

Credit: TROPOMI, ESA, Copernicus, KNMI



Time Series Analysis and Mapping of Aerosol Data

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Application of Satellite Observations for Air Quality and Health Exposure, Oct 9 and 11, 2019

Learning Objectives

By the end of this exercise, you will be:

- familiar with the online visualization and access tool, Giovanni
- able create several types of plots for analysis and edit them as needed
- able to download the created plots, as well as the data plotted

NASA Giovanni - The Bridge Between Data and Science

Online Visualization and Analysis Tool - <http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot displays the NASA Giovanni web interface. At the top, it features the NASA logo, 'EARTHDATA', and a search bar for 'Find a DAAC'. The main header includes the 'GIOVANNI' logo, the tagline 'The Bridge Between Data and Science v 4.31', and links for 'Feedback', 'Help', and 'Log out (melanie_cook)'. A yellow notification bar states 'Giovanni login problem has been fixed ... [1 of 1 messages] Read More'. Below this, the 'Select Plot' section offers options: 'Maps: Time Averaged Map *', 'Comparisons: Select...', 'Time Series: Select...', 'Vertical: Select...', and 'Miscellaneous: Select...'. The 'Select Date Range (UTC)' section includes input fields for 'YYYY-MM-DD.' and 'HH:mm', with a 'Valid Range: 1948-01-01 to 2019-09-18' note. The 'Select Region (Bounding Box or Shape)' section has a text input field and a 'Format: West, South, East, North' label. The 'Select Variables' section is divided into 'Observations' (with checkboxes for 'model (1432)' and 'observation (575)') and 'Disciplines' (with checkboxes for 'Aerosols (188)', 'Atmospheric Chemistry (76)', 'Atmospheric Dynamics (424)', 'Cryosphere (13)', 'Hydrology (1209)', 'Ocean Biology (59)', 'Oceanography (62)', and 'Water and Energy Cycle (1272)'). It also includes expandable sections for 'Measurements', 'Platform / Instrument', and 'Spatial Resolutions'. A search bar with 'Keyword:' and 'Search'/'Clear' buttons is present. At the bottom, there are links for 'Responsible NASA Official: Angela Li' and 'Web Curator: M. Hegde', along with 'Privacy', 'Powered By', and 'Contact Us' links. A 'Reset' button and a large green 'Plot Data' button are at the bottom right.



Visit <https://urs.earthdata.nasa.gov/users/new>



EARTHDATA LOGIN

Register for an Earthdata Login Profile

Profile Information

Username: •

Password: •

Password Confirmation: •

• Required field

Username must:

- Be a Minimum of 4 characters
- Be a Maximum of 30 characters
- Use letters, numbers, periods and underscores
- Not contain any blank spaces
- Not begin, end or contain two consecutive special characters(. _)

Password must contain:

- Minimum of 8 characters
- One Uppercase letter
- One Lowercase letter
- One Number



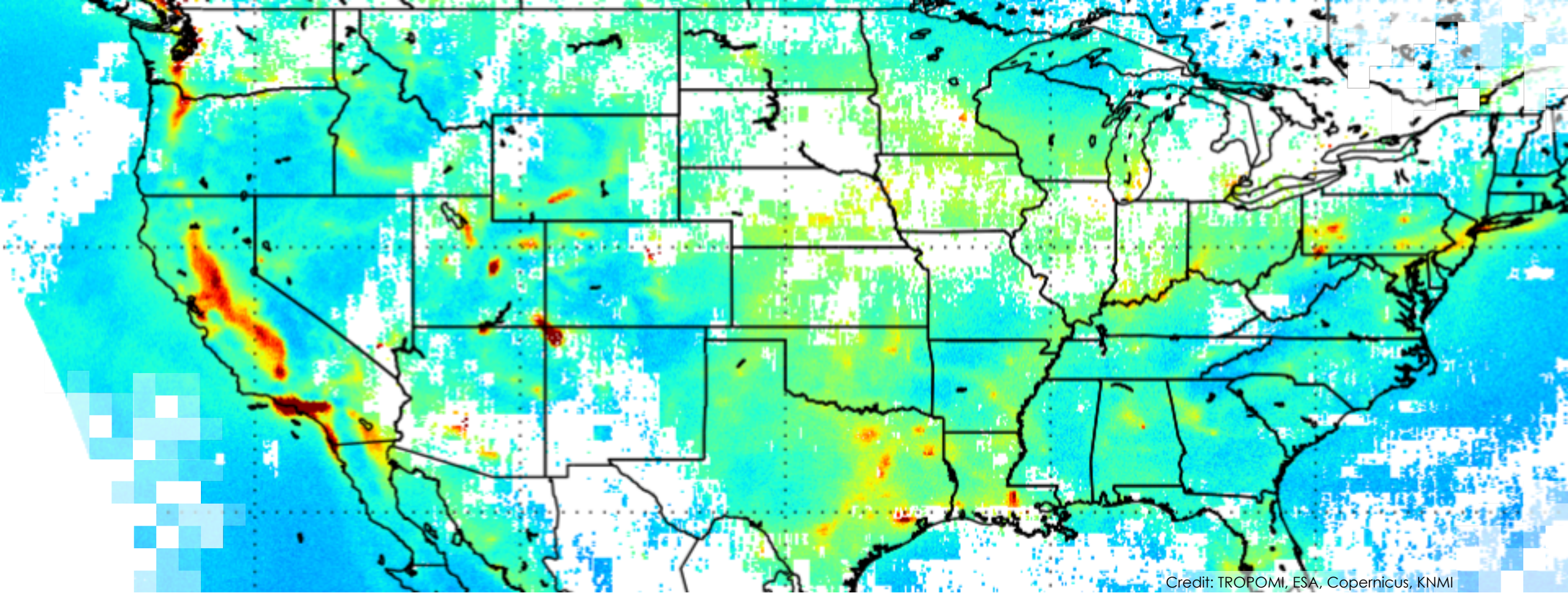
NASA Giovanni - The Bridge Between Data and Science

Online Visualization and Analysis Tool - <http://giovanni.gsfc.nasa.gov/giovanni/>

The screenshot shows the NASA Giovanni web interface. At the top, it says "NASA EARTHDATA" and "Find a DAAC". The main header is "GIOVANNI The Bridge Between Data and Science v 4.31" with links for "Feedback", "Help", and "Log out (melanie_cook)". A yellow banner indicates a "Giovanni login problem has been fixed ...". Below this, there are sections for "Select Plot" (with "Maps: Time Averaged Map" selected), "Select Date Range (UTC)" (with a date range of "00:00" to "23:59"), and "Select Region (Bounding Box or Shape)". A "Select Variables" section is visible on the left, with "Observations" and "Disciplines" expanded. The "Disciplines" list includes Aerosols (188), Atmospheric Chemistry (76), Atmospheric Dynamics (424), Cryosphere (13), Hydrology (1209), Ocean Biology (59), Oceanography (62), and Water and Energy Cycle (1272). The "Measurements", "Platform / Instrument", and "Spatial Resolutions" sections are collapsed. The bottom of the interface shows "Responsible NASA Official: Angela Li" and "Web Curator: M. Hegde", along with "Privacy", "Powered By", and "Contact Us" links. A "Reset" button and a "Plot Data" button are also visible.

Using Giovanni, a user can create:

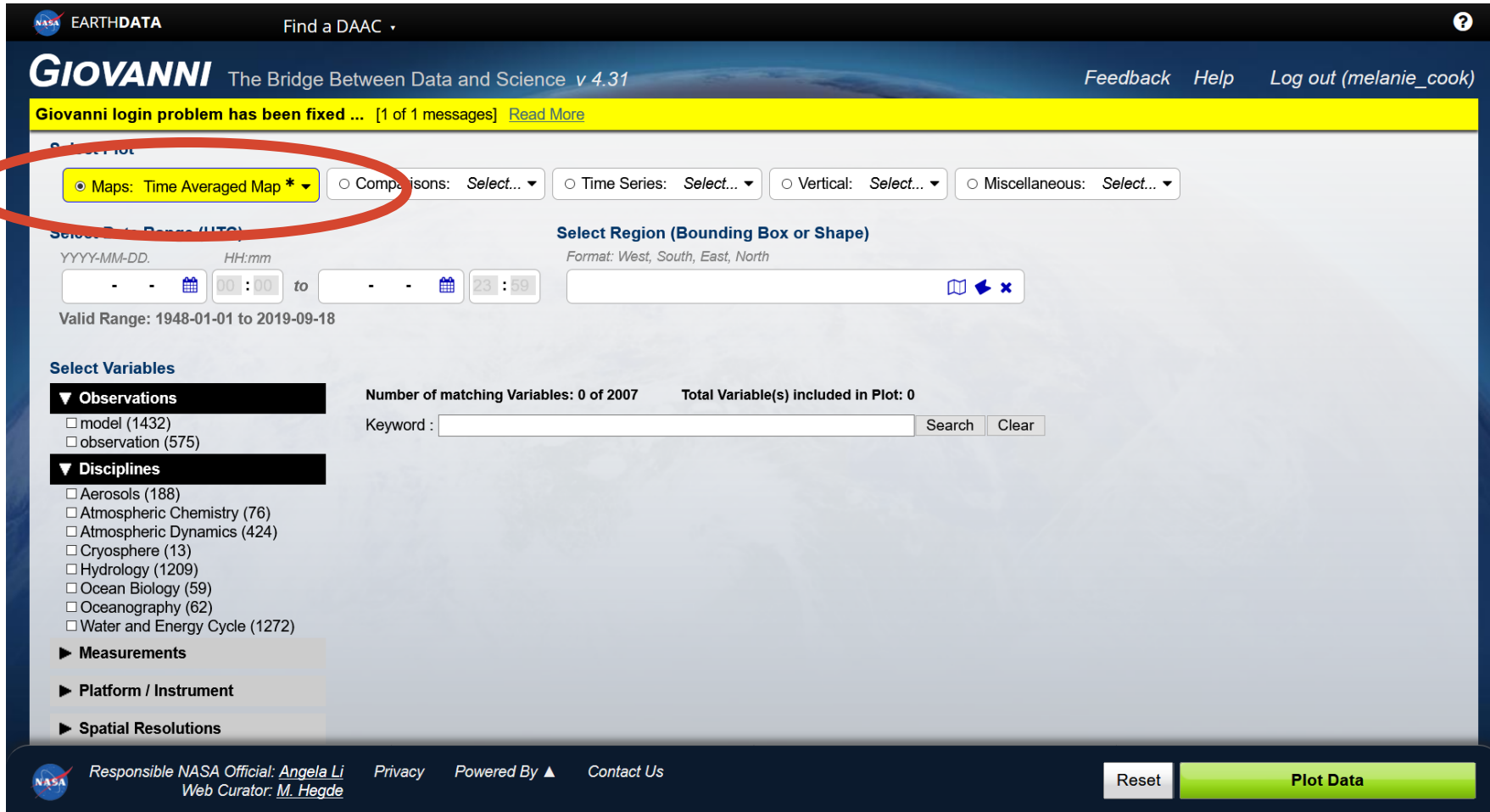
- Time averaged maps
- Compare two different datasets
- Time series
- Vertical profiles
- Histograms



Mapping

Time Averaged Maps: Step 1

- Under **Select Plot**, go to **Maps** and select **Time Averaged Map**



The screenshot displays the NASA Giovanni web interface. At the top, the header includes the NASA logo, 'EARTHDATA', and 'Find a DAAC'. The main title is 'GIOVANNI The Bridge Between Data and Science v 4.31'. A yellow banner at the top contains a message: 'Giovanni login problem has been fixed ... [1 of 1 messages] Read More'. Below this, the 'Select Plot' section is highlighted with a red circle. It features a dropdown menu currently set to 'Maps: Time Averaged Map *', along with other options: 'Comparisons: Select...', 'Time Series: Select...', 'Vertical: Select...', and 'Miscellaneous: Select...'. Below the plot selection, there are fields for 'Select Start Range (UTC)' and 'Select Region (Bounding Box or Shape)'. The 'Select Variables' section is expanded, showing 'Observations' (model (1432), observation (575)) and 'Disciplines' (Aerosols (188), Atmospheric Chemistry (76), Atmospheric Dynamics (424), Cryosphere (13), Hydrology (1209), Ocean Biology (59), Oceanography (62), Water and Energy Cycle (1272)). Other sections include 'Measurements', 'Platform / Instrument', and 'Spatial Resolutions'. At the bottom, there is a 'Reset' button and a green 'Plot Data' button. The footer contains the NASA logo, 'Responsible NASA Official: Angela Li', 'Web Curator: M. Hegde', 'Privacy', 'Powered By', and 'Contact Us'.

Time Averaged Maps: Step 2

- Select **Measurement** → Aerosol Optical Depth
- **Platform/Instrument** → MODIS-Aqua

The screenshot shows the GIOVANNI web interface. On the left, there are navigation menus for Observations, Disciplines, Measurements, and Platform / Instrument. The Measurements menu is expanded, showing 'Aerosol Optical Depth (8)' selected. The Platform / Instrument menu is also expanded, showing 'MODIS-Aqua' selected. The main area displays a search results table with columns for Variable, Units, Source, Temp.Res., Spat.Res., Begin Date, and End Date. The table lists several aerosol-related variables from MODIS-Aqua.

Number of matching Variables: 8 of 2007 **Total Variable(s) included in Plot: 0**

Please select at least 1 variable

Keyword : Search Clear

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/> Aerosol angstrom exponent (MODIS_L3m_RRS_8d_4km v2018)	-	MODIS-Aqua	8-Daily	4 km	2002-07-04	2019-07-27
<input type="checkbox"/> Aerosol optical thickness at 869 nm (MODIS_L3m_RRS_8d_4km v2018)	-	MODIS-Aqua	8-Daily	4 km	2002-07-04	2019-07-27
<input type="checkbox"/> Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/> Aerosol Optical Depth 550 nm (Deep Blue, Land-only) (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/> Aerosol Optical Depth 550 nm (Dark Target) (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/> Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean of Daily Mean (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31
<input type="checkbox"/> Aerosol Optical Depth 550 nm (Deep Blue, Land-only) (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31
<input type="checkbox"/> Aerosol Optical Thickness at 0.55 microns for both Ocean (best) and Land (corrected): Mean of Daily Mean (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31

Reset Plot Data



Time Averaged Maps: Step 3

- Select **Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean (MYD08_D3 v6.1)** (This is a daily value)

EARTHDATA Find a DAAC ?

GIOVANNI The Bridge Between Data and Science v 4.31 Feedback Help Log out (melanie_cook)

Number of matching Variables: 8 of 2007 Total Variable(s) included in Plot: 1

Keyword: Search Clear

	Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date	End Date
<input type="checkbox"/>	Aerosol angstrom exponent (MODIS_L3m_RRS_8d_4km v2018)	-	MODIS-Aqua	8-Daily	4 km	2002-07-04	2019-07-27
<input type="checkbox"/>	Aerosol optical thickness at 869 nm (MODIS_L3m_RRS_8d_4km v2018)	-	MODIS-Aqua	8-Daily	4 km	2002-07-04	2019-07-27
<input checked="" type="checkbox"/>	Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/>	Aerosol Optical Depth 550 nm (Deep Blue, Land-only) (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/>	Aerosol Optical Depth 550 nm (Dark Target) (MYD08_D3 v6.1)	-	MODIS-Aqua	Daily	1 °	2002-07-04	2019-09-16
<input type="checkbox"/>	Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean of Daily Mean (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31
<input type="checkbox"/>	Aerosol Optical Depth 550 nm (Deep Blue, Land-only) (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31
<input type="checkbox"/>	Aerosol Optical Thickness at 0.55 microns for both Ocean (best) and Land (corrected): Mean of Daily Mean (MYD08_M3 v6.1)	-	MODIS-Aqua	Monthly	1 °	2002-07-01	2019-08-31

Observations

- observation (8)

Disciplines

- Aerosols (8)
- Atmospheric Chemistry (5)
- Atmospheric Dynamics (2)
- Ocean Biology (2)
- Oceanography (2)

Measurements

- Aerosol Index (2)
- Aerosol Optical Depth (8)
- Angstrom Exponent (4)
- Atmospheric Moisture (10)
- Chlorophyll (8)
- Cloud Fraction (6)
- Cloud Properties (28)
- Energy (4)
- Organic Carbon (4)
- Particulate Matter (5)
- Phytoplankton (5)
- Radiation, Net (2)
- Reflectivity (21)
- Scattering Angle (2)
- Sea Surface Temperature (6)
- Surface Temperature (8)
- Total Aerosol Optical Depth (2)
- Vegetation (2)

Platform / Instrument

- AMSR-E (4)
- MERRA-2 Model (19)
- MISR (2)

Reset Plot Data

Responsible NASA Official: [Angela Li](#)
Web Curator: [M. Hegde](#)
Privacy Powered By ▲ Contact Us

Time Averaged Maps: Step 4

- Set the date range as **Nov 8, 2018** to **Nov 18, 2018** (Camp Fire)

The screenshot shows the NASA Giovanni web interface. At the top, it says 'GIOVANNI The Bridge Between Data and Science v 4.31'. Below that, there's a yellow banner with a message: 'Giovanni login problem has been fixed ... [1 of 1 messages] Read More'. The main content area is divided into several sections:

- Select Plot:** A dropdown menu is set to 'Maps: Time Averaged Map *'. Other options include 'Comparisons', 'Time Series', 'Vertical', and 'Miscellaneous'.
- Select Date Range (YYYY-MM-DD HH:mm):** This section is circled in red. It shows a date range from '2018 - 11 - 01 00:00' to '2018 - 11 - 30 23:59'. Below this, it says 'Valid Range: 2002-07-04 to 2019-09-16'.
- Select Region (Bounding Box or Shape):** A text input field for region selection.
- Select Variables:** A sidebar on the left lists categories: Observations, Disciplines, and Measurements. Under Measurements, 'Aerosol Optical Depth (8)' is checked.
- Number of matching Variables: 8 of 2007 Total Variable(s) included in Plot: 1**
- Keyword:** A search bar with 'Search' and 'Clear' buttons.
- Table of Variables:** A table with columns: Variable, Units, Source, Temp.Res., Spat.Res., Begin Date, End Date. The selected variable is 'Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean (MYD08_D3 v6.1)'.

At the bottom, there are links for 'Responsible NASA Official: Angela Li' and 'Web Curator: M. Hegde', along with 'Privacy', 'Powered By', and 'Contact Us' links. A 'Reset' button and a green 'Plot Data' button are also visible.



Time Averaged Maps: Step 5

- Select your region either by typing in coordinates, or by clicking **Show Map** and **drawing a box** (about 10 x 10 degrees) around your area of interest
- If you pick too large of an area or time period, it will take a long time for your image to be created
- Click on **Plot Data** (green button) in lower right-hand corner

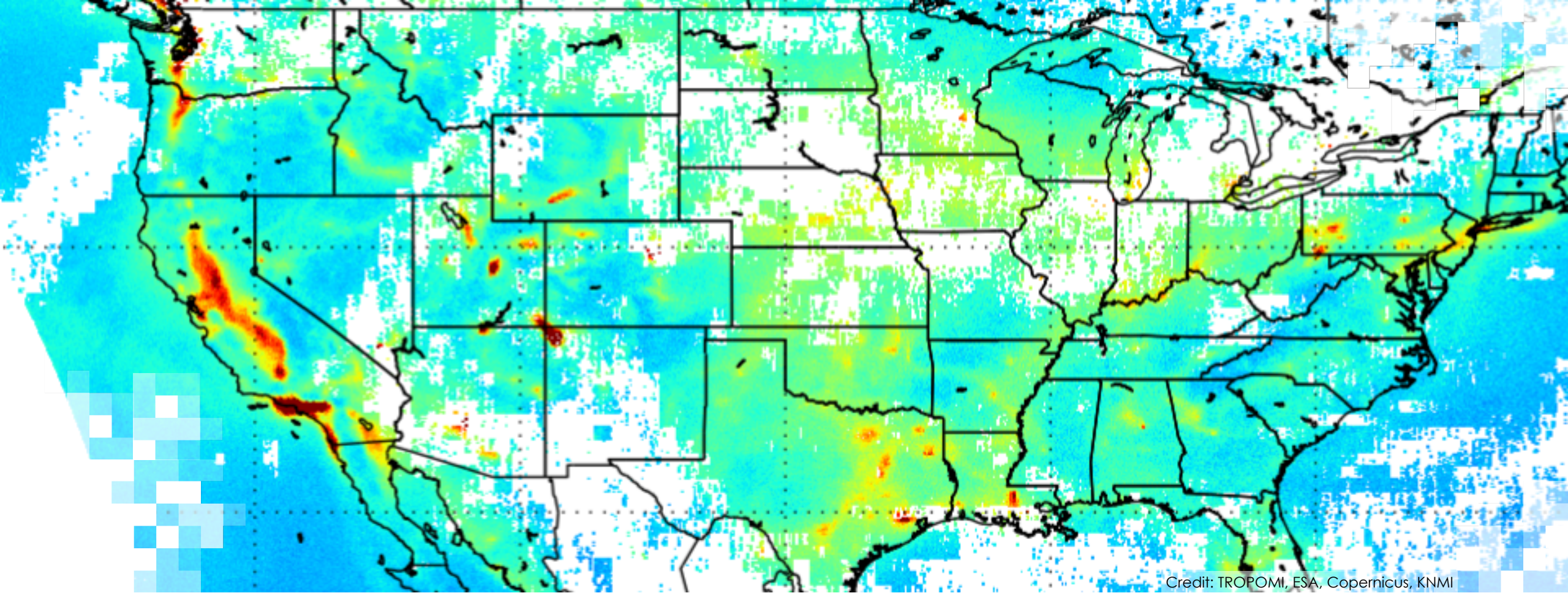
The screenshot shows the NASA Giovanni web interface. The top navigation bar includes the NASA logo, 'EARTHDATA', and 'Find a DAAC'. The main header features the 'GIOVANNI' logo and the tagline 'The Bridge Between Data and Science v 4.31'. A yellow banner indicates a login problem has been fixed. The interface is divided into several sections: 'Select Plot' with a dropdown menu set to 'Maps: Time Averaged Map *'; 'Select Date Range (UTC)' with a date range of '2018 - 11 - 08 00:00 to 2018 - 11 - 18 23:59'; 'Select Region (Bounding Box or Shape)' with a bounding box of '-130.3125,31.7578,-116.25,42.3047' and a 'Show Map' button highlighted by a red arrow; and 'Select Variables' with a list of categories including Observations, Disciplines, and Measurements. A table on the right displays the selected parameters: Temp.Res: Daily, Spat.Res: 1°, Begin Date: 2002-07-04, End Date: 2019-09-16. The 'Plot Data' button in the bottom right corner is highlighted with a green circle.

Temp.Res.	Spat.Res.	Begin Date	End Date
Daily	1 °	2002-07-04	2019-09-16
8-Daily	4 km	2002-07-04	2019-07-27
8-Daily	4 km	2002-07-04	2019-07-27
Daily	1 °	2002-07-04	2019-09-16
Daily	1 °	2002-07-04	2019-09-16

Time Averaged Maps: Step 6

- Scroll down to view the various maps. You can change the color scale, max, and min under the **Options** >> **Options** button on the top right of each map. You can download each image (either as .png, GeoTIFF, or .kmz) under the **Download** link on the left
- You can also download the plot data in NetCDF form

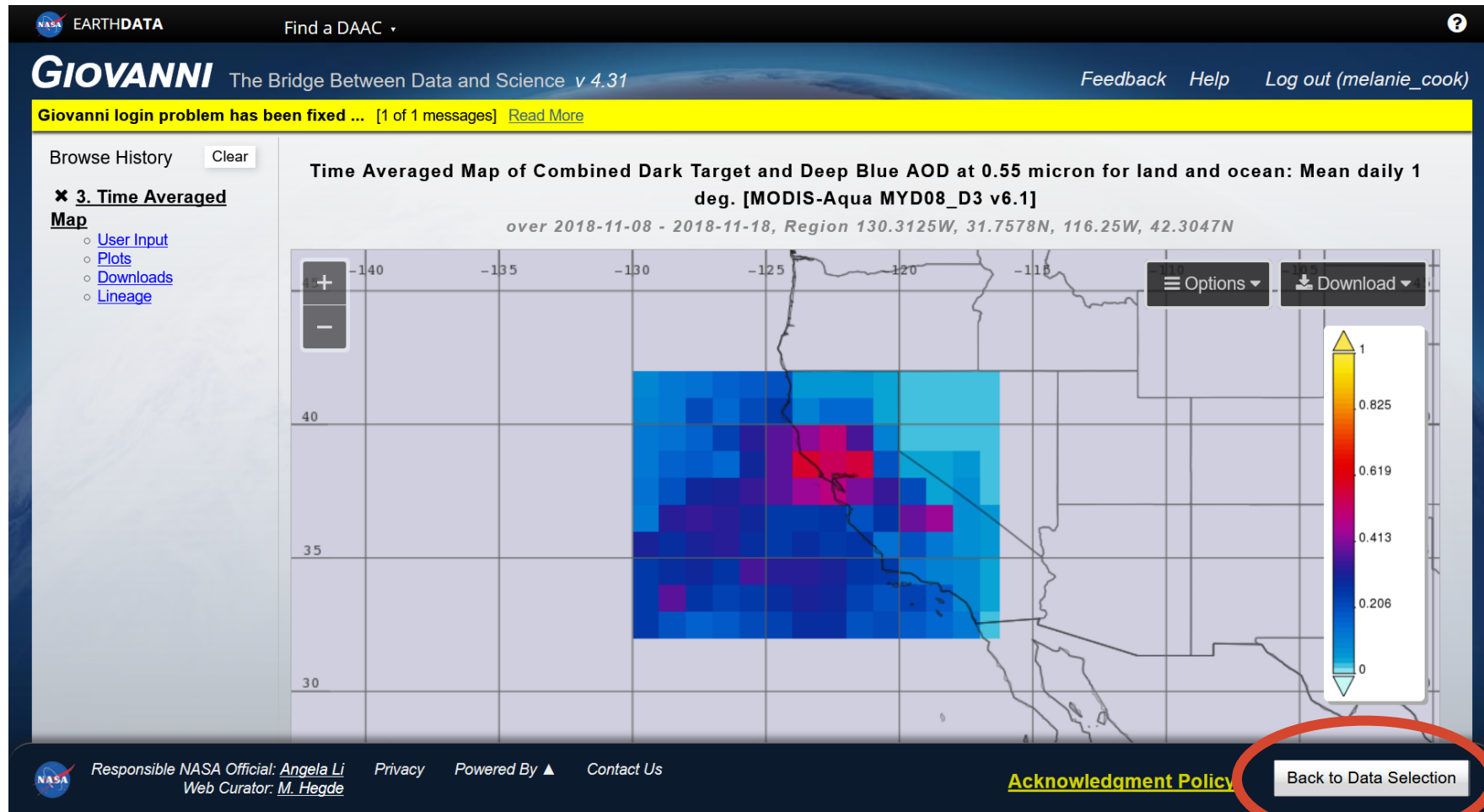
The image displays two screenshots of the GIOVANNI web interface. The top screenshot shows a map titled "Time Averaged Map of Combined Dark Target and Deep Blue AOD at 0.55 micron for land and ocean: Mean daily 1 deg. [MODIS-Aqua MYD08_D3 v6.1]". A red circle highlights the "Options" button in the top right corner of the map area. The bottom screenshot shows the same map with the "Options" menu open. A red circle highlights the "Options" button in the left sidebar, and another red circle highlights the "Options" button in the top right of the map area. The "Options" menu is open, showing various settings: "Data Range" (Minimum: 0, Maximum: 1), "Palette" (Cyan-Red-Yellow (Seq), 65; Yellow-Orange-Brown (Seq), 65), "Smoothing" (On), "Projection" (Equidistant Cylindrical), and "Scaling" (Linear). The "Download" button is also visible in the top right corner of the map area.



Time Series

Time Series: Step 1

- Click **Back to Data Selection**



Time Series: Step 2

- Choose **Time Series** → **Area-Averaged**
- Change **Date Range** to **Nov 1, 2018** to **Nov 30, 2018**
- **Plot Data**

The screenshot shows the NASA Giovanni web interface. The browser address bar displays the URL: <https://giovanni.gsfc.nasa.gov/giovanni/#service=ArAvTs&starttime=2018-11-01T00:00:00Z&endtime=2018-11-30T00:00:00Z>. The page title is "GIOVANNI The Bridge Between Data and Science v 4.31". A yellow banner at the top states "Giovanni login problem has been fixed ... [1 of 1 messages] Read More".

The "Select Plot" section shows the following options:

- Maps: Select...
- Comparisons: Select...
- Time Series: Area-Averaged ***
- Vertical: Select...
- Miscellaneous: Select...

The "Select Date Range (UTC)" section shows the date range: 2018-11-01 to 2018-11-30. The valid range is 2002-07-04 to 2019-09-16.

The "Select Variables" section shows the following categories:

- Observations
 - model (1432)
 - observation (575)
- Disciplines
 - Aerosols (188)
 - Atmospheric Chemistry (76)
 - Atmospheric Dynamics (424)
 - Cryosphere (13)
 - Hydrology (1209)
 - Ocean Biology (59)
 - Oceanography (62)
 - Water and Energy Cycle (1272)
- Measurements
- Platform / Instrument
- Spatial Resolutions

The "Time Series Choices" dropdown is open, showing the following options:

- Hovmoller, Longitude-Averaged
 - Longitude-averaged Hovmoller, plotted over the selected time and latitude ranges
 - [Details...](#)
- Hovmoller, Latitude-Averaged
 - Latitude-averaged Hovmoller, plotted over the selected time and longitude ranges
 - [Details...](#)
- Area-Averaged Differences
 - Time series of area averaged differences between two variables at each spatial grid point
 - [Details...](#)
- Area-Averaged**
 - Time series of area-averaged values
 - [Details...](#)
- Seasonal (inter annual) time series
 - [Details...](#)

The "Plot Data" button is highlighted at the bottom of the interface.

Time Series: Step 3

- Now you have plotted an area-averaged time series covering the same area as the time-averaged maps
- Using the **Downloads** link on the left, you can download the image as a .png or the data as a .csv
- Using the **Options** pull down menu, you can change the axes range and title

