iflg='- ', phflg='- ', logpath=None)
```

Concatenate two SLC images using 2-D SINC interpolation

Copyright 2015, Gamma Remote Sensing, v1.6 11-Nov-2015 clw

Parameters

- **SLC-1** – (input) SLC-1 image
- **SLC-2** – (input) SLC-2 image to be appended to SLC-1

- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset parameter file containing offset polynomials between SLC-1 and SLC-2
- **SLC-3** – (output) concatenated SLC
- **SLC3_par** – (output) ISP image parameter file for concatenated image
- **dopflg** –
Doppler flag:
 - 0: ignore Doppler centroid information, assume 0 Doppler centroid
 - 1: use Doppler centroid information for interpolation (default)
- **iflg** –
input data type flag:
 - 0: input data are SLC images, use data type specified in SLC_par files (SCOMPLEX or FCOMPLEX) (default)
 - 1: input scenes are interferograms, force FCOMPLEX data type
- **phflg** –
phase offset correction flag:
 - 0: no phase offset correction for SLC-2
 - 1: apply phase offset correction to SLC-2 (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_cat_S1_TOPS (SLC_tab1, SLC_tab2, SLC_tab3, log-
                                             path=None)
```

Concatenate adjacent Sentinel-1 TOPS SLC images
 Copyright 2016, Gamma Remote Sensing v1.9 4-Feb-2016

Parameters

- **SLC_tab1** –
(input) 3 column list of the reference TOPS SLC swaths in row order IW1, IW2, IW3... (earlier time)
 SLC_tab line entries: SLC SLC_par TOPS_par
- **SLC_tab2** – (input) 3 column list of TOPS SLC-2 swaths in the same order as the SLC_tab1 IW1, IW2, IW3... (later time)
- **SLC_tab3** – (input) 3 column list of the output concatenated TOPS swaths in the order IW1, IW2, IW3...
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_copy (SLC_in, SLC_par_in, SLC_out, SLC_par_out, fcase='-
                                     ', sc='- ', roff='- ', nr='- ', loff='- ', nl='- ', swap='- ',
                                     header_lines='- ', logpath=None)
```

Copy SLC with options for data format conversion, segment extraction, and byte swapping
 Copyright 2015, Gamma Remote Sensing, v5.1 13-Aug-2015 uw/clw

Parameters

- **SLC_in** – (input) SLC (FCOMPLEX or scOMPLEX format)
- **SLC_par_in** – (input) ISP SLC parameter file for input SLC
- **SLC_out** – (output) selected SLC section (FCOMPLEX or scOMPLEX format)
- **SLC_par_out** – (output) ISP SLC parameter file of output SLC
- **fcase** –
data format conversion (enter - for default: output format = input format)
 - 1: FCOMPLEX → FCOMPLEX (default sc = 1.0)
 - 2: FCOMPLEX → scOMPLEX (default sc = 10000.0)
 - 3: scOMPLEX → FCOMPLEX (default sc = 0.0001)
 - 4: scOMPLEX → scOMPLEX (default sc = 1.0)
- **sc** – scale factor for input SLC data (enter - for default)
- **roff** – offset to starting range sample (enter - for default: 0)
- **nr** – number of range samples (enter - for default: to end of line)
- **loff** – offset to starting line (enter - for default: 0)
- **n1** – number of lines to copy (enter - for default: to end of file)
- **swap** –
swap data (enter - for default)
 - 0: normal (default)
 - 1: swap real/imaginary part of complex data
 - 2: swap left/right (near/far range)
- **header_lines** –
number of input file header lines (enter - for default: 0)
 - NOTE: CEOS format SLC data have 1 header line
 - NOTE: file offset pointer size (bytes): 8
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_copy_S1_TOPS (SLC1_tab, SLC2_tab, BURST_tab, dtype='-',  
                                             logpath=None)
```

Copy multiple bursts from a Sentinel-1 TOPS SLC to an output TOPS SLC

Copyright 2016, Gamma Remote Sensing v1.9 16-Sep-2016 clw

Parameters

- **SLC1_tab** –
(input) 3 column list of TOPS SLC-1 swaths to be copied in row order IW1, IW2, IW3:
SLC_tab line entries: SLC SLC_par TOPS_par
- **SLC2_tab** – (input) 3 column list of the output copied SLC-1 TOPS swaths in the order IW1, IW2, IW3

- **BURST_tab** –

(input) 2 column list of the first and last burst to copy from each swath, one line for each swath

BURST_tab line entries: first_burst last_burst Note: first burst is 1, enter - to select last physical burst Note: if first_burst <= 0, then blank bursts are generated at the start of the output swath if last_burst exceeds the number of bursts in the input data swath, then blank bursts are appended to the end of the output swath

- **dtype** –

output data type (default: same as input data):

- 0: FCOMPLEX
- 1: SCOMPLEX

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_corners (SLC_par, terra_alt='-', logpath=None)
```

Calculate SLC/MLI image corners in geodetic latitude and longitude (deg.)

Copyright 2014, Gamma Remote Sensing, v1.6 21-Aug-2014 clw

Parameters

- **SLC_par** – (input) ISP SLC/MLI image parameter file
- **terra_alt** – (input) average terrain altitude (default: 300.000 meters)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_deramp (SLC_I, SLC_par1, SLC_2, SLC_par2, mode,
                                         dop_ph='-', logpath=None)
```

Calculate and subtract Doppler phase from an SLC image

Copyright 2016, Gamma Remote Sensing, v1.5 4-Feb-2016 clw

Parameters

- **SLC-1** – (input) SLC data file (fcomplex or scomplex format)
- **SLC_par1** – (input) SLC parameter file with Doppler information
- **SLC-2** – (output) SLC with Doppler phase removed (or added)
- **SLC_par2** – (output) SLC parameter file for the output SLC
- **mode** –
mode of operation:
 - 0: subtract Doppler phase ramp (deramp)
 - 1: add Doppler phase ramp (reramp)
- **dop_ph** –
(output) Doppler phase (FLOAT) Note: SLC_par1 contains the Doppler polynomial that is used to calculate the Doppler phase ramp
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_deramp_S1_TOPS (SLC1_tab, SLC2_tab, mode, phflg, log-  
path=None)
```

Calculate and subtract S1 TOPS Doppler phase from burst SLC data

Copyright 2015, Gamma Remote Sensing v1.4 18-Jun-2015

Parameters

- **SLC1_tab** –
(input) 3 column list of TOPS SLC-1 swaths to be deramped in row order IW1, IW2, IW3:
SLC_tab line entries: SLC SLC_par TOPS_par
- **SLC2_tab** – (input) 3 column list of the output deramped SLC-1 TOPS swaths in the order
IW1, IW2, IW3
- **mode** –
mode of operation:
 - 0: subtract TOPS Doppler phase (deramp)
 - 1: add Doppler phase ramp (reramp)
- **phflg** –
deramp phase flag:
 - 0: do not save TOPS Doppler phase (default)
 - 1: save TOPS Doppler phase, output filename is the same as the deramped SLC with
extension .dph
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_interp (SLC_2, SLC1_par, SLC2_par, OFF_par, SLC_2R,  
SLC2R_par, loff='- ', nlines='- ', logpath=None)
```

SLC complex image resampling using 2-D SINC interpolation

Copyright 2015, Gamma Remote Sensing, v4.3 11-Nov-2015 clw

Parameters

- **SLC-2** – (input) SLC-2 image to be resampled to the geometry of the SLC-1 reference
image
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **SLC-2R** – (output) single-look complex image 2 coregistered to SLC-1
- **SLC2R_par** – (output) SLC-2R ISP image parameter file for coregistered image
- **loff** – offset to first valid output line (in SLC-1 lines) (default: 0)
- **nlines** – number of valid output lines (default: 0, to end of file)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_interp_S1_TOPS (SLC2_tab,      SLC2_par,      SLC1_tab,
                                                SLC1_par,      OFF_par,      SLC2R_tab,
                                                SLC_2R='- ',    SLC2R_par='- ',    log-
                                                path=None)
```

Resample S1 TOPS (IW mode) SLC using global offset polynomial

Copyright 2015, Gamma Remote Sensing v1.9 4-Dec-2015

Parameters

- **SLC2_tab** –
(input) 3 column list of TOPS SLC-2 swaths to be resampled to the geometry of the reference SLC1 in row order
SLC_tab line entries: SLC SLC_par TOPS_par
- **SLC2_par** – SLC parameter file of TOPS SLC-2 mosaic, SLC-2 is generated from the TOPS swaths listed in SLC2_tab
- **SLC1_tab** – (input) 3 column list of the reference TOPS SLC swaths in row order IW1, IW2, IW3
- **SLC1_par** – SLC parameter file of the reference TOPS SLC-1 mosaic, SLC-1 is generated from the TOPS swaths listed in SLC1_tab
- **OFF_par** – (input) global ISP offset and interferogram parameter file, the offset model is determined from the TOPS SLC mosaics
- **SLC2R_tab** – (input) 3 column list of the output resampled SLC-2 TOPS swaths in the order IW1, IW2, IW3
- **SLC-2R** – (output) resampled mosaic generated from the swaths listed in SLC2R_tab, coregisted to the TOPS SLC-1 mosaic (enter - for none)
- **SLC2R_par** – (output) SLC parameter file associated with the resampled TOPS SLC-2R mosaic
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_mosaic_S1_TOPS (SLC_tab, SLC, SLC_par, rlks, azlks,
                                                wflg='- ', SLCR_tab='- ', logpath=None)
```

Calculate SLC mosaic of Sentinel-1 TOPS burst SLC data

Copyright 2016, Gamma Remote Sensing v3.5 23-August-2016 clw/awi

Parameters

- **SLC_tab** – (input) 3 column list of SLC, SLC_par, Sentinel-1 TOPS_par sorted in the order IW1, IW2, IW3...
- **SLC** – (output) SLC mosaic image
- **SLC_par** – (output) SLC mosaic image parameter file
- **rlks** – number of range looks used to determine burst window boundaries for the mosaic
- **azlks** – number of azimuth looks used to determine burst window boundaries for the mosaic
- **wflg** –
burst window calculation flag:

- 0: use existing burst window parameters if they exist, otherwise calculate burst window parameters (default)
- 1: calculate burst window parameters from burst parameters and the number of range and azimuth looks
- **SLCR_tab** –
(input) SLC_tab of the reference scene, 3 column list of SLC, SLC_par, TOPS_par sorted in the order
- NOTE: When generating a mosaic of a resampled SLC, the SLC_tab of the reference scene is required
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_ovr (SLC, SLC_par, SLC_ovr, SLC_ovr_par, r_ovr, log-  
                                     path=None)
```

ISP Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/SLC_ovr.c

Copyright 2016, Gamma Remote Sensing, v1.8 5-Mar-2016 clw

Oversample or subsample SLC data in slant-range

Parameters

- **SLC** – (input) SLC file (fcomplex or scomplex)
- **SLC_par** – (input) SLC parameter file of SLC file
- **SLC_ovr** – (output) range resampled SLC file (fcomplex or scomplex)
- **SLC_ovr_par** – (output) SLC parameter file of range resampled SLC data file
- **r_ovr** –
integer range oversampling factor (2 → 16) if r_ovr < 0, the SLC will be subsampled,
integer range subsampling factor (-2 → -16)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SLC_phase_shift (SLC_1, SLC_par1, SLC_2, SLC_par2, ph_shift,  
                                             logpath=None)
```

Add a constant phase from an SLC image

Copyright 2015, Gamma Remote Sensing, v1.1 1-Dec-2015 clw

Parameters

- **SLC-1** – (input) SLC data file (fcomplex or scomplex format)
- **SLC_par1** – (input) SLC parameter file
- **SLC-2** – (output) SLC with phase shift
- **SLC_par2** – (output) SLC parameter file for the output SLC
- **ph_shift** –
phase shift to add to SLC phase (radians)
 - NOTE: Used to apply a constant phase shift of -1.25 radians to Sentinel-1 TOPS SLC data from swath IW1 acquired up to 10-Mar-2015. Used to apply a constant phase

shift of -3.83 radians to Sentinel-1 TOPS SLC data with H-POL on receive (e.g. VH) acquired up to 10-Mar-2015.

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.SR_to_GRD (MLI_par, OFF_par, GRD_par, in_file, out_file, rlks='-',
                                     azlks='-', interp_mode='-', grd_rsp='-', grd_azsp='-',
                                     logpath=None)
```

Conversion to ground range for ISP MLI and INSAR data of type float

Copyright 2009, Gamma Remote Sensing, v1.9 7-May-2009 uw/clw

Parameters

- **MLI_par** – (input) MLI image parameter file of input slant range image (float)
- **OFF_par** – (input) ISP offset/interferogram parameter file of input image (enter - image in MLI geometry)
- **GRD_par** – (input/output) image parameter file of output ground range image
- **in_file** – (input) slant range image (float)
- **out_file** – (output) ground range image (float)
- **rlks** – multi-looking in range (prior to resampling, default=1)
- **azlks** – multi-looking in azimuth (prior to resampling, default=1)
- **interp_mode** –
interpolation mode
 - 0: nearest neighbor (default)
 - 1: spline
 - 2: spline log
- **grd_rsp** – output image ground range sample spacing (m) (default = (input image azimuth spacing) * azlks)
- **grd_azsp** – output image azimuth sample spacing (m) (default = (input image azimuth spacing) * azlks)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.adapt_filt (int, sm, width, low_SNR_thr='-', filt_width='-',
                                     xmin='-', xmax='-', ymin='-', ymax='-', log-
                                     path=None)
```

Adaptive bandpass filtering of interferograms

Copyright 2016, Gamma Remote Sensing, v3.5 clw 17-Feb-2016

Parameters

- **int** – (input) complex interferogram image filename
- **sm** – (output) smoothed interferogram filename
- **width** – number of samples/row
- **low_SNR_thr** – low SNR threshold (default = .25);
- **filt_width** – filter width in pixels (default = 1.0)

- **xmin** – offset to starting range pixel (default = 0)
- **xmax** – offset last range pixel (default = width-1)
- **ymin** – offset to starting azimuth row (default = 0)
- **ymax** – offset to last azimuth row (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.adf (interf, sm, cc, width, alpha='-', nfft='-', cc_win='-', step='-',  
                                loff='-', nlines='-', wfrac='-', logpath=None)
```

Adaptive spectral filtering for complex interferograms

Copyright 2016, Gamma Remote Sensing, v3.5 15-Feb-2016 clw

Parameters

- **interf** – (input) interferogram (fcomplex)
- **sm** – (output) filtered interferogram (fcomplex)
- **cc** – (output) coherence derived from filtered interferogram (float)
- **width** – number of samples/line
- **alpha** – exponent for non-linear filtering (enter - for default: 0.40)
- **nfft** – filtering FFT window size, 2**N, 8 → 512, (enter - for default: 32)
- **cc_win** – coherence parameter estimation window size odd, max: 15 (enter - for default: 5)
- **step** – processing step (enter - for default: nfft/8)
- **loff** – offset to starting line to process (enter - for default: 0)
- **nlines** – number of lines to process (enter - for default: to end of file)
- **wfrac** – minimum fraction of points required to be non-zero in the filter window (enter - for default: 0.200)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.af_SLC (SLC_par, SLC, rwin='-', azwin='-', dr='-', daz='-', thres='-',  
                                   a1_flg='-', b0_flg='-', offsets='-', n_ovr='-', roff='-',  
                                   azoff='-', logpath=None)
```

Focus testing for SLC data using autofocus estimation of effective velocity

Copyright 2016, Gamma Remote Sensing, v1.4 16-Feb-2016 clw/uw

Parameters

- **SLC_par** – (input) ISP SLC image parameter file
- **SLC** – (input) single-look complex image
- **rwin** – range window size (enter - for default: 1024)
- **azwin** – azimuth window size (enter - for default: 4096)
- **dr** – range sample increment (enter - for default: 1024, enter 0 for single patch)
- **daz** – azimuth line increment (enter - for default: 8192, enter 0 for single patch)
- **thres** – offset estimation SNR threshold (enter - for default: 10.000)

- **a1_flg** –
fit a1 for first derivative of the effective velocity w.r.t.range
 - 0: no (default)
 - 1: yes
- **b0_flg** –
fit b0 for first derivative of the effective velocity w.r.t. along-track time
 - 0: no (default)
 - 1: yes
- **offsets** – (output) range and azimuth offsets and SNR data in text format, enter - for no output
- **n_ovr** – SLC oversampling factor (1,2,4: enter - for default: 1)
- **roff** – range offset for single patch center
- **azoff** – azimuth offset for single patch center
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ave_image(im_list, width, ave, start='-', nlines='-', pixav_x='-',
                                     pixav_y='-', zflag='-', nmin='-', logpath=None)
```

Calculate average of a stack of images (float format)

Copyright 2015, Gamma Remote Sensing, v1.9 20-Nov-2015 clw

Parameters

- **im_list** – (input) text file with names of co-registered images in column 1 (float)
- **width** – number of samples/line
- **ave** – (output) average of input image data files (float)
- **start** – starting line (default: 1)
- **nlines** – number of lines to process (enter - for default: entire file)
- **pixav_x** – number of pixels to average in width (default: 1)
- **pixav_y** – number of pixels to average in height (default: 1)
- **zflag** –
zero flag:
 - 0: interpret 0.0 as missing data value (default)
 - 1: interpret 0.0 as valid data
- **nmin** – minimum number of images required to calculate the average if zflag = 0 (default: 3/4*nfiles)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.az_integrate(data, width, azi, cflag, scale='-', lz='-', log-
                                       path=None)
```

Calculate azimuth integral of float data (unwrapped phase or azimuth offsets)

Copyright 2012, Gamma Remote Sensing, v1.2 6-Feb-2012

Parameters

- **data** – (input) input data (example: SBI dtrapped phase) (float)
- **width** – (input) number of range samples/line
- **azi** – (output) input data integrated along azimuth (float)
- **cflg** –
integration constant flag:
 - 0: set azimuth integral value to 0.0 at specified line
 - 1: set average of the azimuth integral to 0.0
- **scale** – scale factor to apply to the data (enter - for default, default: 1.0)
- **lz** – line offset where the azimuth integral is set to 0.0 (cflg = 0, enter - for default, default: 0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.az_spec_SLC (SLC, SLC_par, spectrum, roff='-', namb='-', pltflg='-',  
                                         logpath=None)
```

Doppler centroid estimate from SLC images

Copyright 2016, Gamma Remote Sensing, v2.9 clw 15-Feb-2016

Parameters

- **SLC** – (input) SAR image data file (fcomplex or scomplex format)
- **SLC_par** – (input) ISP SLC image parameter file
- **spectrum** – (output) Doppler spectrum (text format)
- **roff** – range sample offset to center of estimation window (enter - for default=center_swath)
- **namb** – number of multiples of the PRF to add to the estimated centroid (default=0)
- **pltflg** –
azimuth spectrum plotting flag:
 - 0: none (default)
 - 1: output plot in PNG format
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.base_copy (SLC1_par, baseline_1, SLC2_par, baseline_2,  
                                       time_rev='-', logpath=None)
```

Calculate baseline file for a subsection of a reference SLC

Copyright 2003, Gamma Remote Sensing, v1.1 6-Jan-2003 ts/clw/uw

Parameters

- **SLC1_par** – (input) ISP image parameter file of the reference SLC
- **baseline-1** – (input) baseline file derived using the reference SLC geometry
- **SLC2_par** – (input) ISP image parameter file corresponding to the subsection of the reference SLC

- **baseline-2** – (output) baseline file derived using the geometry and timing of the SLC subsection
- **time_rev** – SLC image normal=1, time-reversed = -1 (default=1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.base_est_fft (interf, SLC1_par, OFF_par, baseline, nazfft='- ',
                                           r_samp='- ', az_line='- ', logpath=None)
```

Estimate baseline from interferogram fringe spectrum

Copyright 2016, Gamma Remote Sensing, v2.1 clw/uw 20-Feb-2016

Parameters

- **interf** – (input) multi-look interferogram with range phase
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **baseline** – (output) baseline file
- **nazfft** – size of azimuth FFT (lines read from file, 2**N) (default: 512)
- **r_samp** – range pixel offset to center of the FFT window (default: center)
- **az_line** – line offset from start of the interf. for the FFT window (default=center)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.base_ls (SLC_par, OFF_par, gcp_ph, baseline, ph_flag='- ',
                                     bc_flag='- ', bn_flag='- ', bcdot_flag='- ', bndot_flag='- ',
                                     bperp_min='- ', SLC2R_par='- ', logpath=None)
```

Least squares baseline estimation using terrain heights

Copyright 2005, Gamma Remote Sensing, v2.2 5-Sep-2005 clw/uw

Parameters

- **SLC_par** – (input) ISP parameter file of the reference SLC
- **OFF_par** – (input) ISP interferogram/offset parameter file
- **gcp_ph** – (input) ground control point heights + extracted unwrapped phase (text format)
- **baseline** – (input) baseline parameter file
- **ph_flag** – restore range phase ramp (default=0: do not restore 1: restore)
- **bc_flag** – cross-track baseline component estimate (0:orbit derived 1:estimate from data, default=1)
- **bn_flag** – normal baseline component estimate (0:orbit derived 1:estimate from data, default=1)
- **bcdot_flag** – cross-track baseline rate estimate (0:orbit derived 1:estimate from data, default=1)
- **bndot_flag** – normal baseline rate estimate (0:orbit derived 1:estimate from data, default=0)
- **bperp_min** – minimum perpendicular baseline required for L.S estimation (m, default=10.0)

- **SLC2R_par** – (input) parameter file of resampled SLC, required if SLC-2 frequency differs from SLC-1
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.base_orbit` (*SLC1_par*, *SLC2_par*, *baseline*, *logpath=None*)

Estimate baseline from orbit state vectors

Copyright 2015, Gamma Remote Sensing, v4.1 clw 18-Apr-2015

Parameters

- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **baseline** – (output) baseline file (text format, enter - for none)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.base_perp` (*baseline*, *SLC1_par*, *OFF_par*, *time_rev='-'*, *logpath=None*)

Calculate baseline components perpendicular and parallel to look vector

Copyright 2005, Gamma Remote Sensing, v3.5 10-May-2005 clw/uw

Parameters

- **baseline** – (input) baseline file (text)
- **SLC1_par** – (input) ISP parameter file of SLC-1 (reference SLC)
- **OFF_par** – (input) ISP interferogram/offset parameter file
- **time_rev** – SLC image normal=1 (default), image time-reversed = -1
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.bpf` (*data_in*, *data_out*, *width*, *fc_x*, *bw_x*, *fc_y*, *bw_y*, *roff='-'*, *azoff='-'*, *nr='-'*, *naz='-'*, *data_type='-'*, *f_mode='-'*, *beta='-'*, *fir_len='-'*, *logpath=None*)

Interferometric SAR Processor (ISP): Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/bpf.c

Copyright 2016, Gamma Remote Sensing, v1.7 clw 3-Mar-2016

Bandpass filter for 2-dimensional complex image data (FCOMPLEX or SCOMPLEX format)

Parameters

- **data_in** – (input) input data file (fcomplex, scomplex, float)
- **data_out** – (output) output data file (fcomplex, scomplex, float)
- **width** – number of samples/line
- **fc_x** – normalized x-coord. (across) filter center frequency (range: -0.5 → 0.5)
- **bw_x** – normalized x-coord. bandwidth (range: 0 → 1.0)
- **fc_y** – normalized y-coord. (down) filter center frequency (range: -0.5 → 0.5)
- **bw_y** – normalized y-coord. bandwidth (range: 0 → 1.0)

- **roff** – offset to starting range to filter (default: 0)
- **azoff** – offset to starting azimuth to filter (default: 0)
- **nr** – number of range pixels to filter (default - : width - roff)
- **naz** – number of azimuth lines to filter (default - : nlines - azoff)
- **data_type** – data type (default 0:fcomplex, 1:scomplex, 2:float)
- **f_mode** – fill mode (default 0:force filtered value to 0.0 for input value 0.0, 1:no forcing)
- **beta** – Kaiser window beta parameter (default - : 1.000)
- **fir_len** – finite impulse response filter length (default - : 128)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.bridge(int, flag, unw, bridge, width, xmin='-', xmax='-', ymin='-',
                                  ymax='-', logpath=None)
```

Phase unwrap new regions with bridges to regions already unwrapped
 Copyright 2010, Gamma Remote Sensing, v1.5 clw 4-Nov-2010

Parameters

- **int** – (input) interferogram (fcomplex)
- **flag** – (input) unwrapping flag file
- **unw** – (input/output) unwrapped phase (float)
- **bridge** – (input) bridge data file (text format)
- **width** – number of samples/row
- **xmin** – starting range pixel offset to unwrap (default = 0)
- **xmax** – last range pixel offset to unwrap (default=width-1)
- **ymin** – starting azimuth row offset to unwrap, relative to start (default = 0)
- **ymax** – last azimuth row offset to unwrap, relative to start (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.cc_wave(interf, pwr1, pwr2, corr, width, bx, by, wflg, xmin, xmax,
                                   ymin, ymax, logpath=None)
```

Estimate interferometric coherence
 Copyright 2015, Gamma Remote Sensing, v5.8 27-Jan-2015 clw/uw

Parameters

- **interf** – (input) normalized complex interferogram
- **pwr1** – (input) intensity image of the first scene (enter - for none)
- **pwr2** – (input) intensity image of the second scene (enter - for none)
- **corr** – (output) estimated degree of coherence filename
- **width** – number of samples/row
- **bx** – coherence window size (columns) (default: 5.0)
- **by** – coherence window size (rows) (default: 5.0)

- **wflg** –
magnitude weighting function:
 - 0: constant (default)
 - 1: triangular
 - 2: gaussian
 - 3: none (phase only)
- **xmin** – starting range pixel offset (default = 0)
- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row offset, relative to start (default = 0)
- **ymax** –
last azimuth row offset, relative to start (default = nlines-1)
 - NOTE: omitting pwr1 and pwr2 or setting wflg = 3 selects a coherence estimate algorithm that only uses the complex interferogram values. In the case of wflg = 3, only the interferogram phase is used.
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.clear_flag(flag, width, flag_bits, xmin, xmax, ymin, ymax, logpath=None)
```

Clear phase unwrapping flag bits

Copyright 2005, Gamma Remote Sensing, v1.6 clw 17-Oct-2005

Parameters

- **flag** – (input)phase unwrapping flag filename
- **width** – number of samples/row
- **flag_bits** –
byte with value of flag(s) to be cleared: Charges = 3 Guides = 4 Low SNR = 8 Visited = 16 BRANCH PT. = 32 Cuts = 64 Lawn = 128
- **xmin** – starting range pixel offset (default = 0)
- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row offset, relative to start (default = 0)
- **ymax** – last azimuth row offset, relative to start (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.corr_flag(corr, flag, width, corr_thr, xmin='-', xmax='-', ymin='-', ymax='-', border='-', logpath=None)
```

Low correlation region detection for phase unwrapping

Copyright 2005, Gamma Remote Sensing, v2.4 1-Mar-2005 clw/uw

Parameters

- **corr** – (input)interferometric correlation file
- **flag** – (input/output) phase unwrapping flag filename

- **width** – number of samples/row
- **corr_thr** – correlation threshold (0 -> 1.0)
- **xmin** – starting range pixel offset (default = 0)
- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row offset, relative to start (default = 0)
- **ymax** – last azimuth row offset, relative to start (default = nlines-1)
- **border** – effective range of low coherence pixels to set low coherence flag (default=2)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.create_offset(SLC1_par, SLC2_par, OFF_par, algorithm='-',
                                         rlks='-', azlks='-', iflg='-', logpath=None)
```

Create and update ISP offset and interferogram parameter files

Copyright 2015 Gamma Remote Sensing v5.3 clw/uw 10-Nov-2015

Parameters

- **SLC1_par** – (input) SLC-1/MLI-1 ISP image parameter filename (reference)
- **SLC2_par** – (input) SLC-2/MLI-2 ISP image parameter filename
- **OFF_par** – (input/output) ISP offset/interferogram parameter file
- **algorithm** –
offset estimation algorithm
 - 1: intensity cross-correlation (default)
 - 2: fringe visibility
- **rlks** – number of interferogram range looks (enter - for default: 1)
- **azlks** – number of interferogram azimuth looks (enter - for default: 1)
- **iflg** –
interactive mode flag (enter - for default)
 - 0: non-interactive
 - 1: interactive (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.dcomp_sirc(infile, outfile, samples, loff='-', nlines='-', log-
                                     path=None)
```

Extract SIR-C SLC compressed single-pol data

Copyright 2009, Gamma Remote Sensing, v1.4 16-Oct-2009 clw

Parameters

- **infile** – (input) SIR-C single-pol SLC compressed data
- **outfile** – (output) complex floating point data
- **samples** – number of polarimetric samples per input line (4 bytes/sample)
- **loff** – offset to starting line (default: 0)

- **nlines** – number of lines to copy(default: entire file, 0 = entire file)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.dcomp_sirc_quad(infile, outfile, samples, parameter, loff='',  
                                           nlines='', logpath=None)
```

Extract SIR-C MLC or SLC compressed quad-pol data

Copyright 2009, Gamma Remote Sensing, v1.4 16-Oct-2009 uw/clw

Parameters

- **infile** – (input) SIR-C SLC or MLC quad-pol compressed data
- **outfile** – (output) complex floating point data
- **samples** – number of polarimetric samples per input line (10 bytes/sample)
- **parameter** –
 polarimetric parameter to extract from SLC or MLC product:
 - 0: SLC total power
 - 1: SLC-HH
 - 2: SLC-HV
 - 3: SLC-VH
 - 4: SLC-VV
 - 5: MLC total power
 - 6: MLC-HVHV*
 - 7: MLC-VVVV*
 - 8: MLC-HHHH*
 - 9: MLC-HHHV*
 - 10: MLC-HHVV*
 - 11: MLC-HVVV*
- **loff** – offset to starting line (default: 0)
- **nlines** – number of lines to copy(default: entire file, 0 = entire file)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.fspf(data_in, data_out, width, dtype='', r_max='', spf_type='',  
                                MLI_par='', logpath=None)
```

ISP Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/fspf.c

Copyright 2014, Gamma Remote Sensing, v1.2 28-May-2014 of/clw/uw

Fast spatial filter for 2D data

Parameters

- **data_in** – (input) input image data
- **data_out** – (output) spatially filtered image data
- **width** – number of samples/row

- **dtype** –
data type (enter - for default):
 - 0: FCOMPLEXn 1: SCOMPLEX
 - 2: FLOAT (default)
- **r_max** – maximum filter radius (range samples) (enter - for default: 64)
- **spf_type** –
spatial filter type (enter - for default):
 - 0: uniform average (default for fcomplex and scomplex)
 - 1: triangular weighted average: $1 - (r/r_max)$
 - 2: quadratic weighted average: $1 - (r/r_max)**2$
 - 3: Gaussian weighted average: $\exp(-2. * (r**2/r_max**2))$
 - 4: linear least-squares (default for float data)
- **MLI_par** – MLI or SLC parameter file with the same number of looks as the input image, required for GPRI data
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.gcp_phase(unw, OFF_par, gcp, gcp_ph, win_sz='-', log-
                                     path=None)
```

Extract unwrapped phase at GCP locations

Copyright 2006, Gamma Remote Sensing, v1.5 8-Mar-2006 clw

Parameters

- **unw** – (input) unwrapped interferometric phase
- **OFF_par** – (input) ISP interferogram/offset parameter file
- **gcp** – (input) ground control point data (text format)
- **gcp_ph** – (output) ground control point data + extracted unwrapped phase (text)
- **win_sz** – window size for averaging phase for each gcp, must be odd (default: 1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.grasses(int, flag, unw, width, xmin='-', xmax='-', ymin='-', ymax='-',
                                   xinit='-', yinit='-', init_ph='-', logpath=None)
```

Phase unwrapping by region growing

Copyright 2005, Gamma Remote Sensing, v4.2 1-Mar-2005 clw/uw

Parameters

- **int** – (input) interferogram filename
- **flag** – (input) unwrapping flag filename
- **unw** – (output) unwrapped phase filename
- **width** – number of samples/row
- **xmin** – starting range pixel offset (default = 0)

- **xmax** – last range pixel offset (default=width-1)
- **ymin** – starting azimuth row offset, relative to start (default = 0)
- **ymax** – last azimuth row offset, relative to start (default = nlines-1)
- **xinit** – starting range pixel for unwrapping (default = width/2)
- **yinit** – starting row to unwrap (default = height/2)
- **init_ph** – flag to set phase at starting point to 0.0 (default 0: not set to 0.0, 1: set to 0.0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.hgt_map(unw, SLC_par, OFF_par, baseline, hgt, gr, ph_flag='-',  
                                   loff='-', nlines='-', SLC2R_par='-', logpath=None)
```

Interferometric height/ground range estimation vs. slant range

Copyright 2005, Gamma Remote Sensing, v5.1 clw/uw 9-Sep-2005

Parameters

- **unw** – (input) unwrapped interferometric phase
- **SLC_par** – (input) ISP parameter file for the reference SLC
- **OFF_par** – (input) ISP offset/interferogram processing parameters
- **baseline** – (input) baseline parameter file
- **hgt** – (output) height file (in slant range geometry) relative to the WGS-84 ellipsoid
- **gr** – (output) cross-track ground ranges on the WGS-84 ellipsoid (in slant range geometry)
- **ph_flag** – restore phase slope flag (0:no phase change default=1:add back phase ramp)
- **loff** – offset to starting line (default = 0)
- **nlines** – number of lines to calculate (enter - for default: to end of file)
- **SLC2R_par** – (input) parameter file of resampled SLC, required if SLC-2 frequency differs from SLC-1
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.image_stat(image, width, roff, loff, nr, nl, report, logpath=None)
```

Calculate mean, standard deviation and number of non-zero values for a rectangular image region (float format)

Copyright 2016, Gamma Remote Sensing, v1.3 3-Nov-2016

Parameters

- **image** – (input) image data file (float)
- **width** – image line width (samples/line)
- **roff** – sample offset to region start (enter - for default: 0)
- **loff** – line offset to region start (enter - for default: 0)
- **nr** – region width (samples, enter - for default: width - roff)
- **nl** – number of lines in the region (enter - for default: image_lines - loff)
- **report** –

output text file (keyword:value format) keywords: file, mean, stdev, total_samples, non_zero_samples, fraction_valid)

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.init_offset(SLC1, SLC2, SLC1_par, SLC2_par, OFF_par,
                                       rlks='- ', azlks='- ', rpos='- ', azpos='- ', offr='- ',
                                       offaz='- ', thres='- ', rwin='- ', azwin='- ', cflag='- ',
                                       logpath=None)
```

Determine initial offset between SLC images using correlation of image intensity

Copyright 2016, Gamma Remote Sensing, v3.1 clw 12-Apr-2016

Parameters

- **SLC-1** – (input) single-look complex image 1 (reference)
- **SLC-2** – (input) single-look complex image 2
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **rlks** – number of range looks (default: 1)
- **azlks** – number of azimuth looks (default: 1)
- **rpos** – center of patch in range (samples) (enter - for default: image center)
- **azpos** – center of patch in azimuth (lines) (enter - for default: image center)
- **offr** – initial range offset (samples) (enter - for default: 0)
- **offaz** – initial azimuth offset (lines) (enter - for default: 0)
- **thres** – cross-correlation threshold (enter - for default: 0.150)
- **rwin** – range window size (default: 512)
- **azwin** – azimuth window size (default: 512)
- **cflag** –
 copy offsets to the range and azimuth offset polynomials in the OFF_par
 – 0: do not copy
 – 1: copy constant range and azimuth offset (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.init_offset_orbit(SLC1_par, SLC2_par, OFF_par, rpos='- ',
                                             azpos='- ', cflag='- ', logpath=None)
```

Initial SLC image offset estimation from orbit state-vectors and image parameters

Copyright 2016, Gamma Remote Sensing, v1.7 21-Apr-2016 clw/uw

Parameters

- **SLC1_par** – (input) SLC-1 parameter file
- **SLC2_par** – (input) SLC-2 parameter file
- **OFF_par** – (input/output) ISP/offset parameter file

- **rpos** – range position for offset estimation (enter - for default: center of SLC-1)
- **azpos** – azimuth position for offset estimation (enter - for default: center of SLC-1)
- **cflag** –
copy offsets to the range and azimuth offset polynomials in the OFF_par
 - 0: do not copy
 - 1: copy constant range and azimuth offset (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.interp_ad(data_in, data_out, width, r_max='-', np_min='-',  
                                     np_max='-', w_mode='-', type='-', cp_data='-', log-  
                                     path=None)
```

Weighted interpolation of gaps in 2D data using an adaptive smoothing window
Copyright 2016, Gamma Remote Sensing, v2.1 23-Nov-2016 clw/uw

Parameters

- **data_in** – (input) data with gaps
- **data_out** – (output) data with gaps filled by interpolation
- **width** – number of samples/row
- **r_max** – maximum interpolation window radius (default(-): 16)
- **np_min** – minimum number of points used for the interpolation (default(-): 16)
- **np_max** – maximum number of points used for the interpolation (default(-): 16)
- **w_mode** –
data weighting mode (enter - for default):
 - 0: constant
 - 1: $1 - (r/r_max)$
 - 2: $1 - (r/r_max)**2$ (default)
 - 3: $\exp(-2. * (r**2/r_max**2))$
- **type** –
input and output data type:
 - 0: FCOMPLEX
 - 1: SCOMPLEX
 - 2: FLOAT (default)
 - 3: INT
 - 4: SHORT
- **cp_data** –
copy data flag:
 - 0: do not copy input data values to output
 - 1: copy input data values to output (default)

- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.mask_data(data_in, width, data_out, mask, format_flag='-', logpath=None)`

Mask float or fcomplex data using an 8-bit SUN/BMP/TIFF format raster image

Copyright 2015, Gamma Remote Sensing, v1.3 3-Dec-2015 clw

Parameters

- **data_in** – (input) data file (FLOAT or FCOMPLEX format)
- **width** – width of input data file
- **data_out** – (output) data file, same data format as input
- **mask** –
(input) mask file, SUN/BMP/TIFF raster format, 8-bits/pixel output data values are set to 0.0 at all locations where the mask is black (0,0,0) or dn = 0 * NOTE: mask file must have the same width as the input data file
- **format_flag** –
data format:
 - 0: FLOAT (default)
 - 1: FCOMPLEX
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.mcf(interf, wgt, mask, unw, width, tri_mode='-', roff='-', loff='-', nr='-', nlines='-', npat_r='-', npat_az='-', overlap='-', r_init='-', az_init='-', init_flag='-', logpath=None)`

Phase unwrapping using Minimum Cost Flow (MCF) and triangulation

Copyright 2016, Gamma Remote Sensing, v2.2 clw/uw 30-Nov-2016

Parameters

- **interf** – (input) interferogram (*.int,*.flt)(fcomplex)
- **wgt** – (input) weight factors (0 -> 1.0) file (float)(enter - for uniform weight)
- **mask** – (input) validity mask (SUN/BMP/TIFF raster format, value 0 -> pixel not used)(enter - if no mask)
- **unw** – (output) unwrapped phase image (*.unw)(float)
- **width** – number of samples/row
- **tri_mode** –
triangulation mode
 - 0: filled triangular mesh (default)
 - 1: Delaunay triangulation
- **roff** – offset to starting range of section to unwrap (default: 0)
- **loff** – offset to starting line of section to unwrap (default: 0)
- **nr** – number of range samples of section to unwrap (default(-): width - roff)

- **nlines** – number of lines of section to unwrap (default(-): total number of lines - loff)
- **npat_r** – number of patches in range
- **npat_az** – number of patches in azimuth
- **ovrlap** – overlap between patches in pixels (overlap ≥ 7 , default(-): 512)
- **r_init** – phase reference point range offset (default(-): roff)
- **az_init** – phase reference point azimuth offset (default(-): loff)
- **init_flag** –
flag to set phase at reference point
 - 0: use initial point phase value (default)
 - 1: set phase to 0.0 at initial point
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.mosaic_WB (data_tab, dtype, data_out, data_par_out, sc_flg='-', log-  
                                     path=None)
```

ISP: Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/mosaic_WB.c

Copyright 2011, Gamma Remote Sensing, v1.2 6-Apr-2011 clw

Mosaic Wide-Beam ScanSAR data processed by the MSP

Parameters

- **data_tab** – (input) 2 column list of data and ISP image parameter files for the beams in the mosaic (text)
- **dtype** –
(input) input data type:
 - 0: FLOAT
 - 1: FCOMPLEX
- **data_out** – (output) output image mosaic
- **data_par_out** – (output) ISP image parameter file for output image mosaic
- **sc_flg** –
intensity scaling flag:
 - 0: do not scale different beam data values
 - 1: use overlap regions to scale beam intensities (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.multi_S1_TOPS (SLC_tab, MLI, MLI_par, rlks, azlks, wflg='-',  
                                         SLCR_tab='-', logpath=None)
```

Calculate MLI mosaic from Sentinel-1 TOPS SLC burst data (FCOMPLEX and SCOMPLEX)

Copyright 2016, Gamma Remote Sensing v3.3 23-Aug-2016 awi/clw/uw

Parameters

- **SLC_tab** – (input) 3 column list of SLC, SLC_par, Sentinel-1 TOPS_par, rows sorted in the order IW1, IW2, IW3
- **MLI** – (output) multi-look intensity image
- **MLI_par** – (output) MLI image parameter file
- **rlks** – number of range looks
- **azlks** – number of azimuth looks
- **wflg** –

burst window calculation flag:

- 0: use existing burst window parameters if they exist, otherwise calculate burst window parameters (default)
- 1: calculate burst window parameters from burst parameters and the number of range and azimuth looks

- **SLCR_tab** –

(input) SLC_tab of the reference scene, 3 column list of SLC, SLC_par, TOPS_par sorted in the order IW1,

- NOTE: When generating an MLI mosaic of a resampled SLC, the SLC_tab of the reference scene is required

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.multi_SLC_WSS (SLC, SLC_par, MLI, MLI_par, logpath=None)
```

Calculate multi-look intensity image (MLI) from a ASAR Wide-Swath SLC

Copyright 2008, Gamma Remote Sensing v1.2 08-Jan-2008 clw/awi

Parameters

- **SLC** – (input) ASAR Wide-Swath SLC image
- **SLC_par** – (input) ASAR Wide-Swath SLC image parameter file
- **MLI** – (output) multi-look intensity image
- **MLI_par** – (output) MLI image parameter file
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.multi_cpx (data_in, OFF_par_in, data_out, OFF_par_out, rlks='-',
                                     azlks='-', loff='-', nlines='-', roff='-', nsamp='-', log-
                                     path=None)
```

Calculate multi-look averaged or interpolated 2D image (fcomplex data)

Copyright 2013, Gamma Remote Sensing, v2.5 28-Mar-2013 clw/uw

Parameters

- **data_in** – (input) input fcomplex image file
- **OFF_par_in** – (input) offset parameter file for input image
- **data_out** – (output) output multi-look or interpolated fcomplex data file

- **OFF_par_out** – (input/output) offset parameter file for output, if already exists, then used as input
- **rlks** – number of range looks, values < -1, interpreted as an image oversampling factor (default: 1)
- **azlks** – number azimuth looks, values < -1, interpreted as an image oversampling factor (default: 1)
- **loff** – line offset to starting line (default: 0)
- **nlines** – number of lines (default: 0, to end of file)
- **roff** – offset to starting range sample (default:0)
- **nsamp** – number of range samples to extract (default: 0, to end of line)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.multi_look(SLC, SLC_par, MLI, MLI_par, rlks, azlks, loff='-',  
                                       nlines='-', scale='-', exp='-', logpath=None)
```

Calculate a multi-look intensity (MLI) image from an SLC image

Copyright 2016, Gamma Remote Sensing, v4.1 18-Nov-2016 clw/uw

Parameters

- **SLC** – (input) single-look complex image
- **SLC_par** – (input) SLC ISP image parameter file
- **MLI** – (output) multi-look intensity image
- **MLI_par** – (output) MLI ISP image parameter file
- **rlks** – number of range looks
- **azlks** – number of azimuth looks
- **loff** – offset to starting line (default: 0)
- **nlines** – number of SLC lines to process (enter - for default: entire file)
- **scale** – scale factor for output MLI (default: 1.0)
- **exp** – exponent for the output MLI (default: 1.0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.multi_real(data_in, OFF_par_in, data_out, OFF_par_out, rlks='-',  
                                       azlks='-', loff='-', nlines='-', roff='-', nsamp='-',  
                                       logpath=None)
```

Calculate multi-look averaged or interpolated 2D image (float data)

Copyright 2012, Gamma Remote Sensing, v2.5 16-Jul-2013 clw/uw

Parameters

- **data_in** – (input) input float image file
- **OFF_par_in** – (input) interferogram/offset parameter file for input image
- **data_out** – (output) output multi-look or interpolated float data file

- **OFF_par_out** – (input/output) interferogram/offset parameter file for output, if already existing, used as input
- **rlks** – number of range looks, values < -1, interpreted as an image oversampling factor (default: 1)
- **azlks** – number azimuth looks, values < -1, interpreted as an image oversampling factor (default: 1)
- **loff** – line offset to starting line (default:0)
- **nlines** – number of lines (default:0, to end of file)
- **roff** – offset to starting range sample (default:0)
- **nsamp** – number of range samples to extract (default:0, to end of line)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.neutron(intensity, flag, width, n_thres, ymin='-', ymax='-', log-
                                path=None)
```

Generate phase unwrapping neutrons using image intensity

Copyright 2014, Gamma Remote Sensing, v2.3 20-Jan-2014 clw/uw

Parameters

- **intensity** – (input) image intensity
- **flag** – (input) phase unwrapping flag file
- **width** – number of samples/row
- **n_thres** – neutron threshold, multiples of the average intensity (default=6.0)
- **ymin** – offset to starting azimuth row (default = 0)
- **ymax** – offset to last azimuth row (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_SLC(SLC_1, SLC_2, SLC1_par, SLC2_par, OFF_par, offs,
                                snr, rwin='-', azwin='-', offsets='-', n_ovr='-', nr='-',
                                naz='-', thres='-', ISZ='-', pflag='-', logpath=None)
```

Offsets between SLC images using fringe visibility

Copyright 2016, Gamma Remote Sensing, v2.9 clw 4-Mar-2016

Parameters

- **SLC-1** – (input) single-look complex image 1 (reference)
- **SLC-2** – (input) single-look complex image 2
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **offs** – (output) offset estimates (fcomplex)
- **snr** – (output) offset estimation snr (float)
- **rwin** – search window size (range pixels, (enter - for default from offset parameter file))

- **azwin** – search window size (azimuth lines, (enter - for default from offset parameter file))
- **offsets** – (output) range and azimuth offsets and snr data in text format, enter - for no output
- **n_ovr** – SLC oversampling factor (integer 2**N (1,2,4) default = 2)
- **nr** – number of offset estimates in range direction (enter - for default from offset parameter file)
- **naz** – number of offset estimates in azimuth direction (enter - for default from offset parameter file)
- **thres** – offset estimation quality threshold (enter - for default from offset parameter file)
- **ISZ** – search chip interferogram size (in non-oversampled pixels, default=16)
- **pflag** – print flag (0:print offset summary default=1:print all offset data)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_SLC_tracking(SLC_1, SLC_2, SLC1_par, SLC2_par,
                                                OFF_par, offs, snr, rsw='-', azsw='-',
                                                offsets='-', n_ovr='-', thres='-', rstep='-',
                                                azstep='-', rstart='-', rstop='-',
                                                azstart='-', azstop='-', ISZ='-', pflag='-',
                                                logpath=None)
```

Offset tracking between SLC images using fringe visibility

Copyright 2016, Gamma Remote Sensing, v3.6 clw 4-Mar-2016

Parameters

- **SLC-1** – (input) single-look complex image 1 (reference)
- **SLC-2** – (input) single-look complex image 2
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **offs** – (output) offset estimates (fcomplex)
- **snr** – (output) offset estimation snr (float)
- **rsw** – range search window size (range pixels) (enter - for default from offset parameter file)
- **azsw** – azimuth search window size (azimuth lines) (enter - for default from offset parameter file)
- **offsets** – (output) range and azimuth offsets and snr data in text format, enter - for no output
- **n_ovr** – SLC over-sampling factor (integer 2**N (1,2,4) default: 2)
- **thres** – offset estimation quality threshold (enter - for default from offset parameter file)
- **rstep** – step in range pixels (enter - for default: rsw/2)
- **azstep** – step in azimuth pixels (enter - for default: azsw/2)
- **rstart** – starting range pixel (enter - for default: rsw/2)

- **rstop** – ending range pixel (enter - for default: nr - rsw/2)
- **azstart** – starting azimuth line (enter - for default: azsw/2)
- **azstop** – ending azimuth line (enter - for default: nlines - azsw/2)
- **ISZ** – search chip interferogram size (in non-oversampled pixels, default: 16)
- **pflag** –
print flag:
 - 0: print offset summary (default)
 - 1: print all offset data
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_add(OFF_par1, OFF_par2, OFF_par3, logpath=None)
```

Add range and azimuth offset polynomial coefficients

Copyright 2008, Gamma Remote Sensing, v1.1 12-Feb-2008 clw

Parameters

- **OFF_par1** – (input) ISP offset/interferogram parameter file
- **OFF_par2** – (input) ISP offset/interferogram parameter file
- **OFF_par3** –
(output) ISP offset/interferogram parameter file with sums of the range and azimuth
offset polynomials in OFF_par1 and OFF_par2
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_pwr(SLC1, SLC2, SLC1_par, SLC2_par, OFF_par, offs,
                                     ccp, rwin='-', azwin='-', offsets='-', n_ovr='-', nr='-',
                                     naz='-', thres='-', c_ovr='-', pflag='-', pltflg='-',
                                     ccs='-', logpath=None)
```

Offset tracking between SLC images using intensity cross-correlation

Copyright 2016, Gamma Remote Sensing, v5.1 clw 22-Oct-2016

Parameters

- **SLC1** – (input) single-look complex image 1 (reference)
- **SLC2** – (input) single-look complex image 2
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **offs** – (output) offset estimates in range and azimuth (fcomplex)
- **ccp** – (output) cross-correlation of each patch (0.0->1.0) (float)
- **rwin** – range patch size (range pixels, (enter - for default from offset parameter file)
- **azwin** – azimuth patch size (azimuth lines, (enter - for default from offset parameter file)

- **offsets** – (output) range and azimuth offsets and cross-correlation data in text format, enter - for no output
- **n_ovr** – SLC oversampling factor (integer 2**N (1,2,4,8), enter - for default: 2)
- **nr** – number of offset estimates in range direction (enter - for default from offset parameter file)
- **naz** – number of offset estimates in azimuth direction (enter - for default from offset parameter file)
- **thres** – cross-correlation threshold (enter - for default from offset parameter file)
- **c_ovr** – correlation function oversampling factor (integer 2**N (1,2,4,8,16) default: 4)
- **pflag** –
 print flag (enter - for default)
 - 0: print offset summary
 - 1: print all offset data
- **pltflg** –
 plotting flag (enter - for default)
 - 0: none (default)
 - 1: screen output
 - 2: screen output and PNG format plots
 - 3: output plots in PDF format
- **ccs** – (output) cross-correlation standard deviation of each patch (float)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_pwr_tracking(SLC1, SLC2, SLC1_par, SLC2_par,  
                                              OFF_par, offs, ccp, rwin='- ', azwin='- ',  
                                              offsets='- ', n_ovr='- ', thres='- ',  
                                              rstep='- ', azstep='- ', rstart='- ', rstop='- ',  
                                              azstart='- ', azstop='- ', c_ovr='- ',  
                                              pflag='- ', pltflg='- ', ccs='- ', log-  
                                              path=None)
```

Offset tracking between SLC images using intensity cross-correlation

Copyright 2016, Gamma Remote Sensing, v5.1 clw 22-Oct-2016

Parameters

- **SLC1** – (input) single-look complex image 1 (reference)
- **SLC2** – (input) single-look complex image 2
- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **offs** – (output) offset estimates in range and azimuth (fcomplex)
- **ccp** – (output) cross-correlation of each patch (0.0->1.0) (float)

- **rwin** – range patch size (range pixels, (enter - for default from offset parameter file)
- **azwin** – azimuth patch size (azimuth lines, (enter - for default from offset parameter file)
- **offsets** – (output) range and azimuth offsets and cross-correlation data in text format, enter - for no output
- **n_ovr** – SLC oversampling factor (integer 2**N (1,2,4,8), enter - for default: 2)
- **thres** – cross-correlation threshold (0-> 1.)(enter - for default from offset parameter file)
- **rstep** – step in range pixels (enter - for default: rwin/2)
- **azstep** – step in azimuth pixels (enter - for default: azwin/2)
- **rstart** – offset to starting range pixel (enter - for default: 0)
- **rstop** – offset to ending range pixel (enter - for default: nr-1)
- **azstart** – offset to starting azimuth line (enter - for default: 0)
- **azstop** – offset to ending azimuth line (enter - for default: nlines-1)
- **c_ovr** – correlation function oversampling factor (integer 2**N (1,2,4,8,16) default: 4)
- **pflag** –
print flag (enter - for default)
 - 0: print offset summary
 - 1: print all offset data)
- **pltflg** –
plotting flag (enter - for default)
 - 0: none (default)
 - 1: screen output
 - 2: screen output and PNG format plots
 - 3: output plots in PDF format
- **ccs** – (output) cross-correlation standard deviation of each patch (float)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_pwr_tracking2 (SLC1, SLC2, SLC1_par, SLC2_par,
OFF_par, offs, ccp, OFF_par2='-
', offs2='- ', rwin='- ', azwin='- ',
offsets='- ', n_ovr='- ', thres='- ',
rstep='- ', azstep='- ', rstart='- ',
rstop='- ', azstart='- ', azstop='- ',
c_ovr='- ', pflag='- ', pltflg='- ', ccs='- ',
logpath=None)
```

Intensity cross-correlation offset tracking with the initial offset for each patch determined from input offset map
 Copyright 2016, Gamma Remote Sensing, v1.3 clw 22-Oct-2016

Parameters

- **SLC1** – (input) single-look complex image 1 (reference)
- **SLC2** – (input) single-look complex image 2

- **SLC1_par** – (input) SLC-1 ISP image parameter file
- **SLC2_par** – (input) SLC-2 ISP image parameter file
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **offs** – (output) offset estimates in range and azimuth (fcomplex)
- **ccp** – (output) cross-correlation of each patch (0.0->1.0) (float)
- **OFF_par2** – (input) ISP offset/interferogram parameter file of the offset map to determine initial offsets (enter - for none)
- **offs2** – (input) input range and azimuth offset map to determine initial offsets (enter - for none)
- **rwin** – range patch size (range pixels, (enter - for default from offset parameter file)
- **azwin** – azimuth patch size (azimuth lines, (enter - for default from offset parameter file)
- **offsets** – (output) range and azimuth offsets and cross-correlation data in text format, enter - for no output
- **n_ovr** – SLC oversampling factor (integer 2**N (1,2,4,8), enter - for default: 2)
- **thres** – cross-correlation threshold (0-> 1.)(enter - for default from offset parameter file)
- **rstep** – step in range pixels (enter - for default: rwin/2)
- **azstep** – step in azimuth pixels (enter - for default: azwin/2)
- **rstart** – offset to starting range pixel (enter - for default: 0)
- **rstop** – offset to ending range pixel (enter - for default: nr-1)
- **azstart** – offset to starting azimuth line (enter - for default: 0)
- **azstop** – offset to ending azimuth line (enter - for default: nlines-1)
- **c_ovr** – correlation function oversampling factor (integer 2**N (1,2,4,8,16) default: 4)
- **pflag** –
 print flag (enter - for default)
 - 0: print offset summary
 - 1: print all offset data
- **pltflg** –
 plotting flag (enter - for default)
 - 0: none (default)
 - 1: screen output
 - 2: screen output and PNG format plots
 - 3: output plots in PDF format
- **ccs** – (output) cross-correlation standard deviation of each patch (float)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.offset_tracking(offs, ccp, SLC_par, OFF_par, disp_map,  
                                           disp_val='-', mode='-', thres='-', poly_flag='-',  
                                           logpath=None)
```

Conversion of range and azimuth offsets files to displacement map
 Copyright 2015, Gamma Remote Sensing, v1.8 28-Nov-2015 ts/clw/uw

Parameters

- **offs** – (input) range and azimuth offset estimates (fcomplex)
- **ccp** – (input) cross-correlation of the offset estimates (float)
- **SLC_par** – (input) SLC parameter file of reference SLC
- **OFF_par** – (input) offset parameter file used in the offset tracking
- **disp_map** – (output) range and azimuth displacement estimates (fcomplex)
- **disp_val** – (output) range and azimuth displacement estimates and SNR values (enter - for none) (text)
- **mode** –
flag indicating displacement mode:
 - 0: displacement in range and azimuth pixels
 - 1: displacement in meters in slant range and azimuth directions
 - 2: displacement in meters in ground range and azimuth directions (default)
- **thres** – SNR threshold to accept offset value (default from OFF_par)
- **poly_flag** –
flag indicating if trend calculated using offset polynomials from OFF_par is subtracted:
 - 0: do not subtract polynomial trend from offset data
 - 1: subtract polynomial trend from offset data (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.par_ACS_ERS (CEOS_SAR_leader, SLC_par, logpath=None)`

ISP parameter file generation for ERS SLC data from the ACS processor
 Copyright 2005, Gamma Remote Sensing, v1.3 17-Oct-2005 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file
- **SLC_par** – (output) ISP SLC parameter file (example <orbit>.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

`pyroSAR.gamma.parser_demo.par_ASAR (ASAR_file, output_name, K_dB='-', logpath=None)`

Extract SLC/MLI image parameters and images from ENVISAT ASAR SLC, WSS, APP, and PRI products
 Copyright 2014, Gamma Remote Sensing, v2.7 20-Aug-2014 clw/uw/awi

Parameters

- **ASAR_file** – (input) ASAR data file including header and image as provided by ESA

- **output_name** – (output)common part of output file names (e.g. orbit number)
- **K_dB** –
Calibration factor in dB (nominal value for all ASAR modes = 55.0)
 - NOTE: Use - for the calibration coefficient provided in the header of the ASAR_file
 - NOTE: In the case that a calibration factor is provided, PRI images are converted to radiometrically calibrated ground-range intensity images in float format
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ASF_91 (CEOS_leader, CEOS_trailer, SLC_par, log-  
path=None)
```

SLC parameter file for data data from theAlaska SAR Facility (1991-1996)

Copyright 2008, Gamma Remote Sensing, v3.3 25-Mar-2008 clw/uw

Parameters

- **CEOS_leader** – (input) ASF CEOS leader file
- **CEOS_trailer** – (input) ASF CEOS trailer file
- **SLC_par** – (output) ISP SLC image parameter file
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ASF_96 (CEOS_SAR_leader, SLC_par, logpath=None)
```

ISP parameter file for ASF data 1996→present v1.1

Copyright 2003, Gamma Remote Sensing, v1.4 4-Aug-2003 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) CEOS SAR leader file
- **SLC_par** – (output) ISP SLC parameter file (example <orbit>.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ASF_PRI (CEOS_leader, CEOS_data, GRD_par, GRD, log-  
path=None)
```

ISP parameter file for ASF detected ground range images (L1) Sep 1996 → present

Copyright 2014, Gamma Remote Sensing, v1.3 3-Apr-2014 clw/uw

Parameters

- **CEOS_leader** – (input) CEOS leader file
- **CEOS_data** – (input) CEOS data file binary)
- **GRD_par** – (output) ISP ground range image parameter file
- **GRD** –
(output) ISP ground range image (enter - for none, float intensity)
 - NOTE: The input data converted to intensity using the expression: (dn/1000.)**2
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ASF_RSAT_SS (CEOS_leader, CEOS_data, GRD_par, GRD,  
                                             logpath=None)
```

ISP parameter file for ASF Radarsat-1 SCANSAR images

Copyright 2004, Gamma Remote Sensing, v1.0 27-Aug-2004 clw/uw

Parameters

- **CEOS_leader** – (input) CEOS leader file (Radarsat-1 SCANSAR)
- **CEOS_data** – (input) CEOS data file (Radarsat-1 SCANSAR)
- **GRD_par** – (output) ISP image parameter file (example <orbit>.mli.par)
- **GRD** – (output) ISP image (example <orbit>.mli) (enter - for none, short integer)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ATLSCI_ERS (CEOS_SAR_leader, CEOS_Image, SLC_par, log-  
                                             path=None)
```

ISP parameter file for ATL-SCI ERS SLC data

Copyright 2003, Gamma Remote Sensing, v2.8 24-Nov-2003 clw

Parameters

- **CEOS_SAR_leader** – (input) CEOS SAR leader file (LEA_01.001)
- **CEOS_Image** – (input) CEOS image data segment (DAT_01.001)
- **SLC_par** – (output) ISP SLC parameter file (example <orbit>.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_CS_SLC (HDF5, trunk, logpath=None)
```

Generate ISP SLC parameter and image files for Cosmo-Skymed SCS data

Copyright 2015, Gamma Remote Sensing, v1.7 21-Aug-2015 awi/ms/cw

Parameters

- **HDF5** – (input) SCS data file in HDF5 format
- **trunk** –
(output) output file name trunk used for output filenames (example: yyyymmdd -> yyyymmdd_pol_beamid.slc yyyymmdd_pol_beamid.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_CS_SLC_TIF (GeoTIFF, XML, trunk, logpath=None)
```

Generate ISP SLC parameter and image files for Cosmo Skymed SCS data in GeoTIFF format

Copyright 2015, Gamma Remote Sensing, v1.4 12-Aug-2015 awi/ms/clw

Parameters

- **GeoTIFF** – (input) SCS data file in GeoTIFF format
- **XML** – (input) SCS meta data file in XML format

- **trunk** –
(output) output file name trunk used for output filenames (example: `yyyymmdd -> yyyymmdd_pol_beamid.slc yyyymmdd_pol_beamid.slc.par`)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_EORC_PALSAR (CEOS_leader, SLC_par, CEOS_data, SLC='-',  
                                             logpath=None)
```

Reformat EORC PALSAR + PALSAR2 level 1.1 CEOS format SLC data and generate the ISP parameter file
Copyright 2016, Gamma Remote Sensing, v2.7 27-Apr-2016 clw

Parameters

- **CEOS_leader** – (input) CEOS leader file for PALSAR or PALSAR-2 Level 1.1 SLC data (LED...)
- **SLC_par** – (output) ISP image parameter file (example: `yyyymmdd.SLC.par`)
- **CEOS_data** – (input) PALSAR CEOS format Level 1.1 SLC (IMG...)
- **SLC** – (output) reformatted PALSAR SLC (example: `yyyymmdd.SLC`, enter - for none)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_ESA_ERS (CEOS_SAR_leader, SLC_par, CEOS_DAT='-',  
                                         SLC='-', logpath=None)
```

ISP parameter file generation for ERS SLC data from the PGS, VMP, and SPF processors
Copyright 2012, Gamma Remote Sensing, v1.4 12-Jan-2012 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file
- **SLC_par** – (output) ISP SLC parameter file (example: `<date>.SLC.par`)
- **CEOS_DAT** – (input) CEOS data file (example: `DAT_01.001`)
- **SLC** – (output) SLC data with file and line headers removed (example: `<date>.SLC`)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_KC_PALSAR_slr (factor_m, CEOS_leader, SLC_par, pol,  
                                              pls_mode, KC_data, pwr, fdtab='-', log-  
                                              path=None)
```

Generate ISP parameter file, Doppler table, and images for PALSAR KC Slant-Range data
Copyright 2013, Gamma Remote Sensing, v1.9.1 20-Aug-2013 ms,awi,clw

Parameters

- **factor_m** – (input) PALSAR Kyoto-Carbon parameter file
- **CEOS_leader** – (input) PALSAR Kyoto-Carbon leader file (LED)
- **SLC_par** – (output) ISP image parameter file (example: `yyyymmdd.mli.par`)
- **pol** – polarization e.g. HH or HV
- **pls_mode** –

PALSAR acquisition mode:

- 1: Fine Beam Single
- 2: Fine Beam Double
- 3: Wide Beam
- **KC_data** – (input) PALSAR Kyoto-Carbon data (short, little endian, amplitude)
- **pwr** – (output) PALSAR intensity (float, GAMMA Software endianness)
- **fdtab** – (output) table of output polynomials, one polynomial/block used as input to `gc_map_fd`
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_KS_DGM (HDF5, trunk, logpath=None)
```

Generate ISP SLC parameter and PRI image files for Kompsat DGM data

Copyright 2014, Gamma Remote Sensing, v1.0 5-May-2014 awi

Parameters

- **HDF5** – (input) DGM data file in HDF5 format
- **trunk** –
(output) output file name trunk used for output filenames (example: `yyyymmdd -> yyyymmdd_pol_beamid.slc yyyymmdd_pol_beamid.pri.par`)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_KS_SLC (HDF5, trunk, logpath=None)
```

Generate ISP SLC parameter and image files for Kompsat SCS data

Copyright 2016, Gamma Remote Sensing, v1.4 11-Feb-2016 awi/clw

Parameters

- **HDF5** – (input) SCS data file in HDF5 format
- **trunk** –
(output) output file name trunk used for output filenames (example: `yyyymmdd -> yyyymmdd_pol_beamid.slc yyyymmdd_pol_beamid.slc.par`)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_PRI (CEOS_SAR_leader, PRI_par, CEOS_DAT, PRI, log-  
path=None)
```

ISP parameter file generation for ERS PRI data from the PGS and VMP processors

Copyright 2012, Gamma Remote Sensing, v1.6 12-Jan-2012 clw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file for PRI product
- **PRI_par** – (output) ISP image parameter file (example: `<yyyymmdd>.PRI.par`)
- **CEOS_DAT** – (input) CEOS data file (example: `DAT_01.001`)

- **PRI** – (output) PRI data with file and line headers removed (example: <yyyymmdd>.PRI)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_PRI_ESRIN_JERS (CEOS_SAR_leader, PRI_par, CEOS_DAT,  
                                                PRI, logpath=None)
```

ISP GRD parameter file for ESRIN processed JERS PRI data

Copyright 2008, Gamma Remote Sensing, v1.8 16-May-2008 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file for PRI product
- **PRI_par** – (output) ISP image parameter file (example: <yyyymmdd>.PRI.par)
- **CEOS_DAT** – (input) CEOS data file (example: DAT_01.001)
- **PRI** – (output) PRI data with file and line headers removed (example: <yyyymmdd>.PRI)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_PulsAR (CEOS_SAR_leader, SLC_par, logpath=None)
```

ISP parameter file generation for ERS SLC data from the PULSAR SAR processor

Copyright 2003, Gamma Remote Sensing, v1.2 4-Aug-2003 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file
- **SLC_par** – (output) ISP SLC parameter file (example <orbit>.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RISAT_GRD (CEOS_leader, BAND_META, GRD_par,  
                                           CEOS_image, GRD='-', line_dir='-', pix_dir='-',  
                                           cal_flg='-', KdB='-', logpath=None)
```

Read RISAT-1 Ground-Range data from a CEOS data set and perform radiometric calibration

Copyright 2015, Gamma Remote Sensing, v1.2 24-Feb-2015 clw

Parameters

- **CEOS_leader** – (input) CEOS SAR leader file (example: lea_01.001)
- **BAND_META** – (input) BAND_META.txt, additional RISAT system parameters for the scene (format keyword=value)
- **GRD_par** – (output) ISP GRD parameter file (example: YYYYMMDD.GRD.par)
- **CEOS_image** – (input) CEOS Ground-Range image file (example: dat_01.001)
- **GRD** – (output) Ground-Range data with file and line headers removed (enter - for none: example: YYYYMMDD.GRD)
- **line_dir** –
 set output image line direction (enter - for default):
 - 0: used value derived from CEOS leader file

- 1: retain input data line direction (default)
- -1: reverse input data line direction
- **pix_dir** –
set output pixel direction (enter - for default):
 - 0: used value derived from CEOS leader file
 - 1: retain input data pixel direction (default)
 - -1: reverse input data pixel direction
- **cal_flg** –
calibration flag (enter - for default):
 - 0: do not apply radiometric calibration
 - 1: apply radiometric calibration including KdB and incidence angle correction (default)
- **KdB** – calibration constant (dB) (enter - to use value in the CEOS leader)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RISAT_SLC(CEOS_leader, BAND_META, SLC_par,
                                         CEOS_image, SLC='-', line_dir='-', pix_dir='-',
                                         cal_flg='-', KdB='-', logpath=None)
```

Read RISAT-1 CEOS format SLC data and perform radiometric calibration

Copyright 2013, Gamma Remote Sensing, v1.1 3-Jun-2013 clw

Parameters

- **CEOS_leader** – (input) CEOS SAR leader file (example: lea_01.001)
- **BAND_META** – (input) BAND_META.txt, additional RISAT system parameters for the scene (format keyword=value)
- **SLC_par** – (output) ISP SLC image parameter file (example: YYYYMMDD.grd.par)
- **CEOS_image** – (input) CEOS SLC image file (example: dat_01.001)
- **SLC** – (output) SLC data with file and line headers removed (enter - for none: example: YYYYMMDD.grd)
- **line_dir** –
set output image line direction (enter - for default):
 - 0: used value derived from CEOS leader file
 - 1: retain input data line direction (default)
 - -1: reverse input data line direction
- **pix_dir** –
set output pixel direction (enter - for default):
 - 0: used value derived from CEOS leader file
 - 1: retain input data pixel direction (default)
 - -1: reverse input data pixel direction
- **cal_flg** –

calibration flag (enter - for default):

- 0: do not apply radiometric calibration
- 1: apply radiometric calibration including KdB and incidence angle correction (default)
- **KdB** – calibration constant (dB) (enter - to use value in the CEOS leader)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSAT2_SG (product_XML, lut_XML, GeoTIFF, polarization,  
                                         GRD_par, GRD, logpath=None)
```

Generate SLC parameter and ground range image files for Radarsat 2 SGF/SGX data

Copyright 2015, Gamma Remote Sensing, v1.8 13-Aug-2015 awi/cw

Parameters

- **product_XML** – (input) Radarsat-2 product annotation XML file (product.xml)
- **lut_XML** – (input) Radarsat-2 calibration XML file (lutSigma.xml), use - for no calibration
- **GeoTIFF** – (input) image data file in GeoTIFF format (imagery_PP.tif)
- **polarization** – (input) image polarization: HH, VV, HV, VH
- **GRD_par** – (output) ISP GRD parameter file (example: yyyyymmdd_PP.GRD.par)
- **GRD** – (output) float GRD data file (example: yyyyymmdd_pp.GRD)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSAT2_SLC (product_XML, lut_XML, GeoTIFF, polarization,  
                                           SLC_par, SLC, logpath=None)
```

Generate SLC parameter and image files for Radarsat 2 SLC data from GeoTIFF

Copyright 2015, Gamma Remote Sensing, v2.5 13-Aug-2015 awi/clw

Parameters

- **product_XML** – (input) Radarsat-2 product annotation XML file (product.xml)
- **lut_XML** – (input) Radarsat-2 calibration XML file (lutSigma.xml), use - for no calibration
- **GeoTIFF** – (input) image data file in GeoTIFF format (imagery_PP.tif)
- **polarization** – (input) image polarization: HH, VV, HV, VH
- **SLC_par** – (output) ISP SLC parameter file (example: yyyyymmdd_pp.SLC.par)
- **SLC** – (output) SLC data file (example: yyyyymmdd_pp.SLC)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSAT_SCW (CEOS_leader, CEOS_trailer, CEOS_data,  
                                         GRD_par, GRD, sc_dB='- ', dt='- ', logpath=None)
```

ISP parameter file for SCANSAR Wide Swath Data

Copyright 2012, Gamma Remote Sensing, v2.0 14-Feb-2012 clw

Parameters

- **CEOS_leader** – (input) CEOS SAR leader file

- **CEOS_trailer** – (input) CEOS SAR trailer file
- **CEOS_data** – (input) CEOS data file binary)
- **GRD_par** – (output) ISP ground range image parameter file (example <orbit>.mli.par)
- **GRD** – (output) ISP ground range image (example <orbit>.mli) (enter - for none, float)
- **sc_dB** – intensity scale factor in dB (enter - for default: 0.00)
- **dt** – azimuth image time offset (s) (enter - for default = 0.0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSAT_SGF (CEOS_leader, CEOS_data, GRD_par, GRD,
                                         sc_dB='-', dt='-', logpath=None)
```

ISP parameter file for RSI/Atlantis Radarsat SGF (ground range) and SCANSAR SCW16 data
Copyright 2012, Gamma Remote Sensing, v2.2 14-Feb-2012 clw

Parameters

- **CEOS_leader** – (input) CEOS leader file (RSI SGF or SCW16 products, LEA_01.001)
- **CEOS_data** – (input) CEOS data file (RSI SGF or SCW16 products, DAT_01.001)
- **GRD_par** – (output) ISP ground range image parameter file (example <orbit>.mli.par)
- **GRD** – (output) ISP ground range image (example <orbit>.GRD.par) (enter - for none, float)
- **sc_dB** – intensity scale factor in dB (enter - for default: 0.00)
- **dt** – azimuth image time offset (s) (enter - for default = 0.0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSAT_SLC (CEOS_leader, SLC_par, CEOS_data, SLC='-',
                                         sc_dB='-', dt='-', logpath=None)
```

ISP parameter file for RSI/Atlantis/ASF processed Radarsat SLC data
Copyright 2012, Gamma Remote Sensing, v4.0 5-Sep-2012 clw

Parameters

- **CEOS_leader** – (input) CEOS SAR leader file (example: lea_01.001)
- **SLC_par** – (output) ISP SLC parameter file (example: <date>.SLC.par)
- **CEOS_data** – (input) CEOS data file (example: dat_01.001)
- **SLC** – (output) SLC data with file and line headers removed (example: <date>.SLC)
- **sc_dB** – intensity scale factor in dB (enter - for default: 60.00)
- **dt** – azimuth image time offset (s) (enter - for default = 0.0)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_RSI_ERS (CEOS_SAR_leader, SLC_par, logpath=None)
```

ISP parameter file for RSI processed ERS SLC data
Copyright 2003, Gamma Remote Sensing, v1.7 4-Aug-2003 clw/uw

Parameters

- **CEOS_SAR_leader** – (input) ERS CEOS SAR leader file
- **SLC_par** – (output) ISP SLC parameter file (example <orbit>.slc.par)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_S1_GRD (GeoTIFF, annotation_XML, calibration_XML,  
                                         noise_XML, MLI_par, MLI, GRD_par='- ', GRD='- ',  
                                         eflg='- ', rps='- ', noise_pwr='- ', logpath=None)
```

Generate MLI and GRD images and parameter files from a Sentinel-1 GRD product

Copyright 2016, Gamma Remote Sensing, v2.8 17-Aug-2016 awi/clw/ts

Parameters

- **GeoTIFF** – (input) image data file in GeoTIFF format (*.tiff)
- **annotation_XML** – (input) Sentinel-1 L1 XML annotation file
- **calibration_XML** – (input) Sentinel-1 L1 radiometric calibration XML file (enter - for no radiometric calibration)
- **noise_XML** –
(input) Sentinel-1 L1 noise XML file (enter - to not add back thermal noise)
 - NOTE: The L1 GRD product has thermal noise subtracted, enter noise_XML to add back thermal noise
- **MLI_par** – (output) MLI parameter file (example: yyyyymmdd_pp.MLI.par)
- **MLI** – (output) MLI data file in slant range geometry (example: yyyyymmdd_pp.MLI)
- **GRD_par** – (output) GRD parameter file (example: yyyyymmdd_pp.GRD.par, enter - for none)
- **GRD** – (output) GRD data file (example: yyyyymmdd_pp.GRD, enter - for none)
- **eflg** –
GR-SR grid extrapolation flag:
 - 0: no extrapolation of the GR-SR grid beyond the grid boundaries
 - 1: permit extrapolation of the GR-SR grid to cover the entire image (default)
 - NOTE: extrapolation of the GR-SR grid may introduce geocoding errors
- **rps** – slant range pixel spacing (m) (enter - for default: calculated from ground-range parameters)
- **noise_pwr** –
noise intensity for each MLI sample in slant range using data from noise_XML
 - NOTE: when the noise_pwr file is specified, noise power correction will NOT be applied to the MLI data values
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_S1_SLC (GeoTIFF, annotation_XML, calibration_XML,  
                                         noise_XML, SLC_par, SLC, TOPS_par='- ', dtype='- ',  
                                         sc_dB='- ', noise_pwr='- ', logpath=None)
```

Generate SLC parameter and image files for Sentinel-1 SLC data
 Copyright 2016, Gamma Remote Sensing, v3.3 17-Aug-2016 awi/clw

Parameters

- **GeoTIFF** – (input) image data file in GeoTIFF format (*.tiff)
- **annotation_XML** – (input) Sentinel-1 L1 XML annotation file
- **calibration_XML** – (input) Sentinel-1 L1 radiometric calibration XML file (enter - for no radiometric calibration)
- **noise_XML** – (input) Sentinel-1 L1 noise XML file (enter - to not subtract thermal noise power level)
- **SLC_par** – (output) ISP SLC parameter file (example: yyyyymmdd_iw1_vv.SLC.par)
- **SLC** – (output) SLC data file (example: yyyyymmdd_iw1_vv.SLC)
- **TOPS_par** – (output) SLC burst annotation file, TOPS and EW SLC data only (enter - for none, example: yyyyymmdd_iw1_vv.TOPS_par)
- **dtype** –
output data type:
 - 0: FCOMPLEX (default)
 - 1: SCOMPLEX
- **sc_dB** – scale factor for FCOMPLEX -> SCOMPLEX, (enter - for default: HH,VV (dB): 60.0000, VH,HV: 70.0000)
- **noise_pwr** –
noise intensity for each SLC sample in slant range using data from noise_XML
 - NOTE: when the noise_pwr file is specified, noise power will NOT be subtracted from the image data values
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.par_TX_SLC (annotation_XML, COSAR, SLC_par, SLC, pol='-', log-path=None)
```

Generate SLC parameter file and SLC image from a Terrasar-X SSC data set
 Copyright 2016, Gamma Remote Sensing, v2.3 26-May-2016 awi/clw

Parameters

- **annotation_XML** – (input) TerraSAR-X product annotation XML file
- **COSAR** – (input) COSAR SSC strip-mode SLC data file
- **SLC_par** – (output) ISP SLC parameter file (example: yyyyymmdd.SLC.par)
- **SLC** – (output) SLC data file, example: yyyyymmdd.SLC (enter - for none, SLC output will not be produced)
- **pol** – polarisation HH, HV, VH, VV (default: first polarisation found in the annotation_XML)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ph_slope_base(int_in, SLC_par, OFF_par, base, int_out,  
                                         int_type='-', inverse='-', logpath=None)
```

Subtract/add interferogram flat-Earth phase trend as estimated from initial baseline

Copyright 2006, Gamma Remote Sensing, v4.4 3-Nov-2006 clw

Parameters

- **int_in** – (input) interferogram (FCOMPLEX) or unwrapped phase (FLOAT) (unflattened)
- **SLC_par** – (input) ISP parameter file for the reference SLC
- **OFF_par** – (input) ISP offset/interferogram parameter file
- **base** – (input) baseline file
- **int_out** – (output) interferogram (FCOMPLEX) or unwrapped phase (FLOAT) with phase trend subtracted/added
- **int_type** – interferogram type: 0=unwrapped phase, 1=complex interf. (default=1)
- **inverse** – subtract/add inversion flag (0=subtract phase ramp, 1=add phase ramp (default=0))
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.phase_slope(interf, slopes, width, win_sz='-', thres='-', xmin='-',  
                                       xmax='-', ymin='-', ymax='-', logpath=None)
```

Calculate interferogram phase slopes in range and azimuth

Copyright 2011, Gamma Remote Sensing, v1.3 19-Apr-2011 clw/uw

Parameters

- **interf** – (input) interferogram (fcomplex)
- **slopes** – (output) range and azimuth phase slopes (fcomplex)
- **width** – number of samples/row
- **win_sz** – size of region used for slopes determination (default = 5)
- **thres** – correlation threshold for accepting slope estimates 0.0 -> 1.0 (default=.4)
- **xmin** – starting range pixel offset (default = 0)
- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row offset (default = 0)
- **ymax** – last azimuth row offset (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ptarg_SLC(SLC_par, SLC, r_samp, az_samp, ptr_image, r_plot,  
                                     az_plot, ptr_par='-', osf='-', win='-', pltflg='-', log-  
                                     path=None)
```

Point target response analysis and interpolation for SLC images

Copyright 2016, Gamma Remote Sensing, v1.9 19-Feb-2016 clw

Parameters

- **SLC_par** – (input) SLC image parameter file

- **SLC** – (input) SLC image in FCOMPLEX or SCOMPLEX format
- **r_samp** – point target range sample number
- **az_samp** – point target azimuth line number
- **ptr_image** – (output) oversampled point target image (fcomplex, 1024x1024 samples), with and without phase gradient
- **r_plot** – (output) range point target response plot data (text format)
- **az_plot** – (output) azimuth point target response plot data (text format)
- **ptr_par** – (output) measured point target parameters (text format)
- **osf** – image over-sampling factor, 2, 4, 8, 16, 32, 64 (enter - for default: 16)
- **win** – maximum search window offset (samples) (enter - for default: 1)
- **pltflg** –
plotting mode flag:
 - 0: none
 - 1: output plots in PNG format (default)
 - 2: screen output
 - 3: output plots in PDF format
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ptarg_cal_MLI (MLI_par, MLI, r_samp, az_samp, psigma,
                                           c_r_samp, c_az_samp, ptr_image, r_plot, az_plot,
                                           pcal, osf='-', win='-', pltflg='-', psz='-', csz='-',
                                           theta_inc='-', logpath=None)
```

Point target analysis and radiometric calibration of slant-range and ground-range (GRD) images

Copyright 2016, Gamma Remote Sensing, v2.6 19-Feb-2016 clw

Parameters

- **MLI_par** – (input) slant-range or ground-range image parameter file for detected intensity data
- **MLI** – (input) ground-range or slant range detected image in FLOAT format
- **r_samp** – point target range sample number, target region size is 16x16
- **az_samp** – point target azimuth line number, target region size is 16x16
- **psigma** – radar cross-section of the calibration target in m**2
- **c_r_samp** – clutter region center range sample number, clutter region size is 16x16
- **c_az_samp** – clutter region center azimuth line number, clutter region size is 16x16
- **ptr_image** – (output) oversampled point target image, with and without phase gradient, nominal width: 256
- **r_plot** – (output) range point target response plot data (text format)
- **az_plot** – (output) azimuth point target response plot data (text format)
- **pcal** – (output) measured point target parameters and radiometric calibration factor (text format)

- **osf** – image over-sampling factor, 2, 4, 8, 16, 32, 64 (enter - for default: 16)
- **win** – maximum search window offset (samples) (enter - for default: 1)
- **pltflg** –
 plotting mode flag:
 - 0: none
 - 1: output plots in PNG format (default)
 - 2: screen output
 - 3: output plots in PDF format
- **psz** – point target region size (samples) (enter - for default: 16)
- **csz** – clutter region size (samples) (enter - for default: 16)
- **theta_inc** – incidence angle required for calibration of terrain corrected RISAT-1 images
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.ptarg_cal_SLC(SLC_par, SLC, r_samp, az_samp, psigma,  
                                         c_r_samp, c_az_samp, ptr_image, r_plot, az_plot,  
                                         pcal, osf='-', win='-', pltflg='-', psz='-', csz='-',  
                                         c_image='-', logpath=None)
```

Point target analysis and radiometric calibration of SLC images
Copyright 2016, Gamma Remote Sensing, v2.4 19-Feb-2016 clw

Parameters

- **SLC_par** – (input) SLC image parameter file
- **SLC** – (input) SLC image in FCOMPLEX or SCOMPLEX format
- **r_samp** – point target range sample number, target region size is 16x16
- **az_samp** – point target azimuth line number, target region size is 16x16
- **psigma** – radar cross-section of the calibration target in m**2
- **c_r_samp** – clutter region center range sample number, clutter region size is 16x16
- **c_az_samp** – clutter region center azimuth line number, clutter region size is 16x16
- **ptr_image** – (output) oversampled point target image, with and without phase gradient, nominal width: 256
- **r_plot** – (output) range point target response plot data (text format)
- **az_plot** – (output) azimuth point target response plot data (text format)
- **pcal** – (output) measured point target parameters and radiometric calibration factor (text format)
- **osf** – image over-sampling factor, 2, 4, 8, 16, 32, 64 (enter - for default: 16)
- **win** – maximum search window offset (samples) (enter - for default: 1)
- **pltflg** –
 plotting mode flag:

- 0: none
- 1: output plots in PNG format (default)
- 2: screen output
- 3: output plots in PDF format
- **psz** – point target region size (samples) (enter - for default: 16)
- **csz** – clutter region size (samples) (enter - for default: 16)
- **c_image** – (output) clutter region image (FCOMPLEX format)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.radcal_MLI (MLI, MLI_PAR, OFF_par, CMLI, antenna='-',
                                       rloss_flag='-', ant_flag='-', refarea_flag='-', sc_dB='-',
                                       K_dB='-', pix_area='-', logpath=None)
```

Radiometric calibration for multi-look intensity (MLI) data

Copyright 2016, Gamma Remote Sensing, v2.0 9-Nov-2016 uw/clw/of

Parameters

- **MLI** – (input) MLI image (float)
- **MLI_PAR** – (input) SLC parameter file of input MLI image
- **OFF_par** – (input) ISP offset/interferogram parameter file (enter - for images in MLI geometry)
- **CMLI** – (output) radiometrically calibrated output MLI (float)
- **antenna** – (input) 1-way antenna gain pattern file or - if not provided
- **rloss_flag** –
range spreading loss correction:
 - 0: no correction (default)
 - 1: apply r^3 correction (all modes except ASAR APS)
 - 2: apply r^4 correction (used only for ASAR APS mode)
 - -1: undo r^3 correction
 - -2: undo r^4 correction)
- **ant_flag** –
antenna pattern correction:
 - 0: no correction (default)
 - 1: apply antenna pattern correction
 - -1: undo antenna pattern correction)
- **refarea_flag** –
reference pixel area correction:
 - 0: no pixel area correction (default)
 - 1: calculate σ_0 , scale area by $\sin(\text{inc_ang})/\sin(\text{ref_inc_ang})$

- 2: calculate gamma0, scale area by $\sin(\text{inc_ang})/(\cos(\text{inc_ang})*\sin(\text{ref_inc_ang}))$
- -1: undo sigma0 area scaling factor
- -2: undo gamma0 area scaling factor
- **sc_dB** – scale factor in dB (default: 0.0)
- **K_dB** – calibration factor in dB (default: -(value from MLI_PAR))
- **pix_area** –
(output) ellipsoid-based ground range sigma0 or gamma0 pixel reference area (float)
refarea_flag 1 or -1: sigma0 ref. area refarea_flag 2 or -2: gamma0 ref. area
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.radcal_PRI (PRI, PRI_PAR, GRD, GRD_PAR, K_dB='-', inc_ref='-',  
                                       roff='-', nr='-', loff='-', nl='-', logpath=None)
```

Convert ESA processed short integer format PRI to radiometrically calibrated GRD image (float)

Copyright 2016, Gamma Remote Sensing, v1.5 5-Mar-2016 uw/clw

Parameters

- **PRI** – (input) PRI ground-range image (short integer, $\sqrt{\text{backscat. intensity}}$)
- **PRI_PAR** – (input) SLC parameter file of input PRI ground-range image (yyyymmdd.PRI.par)
- **GRD** – (output) calibrated ground-range image (float, backscat. intensity)
- **GRD_PAR** – (output) ISP image parameter file of output calibrated ground-range image (yyyymmdd.GRD.par)
- **K_dB** –
calibration factor in decibels (default: 59.75 dB) ERS1 (D-Paf,ESRIN): 58.24 dB,
ERS2 (D-Paf,ESRIN,I-Paf,UK-Paf after 1997): 59.75 dB ENVISAT ASAR: 55.0 dB (all
modes) for details see product specifications and ESA publications.
- **inc_ref** –
reference incidence angle in deg. (default: 23.0 deg.) ENVISAT ASAR: 90.0 deg. (all
modes)
- **roff** – offset to starting range sample (default: 0)
- **nr** – number of range samples (default: 0, to end of line)
- **loff** – offset to starting line (default: 0, 1 header line in the input file is assumed for ERS)
- **nl** – number of lines to copy (default: 0, to end of file)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.radcal_SLC (SLC, SLC_PAR, CSLC, CSLC_PAR, fcase='-',  
                                       antenna='-', rloss_flag='-', ant_flag='-',  
                                       refarea_flag='-', sc_dB='-', K_dB='-', pix_area='-',  
                                       logpath=None)
```

Radiometric calibration of SLC data

Copyright 2016, Gamma Remote Sensing, v2.3 9-Nov-2016 uw/clw/of

Parameters

- **SLC** – (input) SLC (fcomplex or scomplex)
- **SLC_PAR** – (input) SLC parameter file of input SLC
- **CSLC** – (output) radiometrically calibrated SLC (fcomplex or scomplex)
- **CSLC_PAR** – (output) SLC parameter file of output calibrated SLC
- **fcase** –
format case (default = 1)
 - 1: fcomplex → fcomplex (pairs of float)
 - 2: fcomplex → scomplex (pairs of short integer)
 - 3: scomplex → fcomplex
 - 4: scomplex → scomplex
- **antenna** – 1-way antenna gain pattern file or - (if not provided)
- **rloss_flag** –
range spreading loss correction:
 - 0: no correction (default)
 - 1: apply r^3 correction (all modes except ASAR APS)
 - 2: apply r^4 correction (used only for ASAR APS mode)
 - -1: undo r^3 correction
 - -2: undo r^4 correction)
- **ant_flag** –
antenna pattern correction:
 - 0: no correction (default)
 - 1: apply antenna pattern correction
 - -1: undo antenna pattern correction)
- **refarea_flag** –
reference pixel area correction:
 - 0: no pixel area correction (default)
 - 1: calculate σ_0 , scale area by $\sin(\text{inc_ang})/\sin(\text{ref_inc_ang})$
 - 2: calculate γ_0 , scale area by $\sin(\text{inc_ang})/(\cos(\text{inc_ang})*\sin(\text{ref_inc_ang}))$
 - -1: undo σ_0 area scaling factor
 - -2: undo γ_0 area scaling factor
- **sc_dB** – scale factor in dB (default: 0.0)
- **K_dB** – calibration factor in dB (default: -(value from SLC_PAR))
- **pix_area** –
(output) ellipsoid-based ground range σ_0 or γ_0 pixel reference area (float)
 refarea_flag 1 or -1: σ_0 ref. area refarea_flag 2 or -2: γ_0 ref. area

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.radcal_pwr_stat(SLC_tab, SLC_tab_cal, plist, MSR_cal,
                                           PWR_cal, roff='-', loff='-', nr='-', nl='-',
                                           plist_out='-', logpath=None)
```

Generate calibrated SLC image files using point targets determined from the Mean/Sigma Ratio and Intensity
Copyright 2012, Gamma Remote Sensing, v1.3 11-May-2012 clw/uw

Parameters

- **SLC_tab** – (input) two column list of the SLC filenames and SLC parameter filenames of the uncalibrated SLC images
- **SLC_tab_cal** – (input) two column list of the SLC filenames and SLC parameter filenames of the calibrated SLC images (enter - for none)
- **plist** – (input) point list for the point to use for calibration (int, enter - to use the data to determine the calibration points)
- **MSR_cal** – mean/sigma ratio for point target selection for relative calibration between scenes: 1.500
- **PWR_cal** – intensity threshold ratio for point target selection for relative calibration between scenes: 1.000
- **roff** – offset to starting range of section to analyze (default -: 0)
- **loff** – offset to starting line of section to analyze (default -: 0)
- **nr** – number of range pixels to analyze (default -: to end of line)
- **nl** – number of azimuth lines to analyze (default -: to end of file)
- **plist_out** – point list of points used to determine calibration using MSR_cal and PWR_cal thresholds
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.rascc_mask(cc, pwr, width, start_cc='-', start_pwr='-', nlines='-',
                                       pixavr='-', pixavaz='-', cc_thres='-', pwr_thres='-',
                                       cc_min='-', cc_max='-', scale='-', exp='-', LR='-',
                                       rasf='-', logpath=None)
```

Generate phase unwrapping validity mask using correlation and intensity

Copyright 2016, Gamma Remote Sensing, v2.0 12-Sep-2016 clw/uw

Parameters

- **cc** – (input) interferometric correlation image (float)
- **pwr** – (input) intensity image (float, enter - if not available)
- **width** – number of samples/row
- **start_cc** – starting line of coherence image (default: 1)
- **start_pwr** – starting line of intensity image (default: 1)
- **nlines** – number of lines to display (default=0: to end of file)
- **pixavr** – number of pixels to average in range (default: 1)
- **pixavaz** – number of pixels to average in azimuth (default: 1)

- **cc_thres** – coherence threshold for masking, pixels with $cc < cc_thres$ are set to 0 (default: 0.0)
- **pwr_thres** – relative intensity threshold for masking, pixels with $intensity < pwr_thres * average\ intensity$ are set to 0 (default: 0)
- **cc_min** – minimum coherence value used for color display (default: 0.1)
- **cc_max** – maximum coherence value used for color display (default: 0.9)
- **scale** – intensity display scale factor (default: 1.)
- **exp** – intensity display exponent (default: .35)
- **LR** – left/right mirror image flag, (1: normal (default), -1: mirror image)
- **rasf** –
(output) image filename, extension determines the format, enter - for default: *.ras
*.bmp BMP format *.ras Sun raster format *.tif TIFF format
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.rascc_mask_thinning(ras_in, in_file, width, ras_out, nmax='-',
                                                thresh_1='-', thresh_nmax='-', logpath=None)
```

Adaptive sampling reduction for phase unwrapping validity mask

Copyright 2015, Gamma Remote Sensing, v1.5 5-Dec-2015 uw/clw

Parameters

- **ras_in** – (input) validity mask (SUN/BMP/TIFF raster format 8-bit image)
- **in_file** – (input) file used for adaptive sampling reduction, e.g. correlation coefficient (float)
- **width** – number of samples/row of in_file
- **ras_out** – (output) validity mask with reduced sampling (8-bit SUN rasterfile or BMP format image)
- **nmax** – number of sampling reduction runs (default: 3)
- **thresh_1** –
first threshold (used for smallest scale sampling reduction) ... further thresholds
- **thresh_nmax** – threshold nmax (used for largest scale sampling reduction)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.residue(int, flag, width, xmin='-', xmax='-', ymin='-', ymax='-',
                                   logpath=None)
```

Determine interferometric phase unwrapping residues

Copyright 2014, Gamma Remote Sensing, v2.6 14-Jan-2014 clw/uw

Parameters

- **int** – (input) interferogram (fcomplex)
- **flag** – (input) flag file (unsigned char)
- **width** – number of samples/row

- **xmin** – offset to starting range pixel (default = 0)
- **xmax** – offset last range pixel (default = width-1)
- **ymin** – offset to starting azimuth row (default = 0)
- **ymax** – offset to last azimuth row (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.residue_cc (int, flag, width, xmin='-', xmax='-', ymin='-', ymax='-',  
                                       logpath=None)
```

Determine interferometric phase unwrapping residues considering low coherence regions

Copyright 2014, Gamma Remote Sensing, v2.6 20-Jan-2014 clw/uw/ts

Parameters

- **int** – (input) interferogram (fcomplex)
- **flag** – (input) flag file (unsigned char)
- **width** – number of samples/row
- **xmin** – offset to starting range pixel (default = 0)
- **xmax** – offset last range pixel (default = width-1)
- **ymin** – offset to starting azimuth row (default = 0)
- **ymax** – offset to last azimuth row (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.sbi_filt (SLC_1, SLC1_par, SLC2R_par, SLCf, SLCf_par, SLCb,  
                                     SLCb_par, norm_sq, iwflg='-', logpath=None)
```

Azimuth filtering of SLC data to support split-beam interferometry to measure azimuth offsets

Copyright 2016, Gamma Remote Sensing, v1.2 clw 5-Mar-2016

Parameters

- **SLC-1** – (input) SLC image (SCOMPLEX or FCOMPLEX format)
- **SLC1_par** – (input) SLC image parameter file
- **SLC2R_par** –
(input) SLC2 ISP image parameter file for the co-registered image of the interferometric pair,
used to determine azimuth common-band for each output SLC (enter - for none)
- **SLCf** – (output) SLC image (forward-looking, FCOMPLEX format)
- **SLCf_par** – (output) SLC parameter file (forward-looking)
- **SLCb** – (output) SLC image (backward-looking, FCOMPLEX format)
- **SLCb_par** – (output) SLC parameter file (backward-looking)
- **norm_sq** – squint between beams as a fraction of the azimuth spectrum width (default:
0.5)
- **iwflg** –
inverse weighting flag:

- 0: no compensation for azimuth spectrum weighting
- 1: compensate for the azimuth spectrum weighting (default)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.sbi_offset(sbi_unw, SLCf_par, SLCb_par, OFF_par, az_offset,
                                     logpath=None)
```

Calculate azimuth offsets from unwrapped split-beam interferogram

Copyright 2011, Gamma Remote Sensing, v1.0 25-Nov-2011

Parameters

- **sbi_unw** – (input) unwrapped phase of split-beam interferogram (float)
- **SLCf_par** – (input) reference SLC parameter file (forward-looking)
- **SLCb_par** – (input) reference SLC parameter file (backward-looking)
- **OFF_par** – (input) offset parameter file
- **az_offset** – (output) azimuth offsets (m)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.slant_range(SLC_par, slr, logpath=None)
```

Calculate slant range for every range sample

Copyright 2013, Gamma Remote Sensing v1.1 28-Aug-2013

Parameters

- **SLC_par** – (input) SLC or MLI image parameter file
- **slr** – (output) slant range for every sample in the image (float)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.split_WB(data_in, data_par_in, data_tab, dtype, logpath=None)
```

ISP: Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/split_WB.c

Copyright 2011, Gamma Remote Sensing, v1.2 31-May-2011 clw

Split WB mosaic image into individual beams using ISP parameter files

Parameters

- **data_in** – (input) input mosaicked data in slant-range geometry (e.g. DEM data)
- **data_par_in** – (input) ISP image parameter file for data in the input mosaic
- **data_tab** – (input) 2 column list of output data filenames and ISP image parameter files for each beam in the mosaic (text)
- **dtype** –
(input) input data type:
 - 0: FLOAT
 - 1: FCOMPLEX

- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.subtract_phase(interf_in, phase_file, interf_out, width, factor='-',  
                                          logpath=None)
```

Land Application Tools: Program /cluster/GAMMA_SOFTWARE-20161207/ISP/bin/subtract_phase.c

Copyright 2001, Gamma Remote Sensing, v3.1 23-Jan-2001 uw/clw

subtract scaled phase image from a complex interferogram

Parameters

- **interf_in** – (input) input interferogram (fcomplex format)
- **phase_file** – (input) unwrapped interferometric phase (float)
- **interf_out** – (output) output interferogram (input interferogram - scaled phase) (fcomplex)
- **width** – number of samples/line
- **factor** – constant scale factor for input phase data [default=1.0]
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.tree_cc(flag, width, mbl='-', xmin='-', xmax='-', ymin='-', ymax='-',  
                                   logpath=None)
```

Phase unwrapping tree generation with low correlation search (modified ARW algorithm)

Copyright 2014, Gamma Remote Sensing, v2.9 20-Jan-2014 clw/uw

Parameters

- **flag** – (input) phase unwrapping flag file
- **width** – number of samples/row
- **mbl** – maximum branch length (default=32, maximum=64)
- **xmin** – starting range pixel offset (default = 0)
- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row, relative to start (default = 0)
- **ymax** – last azimuth row, relative to start (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.tree_gzw(flag, width, mbl='-', xmin='-', xmax='-', ymin='-',  
                                   ymax='-', logpath=None)
```

Phase unwrapping tree generation (GZW algorithm)

Copyright 2008, Gamma Remote Sensing, v3.6 5-Sep-2008 clw/uw

Parameters

- **flag** – (input) phase unwrapping flag file
- **width** – number of samples/row
- **mbl** – maximum branch length (default=32)
- **xmin** – starting range pixel offset (default = 0)

- **xmax** – last range pixel offset (default = width-1)
- **ymin** – starting azimuth row, relative to start (default = 0)
- **ymax** – last azimuth row, relative to start (default = nlines-1)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

```
pyroSAR.gamma.parser_demo.unw_model(interf, unw_model, unw, width, xinit='-', yinit='-',  
                                     ref_ph='-', width_model='-', logpath=None)
```

Phase unwrapping using a model of the unwrapped phase

Copyright 2008, Gamma Remote Sensing, v1.6 5-Sep-2008 clw/uw

Parameters

- **interf** – (input) complex interferogram
- **unw_model** – (input) approximate unwrapped phase model (float)
- **unw** – (output) unwrapped phase (float)
- **width** – number of samples/row of the interferogram
- **xinit** – offset to phase reference location in range (col)
- **yinit** – offset to phase reference location in azimuth (row)
- **ref_ph** – reference point phase (radians) (enter - for phase at the reference point)
- **width_model** – number of samples/row of the unwrapped phase model (default: interferogram width)
- **logpath** (*str* or *None*) – a directory to write command logfiles to

class pyroSAR.S1.auxil.OSV(*osvdir*)

Bases: `object`

interface for management of S1 Orbit State Vector (OSV) files

input is a directory which is supposed to contain, or already contains, OSV files. Two subdirectories are expected and created otherwise: one for Precise Orbit Ephemerides (POE) named POEORB and one for Restituted Orbit (RES) files named RESORB

Using method `match()` the corresponding POE (priority) or RES file is returned for a timestamp. Timestamps are always handled in the format YYYYmmddTHHMMSS.

Parameters `osvdir` (*str*) – the directory to write the orbit files to

catch (*osvtype*='POE', *start*=None, *stop*=None)

check a server for files

Parameters

- **osvtype** (*{ 'POE', 'RES' }*) – the type of orbit files required
- **start** (*str*) – the date to start searching for files
- **stop** (*str*) – the date to stop searching for files

Returns the URLs of the remote OSV files

Return type `list`

clean_res ()

delete all RES files for whose date a POE file exists

date (*file*, *datatype*)

extract a date from an OSV file name

Parameters `datatype` (*{ 'publish', 'start', 'stop' }*) – one of three possible date types contained in the OSV filename

Returns a time stamp in the format YYYYmmddTHHMMSS

Return type `str`

getLocals (*osvtype*='POE')

get a list of local files of specific type

Parameters **osvtype** (`{ 'POE', 'RES' }`) – the type of orbit files required

Returns a selection of local OSV files

Return type `list`

match (*timestamp*, *osvtype*='POE')

return the corresponding OSV file for the provided time stamp. The file returned is one which covers the acquisition time and, if multiple exist, the one which was published last. In case a list of options is provided as osvtype, the file of higher accuracy (i.e. POE over RES) is returned.

Parameters

- **timestamp** (*str*) – the time stamp in the format 'YYYYmmddTHHMMSS'
- **osvtype** (`{ 'POE', 'RES' }` or *list*) – the type of orbit files required; either 'POE', 'RES' or a list of both

Returns the best matching orbit file (overlapping time plus latest publication date)

Return type `str`

maxdate (*osvtype*='POE', *datetype*='stop')

return the latest date of locally existing POE/RES files

Parameters

- **osvtype** (`{ 'POE', 'RES' }`) – the type of orbit files required
- **datetype** (`{ 'publish', 'start', 'stop' }`) – one of three possible date types contained in the OSV filename

Returns a timestamp in format YYYYmmddTHHMMSS

Return type `str`

mindate (*osvtype*='POE', *datetype*='start')

return the earliest date of locally existing POE/RES files

Parameters

- **osvtype** (`{ 'POE', 'RES' }`) – the type of orbit files required
- **datetype** (`{ 'publish', 'start', 'stop' }`) – one of three possible date types contained in the OSV filename

Returns a timestamp in format YYYYmmddTHHMMSS

Return type `str`

retrieve (*files*)

download a list of remote files into the respective subdirectories, i.e. POEORB or RESORB

Parameters **files** (*list*) – a list of remotely existing OSV files as returned by method `catch()`

sortByDate (*files*, *datetype*='start')

sort a list of OSV files by a specific date type

Parameters

- **files** (*list*) – some OSV files

- **datatype** (`{'publish', 'start', 'stop'}`) – one of three possible date types contained in the OSV filename

Returns the input OSV files sorted by the defined date

Return type `list`

update (`update_res=True`)

Caution! This method is intended for downloading all available POE files and all RES files for whose time span no POE file yet exists. This will be a data volume of several GB and is particularly suited for multi-node SAR processing where not all nodes might have internet access and thus all files have to be downloaded before starting the processing.

If you want to download the OSV file for a single scene either use the respective methods of the SAR drivers (e.g. `pyroSAR.drivers.SAFE.getOSV()`) or methods `catch()` and `retrieve()` in combination.

Perform creating/updating operations for POE and RES files: download newest POE and RES files, delete RES files which can be replaced by newly downloaded POE files.

actions performed:

- the ESA Quality Control (QC) server is checked for any POE files not in the local directory
- POE files on the server and not in the local directory are downloaded
- RES files newer than the latest POE file are downloaded; POE files are approximately 18 days behind the actual date, thus RES files can be used instead
- delete all RES files for whose date a POE file now exists locally

Parameters **update_res** (`bool`) – should the RES files also be updated (or just the POE files)

This (still experimental) module is intended to easily prepare SAR scenes processed by pyroSAR for ingestion into an Open Data Cube.

class pyroSAR.datacube_util.**Dataset** (*filename, units='DN'*)

Bases: *object*

__add__ (*dataset*)

override the + operator. This is intended to easily combine two Dataset objects, which were created from different files belonging to the same measurement, e.g. two GeoTiffs with one polarization each.

Parameters **dataset** (*Dataset*) – the dataset to add to the current one

Returns the combination of the two

Return type *Dataset*

__radd__ (*dataset*)

similar to Dataset.__add__ but for function sum, e.g. sum([Dataset1, Dataset2])

Parameters **dataset** (*Dataset*) – the dataset to add to the current one

Returns the combination of the two

Return type *Dataset*

close ()

filenames

Returns all file names registered in the dataset

Return type *dict*

identifier

Returns a unique dataset identifier

Return type *str*

units

Returns all measurement unit names registered in the dataset

Return type `dict`

class `pyroSAR.datacube_util.Product` (*definition=None, name=None, product_type=None, description=None*)

Bases: `object`

add (*dataset*)

Add a dataset to the abstracted product description. This first performs a check whether the dataset is compatible with the product and its already existing measurements. If a measurement in the dataset does not yet exist in the product description it is added.

Parameters **dataset** (`Dataset`) – the dataset whose description is to be added

check_integrity (*dataset, allow_new_measurements=False*)

check if a dataset is compatible with the product definition.

Parameters

- **dataset** (`Dataset`) – the dataset to be checked
- **allow_new_measurements** (`bool`) – allow new measurements to be added to the product definition? If not and the dataset contains measurements, which are not defined in the product, an error is raised.

Raises `RuntimeError`

close ()

export_indexing_yaml (*dataset, outdir*)

export_ingestion_yaml (*outname, product_name, ingest_location*)

measurements

Returns a dictionary with measurement names as keys

Return type `dict of dict`

write (*yamlfile*)

write the product definition to a YAML file

Parameters **yamlfile** (`str`) – the file to write to

Ancillary Functions

This script gathers central functions and classes for general pyroSAR applications.

`pyroSAR.ancillary.find_datasets(directory, recursive=False, **kwargs)`
 find pyroSAR datasets in a directory based on their metadata

Parameters

- **directory** (*str*) – the name of the directory to be searched
- **recursive** (*bool*) – search the directory recursively into subdirectories?
- **kwargs** – Metadata attributes for filtering the scene list supplied as *key=value*. e.g. *sensor='S1A'*. Multiple allowed options can be provided in tuples, e.g. *sensor=('S1A', 'S1B')*. Any types other than tuples require an exact match, e.g. *proc_steps=['grd', 'mli', 'geo', 'norm', 'db']* will be matched if only these processing steps are contained in the product name in this exact order. See function `parse_productname()` for options.

Returns the file names found in the directory and filtered by metadata attributes

Return type list of str

Examples

```
>>> selection = find_datasets('path/to/files', sensor=('S1A', 'S1B'),
↳ polarization='VV')
```

`pyroSAR.ancillary.groupby(images, attribute)`
 group a list of images by a metadata attribute

Parameters

- **images** (*list of str*) – the names of the images to be sorted
- **attribute** (*str*) – the name of the attribute used for sorting; see `parse_datasetname()` for options

Returns a list containing a list with image names ofr each group

Return type list of lists

`pyroSAR.ancillary.groupbyTime(images, function, time)`
function to group images by their acquisition time difference

Parameters

- **images** (*list of str*) – a list of image names
- **function** (*function*) – a function to derive the time from the image names; see e.g. `seconds()`
- **time** (*int or float*) – a time difference in seconds by which to group the images

Returns a list of sub-lists containing the grouped images

Return type list

`pyroSAR.ancillary.parse_datasetname(name, parse_date=False)`

Parse the name of a pyroSAR processing product and extract its metadata components as dictionary

Parameters

- **name** (*str*) – the name of the file to be parsed
- **parse_date** (*bool*) – parse the start date to a `datetime` object or just return the string?

Returns the metadata attributes

Return type dict

Examples

```
>>> meta = parse_datasetname('S1A__IW__A_20150309T173017_VV_grd_mli_geo_norm_db.
↳tif')
>>> print(list(meta.keys()))
['sensor', 'acquisition_mode', 'orbit', 'start', 'extensions', 'polarization',
↳'proc_steps']
```

`pyroSAR.ancillary.seconds(filename)`

function to extract time in seconds from a file name. the format must follow a fixed pattern: YYYYmmddTHH-MMSS Images processed with pyroSAR functionalities via module snap or gamma will contain this information.

Parameters **filename** (*str*) – the name of a file from which to extract the time from

Returns the difference between the time stamp in filename and Jan 01 1900 in seconds

Return type float

CHAPTER 7

Indices and tables

- `genindex`
- `modindex`
- `search`

p

- `pyroSAR.ancillary`, [87](#)
- `pyroSAR.datacube_util`, [85](#)
- `pyroSAR.drivers`, [1](#)
- `pyroSAR.gamma`, [17](#)
- `pyroSAR.gamma.parser`, [21](#)
- `pyroSAR.gamma.parser_demo`, [22](#)
- `pyroSAR.S1.auxil`, [81](#)
- `pyroSAR.snap.util`, [15](#)

Symbols

`__add__()` (*pyroSAR.datacube_util.Dataset method*), 85

`__radd__()` (*pyroSAR.datacube_util.Dataset method*), 85

A

`adapt_filt()` (*in module pyroSAR.gamma.parser_demo*), 33

`add()` (*pyroSAR.datacube_util.Product method*), 86

`adf()` (*in module pyroSAR.gamma.parser_demo*), 34

`af_SLC()` (*in module pyroSAR.gamma.parser_demo*), 34

`Archive` (*class in pyroSAR.drivers*), 2

`ASAR_LO_phase_drift()` (*in module pyroSAR.gamma.parser_demo*), 22

`ASAR_XCA()` (*in module pyroSAR.gamma.parser_demo*), 22

`autoparse()` (*in module pyroSAR.gamma.parser*), 21

`ave_image()` (*in module pyroSAR.gamma.parser_demo*), 35

`az_integrate()` (*in module pyroSAR.gamma.parser_demo*), 35

`az_spec_SLC()` (*in module pyroSAR.gamma.parser_demo*), 36

B

`base_copy()` (*in module pyroSAR.gamma.parser_demo*), 36

`base_est_fft()` (*in module pyroSAR.gamma.parser_demo*), 37

`base_ls()` (*in module pyroSAR.gamma.parser_demo*), 37

`base_orbit()` (*in module pyroSAR.gamma.parser_demo*), 38

`base_perp()` (*in module pyroSAR.gamma.parser_demo*), 38

`bbox()` (*pyroSAR.drivers.ID method*), 7

`bpf()` (*in module pyroSAR.gamma.parser_demo*), 38

`bridge()` (*in module pyroSAR.gamma.parser_demo*), 39

C

`catch()` (*pyroSAR.S1.auxil.OSV method*), 81

`cc_wave()` (*in module pyroSAR.gamma.parser_demo*), 39

`CEOS_ERS` (*class in pyroSAR.drivers*), 4

`CEOS_PSR` (*class in pyroSAR.drivers*), 5

`check_integrity()` (*pyroSAR.datacube_util.Product method*), 86

`clean_res()` (*pyroSAR.S1.auxil.OSV method*), 81

`clear_flag()` (*in module pyroSAR.gamma.parser_demo*), 40

`close()` (*pyroSAR.datacube_util.Dataset method*), 85

`close()` (*pyroSAR.datacube_util.Product method*), 86

`close()` (*pyroSAR.drivers.Archive method*), 2

`compression` (*pyroSAR.drivers.ID attribute*), 7

`convert2gamma()` (*in module pyroSAR.gamma*), 18

`corr_flag()` (*in module pyroSAR.gamma.parser_demo*), 40

`correctOSV()` (*in module pyroSAR.gamma*), 20

`create_offset()` (*in module pyroSAR.gamma.parser_demo*), 41

D

`Dataset` (*class in pyroSAR.datacube_util*), 85

`date()` (*pyroSAR.S1.auxil.OSV method*), 81

`dcomp_sirc()` (*in module pyroSAR.gamma.parser_demo*), 41

`dcomp_sirc_quad()` (*in module pyroSAR.gamma.parser_demo*), 42

`DELFT_vec2()` (*in module pyroSAR.gamma.parser_demo*), 22

`DORIS_vec()` (*in module pyroSAR.gamma.parser_demo*), 23

E

`envidict()` (*pyroSAR.gamma.ISPPar method*), 19

ESA (class in `pyroSAR.drivers`), 7
examine() (`pyroSAR.drivers.ID` method), 7
export2dict() (`pyroSAR.drivers.ID` method), 8
export2shp() (`pyroSAR.drivers.Archive` method), 2
export2sqlite() (`pyroSAR.drivers.ID` method), 8
export_indexing_yaml() (`pyroSAR.datacube_util.Product` method), 86
export_ingestion_yaml() (`pyroSAR.datacube_util.Product` method), 86

F

filenames (`pyroSAR.datacube_util.Dataset` attribute), 85
filter_processed() (in module `pyroSAR.drivers`), 11
filter_scenelist() (`pyroSAR.drivers.Archive` method), 3
find_datasets() (in module `pyroSAR.ancillary`), 87
findfiles() (in module `pyroSAR.drivers`), 12
findfiles() (`pyroSAR.drivers.ID` method), 8
fspf() (in module `pyroSAR.gamma.parser_demo`), 42

G

gcp_phase() (in module `pyroSAR.gamma.parser_demo`), 43
gdalinfo() (`pyroSAR.drivers.ID` method), 8
geocode() (in module `pyroSAR.gamma`), 17
geocode() (in module `pyroSAR.snap.util`), 15
get_colnames() (`pyroSAR.drivers.Archive` method), 3
get_tablenames() (`pyroSAR.drivers.Archive` method), 3
get_unique_directories() (`pyroSAR.drivers.Archive` method), 3
getCorners() (`pyroSAR.drivers.CEOS_ERS` method), 5
getCorners() (`pyroSAR.drivers.CEOS_PSR` method), 6
getCorners() (`pyroSAR.drivers.ESA` method), 7
getCorners() (`pyroSAR.drivers.ID` method), 8
getCorners() (`pyroSAR.drivers.SAFE` method), 10
getCorners() (`pyroSAR.drivers.TSX` method), 11
getFileObj() (in module `pyroSAR.drivers`), 12
getFileObj() (`pyroSAR.drivers.ID` method), 8
getGammaImages() (`pyroSAR.drivers.ID` method), 8
getHGT() (`pyroSAR.drivers.ID` method), 8
getLocals() (`pyroSAR.SI.auxil.OSV` method), 82
getOSV() (`pyroSAR.drivers.SAFE` method), 10
grasses() (in module `pyroSAR.gamma.parser_demo`), 43
groupby() (in module `pyroSAR.ancillary`), 87
groupByTime() (in module `pyroSAR.ancillary`), 88

H

hgt_map() (in module `pyroSAR.gamma.parser_demo`), 44

I

ID (class in `pyroSAR.drivers`), 7
identifier (`pyroSAR.datacube_util.Dataset` attribute), 85
identify() (in module `pyroSAR.drivers`), 12
identify_many() (in module `pyroSAR.drivers`), 12
image_stat() (in module `pyroSAR.gamma.parser_demo`), 44
import_outdated() (`pyroSAR.drivers.Archive` method), 3
init_offset() (in module `pyroSAR.gamma.parser_demo`), 45
init_offset_orbit() (in module `pyroSAR.gamma.parser_demo`), 45
insert() (`pyroSAR.drivers.Archive` method), 3
interp_ad() (in module `pyroSAR.gamma.parser_demo`), 46
is_processed() (`pyroSAR.drivers.ID` method), 9
is_registered() (`pyroSAR.drivers.Archive` method), 3
ISPPar (class in `pyroSAR.gamma`), 19

K

keys (`pyroSAR.gamma.ISPPar` attribute), 19

L

led_filename (`pyroSAR.drivers.CEOS_PSR` attribute), 6

M

mask_data() (in module `pyroSAR.gamma.parser_demo`), 47
match() (`pyroSAR.SI.auxil.OSV` method), 82
maxdate() (`pyroSAR.SI.auxil.OSV` method), 82
mcf() (in module `pyroSAR.gamma.parser_demo`), 47
measurements (`pyroSAR.datacube_util.Product` attribute), 86
mindate() (`pyroSAR.SI.auxil.OSV` method), 82
MLI_cat() (in module `pyroSAR.gamma.parser_demo`), 23
MLI_copy() (in module `pyroSAR.gamma.parser_demo`), 23
mosaic_WB() (in module `pyroSAR.gamma.parser_demo`), 48
move() (`pyroSAR.drivers.Archive` method), 3
multi_cpx() (in module `pyroSAR.gamma.parser_demo`), 49
multi_look() (in module `pyroSAR.gamma.parser_demo`), 50

`multi_real()` (in module `roSAR.gamma.parser_demo`), 50
`multi_S1_TOPS()` (in module `roSAR.gamma.parser_demo`), 48
`multi_SLC_WSS()` (in module `roSAR.gamma.parser_demo`), 49

N

`neutron()` (in module `pyroSAR.gamma.parser_demo`), 51

O

`offset_add()` (in module `roSAR.gamma.parser_demo`), 53
`offset_pwr()` (in module `roSAR.gamma.parser_demo`), 53
`offset_pwr_tracking()` (in module `roSAR.gamma.parser_demo`), 54
`offset_pwr_tracking2()` (in module `roSAR.gamma.parser_demo`), 55
`offset_SLC()` (in module `roSAR.gamma.parser_demo`), 51
`offset_SLC_tracking()` (in module `roSAR.gamma.parser_demo`), 52
`offset_tracking()` (in module `roSAR.gamma.parser_demo`), 56
`ORB_prop_SLC()` (in module `roSAR.gamma.parser_demo`), 24
`ORRM_vec()` (in module `roSAR.gamma.parser_demo`), 24
`OSV` (class in `pyroSAR.S1.auxil`), 81
`outname_base()` (`pyroSAR.drivers.ID` method), 9
`ovs()` (in module `pyroSAR.gamma`), 19

P

`par_ACS_ERS()` (in module `roSAR.gamma.parser_demo`), 57
`par_ASAR()` (in module `roSAR.gamma.parser_demo`), 57
`par_ASF_91()` (in module `roSAR.gamma.parser_demo`), 58
`par_ASF_96()` (in module `roSAR.gamma.parser_demo`), 58
`par_ASF_PRI()` (in module `roSAR.gamma.parser_demo`), 58
`par_ASF_RSAT_SS()` (in module `roSAR.gamma.parser_demo`), 59
`par_ATLSCI_ERS()` (in module `roSAR.gamma.parser_demo`), 59
`par_CS_SLC()` (in module `roSAR.gamma.parser_demo`), 59
`par_CS_SLC_TIF()` (in module `roSAR.gamma.parser_demo`), 59

`py-par_EORC_PALSAR()` (in module `py-roSAR.gamma.parser_demo`), 60
`py-par_ESA_ERS()` (in module `py-roSAR.gamma.parser_demo`), 60
`py-par_KC_PALSAR_slr()` (in module `py-roSAR.gamma.parser_demo`), 60
`par_KS_DGM()` (in module `py-roSAR.gamma.parser_demo`), 61
`par_KS_SLC()` (in module `py-roSAR.gamma.parser_demo`), 61
`par_PRI()` (in module `pyroSAR.gamma.parser_demo`), 61
`py-par_PRI_ESRIN_JERS()` (in module `py-roSAR.gamma.parser_demo`), 62
`py-par_PulsAR()` (in module `py-roSAR.gamma.parser_demo`), 62
`py-par_RISAT_GRD()` (in module `py-roSAR.gamma.parser_demo`), 62
`py-par_RISAT_SLC()` (in module `py-roSAR.gamma.parser_demo`), 63
`py-par_RSAT2_SG()` (in module `py-roSAR.gamma.parser_demo`), 64
`py-par_RSAT2_SLC()` (in module `py-roSAR.gamma.parser_demo`), 64
`py-par_RSAT_SCW()` (in module `py-roSAR.gamma.parser_demo`), 64
`py-par_RSAT_SGF()` (in module `py-roSAR.gamma.parser_demo`), 65
`py-par_RSAT_SLC()` (in module `py-roSAR.gamma.parser_demo`), 65
`par_RSI_ERS()` (in module `py-roSAR.gamma.parser_demo`), 65
`par_S1_GRD()` (in module `py-roSAR.gamma.parser_demo`), 66
`par_S1_SLC()` (in module `py-roSAR.gamma.parser_demo`), 66
`py-par_TX_SLC()` (in module `py-roSAR.gamma.parser_demo`), 67
`py-parse_command()` (in module `py-roSAR.gamma.parser`), 21
`py-parse_datasetname()` (in module `py-roSAR.ancillary`), 88
`py-parse_date()` (in module `pyroSAR.drivers`), 12
`py-parse_date()` (`pyroSAR.drivers.ID` static method), 9
`py-parse_module()` (in module `py-roSAR.gamma.parser`), 21
`py-ph_slope_base()` (in module `py-roSAR.gamma.parser_demo`), 67
`py-phase_slope()` (in module `py-roSAR.gamma.parser_demo`), 68
`py-PRC_vec()` (in module `pyroSAR.gamma.parser_demo`), 25
`py-process()` (in module `pyroSAR.gamma`), 19
`Product` (class in `pyroSAR.datacube_util`), 86

ptarg_cal_MLI() (in module
roSAR.gamma.parser_demo), 69
ptarg_cal_SLC() (in module
roSAR.gamma.parser_demo), 70
ptarg_SLC() (in module
roSAR.gamma.parser_demo), 68
pyroSAR.ancillary (module), 87
pyroSAR.datacube_util (module), 85
pyroSAR.drivers (module), 1
pyroSAR.gamma (module), 17
pyroSAR.gamma.parser (module), 21
pyroSAR.gamma.parser_demo (module), 22
pyroSAR.S1.auxil (module), 81
pyroSAR.snap.util (module), 15

R

radcal_MLI() (in module
roSAR.gamma.parser_demo), 71
radcal_PRI() (in module
roSAR.gamma.parser_demo), 72
radcal_pwr_stat() (in module
roSAR.gamma.parser_demo), 74
radcal_SLC() (in module
roSAR.gamma.parser_demo), 72
rascc_mask() (in module
roSAR.gamma.parser_demo), 74
rascc_mask_thinning() (in module
roSAR.gamma.parser_demo), 75
removeGRDBorderNoise() (pyroSAR.drivers.SAFE
method), 10
residue() (in module pyroSAR.gamma.parser_demo),
75
residue_cc() (in module
roSAR.gamma.parser_demo), 76
retrieve() (pyroSAR.S1.auxil.OSV method), 82
RSAT2_vec() (in module
roSAR.gamma.parser_demo), 25

S

S1_burstloc() (in module
roSAR.gamma.parser_demo), 25
S1_deburst() (in module pyroSAR.gamma), 20
S1_OPOD_vec() (in module
roSAR.gamma.parser_demo), 25
SAFE (class in pyroSAR.drivers), 9
sbi_filt() (in module
roSAR.gamma.parser_demo), 76
sbi_offset() (in module
roSAR.gamma.parser_demo), 77
scanMetadata() (pyroSAR.drivers.CEOS_ERS
method), 5
scanMetadata() (pyroSAR.drivers.CEOS_PSR
method), 6
scanMetadata() (pyroSAR.drivers.ESA method), 7

py-scanMetadata() (pyroSAR.drivers.ID method), 9
py-scanMetadata() (pyroSAR.drivers.SAFE method),
10
py-scanMetadata() (pyroSAR.drivers.TSX method), 11
py-seconds() (in module pyroSAR.ancillary), 88
py-select() (pyroSAR.drivers.Archive method), 4
py-select_duplicates() (pyroSAR.drivers.Archive
method), 4
py-size (pyroSAR.drivers.Archive attribute), 4
py-slant_range() (in module
roSAR.gamma.parser_demo), 77
py-SLC_burst_copy() (in module
roSAR.gamma.parser_demo), 26
py-SLC_burst_corners() (in module
roSAR.gamma.parser_demo), 26
py-SLC_cat() (in module pyroSAR.gamma.parser_demo),
26
py-SLC_cat_S1_TOPS() (in module
roSAR.gamma.parser_demo), 27
py-SLC_copy() (in module
roSAR.gamma.parser_demo), 27
py-SLC_copy_S1_TOPS() (in module
roSAR.gamma.parser_demo), 28
py-SLC_corners() (in module
roSAR.gamma.parser_demo), 29
py-SLC_deramp() (in module
roSAR.gamma.parser_demo), 29
py-SLC_deramp_S1_TOPS() (in module
roSAR.gamma.parser_demo), 29
py-SLC_interp() (in module
roSAR.gamma.parser_demo), 30
py-SLC_interp_S1_TOPS() (in module
roSAR.gamma.parser_demo), 30
py-SLC_mosaic_S1_TOPS() (in module
roSAR.gamma.parser_demo), 31
py-SLC_ovr() (in module pyroSAR.gamma.parser_demo),
32
py-SLC_phase_shift() (in module
roSAR.gamma.parser_demo), 32
py-sortByDate() (pyroSAR.S1.auxil.OSV method), 82
py-split_WB() (in module
roSAR.gamma.parser_demo), 77
py-SR_to_GRD() (in module
roSAR.gamma.parser_demo), 33
py-subtract_phase() (in module
roSAR.gamma.parser_demo), 78
py-summary() (pyroSAR.drivers.ID method), 9

T

tree_cc() (in module pyroSAR.gamma.parser_demo),
78
tree_gzw() (in module
roSAR.gamma.parser_demo), 78
TSX (class in pyroSAR.drivers), 10

U

`units` (`pyroSAR.datacube_util.Dataset` attribute), [85](#)
`unpack()` (`pyroSAR.drivers.CEOS_ERS` method), [5](#)
`unpack()` (`pyroSAR.drivers.CEOS_PSR` method), [6](#)
`unpack()` (`pyroSAR.drivers.ESA` method), [7](#)
`unpack()` (`pyroSAR.drivers.ID` method), [9](#)
`unpack()` (`pyroSAR.drivers.SAFE` method), [10](#)
`unpack()` (`pyroSAR.drivers.TSX` method), [11](#)
`unw_model()` (in module `pyroSAR.gamma.parser_demo`), [79](#)
`update()` (`pyroSAR.S1.auxil.OSV` method), [83](#)

W

`write()` (`pyroSAR.datacube_util.Product` method), [86](#)