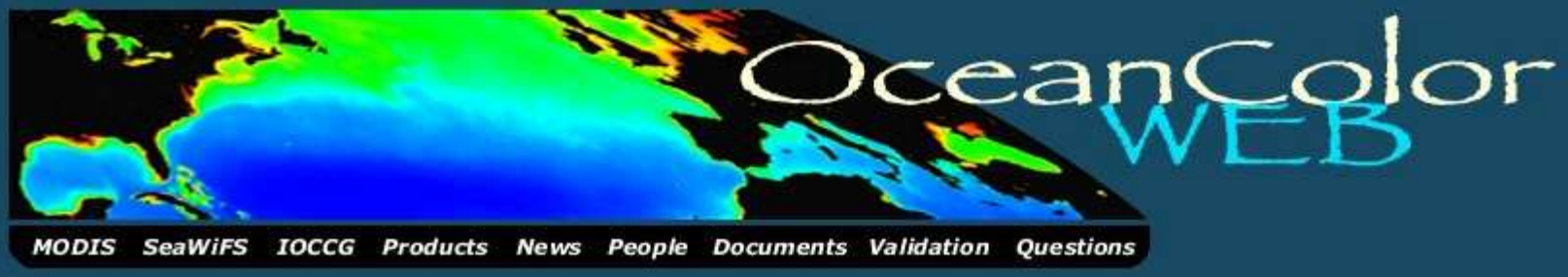


Integrating the Scientific Community with a Measurement Based, Multi-Sensor Data Processing and Distribution System

Bryan Franz, Donna Thomas, Sean Bailey, Norman Kuring, Gene Feldman, Chuck McClain, John Wilding

NASA Ocean Biology Processing Group

AGU Meeting, December 2005, San Francisco, CA

The Ocean Biology Processing Group

A Component of NASA's Missions-to-Measurements Initiative

- Heritage: SeaWiFS, SIMBIOS, SeaBASS, SeaDAS
- Designated NASA team responsible for the processing and distribution of ocean color measurements and SST from various spaceborne instruments.

  Ocean Color: CZCS, OCTS, SeaWiFS, MODIS/Aqua
  SST: MODIS/Aqua, MODIS/Terra

- Product Evaluation & Test Element (PEATE) for OC and SST, and Science Team Lead for OC on NPP/VIIRS.
- Designated as the software development, processing, and distribution element for Sea Surface Salinity measurements from Aquarius.

NASA's Goal

To make available the highest quality ocean data products to the broadest user community in the most timely and efficient manner possible, and to provide sufficient documentation and support to facilitate the use of that data for global and regional studies.

Approach

- highly integrated project structure with all elements co-located
- flexible, mission-independent data processing system that constantly upgrades procedures, technologies, and hardware
- comprehensive, centralized calibration and validation program closely coupled to the data processing and quality control system
- multi-mission software development
  - common code for MODIS, SeaWiFS, OCTS, CZCS, future sensors
  - common Level-2 & Level-3 formats
- a project philosophy designed to support and involve as large a community as possible
  - providing opportunities for user input, evaluation, and feedback

Data Processing and Storage

- database controlled, distributed processing and storage system
- many Linux-based, processing nodes (34 dual 3GHz Xeon)
- 200X processing for MODIS/Aqua ocean color
- 4000X processing through-put for SeaWiFS ocean color
- 9-month OCTS mission can be reprocessed over lunch
- all data online for direct access (100TB RAID-5 array)

- capacity for global mission testing prior to reprocessing, allowing opportunity for community participation in reprocessing decisions

- direct and near real-time user access to data archives

gigabit ethernet

processing node

storage node

database server

Current Level-1 & Level-2 Data Latency

Minimizing Time Between Observation and Data Availability

- MODIS/Aqua Level-1 & Level-2 Ocean Color & SST
  - Quicklook, average latency 4 hours, 52 minutes
  - Refined, available within 2-8 days
- MODIS/Terra Level-1
  - Quicklook, average latency 4 hours, 38 minutes
- SeaWiFS Level-1 & Level-2 Ocean Color
  - Quicklook, 1-13 hours (2 downlinks per day)
  - Refined, available within 4 days
- Latency minimization facilitates near real-time applications
  - coastal monitoring (HAB detection), GHRSST, cruise support

Most Data Available By FTP

Simplifying Data Access

- All Level-3 data available
  - bin & map files
  - daily, 8-day, monthly
  - seasonals & climatologies
- Rolling archives of Level-1 & 2
  - quicklook
  - refined
  - 30-days
- All ancillary files
  - meterological data
  - ozone data
  - attitude & ephemerides

MODIS Aqua

Binned	Mapped	Level 1, GEO, & Level 2
Level 3 Binned Standard Product Suite	Level 3 Mapped Standard Product Suite	Quicklook Daytime
Binned Daily	Mapped Daily	Refined Daytime
Binned Daily / 3Day Quicklook	Mapped Daily / 3Day Quicklook	
Binned 8Day	Mapped 8Day	
Binned Monthly	Mapped Monthly	
Binned Monthly Climatology	Mapped Monthly Climatology	
Binned Seasonal	Mapped Seasonal	
Binned Seasonal Climatology	Mapped Seasonal Climatology	
Binned Annual	Mapped Annual	

SeaWiFS Level 3

Binned	Mapped
Level 3 Binned Standard Product Suite and PAR	Level 3 Mapped Standard Product Suite and PAR
Binned Daily	Mapped Daily
Binned 8 Day	Mapped 8 Day
Binned Monthly	Mapped Monthly
Binned Monthly Climatology	Mapped Monthly Climatology
Binned Seasonal	Mapped Seasonal
Binned Annual	Mapped Annual

Ancillary Products

METOZ : NCEP Meteorological (MET) and TOMS/TOAST Ozone (OZ) ancillary data used for L1 L2 processing (updated every 4 hours)

OISST : NOAA Optimum Interpolation (OI) Sea Surface Temperature.These files are used as input for the L1 L2 SST processing

MODISA/ATTEPH: MODIS Aqua definitive attitude and ephemeris data

MODISA/CAL: Updated MODIS Aqua Level 1B LUTs (Look-up tables) and Geolocation files

MODIST/CAL: Updated MODIS Terra Level 1B LUTs and Geolocation files

utcpole.dat: Most recent version of the Earth motion file used in Level 1 processing.

leapsec.dat: Most recent version of the Leap seconds file - required for accurate time conversions in Level 1 processing.

SeaWiFS GPS elements (elements.dat)

Global 1 Kilometer Land Mask (landmask.dat) Documentation

Level-3 Multi-Sensor Browse & Distribution

Level-3 Standard Mapped Images

Help

View the color scales. | Browse the rolling 32-day composites. | Browse the "filled-in" version of the rolling 32-day biosphere composites. | Browse the seasonal, monthly, and 8-day climatologies.

Aqua-MODIS	Chlorophyll	Diffuse attenuation	nLw at 551 nm	Aerosol optical thickness	Angstrom coefficient	SST
SeaWiFS	Chlorophyll	Diffuse attenuation	nLw at 555 nm	Aerosol optical thickness	Angstrom coefficient	
	Biosphere	PAR	NDVI	Land Reflectance		
OCTS	Chlorophyll	Diffuse attenuation	nLw at 565 nm	Aerosol optical thickness	Angstrom coefficient	
CZCS	Chlorophyll		nLw at 550 nm	Aerosol optical thickness	Angstrom coefficient	
Evaluation Products	Calcite	Fluorescence Line Height				

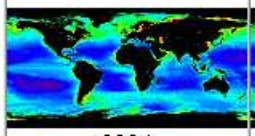
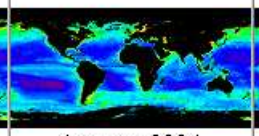
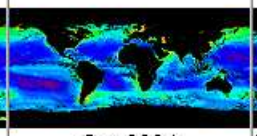
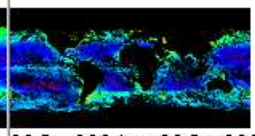
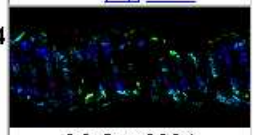
						Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002
Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003	Aug 2003	Sep 2003	Oct 2003	Nov 2003	Dec 2003
Jan 2004	Feb 2004	Mar 2004	Apr 2004	May 2004	Jun 2004	Jul 2004	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004
Jan 2005	Feb 2005	Mar 2005	Apr 2005	May 2005	Jun 2005	Jul 2005	Aug 2005	Sep 2005	Oct 2005	Nov 2005	Dec 2005

Previous

Chlorophyll (Aqua-MODIS)

2 rows in the rightmost column

Next

Yearly	Seasonal	Monthly	Weekly	Daily 3
				 25-Oct-2004 9km png HDF 4km png HDF
2004 9km png HDF 4km png HDF	Autumn-2004 9km png HDF 4km png HDF	Oct-2004 9km png HDF 4km png HDF	23Oct2004 to 30Oct2004 9km png HDF 4km png HDF	 26-Oct-2004 9km png HDF 4km png HDF

Level-1 & 2 Multi-Sensor Browse & Distribution

TC CHL SST SeaWiFS User Login

Comment Help

SeaWiFS

GAC LAC MLAC

OCTS (ADEOS) MODIS (Aqua) CZCS (Nimbus-7)

Radius (*km*) about map click or typed-in location:

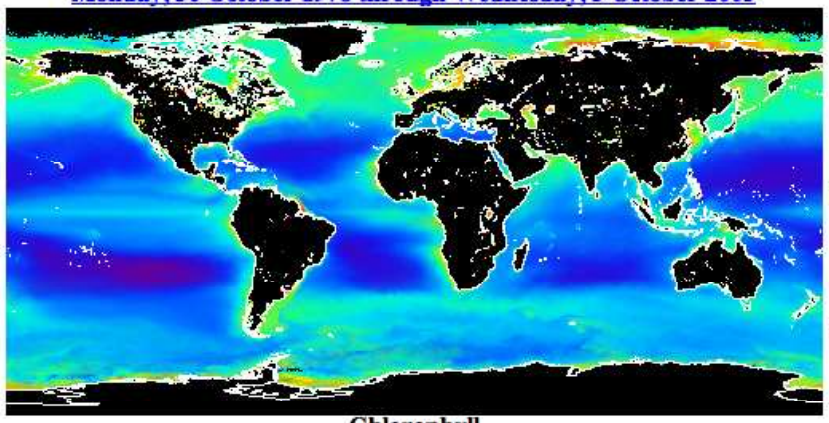
36 400 800 1200 1500

Select swaths containing *(at least)*:

any part 25 % 50 % 75 % all of the area of interest.

Display results 10 at a time.

Monday, 30 October 1978 through Wednesday, 5 October 2005



Chlorophyll

Select one or more regions:

AdriaticSea
AegeanSea
Antarctica
ArabianSea
AralSea
Australia
Azores

or specify boundary coordinates or a single location:

N:

W: :E

S:

or check this box to select all of this time period's scenes.

Find swaths

Reconfigure page

Mission													
	1978	J	F	M	A	M	J	J	A	S	O	N	D
	1979	J	F	M	A	M	J	J	A	S	O	N	D
	1980	J	F	M	A	M	J	J	A	S	O	N	D
	1981	J	F	M	A	M	J	J	A	S	O	N	D
	1982	J	F	M	A	M	J	J	A	S	O	N	D
	1983	J	F	M	A	M	J	J	A	S	O	N	D
	1984	J	F	M	A	M	J	J	A	S	O	N	D
	1985	J	F	M	A	M	J	J	A	S	O	N	D
	1986	J	F	M	A	M	J	J	A	S	O	N	D
	1996	J	F	M	A	M	J	J	A	S	O	N	D
	1997	J	F	M	A	M	J	J	A	S	O	N	D
	1998	J	F	M	A	M	J	J	A	S	O	N	D
	1999	J	F	M	A	M	J	J	A	S	O	N	D
	2000	J	F	M	A	M	J	J	A	S	O	N	D
	2001	J	F	M	A	M	J	J	A	S	O	N	D
	2002	J	F	M	A	M	J	J	A	S	O	N	D
	2003	J	F	M	A	M	J	J	A	S	O	N	D
	2004	J	F	M	A	M	J	J	A	S	O	N	D
	2005	J	F	M	A	M	J	J	A	S	O	N	D

August 2005

S	M	T	W	T	F	S
	1 xxx	2 xxx	3 xxx	4 xxx	5 ^^^	6 ^^^
7 ^^^	8 ^^^	9 ^^^	10 ^^^	11 ^^^	12 ^^^	13 ooo
14 ooo	15 ooo	16 ooo	17 ooo	18 ooo	19 ooo	20 ooo
21 ***	22 ***	23 ***	24 ***	25 ***	26 ***	27 ***
28 ***	29 xxx	30 xxx	31 xxx			

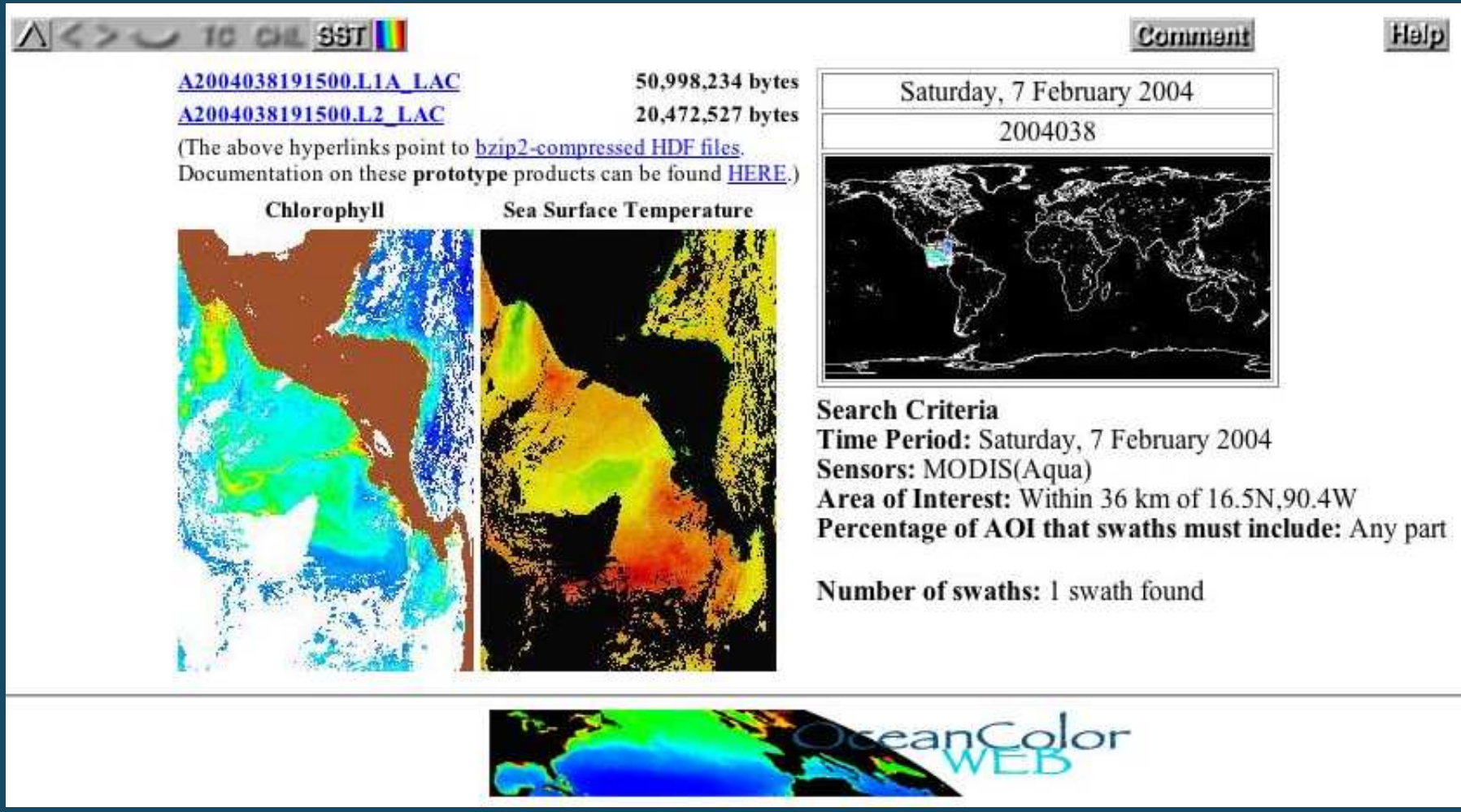
September 2005

S	M	T	W	T	F	S
				1 xxx	2 xxx	3 xxx
4 xxx	5 xxx	6 ^^^	7 ^^^	8 ^^^	9 ^^^	10 ^^^
11 ^^^	12 ^^^	13 ^^^	14 ooo	15 ooo	16 ooo	17 ooo
18 ooo	19 ooo	20 ooo	21 ooo	22 ***	23 ***	24 ***
25 ***	26 ***	27 ***	28 ***	29 ***	30 xxx	

October 2005

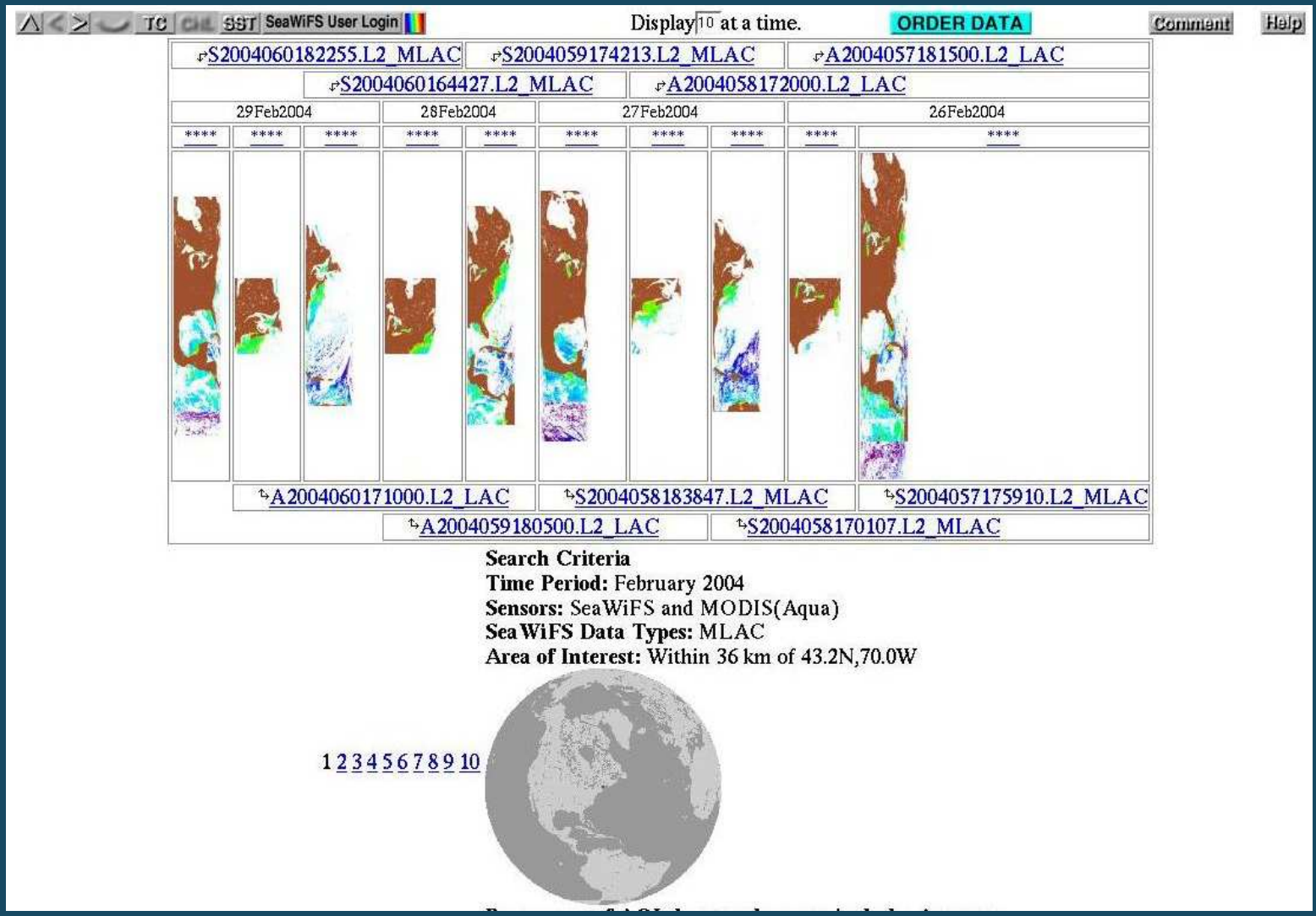
S	M	T	W	T	F	S
						1 xxx
2 xxx	3 xxx	4 xxx	5 xxx	6 xxx	7 xxx	8 ^^^
9 ^^^	10 ^^^	11 ^^^	12 ^^^	13 ^^^	14 ^^^	15 ^^^
16 ooo	17 ooo	18 ooo	19 ooo	20 ooo	21 ooo	22 ooo
23 ooo	24 ***	25 ***	26 ***	27 ***	28 ***	29 ***
30 ***	31 ***					

Single File Browse and Download



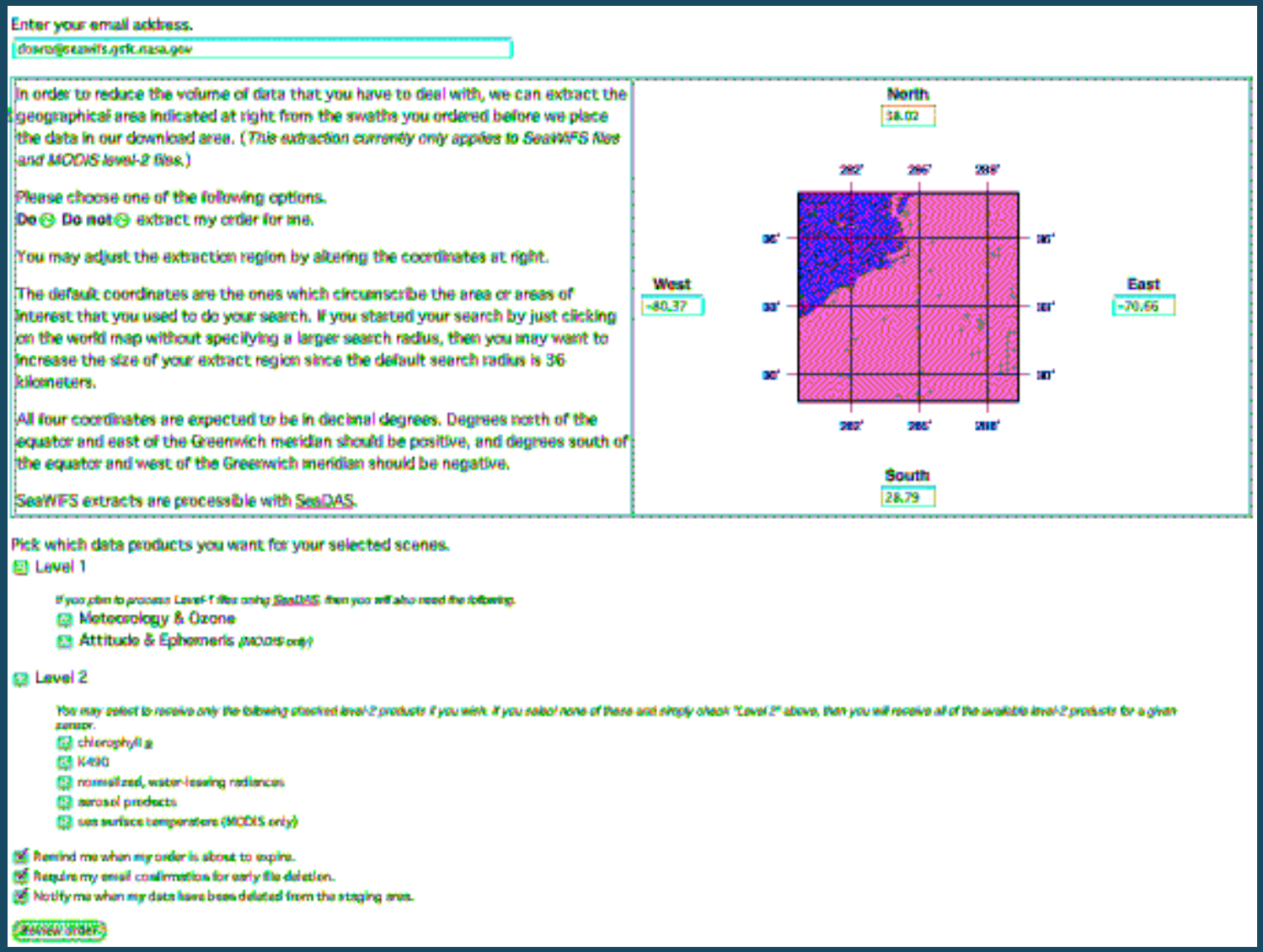
Multiple File Browse and Order

users can order one file or the entire multi-mission data set



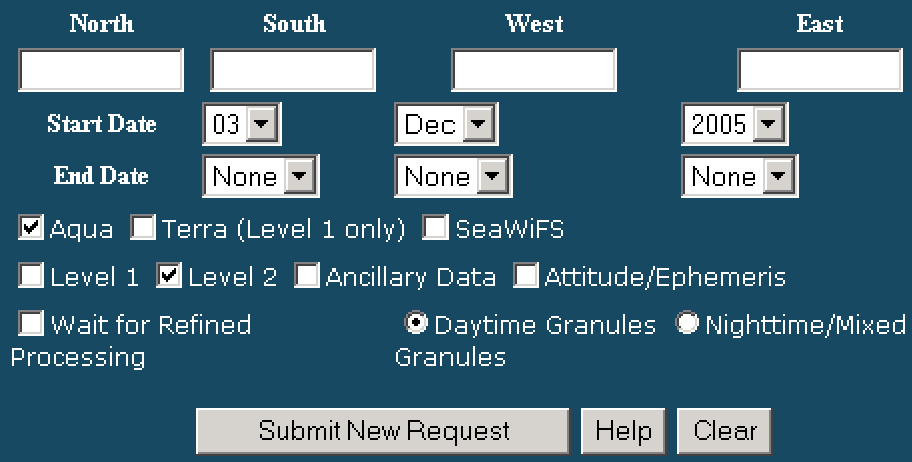
Regional and Product Subsetting of Order

users only download what they need



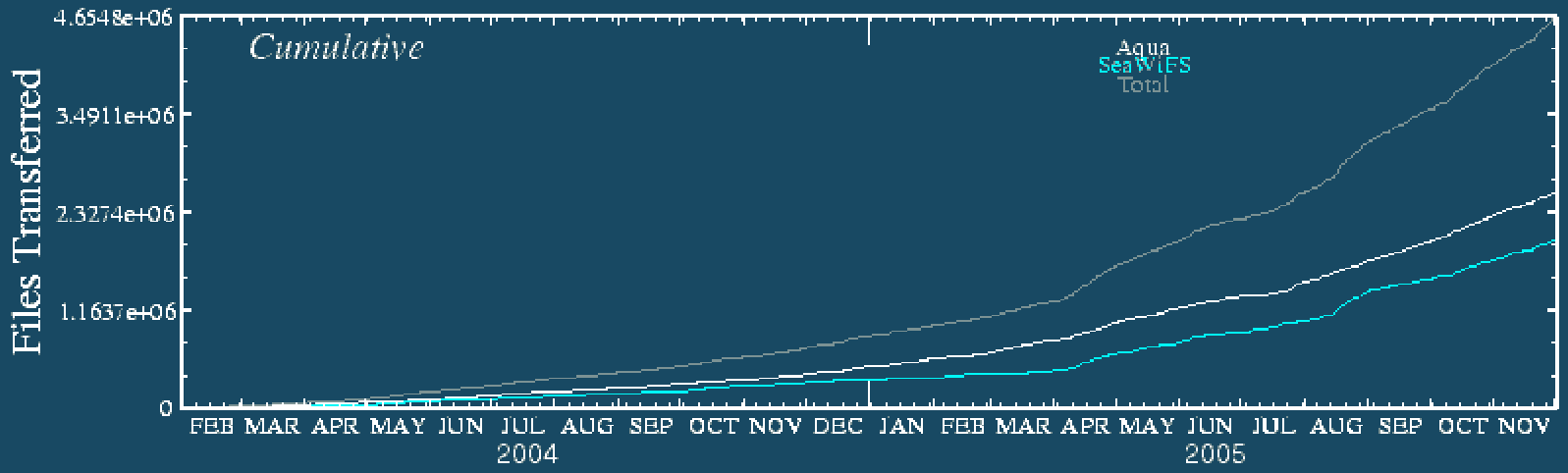
Data Subscription Service

users can fully automated future data acquisition



- specify region of interest
- specify type of data (Level-1, Level-2, Quicklook or Refined, Day/Night)
- files automatically staged for ftp transfer

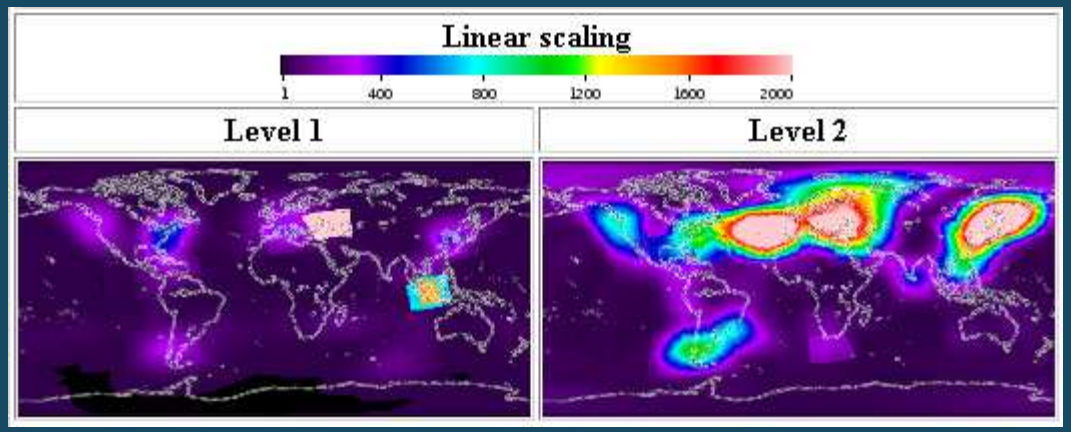
Files Distributed to Users
4.6 Million Since February 2004



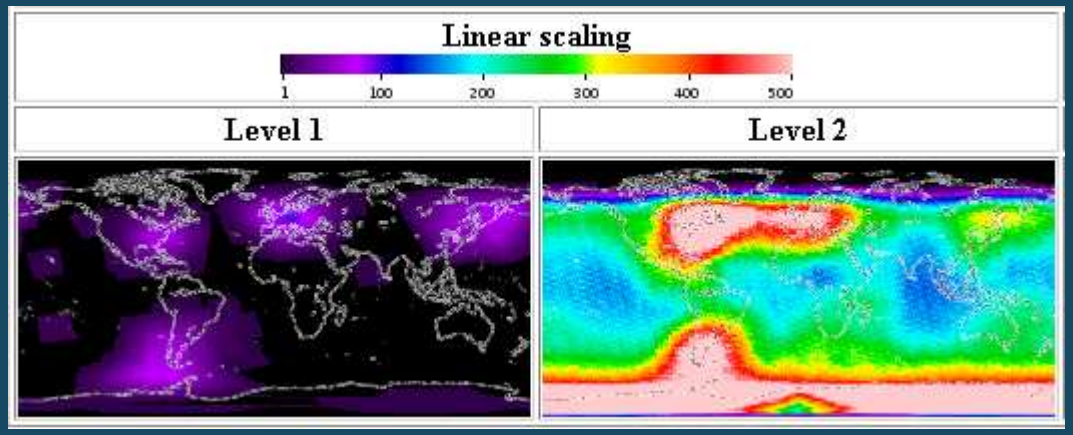
Source	L1	L2	L3	Ancillary	Totals
SeaWiFS	HTTP REQ REC ARC Files: 2494 297058 0 2611 GB: 71.7 3636.3 0 14.5	HTTP REQ REC ARC Files: 3842 525249 0 1590 GB: 68.7 2151.2 0 23.2	HTTP REQ REC ARC Files: 9165 0 0 625455 GB: 14.8 0 0 3295.2	ARC Files: 535783 GB: 557.07	SeaWiFS Files: 2003247 GB: 9832.67
Aqua	HTTP REQ REC ARC Files: 15576 54249 18308 21036 GB: 303.8 2443.9 559.6 204.7	HTTP REQ REC ARC Files: 42787 304417 455401 10209 GB: 286 2026.8 3116.9 83.7	HTTP REQ REC ARC Files: 21841 0 0 321904 GB: 35.2 0 0 1792	ARC Files: 1302814 GB: 3879.48	Aqua Files: 2568542 GB: 14732.08
TOTALS	Files: 411332 GB: 7234.5	Files: 1343495 GB: 7756.5	Files: 978365 GB: 5137.2	Files: 1838597 GB: 4436.55	Files: 4571789 GB: 24564.75

Geographical Distribution of File Downloads

Web Browser Downloads



FTP Downloads



European and Asian researchers prefer web access, while American and Southern Ocean folks prefer ftp.

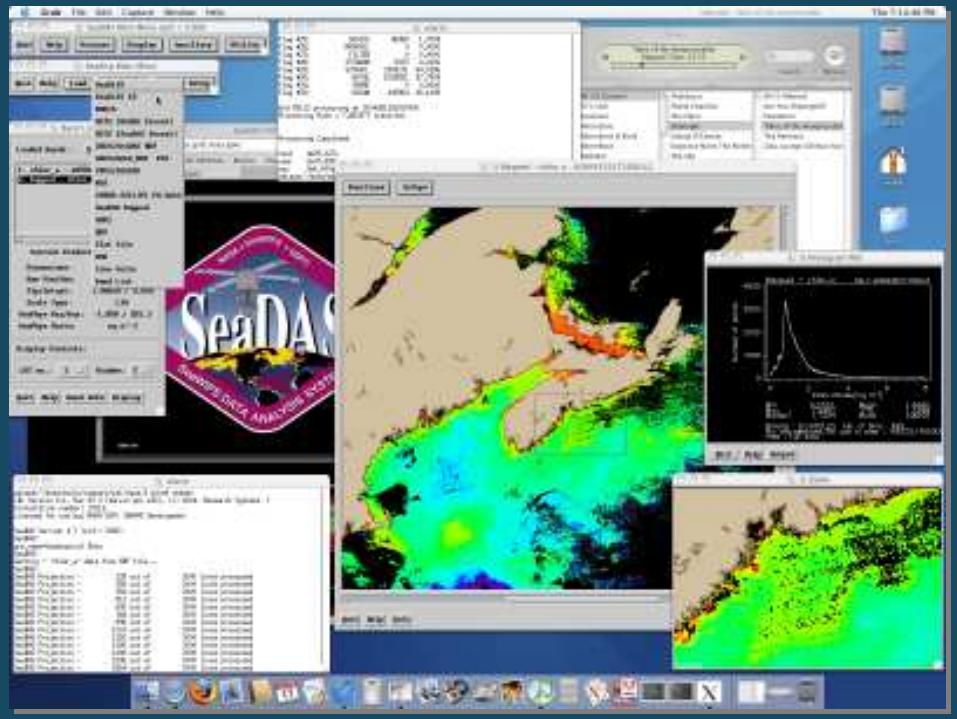
SeaDAS

providing the user with the required tools
expanding the standard product suite

- software to display and analyze all products produced by the OBPG
- software AND source code to process from Level-0 through Level-3
- allows users to do local reprocessing (reproduce standard products)
- provides for user-specific product suites

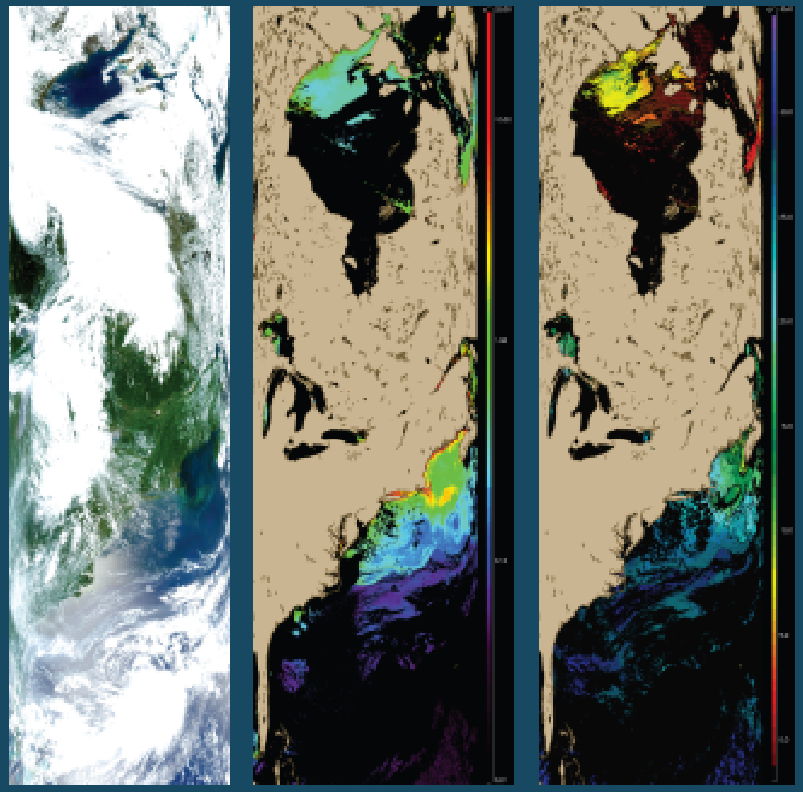
Some Product Algorithms in SeaDAS

- **water-leaving radiances**
- **remote sensing reflectance**
- **SST (thermal and short-wave IR)**
- **chlorophyll (8 algorithms)**
- **diffuse attenuation of sea water**
- **IOP (GSM01, Carder, QAA):**
- **particulate organic carbon**
- **total suspended matter**
- **calcite concentration**
- **fluorescence line height**
- **PAR, IPAR**
- **aerosol products (AOT, Angstrom)**
- **intermediate products (Lr, La, etc.)**

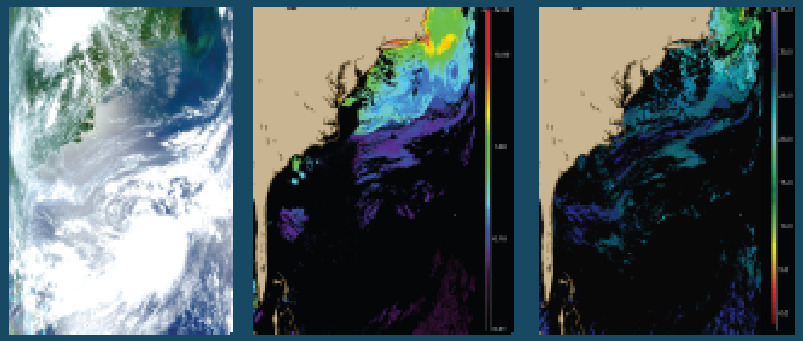


Direct Broadcast Support

facilitating real-time product generation



True Color Chlorophyll SST



12 minute MODIS pass from University of Wisconsin DB Station, processed from Level-0 through Level-2 with SeaDAS

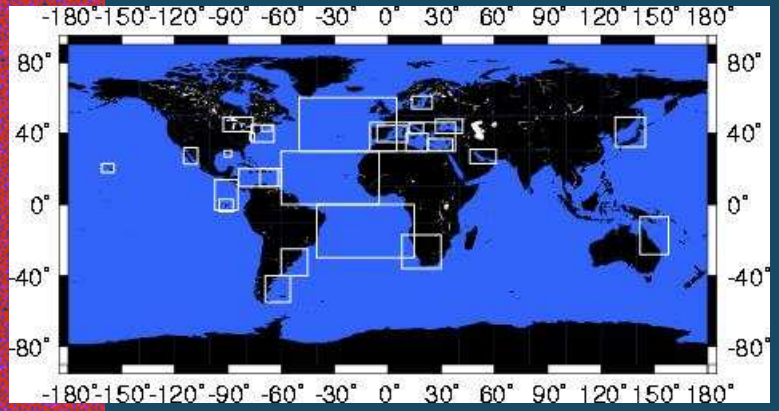
Standard 5-minute MODIS granule processed from Level-0 to Level-2 by OBPG

Near Real-Time Mapped Image Support

supporting field campaigns for collection of validation data

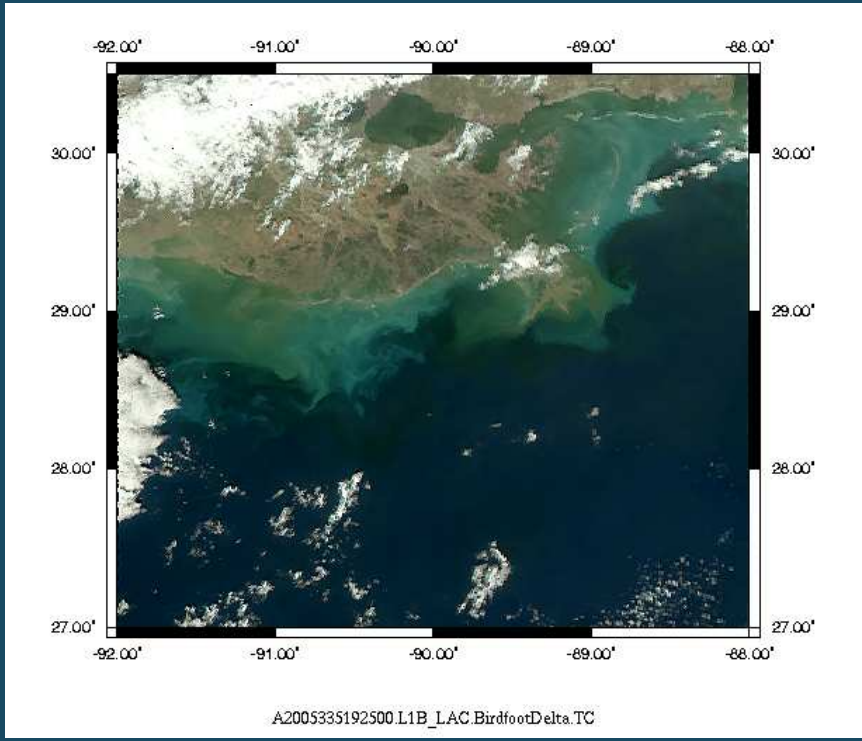
- select region
- select products
- select map characteristics
- receive daily images
- email or ftp

current subscriptions for image support

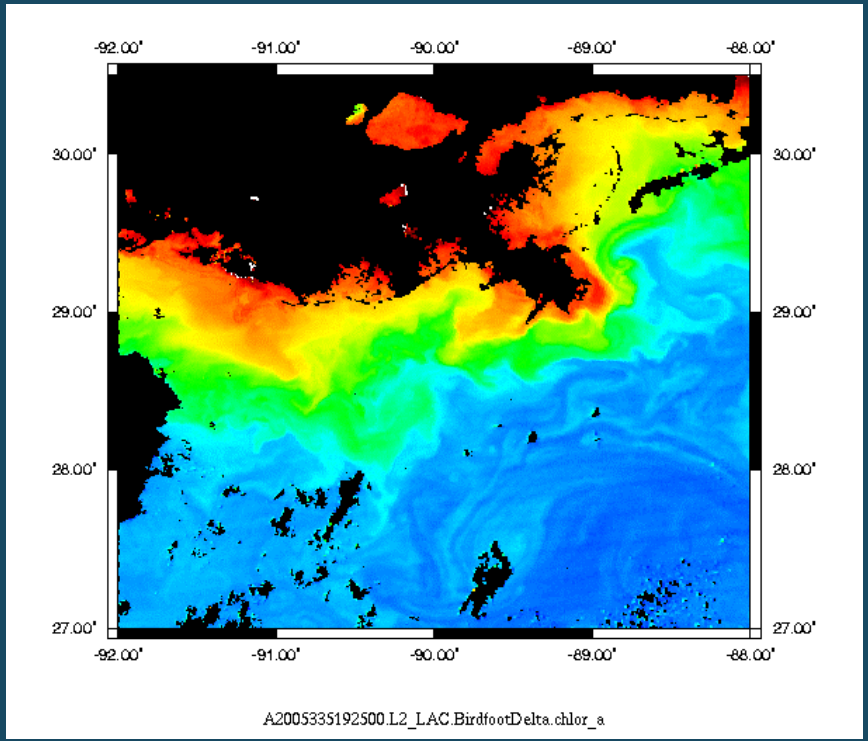


Near Real-Time Mapped Image Support

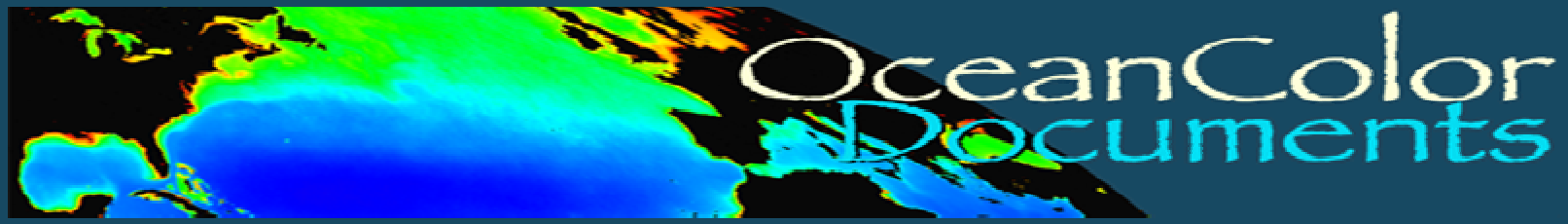
True Color



Chlorophyll-a



Option to receive corresponding Level-1 and Level-2 HDF files, extracted to the region



Ocean Color Data Reprocessing

As algorithms mature, reprocessing of the data set is required to improve the archived products. Additionally, it occasionally becomes necessary to redefine the archive product suite as more useful data products are recommended to the Project. To address these issues, periodic reprocessings are planned by the Project. The Ocean Color Data Processing staff continues to work diligently to address those problems that remain in the data products. Further details on current and past reprocessing efforts are available below.

SeaWiFS

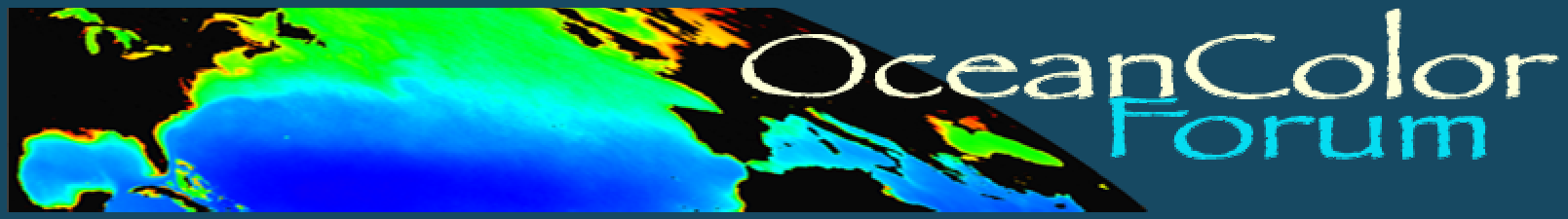
Reprocessing 5.1 - Completed July 5, 2005
Reprocessing 5 - Completed March 18, 2005
Reprocessing 4.1 - Completed May 24, 2004
Reprocessing 4 - Completed July 25, 2002
Reprocessing 3 - Completed May 24, 2000
Reprocessing 2 - August, 1998
Reprocessing 1 - January, 1998
Calibration Update - April 10, 2001
Calibration Update - December 1, 2000

Aqua

Reprocessing 1.1 - Completed August 4, 2005
Reprocessing 1 - Completed February 2005
Initial Processing by ODPS - Completed May 24, 2004

Curator: OceanColor Webmaster
Authorized by: gene carl feldman
Updated: 10 August 2005

Security, Privacy, and Accessibility Policy



Ocean Color Forum - Welcome, bryan

Forum | OceanColor Home | Help | Search | Options | Logout

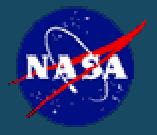
Forum

Mark Old | Mark Read | New | Unread | Replies | ToDo | Feeds | Info

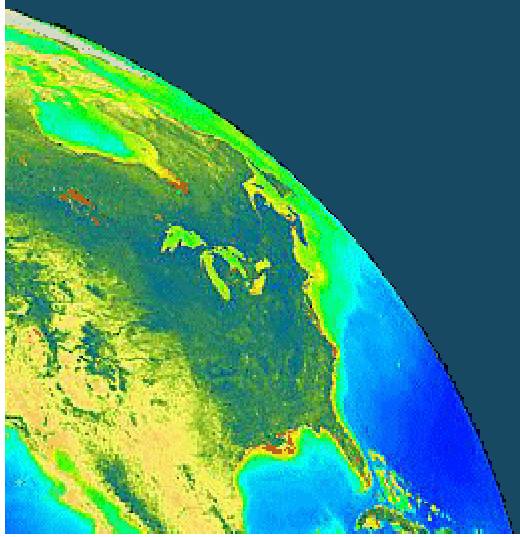
Ocean Color	Posts	Last Post
OceanColor Announcement	42	2005-08-19 09:38
Algorithms and Products	**Posts**	**Last Post**
Frequently Asked Questions	23	2005-10-25 14:24
Satellite Data Products & Algorithms	563 (2 new)	2005-12-02 16:27
Satellite Data Access	445 (1 new)	2005-12-02 16:43
Field Data	14	2005-09-12 14:27
Mission Events	2	2004-04-23 12:17
SeaDAS	**Posts**	**Last Post**
SeaDAS: Known Problems and Fixes	5	2005-11-01 16:25
SeaDAS: General Questions	1217 (8 new)	2005-12-03 13:14
MODIS Direct Broadcast Support	20	2005-11-18 18:50

Curator: OceanColor Webmaster
Authorized by: gene carl feldman
Updated: 20 October 2005

Security, Privacy, and Accessibility Policy



http://oceancolor.gsfc.nasa.gov/



Notes

The Ocean Color Web http://oceancolor.gsfc.nasa.gov was developed and is maintained by the Ocean Biology Processing Group (OBPG) at NASA's Goddard Space Flight Center as a means for disseminating information and data in support of NASA's Ocean Color program. The OBPG is responsible for the processing, validation, and distribution of Ocean Color and SST data from MODIS, and Ocean Color data from SeaWiFS, OCTS, and CZCS. The Ocean Color web is the public interface to a fully automated data system for acquisition, processing, analysis, and distribution of data from these spaceborne sensors. Key features include web and ftp-based data access, timely availability of data products, data subscription services, parameter and regional subsetting, image support for field campaigns, extensive documentation, and user support forums. This paper presents an overview of the valuable Ocean Color Web resources that allow the scientific community to browse, download, and analyze Ocean Color and SST data from multiple satellites.

Ocean Biology Data Processing System - Processing Node

Supermicro 6024 rack mount server

2	Intel Xeon CPUs 3.06 Ghz
8	1 GB DDR2 RAM modules
2	Intel Gigabit Ethernet network interfaces
1	Seagate 80 GB EIDE disk (system)
5	Maxtor 73.4 GB Atlas 10K IV Ultra320 SCSI disks (processing)
1	CD-ROM (low profile)
1	Supermicro X5DP8-G2 motherboard with built-in Ultra320 SCSI controller
1	Supermicro 6024H 2U rack mount server case with dual power supplies

Operating system: Linux

Ocean Biology Data Processing System - Storage Node

NAS 1.2 TB rack mount server

1	Intel Pentium-4 CPU 3.06 Ghz
2	512 MB DDR2 RAM modules
1	Gigabit Ethernet network interface
1	Seagate 80 GB EIDE disk (system)
8	Maxtor 250 GB MaxLine Plus II EIDE disks (RAID 5, 6 data + 2 hot spares)
1	CD-ROM (low profile)
1	Asus P4C800-E Motherboard
1	3ware Escalade RAID controller for 8 drives
1	Comix Computer RM-3U9SCA (IDE) ATX rackmount chassis 3 U, 9 hot swappable drive bays

Operating system: Linux

Ocean Biology Data Processing System - Large Server

SunFire V880 rack mounted

4-8 UltraSPARC-III+ processors

8-16 GB RAM

6-12 73 GB 10K RPM FibreChannel disks

2 Gigabit Ethernet nework interfaces

1-5 Fast Ethernet network interfaces

1 External FibreChannel adapter

Operating system:Solaris

Ocean Biology Data Processing System - Network Switch

Extreme Networks Black Diamond 6816

768 Gbps total switching capacity
Route/filter/forward 192 million pps

160 GigE ports in current configuration

All modules are hot swappable

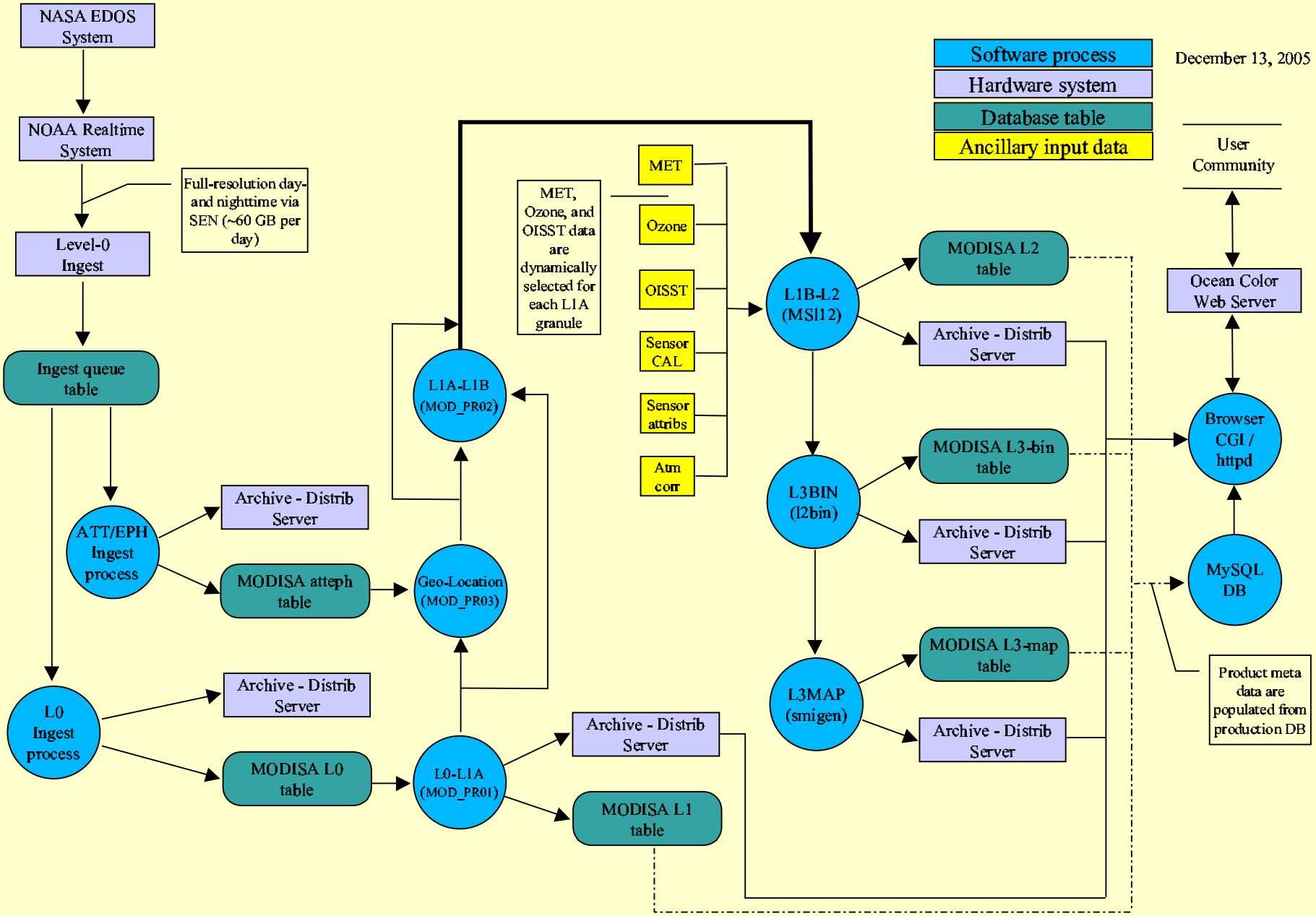
4 MSM management modules

2 G8Ti 8 port Gigabit Ethernet modules

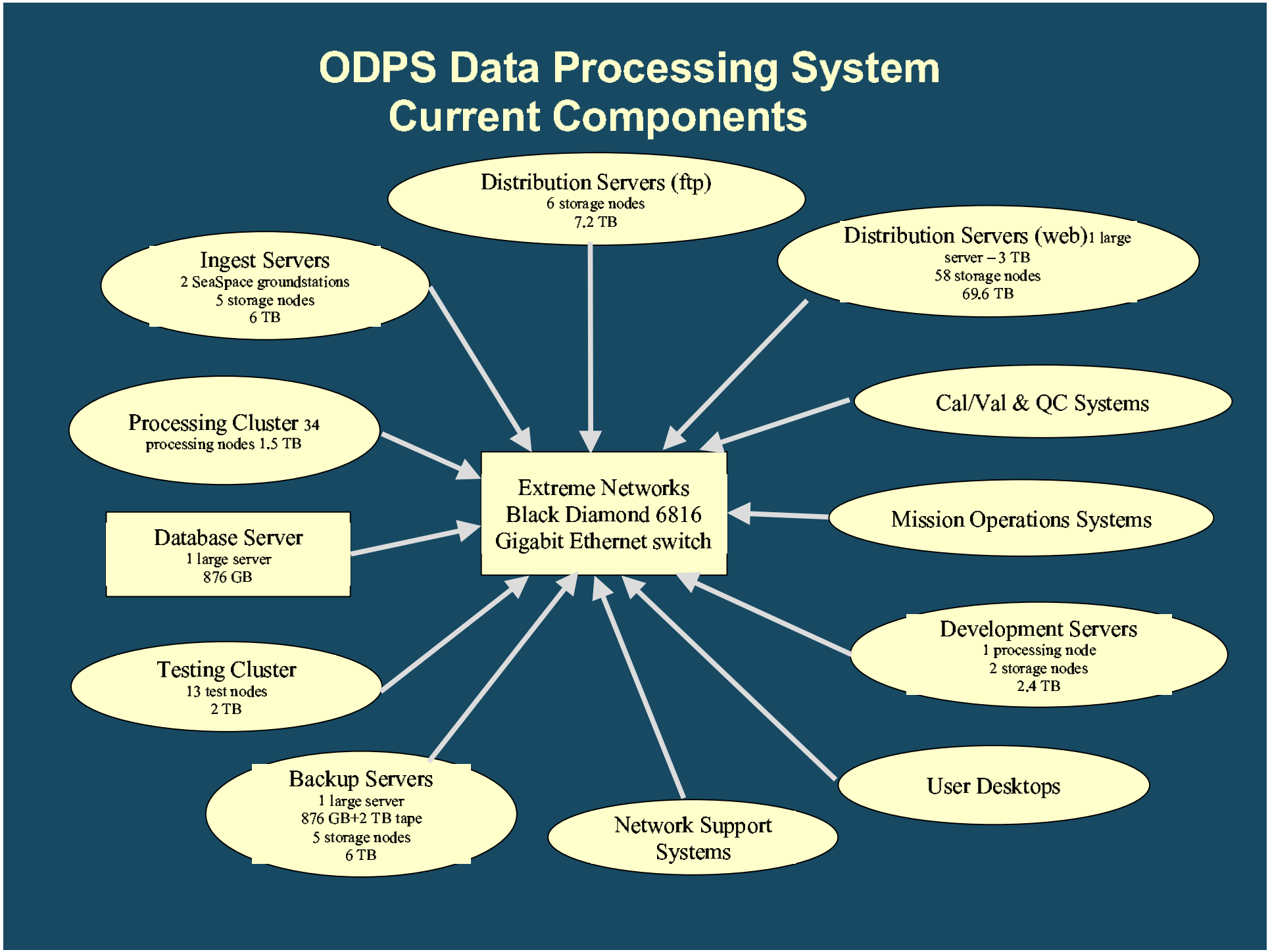
6 G24T3 24 port Gigabit Ethernet modules

4 Hot-swappable power supplies

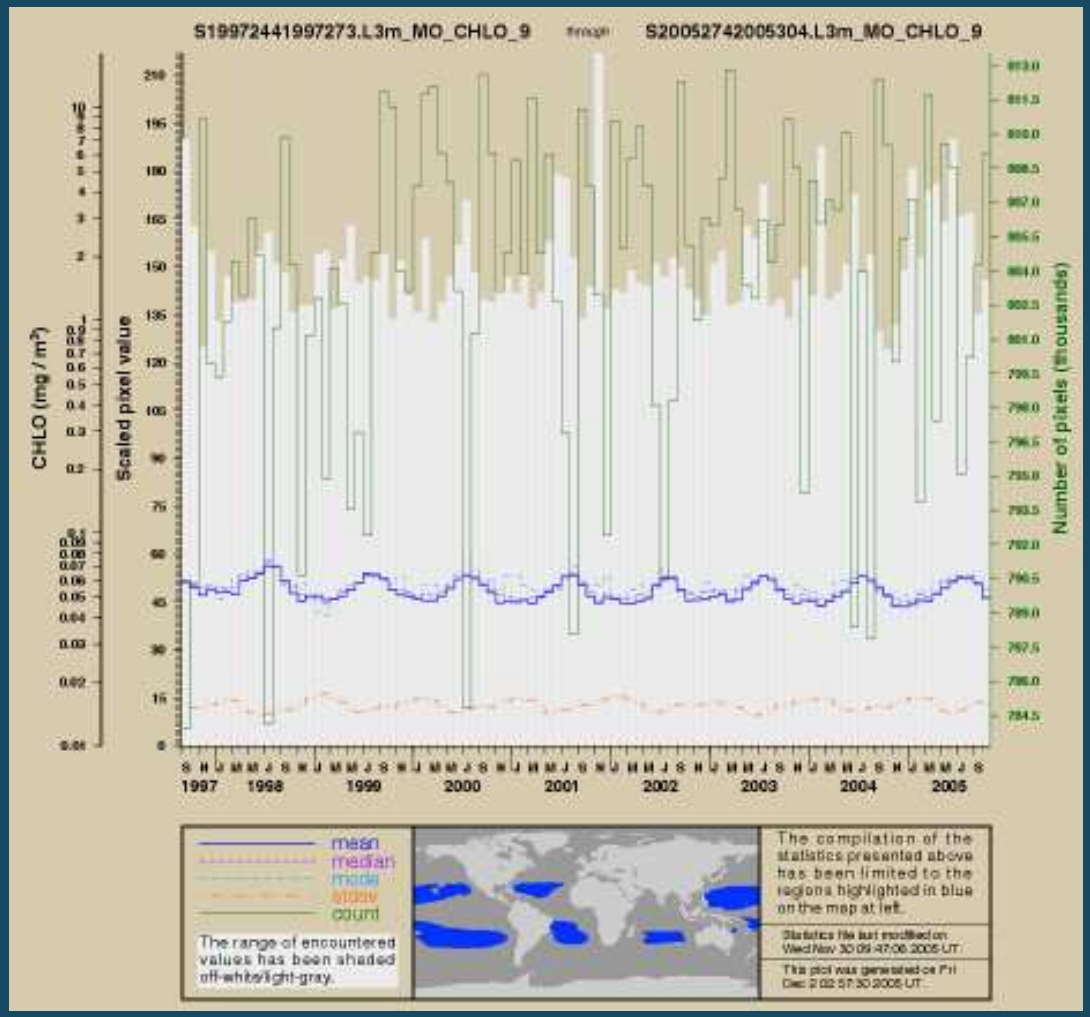
Operational MODIS-Aqua Data Flow



ODPS Data Processing System
Current Components



Time-Series Utility



MODIS Direct Broadcast Receiving Stations