



Data Visualization and Analysis for Climate Studies Using NASA Giovanni Online System

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<http://Giovanni.gsfc.nasa.gov>

Introduction

With many global earth observation systems and missions, focused on climate systems, and the associated large volumes of observational data available for exploring and explaining how climate is changing and why, there is an urgent need for climate services. Giovanni, the NASA GES DISC Interactive Online Visualization ANd ANalysis Infrastructure, is a simple-to-use yet powerful tool for analysing these data for research on global warming and climate change, as well as for applications to weather, air quality, agriculture, and water resources.

Giovanni Capabilities

Input Data Formats: HDF4, HDF5, NetCDF, and binary

Input Data Types: Gridded, Swath

Data Access Methods: FTP, HTTP, WCS, OPeNDAP, and GDS

Giovanni User Access Methods: Web GUI, WCS, and WMS

Visualization and Analysis Types:

Single Parameter:

- Curtain Along Swath
- Swath Strip Plot
- Lat-Lon Map, Time-averaged
- Time Series, Area-averaged
- Time-Lat Hovmöller, Longitude-Averaged
- Time-Lon Hovmöller, Latitude-averaged
- Cross Map, Lat-Pressure, Time-Lon-averaged
- Cross Map, Lon-Pressure, Time-Lat-averaged
- Cross Map, Lon-Pressure, Time-Area-averaged
- Vertical Profile
- Climatology and Anomaly Analysis

Multi-Parameters:

- Correlation Map
- Scatter
- Difference of Lat-Lon Maps
- Overlay of Lat-Lon Map
- Overlay of Vertical Profile
- Difference of Time Series
- Line Plot overlay on Curtain

Data Output Formats

- Image: gif, png, animation, KMZ (ready for displaying on Google Earth)
- Data: HDF4, NetCDF, ASCII

Work Flow status, Data Lineage, Data Download, Documentation, and more.

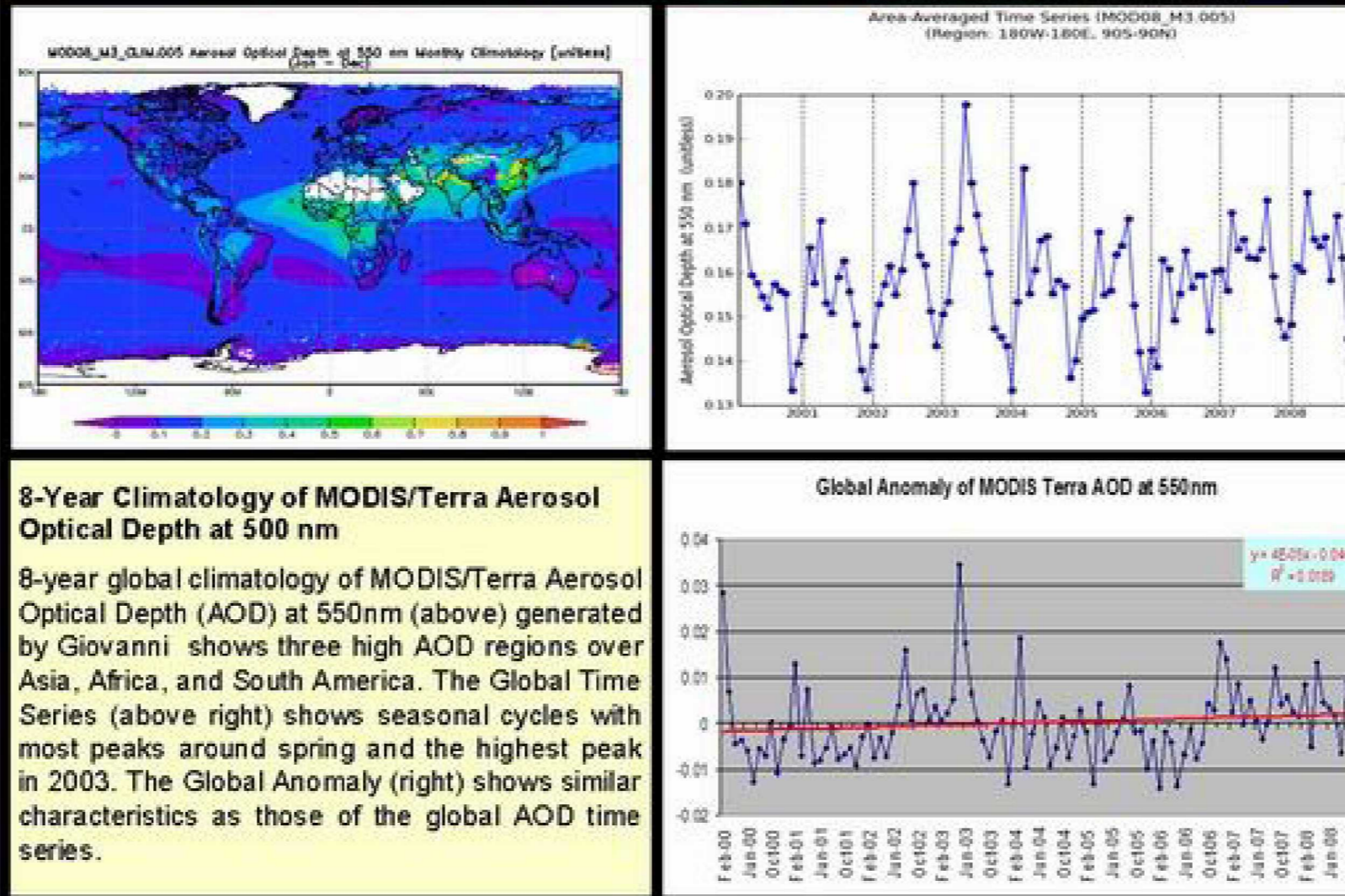
24 Giovanni Instances with focus on different disciplines

Instance	Title: Subtitle
1 aerosol_daily	Daily Aerosol Optical Thickness Measurement and Model Comparison Beta Version
2 aerosol_monthly	Monthly MODIS-GOCART Aerosol Optical Thickness Intercomparison Beta Version
3 Air_Quality	Giovanni Air Quality: EPA AIRNOW PM2.5
4 AIRS_Level3Daily	AIRS Online Visualization and Analysis: AIRS Global 1.0° x 1.0° Daily Level-3 Products
5 AIRS_Level3Monthly	AIRS Online Visualization and Analysis: AIRS Global 1.0° x 1.0° Monthly Level-3 Products
6 atrain	A-Train Along CloudSat Track Instance: CloudSat
7 atrain3d	HIRDL/Aura Online Visualization and Analysis System: Level 2 Vertical Profiles
8 MERRA_MONTH_2D	MERRA Monthly 2D Data Collections:
9 MERRA_MONTH_3D	MERRA Monthly 3D Data Collections:
10 MISR_Daily_L3	MISR Daily Level-3 Data: Daily Global 0.5 x 0.5 Degree Aerosol Product
11 MISR_Monthly_L3	MISR Monthly Level-3 Data: Monthly Global 0.5 x 0.5 Degree Aerosol Product
12 inds	MLS/Aura Online Visualization and Analysis System: Version 2.2 Vertical Profiles
13 MODIS_DAILY_L3	MODIS Terra and Aqua Daily Level-3 Data: Atmosphere Daily Global 1x1 Degree Products
14 MODIS_MONTHLY_L3	MODIS Terra and Aqua Monthly Level-3 Data: Atmosphere Monthly Global 1x1 Degree Products
15 neespi	NEESPI Experimental Instance: Northern Eurasia Earth Science Partnership Initiative Monthly Products
16 neespi_daily	NEESPI Experimental Instance: Northern Eurasia Earth Science Partnership Initiative Daily Products
17 ocean_model	Ocean Color Radiometry Online Visualization and Analysis: NOEM Assimilated Monthly Global Products
18 ocean_model_daily	Ocean Color Radiometry Online Visualization and Analysis: NOEM Assimilated Daily Global Products
19 ocean_model_monthly	Ocean Color Radiometry Online Visualization and Analysis: Global Monthly Products
20 omi	OMIAura L3 Online Visualization and Analysis: Daily Level 3 Global Gridded Products
21 omi2g	OMIAura L2G Online Visualization and Analysis: «BETA» Daily Level 2G Global Binned Products «BETA»
22 toms	TOMS Online Visualization and Analysis: Daily Level 3 Global Gridded Products
23 TRMM_3_Hourly	TRMM Online Visualization and Analysis System (TOVAS): 3-hourly TRMM and Other Rainfall Estimate (3B42 V6)
24 TRMM_Monthly	TRMM Online Visualization and Analysis System (TOVAS): TRMM Level-3 Monthly Products.

Currently, there are 130 NASA Earth Science data products and more than 1000 parameters registered in Giovanni. These products and parameters are included in 24 instances (GUI Interface pages), with focus on different disciplines, such as Atmospheric Dynamics, Atmospheric Composition, Air Quality, Hydrology, Precipitation, Aerosol, Cloud, Oceans, etc. Many data products have long time records. The table to the left lists some Giovanni gridded products with data coverage length longer than four years. Most of these data products continue to present. With these long data records, Giovanni can facilitate climate studies.

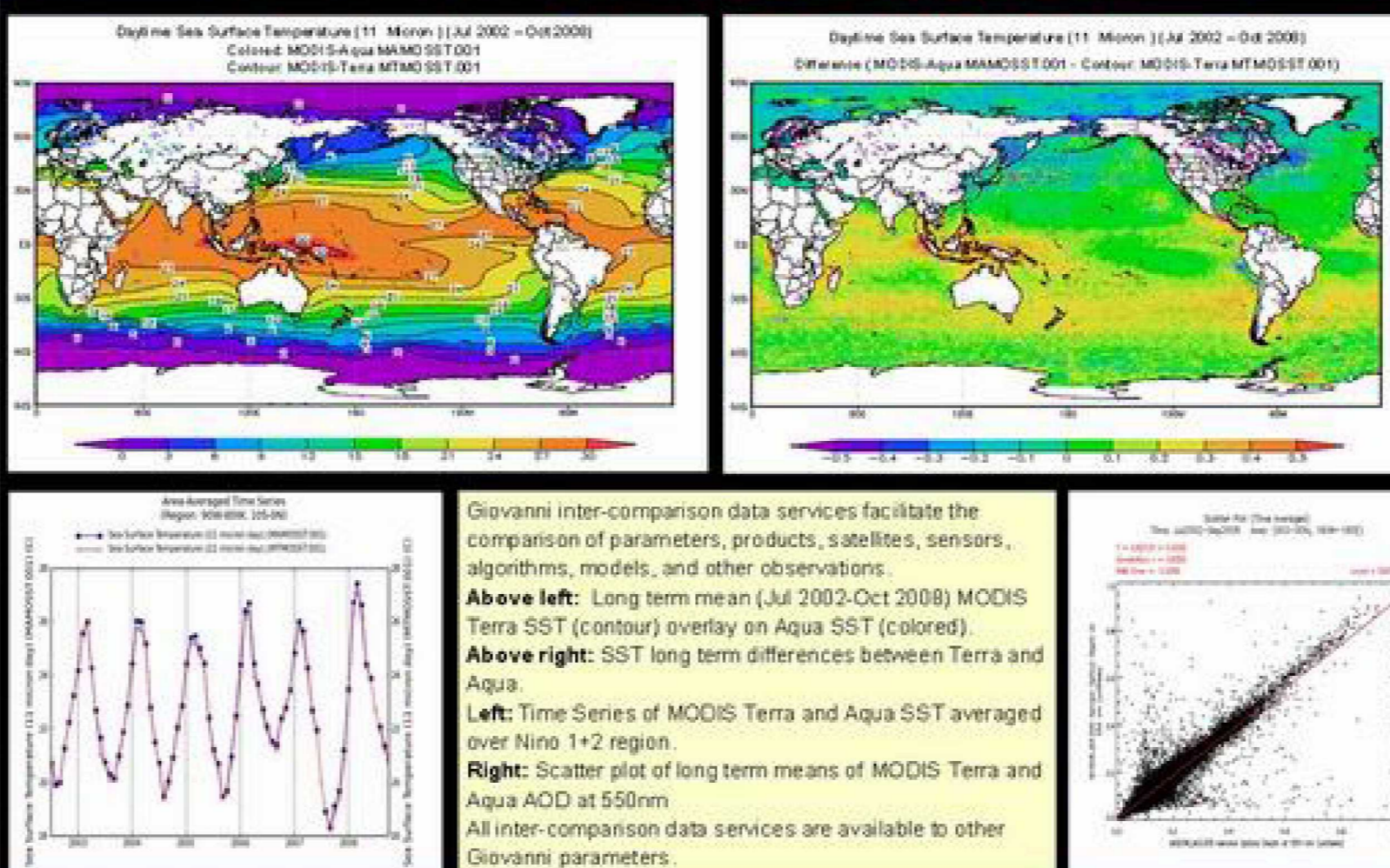
¹GPCP - Global Precipitation Climatology Project
²GPCP - Global Precipitation Climatology Center

Global Climate Viewed by Giovanni

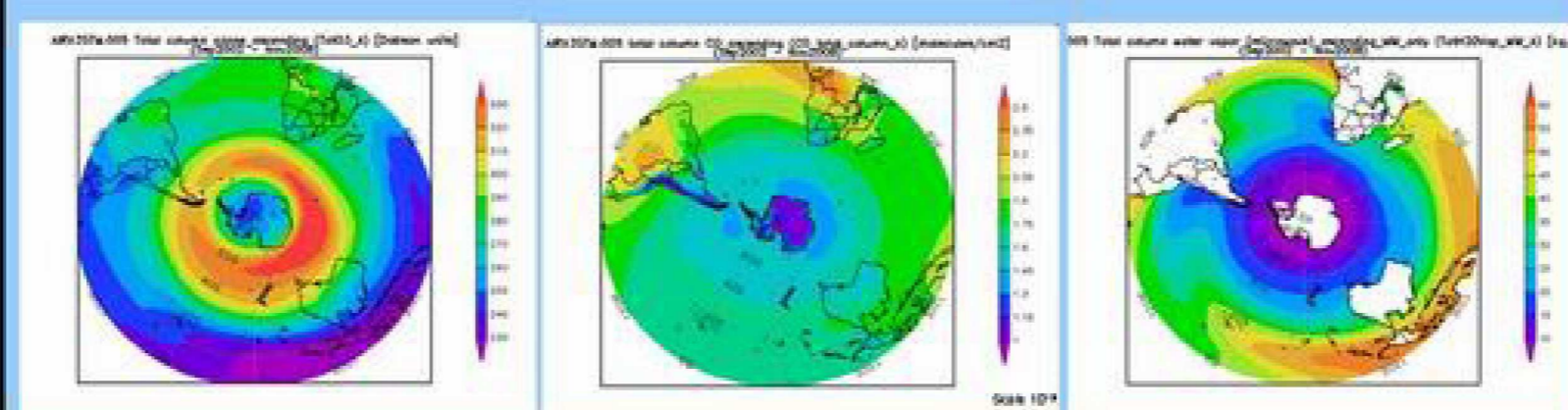


Similarly, Giovanni can generate long term mean, annual mean, seasonal mean, time series, Hovmöller diagram, and anomaly for any other Giovanni parameters. Giovanni provides HDF, NetCDF, and ASCII outputs, which can facilitate further studies on these data by users. For example, the Global Anomaly AOD Time Series (above right) was generated by Excel using the ASCII data downloaded from the Giovanni result page. **New options, such as Running Mean, Trend, Zonal Mean, Bar Graph, etc. are planned to become available in upcoming Giovanni releases.**

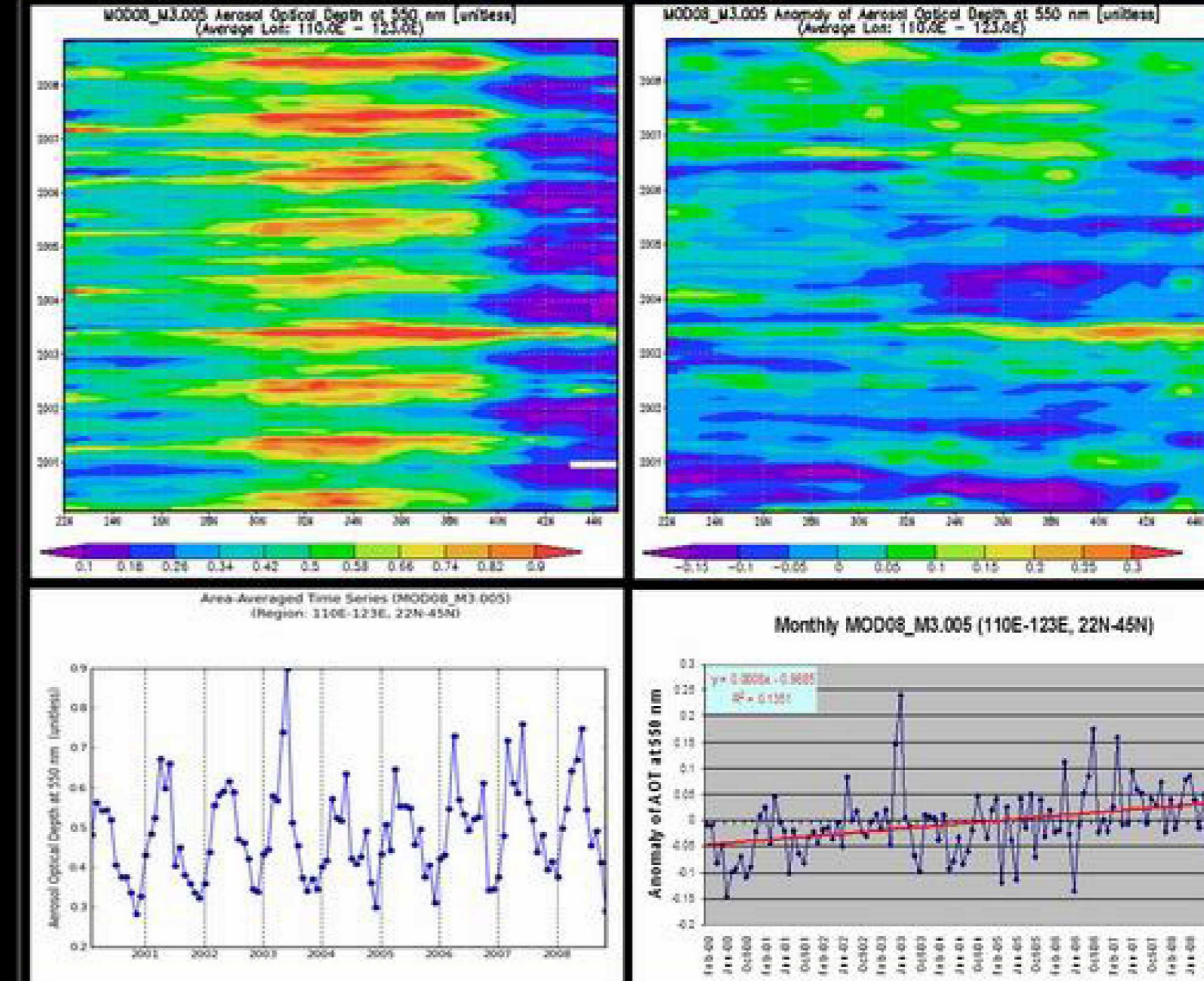
Climatology Inter-comparison by Giovanni



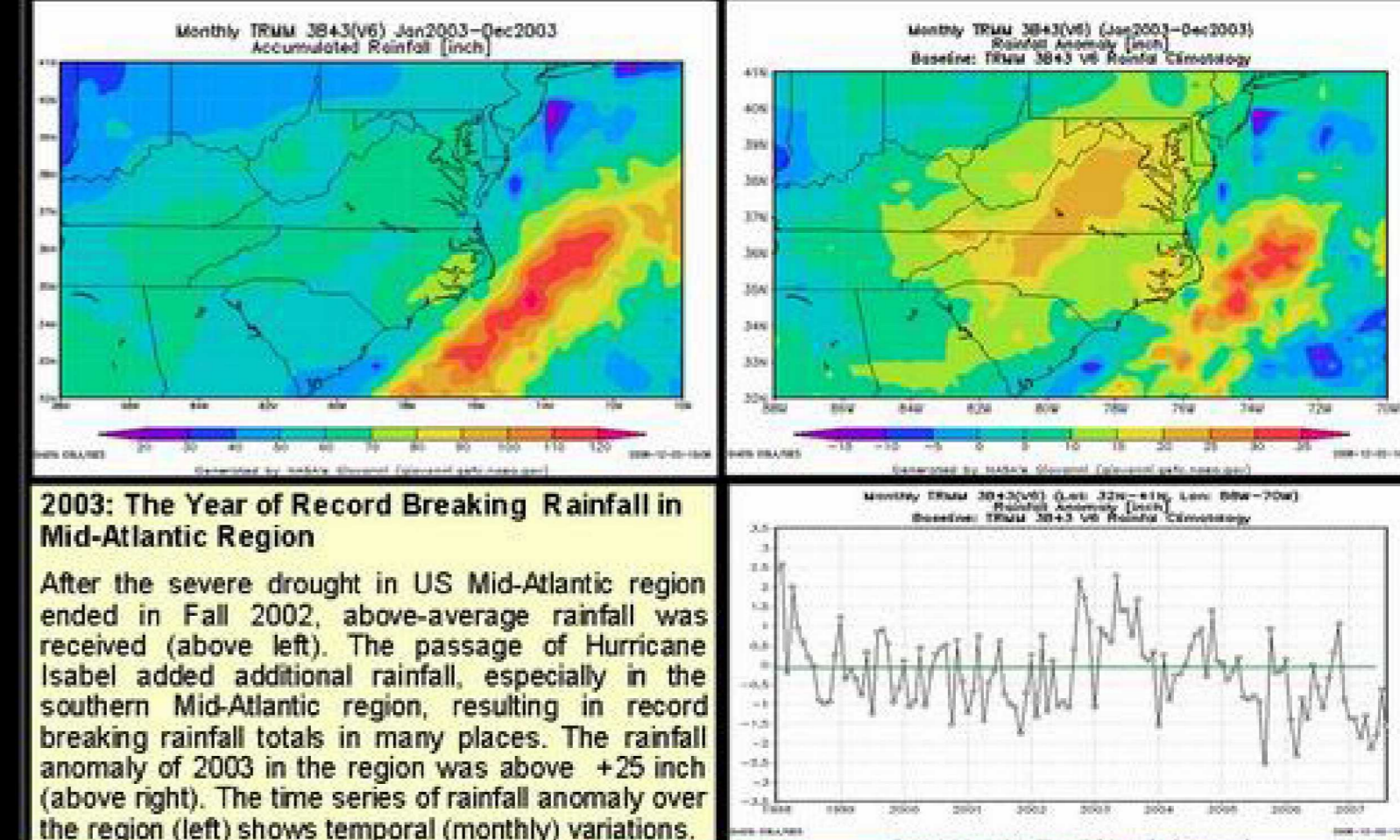
Long term (Sep 2002 – Nov 2008) mean of AIRS Total Column Ozone, CO, and Water Vapor



Regional Climate Studies with Giovanni



The Hovmöller diagram of MODIS Terra Aerosol Optical Depth at 550nm (above upper left) shows clear seasonal cycles, tendency of an increasing trend, and anomalous high AOT in Springs of 2003 and 2008, which are confirmed in the anomalies plot (above upper right). The AOT maxima occur between latitudes of 30N and 40N, where the majority of deserts in China are located. The area averaged time series (above lower left) reveals further temporal behaviors, of which an obvious upward trend in anomalies is most evident (above lower right).



Conclusions

Giovanni is an online data system with a remarkable and proven capability for data exploration, basic research, and exemplary data visualization, available for data from many different NASA Earth observation missions. With these long-term and widely available data sets, including parameters such as temperature, precipitation, and greenhouse gases, Giovanni provides capabilities to facilitate climate change and global warming research. Giovanni has proven to be a highly successful and popular climate services infrastructure that is significantly contributing to the study of global warming and climate change and the consequential environmental issues that affect all of us on this planet.

Giovanni URL: <http://Giovanni.gsfc.nasa.gov>