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

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Science Applications International Corp.
and
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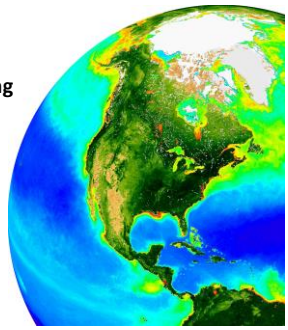
AMS Washington Forum
24 April 2018



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.

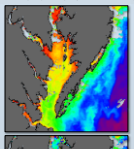
Global Processing & Distribution
- **VIIRS/NPP** (USA)
- **MODIS/Aqua** (USA)
- **MODIS/Terra** (USA)
- SeaWiFS (USA)
- CZCS (USA)
- Aquarius (USA/Argentina)
- **SMAP** (USA)
- **OLCI/S3A** (Europe)
- MERIS (Europe)
- OCTS (Japan)

Regional Processing & Distribution
- **GOCI** (Korea)
- HICO (USA)

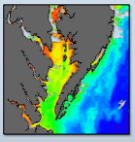
Limited Mission Support
- **Landsat-8/OLI** (USA)
- OCM-1/2 (India)
- OSMI (Korea)
- MOS (Germany/India)

Ocean Color Data Products

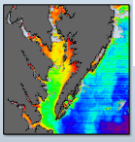
chlorophyll-a (*algal biomass*)

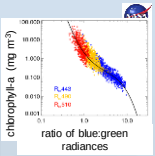


diffuse light attenuation (*water clarity, turbidity*)

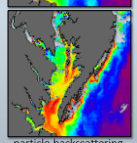


dissolved organic matter absorption (*runoff*)

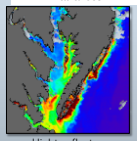




and, many others, including:
phytoplankton community composition (*including HABs*)
particle size distributions (*water composition*)
particulate (in)organic carbon (*productivity*)
euphotic depth (*visibility, water clarity*)

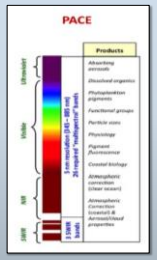


particle backscattering (*sediment load*)

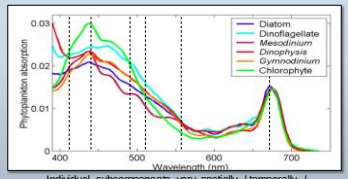


red light reflectance (*sediment load*)

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

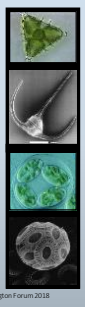


A hyperspectral instrument will enable a quantum leap forward in our ability to identify seawater components & how their distributions change & respond to forcings



Individual subcomponents vary spatially / temporally / biogeochemically / physiologically

Phytoplankton



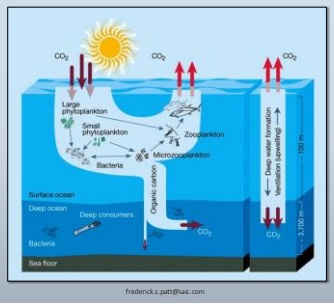
Phytoplankton represent the first link in the marine food web & play a key role in the ecology of the ecosystem.

Just like plants on land, phytoplankton require light, water, CO_2, and nutrients to grow

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

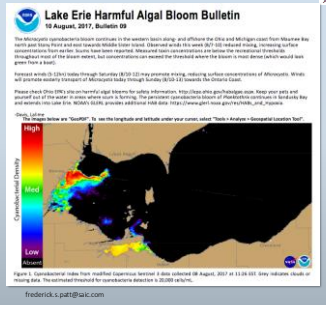
Phytoplankton play a major role in the global carbon cycle - comprise < 1% of plant biomass on Earth
- 100 million tons of carbon per day
- complete global turnover every 2 to 6 days
- >99% of all organic carbon in marine sediments

Phytoplankton Transport Carbon to the Deep Ocean

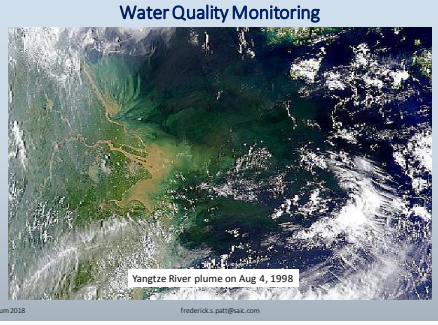


Harmful Algal Blooms

Toledo's water crib in Lake Erie



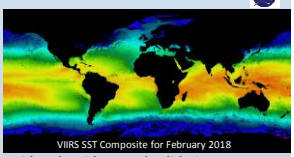
Water Quality Monitoring



Yangtze River plume on Aug 4, 1998

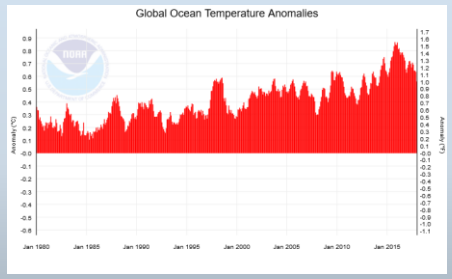
Sea Surface Temperature

- 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

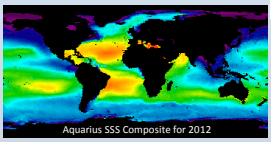
Global Ocean Temperature Anomalies



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

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.



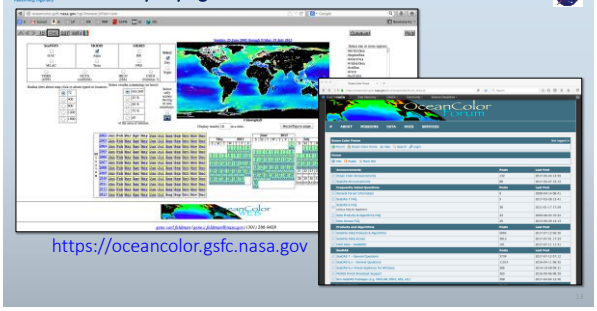
Aquarius SSS Composite for 2012

Thank you! Questions?

PACE

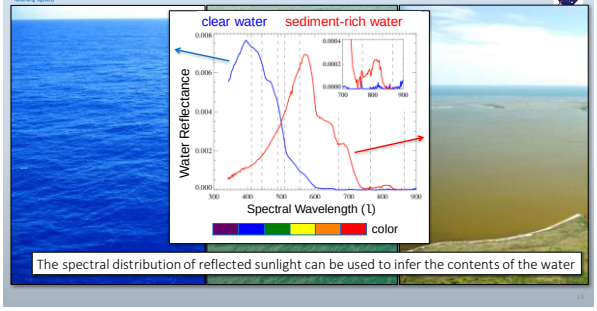
https://oceancolor.gsfc.nasa.gov
https://pace.gsfc.nasa.gov

Demystifying the Use of Satellite Ocean Color Data



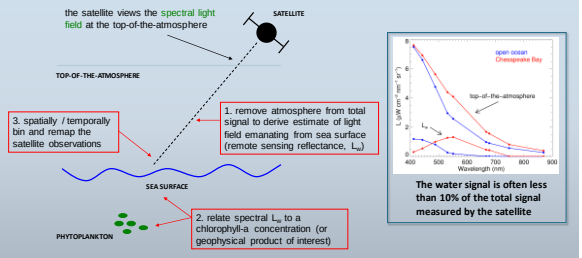
https://oceancolor.gsfc.nasa.gov

What is "ocean color"?



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

Steps for deriving ocean color data products from space



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

PACE mission characteristics

Key Mission Elements

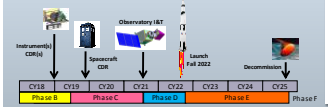
Mission management	NASA Goddard SFC
Ocean Color Instrument	NASA Goddard SFC
HARP2 polarimeter	U. Maryland Baltimore County
SPEXone polarimeter	SRON (Netherlands)
Spacecraft/Mission Ops	NASA Goddard SFC
Science data processing	Ocean Biology Processing Group
Competed science teams	NASA Earth Sciences Division

Key Mission Features

Cost	Directed, DTC, $805M
Life	3-yr, Class C, 10-yr fuel
Orbit	676.5 km, Sun sync, 1-pm MLT AN
Coverage (OCI)	2-day global
RF Communication	Ka direct to ground, 600Mbps

Key Mission Science Requirements

- Ground sample distance of 1 ± 0.1 km² at nadir
- Sun glint mitigation (OCI tilt ± 20°)
- 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



40 billion tons of carbon taken up by phytoplankton each year