WATER & ICE RESEARCH LAB

WIRL

SigLib Documentation

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CHAPTER

ONE

OVERVIEW OF THE PROJECT

Introduction

SigLib stands for Signature Library and is a suite of tools to query, manipulate and process remote sensing imagery (primarily Synthetic Aperture Radar (SAR) imagery) and store the data in a geodatabse. It uses open source libraries and can be run on Windows or Linux.

There are 4 main *modes* that it can run in (or combinations of these)

1. A data **Discovery Mode** where remote sensing scenes are discovered by ingesting a copy of the Canadian Ice Service archive (or other geodatabase containing metadata, with tweaks), or by crawling through a hard drive and extracting metadata from zipped SAR scenes, or by querying a table in a local database that contains geospatial metadata. Queries take a Region Of Interest or **ROI shapefile** with a specific format as input to delineate the spatial and temporal search boundaries. The required attribute fields and formats for the ROI are elaborated upon in a section below.
2. An **Exploratory Mode** where remote sensing scenes are made ready for viewing. This includes opening zip files, converting imagery (including Single Look Complex), geographical projection, cropping, masking, image stretching, renaming, and pyramid generation. The user must supply the name of a single zip file that contains the SAR imagery, a directory where a batch of zip files to be prepared resides, or a query that selects a list of zip files to be processed.
3. A **Scientific Mode** where remote sensing scenes can be converted to sigma, beta, or gamma nought. Image data (from each band) is then subsampled by way of an **ROIshapefile** that references every image and specific polygon to be analyzed. These polygons represent sampling regions that are known (a priori) or are hand digitized from Exploratory mode images. Data can be stored in a table in a geodatabase for further processing.
4. A **Polarimetric Mode** where quad-pol scenes are converted to sigma0, cropped to tracking beacon instances, have polarimetric matricies generated, polarimetric filtering, and polarimetric decompositions generated.

These modes are brought together to work in harmony by **SigLib.py**, the recommended way to interact with the software. This program reads-in a configuration file that provides all the parameters required to do various jobs. However, this is only one way to go... Anyone can call the modules identified above from a custom made python script to do what they wish, using the SigLib API

In addition, there are different ways to process *input* through SigLib.py that can be changed for these modes. You can input based on a recursive **scan** of a directory for files that match a pattern; you can input one **file** at a time (useful for parallelization, when many processes are spawned by gnu parallel) and; you can input an SQL **query** and run the resulting matching files through SigLib (note that query input is not yet enabled, but it wouldn't take long).

Acknowledgements

This software was conceived and advanced initially by Derek Mueller (while he was a Visiting Fellow at the Canadian Ice Service). Some code was derived from from Defence Research and Development Canada (DRDC). At CIS he benefited from discussions with Ron Saper, Angela Cheng and his salary was provided via a CSA GRIP project (PI Roger De Abreu).

At Carleton this code was modified further and others have worked to improve it since the early days at CIS: Cindy Lopes (workstudy student & computer programmer) 2012, Sougal Bouh-Ali (workstudy student & computer programmer) 2013-2016, and Cameron Fitzpatrick (computer programmer) 2018-Present. Ron Saper, Anna Crawford and Greg Lewis-Paley helped out as well (indirectly).

CHAPTER TWO

SETUP

Once all the dependencies are met you can set up the SigLib software

SigLib

Depending on your level of experience with coding and, in particular, Python, this portion of the the setup should take about an hour for those who are familiar with setting up code repositories. If you are a novice programmer you may want to set aside more time then that.

- Download or clone the latest version of SigLib from Github (https://github.com/wirl-ice/SigLib - N.B. link is private to WIRL members for now)
- Install Python Libraries - in your SigLib folder, there is a file named Requirements.txt that contains all the necessary Python Libraries. The libraries can be installed all at once by entering the following command in your terminal:

```
pip install -r /path/to/Requirements.txt
```

- Setup Directories - you will need to create a set of directories (folders) that SigLib will access through the config.cfg file. The contents of each folder will be explained later on, for now you just need to create empty folders. They should be named to reflect the associated variable in the config.cfg file, for example, create a folder named 'ScanDirectory' to link to the 'scanDir' variable.
- Config File Setup - Enter the paths to the directories you just created into your config file in the [Directories] section. If you know the name and host of the database you would like to use, enter these now into the [Database] section. If you are creating a new database, then refer to the next section.
- You will need to add projections to the folder you created for the *projDir*. Please refer to the following section on A Note on Projections for more information. Adding at least one projection file into your projection directory is a necessary step in order to run SigLib functions that operate outside of a PostGIS database, such as when using Exploratory mode.

Postgres/PostGIS

Whether you are accessing an external or local PostGIS database, you will need to take steps to set up your PostGIS database in such a way that SigLib.py can connect to it. The following provides an overview on how to add new users, create a new database, and add new projections. For those who are familiar with PostGres/PostGIS this setup should only take about an hour; if you are new to PostGres/PostGIS you will likely want to set aside a few hours.

- Setup/modify users in **PGAdmin** (Postgres GUI) or using **psql** (the command line utility)
- Ideally, the username should be the same as your username (or another user) on that computer

PGAdmin

- Enter the Login/Group Roles dialog under Server
- Create a user that can login and create databases. Ideally, the username should be the same as the username on that computer.

psql
This method is for Linux users only, if you are using Windows see the above steps for adding new users in PGAdmin.

- At the command line type (where newuser is the new username) to create a user that can create databases:

```
createuser -d newuser
```

- Enter psql by specifying the database you want (use default database 'postgres' if you have not created one yet)

```
psql -d postgres
```

- Give the user a password like so:

```
\password username
```

Once a user is set up, they can be automatically logged in when connecting to the Postgres server if you follow these steps (recommended). If not, the user will either have to type in credentials or store them hardcoded in the Python scripts (bad idea!).

Windows The PostgreSQL server needs to have access to the users password so that SigLib can access the database. This achieved through the pgpass.conf file, which you will need to create.

- Navigate to the Application data subdirectory

```
cd %APPDATA%
```

- Create a directory called postgresql and enter it

```
mkdir postgresql
cd postgresql
```

- Create a plain text file called pgpass.conf

```
notepad pgpass.conf
```

- Enter the following information separated by colons –host:port:database:username:password – for example the following gives user dmueller access to the postgres server on the localhost to all databases (*). The port number 5432 is standard

```
localhost:5432:*:dmueller:password_dmueller
```

- Save the file

Linux

- Make a file called .pgpass in your home directory and edit it to include host:port:database:username:password (see above for details and example)
- Save the file then type the following to make this info private:

```
chmod 600 .pgpass
```

Permissions

If you are the first or only user on the postgres server then you can create databases and will have full permissions. Otherwise you will have read access to the databases that you connect to (typically). To get full permissions (recommended for SigLib) to an existing database do the following (to give user 'username' full permissions on database 'databasename'):

- **PGAdmin** – Under Tools, select Query tool, type the following and execute - lightning icon or F5:
- **psql** – At the pqsl prompt, type the following and press enter:

```
GRANT ALL PRIVILEGES ON DATABASE databasename TO username;
```

Creating a New Database – To create a new database you will need to have PostGIS installed on your machine. If you are using Windows it is recommended you install the PGAdmin GUI (this should be included with your installation of PostGIS).

- Open a server in PGAdmin and create a new database. Set the **db** variable in the config file to the name of your new database.
- Set the **host** variable in the config file to the 'Owner' of the database, this is typically your username for a local database setup.
- Check that the 'spatial_ref_sys' table has been automatically created under **Schemas|Tables**. This table contains thousands of default projections; additionally, you can add new projections. If the table have to been created, you will have to add it manually. Under Tools, select Query Tool, type the following and execute:

```
CREATE EXTENSION postgis;
```

- In the config file, set the **create_tblmetadata** variable to **1**
- Save your config file with these changes and run SigLib.py

```
python /path_to_script/SigLib.py /path_to_file/config_file.cfg
```

- You will be prompted in the terminal to create/overwrite *tblMetadata*. Select yes to create a new metadata table.

CHAPTER

THREE

MODULES

There are several modules that are organized according to core functionality.

1. **Util.py** - a bunch of utilities for manipulating files, shapefiles, etc
2. **Metadata.py** - used to discover and extract metadata from image files
3. **Database.py** - used to interface between the PostGIS database for storage and retrieval of information
4. **Image.py** - used to manipulate images, project, calibrate, crop, etc.
5. **LogConcat.py** - used to combine individual log files into one master .txt file, and separate log files containing errors for analysis (Mainly for use after large runs in parallel)

SigLib.py is the front-end of the software. It calls the modules listed above and is in turn controlled by a configuration file. To run, simply edit the *.cfg file with the paths and inputs you want and then run siglib.py.

However, you can also code your own script to access the functionality of the modules if you wish.

CHAPTER

FOUR

CONFIG FILE

The ***.cfg** file is how you interface with siglib. It needs to be edited properly so that the job you want done will happen! Leave entry blank if you are not sure. Leave entry blank if you are not sure. Do not add comments or any additional text to the config file as this will prevent the program from interpreting the contents. Only update the variables as suggested in their descriptions. There are several categories of parameters and these are:

Directories

- scanDir = path to where you want siglib to look for SAR image zip files to work with
- tmpDir = a working directory for extracting zip files to (Basically, a folder for temporary files that will only be used during the running of the code, then deleted, in scratch folder).
- projDir = where projection definition files are found in well-known text (.wkt) format (/tank/ice/data/proj). This folder should be populated with any projection files that you plan to use in your analysis.
- vectDir = where vector layers are found (ROI shapefiles or masking layers)
- imgDir = a working directory for storing image processing intermediate files and final output files, in scratch folder
- logDir = where logs are placed
- errorDir = Where logConcat will send .log files with errors (For proper review of bad zips at end of run)

Database

- db = the name of the database you want to connect to
- host = hostname for PostGIS server
- create_tblmetadata = 0 for append, 1 for overwrite/create. Must initially be set to 1 to initialize a new database.
- uploadROI = 1 if ROI file listed should be uploaded to the database
- table = database table containing image information that Database.py will query against

Input

Note that these are mutually exclusive options - sum of 'Input' options must = 1

- path = 1 for scan a certain path and operate on all files within; 0 otherwise
- query = 1 for scan over the results of a query and operate on all files returned; 0 otherwise
- file = 1 for run process on a certain file, which is passed as a command line argument (note this enables parallelized code); 0 otherwise
- scanFor = a file pattern to search for (eg. *.zip) - use when path=1
- uploadData = 1 to upload descriptive statistics of subscenes generated by Scientific mode to database

Process

- data2db = 1 when you want to upload metadata to the metadata table in the database (Discovery Mode)
- data2img = 1 when you want to manipulate images (as per specs below) (Exploratory Mode)
- scientific = 1 when you want to do image manipulation involving the database (Scientific Mode)
- polarimetric = 1 when you want to do sar polarimetry (Polarimetric Mode)

IMGMode

- proj = basename of wkt projection file (eg. lcc)
- projSRID = SRID # of wkt projection file
- imgtypes = types of images to process
- imgformat = File format for output imagery (gdal convention)
- roi = name of ROI Shapefile for Discovery or Scientific modes, stored in your *vectDir* folder
- roiprojSRID = Projection of ROI as an SRID for use by PostgreSQL (see 'A Note on Projections' for instructions on finding your SRID and ensuring it is available within your PostGIS database)
- mask = a polygon shapefile (one feature) to mask image data with (eg. /tank/ice/data/vector/CIS_Vectors/coast_poly.shp)
- crop = nothing for no cropping, or four space-delimited numbers, upper-left and lower-right corners (in proj above) that denote a crop area: ul_x ul_y lr_x lr_y
- spatialrel = ST_Contains (Search for images that fully contain the roi polygon) or ST_Intersects (Search for images that merely intersect with the roi)

CHAPTER FIVE

A NOTE ON PROJECTIONS

SigLib uses projections in two ways; either as .wkt files during image processing outside the database, or SRID values when using PostgreSQL/PostGIS. For when Database.py is not being used, projections should be downloaded as .wkt files from spatialreference.org and placed into the projection directory designated in your config file. If using Database.py functionality, make sure the *spatial_ref_sys* table is defined in your database. This table has a core of over 3000 spatial reference systems ready to use, but custom projections can be added very easily!

To add a custom spatial reference, download the desired projection in "PostGIS spatial_ref_sys INSERT statement" format from spatialreference.org. This option is an sql executable that can be run within PostgreSQL to add the desired projection into the *spatial_ref_sys* table.

You can find the SRID of your projection by examining the INSERT statement as described above. The SRID is the first value in the query. This is the value that should be entered into the *roiprojSRID* field of your config file if you are working with an ROI shapefile.

CHAPTER SIX

DIMGNAME CONVENTION

“The nice thing about standards is that there are so many to chose from” (A. Tannenbaum), but this gets annoying when you pull data from MDA, CSA, CIS, PDC, ASF and they all use different file naming conventions. So I made this problem worse with my own standard image naming convention called **dimgname**. All files processed by SigLib get named as follows, which is good for:

- sorting on date (that is the most important characteristic of an image besides where the image is - and good luck conveying that simply in a file name).
- viewing in a list (because date is first, underscores keep the names tidy in a list - you can look down to see the different beams, satellites, etc.)
- extensibility - you can add on to the file name as needed - add a subscene or whatever on the end, it will sort and view the same as before.
- extracting metadata from the name (in a program or spreadsheet just parse on “_”)

Template: date_time_sat_beam_data_proj.ext

Example: 20080630_225541_r1_scwa__hh_s_lcc.tif

Table: **dimgname fields**

CHAPTER

SEVEN

ROI.SHP FORMAT

The ROI.shp or Region Of Interest shapefile is what you need to extract data. Basically it denotes *where* and *when* you want information. It has to have certain fields to work properly. There are two basic formats, based on whether you are using the **Discovery** or **Scientific** mode. If you are interested in 1) finding out what scenes/images might be available to cover an area or 2) generating images over a given area then use the *Discovery* format. If you have examined the images already and have digitized polygons of areas that you want to analyze (find statistics), then make sure those polygons are stored in a shapefile using the *Scientific* format. In either case you must have the fields that are required for *Both* formats in the table below. You can add whatever other fields you wish and some suggestions are listed below as *Optional*.

Note: There are two sample ROI files (one for discovery mode, one for scientific mode) provided in the SigLib repository. To make your own ROI file, it is highly recommended that you copy one of the sample files and edit the rows accordingly, rather than creating a shapefile from scratch.

The two fields which are required for both Discovery or Scientific mode use may be confusing, so here are some further details with examples.

- OBJ - this is a unique identifier for a given area or object (polygon) that you are interested in getting data for.
- INSTID - A way to track OBJ that is repeatedly observed over time (moving ice island, a lake during fall every year for 5 years). [If it doesn't repeat just put '0']

Example workflow:

You could be interested in lake freeze-up in the Yukon, drifting ice islands, or soil moisture in southern Ontario farm fields. First you will want to find out what data are available, retrieve zip files and generate imagery to look at. In this case use the *Discovery* format. Each lake, region that ice islands drift through or agricultural area that you want to study would be given a unique OBJ. If you have only one time period in mind for each, then INSTID would be '0' in all cases. If however, you want to look at each lake during several autumns, ice islands as they drift or farm fields after rain events, then each OBJ will have several rows in your shapefile with a different FROMDATE and TODATE. Then for each new row with the same OBJ, you must modify the INSTID such that a string that is composed of OBJ+INSTID is unique across your shapefile. This is what is done internally by SigLib and a new field is generated called INST (in the PostGIS database). Note that the FROMDATE and TODATE will typically be different for each OBJ+INSTID combination.

If you know what imagery is available already, or if you have digitized specific areas corresponding where you want to quantify backscatter (or image noise, incidence angle, etc), then you should use the *Scientific* format. In this case, the principles are the same as in the *Discovery* mode but your concept of what an OBJ might be, will be different. Depending on the study goals, you may want backscatter from the entire lake, in which case your OBJ would be the same as in *Discovery* mode, however, the INSTID must be modified such that there is a unique OBJ+INSTID for each image (or image acquisition time) you want to retrieve data for. The scientific OBJ should change when you are hand digitizing a specific subsample from each OBJ from the *Discovery* mode. For example:

- within each agricultural area you may want to digitize particular fields;
- instead of vast areas to look for ice islands you have actually digitized each one at a precise location and time

Build your *Scientific* ROI shapefile with the field IMGREF for each unique OBJ+INSTID instead of the FROMDATE and TODATE. By placing the dimgname of each image you want to look at in the IMGREF field, SigLib can pull out the date and time and populate the DATEFROM and DATETO fields automatically. Hint: the INSTID could be IMGREF if you wished (since there is no way an OBJ would be in the same image twice).

Once you complete your ROI.shp you can name it whatever you like (just don't put spaces in the filename, since that causes problems).

Field	Datatype	Description	Example	ROI Format
| OBJ	String	A unique identifier for each polygon object you are interested in	00001, 00002	Both
| INSTID	String	An iterator for each new row of the same OBJ	0,1,2,3,4	Both
| FROMDATE	String	ISO Date-time denoting the start of the time period of interest	2002-04-15 00:00:00	Discovery
| TODATE	String	ISO Date-time denoting the end of the time period of interest	2002-09-15 23:59:59	Discovery
| IMGREF	String	dimgname of a specific image known to contain the OBJ polygon (this prompts the generation of From and To Date in the program)	20020715_135903_r1_scwa__hh_s_lcc.tif	Scientific
| Name	String	A name for the OBJ is nice to have	Ward Hunt, Milne, Ayles	Optional
| Area	Float	You can calculate the Area of each polygon and put it here (choose whatever units you want)	23.42452	Optional
| Notes	String	Comment field to explain the OBJ	Georeferencing may be slightly off here?	Optional

Table: **ROI.shp fields**

- See folder ROISamples for example ROIs - Discovery and Scientific mode

CHAPTER

EIGHT

USING SIGLIB

Welcome to the tutorial sections of the SigLib documentation! This section gives a brief overview of how to use the Metadata, Util, Database, and Image functions via SigLib and its config file, or in a custom way via qryDatabase.

Basic SigLib Setup

Before SigLib and its dependencies can be used for the first time, some basic setup must first be completed. In the downloaded SigLib file, there are five Python files (*.py), a config file (*.cfg), and an extras folder containing some odds and ends (including this very document you are reading!).

A number of folders must be created and refered to the config file. Please see the config section of the documentation above for the required folders. These directories are used to keep the various input, temporary, and output files organized. Once created, the full path to each file must be added to the config file alongside the directory it is set to represent. The config file contains example path listings.

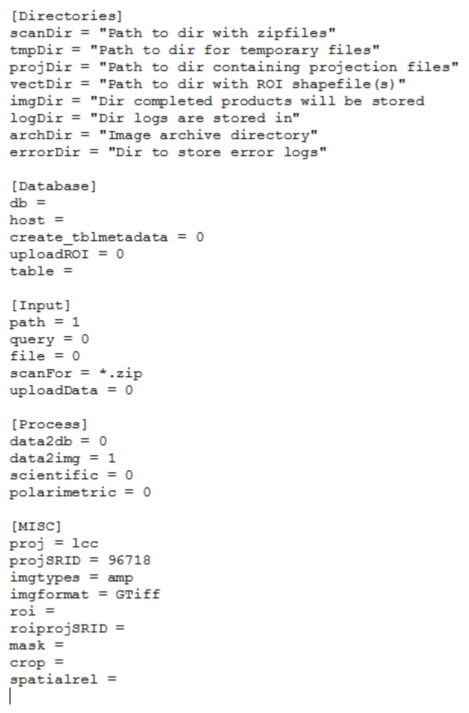
For SigLib.py to recognise and use the config file properly, your Python IDE must be set up for running via the command line. The following instructions are given for the Spyder Python IDE; the setup for other IDEs may vary.

1.Go to Run -> Configuration per file... (Ctrl + F6) 2.Under General Settings, check the box labeled *Command Line Options:* 3.In the box to the right, put the full path to the config file, including the config file itself and its extension. 4.Press the OK button to save the setting and close the window

Example #1: Basic Radarsat2 Image Calibration using SigLib

In this example we will be using SigLib to produce Tiff images from Amplitude Radarsat2 image files. Before any work beings in Python, the config file must be configured for this type of job, see the figure below for the required settings. Place a few Radarsat2 zip files in your scanDir, then open your IDE configured for command line running, and run SigLib.

What will happen is as follows: The zipfile will be extracted to the temp directory via Util.py. The metadata will then be extracted and saved to the output directory, via Metadata.py. Image.py will create an initial Tiff image via GDAL or SNAPPY, and saved to the output directory. The image will then be reprojected and stretched into a byte-scaled Tiff file. All intermediate files will then be cleaned and Siglib will move onto the next zipfile, until all the files in the scanDir are converted.



```
[Directories]
scanDir = "Path to dir with zipfiles"
tmpDir = "Path to dir for temporary files"
projDir = "Path to dir containing projection files"
vectDir = "Path to dir with ROI shapefile(s)"
imgDir = "Dir completed products will be stored
logDir = "Dir logs are stored in"
archDir = "Image archive directory"
errorDir = "Dir to store error logs"

[Database]
db =
host =
create_tblmetadata = 0
uploadROI = 0
table =

[Input]
path = 1
query = 0
file = 0
scanFor = *.zip
uploadData = 0

[Process]
data2db = 0
data2img = 1
scientific = 0
polarimetric = 0

[MISC]
proj = lcc
projSRID = 96718
imgtypes = amp
imgformat = GTiff
roi =
roiprojSRID =
mask =
crop =
spatialrel =
```

Fig. 8.1: A basic config file for this task

Example #2: Discover Radarsat metadata and upload to a geodatabase

This example will be the first introduction to Database.py and PGAdmin. In this example we will be uploading the metadata of Radarsat scenes to a geodatabase for later reference (and for use in later examples). This process will be done using the parallel library on linux. See https://www.gnu.org/software/parallel for documentation and downloads for the parallel library. **NOTE:** This example only works on *linux* machines, how the results of this example can be replicated on other machines will be explained afterwards.

This job will be done via the data2db process of SigLib, as seen in the config. Also, since we are running this example in parallel, the input must be **File** not **Path**.

In this case, we need the metadata table in our geodatabase to already exist. If this table has not been created yet, run SigLib with "create_tblmetadata" equal to 1, with all modes under **Process** equal to 0 before continuing with the rest of this example.

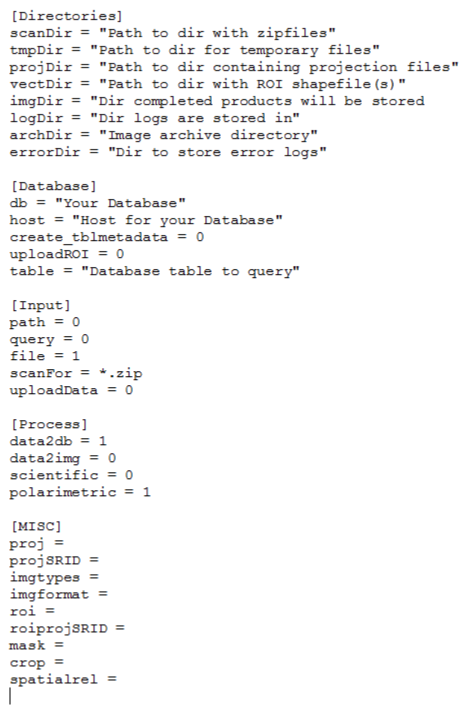
A review of the settings needed for this particular example can be seen in the figure below.

To start the parallel job:

1. Open a terminal

2. cd into the directory containing all your radarsat images (They can be in multiple directories, just make sure they are below the one you cd into, or they will not be found) 3. Type in the terminal: **find . -name '*.zip' -type f | parallel -j 16 –nice 15 –progress python /path/to/SigLib.py/ /path/to/config.cfg/** Where -j is the number of cores to use, and –nice is how nice the process will be to other processes (I.E. A lower –nice level gives this job a higher priority over other processes). The first directory is the location of your verison of SigLib.py, the second is the location of the associated config file.

NOTE: ALWAYS test parallel on a small batch before doing a major run, to make sure everything is running correctly.



```
[Directories]
scanDir = "Path to dir with zipfiles"
tmpDir = "Path to dir for temporary files"
projDir = "Path to dir containing projection files"
vectDir = "Path to dir with ROI shapefile(s)"
imgDir = "Dir completed products will be stored
logDir = "Dir logs are stored in"
archDir = "Image archive directory"
errorDir = "Dir to store error logs"

[Database]
db = "Your Database"
host = "Host for your Database"
create_tblmetadata = 0
uploadROI = 0
table = "Database table to query"

[Input]
path = 0
query = 0
file = 1
scanFor = *.zip
uploadData = 0

[Process]
data2db = 1
data2img = 0
scientific = 0
polarimetric = 1

[MISC]
proj =
projSRID =
imgtypes =
imgformat =
roi =
roiprojSRID =
mask =
crop =
spatialrel =
```

Fig. 8.2: Config file settings for discovering and uploading metadata.

Once started, Parallel will begin to step though your selected directory looking for .zip files. Once one is found, it will pass it to one of the 16 availible (or however many cores you set) openings of Siglib.py. SigLib will unzip the file via Util.py, grab the metadata via Metadata.py, then connect to your desired database, and upload this retrieved metadata to the relational table *tblmetadata* (which will have to be created by running createTblMetadata() in Database.py before parallelizing) via Database.py. This will repeat until parallel has fully stepped through your selected directory.

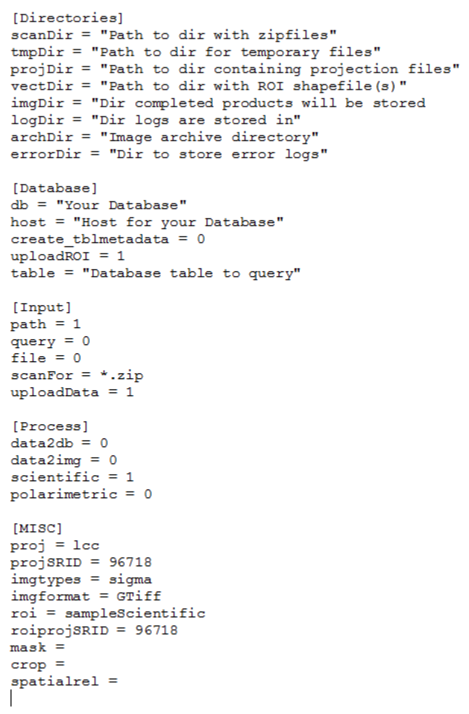
Most SigLib process can be parallelized, as long as the correct config parameters are set, and the above steps on starting a parallel job are followed.

The same results for this example can be achieved for non-linux machines by putting all the zip files containing metadata for upload into your scanDir, and using the same settings as in the above figure, except in the *Input* section, **File** must be set to 0, and **Path** must be set to 1.

Example #3: Scientific Mode!

In this example, we will dive into the depths of SigLibs' Scientific Mode! Scientific Mode (as described in an earlier section of this documentation) is a way of taking normal radarsat images and converting them to a new image type (sigma0, beta0, and gamma0) followed by cropping and masking them into small pieces via a scientific ROI. The ROI should contain a series of polygons representing regions of interest for different scenes. For example, the polygons could be individual farmers fields, or individual icebergs. The ROI created must be uploaded to the geodatabase for querying by SigLib. To upload the ROI specified in the config, set 'uploadROI' equal to 1, as seen below in the example config. **NOTE:** This config setting **MUST** be 0 if running in parallel, or else the ROI will constantly be overwritten. This case also requires a database with SAR image footprints, like the one made in the previous example!

Once begun, this mode takes a SAR image in the scanDir, and calibrates it to the selected image type. Once completed, database.py is used to query the ROI against the image footprint to find which polygons in the ROI are within the scene being processed. Each of these hits is then processed one at a time, beginning with a bounding-box crop around the



```
[Directories]
scanDir = "Path to dir with zipfiles"
tmpDir = "Path to dir for temporary files"
projDir = "Path to dir containing projection files"
vectDir = "Path to dir with ROI shapefile(s)"
imgDir = "Dir completed products will be stored
logDir = "Dir logs are stored in"
archDir = "Image archive directory"
errorDir = "Dir to store error logs"

[Database]
db = "Your Database"
host = "Host for your Database"
create_tblmetadata = 0
uploadROI = 1
table = "Database table to query"

[Input]
path = 1
query = 0
file = 0
scanFor = *.zip
uploadData = 1

[Process]
data2db = 0
data2img = 0
scientific = 1
polarimetric = 0

[MISC]
proj = lcc
projSRID = 96718
imgtypes = sigma
imgformat = GTiff
roi = sampleScientific
roiprojSRID = 96718
mask =
crop =
spatialrel =
```

Fig. 8.3: Config file settings for scientific mode. Note that we are uploading an ROI in this example. The first time scientific is run with a new ROI, this setting will be nessesary, otherwise it can be set equal to 0

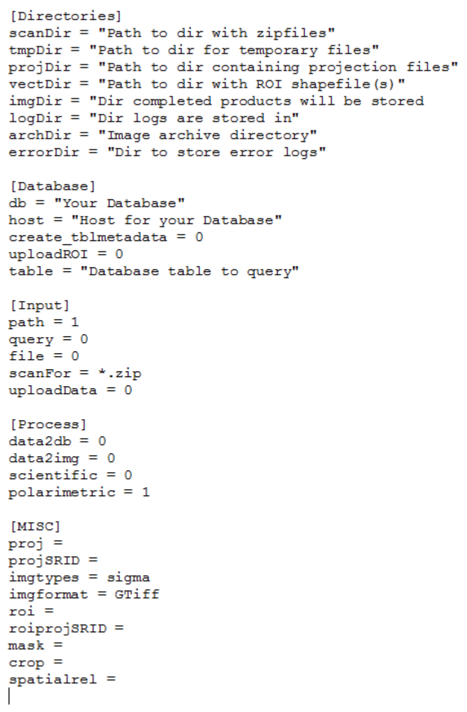
instance, followed by a mask using the ROI polygon (both queried via Database.py). At this point, each instance is projected and turned into its own TIFF file for delivery, or the image data for the instances is uploaded to a database table made to store data from this run.

Example #4: Polarimetric Mode!

In this final example, we will look at using SigLib's Polarimetric mode. Polarimetric mode uses the SNAP python library SnapPy to perform SAR polarimetry for quad-pol scenes containing tracking beacon instances. Three different polarimetric operations are conducted in this mode: Matrix Generation, Polarimetric Speckle Filtering (Using Refined Lee Filter), and Polarimetric Decomposition Generation. All the matricies and decompositions available in SnapPy that are designed for quad-pol imagery are stored in lists in *polarimetric* in **SigLib.py**, these can be edited to contain only desired options. No terrain-correction/reprojections are done in this mode.

This example requires a database table containing tracking beacon instances and one containing quad-pol SAR image footprints. The nessesary columns for the tracking beacons are geom, latitude, longitude, beaconid, and time (in UTC). The geom and time columns will be comparied to similar columns in the SAR footprints table. The sql statement to compare these two tables will need to be edited to match your column names, see *beaconIntersections* in **Image.py** to make appropriate edits.

Once started, this mode goes through the images in the scan directory, processing one image at a time. The program checks to make sure the images are quad-pol, and then queries the geodatabase to see if any beacon pings are contained in the image within a 91 minute buffered timeframe of the SAR data being collected. If there are beacons in the image, the ID's, latitudes, and longitudes of the beacons are collected. The scene is then calibrated to sigma0. At this point, image processing begins per beacon instance in this scene. First, both polarimetric matricies, C3 and T3, are applied (two separate files are created, one with each). Each of these files is then speckle-filtered with a Refined-Lee Filter. After, each decomposition type specified is generated upon each matrix type (again, separate file for each). For the



```
[Directories]
scanDir = "Path to dir with zipfiles"
tmpDir = "Path to dir for temporary files"
projDir = "Path to dir containing projection files"
vectDir = "Path to dir with ROI shapefile(s)"
imgDir = "Dir completed products will be stored
logDir = "Dir logs are stored in"
archDir = "Image archive directory"
errorDir = "Dir to store error logs"

[Database]
db = "Your Database"
host = "Host for your Database"
create_tblmetadata = 0
uploadROI = 0
table = "Database table to query"

[Input]
path = 1
query = 0
file = 0
scanFor = *.zip
uploadData = 0

[Process]
data2db = 0
data2img = 0
scientific = 0
polarimetric = 1

[MISC]
proj =
projSRID =
imgtypes = sigma
imgformat = GTiff
roi =
roiprojSRID =
mask =
crop =
spatialrel =
```

Fig. 8.4: Config file settings for polarimetry mode

Touzi and H-A-Alpha Decompositions, they are generated four times per matrix, each with a different set of bands. Max conditions will generate 28 GeoTiff files per beacon instance, if both matricies and all snap decompositions are utilized.

Conclusion

This is the conclusion to the *Using SigLib* section of this documentation. For additional help in using SigLib.py and its dependencies, please refer to the next section of this documentation, *SigLib API*. This section gives and overview, the parameters, and the outputs, of each function in the main five modules.

CHAPTER

NINE

SIGLIB API

SigLib

SigLib.py

This script is thr margin that brings together all the SigLib modules with a config script to query, maniputlate and process remote sensing imagery

Created on Mon Oct 7 20:27:19 2013 @**author:** Sougal Bouh Ali **Modified on** Wed May 23 11:37:40 2018 @**reason:** Sent instance of Metadata to data2img instead of calling Metadata again @**author:** Cameron Fitzpatrick

Common Parameters of this Module:

zipfile : a valid zipfile name with full path and extension

zipname : zipfile name without path or extension

fname : image filename with extention but no path

imgname : image filename without extention

granule : unique name of an image in string format

class `SigLib.`**`SigLib`**

`createLog`(*zipfile=None*)

Creates log file that will be used to report progress and errors **Parameters**

zipfile

`data2db`(*meta*, *db*, *zipfile*)

Adds the image file metadata to tblmetadata table in the specified database. Will create/overwrite the table tblmetadata if prompted (be carefull)

Parameters

meta : A metadata instance from Metadata.py

db : database connection

`data2img`(*fname*, *imgname*, *zipname*, *sattype*, *granule*, *zipfile*, *sar_meta*, *unzipdir*)

Opens an image file and converts it to the format given in the config file

Parameters

fname

imgname

zipname

sattype : satelite platform

granule

zipfile

sar_meta : instance of the Metadata class

unzipdir : directory zipfiles were unzipped into

`polarimetric`(*db*, *fname*, *imgname*, *zipname*, *sattype*, *granule*, *zipfile*, *sar_meta*, *unzipdir*)

This function will take full FQ images and perform desired polarimetric matrix generation(s), speckle filtering, and decomposition(s). Combinations can be set in the config file. BE CAREFULL, if no combination is specified, then all possible combinations will be performed, so be prepared for a long run-time and large amounts of data!

Parameters

db : an instance of the Database class

fname

imgname

zipname

sattype : Satellite platform

granule

zipfile

sar_meta : an instance of the Metadata class

unzipdir : location zipfiles were unzipped into

`proc_Dir`(*path*, *pattern*)

Locates satelite image raw data files (zipfiles) using a *pattern* in *path* search method, and then calls createImg() to process the data into image.

Parameters

path : directory tree to scan

pattern : file pattern to discover

`proc_File`(*zipfile*)

Locates a single satellite image zip file and processes it according to the config file. Note this cannot be nested in proc_dir since the logging structure and other elements must parallelizable

Parameters

zipfile

`retrieve`(*zipfile*)

Given a zip file name this function will: find out what satellite it is, unzip it, get instance of metadata, then dependant on the config, save metadata in a file and/or one of the following: Process to image or process to database.

Parameters

zipfile

`scientific`(*db*, *fname*, *imgname*, *zipname*, *sattype*, *granule*, *zipfile*, *sar_meta*, *unzipdir*)

Process images 'Scientifically', based on an ROI in the database, and per zipfile: -Qry to find what polygons in the ROI overlap this image -Process one polygon at a time (Project, crop, and mask), saving each as its own img file OR uploading img data to database

Parameters

db : instance of the Database class

fname

zipname

sattype : satellite platform

granule

zipfile

sar_meta : instance of the Metadata class

unzipdir : directory zipfile was unzipped into

Metadata

class `SigLib.`**`Metadata`**(*granule*, *imgname*, *path*, *zipfile*, *sattype*, *loghandler=None*)
This is the metadata class for each image RSAT2, RSAT1 (ASF and CDPF)

Parameters

granule : unique name of an image in string format

imgname : image filename without extention

path : path to the image in string format

zipfile : a valid zipfile name with full path and extension

sattype : type of data (String)

loghandler : A valid pre-set loghandler (Optional)

Returns

An instance of Metadata

Metadata.py

Created on Jan 1, 2009 @**author:** Derek Mueller

This module creates an instance of class Meta and contains functions to query raw data files for metadata which is standardized and packaged for later use, output to file, upload to database, etc.

This source code to extract metadata from CEOS-format RADARSAT-1 data was developed by Defence Research and Development Canada [Used with permission]

Modified on Wed May 23 11:37:40 2018 @**reason:** Sent instance of Metadata to data2img instead of calling Metadata again @**author:** Cameron Fitzpatrick

class `Metadata.`**`Metadata`**(*granule*, *imgname*, *path*, *zipfile*, *sattype*, *loghandler=None*)
This is the metadata class for each image RSAT2, RSAT1 (ASF and CDPF)

Parameters

granule : unique name of an image in string format

imgname : image filename without extention

path : path to the image in string format

zipfile : a valid zipfile name with full path and extension

sattype : type of data (String)

loghandler : A valid pre-set loghandler (Optional)

Returns

An instance of Metadata

clean_metaASF(*result*)

Takes meta data from origmeta and checks it for completeness, coerces data types splits values, if required and puts it all into a standard format

NOT TESTED!!

Parameters

result : Dictionary of metadata

clean_metaCDPF(*result*)

Takes meta data from origmeta and checks it for completeness, coerces data types splits values, if required and puts it all into a standard format

Parameters

result : A dictonary of metadata

createMetaDict()

Creates a dictionary of all the metadata fields for an image which can be written to file or sent to database

Returns

metadict : Dictionary containing all the metadata fields

extractGCPs(*interval*)

Extracts the lat/long and pixel col/row of ground control points in the image

Parameters

interval : line spacing between extractions

Returns

gcps (tuple) : GCP's returned in tuple format

getASFMetaCorners(*ASFName*)

Use ASF Mapready to generate the metadata

Parameters

ASFName : Name with extention, of the ASF meta file

getASFProductType(*ASFName*)

Description needed!

Parameters

ASFName : Name with extention, of the ASF meta file

getCEOSmetafile()

Get the filenames for metadata

getCornerPoints()
Given a set of geopts, calculate the corner coords to the nearest 1/2 pixel. Assumes that the corners are among the GCPs (not randomly placed)

getDimgname()

Create a filename that conforms to the dimgname standard naming convention:
yyyymmdd_HHmmss_sat_beam_pol...

See *Dimgname Convention* in SigLib Documentation for more information

Returns

dimgname : Name for image file conforming to standards above

getMoreGCPs(*n_gcps*)
If you have a CDPF RSat1 image, gdal only has 15 GCPs Perhaps you want more? If so, use this function. It will grab all the GCPs available (3 on each line) and subselect n_gcps of these to return.

The GCPs will not necessarily be on the 'bottom corners' since the gcps will be spaced evenly to get n_gcps (or more if not divisible by 3) If you want corners the only way to guarantee this is to set n_gcps = 6

Parameters

n_gcps : # of GCP's to return

Returns

gcps (tuple) : GCP's specified returned in tuple format

getRS2metadata()
Open a Radarsat2 product.xml file and get all the required metadata

get_ceos_metadata(**file_names*)
Take file names as input and return a dictionary of metadata file_names is a list of strings or a string (with one filename)

This source code to extract metadata from CEOS-format RADARSAT-1 data was developed by Defence Research and Development Canada [Used with Permission]

Parameters

file_names : List of strings

Returns

result : Dictionary of Metadata

getgdalmeta()
Open file with gdal and get metadata that it can read. Limited!

Returns

gdal_meta : Metadata found by gdal

saveMetaFile(*dir=''*)
Makes a text file with the image metadata

Metadata.**byte2int**(*byte*)
Reads a byte and converts to an integer

Metadata.**date2doy**(*date*, *string=False*, *float=False*)
Provide a python datetime object and get an integer or string (if string=True) doy, fractional DayOfYear(doy) returned if float=True

Parameters

date : Date in python datetime convension

Returns

doy : Day of year

Metadata.**datetime2iso**(*datetimeobj*)
Return iso string from a python datetime

Metadata.**getEarthRadius**(*ellip_maj*, *ellip_min*, *plat_lat*)
Calculates the earth radius at the latitude of the satellite from the ellipsoid params

Metadata.**getGroundRange**(*slantRange*, *radius*, *sat_alt*)
Finds the ground range from nadir which corresponds to a given slant range must be an slc image, must have calculated the slantRange first

Metadata.**getSlantRange**(*gsr*, *pixelSpacing*, *n_cols*, *order_Rg*, *groundRangeOrigin=0.0*)

gsr = ground to slant range coefficients -a list of 6 floats pixelSpacing - the image resolution, n_cols - how many pixels in range ground range orig - for RSat2 (seems to be zero always)

Valid for SLC as well as SGF

Metadata.**getThetaPixel**(*RS*, *r*, *h*)
Calc the incidence angle at a given pixel, angle returned in radians

Metadata.**getThetaVector**(*n_cols*, *slantRange*, *radius*, *sat_alt*)
Make a vector of incidence angles in range direction

Metadata.**get_data_block**(*fp*, *offset*, *length*)
Gets a block of data from file

Parameters

fp : Open file to read data block from

offset : How far down the file to begin the block

length : Length of the data block

Metadata.**get_field_value**(*data*, *field_type*, *length*, *offset*)
Take a line of data and convert it to the appropriate data type

Parameters

data : Line of data read from the file

field_type : Datatype line is (ASCII, Integer, Float, Binary)

length : Length of line

offset : How far down the block the line is

Returns

converted data_str

Metadata.**readdate**(*date*, *sattype*)
Takes a Rsat2 formated date 2009-05-31T14:43:17.184550Z and converts it to python datetime. Sattype needed due to differing date convensions between RS2 and CDPF.

Parameters

date : Date in Rsat2 format

sattype : Satellite type (RS2, CDPF)

Returns

Date in python datetime convension

Image

imgProcess.py

Created on 14 Jul 9:22:16 2009 **@author:** Derek Mueller

This module creates an instance of class Image. It creates an image to contain Remote Sensing Data as an amplitude, sigma naught, noise or theta (incidence angle) image, etc. This image can be subsequently projected, cropped, masked, stretched, etc.

Modified on 3 Feb 1:52:10 2012 **@reason:** Repackaged for r2convert **@author:** Derek Mueller **Modified on** 23 May 14:43:40 2018 **@reason:** Added logging functionality **@author:** Cameron Fitzpatrick **Modified on** 9 Aug 11:53:42 2019 **@reason:** Added in/replaced functions in this module with snapPy equivilants **@author:** Cameron Fitzpatrick

Common Parameters of this Module:

zipfile : a valid zipfile name with full path and extension

zipname : zipfile name without path or extension

fname : image filename with extention but no path

imgname : image filename without extention

granule : unique name of an image in string format

path : path to the image in string format

class `Image.`**`Image`**(*fname*, *path*, *meta*, *imgType*, *imgFormat*, *zipname*, *imgDir*, *tmpDir*, *loghandler=None*, *pol=False*)

This is the Img class for each image. RSAT2, RSAT1 (CDPF)

Opens the file specified by fname, passes reference to the metadata class and declares the imgType of interest.

Parameters

fname

path

meta : reference to the meta class

imgType : amp, sigma, beta or gamma

imgFormat : gdal format code gtiff, vrt

zipname

`applyStretch`(*stats*, *procedure='std'*, *sd=3*, *bitDepth=8*, *sep=False*)

Given an array of stats per band, will stretch a multiband image to the dataType based on procedure (either std for standard deviation, with +ve int in keyword sd, or min-max, also a linear stretch).

A nodata value of 0 is used in all cases

For now, dataType is byte and that's it

Note: gdal_translate -scale does not honour nodata values See: http://trac.osgeo.org/gdal/ticket/3085

Have to run this one under the imgWrite code. The raster bands must be integer, float or byte and int data assumed to be only positive. Won't work very well for dB scaled data (obviously) it is important that noData is set to 0 and is meaningful.

sep = separate: applies individual stretches to each band (=better visualization/contrast)

!sep = together: applies the same stretch to all bands (looks for the band with the greatest dynamic range) (=more 'correct')

For further ideas see: http://en.wikipedia.org/wiki/Histogram_equalization

Parameters

stats : Array of stats for a band, in arrary: band, range, dtype, nodata, min,max,mean,std

procedure : std or min-max

sd : # of standard deviations

bitDepth : # of bits per pixel

sep : False for same stretch to all bands, True for individual stretches

`cleanFiles`(*levels=['crop']*)

Removes intermediate files that have been written within the workflow.

Input a list of items to delete: raw, nil, proj, crop

Parameters

levels : a list of different types of files to delete

`compress`()

Use gdal to LZW compress an image

`cropBig`(*llur*, *subscene*)

If cropping cannot be done in a straight-forward way (cropSmall), gdalwarp is used instead

Parameters

llur : list/tuple of tuples in projected units

subscene : the name of a subscene

`cropImg`(*ullr*, *subscene*)

Given the cropping coordinates, this function tries to crop in a straight-forward way using cropSmall. If this cannot be accomplished then cropBig will do the job.

Parameters

ullr : upper left and lower right coordinates

subscene : the name of a subscene

`cropSmall`(*urll*, *subscene*)

This is a better way to crop because there is no potential for warping. However, this will only work if the region falls completely within the image.

Parameters

urll : list/tuple of tuples in projected units

subscene : the name of a subscene

`decomp`(*format='imgFormat'*)

Takes an input ds of a fully polarimetric image and writes an image of the data using a pauli decomposition.

Differs from imgWrite because it ingests all bands at once...

`decomposition_generation`(*decomposition*, *outputType=0*, *amp=False*)

Generate chosen decomposition on a fully polarimetric product, if looking to create an amplitude image with quad-pol data, set amp to True and send either a Pauli Decomposition or Sinclair Decomposition

Parameters

decomposition : decomposition to be generated. options include: Sinclair Decomposition, Pauli Decomposition, Freeman-Durden Decomposition, Yamagushi Decomposition, van Zyl Decomposition, H-A-Alpha Quad Pol Decomposition, Cloude Decomposition, or Touzi Decomposition

pixel_posUL = info.getPixelPos(GeoPos(ullr[0][1], ullr[0][0]), geoPosOP())

outputType : option to select which set of output parameters that will be used for the Touzi or HAAlpha (1-8, leave 0 for none)

amp : True if looking to generate Pauli or Sinclair decomposition to create quad-pol amp image

Returns

output : filename of new product

fnameGenerate(*names=False*)

Generate a specific filename for this product.

Returns

bands : Integer

dataType : Gdal data type

outname : New filename

getAmp(*datachunk*)

return the amplitude, given the amplitude... but make room for the nodata value by clipping the highest value...

Parameters

datachunk : Chunk of data being processed

Returns

outdata : chunk data in amplitude format

getBandData(*band*, *inname=None*)

opens an img file and reads in data from a given band assume that the dataset is small enough to fit into memory all at once

Parameters

Band : Array of data for a specific band

Returns

imgData : data from the given band

xSpacing : size of pixel in x direction (decimal degrees)

ySpacing : size of pixel in y direction (decimal degrees)

getImgStats()

Opens a raster and calculates (approx) the stats returns an array - 1 row per band cols: band, dynamicRange, dataType, nodata value, min, max, mean, std

Returns

stats : stats from raster returned in an array of 1 row per band

getMag(*datachunk*)

return the magnitude of the complex number

getNoise(*n_lines*)
For making an image with the noise floor as data

getPhase(*datachunk*)
Return the phase (in radians) of the data (must be complex/SLC)

getSigma(*datachunk*, *n_lines*)
Calibrate data to Sigma Nought values (linear scale)

Parameters

datachunk : chunk of data being processed

n_lines : size of the chunk

Returns

caldata : calibrated chunk

getTheta(*n_lines*)
For making an image with the incidence angle as data

imgWrite(*format='imgFormat'*, *stretchVals=None*)
Takes an input dataset and writes an image.

self.imgType could be 1) amp, 2) sigma, 3) noise, 4) theta

all bands are output (amp, sigma)

Also used to scale an integer img to byte with stretch, if stretchVals are included

Note there is a parameter called chunk_size hard coded here that could be changed If you are running with lots of RAM

makeAmp(*newFile=True*, *save=True*)
Use snap bandMaths to create amplitude band for SLC products

Parameters

newFile : True if the inname is the product file

save : True if output filename should be added into internal filenames array for later use

makePyramids()
Make image pyramids for fast viewing at different scales (used in GIS)

maskImg(*mask*, *vectdir*, *side*, *inname=None*)
Masks all bands with gdal_rasterize using the 'layer'

side = 'inside' burns 0 inside the vector, 'outside' burns outside the vector

Note: make sure that the vector shapefile is in the same proj as img (Use reprojSHP from ingestutil)

Parameters

mask : a shapefile used to mask the image(s) in question

vectdir : directory where the mask shapefile is

side : 'inside' or 'outside' depending on desired mask result

matrix_generation(*matrix*)
Generate chosen matrix for calibrated quad-pol product

Parameters

matrix : matrix to be generated. options include: C3, C4, T3, or T4

Returns

output : filename of new product

openDataset (*fname*, *path=''*)
Opens a dataset with gdal

Parameters

fname : filename

polarFilter (*save=True*)
Apply a speckle filter on a fully polarimetric product

Parameters

save : True if output filename should be added into internal filenames array for later use

Returns

output : filename of new product

projectImg (*projout*, *projdir*, *format=None*, *resample='bilinear'*, *clobber=True*)
Looks for a file, already created and projects it to a vrt file.

Parameters

projout : projection base name

projdir : path to the projection

format : the image format, defaults to VRT

resample : resample method (as per gdalwarp)

clobber : True/False should old output be overwritten?

Note The pixel IS NOT prescribed (it will be the smallest possible)

reduceImg (*xfactor*, *yfactor*)
Uses gdal to reduce the image by a given factor in x and y(i.e, factor 2 is 50% smaller or half the # of pixels). It overwrites the original.

Parameters

xfactor : float

yfactor : float

slantRangeMask (*mask*, *inname*, *name*)
This function takes a wkt with lat long coordinates, and traslates it into a wkt in line-pixel coordinates

Parameters

mask : wkt file of a polygonal mask in wgs84 coordinates

inname : snap product to cross-reference mask corrdinated to convert them to slant-range

Returns

newMask : wkt file of a polygonal mask in slant-range line-pixel coordinates

snapCalibration (*outDataType='sigma'*, *saveInComplex=False*)
This fuction calibrates radarsat images into sigma, beta, or gamma

Parameters

outDataType : Type of calibration to perform (sigma, beta, or gamma), default is sigma

saveInComplex : Output complex sigma data (for polarimetric mode)

`snapDataTypeConv` (*outFormat='GeoTiff-BigTiff'*)
Convert image data to byte format using gdal

Parameters

outFormat : Format of product this function returns, default is GeoTiff-BigTiff

`snapSubset` (*idNum*, *lat*, *longt*, *dir*, *ullr=None*)
Using lat long provided, create bounding box 200x200 pixels around it, and subset this (This requires id, lat, and longt) OR Using ul and lr coordinates of bounding box, subset (This requires idNum and ullr)

parameters

idNum : id # of subset region (for filenames, each subset region should have unique id)

lat : latitiude of beacon at centre of subset (Optional)

longt : longitude of beacon at centre of subset (Optional)

dir : location output will be stored

ullr : Coordinates of ul and lr corners of bounding box to subset to (Optional)

`snapTC` (*proj*, *projDir*, *smooth=True*, *outFormat='BEAM-DIMAP'*)
Perform an Ellipsoid-Correction using snap. This function also projects the product

Parameters

proj : name of wkt projection file (minus file extension)

projDir : directory containing projection file

smooth : If quanitative data, do not smooth (Smooth using Bilinear resampling for quality)

outFormat : Format of product this function returns, default is BEAM-DIMAP

`stretchLinear` (*datachunk*, *scaleRange*, *dynRange*, *minVal*, *offset=0*)
Simple linear rescale: where min (max) can be the actual min/max or mean+/- n*std or any other cutoff

Note: make sure min/max don't exceed the natural limits of dataType takes a numpy array datachunk the range to scale to, the range to scale from, the minVal to start from and an offset required for some stretches (see applyStretch keyword sep/tog)

Parameters

datachunk : array

scaleRange : Range to scale to

dynRange : Range to scale from

minVal : strating min value

Returns

stretchData : datachunk, now linearly rescaled

`vrt2RealImg` (*subset=None*)
Used to convert a vrt to a tiff (or another image format)

Database

Database.py

Created on Tue Feb 12 23:12:13 2013 @**author:** Cindy Lopes

This module creates an instance of class Database and connects to a database to create, update and query tables.

Tables of note include:

table_to_query - a table that contains metadata that is gleaned by a directory scan

roi_tbl - a table with a region of interest (could be named something else)

trel_roiinst_con or _int - a relational table that results from a spatial query

tblArchive - a copy of the metadata from the CIS image archive

Modified on 23 May 14:43:40 2018 @**reason:** Added logging functionality @**author:** Cameron Fitzpatrick

class `Database.`**`Database`**(*table_to_query*, *dbname*, *loghandler=None*, *user=None*, *password=None*, *port='5432'*, *host='localhost'*)

This is the Database class for each database connection.

Creates a connection to the specified database. You can connect as a specific user or default to your own username, which assumes you have privileges and a password stored in your ~/.pgpass file

Note: if you have any issues with a bad query, send a rollback to the database to reset the connection. >>>>db.connection.rollback()

Parameters

dbname : database name

user : user with read or write (as required) access on the specified databse (eg. postgres user has read/write access to all databses)

password : password to go with user

port : server port (i.e. 5432)

host : hostname of postgres server

`beaconIntersections`(*beacontable*, *granule*)

Get id, lat and long of beacons that intersect the image within a ninty minutes of the image data being collected

Parameters

beacontable : database table containing beacon tracks

granule : unique identifier of image being analysed

Returns

rows : all beacon pings that meet requirements. Each row has three columns: beacon id, lat, and long

`beaconShapefilesToTables`(*dirName*)

Takes a directory containing beacon shape files and converts them to tables and inserts them into the database appending *beacon_* before the name

Parameters

dirName : Directory containing the beacon shapefiles

convertGPSTime(*shpTable*)
Takes a shape file and converts the gps_time from character type to timestamp time.

Parameters

shpTable : Shapefile table in the database

createTblMetadata()
Creates a metadata table of name specified in the cfg file under Table. It overwrites if that table name already exist, be careful!

exportToCSV(*qryOutput*, *outputName*)
Given a dictionary of results from the database and a filename puts all the results into a csv with the filename outputName

Parameters

qryOutput : output from a query - needs to be a tupple - numpy data and list of column names

outputName : the file name

imgData2db(*imgData*, *bandName*, *inst*, *dimgname*, *granule*)
Upload image data as an array to a new database table

What is needed by function: imgData, the imgType, the bandName, the inst, dimgname and granule What is computed to add to upload: count, mean, std, min, max for non-zero elements

Parameters

imgData : Pixel values

bandName : Name of the band being uploaded

inst : instance id

dimgname : Image name

granule : granule name

meta2db(*metaDict*, *overwrite=False*)
Uploads image metadata to the database as discovered by the meta module. *meta* is a dictionary - no need to upload all the fields (some are not included in the table structure)

Note that granule and dimgname are unique - as a precaution - a first query deletes records that would otherwise be duplicated. This assumes that they should be overwritten!

Parameters

metaDict : dictionnary containing the metadata

nameRelationTable(*roi*, *spatialrel*)
Automatically gives a name to a relational table in the format: "trel" + roi + "img" + _int or _con (in reference to spatialrel)

Parameters

roi : region of interest

spatialrel : spatial relationship (i.e. ST_Contains or ST_Intersect)

Returns

name : name of the table

numpy2sql(*numpyArray*, *dims*)
Converts a 1- or 2-D numpy array to an sql friendly array Do not use with a string array!

Parameters

numpyArray : numpy array to convert

dims : dimension (1 or 2)

Returns

array_sql : an sql friendly array

polarimetricDonuts(*granule*, *beaconid*)

Parameters

granule : unique name of an image in string format

beaconid : identification number of a tracking beacon assocated with this image

Returns

results : array of polygonal masks in wkt format associated witht eh above beacon and image

qryCropZone(*granule*, *roi*, *spatialrel*, *inst*, *metaTable*, *srid=4326*)

Writes a query to fetch the bounding box of the area that the inst polygon and image in question intersect. returns a crop ullr tupple pair in the projection given

Parameters

granule : granule name

roi : region of interest file

spatialrel : spatial relationship (i.e. ST_Contains or ST_Intersect)

inst : instance id (i.e. a 5-digit string)

metaTable : metadata table containing data of images being worked on

srid : srid of desired projection (default WGS84, as this comes out of TC from snap, crop can be done before projection)

Returns

ullr : upper left, lower right tupple pair in the projection given

qryFromFile(*fname*, *path*, *output=False*)

Runs a query in the current databse by opening a file - adds the path and .sql extension - reading contents to a string and running the query

Note: do not use '%' in the query b/c it interfers with the pyformat protocol used by psycopg2

Parameters

fname : file name (don't put the sql extension, it's assumed)

path : full path to fname

output : make true if you expect/want the query to return results

qryFromText(*sql*, *output=False*)

Runs a query in the current databse by sending an sql string

Note: do not use '%' in the query b/c it interfers with the pyformat protocol used by psycopg2. Also be sure to triple quote your string to avoid escaping single quotes.

IF EVER THE Transaction block fails, just conn.rollback(). Try to use pyformat for queries - see dbapi2 (PEP). You can format the SQL nicely with an online tool - like SQLinForm

Parameters

sql : the sql text that you want to send

output : make true if you expect/want the query to return results

Returns

The result of the query as a tupple containing a numpy array and the column names as a list (if requested and available)

qryGetInstances(*granule*, *roi*, *metaTable*)
Writes a query to fetch the instance names that are associated spatially in the relational table.

Parameters

granule : granule name

roi : region of interest file

metaTable : metadata table containing data of images being worked on

Returns

instances : instances id (unique for entire project, i.e. 5-digit string)

qryMaskZone(*granule*, *roi*, *srid*, *inst*, *metaTable*)
Writes a query to fetch the area the inst polygon in the roi and the image in question intersect. This polygon will be used to mask the image.

Parameters

granule : granule name

roi : region of interest file

srid : srid of desired projection

inst : instance id (i.e. a 5-digit string)

metaTable : metadata table containing data of images being worked on

idField : name of field containing instance id's

Returns

polytext : gml text

qrySelectFromAvailable(*roi*, *selectFrom*, *spatialrel*, *srid*)
Given a roi table name (with polygons, from/todates), determine the scenes that cover the area from start (str that looks like iso date) to end (same format).

Eventually include criteria: subtype - a single satellite name: ALOS_AR, RADAR_AR, RSAT2_AR (or ANY) beam - a beam mode

Returns a list of images+inst - the bounding box

Parameters

roi : region of interest table in the database

spatialrel : spatial relationship (i.e. ST_Contains or ST_Intersect). Does the image contain the ROI polygon or just intersect with it?

srid : srid of desired projecton

selectFrom : table in the database to find the scenes

Returns

copylist : a list of image catalog ids

instimg : a list of each instance and the images that correspond

`relations2db` (*roi*, *spatialrel*, *instimg*, *fname=None*, *mode='refresh'*, *export=False*)

A function to add or update relational tables that contain the name of an image and the features that they are spatially related to: For example: a table that shows what images intersect with general areas or a table that lists images that contain ROI polygons

This function runs in create mode or refresh mode Create - Drops and re-creates the table

Refresh - Adds new data (leaves the old stuff intact)

Parameters

roi : region of interest table

spatialrel : spatial relationship (i.e. ST_Contains or ST_Intersect)

instimg : a list of images that are spatially related to each inst

fname : csv filename if exporting

mode : create or refresh mode

export : If relations should be exported to a csv or not

`sql2numpy` (*sqlArray*, *dtype='float32'*)

Coming from SQL queries, arrays are stored as a list (or list of lists) Defaults to float32

Parameters

sqlArray : an sql friendly array

dtype : default type (float32)

Returns

list : list containing the arrays

`updateFromArchive` (*archDir*)

Goes to CIS Archive metadata shapefiles and (re)creates and updates tblArchive in the connected database tblArchive then represents all the image files that CIS has (in theory) The first thing this script does is define the table - this is done from an sql file and contains the required SRID Then it uses ogr2ogr to upload each shp in the archDir The script looks for the *.last files to know which files are the most current (these need to be updated)

Can be extended to import from other archives (In the long term - PDC?)

Parameters

archDir : archive directory

`updateROI` (*inFile*, *srid*, *wdir*, *ogr=False*)

This function will update an ROI (Region Of Interest) table in the database. It has a prescribed format It will take the shapefile named inFile and update the database with the info

Note that this will overwrite any table named *inFile* in the database

The generated table will include a column *inst* - a unique identifier created by concatenating obj and instid

Parameters

inFile : Basename of a shapefile (becomes the ROI table name too)

srid : srid of desired projection

wdir : Full path to directory containing ROI (NOT path to ROI itself, just the directory containing it)

Required in ROI (In shp attribute table)

obj - The id or name of an object/polygon that defines a region of interest. Very systematic, no spaces.

instid - A number to distinguish repetitions of each obj in time or space. For example an ROI that occurs several summers would have several instids.

fromdate - A valid iso time denoting the start of the ROI - can be blank if imgref is used

todate - A valid iso time denoting the start of the ROI - can be blank if imgref is used

Optional in ROI (in shp attribute table)

imgref - A reference image dimage name (for a given ROI) - this can be provided in place of datefrom and dateto

name - A name for each obj (Area51_1950s, Target7, Ayles)

comment - A comment field

Any other field can be added...

Utilities

util.py

This module contains miscellaneous code that helps siglib work with directories, zip files, clean up intermediate files and so on.

Created on Tue Feb 12 20:04:11 2013 **@author:** Cindy Lopes **Modified on** Sat Nov 23 14:49:18 2013 **@reason:** Added writeIssueFile and compareIssueFiles **@author:** Sougal Bouh Ali **Modified on** Sat Nov 30 15:37:22 2013 **@reason:** Redesigned getFilname, getZipRoot and unZip **@author:** Sougal Bouh Ali **Modified on** Wed May 23 14:41:40 2018 **@reason:** Added logging functionality **@author:** Cameron Fitzpatrick

`Util.`**`az`**(*pt1*, *pt2*)

Calculates the great circle initial azimuth between two points in dd.ddd format. This formula assumes a spherical earth. Use Vincenty's formulae for better precision

https://en.wikipedia.org/wiki/Azimuth https://en.wikipedia.org/wiki/Vincenty%27s_formulae

Parameters:

pt1 : point from (tuple of lon and lat)

pt2 : point to (tuple of lon and lat)

Returns

az : azimuth from North in degrees

`Util.`**`copyfiles`**(*self*, *copylist*, *wrkdir*, *fname=None*, *export=False*, *loghandler=None*)

Copies files from a local archive. If file could not be found, check that the drive mapping is correct (above).

Parameters

copylist : a list of images + inst

wrkdir : working directory

fname : Filename if exporting copylist as txt *export* : True if want to export copylist as txt

`Util.`**`getFilename`**(*zipname*, *unzipdir*, *loghandler=None*)

Given the name of a zipfile, return the name of the image, the file name, and the corresponding sensor/platform (satellite).

Parameters

zipname : The basename of the zip file you are working with

unzipdir : Where the zipfile will unzip to (find out with getZipRoot)

Returns

fname : The file name that corresponds to the image

imgname : The name of the image (the basename, sans extension)

sattype : The type of satellite/image format this file represents

`Util.`**`getPowerScale`**(*dB*)

Convert a SAR backscatter value from the log dB scale to the linear power scale

Note: dB must be a scalar or an array of scalars

Parameters

dB : backscatter in dB units

Returns

power : backscatter in power units

`Util.`**`getZipRoot`**(*zip_file*, *tmpDir*)

Looks into a zipfile and determines if the contents will unzip into a subdirectory (named for the zipfile); or a sub-subdirectory; or no directory at all (loose files)

Run this function to determine where the files will be unzipped to. If the files are in the immediate subfolder, then that is what is required.

Returns the unzipdir (where the files will -or should- go) and zipname (basename of the zipfile)

Parameters

zip_file : full path, name and ext of a zip file

tmpDir : this is the path to the directory where you are working with this file (the path of the zip_file - or wrkdir)

Returns

unzipdir : the directory where the zip file will/should unzip to

zipname : basename of the zip file AND/OR the name of the folder where the image files are

`Util.`**`getdBScale`**(*power*)

Convert a SAR backscatter value from the linear power scale to the log dB scale

Note: power must be a scalar or an array of scalars,negative powers will throw back NaN.

Parameters

power : backscatter in power units

Returns

dB : backscatter in dB units

`Util.`**`llur2ullr`**`(`*llur*`)`

a function that returns: upperleft, lower right when given... lowerleft, upper right a list of tupples [(x,y),(x,y)]

Note - this will disappoint if proj is transformed (before or after)

Parameters

llur : a list of tupples [(x,y),(x,y)] corresponding to lower left, upper right corners of a bounding box

`Util.`**`reprojSHP`**`(`*in_shp*, *vectdir*, *proj*, *projdir*`)`

Opens a shapefile, saves it as a new shapefile in the same directory that is reprojected to the projection wkt provided.

Note: this could be expanded to get polyline data from polygon data for masking lines (not areas) ogr2ogr -nlt MULTILINESTRING

Parameters

in_shp :

vectdir :

proj :

projdir :

Returns

out_shp : name of the proper shapefile

`Util.`**`ullr2llur`**`(`*ullr*`)`

a function that returns: lowerleft, upper right when given... upperleft, lower right a list of tupples [(x,y),(x,y)]

Note - this will disappoint if proj is transformed (before or after)

Parameters

ullr : a list of tupples [(x,y),(x,y)] corresponding to upper right, lower left corners of a bounding box

`Util.`**`unZip`**`(`*zip_file*, *unzipdir*, *ext='all'*`)`

Unzips the zip_file to unzipdir with python's zipfile module.

"ext" is a keyword that defaults to all files, but can be set to just extract a leader file L or xml for example.

Parameters

zip_file : Name of a zip file - with extension

unzipdir : Directory to unzip to

Optional

ext : 'all' or a specific ext as required

`Util.`**`wkt2shp`**`(`*shpname*, *vectdir*, *proj*, *projdir*, *wkt*`)`

Takes a polygon defined by well-known-text and a projection name and outputs a shapefile into the current directory

Parameters

shpname :

vectdir :

proj :

projdir :

wkt :

`Util.`**`wktpoly2pts`**`(`*wkt*, *bbox=False*`)`

Converts a Well-known Text string for a polygon into a series of tuples that correspond to the upper left, upper right, lower right and lower left corners

This works with lon/lat rectangles.

If you have a polygon that is not a rectangle, set bbox to True and the bounding box corners will be returned

Note that for rectangles in unprojected coordinates (lon/lat deg), this is slightly different from ullr or llur (elsewhere in this project) which are derived from bounding boxes of projected coordinates

Parameters

wkt : a well-known text string for a polygon

Returns

ul,ur,lr,ll : a list of the four corners