Session 4 - Wednesday pm - 13th September

Introduction

In this session we will look in more detail at the information contained in SeaDAS data files, how that data is processed, and methods for accessing specific sections of data.

The SeaWiFS web site at *seawifs.gsfc.nasa.gov* and the DAAC site at *daac.gsfc.nasa.gov* both contain much useful information on the SeaWiFS products. Examples of web pages specificaly related to this topic include:

seawifs.gsfc.nasa.gov/SEAWIFS/SOFTWARE/DATA_PRODUCTS.html

and

daac.gsfc.nasa.gov/DATASET_DOCS/SeaWiFS_L1A2_Guide.html

Another useful page is located at

falefa.gsfc.nasa.gov/ seawifsd/sdpsdoc/html/main.html

The web site *seadas.gsfc.nasa.gov/doc/sds_faq.html#G_levels* provides an overview

of the different levels of SeaWIFS data.

Overview of processing stages

The raw SeaWiFS data is converted to a standard format level 0 (L0) data file. This L0 data is then converted to level 1a (L1A) data using the SeaDAS routine **l1agen**. The L1A data is basically the same as the L0, but some extra calibration, navigation and telemetry data have been placed in the L1A file. Top of atmosphere radiance values (level 1b or L1B data) may be produced using the SeaDAS **l1bgen** routine.

Geophysical products such as chlorophyll concentration are derived from the L1A/L1B radiance data via the SeaDAS **msl12** routine. Earlier versions of SeaDAS used **l2gen**. The options available to create L2 data are vast, therefore it is typical to archive SeaWiFS data at the L1A level.

There is a suite of routines available to sample the L1A, L1B and L2 products in a variety of ways including sub-sampling, extracting specific regions, re-mapping to standard map projections, and performing time and space averaging. We will not cover every function of SeaDAS in this workshop, but rather will provide an overview of some core elements of SeaDAS to enable new users to process raw data to a useful geophysical product and to access that data in a number of ways.

naming conventions

The filename format for SeaWiFS L1A HRPT data files is **syyyydddhhmmss.L1A_Hhhh** where **s** stands for SeaWiFS, **yyyy** is the year, and **hhmmss** is the GMT time of the first scan line of the image in hours, minutes and seconds. **hhh** is a code identifying the agency or

HRPT station. Other L1A data types have the Hhhh replaced with a three character data description (eg. GAC, LAC, SOL etc.) The *pdf* document **arch_prod_specs.v40.pdf** at *seawifs.gsfc.nasa.gov/SEAWIFS/SOFTWARE/SOFTWARE.html* provides a more detailed description of the naming convention and different products.

l1atol0

As algorithms are created or improved, new SeaWiFS products may be developed, or old products may be improved. SeaDAS version 4.0 has an improved navigation calculation for the L0 to L1A processing step. Typically SeaWiFS ground stations or SeaWiFS data users archive SeaWiFS data at the L1A stage or higher. This requires us to process the archived L1A data back to L0, then reprocess to the new L1A level, with improved navigation accuracy. The web site *seawifs.gsfc.nasa.gov/SEAWIFS/RECAL/* provides more information on the reprocessing of SeaWiFS data.

The reprocessing of SeaWiFS L1A data is handled by **l1atol0**.

- Look at the **l1atol0** help page.
- Select **Process -> SeaWiFS -> l1atol0** from the SeaDAS **Main Menu**
  - Enter the filename, with the full path description, of a SeaWiFS L1A file.
  - Enter the filename, with the full path description, of a SeaWiFS L0 file.
  - Select the **Run** button.
- Look in the output directory to see that the L0 file was produced.

l1agen

This program reads in SeaWiFS Level 0 files and creates Level-1A files in Hierarchical Data Format (HDF). Level 1A data are effectively the same as the raw L0 data, with all spacecraft and instrument telemetry in raw form. The **l1agen** process also converts and appends calibration and geolocation data, instrument telemetry and selected spacecraft telemetry.

- Look at the **l1agen** help pages.
- Select **Process -> SeaWiFS -> l1agen** from the SeaDAS **Main Menu**.
  - Enter the filename, with the full path description, of the SeaWiFS L0 file created in the previous section.
  - Enter the filename, with the full path description, of the SeaWiFS L1A output file.
  - Make sure **No** is selected for **Generate Mail File For SeaWiFS Project**.
  - Select the **Run** button.
- Look in the output directory to see that the L1A file was produced.
- View the L0 and the new L1A files with SeaDAS.

The **l1agen** process performs navigation calculations to geolocate the SeaWiFS scene. For these calculations to be accurate up-to-date spacecraft navigation is required. This navigation data is supplied in the form of the **elements.dat** file. SeaDAS will update this file to extrapolate location information data for recent dates. Typically however we download updated **elements.dat** files on a regular basis.

- Read the "**NOTE: See additional information on navigation files which must be kept up-to-date**" in the **l1agen** help page. Here the location of the **elements.dat** file is explained as:
  - Connect by ftp to **samoa.gsfc.nasa.gov**
  - When prompted for **username** type **anonymous**.
  - When prompted for a password type your email address.
  - Change (**cd**) directory to **/pub/gps-elements**
  - Select binary mode transfer (type **bin**).
  - Get elements.dat (type **get elements.dat**).
  - Quit

When you obtain an updated elements.dat file it must be placed in the **$SEADAS/data/seawifs/nav** directory.

The **l1agen** process may also be run from the command line. Command line processing is useful for routine batch processing.

- Look at the **l1agen** help page.
- Read the **Command Mode** section.
- At the LINUX prompt type **l1agen**. You should be provided with a brief usage note.
- Run **l1agen** by providing a L0 file name as an argument as well as an output filename.

  l1agen /home/visitor/s1999123020304.L0 /home/visitor/s1999123020304.new.L1A
- Use SeaDAS to view the original L0 file and the newly created L1A file.

Access to data

Processing of a whole pass can be very time consuming. One SGI machine we have regularly been using for L2 processing took between 1.5 and 2 hours to create each L2 pass! We have now upgraded to a 700 MHz LINUX PC and a full pass now takes roughly 0.5 hours, much faster, but still a time consuming process. Often we are interested in a particular region within the complete pass. We are able to extract the region of interest at the L1A stage and process that to the L2 stage. This saves considerable time.

extracting data

Earlier versions of SeaDAS had a function called **extract** which enabled the user to extract a section of L1A data specified by line and pixel. SeaDAS 4.0 provides **subscene**, a routine which utilises the **extract** function but provides for the user to enter longitude and latitude locations.

- Look at the **subscene** help page.
- Select **Display** -> **subcene** under the **SeaDAS Main Menu**.
- Select a L1A filename.
- Try moving the box about in the image region, noting how the location information changes.
- Select the **Gridline** button at the bottom of the widget to apply a gridline to the image window.
- Type a set of latitude and longitude ranges in the empty boxes beside **1. Lat range (N/S)** and **Lon range (W/E)**.

- Select the **Apply: 1. Lat/Lon range** button below this. Note the box in the image display is resized. Note also that the box extends outside the specified lat/lon range on two corners. This is because the **extract** function only operates on line and pixel coordinates and the image has not been remapped to a standard projection yet.
- Select the **Save** button. Enter a suitable filename. Note there is the option to sub-sample the data by selecting a line and/or pixel sub-sampling rate.
- Select **Okay**.
- Check the extracted file has been produced.
- View the extracted file with SeaDAS.

Level 2 processing

Earlier versions of SeaDAS utilised a routine called **l2gen** to effect the processing of SeaWiFS data from L1A to L2. SeaDAS 4.0 uses **msl12** to do the L2 processing. We will look at the **msl12** routine. For those using earlier versions of SeaDAS the syntax is very similar. Check the SeaDAS help pages for specific information on **l2gen**.

- Load a L2 file
- Look at the list of L2 products displayed in the **Product Selection for SeaWiFS File** widget. The specific L2 products displayed in this widget will depend upon the products specified when the L2 file was created (We will be performing this task shortly). These products are derived from the L1A data.

- Look at the **msl12** help page. Note the large number of L2 products. When a SeaWiFS file is processed to L2, not all of these products are produced. You are able to specify exactly which products you require, but if you do not specify any products, a default set is produced. The list of default L2 products is stored in the file **$MSL12_DATA/seawifs/seawifs_def_l2prod.dat**. You are able to edit this file, or preferably create your own **seawifs_def_l2prod.dat** file. We will be looking at how to do this in the following sections.

msl12 - interactive

This section will describe the generation of a L2 SeaWiFS data file by using the SeaDAS GUI interface. The following section will describe the command line method of generating a SeaWiFS L2 file.

- Select **Process** -> **SeaWiFS** -> **msl12,0** under the **SeaDAS Main Menu**.
- Select a SeaWiFS L1A input file (use the file extracted earlier, the L2 processing will not take as long.).
- Enter a L2 output file name. There is the option to create up to 4 output files, but we will be satisfied with just one for now.
- Select the **Select L2 products** button. The **MSL12 Output File 1 L2 Products Selection Widget** will open.
  - Select the **Load default** button. Note the products selected.
  - Select the **Okay** button.
- The next panel down in the **SEADAS SeaWiFS L2 File Generating Program** widget allows you to select a line and pixel range. Leave this with the default settings.

- The next panel down allows you to select various processing parameters. Again, we will leave the default settings here.
- The next panel lists various required data files.
- The bottom of the widget has an entry field for a **Parameter file**. Enter a name here, say "**test1.par**" (with the full path desription).
- Beside the entry field select **Option** -> **Save**.
  - The ".par" file should have been created and written to the specified location. Check that it exists and have a look at it's contents. We will come back to this file in the next section.
- Select the **Run** button at the bottom of the **SEADAS SeaWiFS L2 File Generating Program** widget.
  - While the **msl12** process is running observe the terminal in which SeaDAS was started. The L2 processing progress is displayed here.
- When the L2 processing is complete, use SeaDAS to view the L2 file.

Exercise 2:

Note the option to select line and pixel ranges in the **msl12** processing. If you were given a latitude and longitude range, how could you determine the equivalent line and pixel range? Email us the answer

Exercise 3:

List all the required files for **msl12** processing. You may have to provide a few slightly different lists, each dependent on a different processing situation. The first list may be headed "*Files required for default* **msl12** *processing*". Email us the answer.

msl12 - command line

If you have a large number of repetitive L2 processing tasks to perform, there is no need to use the GUI interface. It may be more efficient to produce parameter files then run **msl12** from the command line.

- Copy the **test1.par** file to **test2.par**, changing the output file name to say **test2.L2**. Save and close the ".par" file.
- At the LINUX prompt type **msl12 par=test2.par**. This command passes the information contained in the parameter file just created to the **msl12** process. You will see the same processing information displayed in the terminal as you did previously.
- When the processing is complete, check to see the output L2 file was produced.

When you are learning about SeaDAS and exploring different processing options, using the GUI may help you in preparing ".par" files. Eventually it may be quicker to create ".par" files "from scratch" with an editor.

If you have a large number of input files, all to be processed to L2, all with the same processing parameters, you will notice each ".par" file is very similar, the only differences being the names of the input and output file names. It is a simple matter to create a script which reads the list of input file names and creates all the required ".par" files. The section "Batch processing scripts" below provides examples of this.

climatology vs NRT data

You will have noticed in the **SEADAS SeaWiFS L2 File Generating Program** widget two files listed, the **First MET file** and **First OZONE**

file. If you did not notice these you may need to open the widget again and find them (The names of these files should have been submitted as part of your answer to exercise 3).

You have learnt that atmospheric conditions must be taken into account when processing remotely sensed data. In the absence of any specific knowledge about actual climatic conditions, one may estimate the local conditions based on experience (and a long time series of observations). The two files **CLIMATOLOGY.MET** and **CLIMATOLOGY.OZONE** provide just such information.

SeaDAS allows the user to specify Near Real Time (NRT) data as input to the **msl12** processing in place of the CLIMATOLOGY data.

The NRT ".met" files are named syyyydddhh_ncep.met where "s" stands for SeaWiFS, "yyyy" is the year, "ddd" is the day, and "hh" is hours, being either 00, 06, 12 or 18.

The NRT ".ozone" files are named syyyydddhh_eptoms.ozone or syyyyddtttttttt_tovs.ozone where "s" stands for SeaWiFS, "yyyy" is the year, "ddd" is the day, "hh" is the hour and "ttttttt" is the time. Only one ".ozone" file is available from each sensor per day.

- Look in the **MET** and **OZONE** directorys to see the database of NRT data files.
- Open the **msl12** help page. Read the sections on **Additional required input data files** carefully.

Exercise 4:

Create (copy the previous ".par" file and edit it) a ".par" file to use three ancillary NRT MET files and the CLIMATOLOGY.OZONE file. Specify only four L2 products. Change the L2 output file name then run the **msl12** process. When you have it working, email the ".par" file to us.

flags and masks

You will have seen one of the L2 products listed as "l2_flags". There are 24 "l2_flags" listed in the **msl12** help page. Flags may be used to alert the user to the presence of possibly poor data, based on predefined threshold values or limits.

- Open the **msl12** help page and read the sections on **l2_flags** and Masking keywords.
- Start the **SEADAS SeaWiFS L2 File Generating Program** and observe the default values for the flags.
- Just above the flag values are listed the **L2 mask flags selection** buttons. The default mask buttons are selected. Change the settings of a few of the buttons then save the parameter file. If you have not specified an **ifile** and an **ofile1** you will get an error message.
- Save the parameter file then view it's contents. Note the non-default mask values have been defined explicitly.

Batch processing scripts

I have written a number of Perl scripts. These scripts control the routine processing of SeaWiFS data (I am not a programmer, so don't expect anything too fancy here).

- batch.redoL1A.perl - This will process the L1A data back to L0 then process the L0 data back to L1A. Type **./batch.redoL1A.perl** to see the usage notes.
- batch.extract.perl - This extracts a region from a L1A SeaWiFS pass. Type **./batch.extract.perl** to see the usage notes.
- batch.msl12.perl - This processes SeaWiFS L1A data to L2. Type **./batch.msl12.perl** to see the usage notes.

Black Sea Study

Your task for this workshop will be to process a representative set of SeaWiFS data for the Black Sea, covering a period of at least one year. The most efficient way to do this is to have each group of students responsible for processing a different section of the year, then combine all the data for final analysis.

- Decide what we want to produce at the end of the workshop. What is the AIM? A good idea now is to start planning the final report, which may be submitted as a journal article.
- Select the time period, study region and L2 products.
  - Make a note of starting and ending dates.

  - Make a note of latitude and longitude extent.
  - Make a note of the level 2 products.

- Break the total period into sub-periods, one for each group.
  - Make a note of each groups sub-period.

- Each group must plan how to produce their L2 data.
  - Consider how much time will be required to process each pass. How much time do we have?
  - Decide who will be responsible for each task.
  - Decide which passes to process. Do we process every pass? Do we check to make sure the pass contains the study region? Do we check to make sure the pass is relatively cloud free? Do we process everything then check the data quality later?
  - Prepare a processing schedule. Who will be responsible for checking the processing and when?

- Start processing! We are not scheduled to meet until next week. By the time we meet you are expected to have the bulk of the processing done. Next week we will re-map the data to a standard size and map projection then analyse the time series.