GIOVANNI
Interactive Visualization and Analysis

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Giovanni
Interactive Visualization and Analysis

Invitation

Since artificial satellites first orbited Earth in 1956, scientists, both amateur and professional, have collected and studied the vast amounts of observations made by, and transmitted to us, from those satellites. Most of those data are archived in databases that have only been used by expert investigators trained in the use of specialized retrieval techniques and analysis tools.

More recently, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), among others, have developed new online tools for easy retrieval of archived data in various formats that serve the needs of every level of scientific research including middle and high school grades.

This lesson offering is an introduction to Giovanni, an online, interactive visualization and analysis tool that provides easy access to remotely sensed data from many environmental satellites. It includes a hands-on tutorial allowing learners to experience the value and utility of Giovanni for themselves while becoming familiar with its "look and feel."

Grade Level:	6-12
Time Requirement:	1 class period
Prerequisites:	None
Relevant Disciplines:	All

Student Learning Outcomes

By the end of this lesson, students should be able to do the following:
- Use Giovanni, an online data retrieval tool from NASA
- Access satellite-based remote sensing data from NASA and NOAA archives
- Demonstrate knowledge of how to use Giovanni independently
- Analyze image maps of data retrieved with Giovanni
- Construct explanations for the interpretations
- Assess the value of various graphical displays of data generated with Giovanni
- Communicate findings with others

Lesson Description

Giovanni is a Web application that provides a simple, intuitive way to access, visualize, and analyze vast amounts of Earth science remote sensing data, particularly from satellites, without having to download the data.

This tutorial lesson is intended to supplement existing curriculum in order to add Giovanni to the student's toolbox of data acquisition skills. Learners will read a little

about the Giovanni tool on a NASA Earth Data Web site. Following this tutorial guide, they will access, visualize, and analyze selected data. Then, learners are invited to further explore the available data sets by repeating the process to retrieve data of their own choosing. They will have access to the online Giovanni User Guide from which they will extract source and parameter information related to their selected data and enhance their explanation of the generated imagery. Throughout the tutorial, learners will encounter questions to be answered on a separate answer sheet.

This is a Web based activity that requires computer terminals with Internet access for each student or group of students. It is recommended that no more than two to four students be assigned to a computer at one time.

While no prerequisite is listed for this activity, the tutorial would be much more meaningful if students had a reason for learning how to use Giovanni. Some knowledge of satellite remote sensing and remotely sensed data sets ahead of time would be valuable. For example, learners may want to access and visualize sea surface temperature data in the tropical Pacific Ocean to support a study of the El Niño Southern Oscillation (ENSO) effect.

Important Terms

Analysis	Giovanni	Remote sensor
Data	Gridded map	Time-averaged
Environmental satellite	Level 3	Visualization

Assessment

Summative assessment: correct completion of the answer sheet; determination of whether learners are able to use Giovanni to obtain sufficient data relevant to their own investigations. This is best determined when individual learners are able to complete the Your Turn extension activities on their own. Formative assessments can be made while learners work through the tutorial and the teacher circulates to monitor student-computer and student-student interactions.

Next Generation Science Standards

The Next Generation Science Standards present performance expectations for assessment of learning. Each suggested assessment task bundles together a disciplinary core idea, science and engineering practice, and crosscutting concept to be addressed in the same lesson. The National Research Council (NRC) states that standards must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry. At the same time, they cannot show competence in practices except in the context of specific content. Following that line of reasoning, the NRC identified eight practices of science and engineering that are essential for all students to learn:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data

5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The tutorial guide in this lesson plan is meant to augment curriculum and instruction of other content by providing broader access to specific data that may otherwise not be available to middle and high school students in the course of learning about that other content. Therefore, this lesson plan does not emphasize any specific core content, but rather supports the learning of appropriate practice associated with many core content ideas. Of the eight identified science and engineering practices listed by the NRC, this lesson plan supports the learning and teaching of these specifically:

4. **Analyzing and interpreting data**
6. **Constructing explanations (for science) and designing solutions (for engineering)**
8. **Obtaining, evaluating, and communicating information**

Components of each of these practices can be found in the Next Generation Science Standards at all grade levels K-2, 3-5, 6-8, and 9-12 and are associated with disciplinary core ideas and performance expectations for all subject areas.

Preparation

The teacher is urged to work through the Student Activity pages before distribution to learners. There is an additional trick for changing the appearance of the image maps displayed in Giovanni. It is described in the Answer Key for Question 12. It is left to the teacher's discretion when or if to share this information with learners.

It is recommended that learners work in groups of two to four. An Internet enabled computer is needed for each individual or group. The tutorial guide in the Student Activity pages should be duplicated and distributed one copy per learner group or one to each student. The answer sheet in the Student Activity section should be duplicated and distributed to each student.

The lesson plan document is supplied in portable document format (PDF). An acceptable PDF viewer such Adobe Reader (https://get.adobe.com/reader/) or equivalent is required to read or print the document. The Student Activity pages are also provided in Microsoft Word document (DOCX) format to allow teachers to easily adapt those pages to meet the varying needs of students, curricula, and classroom situations.

Most local computers already have a default image viewer installed which should be sufficient for viewing PNG files downloaded in this lesson. In lieu of the default image viewer or for further exploration of data image viewing and analysis, the following are recommended: ImageJ for viewing and analyzing imagery, MultiSpec for viewing GeoTIFF and NetCDF files, and Google Earth or ArcGIS Online for viewing KMZ files. See the Resources section of these Teaching Notes and the SEA Library's Analysis Toolbox at https://SatEd.org/library/Tools.htm for more information.

All image formats except NetCDF can be downloaded from GIOVANNI without logging

in. However, NetCDF data requires a NASA EarthDATA login. Click the Login button on GIOVANNI's data selection page to login or create an account. Account creation is easily done online and takes only moments.

Background

Throughout this edition of Teaching Notes and the associated Student Activity, software packages for viewing, analyzing qualitatively and quantitatively, and interpreting satellite-based remote sensing data are mentioned in passing. Especially important among these are **ImageJ** from the National Institute of Health, **MultiSpec** from Purdue University, and ESRI's **ArcGIS Online**. They offer significant advantages for middle and high school students: high quality programs, easy-to-use, and available for use without cost. More information about each of these programs as well as an introduction to satellites and remote sensing can be found at https://SatEd.org/satellites.htm.

Giovanni is a NASA acronym that stands for **G**eospatial **I**nteractive **O**nline **V**isualization **AN**d a**N**alysis **I**nfrastructure. Housed at NASA Goddard Space Flight Center, Giovanni is accessed online at: https://giovanni.gsfc.nasa.gov/giovanni/.

Although not required, it may be helpful to look at the Giovanni home page while reading through the following material.
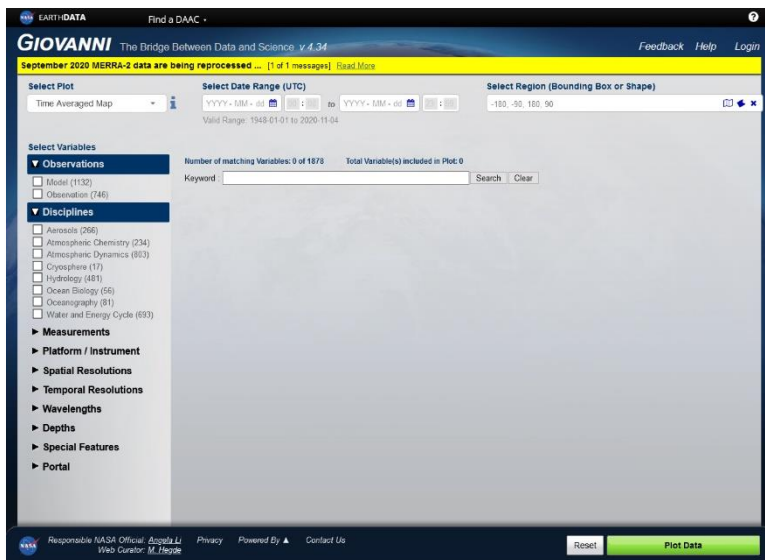
When planning to use Giovanni as a data search and retrieval tool, consideration should be given to the type of data that would most inform the research question; the source of the data including the sensor, its satellite and its years of operation; and the format in which the data can be downloaded.

Type of Data

The type of data depends on the research question or hypothesis under consideration. For example, if the question relates to changes in the atmosphere following significant volcanic activity, the investigator would want to utilize aerosol optical density data rather than sea surface temperature data. Likewise, if the hypothesis relates to coral reef bleaching, the investigator would want to utilize sea surface temperature data as

opposed to data about tropical rainfall over land masses. The list of variables, or data types, available using Giovanni, is extensive and updates regularly. Variables are sorted into categories such as measurement, platform instrument, spatial and temporal resolutions, wavelength and depth. A full list of currently available parameters is found on the Giovanni home page online.

Data Source
The Giovanni User Guide is accessed with the Help link found on the right side above the user interface window. The first section of the User Guide is a Quick Start guide that should be reviewed by those new to GIOVANNI. Here you will see the variable list contains source information including the remote sensor, satellites carrying the sensor, the sensor's dates of operation (and therefore the dates of available data), spectral and spatial resolution, and the processing level of the available products.

Data Format
Data retrieved with Giovanni is presented onscreen processed to Level 3 or 4. As seen from the chart below, K-12 learners will most easily understand Level 3-4 data in their own for analyses.

Data Level	Description
0	Reconstructed, unprocessed instrument and payload data at full resolution, with any and all communications artifacts removed.
1a	Reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with radiometric and geometric calibration coefficients and georeferencing parameters computed and appended but not applied to Level 0 data. Level 0 data are recoverable from 1a data.
1b	Level 1a data that have been processed to sensor units; not all instruments have Level 1b data; Level 0 data are not recoverable from Level 1b data.
2	Derived geophysical variables at the same resolution and location as Level 1 source data.
3	Variables mapped on uniform spacetime grid scales, usually with some completeness and consistency (e. g., missing points interpolated, complete regions composited from multiple orbits, etc.).
4	Model output or results from analyses of lower level data (i. e., variables that were not measured by the instruments but instead are derived from these measurements).

For example, the images below show Chlorophyll-a concentration data processed to Level 3 for the same coastal waters of sub-Sahel Africa at different seasons of 2012, late autumn on the left and late spring on the right. The amount of Chlorophyll-a is an indicator of oxygenic photosynthetic activity in the surface layers of the ocean.
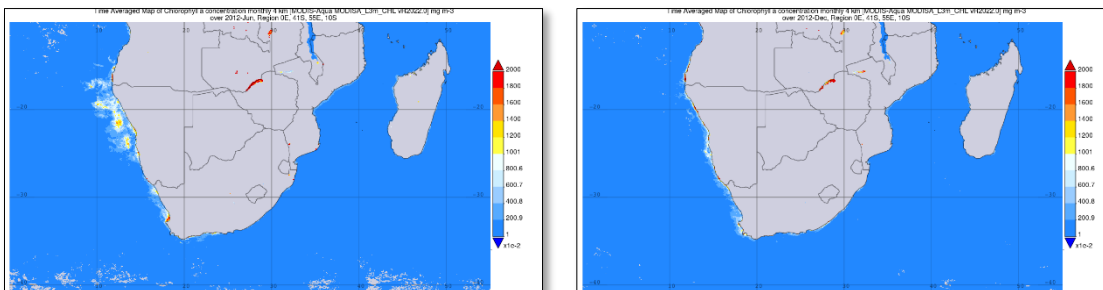
Imagery produced by Giovanni can be downloaded in three different formats:
- **GEOTIFF** – TIFF image file with embedded georeferencing information
- **KMZ** - Zipped (compressed) version of data in Google Earth's Keyhole Markup Language (KML) format
- **PNG** – Portable Network Graphics, a compressed format for ease of transfer on the Internet
- **NetCDF** – Network Common Data Format, a compressed library of related files more useful for research

PNG is a raster graphics file format, a non-patented alternative to GIF with lossless compression that can be displayed in most image viewers. Its compressed nature promotes shorter upload/download times and/or greater amounts of information per pixel. GEOTIFF is tagged image file format (TIFF) in which latitude, longitude, and distance data have been embedded for each pixel. GEOTIFF can be viewed and analyzed in programs that can display georeferencing information including MultiSpec and ImageJ. KML was developed for three-dimensional imaging programs like Google Earth as a means of storing things like placemarks and network link information. Today, many two-dimensional display and analysis programs now incorporate KML capabilities. KMZ (compressed or "zipped" KML) can be opened directly with Google Earth. NetCDF can be opened and analyzed with specialized scientific visualization programs like MultiSpec.

At this point, teachers are invited to experience Giovanni by trying the tutorial in the Student Activity pages for themselves.

Acknowledgements

Except as noted, all of the materials for the data and image generation used in this tutorial are from National Aeronautics and Space Administration's EarthData housed at NASA Goddard Space Flight Center. NASA requests the following statement for

acknowledgement: "Analyses and visualizations used in these lesson materials were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC." The one exception is data image from NASA's Ocean Color Web site. When duplicating or otherwise using any portion of this lesson or its associated materials, full credit to all contributors to the lesson and its associated materials must be included.

Resources

Note: All of these URLs were current and active as of this writing. If any are unreachable as printed, the use of on-line search engines such as DuckDuckGo, Ask, or Google is suggested to find current links.

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_____. "SeaWiFS, Level-4 Mapped, Direct Data Access." Ocean Color Data, NASA EarthData, National Aeronautics and Space Administration. Retrieved June 2024 from https://oceandata.sci.gsfc.nasa.gov/directdataaccess/Level-4%20Mapped/SeaWiFS

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National Research Council. _Next Generation Science Standards: For States, By States,_ Washington, DC: The National Academies Press, 2013. Retrieved June 2024 from https://nap.nationalacademies.org/catalog/18290/next-generation-science-standards-for-states-by-states

Answers to Questions in the Student Activity

1. In which Discipline would you find variables for each of these:
   a. Soil Moisture – Hydrology, Water and Energy Cycle
   b. Sea Surface Temperature – Oceanography
   c. Cloud properties – Atmospheric Dynamics, Hydrology, Water and Energy Cycle
   d. Dust – Aerosols, Atmospheric Chemistry
   e. Snow/Ice – Atmospheric Dynamics, Cryosphere, Hydrology, Oceanography, Water and Energy Cycle

2. Which of the four data formats illustrated above (GEOTIFF, KMZ, PNG, or NetCDF) would you find most helpful in your own investigations? Why do you think so?
   Answers will vary. PNG images are probably most helpful because they are already mapped and color coded with a legend, they are easy to obtain, and can be viewed in almost any image viewer. KMZ formatted data are easiest to use in Google Earth and ArcGIS Online to place the local data in a global context. GEOTIFF will open in any viewer supporting TIF images. They also contain latitude and longitude information for each pixel whereas PNG and KML imagery rely on the viewing program to place the image location. NetCDF require specialized software (such as MultiSpec) to view and requires a NASA EarthDATA login to download.

3. **How are the images alike and how are they different?**
Both cover the same geographic area and have the same color scale. The Chlorophyll-a concentration is greater closer to the west shoreline in June. The concentration is less in December and does not extend as far from shore.

4. **What season of the year is shown in each image?**
In the Southern Hemisphere, June is late autumn/early winter while December is late spring/early summer.

5. **Suggest several environmental factors that could account for the differences.**
Answers will vary. There is a possibility that warmer air and higher sea water temperatures in the late autumn contributed to greater concentrations over wider area. Water currents may also be a factor.

6. **Can Giovanni be used to validate any of those suggestions? If so, how?**
Answers will vary. Generate image maps of sea surface temperatures for same location and times. Compare these data with the Chlorophyll-a concentration data. Also compare June and December for different years.

7. **How many versions of Giovanni are there? Which one was used to acquire the images in this tutorial?**
As of this printing, there were four versions of Giovanni. A version of Giovanni-4.x was used for this tutorial.

8. **Which browser is recommended for using Giovanni? Will another browser work?**
Answers will vary. The Help > Browser Compatibility link on the home page indicates Giovanni is tested in Firefox, Chrome, Safari, Edge, and Internet Explorer on various operating systems. Problems may have been identified with each depending on the choice of platform, operating system, and browser. While it is possible other major browsers, such as Opera or Aloha, will also work with Giovanni, it is best to use only the tested browsers.

9. **Which remote sensors are used for scanning ocean color including Chlorophyll-a? On which satellites are these sensors carried?**
Answers may vary. From the Oceanography-Chlorophyll variable list…
Ocean Color and Temperature Scanner (OCTS) on Advanced Earth Observing Satellite (ADEOS) and Moderate Resolution Imaging Spectroradiometer (MODIS) on the Aqua environmental satellite;

10. **The map image you downloaded was a "time-averaged map." Explain what that means.**
The time-averaged map shows data values for each grid cell within the region of interest averaged over the time range as a map layer. The map can be zoomed and panned.

11. **Does this data range look familiar? Where have you seen it before?**
This range of 0.01 to 20 mg/m^3 was automatically selected by the Ocean Color data processor. This is the same range to which the GIOVANNI image data was set. The change in data range was changed in GIOVANNI not only to make the chlorophyll easier to find, but to make comparison between the GIOVANNI and Ocean Color images easier.

12. **Compare these two images. How are they alike? How are they different?**
Answers will vary. Both images display chlorophyll-a concentration data in an equidistant cylindrical projection. Both images have fairly high resolution and detail although different colors are assigned to various concentrations. The Giovanni image is pre-selected for sub-Sahel Africa and includes a calibrated color scale. The Ocean Color Web image is global. It must be displayed on the screen and zoomed-in to display just the African region of interest. The calibrated color scale is not included with this image; rather it is displayed on Ocean Color's selection page. With extra work, it is possible to save the color scale using screen capture and manipulation with an image processing program. Both color scales show the same units of measurement (mg/m^3). Since the data range was adjusted in GIOVANNI, both images visually indicate similar concentrations of chlorophyll.

13. **Which was easiest to obtain? Why was obtaining this one easier than the other?**
Answers will vary. A likely response is that the Ocean Color Web image was easier to obtain with fewer steps and offered thumbnails of the images from which to preview and select. A different response might extol the benefits of obtaining the image from Giovanni because the resulting image could be downloaded in three different

usable formats and includes a calibrated color scale with the image.

14. **Which do you think might be most useful for your investigations? Why do you think so?**
Answers will vary. The response really depends on the involvement of the learner in, and the topic of, the current investigation. The learner should be encouraged to think ahead to a point of such involvement and attempt to determine whether Giovanni or a different online tool might (1) provide data best suited to the investigation at hand and (2) be easy to use. They should also realize, here, that Giovanni provides access to data that is intended for a much broader audience of researchers than just middle and high school students.

15. **To sum up, Giovanni is an online data search and retrieval tool that allows researchers to more easily retrieve, analyze, and interpret environmental data from satellite-based remote sensors. List at least three important characteristics of Giovanni that make it easy to use in your own investigations.**
Answers will vary. Here are some characteristics of Giovanni. Look for at least three of these in the response.
- All data are processed to Level 3 (error corrected, interpolated or averaged, georeferenced, color coded)
- Lots of data types available
- User defined geographic location
- User defined observation timeframe
- User defined parameters for display
- Several different data download formats catering to many levels of expertise and investigatory need

Giovanni
Interactive Visualization and Analysis

Introduction

Since artificial satellites first orbited Earth in 1956, scientists, both amateur and professional, have collected and studied the vast amounts of observations made by, and transmitted to us, from those satellites. Most of those data are archived in databases that have been used only by expert investigators trained in the use of specialized retrieval techniques and analysis tools.

More recently, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), and United States Geological Survey (USGS) have developed online tools for easy retrieval of archived data in various forms that serve the needs of every level of scientific research including middle and high school grade levels.

This hands-on tutorial guide is an introduction to **Giovanni**, an interactive visualization and analysis tool provided by NASA at the Goddard Earth Science Data Information Services Center (GES DISC). It will provide easy access to remotely sensed data from many environmental satellites. Following the tutorial steps, you will experience the value and utility of Giovanni for yourself while becoming familiar with its "look and feel."

What is Giovanni?

Giovanni is an acronym for **G**eospatial **I**nteractive **O**nline **V**isualization **AN**d **A**nalysis **I**nfrastructure. That's really just a fancy name for an easy-to-use, tool. It is designed to help you search for, and retrieve, specific Earth science data collected from satellite-based remote sensors. This Web-based tool is provided by NASA. Giovanni includes access to data in a number of fields:
- Aerosols
- Atmospheric chemistry
- Atmospheric temperature and moisture
- Rainfall
- and much more...

Some research programs are working to produce accurate and usable models of atmospheric, land surface, and oceanographic processes based on the above data. Many of the modeling products can be accessed with Giovanni as well.

Giovanni - Getting Started

Giovanni is easy to use

⌨ **Ensure your computer is Internet enabled.**

⌨ **Launch your browser. Point the browser to the Giovanni home page at this address: https://giovanni.gsfc.nasa.gov/giovanni/. Click** Continue with limited Access**.**
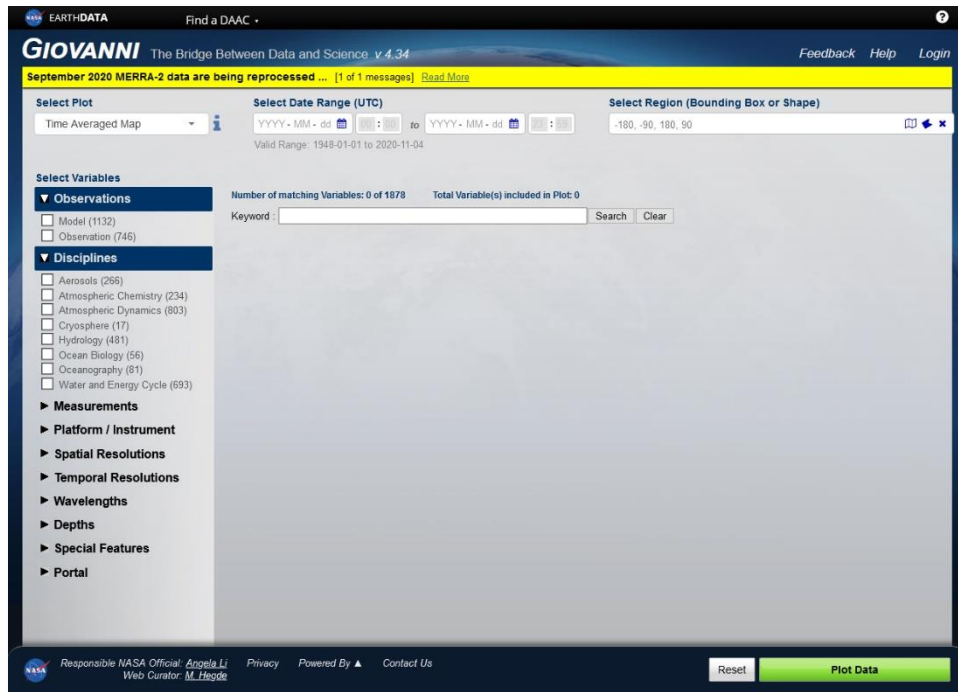
The available variable (data type) categories are listed on the left:

▶ Observations
▶ Disciplines
▶ Measurements
▶ Platform / Instrument
▶ Spatial Resolutions
▶ Temporal Resolutions
▶ Wavelengths
▶ Depths
▶ Special Functions
▶ Portal

Cataloging the variables this way demonstrates there are many ways to sort and find the particular data set you need. Let's explore the Disciplines list.

⌨ **Ensure the** Disciplines **and** Measurements **lists are expanded. If necessary,** click the expansion arrow **of each to expand each list.**

🖥 Click the check box for various portals in Disciplines (one at a time) **to see the data types available. Notice when the name of a data portal is checked in the Disciplines list, the Measurement list changes to reflect the data available for that Discipline.**

1. *In which Discipline would you find data for each of these measurements:*
   a. *Soil Moisture –*
   b. *Sea Surface Temperature –*
   c. *Cloud Properties -*
   d. *Dust -*
   e. *Snow/Ice -*

Accessing Data

Let's try a simple example. Suppose you are interested in the amount of phytoplankton (microscopic plants, mostly algae) in the upper layers of ocean water. Perhaps you would like to know if the amount of plankton changes seasonally. Since phytoplankton is at the base of the food web and produces most of our oxygen, the amount of green algae in the ocean can be an indicator of the amount of larger species present in the area and of the health of the ocean in general. Satellite-based remote sensors can scan for the particular wavelengths of light reflected by Chlorophyll-a in the green algae. You will be looking for Chlorophyll-a data from the year 2012.

🖥 **Check the** Oceanography **in the Disciplines list. Then check** Chlorophyll **in the Measurements list.**

🖥 **In the resulting list displayed in the middle of the screen, check** Chlorophyll-a concentration – MODIS-Aqua – Monthly**.**

	Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
☐	Chlorophyll a Concentration (OCTS_L3m_CHL v2014)	mg m-3	OCTS	Monthly	9 km	1996-11-01	1997-06-30
☐	Concentration of Particulate Organic Carbon (OCTS_L3m_POC v2014)	mg m-3	OCTS	Monthly	9 km	1996-11-01	1997-06-30
☑	Chlorophyll a concentration (MODISA_L3m_CHL vR2022.0)	mg m-3	MODIS-Aqua	Monthly	4 km	2002-07-04	2023-04-30
☐	Chlorophyll a concentration (MODISA_L3m_CHL_8d_4km vR2022.0)	mg m-3	MODIS-Aqua	8-Daily	4 km	2002-07-04	2023-04-30

Before requesting a visualization, each of the following output properties must be set in the Giovanni interface (in the area above variable selection):
- Plot type
- Date Range for the data
- Region bounding box (latitudes & longitudes)

The resulting visualization will produce a Level 3 colored map with a color-keyed measurement legend. Level 3 data are preprocessed to average over time and interpolate some missing data. The data are also georeferenced so they can be displayed easily as a map gridded with latitude and longitude. Follow these steps:

   ⌨ **In the** Select Plot **section, use the** Maps **drop-down arrow to select** Time Averaged Map**.**

   ⌨ **In the** Select Date Range **section, use the** calendar icon **to select a start date: year –** 2012**; month --** 06-Jun**. Then select the same for end date. The date range should now read** *2012-06-01 to 2012-06-30*. Close **the calendar pop-up.**

   ⌨ **In the** Select Region **section, you will type in the longitudes and latitudes bounding the area of interest. The region of interest includes the ocean areas nearest sub-Saharan Africa. This region is bounded by 0˚ longitude on the west, -10˚ latitude on the north, 55˚ longitude on the east, and -40˚ latitude on the south. Type** 00, -40, 55, -10**.**

Select Plot	Select Date Range (UTC)	Select Region (Bounding Box or Shape)
Time Averaged Map ▾ ℹ	2012 - 06 - 01 📅 00 : 00 *to* 2012 - 06 - 30 📅 23 : 59	0,-40,55,-10 📖 ← ✕
Guest limit: **4 time steps**	Valid Range: 2002-07-04 to 2022-02-28	

   ⌨ **Click the big green** Plot Data **button in the bottom right corner of the screen.**

A screen will appear showing a progress bar. The processing speed depends on how busy the server is and where your request falls in the queue. Shortly, the progress bar will disappear and the image will be displayed.
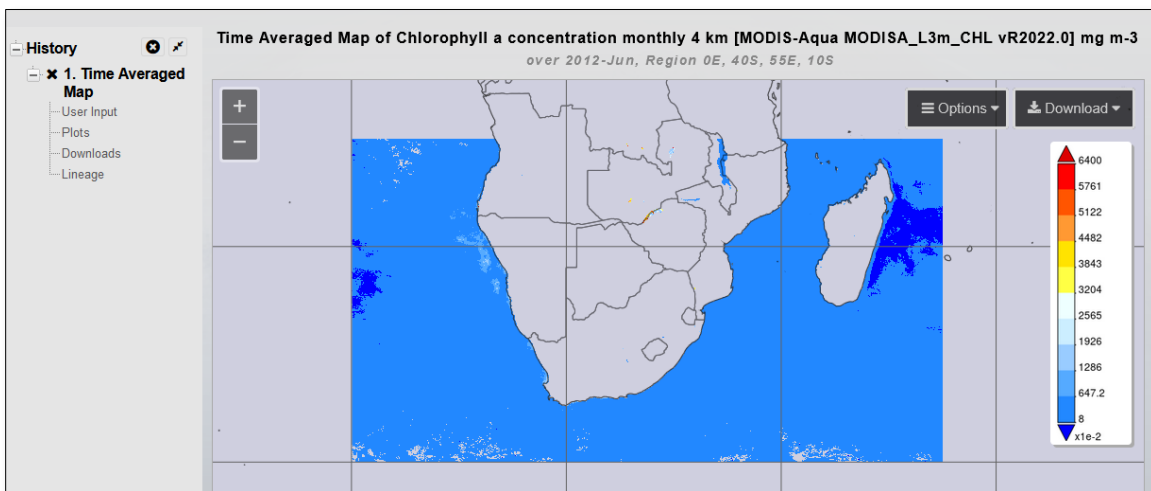
Adjusting the Color Palette

Looking at the above image, it is apparent that noteworthy chlorophyll concentrations are color-coded with shades of blue only. It is difficult to distinguish chlorophyll from ocean water. Adjusting the color palette might be helpful in more clearly defining the chlorophyll areas of the map.

   ⌨ **In the image window, click the** drop down **arrow for** Options**.**

   ⌨ **In the Options dialogue, click the** gear symbol **next to Options.**

⌨ **In the Map Options dialogue, change the** Data Range **to** Minimum 0.01 **and** Maximum 20**.**

⌨ **Click** Re-Plot**.**

The reason for selecting this particular data range will become clear shortly.

Downloading Data

⌨ **In the upper right corner of the image window, click the** Download drop down **arrow.**

Notice the data are available in GEOTIFF, KMZ, PNG, and NetCDF formats. Right now, you are most interested in the PNG image file. The PNG format is commonly used for Internet graphics because this type of compression results in smaller files that are easy to transfer.

⌨ **From the Download options, select** PNG**.**

⌨ **From the pop-up,** note the file name**. Then click** Save File**. The image file will download to your local computer's default download folder.**

⌨ **Click the** Back to Data Selection **button in the bottom right corner of the screen.**

Congratulations! You have successfully used Giovanni to find and download your data. Now, try it on your own. Retrieve chlorophyll concentration for Dec. 2012.

⌨ **Use Giovanni to find and save image data showing** Chlorophyll-a concentration **in an area bounded by** 0˚ on the west, -40˚ on the south, 55˚on the east, **and** -10˚ on the north **around sub-Saharan Africa from** December 1, 2012 **through** December 31, 2012**. Don't forget to change the Data Range for the color palette.**

⌨ **When finished, be sure to go** Back to Data Selection**, and** Reset**.**

⌨ **If you logged in,** Logout**. Then exit GIOVANNI by** closing your browser**.**

Viewing the Downloaded Data

You have seen examples of PNG images generated by the Giovanni tool. The PNG images can be viewed in most image viewers. Many prefer ImageJ as it allows relatively complete image processing and analysis to aid interpretation. Image data can also be downloaded from Giovanni in other formats. Here is an example of the same chlorophyll-a data in each of those formats.


KMZ - *Keyhole Markup Language (Zipped)*
This is a KML file compressed (zipped) to reduce file size for transport. KML is Google Earth's language for adding placemarks and other map related information. This KMZ was opened directly in **Google Earth.** The color legend is included in the displayed image.
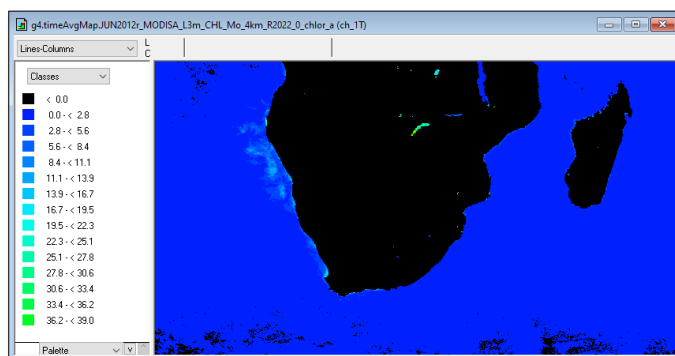

GEOTIFF
This is a tagged image file format (TIFF or TIF) to which latitude and longitude has been added for each pixel. This file was opened directly in **MultiSpec** and a color palette added. The cursor position, (the numbers above the image) is shown as latitude and longitude.
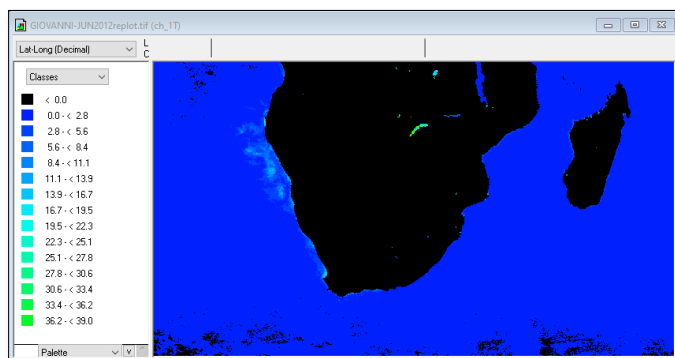
NetCDF
A Network Common Data Format file (NetCDF) is a library of related data. The library can be opened and the data visualized in **MultiSpec** with the same color palette added. Notice, the data pixels are not georeferenced yet. NASA EarthDATA login is required to save a NetCDF file.

2. *Which of the four data formats illustrated above (GEOTIFF, KMZ, PNG, or NetCDF) would you find most helpful in your own investigations? Why do you think so?*

⌨ **Open both Chlorophyll-a images in your computer's default image viewer. Arrange them on the screen for side-by-side examination and comparison.**
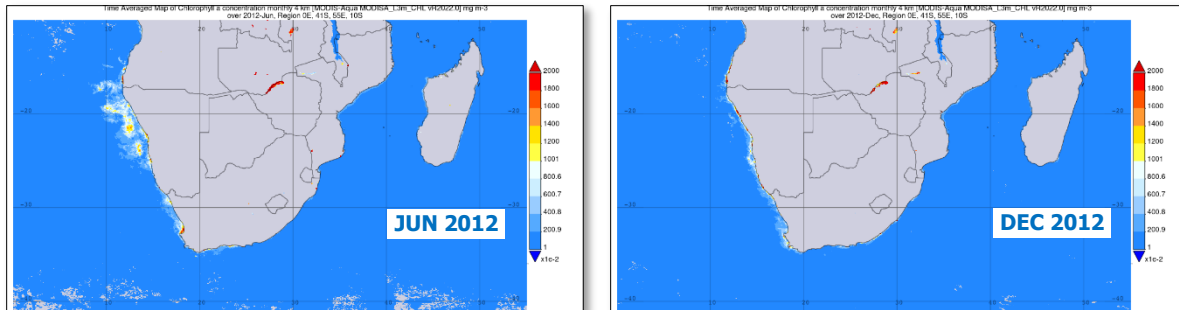
3. How are the images alike and how are they different?

4. What season of the year is shown in each image?

5. Suggest several environmental factors that could account for the differences.

6. Can Giovanni be used to validate any of those suggestions? If so, how?

⌨ Close **your image viewer.**

The Giovanni User Guide

As you use Giovanni you may find disciplines, measurements, instruments, and resolutions confusing. Giovanni has an online user manual with complete information about each step of the data selection process.

⌨ **Return to the Giovanni selection page. Click the** Help **button at the top right of the screen and select** User Guide**.**

Look through the online User Guide to find answers to the following questions.

7. How many versions of Giovanni are there? Which one was used to acquire the images in this tutorial?

8. Which browser is recommended for using Giovanni? Will another browser work?

9. Which remote sensors are used for scanning ocean color including Chlorophyll-a? On which satellites are these sensors carried?

10. The map image you downloaded was "**time-averaged map**." Explain what that means.

⌨ Close **the Giovanni User Guide window.**

⌨ **If logged in, be sure to** logout. **Exit GIOVANNI by** closing your browser**.**

Is Giovanni the Only Way?

When using Giovanni, there are two more points to remember:

(1) Some database home pages provide direct access to Giovanni in order to retrieve data.
(2) Some database home pages provide their own data retrieval tools instead of Giovanni, and some of those other online tools duplicate the Giovanni search and retrieval actions.

Do not be confused by the fact that Giovanni is only <u>one of many</u> data access tools available online. A quick example might be helpful here. Again, you will search for a MPODIS-Aqua, Level 3 data image of chlorophyll-a around sub-Sahel Africa during June (early autumn) of 2012.

⌨ **Point your browser to** https://oceancolor.gsfc.nasa.gov/**; the Ocean Color section of NASA EarthData appears.**

⌨ **From the menu bar, click** Data**, and select** Find Data**.**

⌨ **On the resulting page, look down the page to find and click** Level-3 & 4 Browser**.**

⌨ **In the Level-3 Browser, ensure these filters are set.**
  ✓ **Product Status:** Standard
  ✓ **Sensor:** Aqua-MODIS
  ✓ **Product:** Chlorophyll concentration
  ✓ **Period:** Monthly
  ✓ **Resolution:** 4km
  ✓ **Start Date:** 2012-06-01
  ✓ **End Date:** 2012-06-30

Product Status	Instrument	Product	Period	Resolution
Standard ∨	Aqua-MODIS ∨	Chlorophyll concentration ∨	Monthly ∨	4km ∨
Start Date	2012-06-01	**End Date** 2012-06-30		

⌨ **Make note of the data range shown in the color palette.**

Chlorophyll Concentration, OCI Algorithm (mg m^{-3})

0.01 0.02   0.05   0.1   0.2   0.5   1   2   5   10   20
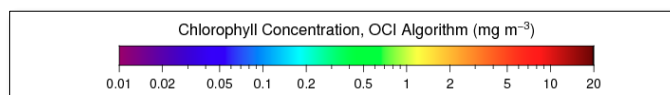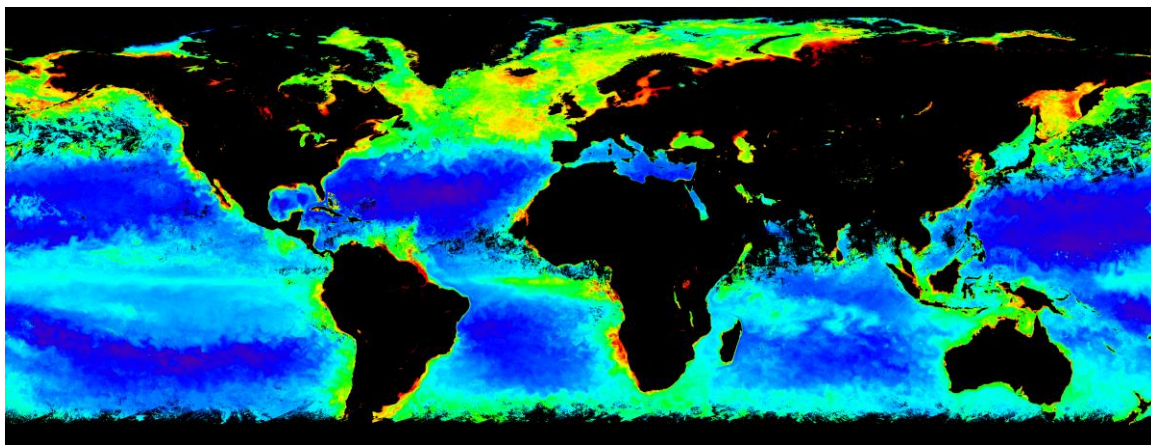
11. Does this data range look familiar? Where have you seen it before?

⌨ **Scroll down slightly to see the year buttons. Click** 2012**.**

⌨ <u>**Above the year buttons**</u>**, click the thumbnail for** June 2012 **to display the image.**

The image is displayed.

⌨ Right-click **or** CTRL-click **the image, select** Save Image as**, navigate to this lesson's data folder, and click** OK**.**

Remember where you saved that image. You will come back to it in a moment.

⌨ Close **your browser.**

Now, for comparison purposes only…

⌨ Open **both the Ocean Color Web image and the Giovanni image of chlorophyll-a for June 2012 in ImageJ or another image viewer. Arrange the two image windows on the screen so you can see both at the same time.**

12. *Compare these two images. How are they alike? How are they different?*

13. *Which was easiest to obtain? Why was obtaining this one easier than the other?*

14. *Which do you think might be most useful for your investigations? Why do you think so?*

⌨ **Close your image viewer.**

15. *To sum up, Giovanni is an online data search and retrieval tool that allows researchers to more easily retrieve, analyze, and interpret environmental data from satellite-based remote sensors. List at least three important characteristics of Giovanni that make it easy to use in your own investigations.*

Your Turn

↓ Determine how to find sea surface temperature data (MODIS-Aqua, 4 km spatial resolution, 11-micron daytime data). Download a map image for the same two time-frames and locations as the ocean color data you found with this tutorial. Examine, compare, and contrast the two sea surface temperature images with each other and with the Chlorophyll-a concentration images. Do they appear to relate in any way to the Chlorophyll-a concentration images? Describe how they appear related. How does this relationship explain the seasonal differences in Chlorophyll-a concentration?

↓ Select any data parameter of interest to you. This time be sure to set the Begin Date and the End Date at least 24 months apart (for example, January 2011 to December 2012). This time, in the Select Visualization section, use the drop-down arrow to change *Time-Averaged Map* to *Animation*. When the visualization has been generated, play the animation several times. How does animating the monthly images help you understand the way the parameter changes over time?

↓ Devise a plan to investigate a possible relationship between sea surface temperature and Chlorophyll-a concentration related to local fishing - sport fishing or commercial – in a location of your choice. Have the plan approved by your teacher. Carry out your investigation using Giovanni. Communicate your findings to your class or other audience in a manner pre-approved by your teacher.

↓ Are you currently investigating something in your class that can be aided by using Giovanni? If so, what is it? How will you use Giovanni now?

Giovanni
Answer Sheet

1. In which Discipline would you find data for each of these measurements:
   a. Soil moisture -

   b. Sea surface temperature-

   c. Cloud properties -

   d. Dust -

   e. Snow/Ice -

2. Which of the three data formats illustrated above (GEOTIFF, KMZ, or PNG) would you find most helpful in your own investigations? Why do you think so?

3. How are the images alike and how are they different?

4. What season of the year is shown in each image?

5. Suggest several environmental factors that could account for the differences.

6. Can Giovanni be used to validate any of those suggestions? If so, how?

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11. Does this data range look familiar? Where have you seen it before?

12. Compare these two images. How are they alike? How are they different?

13. Which was easiest to obtain? Why was obtaining this one easier than the other?

14. Which do you think might be most useful for your investigations? Why do you think so?

15. To sum up, Giovanni is an online data search and retrieval tool that allows researchers to more easily retrieve, analyze, and interpret environmental data from satellite-based remote sensors. List at least three important characteristics of Giovanni that make it easy to use in your own investigations.