P 2.4 THE ATMOSPHERIC COMPOSITION DATA AND INFORMATION SERVICES CENTER (ACDISC)

I. Gerasimov, S. Kempler, G. Leptoukh, S. P. Ahmad, and J. E. Johnson Goddard Earth Sciences Data and Information Services Center, Code 610.2, NASA GSFC, Greenbelt, Maryland 20771, USA

1. INTRODUCTION

Studying Atmospheric Composition using Earth science data sets from multiple sources can be a daunting task. It involves identifying appropriate geophysical parameters, then trying to understand what datasets contain these parameters, then locating at various locations, and then obtaining voluminous amounts of data, subsetting to extract the parameters and spatial areas desired, and colocating the data with other data. Thus, there is often a significant upfront investment before the core investigation can begin. To ease the burden of such investigations among the Atmospheric Composition community, the Goddard Earth Science (GES) Data and Information Services Center (DISC) has undertaken the development of the Atmospheric Composition Data and Information Services Center (ACDISC), Leptoukh (2005). ACDISC (http://acdisc.gsfc.nasa.gov/) is a portal to the Atmospheric Composition (AC) specific, user driven, multi-sensor, on-line, easy access archive and distribution system employing data analysis and visualization, data subsetting, and other user requested techniques for the better science data usage. It provides convenient access to AC data and information from various remote-sensing missions, from TOMS, UARS, MODIS, and AIRS datasets, to the most recent data from Aura OMI, MLS, HIRDLS, as well as AC datasets residing at other remote archive sites. It adequately addresses the NASA Strategic Atmospheric Composition Roadmap.

The goals of the AC-DISC are:

- Serve as a **one-stop shopping** data center for Atmospheric Composition (AC) Scientists, guided by Atmospheric Composition Scientists
- Provide services and expertise for effortless and convenient access to and usage of AC data
- Collaborate with AC scientists to establish a framework for seamless utilization of data from multiple sensors for long-term atmospheric research

2. ACDISC APPROACH

 AC scientist guided - AC community representatives make suggestions and evaluate results

- Multi-sensor Archive and distribute AC data from multiple sensors to facilitate long term, AC-specific research.
- On-line archive Allows for direct retrieval of data via ftp.
- Web-based access Reuses popular and easy to use GES DISC home grown interfaces
- On-line analysis and visualization Reuses popular customizable tool (Giovanni) for online analysis and visualization.
- Subsetting tools Allows retrieval of smaller volume data.
- Data safely stewarded Ensures all AC data and documentation is safely kept for long-term science objectives.



Fig. 1. Goddard ACDISC home page

3. ACDISC DATA ACCESS

Users can access ACDISC data via using several web interfaces. Fig. 2 shows ACDISC Parameters page, which have links to various atmospheric chemistry, aerosol and cloud parameter pages. Each parameter page, like one shown on Fig. 3, has short parameter description, parameter measurement specifics and links for access to specific GES DISC data products that contain this parameter. Data access links on this interface lead to the well-known GES DISC WHOM interface, from which data products can be ordered.

e <u>E</u> dit <u>V</u> iew <u>G</u> o <u>B</u> oo	tuents - Mozilla Firefox kmarks Tools Help I http://acdisc.gsfc.nasa.gov/comp_para	ams.shtml 🔍 🛛 Go 📿
	ERONAUTICS ADMINISTRATION	FIND IT @ NASA : + G0 + Advanced Search
+ ABOUT NASA + NE	EWS & EVENTS + MULTIMEDIA + MI	ISSIONS + POPULAR TOPICS + MyNASA
+ ACDISC Home + GES DISC Home	AGDISC ATMOSPHERIC CO DATA & INFORM	OMPOSITION MATION SERVICES CENTER
Atmospheric Composition	Atmospheric Composition Data Parameters Click on the parameter name to view parameter that parameter.	description and data access links to the products containing
+ NEWS	Oxygen Compounds	Aerosola
+ DATA ACCESS	Oxygen Compounds Ozone (O.,)	Acrosols
- PARAMETERS	Nitrogen Compounds	Aerosol Optical Depth/Thickness
+ SERVICES	Nitric cxide (NO)	Aerosol Extinction Profile
* OLIVIDLO	Nitrous oxide (N ₂ O)	Aerosol Angstrom Exponent
- 10010		
+ TOOLS	Nitrogen dioxide (NO_)	Aerosol Mass Concentration
+ IMAGE GALLERY	Nitrogen dioxide (NO ₂) Dintrogen pentaoxide (N ₂ O ₂)	Aerosol Mass Concentration Cloud Condensation Nuclei Aerosol Effective Radius
+ IMAGE GALLERY + SCIENCE FOCUS		Cloud Condensation Nuclei
+ IMAGE GALLERY	Dinitrogen pentaoxide (N2O3)	Cloud Condensation Nuclei Aerosol Effective Radius
+ IMAGE GALLERY + SCIENCE FOCUS	Dintrogen pentaoxide (N ₂ O ₉) Ntric acid (HNO ₉)	Cloud Condensation Nuclei Aerosol Effective Radius Aerosol Asymmetry Factor
+ IMAGE GALLERY + SCIENCE FOCUS + TECHNOLOGY LAB	Dintrogen pentaoxide (N ₂ O ₃) Nitric acid (HNO ₃) Sulfur Compounds	Cloud Condensation Nuclei Aerosol Effective Pladus Aerosol Asymmetry Factor Aerosol Back Scattering Platos

Fig. 2. ACDISC Parameters Page

	marks Tools Help						
📭 🖗 - 🔊 😢 😚	ttp://disc.gsfc.nasa.gov/PIP/sht	ml/atmo	ospheric_temp	👻 🗘 Ge	G,		
+ GES DISC Home GES DISC	Goddard Earth Science Almospheric Temperature Profile	1000	and the second second	mations	Grvices	(ejan	L.
	Other Names						
+ ABOUT US	T						
- DATA ACCESS	Definition A measure of the average kinetic energy of	f the air i	molecules.				
Online FTP Order F80m Archive Search Data Types (ESDT) Search Parameters Parameter Information Pages	This is the most measured quantity in the is GES DISC DAAC Datasets To access products that have specific per			and the black		in the t	
+ IMAGE GALLERY	below.	urneter c	skik on the correct	ponding data	Laccass, Ini	is in the t	1040
+ SCIENCE FOCUS				Data			
+ SERVICES	Parameter	Units	Platform /instrument	Begin Date	End Date	Access	Doc
+ TOOLS + CONTACT US		Kelvin Aura 1	AuraMLS	2004-08-08	Current	tp] archive	Y
+ USER FORUM	Atmospheric Temperature Profile (ground pixel resolution)		AuraHIRDLS	2005-01-21	Current		Y
+ TECHNOLOGY LAB	(ground pixel resolution)		UARSHALOE	1991-10-11	Current	fp archive	۷
+ REFERENCES	Atmospheric Temperature Profile					tp archive	Y
SEARCH DISC	(Day/Night) (ground pixel resolution, 45 km at nadir)	Kelvin	Aqua/AIRS	2002-08-30	Current	tp archive	Y
+ 60							

Fig. 3. ACDISC Temperature Parameter Page

Another ACDISC interface, shown on Fig. 4, provides more efficient ways of product search and ordering. When using this interface user can select one or more of 88 atmospheric data parameters, the platform/instrument, the data processing level, and the time range. Once these selections are done user will see the list of data products that contain all these preferences.

ACDISC Search and O e Edit View Go Bookn	rder Tool - Mozilla Fire arks Tools Help	ox					
🖬 • 🤹 • 🛃 🙁 🕎		and ACE!	🗸 🖸 Co 🔀				
	 http://discette-tsz.gstc.h 	Isalgov/Mc b/					
GES DISC	ACDISC Search and Order Too						
and the first of the second			(the Data Products by Parameters related	ed to Atmospheric			
+ ABOUT US	Composition. See Parameter to	minology help to u	inderstand parameter categorization.				
+ DATA ACCESS		Select 'Term	> Variable > Parameter':				
+ IMAGE GALLERY	Atmospheric Chemistry > Ozor	ie (O3) > Ozone F	hofiles				
	Atmospheric Chemistry > Ozor	e (O3) > Ozone T	otal Column				
+ SCIENCE FOCUS	Atmospheric Chemistry > Sulfu						
+ SERVICES	Atmospheric Chemistry > Sulfu						
+ TOOLS			Pressure > Atmospheric Pressure Profile				
	Atmospheric Pressure and Hei Atmospheric Pressure and Hei		Height > Geopotential height profiles				
+ CONTACT US	Atmospheric Pressure and Hei Atmospheric Pressure and Hei			-			
+ USER FORUM	Amospieric Pressure and He	Jur > Servace Pres	sure	•			
+ TECHNOLOGY LAB		Refine Da	ta Product Search by:				
+ REFERENCES	1. Mission Instrument:	2. Processing Level:	3. Time Range:	Day/Night Coverage:			
SEARCH DISC	At (7) Aqua AIRS Aqua MODIS	All (4)	Begin: 1978 ¥ 11 ¥ 01 ¥ End: 2005 ¥ 10 ¥ 18 ¥	Al(3)			
* ADVANCED SEARCH	Aura MLS 💌	3 Daily 📼		Both "Twiight" 💌			
	Select Products:						
	AIRX2RET: AIRS/Agua FINAL	Level 2 Products					
	AIRX25UP: AIRS/Aqua Level-2	Support Product		_			
	ML2O3: MLS/Aura L2 Ozone (03) Mixing Ratio					
			er Vapor Profiles 5-Min L2 Swath 5km				
	MYD07_L2: MODIS/Aqua Tem	perature and Wate	r Vapor Profiles 5-Min L2 Swath 5km				

Fig. 4. ACDISC Search and Order Tool

After selecting those products, and coordinates of needed spatial region user will be transferred to another page like one on Fig. 5, which lists data products that contain 'Ozone Total Column' parameter. This page shows estimated number of granules per each product, the links on this page lead to the WHOM interface. On this page user can refine data search options and order the listed data products.

e <u>E</u> dit <u>V</u> iew <u>G</u> o <u>B</u> or						
GES DISC	thtp://discette-ts2.gsfc.nasa.gov/daac Product Search Results Your Shopping Carl Back to Parameter Search	,				
+ ABOUT US + DATA ACCESS + IMAGE GALLERY + SCIENCE FOCUS	Number of granukes (ike) shown in D Note: exact number of granukes and availab Dewnload and Archive Order Search: Search: Select boxes and click the Ref Order: To order granukes check Select boxes	ie data subse Time Range, Ine Search b	tting services Day/Night C utton	s click o coverage	n the links und e, Geographic	er Direct Area,
+ SERVICES		Product Time Range View R				
+ TOOLS	Product Name: Description (Processing Level, Parameters, Document)	Begin	End	Select	Direct	Archive
+ CONTACT US + USER FORUM	AIRX2RET: AIRS/Aqua FINAL Level 2 Products (L2, par, doc.)	2002-08-30	2005-10-17	R	-87600	~200078
+ TECHNOLOGY LAB	AIRX2SUP: AIRS/Aqua Level-2 Support Product (L2, par, doc.)	2002-08-30	2005-10-17	3	~150838	~256078
+ REFERENCES	ML203: MLS/Aura L2 Ozone (O3) Mixing Ratio (L2, par , doc)	2004-08-08	2005-10-13	E	~405	~405
+ ADVANCED SEARCH	MOD07_L2: MODIS/Terra Temperature and Water Vapor Profiles 5-Min L2 Swath Skm (L2, par , doc)	2000-02-24	2005-10-18	R	-6	-575641
	MYD07_L2: MODIS/Aqua Temperature and Water Vapor Profiles 5-Min L2 Swath 5km (L2, par , doc)	2002-07-04	2005-10-17	R	-25920	-338526
	OMTO3: OMI/Aura Ozone (O3) Total Column 1-Orbit L2 Seath 13x24km (L2, par , doc)	2004-08-17	2005-10-18	R	~5386	~5386
	TOMSN7L2: Nimbus-7 TOMS geolocated	1978-11-01	1993-05-08	-	-0	-71696

Fig. 5. ACDISC search results example

The ACDISC Parameter Pages and Search and Order interfaces provide search and order for the data products from historic missions such as Nimbus-7 (LIMS and TOMS instruments), TIROS and various NOAA missions (TOVS); current missions such as UARS (HALOE, MLS, ISAMS, etc), Earth Probe (TOMS), Aqua (AIRS and MODIS), Terra (MODIS) and the latest Aura (OMI, MLS and HIRDLS) mission. In the future, data products from other historic and new missions as well as atmospheric composition data products from remote data sites will be added to search and order tool.

4. ACDISC DATA SUBSETTING

ACDISC employs subsetting as means to reduce data volumes during data transport to users. Depending on data product file format, various subsetters are used.

4.1 GES DISC HDF-EOS5 subsetter

To handle Aura that is packed in the so-called HDF-EOS5 data format, which is different from HDF4-based HDF-EOS typical for data from previous EOS missions, the HDF-EOS5 subsetter has been developed at the ACDISC. It is written in C Code using HDF-EOS5 libraries. It supports any properly formatted HDF-EOS5 file, and runs from the command line.



Fig. 6. WHOM interface for subsetting OMI Level 2 data

Currently, the subsetter works during FTP data download. The subsetter allows spatial and parameter subsetting of Aura/OMI and spatial subsetting of Aura/MLS Level 2 products and is available via GES DISC <u>WHOM</u> search and order tool. Fig. shows example of the WHOM interface that provides access to subsetting service for OMI OMTO3 data product. By limiting selection to the specific spatial region and certain parameters like Column Amount Ozone, UV Aerosol Index, SO2 Index, etc., users can significantly reduce data transfer sizes of ~48MB OMTO3 files. Note, that the original metadata and attributes are retained during subsetting.

4.2 HEW/HSE Subsetter

For handling Level 3 (gridded) data, HDF-EOS Subsetting Engine, <u>HSE</u>, libraries are used. HSE was developed and made available by the University of Alabama. GES DISC has configured HSE to subset Terra and Aqua Level 3 atmospheric globally gridded daily, weekly and monthly files, whose size varies from 450 MB to 800 MB. These files can be subsetted by 37 most popular aerosol and cloud parameters and well as by spatial regions. The subsetter works during FTP download and accessible via WHOM interface in a manner similar to Aura OMI and MLS interfaces.

HSE was recently enhanced to process HDF-EOS5 data files, which made it suitable for subsetting OMI and MLS Level 3 data. Once those data sets become available, ACDISC will develop WHOM interface to provide the subsetting service.

5. GIOVANNI

The goal of the GES-DISC Interactive Online Visualization and Analysis Infrastructure (Giovanni) is to relieve the science investigator of some of the upfront data preparation work and provide a tool for obtaining science knowledge via plots, graphs, and tables without having to download and prepare large amounts of data.

The principal design goal for Giovanni, Berrick (2004), was to provide a quick and simple interactive means for science data users to study various phenomena by trying various combinations of parameters measured by different instruments, arrive at a conclusion, and then generate graphs suitable for a publication. Alternatively, Giovanni would provide a means to ask relevant what-if questions and get back answers that would stimulate further investigations. This would all be done without having to download and preprocess large amounts of data. Another goal of Giovanni was to off-load as much as possible the data processing workload onto the machines hosting the data and to reduce data transfers to a minimum. Giovanni supports HDF, HDF-EOS, as well as binary formats.

5.1 Giovanni User Interface

From the user's perspective, Giovanni is a simple Web application. A user can select either the Java or non-Java version. The resulting Web page allows the user to select the spatial area via the Java image map applet or, if the non-Java version was selected, manually by entering in coordinates defining a bounding box. The user also selects the temporal range of the data, one or more parameters from this data set, and the output type (ASCII or one of several plot types).

Depending upon the parameters selected, the vast majority of users will see the results in a matter of seconds. For users who choose large amounts of data either spatially or temporally, the results may take several minutes.

Giovanni allows scientists and researchers to easily access, visualize and analyze various gridded Level-3 and some Level-2 atmospheric products, thus helping them to understand seasonal-to-interannual variation of atmospheric parameters. Giovanni can provide information at every single point and in any rectangular area within the data domain, which allows researchers to conduct nearly unlimited investigations. The ASCII output option allows users to do their own customized analyses or applications.

5.2 TOMS and OMI Giovanni

TOMS from Nimbus-7 and Earth Probe missions were the first Atmospheric Composition daily datasets implemented in Giovanni. Later, similar interface, which is shown on Fig. 7, was added for analysis of Aura/OMI TOMS-like product.



Fig. 7. Aura OMI TOMS-like product Giovanni interface

When using these interfaces, scientists can generate time-averaged area plots and areaaveraged time-series plots for Ozone, Aerosol Index and Effective Surface Reflectivity parameters. Fig. 8 displays time-averaged area plot for OMI Ozone parameter over North America region. Other TOMS/OMI Giovanni plotting functions include animation and Hovmoller.



Fig. 8. Time-averaged area plot for OMI product

ACDISC will soon release L2G Giovanni interface, which will utilize OMI Level-2G daily product consisting of data from 15 orbits that are binned onto a $0.25^{\circ} \times 0.25^{\circ}$ global grid. In Giovanni, user will be able to generate OMI gridded product at a coarser spatial resolution as well as to get its spatial and parameter subset.

5.3 HALOE Giovanni

UARS/HALOE Giovanni interface allow users displaying vertical profiles of ozone, water vapor, CH4, NO2, NO, HCI, HF, and temperature, as well as aerosol extinction profiles at four wavelengths.

5.4 MLS Giovanni

Similar to HALOE Giovanni, Aura/MLS Giovanni interface allows to display vertical profiles for ozone, temperature, water vapor, CIO, CO, HCI, HCN, HNO3, N2O, OH, geopotential height and relative humidity with respect to ice parameters.

5.5 AIRS Giovanni

The Aqua/AIRS interface is the first Giovanni instance where various vertical and horizontal 2D slices are employed within a single Giovanni instance. This interface allows display of zonal and meridional vertical cross-sections of temperature, water vapor, relative humidity and geopotential height. Time-series, spatial averages and hovmoller functions are also available.

5.6 Other Giovanni instances

- MOVAS: MODIS aerosol related
- Ocean-color (SeaWiFS and MODIS Aqua)
- TOVAS: TRMM and other gridded precipitation data

6. FUTURE ACDISC DIRECTIONS

In the near-term, other OMI products (Cloud, NO2, Aerosols, etc) will be available. The standard Aura Level-3 product will be made available as well as implemented in the Giovanni. Various Giovanni inter-comparison options will be employed to compare parameters from TOMS, OMI, MLS, AIRS, and MODIS data products.

7. ACKNOWLEDGMENT

The ACDISC wishes to thank Drs. M. Schoeberl, A. Douglass, P.K. Bhartia, E. Hilsenrath, Y. Kaufman, M. Chin and W. Gregg (NASA GSFC) for their support of the ACDISC effort.

8. REFERENCES

Leptoukh, G., Kempler, S., Gerasimov, I., Ahmad, S., Johnson, J., 2005: Goddard Atmospheric Composition Data Center: Aura Data and Services in One Place, IGARRS'05, Proceedings

Berrick, S., Leptoukh G., 2004: Multi-sensor distributive on-line processing, visualization and analysis system, IGARSS'04, Proceedings, III: 2030-2033, 2004

ACDISC URL: <u>http://acdisc.gsfc.nasa.gov</u>