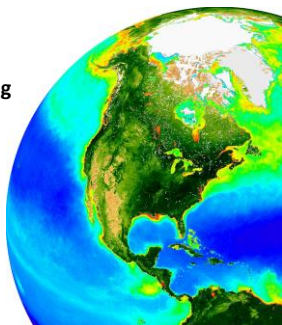


The NASA Ocean Biology Processing Group: Satellite-based Remote Sensing of the Ocean

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 and
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AMS Washington Forum
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SAIC
Science Applications International Corp.

NASA Ocean Biology Processing Group

Currently supporting calibration, validation, software development, (re)processing, and distribution for a multitude of missions & sensors.

Producing **ocean color**, sea surface temperature, sea surface salinity & winds, aerosol and some land products from VIS-NIR, IR and MW sensors.

Currently ingesting > **370 GB/day** of MODIS x 2, VIIRS, OLCI, SMAP, and GOCI data.

Expected PACE ingest < 424 GB/day.

Global Processing & Distribution

- VIIRS/NPP (USA)
- MODIS/Aqua (USA)
- MODIS/Terra (USA)
- SeaWiFS (USA)
- CZCS (USA)
- Aquarius (USA/Argentina)
- SMAP (USA)
- OLCI/S3A (Europe)
- MERIS (Europe)
- OCTS (Japan)

Regional Processing & Distribution

- GOCI (Korea)
- HICO (USA)

Limited Mission Support

- Landsat-8/OLI (USA)
- OCM-1/2 (India)
- OSMI (Korea)
- MOS (Germany/India)

Ocean Color Data Products

chlorophyll-a (algal biomass)

diffuse light attenuation (water clarity, turbidity)

dissolved organic matter absorption (runoff)

ratio of blue:green radiances

particle backscattering (sediment load)

red light reflectance (sediment load)

and, many others, including:
 phytoplankton community composition (including HABs)
 particle size distributions (water composition)
 particulate (in)organic carbon (productivity)
 euphotic depth (visibility, water clarity)

Phytoplankton, Aerosol, Cloud, ocean Ecosystem (PACE): Advancing Ocean Color

A hyperspectral instrument will enable a quantum leap forward in our ability to identify seawater components & how their distributions change & respond to forcings

Individual subcomponents vary spatially / temporally / biogeochemically / physiologically

Phytoplankton

Phytoplankton represent the first link in the marine food web & play a key role in the ecology of the ecosystem.

Just like plants on land, phytoplankton require light, water, CO₂, and nutrients to grow

The patterns & distributions of phytoplankton that we observe are related to both physical & biological processes

Phytoplankton play a major role in the global carbon cycle - comprise < 1% of plant biomass on Earth

- 100 million tons of carbon per day
- complete global turnover every 2 to 6 days
- >99% of all organic carbon in marine sediments

Phytoplankton Transport Carbon to the Deep Ocean

The diagram illustrates the vertical transport of carbon from the surface ocean to the deep ocean. It shows phytoplankton at the surface, which are consumed by zooplankton and bacteria. Organic carbon is then transported to the deep ocean, where it is buried in sediments or consumed by deep-sea organisms. The process is influenced by factors like deep water formation and ventilation.


Harmful Algal Blooms

Lake Erie Harmful Algal Bloom Bulletin
19 August, 2017, Bulletin 09

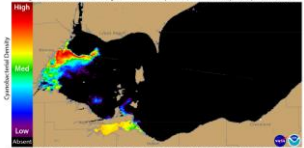
The harmful cyanobacteria (blue-green algae) in the western basin along and offshore the Ohio and Michigan coast from Huron Bay, near Port Huron, the east and west towards Middle Island Island. Observed as it is near 20°-30° chlorophyll a, increasing surface concentrations from the south have been reported. Reported from observations on the western shore of Huron Bay. The bloom extent, but current status can be seen the forecast where the bloom is most dense (dark) would have been from a boat.

Forecast for the 24-hour period through Sunday, 20/08/17: The general trend, indicating a slight concentration of chlorophyll a, which will provide a better forecast of the bloom through Sunday, 20/08/17 (Sunday, 20/08/17).

Please check the 24-hour forecast for updates for more information. <http://www.glovis.gov/hydrology.html>. Keep your eyes on the water for any change in color, depth, or texture. For the most up-to-date information on the bloom, visit the [GLOVIS](http://www.glovis.gov/hydrology.html) website.

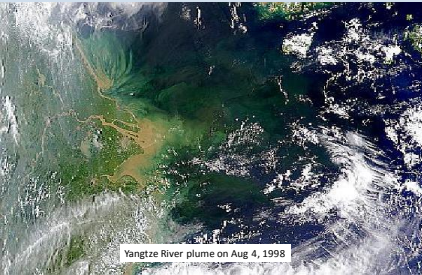


Toledo's water crib in Lake Erie



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Water Quality Monitoring

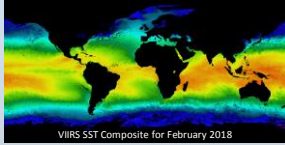


Yangtze River plume on Aug 4, 1998

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Sea Surface Temperature

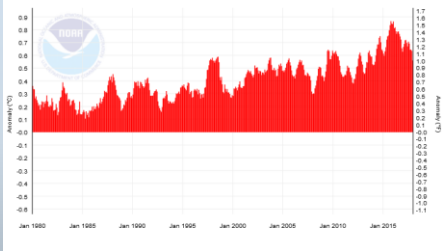
- SST is one of the longest continuous satellite-based climate data records.
 - AVHRR data since 1981
 - MODIS starting in 2000
 - VIIRS starting in 2012
- U. Miami RSMAS (Peter Minnett, PI) provides algorithms and validation data to OBPG for MODIS and VIIRS.
- Algorithms rely primarily on thermal IR wavelengths; mid-wave IR wavelengths are also used at nighttime.
- SST is a primary driver of the global climate.
- Increasing SST is also a key indicator of global warming.



VIIRS SST Composite for February 2018

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Global Ocean Temperature Anomalies

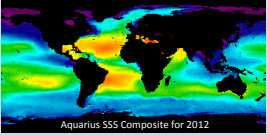


NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, published March 2018

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Sea Surface Salinity

- The Aquarius sensor on the SAC-D spacecraft was the first global satellite-based SSS sensor.
- SSS remote sensing is performed using microwave radiometry (1.4 GHz).
- The OBPG functioned as the data processing center for Aquarius, with Dr. Gary Lagerloef as the PI and science algorithms provided by Remote Sensing Systems.
- SSS is a driver of the global water cycle through its effects on ocean circulation and evaporation.
- It is a key indicator of freshwater inflow to the oceans.
- SSS is assimilated into climate models.



Aquarius SSS Composite for 2012

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Thank you! Questions?

PACE

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



SAIC Demystifying the Use of Satellite Ocean Color Data

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

SAIC What is "ocean color"?

The spectral distribution of reflected sunlight can be used to infer the contents of the water

SAIC Steps for deriving ocean color data products from space

1. remove atmosphere from total signal to derive estimate of light field emanating from sea surface (remote sensing reflectance, L_w)
2. relate spectral L_w to a chlorophyll-a concentration (or geophysical product of interest)
3. spatially / temporally bin and remap the satellite observations

The water signal is often less than 10% of the total signal measured by the satellite

SAIC PACE mission characteristics

Key Mission Elements		Key Mission Features	
Mission management	NASA Goddard SFC	Cost	Directed, DTC, \$805M
Ocean Color Instrument	NASA Goddard SFC	Life	3-yr, Class C, 10-yr fuel
HARP2 polarimeter	U. Maryland Baltimore County	Orbit	676.5 km, Sun-sync, 1-pm MLT AN
SPEXone polarimeter	SRON (Netherlands)	Coverage (OCI)	2-day global
Spacecraft/Mission Ops	NASA Goddard SFC	RF Communication	Ka direct to ground, 600Mbps
Science data processing	Ocean Biology Processing Group		
Competed science teams	NASA Earth Sciences Division		

Key Mission Science Requirements	
Ground sample distance of $1 \pm 0.1 \text{ km}^2$ at nadir	
Sun glint mitigation (OCI tilt $\pm 20^\circ$)	
OCI spectral range from (320) 350-865 nm @ 5 nm resolution	
OCI with 940, 1038, 1250, 1378, 1615, 2130, 2260 nm bands	
Twice-monthly lunar calibration	
Onboard solar calibration (daily, monthly, dim)	
A vicarious calibration system	
Core data products, uncertainties, & a validation program	

SAIC 40 billion tons of carbon taken up by phytoplankton each year

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