Chapter
22

Satellite Data Products for Marine Ecosystem Studies

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Introduction

Ecosystem modelling studies are important concerning its vital role in determining the primary, secondary and tertiary productivity over the coastal as well as open oceanic domains. Two decades back, major limitation in these studies was the lack of high resolution oceanographic as well as meteorological data. Hence most of the studies were limited in regional scale because of the large scale collection of *in-situ* data sets are highly expensive and tedious. The advent of satellite oceanography during 1990's helps us to reasonably resolve the major limitation concerning the availability of data sets in the global domain. Since then extensive use of satellite oceanographic products were incorporated in the major oceanographic, meteorological as well as ecosystem studies. In the climate change scenario, these data are also being effectively utilised to resolve many issues in the climate related studies. In this tutorial note, we tried to give an insight to some of the major geophysical data products derived from satellite remote sensing techniques that are commonly used in the ecosystem studies and also to familiarise a major data provider named 'Asia Pacific Data Research Centre (APDRC)'. Basic geophysical data products and Tools, Software and Languages commonly used for analysis are listed in Table 1.

Table 1: List of basic satellite data products and Tools/Software/Languages commonly used for analysis.

Basic Geophysical Data Products	Tools/Softwares/Languages
SST SALINITY SLA	FORTRAN C & C++ R
WIND CURRENTS PRECIPITATION	GRAPHER SURFER SNAP
AEROSOL HEAT FLUX	ORIGIN ODV SeaDAS
BIO-OPTICAL PROPERTIES	PYTHON IDL MATLAB FERRET
CHLOROPHYLL-A	GRADS PRIMER
	Arc GIS Q-GIS

Product Levels

In general, satellite data products are processed at varying levels. The National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) defines these levels as ranging from Level 0 to Level 4. Level 0 represents raw data, while Level 4 data have had the greatest amount of processing applied (Source: Ocean Colour Web).

Level 0

Level 0 data are unprocessed instrument/payload data at full resolution. Any artefacts of the communication (e.g. synchronization frames, communication headers) of these data from the spacecraft to the ground station have been removed. These data are the rawest format available, and are only provided for a few of the missions that we support.

Level 1A

Level 1A data are reconstructed, unprocessed instrument data at full resolution, time-referenced and annotated with ancillary information including radiometric and geometric calibration coefficients and georeferencing parameters computed and appended but not applied to the Level 0 data.

Level 1B

Level 1B data are Level 1A data that have had instrument/radiometric calibrations applied.

Level 2

Level 2 data consist of derived geophysical variables at the same resolution as the source Level 1 data. These variables are grouped into a few product suites (e.g. OC [ocean colour], SST, and SST4 for MODIS).

Level 3

Level 3 data are derived geophysical variables that have been aggregated/projected onto a well-defined spatial grid over a well-defined time period. We archive two types of Level 3 data.

Binned

Each Level 3 binned data product consists of the accumulated data for all L2 products in a product suite, for the specified instrument and resolution, corresponding to a period of time (e.g. daily, 8 days, monthly, etc.) and stored in a global, nearly equal-area, integerized sinusoidal grid.

Mapped

The Level 3 Standard Mapped Image (SMI) products are created from the corresponding Level 3 binned products. A colour look-up table is also provided in each file that may be used to generate an image from the data.

Level 4

Level 4 data are model output or results from analyses of lower level data (e.g.,

variables derived from multiple measurements). Ocean Primary Productivity is a good example of a Level 4 product.

Data Access

There are different websites which provide various geophysical data products and that are offered either freely accessible or payment basis. Here we introduce three websites (Figure 1) named as Ocean Colour Web, GIOVANNI both are being maintained by NASA and Asia Pacific Data Research Centre (APDRC) website by International Pacific Research Centre (IPRC). GIOVANNI is an acronym for the Goddard Earth Sciences Data and Information Services Centre (GES-DISC) Interactive Online Visualization ANd aNalysis Infrastructure. The first two are specially dedicated for ocean colour data products and the latter provides all available data products.

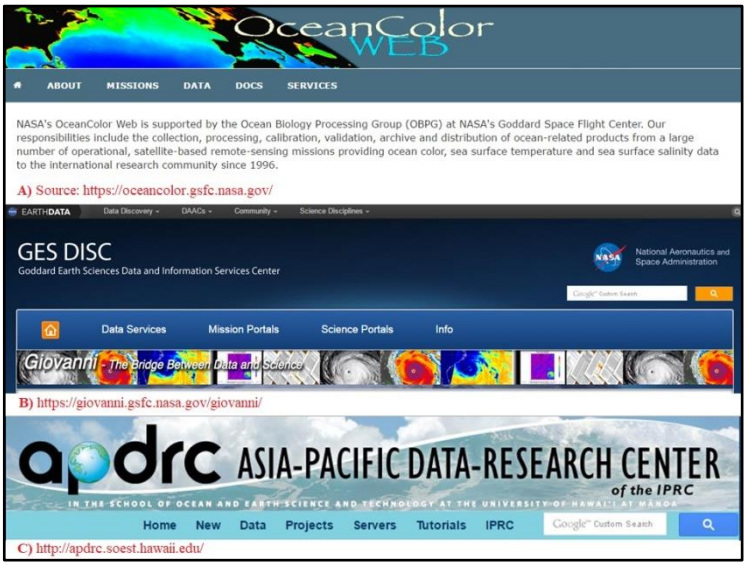

Figure 1: Screen shots of A) Ocean Colour Web B) GIOVANNI and C) APDRC website.

The access of data in different formats and their web based analysis using APDRC website are briefly explained in the following sections. The home page of the website has filters to select the desired data sets for ocean, atmosphere, terrestrial etc. which are shown in the left panel and the available data sets are displayed alphabetically in the right panel according to the selection of filters (Figure 2). We have selected 'Chlorophyll-a' as a representative variable to demonstrate the access and process the data. To access Chlorophyll-a data, filter should be selected as 'All Disciplines' in the sub-section of 'Data'. Then 'Chlorophyll-a' data from MODIS sensor can be seen in the right panel of the

website (Figure 3). There are different options to access the data that can be seen adjacent to the variable name as LAS, LAS8, OPeNDAP etc. Select the LAS option to go for the next step (a new TAB will be opened automatically in this step) where all the available data either in monthly or weekly temporal scale will be displayed (Figure 4A). A single click on desired temporal scale is required to go for next step.

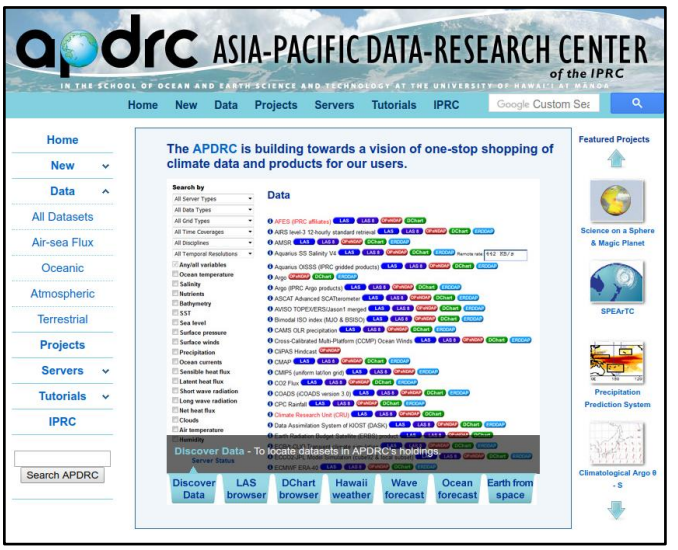

Figure 2. Home page of APDRC website.

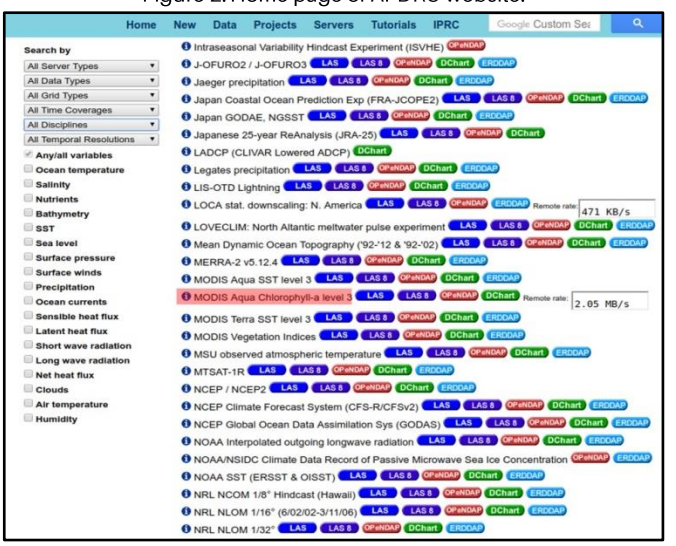

Figure 3. Selection of MODIS Chlorophyll-a data highlighted in red colour.

After the selection of 'monthly/weekly' data, the same window will be redirected

to next step where the available variable names will be shown as in Figure 4B (here it is 'Chlorophyll-a concentration').

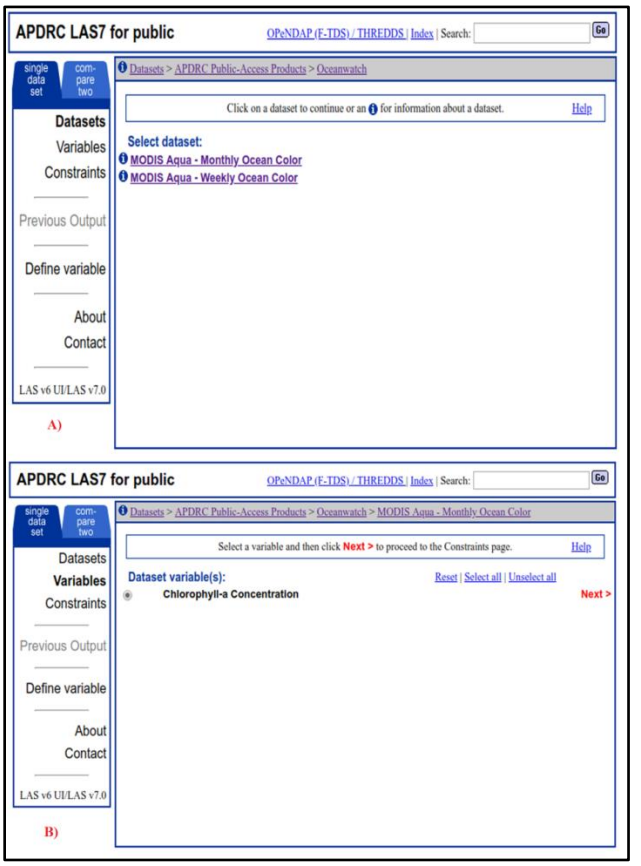

Figure 4. Screen shots of webpage opened in a new TAB where options A) To select Monthly/Weekly data B) To select Chlorophyll-a data.

The user has to click on 'Next' at the right end of the same page as shown in the Figure 4B. Then the page will be redirected to the final step to select the grid and format of the data (Figure 5). The options 'Select view', 'Select output' and 'Select region' (upper side as shown in Figure 5) has to be changed in order to access the data in the desired format. The option 'Select view' may be changed to 'Time-series' or 'Hovmoller diagram' as per the requirement of the user to get long term time series plots and latitude/longitude averaged variability with time. The required period can also be applied in this step. At the end, a final click on 'Next' (Figure 5) is required to generate the map (Figure 6) or data in different format (ASCII or NetCDF) as shown in Figure 7. Here, the user will be redirected

in to a new window with a link to download the data or save the image to the desired directory.

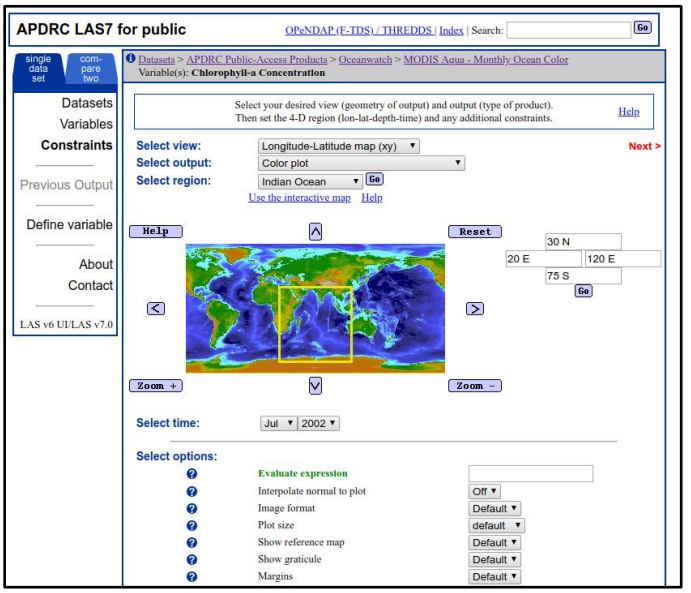

Figure 5. Final step to select grid, format of data, period etc.

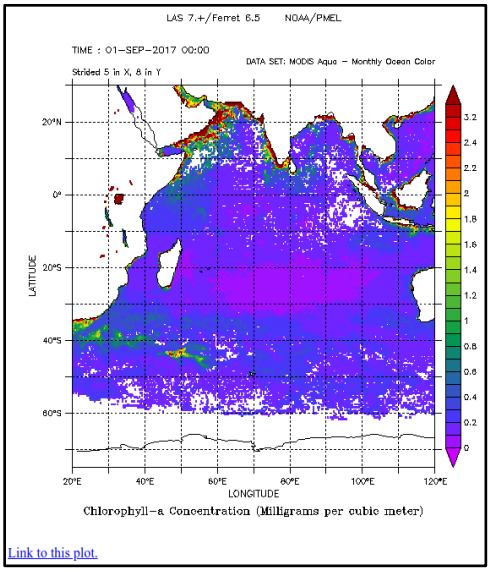

Figure 6. Output data generated as 'map' and link (see left bottom side) to download it as image.

Figure 7. Option to download output data in 'NetCDF' format.

Conclusion

The geo-physical data sets available in open source data bases can be effectively utilised to resolve research problems related to climate change studies. Often we lack long term time series data sets to study climate change related impacts in marine ecosystems. Collection of *in-situ* information is tedious and expensive. Most of the time it is practically impossible to collect such data. In this chapter, we have given an insight to major oceanographic and climate related variables which will facilitate research related to climate change studies.

References

APDRC Website (http://apdrc.soest.hawaii.edu/)
NASA-GIOVANNI (https://giovanni.gsfc.nasa.gov/giovanni/)
NASA- Ocean Colour (https://oceancolor.gsfc.nasa.gov/)