

Introduction to The Ocean Color Missions



MERIS

Sentinel-3a,b OLCI

Sentinel-2a,b MSI

SeaWiFS

MODIS-Aqua, MODIS-Terra

VIIRS-NPP, VIIRS-JPSS1

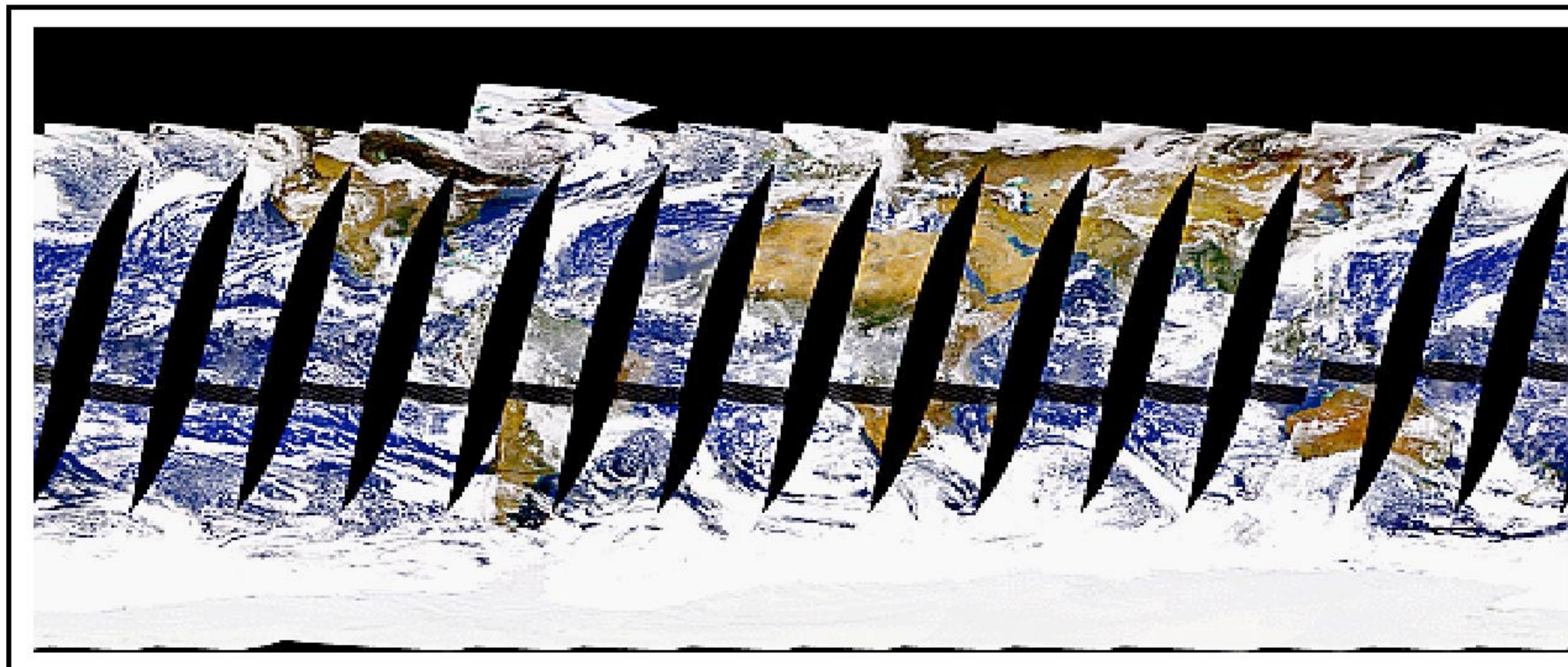
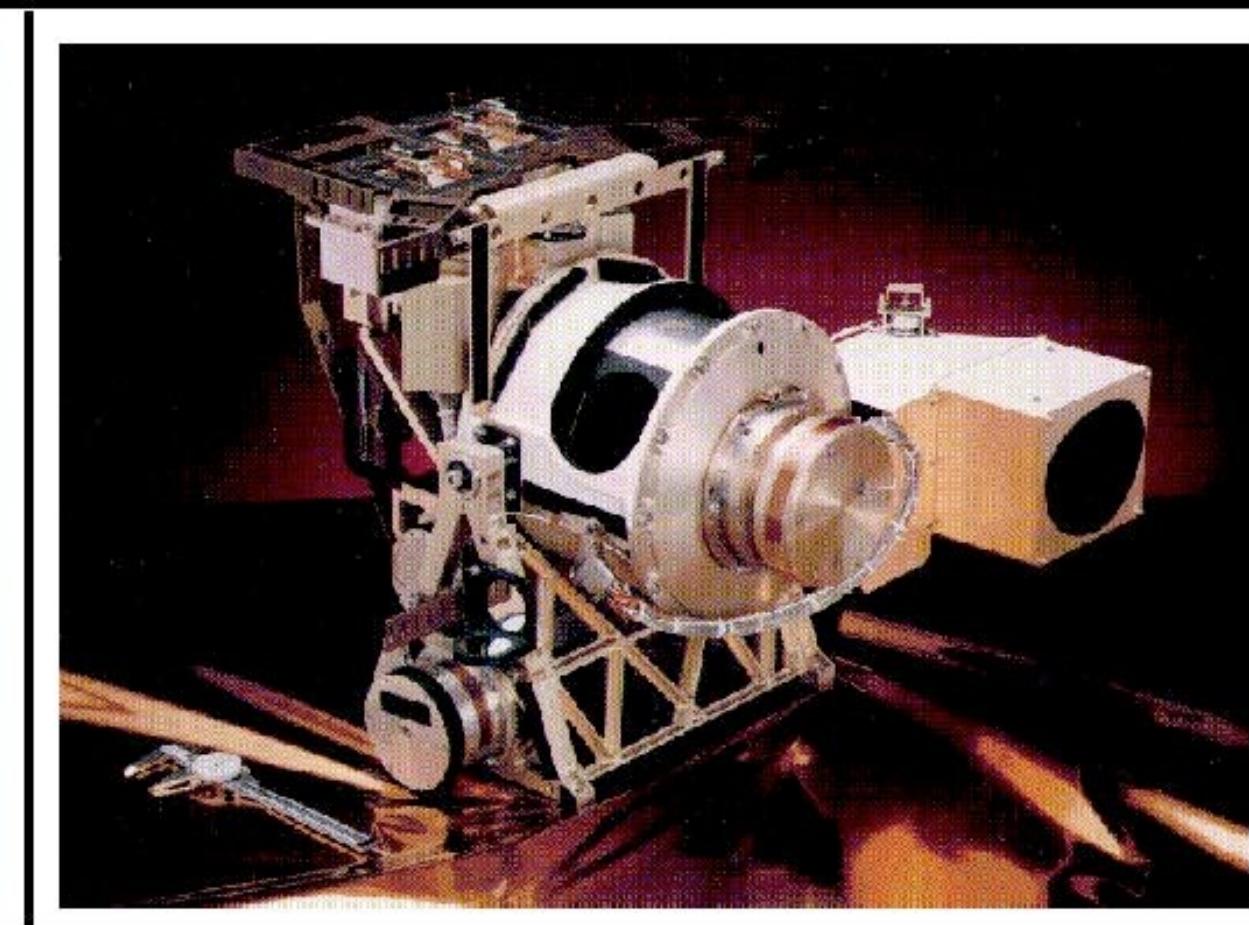
HICO, Landsat-8 OLI

PACE

HawkEye

SeaWiFS

(Sea-viewing Wide Field-of-view Sensor)



SeaWiFS

Sea-viewing Wide Field-of-view Sensor

Band	Center Wavelength (nm)	Purpose
1	412	detritus cdom correction
2	443	pigment algorithm
3	490	pigment algorithm
4	510	pigment algorithm
5	555	pigment algorithm
6	670	atmospheric correction
7	765	atmospheric correction
8	865	atmospheric correction

Period: 1997 - 2010

Sun Synchronous Orbit: 12:00 PM Equator Crossing

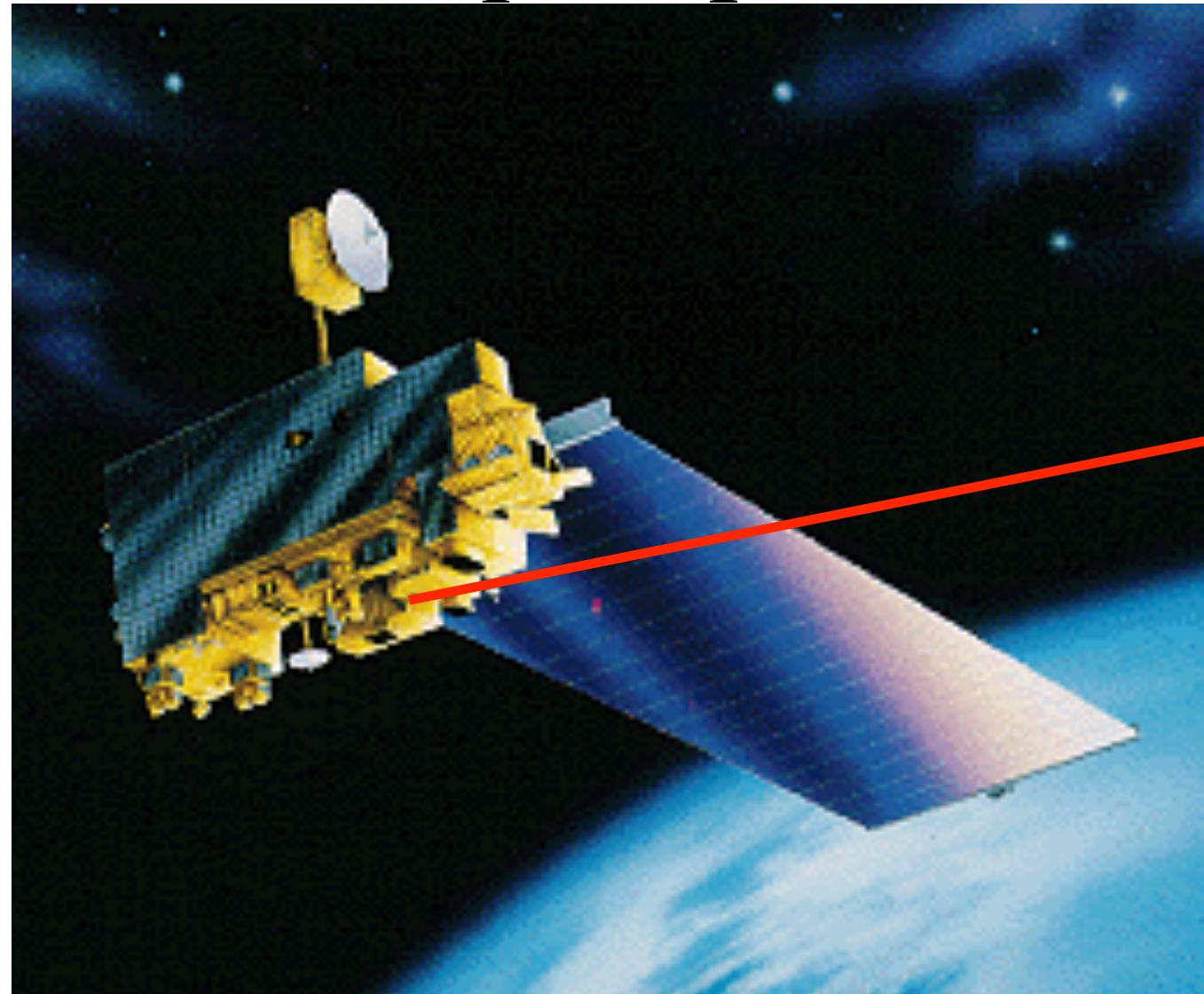
MODIS-*Terra* and MODIS-*Aqua*

Moderate Resolution Imagining Spectroradiometer

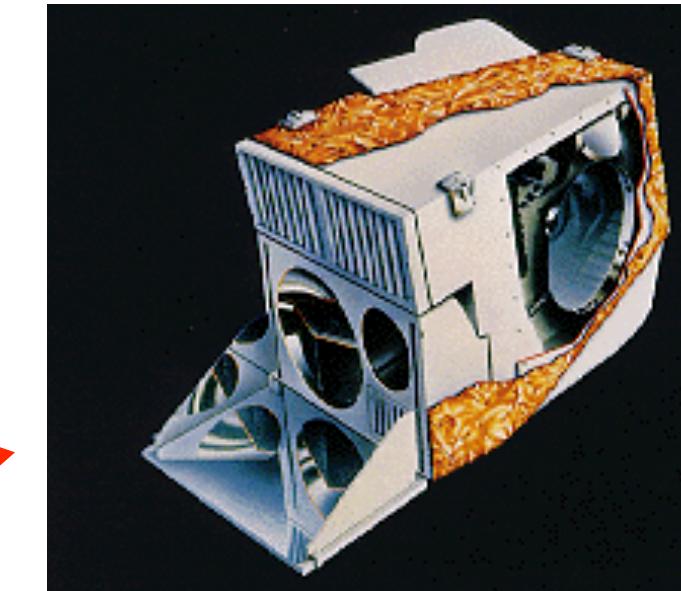
Five Instruments on the **Terra** Spacecraft: CERES ,MOPITT ,MISR, ASTER, **MODIS**

Six Instruments on the **Aqua** Spacecraft:
AIRS, AMSU-A, HSB, AMSR-E, CERES and **MODIS**

Terra/Aqua Spacecraft



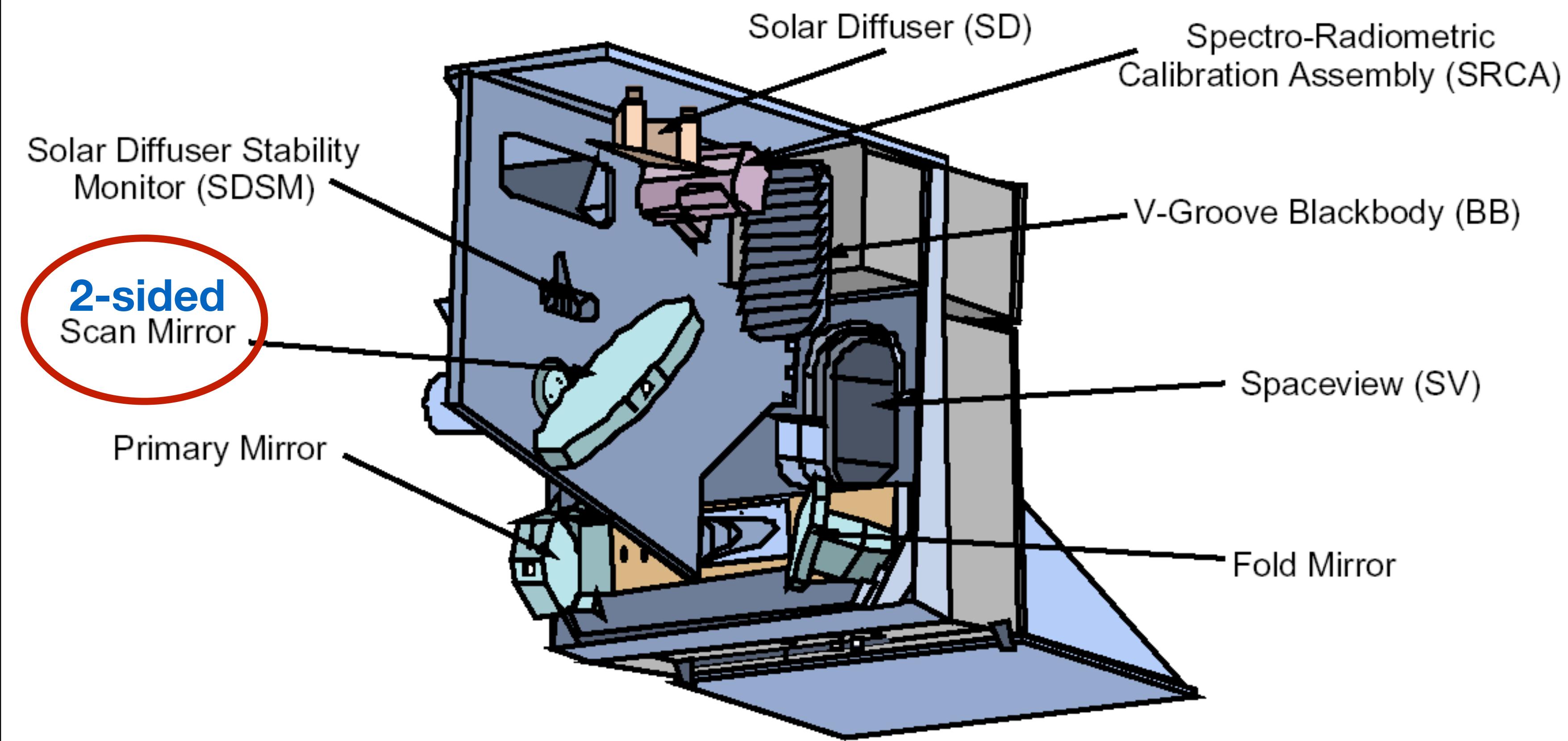
MODIS Sensor



1. MODIS **Ocean**
2. MODIS *Land*
3. MODIS *Atmosphere*

MODIS Instrument Design

On-Board Calibrators in MODIS Scan Cavity



SeaWiFS

Sea-viewing Wide Field-of-view Sensor

Single-Sided
Scan Mirror

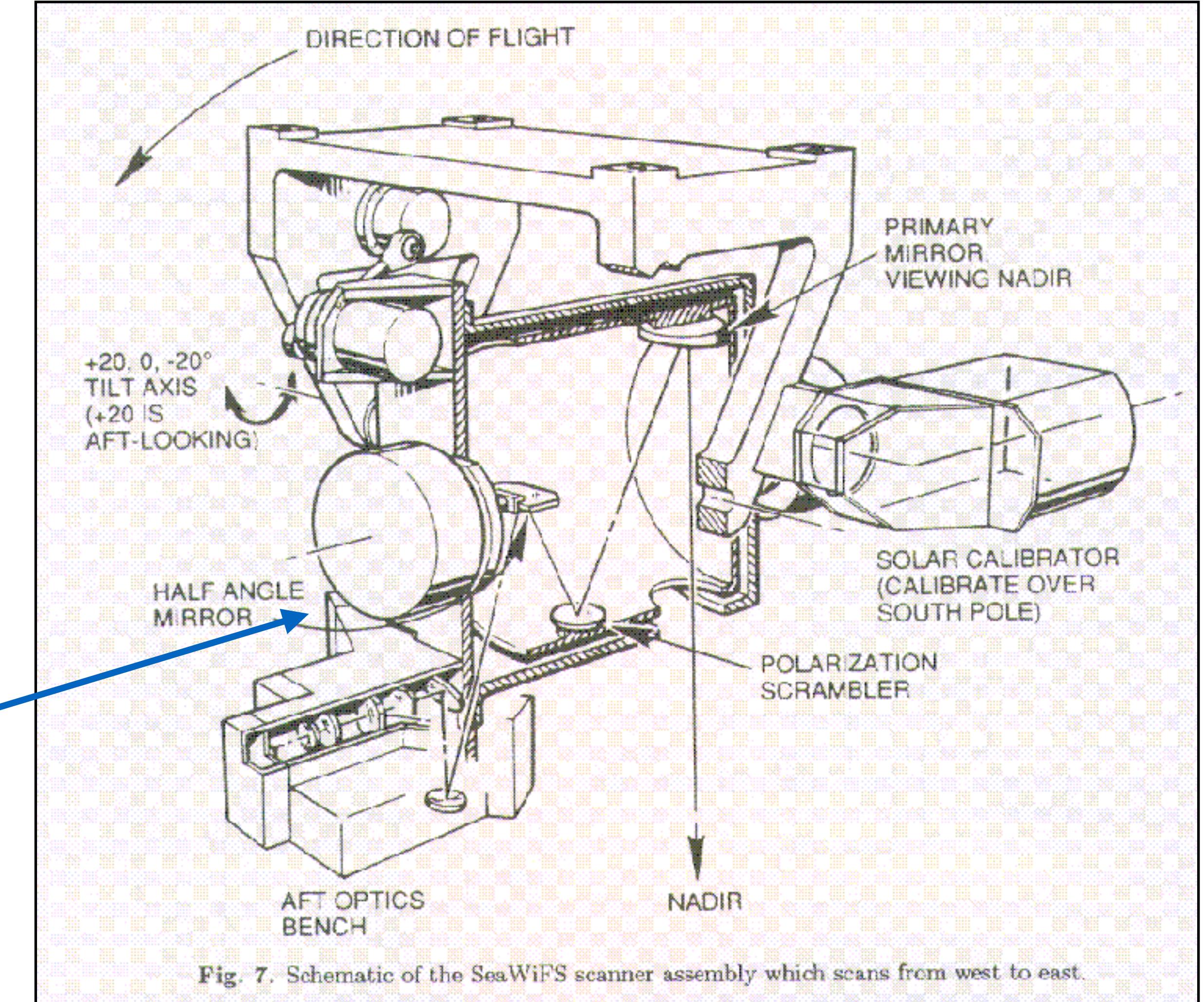
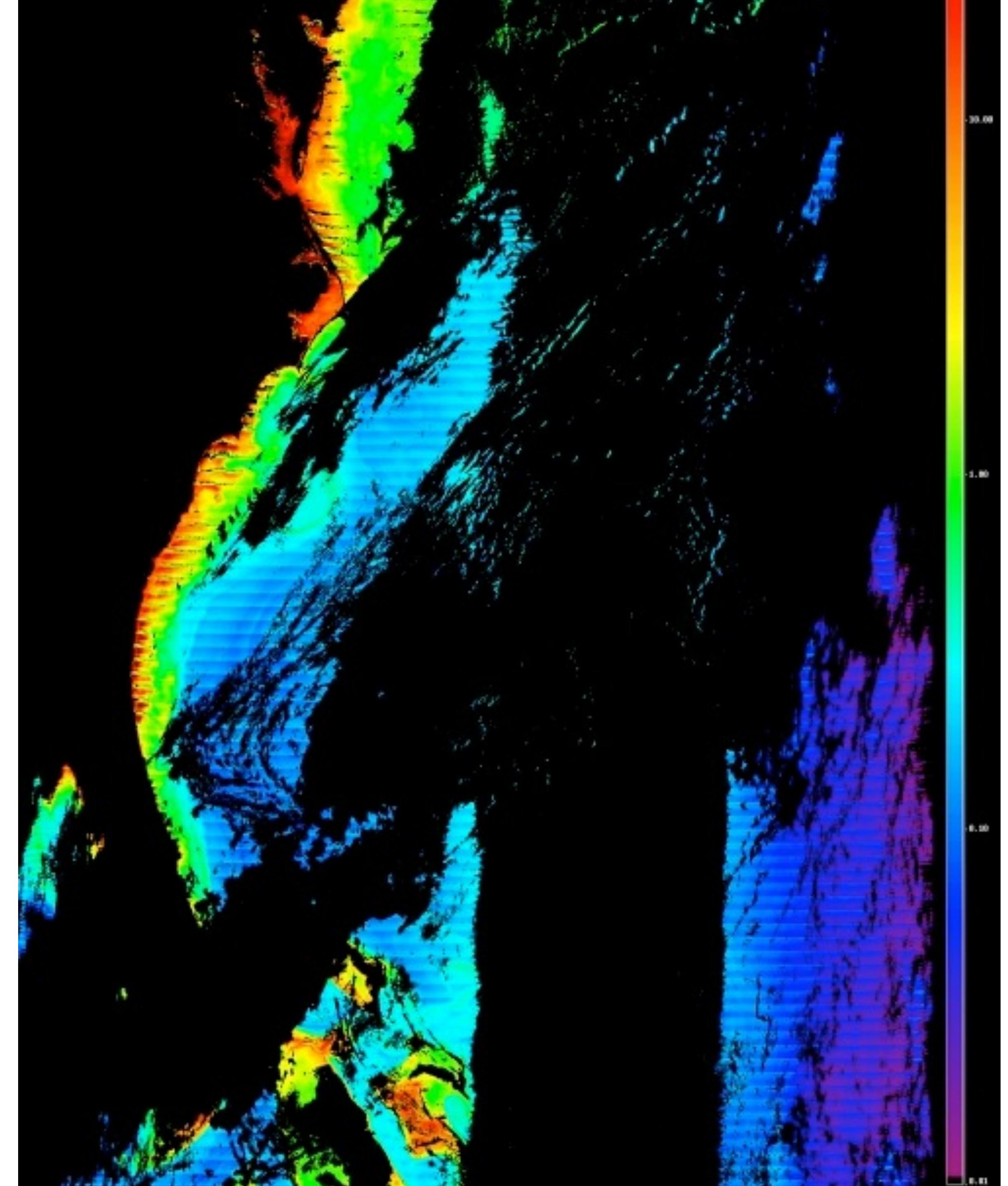
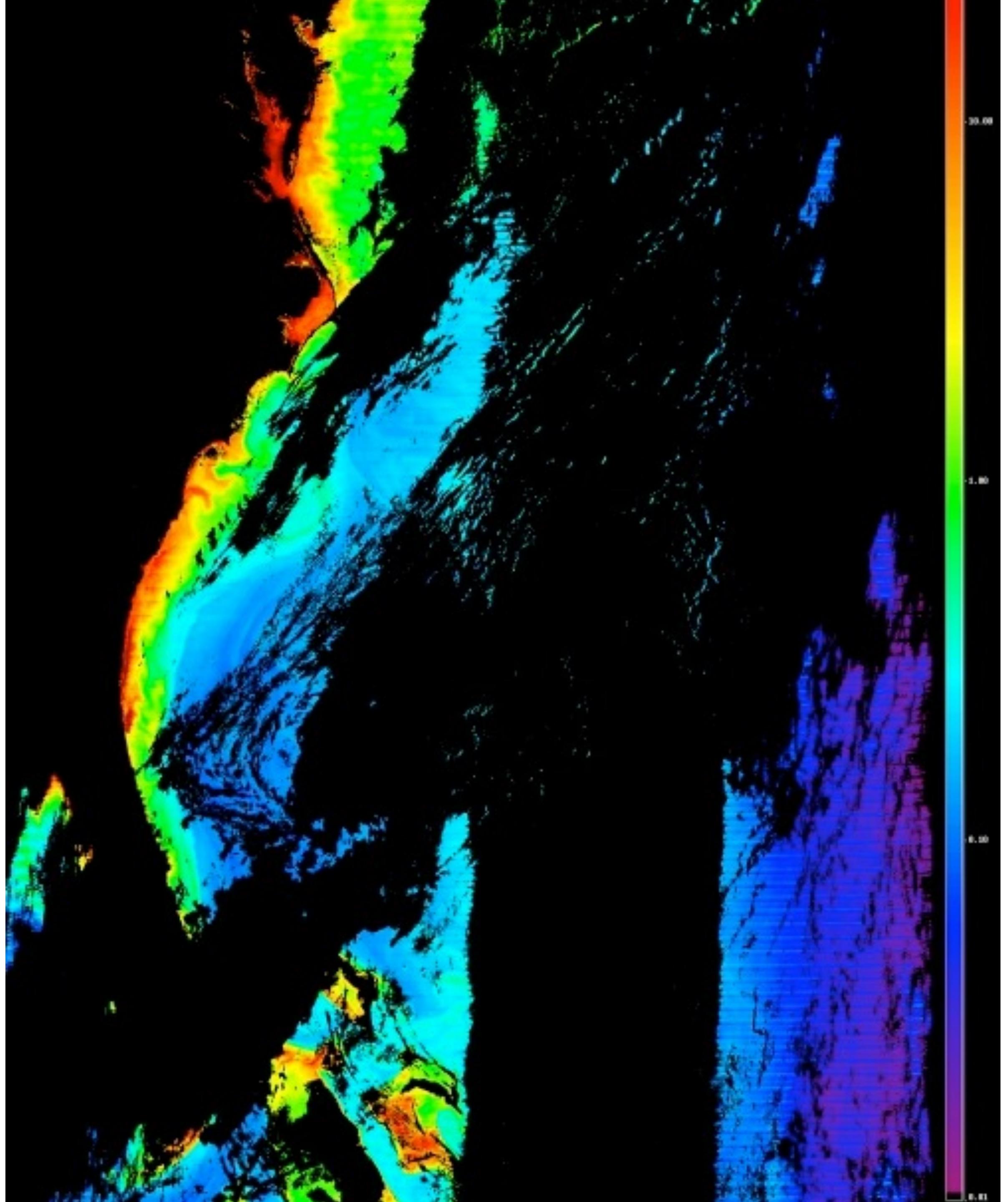


Fig. 7. Schematic of the SeaWiFS scanner assembly which scans from west to east.





MODIS Striping and Banding

Striping is an artifact of the instrument design. Any MODIS image will show some level of **detector striping** and mirror-side banding. The relative calibration is imperfect, and the relative response of **each detector and each mirror-side** is dependent to some degree on the source strength, source spectral distribution, and source polarization.

Significant effort has been made to reduce these relative differences in detector to detector and mirror-side to mirror-side response, but it will never be perfect. **It is a fact of life for instruments of this design.**

SeaWiFS does not have this problem because it has only one effective detector per band, and it always looks at the mirror through the same angle-of-incidence.

MODIS- Traditional Ocean Bands

Moderate Resolution Imaging Spectroradiometer

Terra: December 1999 - Current

Sun Synchronous Orbit

10:30 AM equator crossing

Note: Terra ocean color prods are generally considered lower quality than aqua.

SST products are high quality

Aqua: May 2002 - Current

Sun Synchronous Orbit

1:30 PM equator crossing

Band	Ctr. Wavelength (nm)	Purpose
1	412 nm	detritus correction
2	443 nm	pigment algorithm
3	488 nm	pigment algorithm
4	531 nm	pigment algorithm
5	547 nm	pigment algorithm
6	667 nm	atmospheric correction
7	748 nm	atmospheric correction
8	869 nm	atmospheric correction
9	3.78 µm	sst4 nighttime
10	3.97 µm	sst4 nighttime
11	4.05 µm	sst4 nighttime
12	11.01 µm	sst daytime
13	12.03 µm	sst daytime

MODIS Ocean HiRes Bands

Band Number	Wavelength (nm)	Band Width (nm)	Spatial Resolution (m)	SNR at L _{typ}	L _{typ} mW cm ⁻² μm ⁻¹ sr ⁻¹	L _{max} mW cm ⁻² μm ⁻¹ sr ⁻¹	Notes
8	412	15	1000	1773	7.84	26.9	1
9	443	10	1000	2253	6.99	19.0	1
3	469	20	500	556	6.52	59.1	
10	488	10	1000	2270	5.38	14.0	1
11	531	10	1000	2183	3.87	11.1	1
12	551	10	1000	2200	3.50	8.8	1
4	555	20	500	349	3.28	53.2	
1	645	50	250	140	1.65	51.2	3
13	667	10	1000	1962	1.47	4.2	1
14	678	10	1000	2175	1.38	4.2	1
15	748	10	1000	1371	0.889	3.5	1
2	859	35	250	103	0.481	24.0	
16	869	15	1000	1112	0.460	2.5	1
5	1240	20	500	25	0.089	12.3	
6	1640	35	500	19	0.028	4.9	2
7	2130	50	500	12	0.008	1.7	

¹ Standard bands for ocean color, ² 1640 channel not functional on MODIS/Aqua, ³ Never saturated

Table 2: Thermal Bands for SST

Band Number	Wavelength (μm)	Spatial Resolution (m)
22	3.9	1000
23	4.0	1000
31	11	1000
32	12	1000

VIIRS-Suomi NPP

Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP Spacecraft



Mission: 2011 - Current



*National Polar-Orbiting Partnership (NPP)

Visible Infrared Imaging Radiometer Suite (VIIRS)

Suomi NPP* Spacecraft

- ▶ Crosses the equator at **1:30 p.m.**
- ▶ **Carries five key instruments**
 1. Advanced Technology Microwave Sounder (**ATMS**)
 2. Cross-track Infrared Sounder (**CrIS**)
 3. Ozone Mapping and Profiler Suite (**OMPS**)
 - 4. Visible Infrared Imaging Radiometer Suite (VIIRS)**
 5. Clouds and the Earth's Radiant Energy System (**CERES**).

*National Polar-Orbiting Partnership (NPP)

VIIRS Features

Characteristic	SeaWiFS	MODIS	VIIRS
Band Set (nm)	412, 443, 490, 510, 555, 670, 765, 865	412, 443, 488, 531, 547, 667, 678, 748, 869	412, 445, 488, 555, 672, 746, 865
Nadir Pixel Size	1.1 km	1 km	0.75 km
SNR Range	364 to 1010	726 to 2219	540 to 1239
Polarization Sensitivity	< 0.25% (Vis) < 0.5% (NIR)	1% to 6%	0.5% to 2.5%
Out-of-Band (worst case)	5.7% @865nm	3.8% @748 nm	4.9% @551 nm
Crosstalk?	None	SWIR	VisNIR
Tilt	-20,0,+20°	0°	0°
Detectors per	1	10	16

The diagram illustrates the spectral bands for four instruments: CZCS, SeaWiFS, MODIS, and VIIRS. The x-axis represents wavelength, and the y-axis represents the number of bands. The legend indicates color mapping: Ultraviolet (purple), Visible (blue, green, yellow), and SWIR (red). The diagram shows that VIIRS has the most extensive visible and SWIR coverage compared to the other instruments.

Comments About VIRRS From The OBPG...

- 1. The official source for NPP-VIIRS data is at NOAA.**
2. The OBPG group is working toward producing products that will extend the climate data record begun by missions such as SeaWiFS and MODIS.
- 3. As we develop our algorithms and calibration strategies, we are making the products that we produce available to the community for evaluation purposes.**
4. Since this is still a new mission and we do not have an operational mandate, some changes are to be expected from time to time.
5. Products that have NPP in their names have been produced -- soup to nuts -- by our data system, running our own versions of software from the lowest level RDR (akin to our level-0 designation) products. **Note: RDR= Raw Data Record**
6. Products having NPPS in their names have been produced from NOAA-supplied SDRs (akin to our level-1B products). **Note: SDR= Science Data Record**
7. Products having NPPE in their names have been produced from NOAA-supplied EDRs (akin to our level-2 products). **Note: EDR= Earth Data Record**

VIIRS-JPSS1 = VIIRS NOAA20

VIIRS on the Joint Polar Satellite System-1 (JPSS-1)

Launched: **November 2017**

Leads VIIRS-NPP by a half orbit

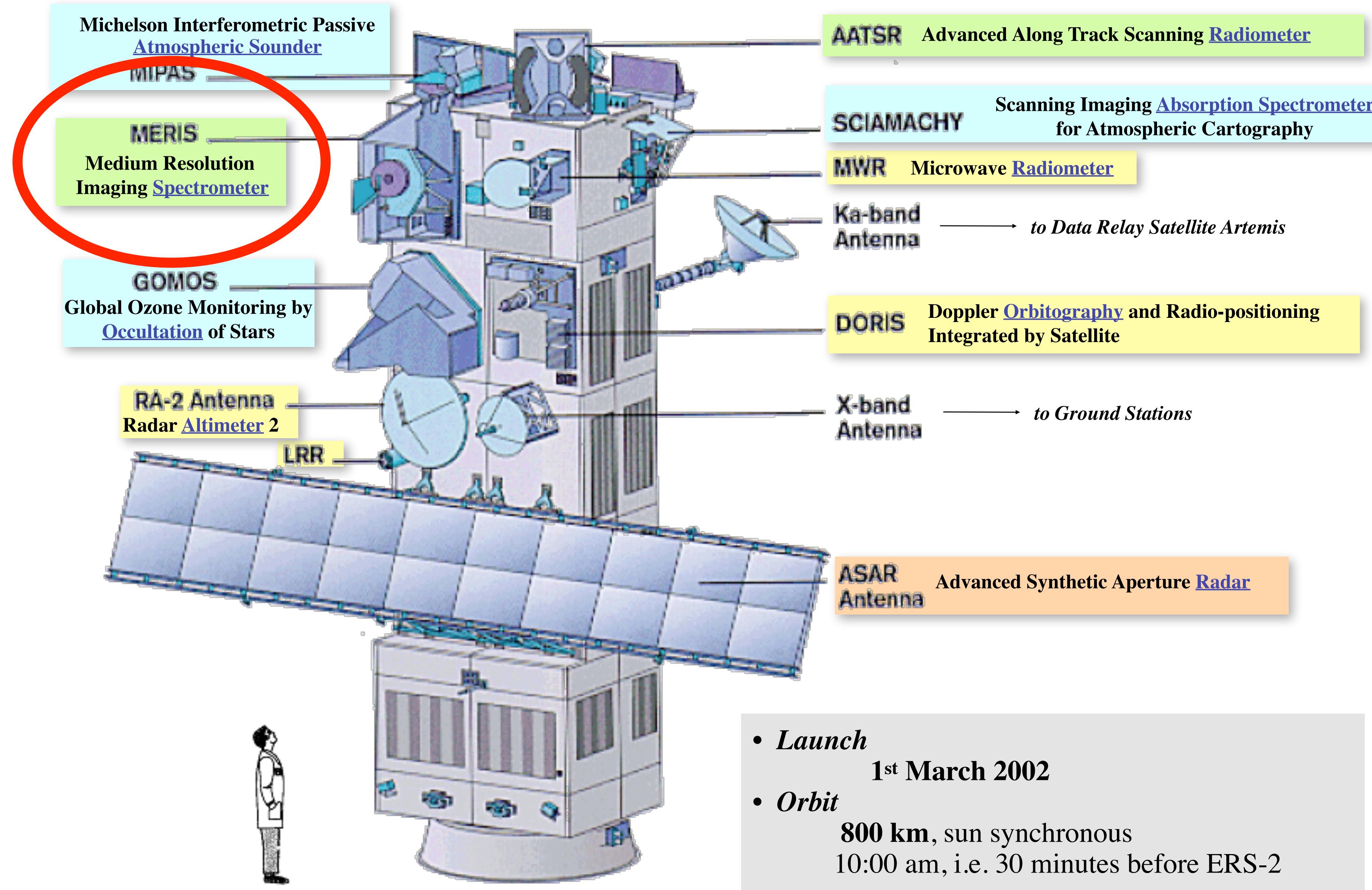


ENVISAT

Mission: 2002 - 2012



ENVISAT: 10 ways to monitor the Earth



MERIS - BANDS

	Band	Band centre (nm)	Bandwidth (nm)	Primary Use
V I S I B L E	1	412.5	10	Yellow substance and pigments detritus
	2	442.5	10	Chlorophyll absorption maximum
	3	490	10	Chlorophyll and other pigments
	4	510	10	Suspended sediment, red tides
	5	560	10	Chlorophyll absorption minimum
	6	620	10	Suspended sediment
	7	665	10	Chlorophyll absorption and fluo. reference
	8	681.25	7.5	Chlorophyll fluorescence peak
	9	708.75	10	Fluo. Reference, atmospheric corrections
I N F R A R E D	10	753.75	7.5	Vegetation, cloud
	11	761.75	3.75	Oxygen absorption R-branch
	12	778.75	15	Atmosphere corrections
	13	865	20	Atmosphere corrections
	14	885	10	Vegetation, water vapour reference
	15	900	10	Water vapour, land

MERIS Has Two Operation Modes:

Reduced Resolution (RR) – 1.2 km

Full Resolution (FR) – 300m

NASA and the European Space Agency Data Sharing Agreement

Under this agreement, the MERIS collection is available publicly at no cost to registered users who have agreed to the terms and conditions set by NASA and the European Space Agency (ESA) to access MERIS data.

Before you are allowed to download MERIS data:

- 1) You need to be **a registered user within the EOSDIS system**
- 2) You have to fill out additional questions pertaining to use of MERIS data
- 3) You have agree with ESA's terms and conditions.

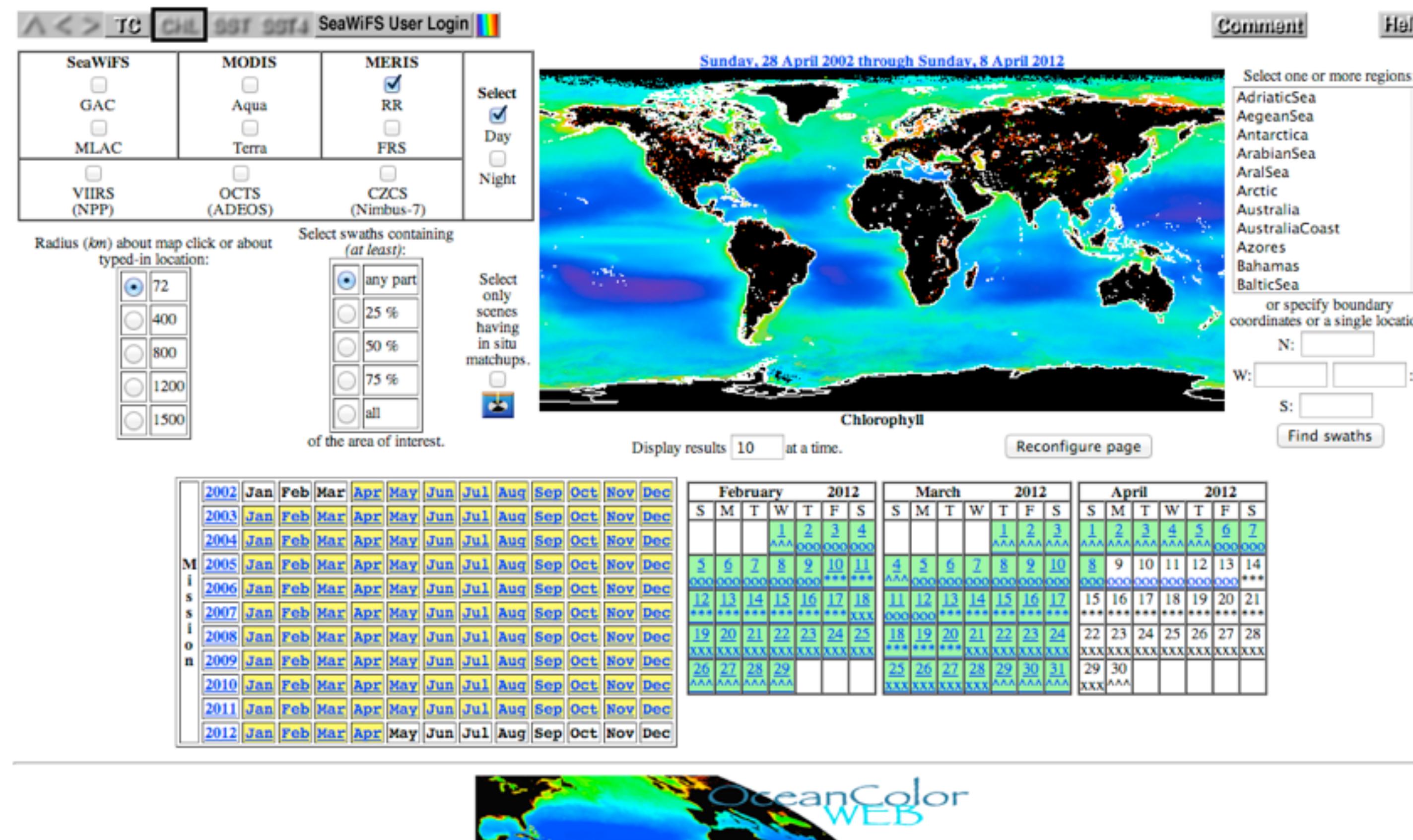
To create a new EOSDIS account, AND/OR to add authorization for MERIS data to a pre-existing EOSDIS account, please visit the Ocean Biology Processing Group (OBPG) Registration Site:

<http://oceancolor.gsfc.nasa.gov/SUPPORT/register.html>

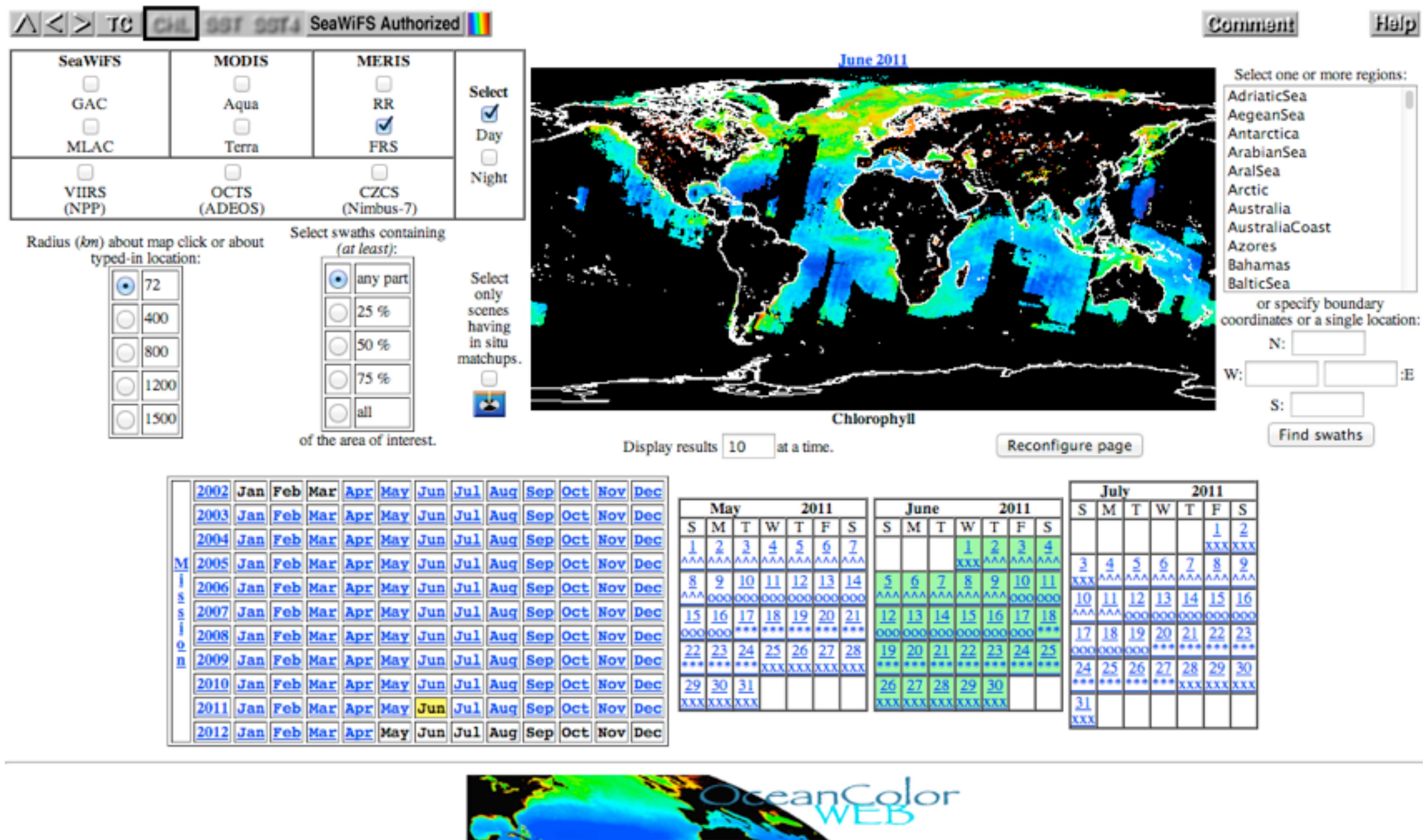
MERIS (2002-2012) Reduced Resolution Data

The entire global MERIS mission (**reduced resolution - 1.2km**) available through the Ocean Color Web Ordering System

Uses the same OBPG algorithms that are used for SeaWiFS and MODIS processing - this is different from ESA algorithms



MERIS (2002-2012) Full Resolution (300m) Data is Also Now Available at the OceanColor Web





<http://hico.coas.oregonstate.edu/datasets/datacharacteristics.shtml#NASA>

platform	International Space Station (ISS)
Mission Duration	September, 2009 - September 2014
altitude	343 km (varies)
orbit repeat time	3 days (approximate)
orbit period	90 minutes
scenes per orbit	1 maximum
scenes per day	15 maximum
swath orientation	NW to SE (descending), SW to NE (ascending)
ground sample distance (GSD)	90 m (varies with altitude and angle)
scene size (km)	42 x 192 km (varies with altitude and angle)
scene size (pixels)	512 x 2000 pixels uncropped)
wavebands	128 bands uncropped
wavelengths	353 - 1080 nm uncropped
RGB bands	R : 638.9 nm (band 42), G : 553.0 nm (band 27), B : 461.4 nm (band 11)
spectral resolution	5.7 nm
data format	Band Sequential NASA: HDF5

NASA HICO File Format: HDF5

The HICO data files provided by NASA differ in format from the Office of Naval Research and provided through Oregon State University (OSU)

File Naming Convention...

HYYYYDDDH

H	HICO
YY	collection
L*	processing
ISS	HICO

Ocean and Land Imager (OLI) on Landsat 8

Website for Ordering Data: <http://earthexplorer.usgs.gov>

Mission: 2013 - Current

Resolution: 30 meters

Repeat Coverage: 16 days

Filename Convention

LX~~S~~PPP~~R~~RRR~~Y~~YY~~D~~DDGSI~~V~~V

L = Landsat

X = Sensor

S = Satellite

PPP = WRS path

RRR = WRS row

~~Y~~YY = Year

~~D~~DD = Julian day of year

GSI = Ground station identifier

~~V~~V = Archive version number



Landsat 8 Bands

Spectral Band	Wavelength	Resolution
Band 1 - Coastal / Aerosol	0.433 - 0.453 μm	30 m
Band 2 - Blue	0.450 - 0.515 μm	30 m
Band 3 - Green	0.525 - 0.600 μm	30 m
Band 4 - Red	0.630 - 0.680 μm	30 m
Band 5 - Near Infrared	0.845 - 0.885 μm	30 m
Band 6 - Short Wavelength Infrared	1.560 - 1.660 μm	30 m
Band 7 - Short Wavelength Infrared	2.100 - 2.300 μm	30 m
Band 8 - Panchromatic	0.500 - 0.680 μm	15 m
Band 9 - Cirrus	1.360 - 1.390 μm	30 m

Thermal InfraRed Sensor (TIRS)on Landsat 8

There are IR bands on Landsat 8...

However, SeaDAS currently does not process these bands to get SST...

Thermal InfraRed Sensor (TIRS)

Spectral Band	Wavelength	Resolution
Band 10 - Long Wavelength Infrared	10.30 - 11.30 μm	100 m
Band 11 - Long Wavelength Infrared	11.50 - 12.50 μm	100 m

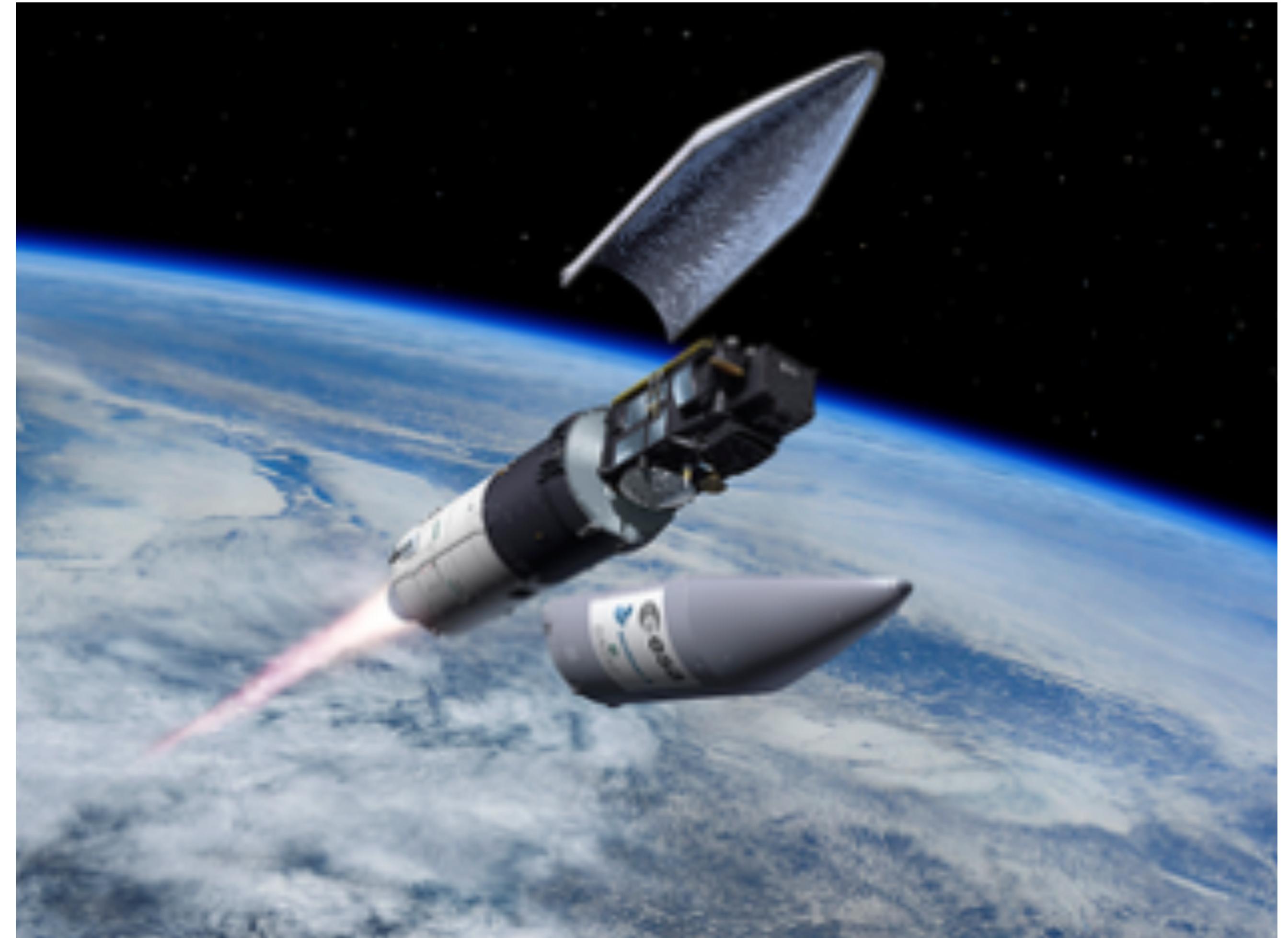
Ocean and Land Color Imager (**OLCI**) on Sentinel-3A, 3B

MERIS-Like Follow-On Missions by ESA...

300 meter resolution

Data Ordering:
NASA's OceanColorWeb

Mission Duration:
S3A – 2016 - Current
S3B – 2018 - Current

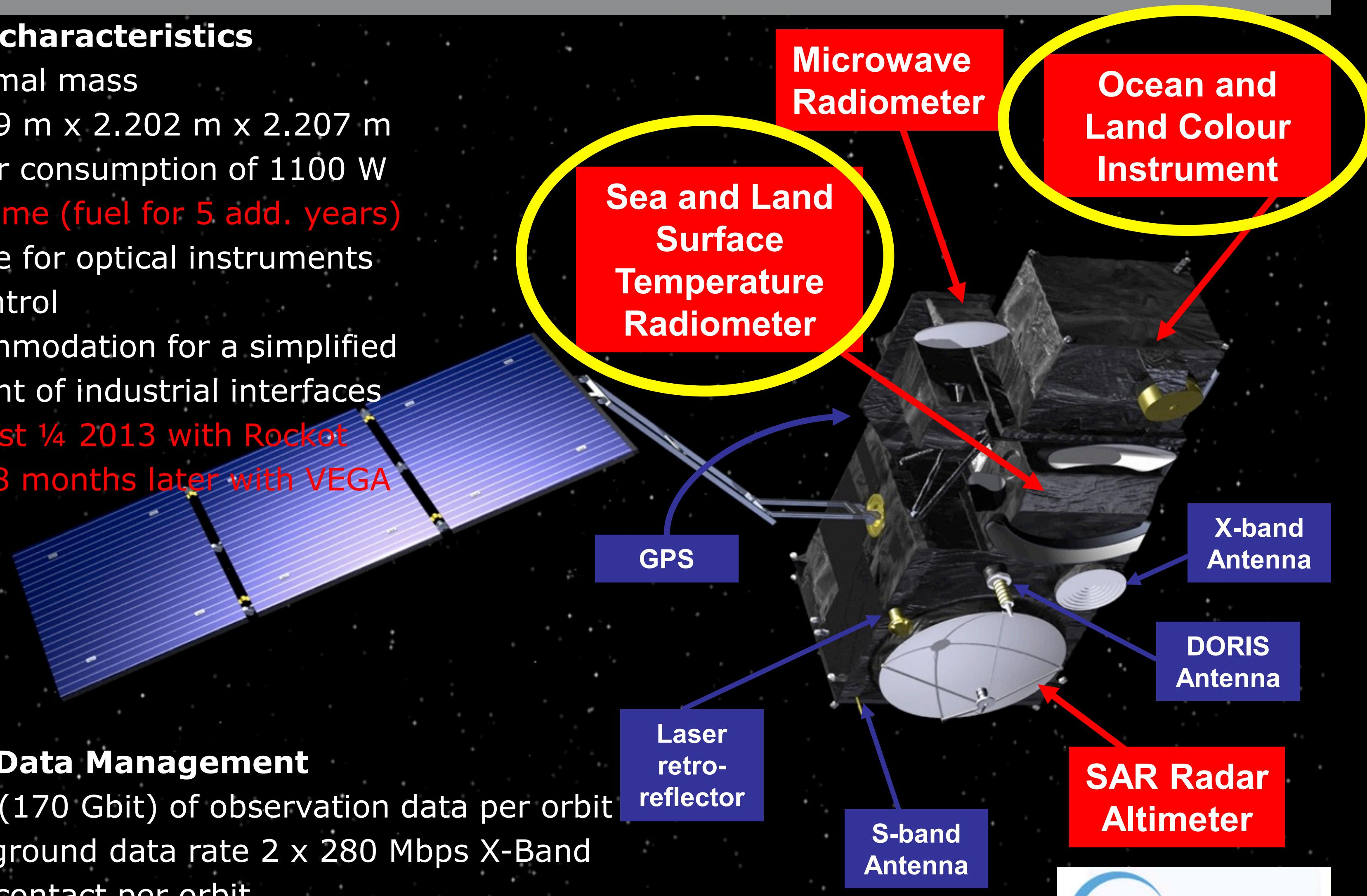


Sentinel-3: Continuity of ENVISAT Ocean Observation



Main satellite characteristics

- 1250 kg maximal mass
- Volume in 3.89 m x 2.202 m x 2.207 m
- Average power consumption of 1100 W
- **7.5 years lifetime (fuel for 5 add. years)**
- Large cold face for optical instruments thermal control
- Modular accommodation for a simplified management of industrial interfaces
- Launch S3A last ¼ 2013 with Rockot
- Launch S3B 18 months later with VEGA



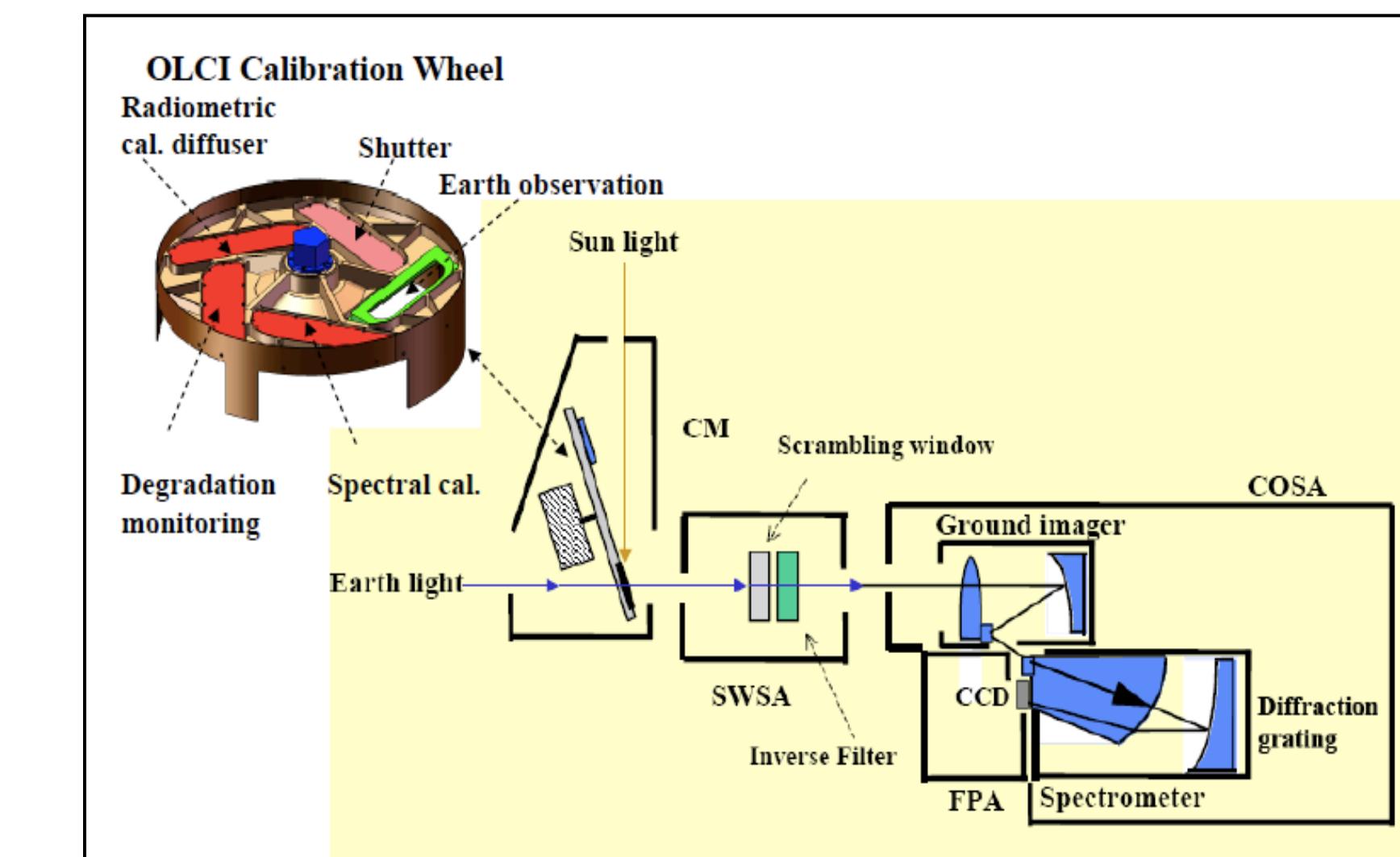
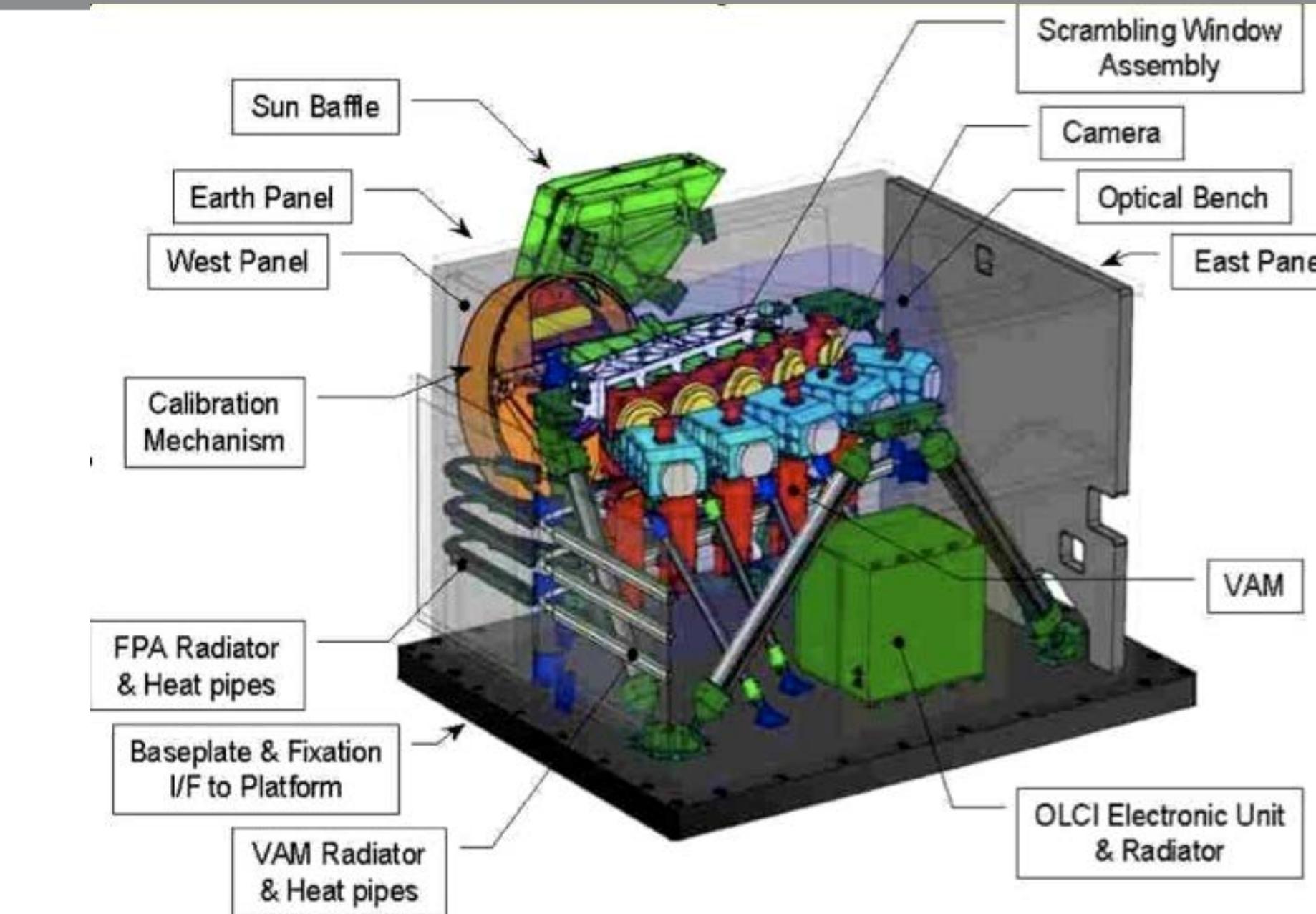
Observation Data Management

- 21.25 Gb (170 Gbit) of observation data per orbit
- Space to ground data rate 2 x 280 Mbps X-Band
- 1 ground contact per orbit
- 3h delivery timeliness (from satellite sensing)

S3 Technical Overview : Ocean and Land Colour Instrument (OLCI) Instrument



- Pushbroom Imaging Spectrometer (VIS-NIR)
- Close heritage to MERIS (spectral bands and radiometric performances)
- Key Improvements:
 - a. number of spectral bands (from 15 to 21)
 - b. reduced sun glint by camera tilt in west direction
 - c. Full Resolution 300m over land/ocean,
 - d. Reduced Resolution (1200m) over Ocean binned on ground (L1B)
 - e. improved characterisation, e.g., straylight, camera overlap
 - f. improved (1 sat) coverage Ocean < 4 days, Land < 3 days (MERIS eff. 15 days)
 - g. Timeliness: 3 hours NRT Level 2 product
 - h. 100% overlap with SLSTR



Sentinel-2A, 2B

ESA Land Mission(s) that are similar to the US Landsat Missions

10-day repeat times for one satellite
and 5-day repeat for two satellites



Spatial Resolution: 10 m, 20 m and 60 m

10 m: 490 nm (B2), 560 nm (B3), 665 nm (B4), 842 nm (B8)

20 m: 705 nm (B5), 740 nm (B6), 783 nm (B7), 865 nm (B8a), 1610 nm, (B11), 2190 nm (B12)

60 m: 443 nm (B1), 945 nm (B9) and 1375 nm (B10).

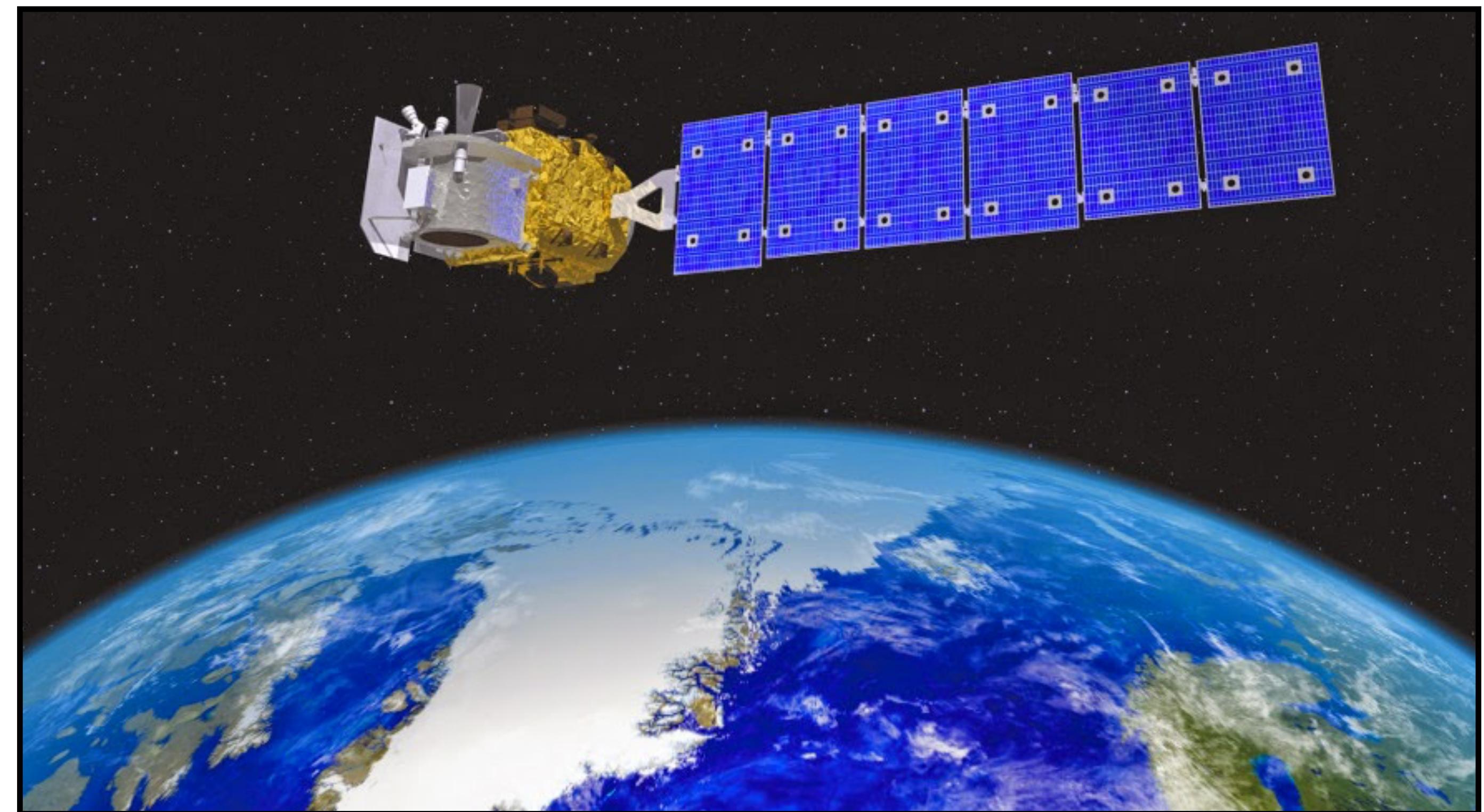
Missions:

Sentinel-2A 2015 – Current

Sentinel-2B 2017 – Current

NASA's PACE Mission

- Tentatively Launch Set For
January 2024
- Spatial Resolution: **1-km**
- Spectral Resolution:
Hyperspectral
- **Sensor Tilt Capability** to
Reduce Sun Glint
- **Two Polarimeters** to Improve
Atmospheric Correction!



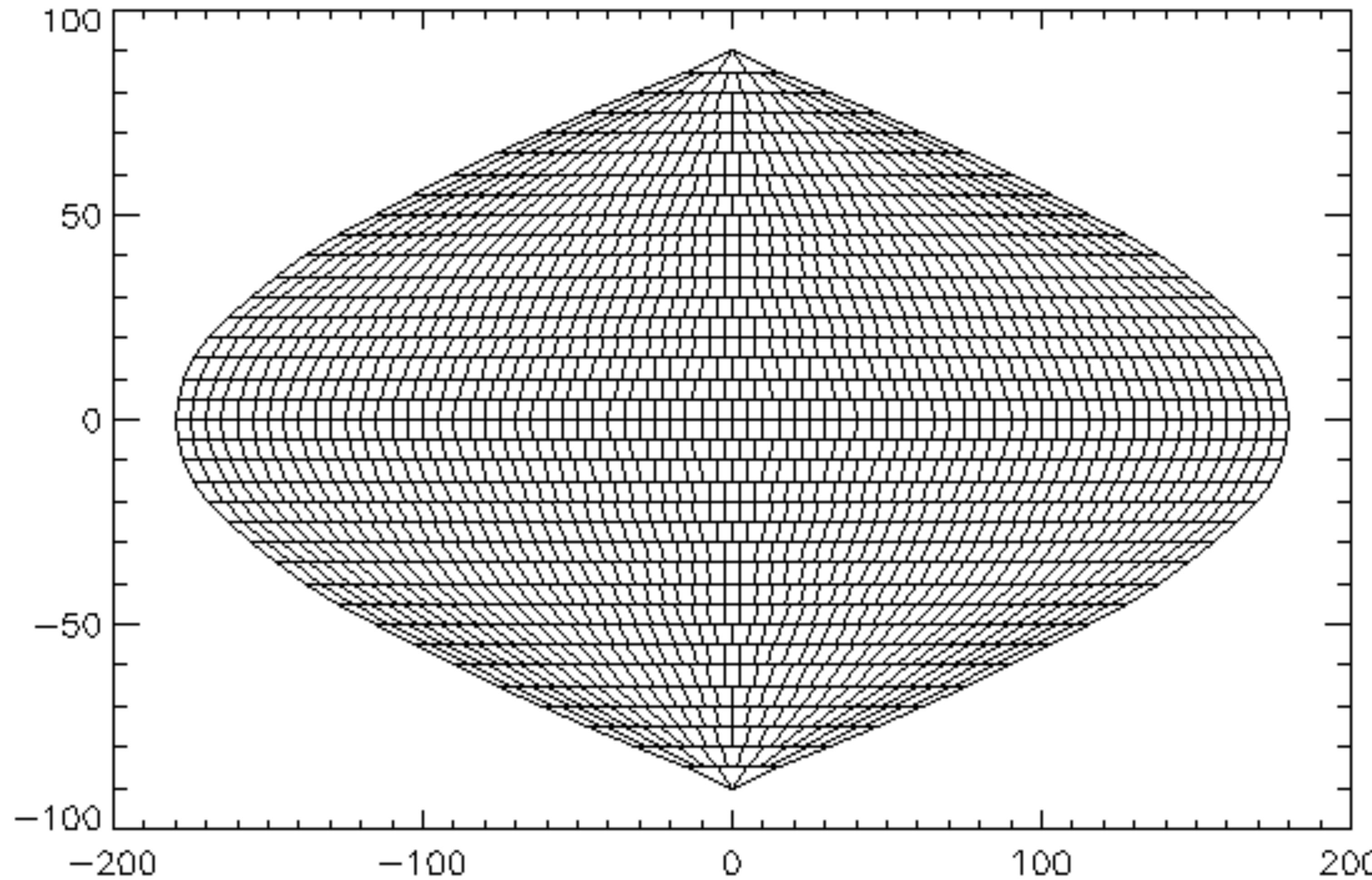
<https://pace.gsfc.nasa.gov/>

Data Levels and Processing Flow...

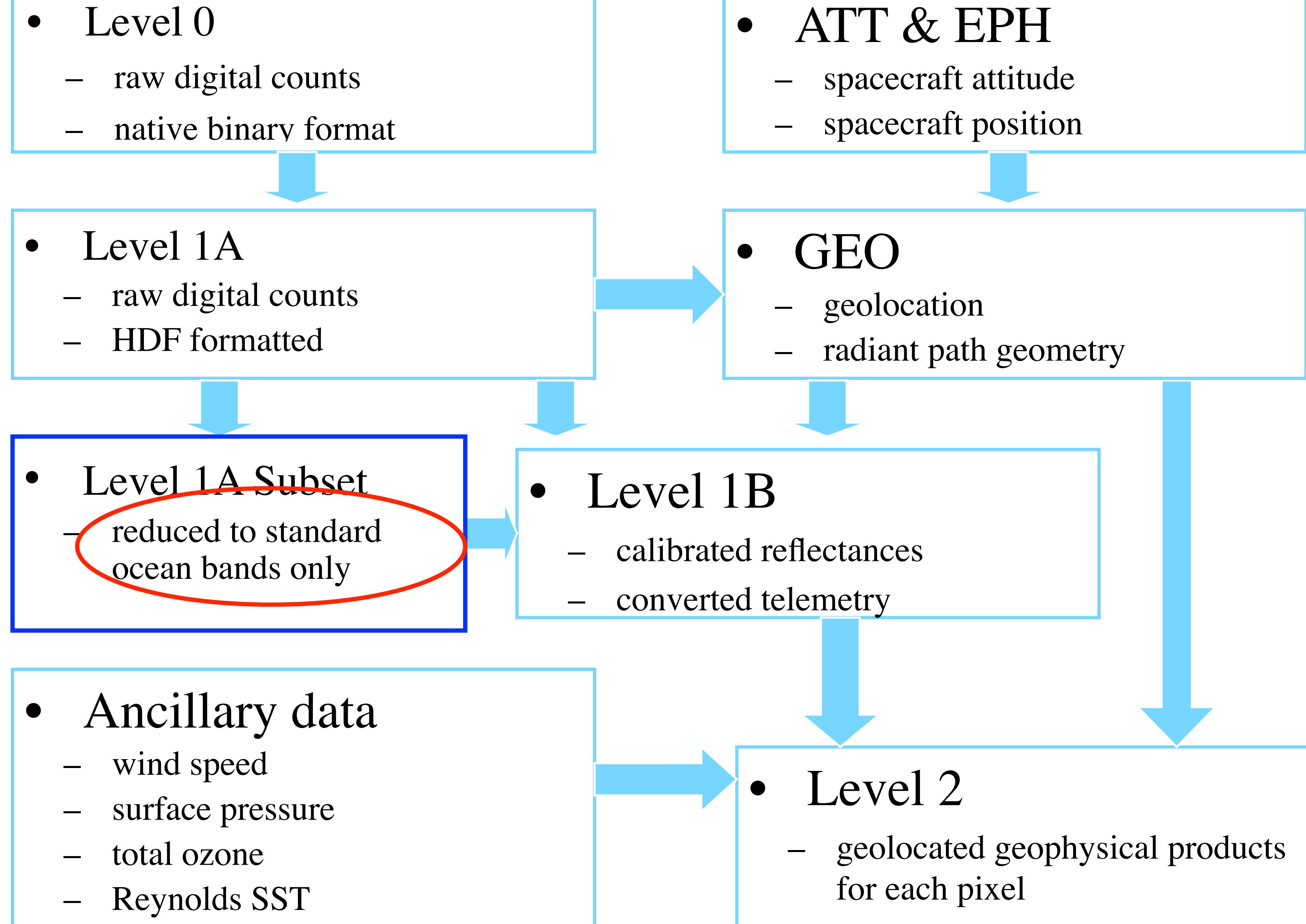
Satellite Data Level Definitions

- **Level-0**
 - raw radiance counts
- **Level-1A**
 - raw radiance counts as well as spacecraft and instrument telemetry **and calibration data included, but not yet applied.**
- **The Level 1B**
 - **calibrated and geolocated radiances** generated from Level 1A data **applied calibrations.**
- **Level-2**
 - **derived geophysical variables** at the same full resolution and location as the Level 1 source data.
- **Level-3**
 - **variables arranged in a uniform space-time grid**
 - **binned** --> data spatially averaged into equal area bins and then optionally averaged into a specified time interval
 - **binned and then mapped** to produce --> **(binmapped)** = **standard mapped image (SMI)** at the ocean color web
 - **just mapped straightway** from L2 data and optionally averaged into a specified time interval

Equal-Area Bins



Data Levels & Flow



Required Files for Level-1 to Level-2 Processing Using SeaDAS' l2gen

SeaWiFS:

L1A + Meteorology & Ozone files ----> Level-2 file

MODIS:

L1A + Attitude & Ephemeris files ----> GEO file

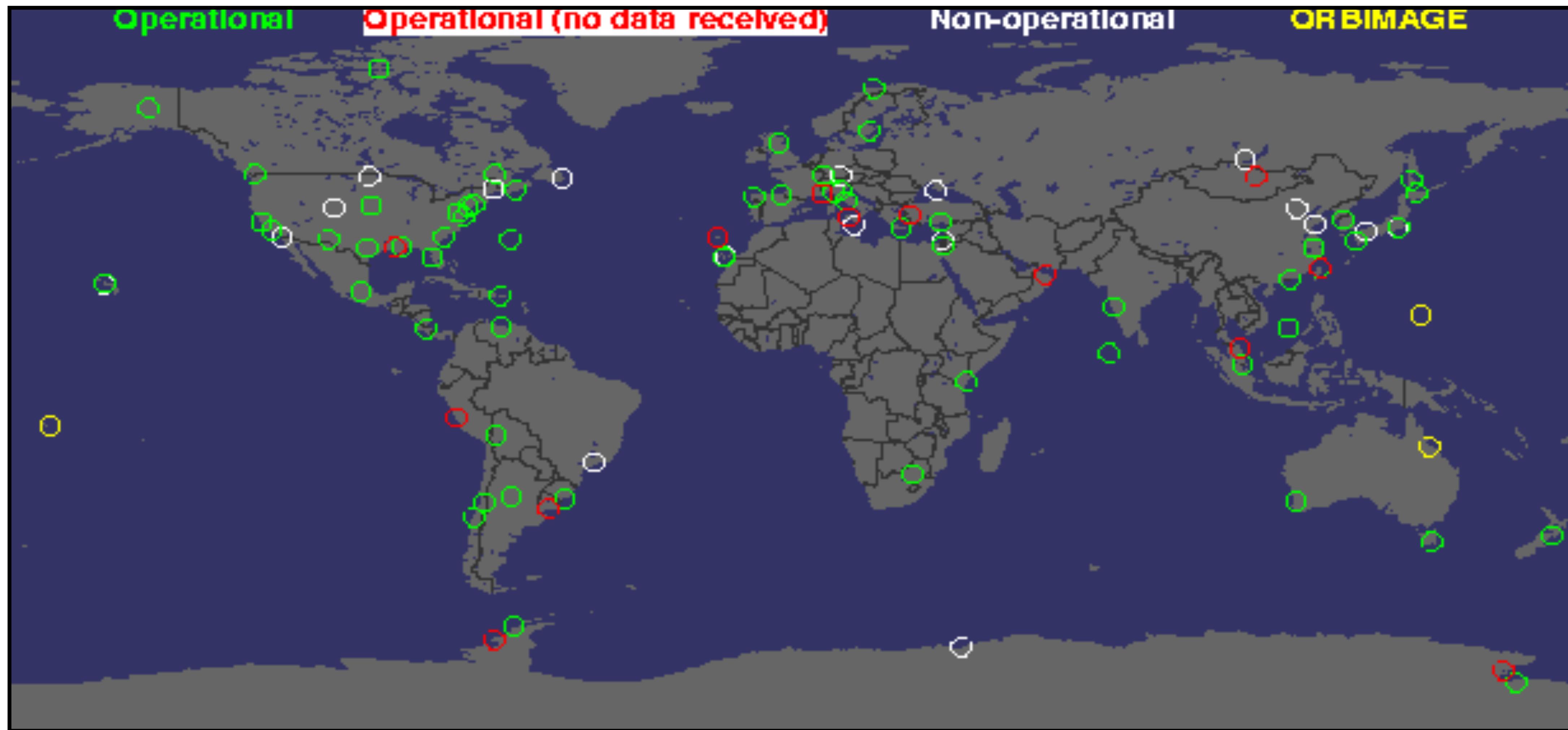
L1A + GEO ----> L1B

L1B + GEO & Meteorology & Ozone & OISST files –> Level-2 file

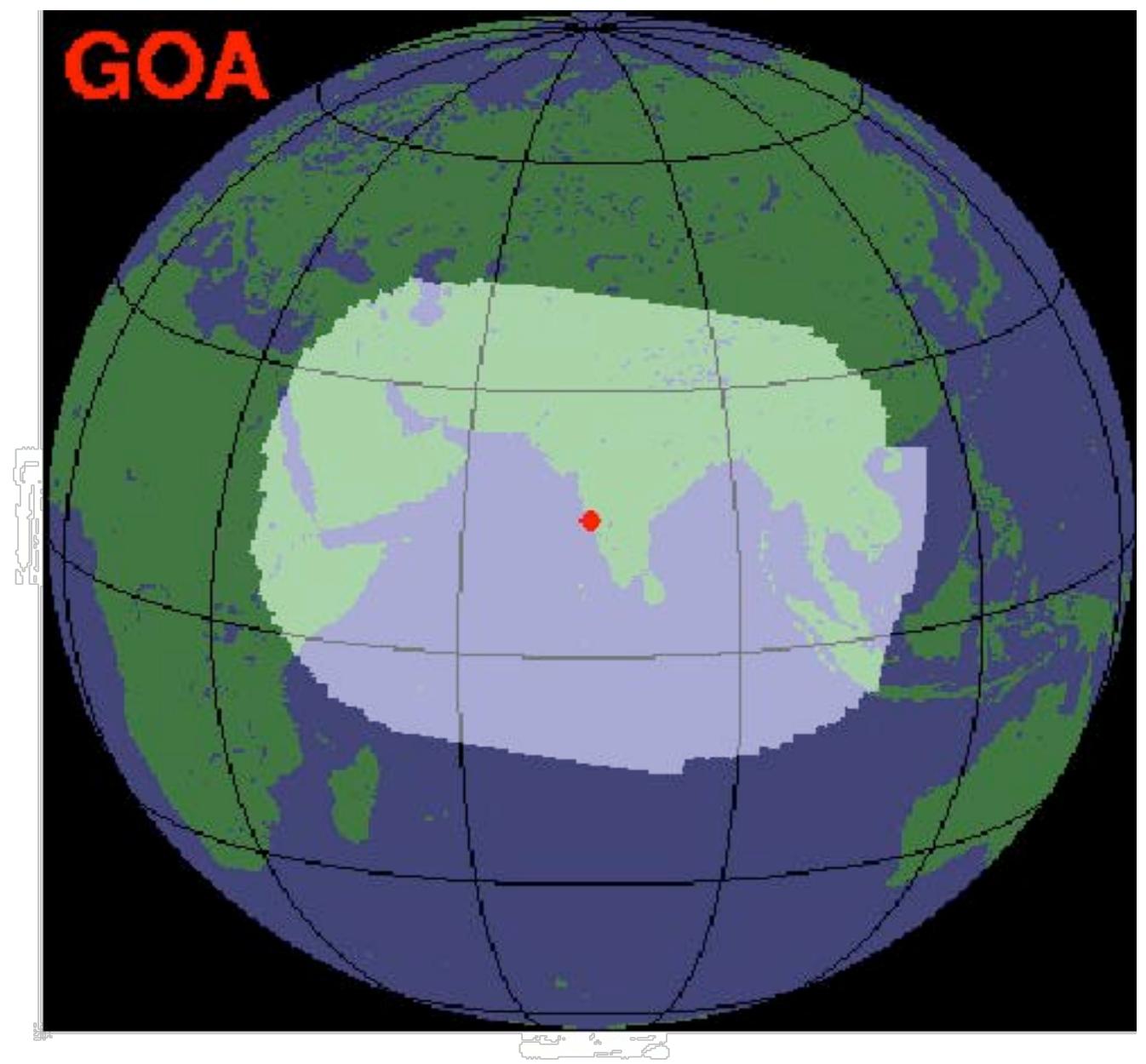
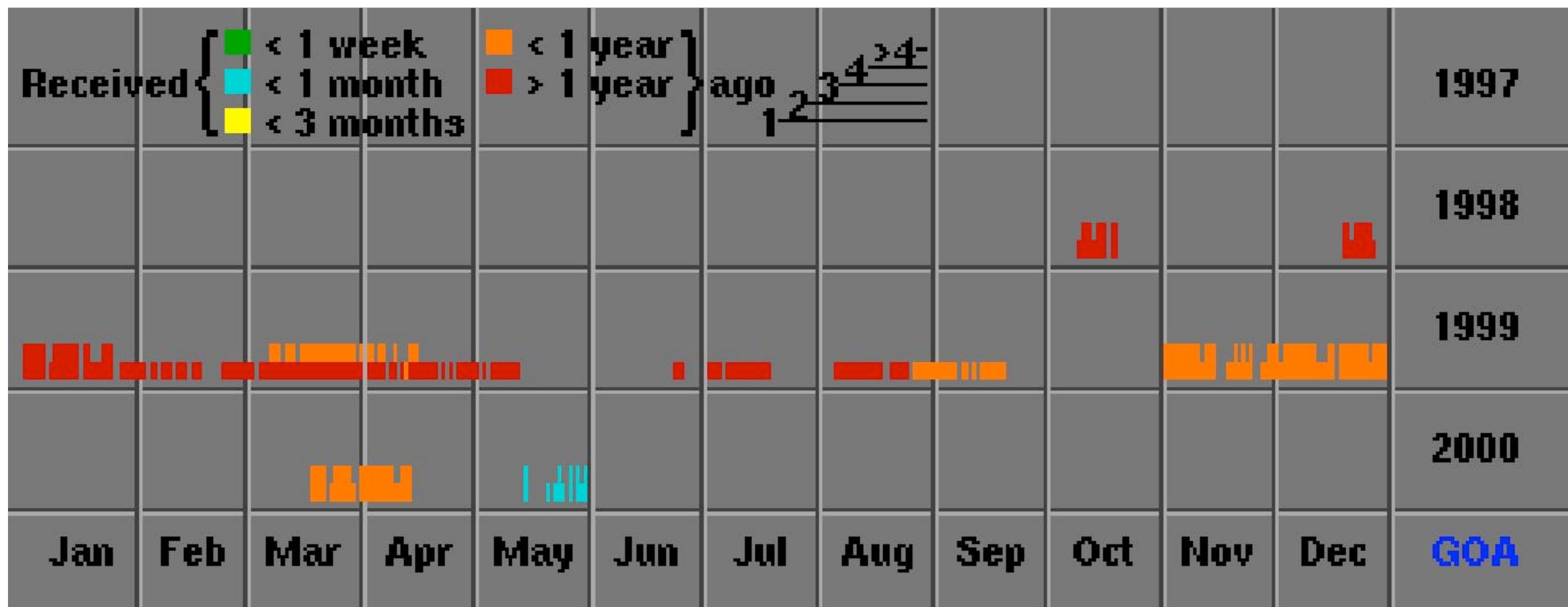
Data Granules

Incremental Unit of File Storage

Global Distribution of SeaWiFS HRPT Stations



Typical Spatial & Temporal Coverage by a SeaWiFS HRPT Station



SeaWiFS MLAC Coverage for 1997-2002

Navigation: ▲ < > IC CHL SST SST4 [Color]

Search Options:

SeaWiFS	MODIS	MERIS	
<input type="checkbox"/> GAC	<input type="checkbox"/> Aqua	<input type="checkbox"/> RR	<input type="checkbox"/> Select
<input checked="" type="checkbox"/> MLAC	<input type="checkbox"/> Terra	<input type="checkbox"/> FRS	<input checked="" type="checkbox"/> Day
<input type="checkbox"/> VIIRS (NPP)	<input type="checkbox"/> OCTS (ADEOS)	<input type="checkbox"/> HICO (ISS)	<input type="checkbox"/> Night

Radius (km) about map click or about typed-in location:
 72
 400
 800
 1200
 1500

Select swaths containing (at least):
 any part
 25 %
 50 %
 75 %
 all

Select only scenes having in situ matchups.

of the area of interest.

Map View: 2001 Quasi True Color

Display results at a time.

Reconfigure page

Comment **Help**

Select one or more regions:

- AdriaticSea
- AegeanSea
- Antarctica
- ArabianSea
- AralSea
- Arctic
- Australia
- AustraliaCoast
- Azores
- Bahamas
- BalticSea

or specify boundary coordinates or a single location:
 N:
 W: :E
 S:
Find swaths

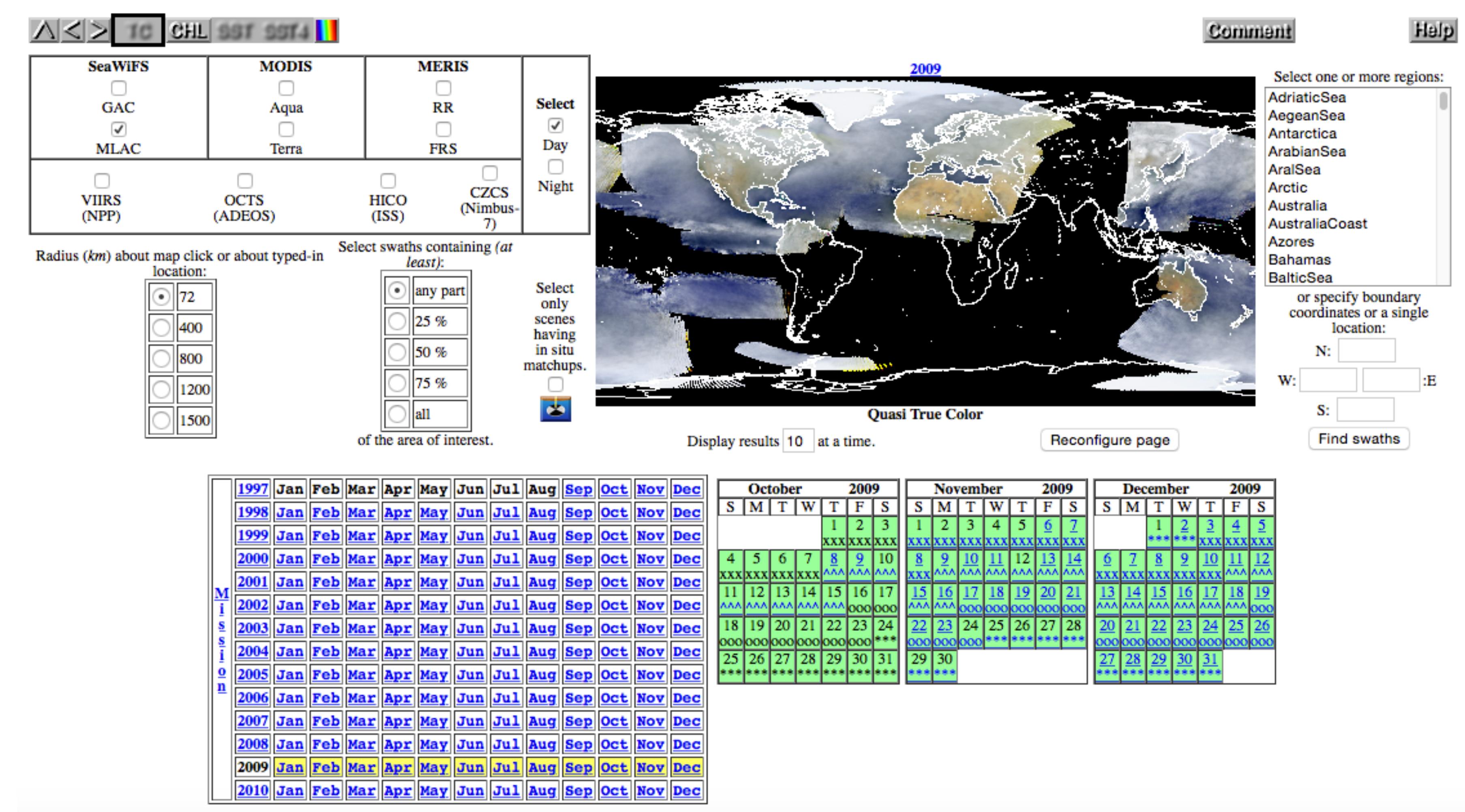
Timeline:

1997	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Calendars:

October 2001												November 2001												December 2001											
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S															
1	2	3	4	5	6		1	2	3	4	5	6	1	2	3	4	5	6	7																
XXX	XXX	XXX	XXX	XXX	XXX		XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX																
7	8	9	10	11	12	13	7	8	9	10	11	12	11	12	13	14	15	16	17																
XXX	AAA	AAA	AAA	AAA	AAA	AAA	XXX	XXX	XXX	XXX	XXX	XXX	AAA																						
14	15	16	17	18	19	20	14	15	16	17	18	19	18	19	20	21	22	23	24																
XXX	AAA	AAA	AAA	AAA	AAA	AAA	XXX	XXX	XXX	XXX	XXX	XXX	AAA																						
21	22	23	24	25	26	27	21	22	23	24	25	26	25	26	27	28	29	30	31																
XXX	000	000	000	000	000	000	XXX	000	000	000	000	000	000	000	000	000	000	000	000																
28	29	30	31				28	29	30	31			25	26	27	28	29	30	31																
***	***	***	***				***	***	***	***			***	***	***	***	***	***	***																

SeaWiFS MLAC Coverage for 2003-2010



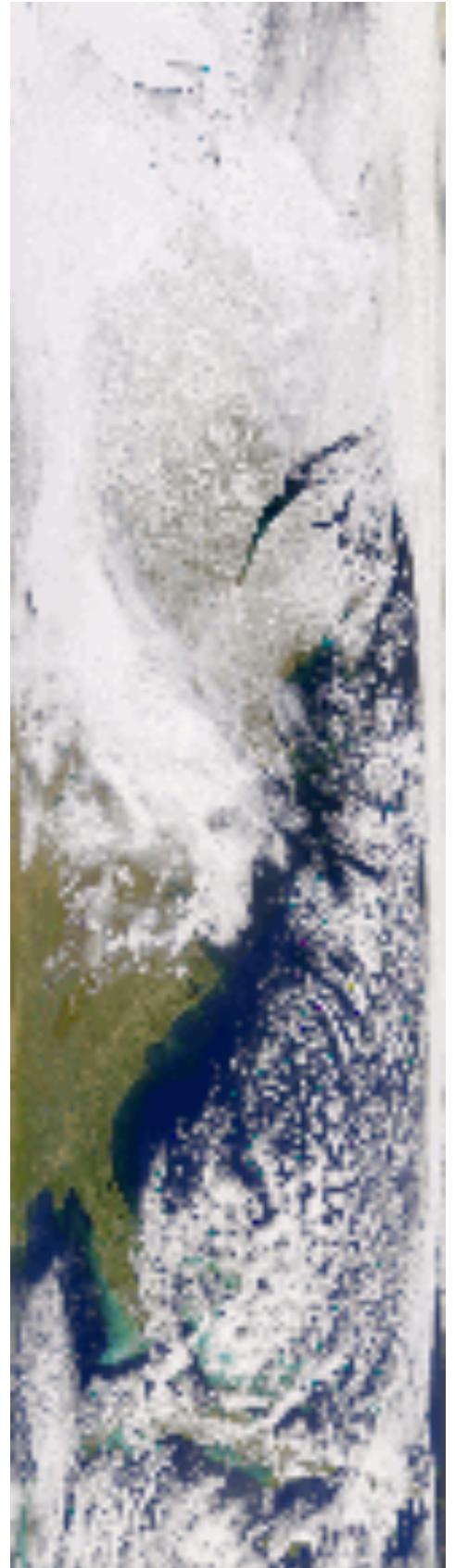
NASA purchased 100 HRPT Station Licenses that lasted for 5 years (1997-2002). Data purchases after that time period were less consistent

SeaWiFS MODIS and VIIRS LAC Data Granules

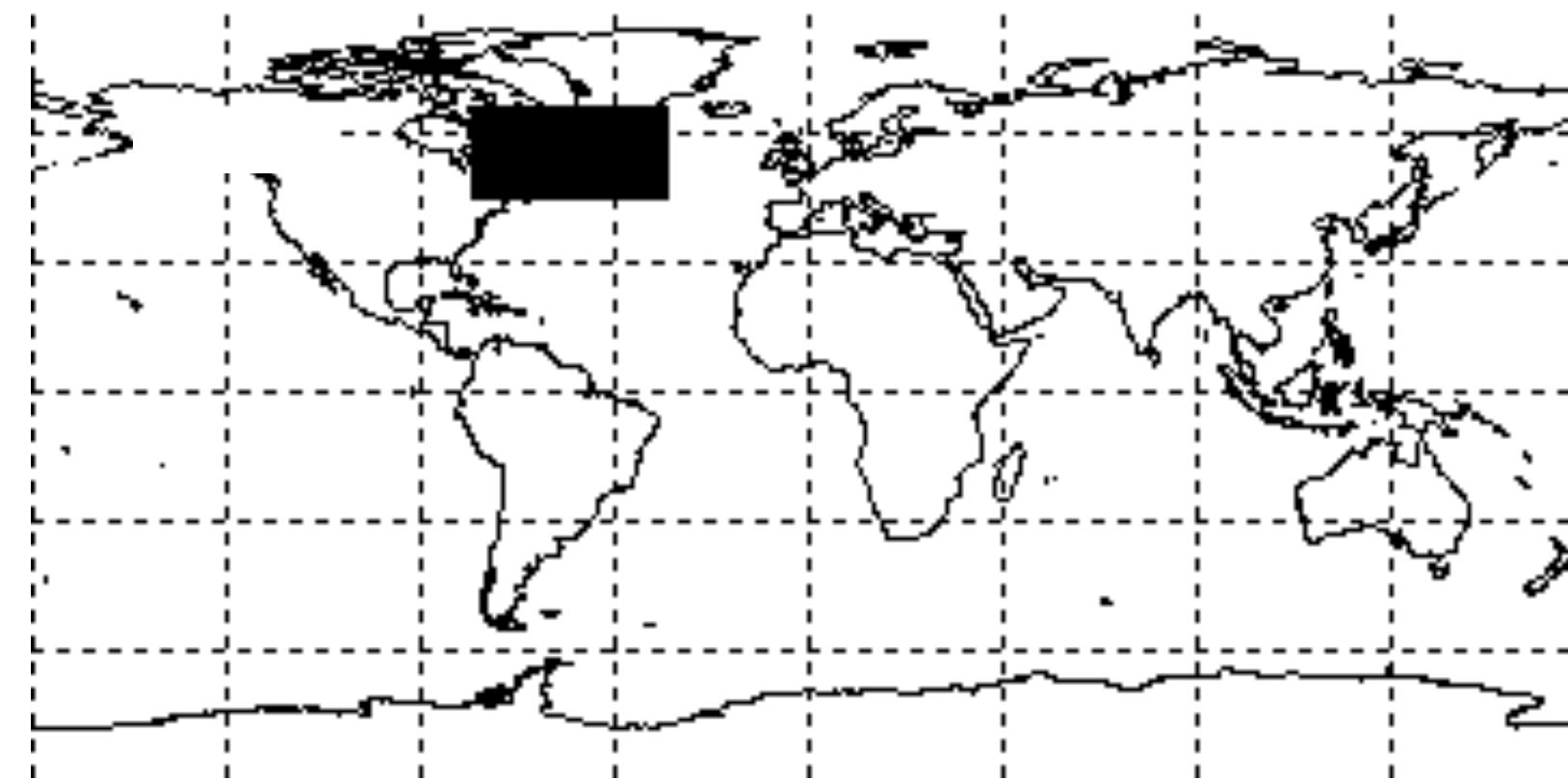
SeaWiFS

Data Granule = Horizon-to-Horizon

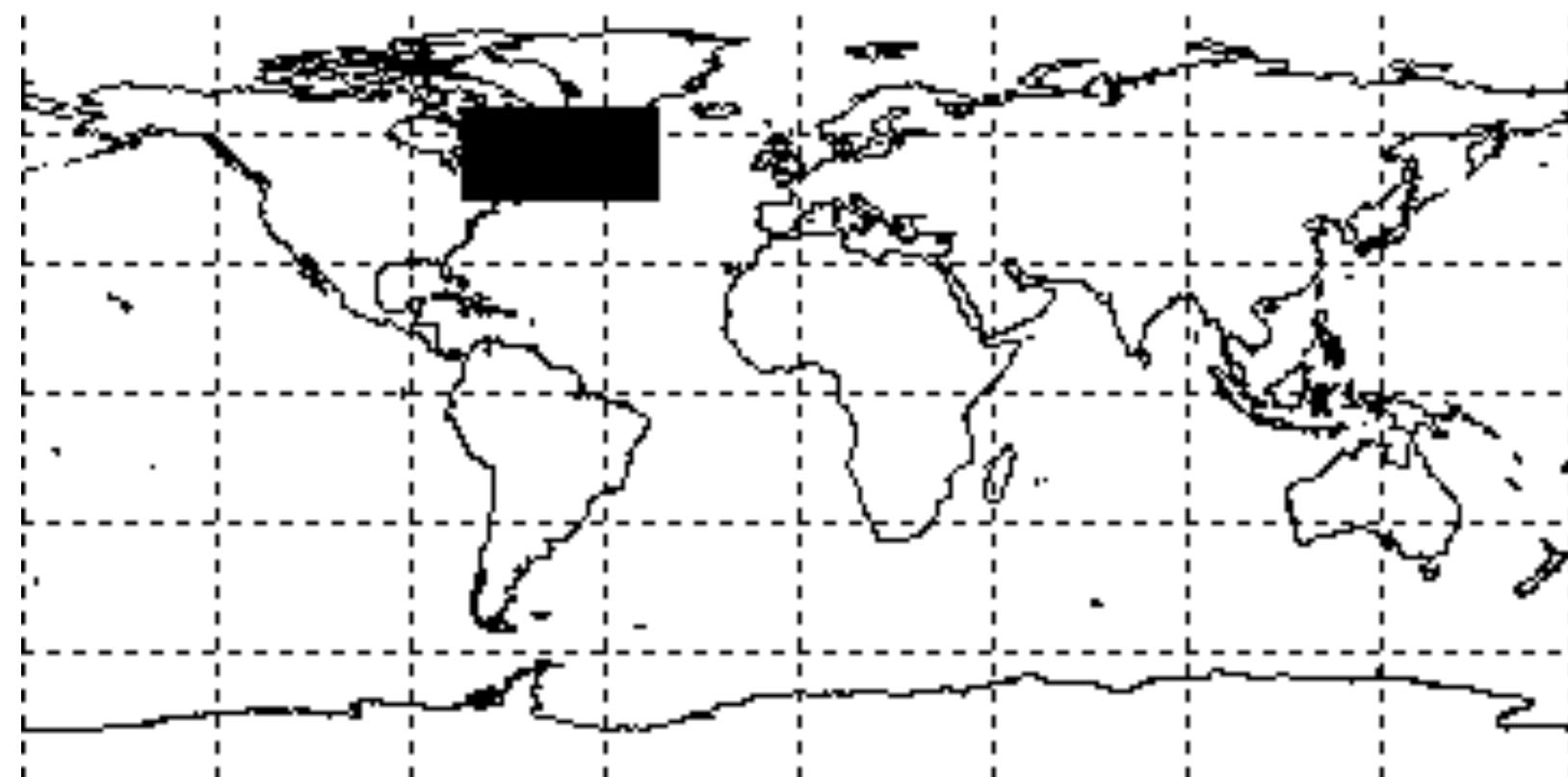
About 1/2 hr Duration



MODIS 5-minute Data Granule



VIIRS about 6 minute Data Granule



LAC and GAC Data

LAC = Local Area Coverage = **Full Resolution**

GAC = Global Area Coverage = **Reduced Resolution**

- Most modern instruments (MODIS onwards) **record full resolution (LAC) data onboard** for the whole earth and then transmit the LAC data to earth each day. Typical resolutions are 350m to 1km resolution
- **SeaWiFS is older, and therefore somewhat exceptional, in how it handles LAC Data**
 - **LAC:** 1-km full resolution **from HRPT reception by individual ground stations**
 - **Global Recorded Coverage was 4-km resolution (*subsampled*) - recorded for full earth each day**
- **SeaWiFS Merged LAC (MLAC) obtained from Original HRPT Transmission**
 - **MLAC:** 1-km resolution HRPT data covering **vast regions.**
Derived by merging the separate ground HRPT station data into a single continuous global product.

File Naming Convention at the Ocean Color Web and Some General Satellite Data Jargon Terms

Original Naming Convention

SeaWiFS and SeaWiFS-MODIS-MERIS and VIIRS Files

Syyyydddhhmmss.<suffix>

SeaWiFS File

Ayyyydddhhmmss .<suffix>

Aqua-MODIS

Tyyyydddhhmmss .<suffix>

Terra-MODIS

Myyyydddhhmmss .<suffix>

MERIS*

Vyyyydddhhmmss .<suffix>

VIIRS on NPP

Hyyyydddhhmmss .<suffix>

HICO on ISS

New Naming Convention

MMMM_III_TT.YYYYMMDDTHHMMSS.LLLL.PPPP.SSSS.pppp.RRRR.NRT.nc

MMMM: variable-length string indicating the **mission**.

e.g. AQUA, PACE, S3A

III: variable-length string indicating the **instrument**

e.g., SEAWIFS, MODIS, OCI

TTT: (value is absent if not relevant to product) variable-length uppercase character string indicating the **data "type"**

e.g. GAC;, LAC, EFR

YYYYMMDDTHHMMSS: ISO8601 **time format**,

YYYY MM DD == year, month, day, T == time HHMMSS hour, minutes, and seconds.

LLL: variable-length string indicating the **data level**.

e.g. L1B, L2, L3m

PPP: **period indicator for L3**

e.g. DAY, MO, YR, R32

SSSS: suite identifier e.g., CHL, SST

New Naming Convention Examples

SEASTAR_SEAWIFS_GAC.20030601T153712.L1A.nc

AQUA_MODIS.20050630T133500.L2.SST.nc

TERRA_MODIS.20181001.L3m.DAY.CHL.chlor_a.4km.nc

S3A_OLCI_ERR.2019001.L3b.DAY.CHL.nc

SNPP_VIIRS.20190101T123600.L1A.nc

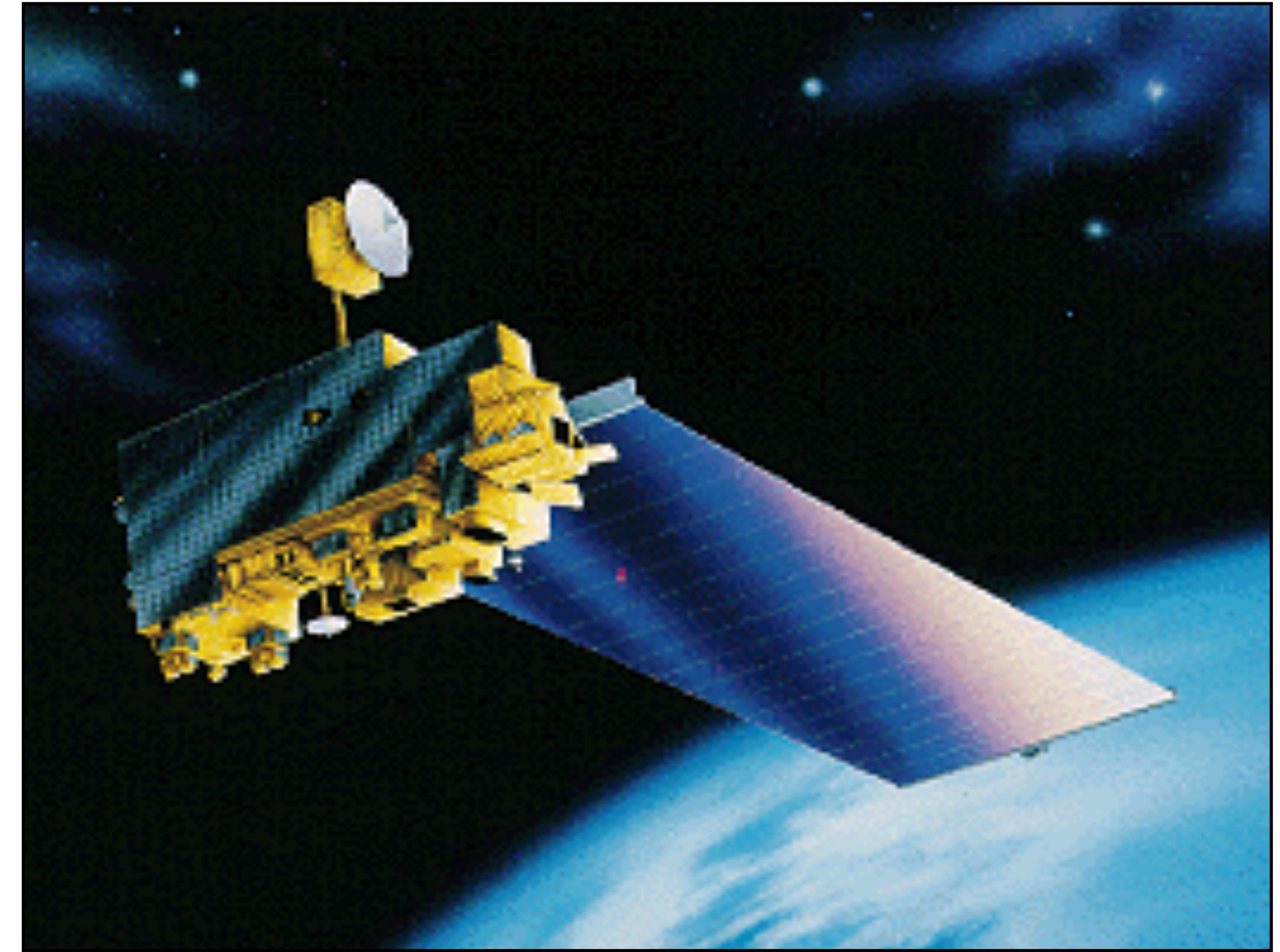
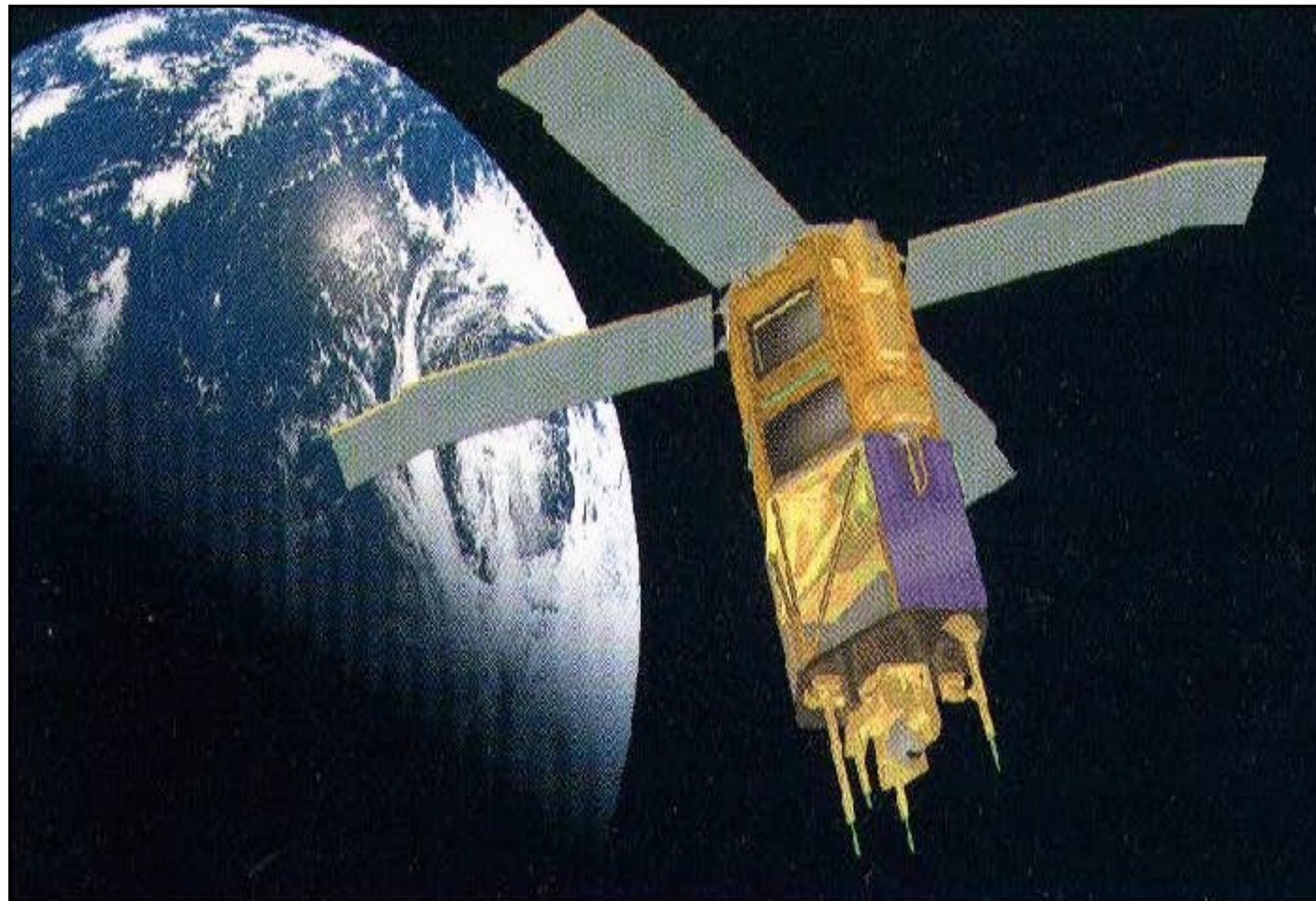
NOAA20_VIIRS.20190101T123500.GEO_M.nc

ENVISAT_MERIS_FR.20030630T153712.L2.OC.nc

AQUA_MODIS.20050101_20050108.L3b.8D.IOP.nc

Standard Products

Produced by the Ocean Biology Processing Group NASA/Goddard



Standard Products (Level-2 OC)

Remote Sensing Reflectance (Rrs; sr-1)

The at-surface spectral remote-sensing reflectances observed by the satellite instrument after atmospheric correction. The aerosol optical thickness and aerosol Ångström exponent products are also described.

Chlorophyll a (chlor_a; mg m-3)

The concentration of the photosynthetic pigment chlorophyll a

Diffuse attenuation coefficient for downwelling irradiance at 490 nm (Kd_490; m-1)

The diffuse attenuation coefficient for downwelling irradiance over the first optical attenuation layer

Particulate Organic Carbon (POC; mg m-3)

The concentration of particulate organic carbon

Particulate Inorganic Carbon (PIC; mol m-3)

The concentration of particulate inorganic carbon

Photosynthetically Available Radiation (PAR; Einstein m-2 d-1)

Daily mean photosynthetically available radiation at the ocean surface

Instantaneous Photosynthetically Available Radiation (iPAR; Einstein m-2 s-1)

PAR at the ocean surface at the time of the satellite observation

Normalized Fluorescence Line Height (nFLH; mW cm-2 μm-1 sr-1) - MODIS

Relative measure of water-leaving radiance associated with chlorophyll fluorescence

Inherent Optical Properties (Level-2 IOP)

- total absorption, a , in all visible channels (400-710nm)
- total backscattering, bb , in all visible channels (400-710nm)
- absorption coefficient at 443nm, aph_443 , due to phytoplankton
- absorption coefficient at 443nm, adg_443 , due to detritus and gelbstoff
- particle backscattering coefficient at 443nm, bbp_443
- spectral slope of adg_443
- spectral slope of bbp_443
- uncertainty in aph_443
- uncertainty in adg_443
- uncertainty in bbp_443
- relative difference between input Rrs and modeled Rrs

See: <https://oceancolor.gsfc.nasa.gov/reprocessing/r2014/>

To get products other than the standard products, you need to obtain Level-1A data and process it yourself using SeaDAS **I2gen** processing

Quality Control Masks and L2-Flags

Lots of flexibility in the level of **quality certainty** is included with your satellite data through the use of quality **Masks and Flags**.

1. **MASKING** – If Level-1 to Level-2 masking is turned on for a given problematic condition (e.g., clouds detected or Land) then processing is halted and a missing data value (e.g., NAN) is inserted at that pixel location. **There is no going back from this lost pixel unless you reprocess with the mask turned off.** **NOTE - reprocessing is computationally intensive - i.e. time consuming process.**

2. **FLAGGING** – If a problematic condition is detected during the processing, and masking is turned off, the processing will continue to the end, but a **quality flag will be set in a separate image file** at the pixel location where the problem occurred. **After** Level-2 processing you can **choose to heed or ignore the condition** of the Level-2 quality flag l2_flags **without the need for reprocessing**. Heeding lots of different flags insures high data quality at the expense of lost data in the image.

Flags and Masks

The table shows the flags that are used to indicate quality of Level 2 data.

Each flag is assigned one of the 32 bits of the `l2_flags` array.

Some conditions make it impossible to calculate any meaningful **Level 2 parameters**. These are **masked** by default and will cause a fill value to be written for the Level-2 pixel location.

Only high-quality data is included in **binned Level 3 products**; `l2_flags`, which will exclude data during binning, are listed under "L3 Mask Default".

Bit	Name	Short Description	L2 Mask Default	L3 Mask Default
00	ATMFAIL	Atmospheric correction failure		ON
01	LAND	Pixel is over land	ON	ON
02	PRODWARN	One or more product algorithms generated a warning		ON
03	HIGLINT	Sunglint: reflectance exceeds threshold		ON
04	HILT	Observed radiance very high or saturated	ON	ON
05	HISATZEN	Sensor view zenith angle exceeds threshold		ON
06	COASTZ	Pixel is in shallow water		
07	spare			
08	STRAYLIGHT	Probable stray light contamination	ON	ON
09	CLDICE	Probable cloud or ice contamination	ON	ON
10	COCCOLITH	Coccolithophores detected		ON
11	TURBIDW	Turbid water detected		
12	HISOLZEN	Solar zenith exceeds threshold		ON
13	spare			
14	LOWLW	Very low water-leaving radiance		ON
15	CHLFAIL	Chlorophyll algorithm failure		ON
16	NAVWARN	Navigation quality is suspect		ON
17	ABSAER	Absorbing Aerosols determined (disabled?)		ON
18	spare			
19	MAXAERITER	Maximum iterations reached for NIR iteration		ON
20	MODGLINT	Moderate sun glint contamination		
21	CHLWARN	Chlorophyll out-of-bounds		
22	ATMWARN	Atmospheric correction is suspect		ON
23	spare			
24	SEAICE	Probable sea ice contamination		
25	NAVFAIL	Navigation failure		ON
26	FILTER	Pixel rejected by user-defined filter OR Insufficient data for smoothing filter ?		
27	spare	(used only for SST)		
28	spare	(used only for SST)		
29	HIPOL	High degree of polarization determined		
30	PRODFAIL	Failure in any product		
31	spare			

Standard Processing masks
Standard Processing l2_flags