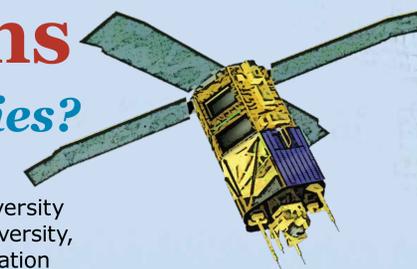


Sustained Ocean Color Research and Operations

What are the minimum requirements to continue the SeaWiFS/MODIS time-series?



Based on a National Research Council report by the Ocean Studies Board, May 2011

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BOX 1

Abstract

The United States is at risk of losing access to ocean color data because SeaWiFS has ceased operation, MODIS is aging and planned new U.S. satellite missions might not meet accuracy requirements for climate/research quality data (see Figure 1).

Ocean color refers to the technique of measuring water-leaving spectral radiance from the ocean, which is used to determine ocean phytoplankton biomass and other biogeochemical constituents of ocean waters.

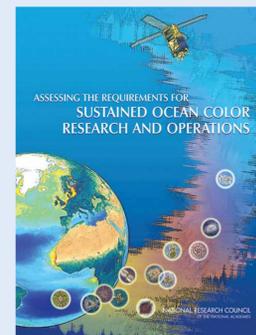
Given the importance of maintaining the ocean color time-series for (A) determining impacts of climate change on global

phytoplankton abundance, (B) determining primary production in relation to the ocean carbon and other cycles and for ecosystem-based management, (C) determining role of phytoplankton absorption for upper ocean heat fluxes, (D) monitoring harmful algal blooms, (E) for Naval operations and for (F) oil spill monitoring; NOAA, NASA, NSF, and ONR asked the National Research Council (NRC) to convene a committee of experts to identify options to minimize the risk of a data gap (see Box 2).

Here we summarize the NRC report's findings (see Box 3).

BOX 3

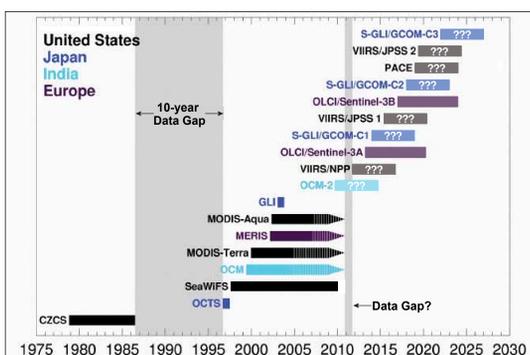
Key Findings and Recommendations



- A single sensor type cannot meet all the research and operational needs (see Box 4).
- To meet the needs for ocean color research and operations in the long-term, **international cooperation and data exchange** is absolutely essential.
- VIIRS on NPP does currently not meet the minimum requirements (see Box 5).
Recommendation: Fix VIIRS on NPP mission and make improvements on JPSS-VIIRS.
- New sensor capabilities for new and improved applications are needed (NASA's continuity and decadal survey missions: PACE, ACE, GEO-CAPE and HypSIIRI).

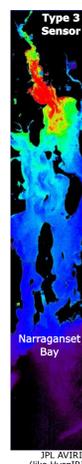
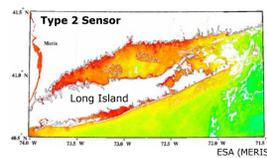
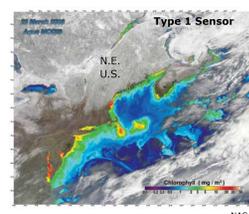
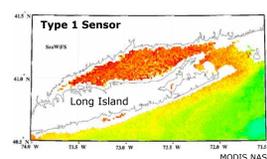
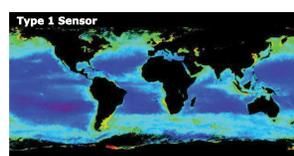
FIGURE 1

Global Ocean-Color Sensors



BOX 4

Types of Sensors and Illustrative Imagery



Type	Description
1	Polar-orbiting sensors with relatively low spatial resolution (1 km) with 8 (or more) wave bands, repeat coverage at 1-2 days (e.g., SeaWiFS, MODIS, VIIRS, PACE)
2	Polar-orbiting sensors with medium spatial resolution (250-300m) and many spectral bands to provide a global synoptic view at the same time as allowing for better performance in coastal waters, repeat coverage 2-3 days or longer (e.g., MERIS, OLCI, maybe SGU on GOOM-C)
3	Polar-orbiting hyper-spectral sensors with high spatial resolution (~30-100m), repeat coverage at 5-15 days (HypSIIRI)
4	Hyper- or multi-spectral sensors with high spatial resolution in geostationary orbit, and with hourly repeat coverage (S. Korea's GOO, GEO-CAPE)

BOX 5

Fix VIIRS

As of now, the following requirements are not met for VIIRS/NPP:

- Stability monitoring using monthly lunar looks;
- Data processing, reprocessing and distribution plan;
- Vicarious calibration program;
- Global validation program throughout the life span of the mission; and
- Algorithm development and research.

The report recommends that NOAA and JPSS take the necessary steps immediately to make sure that these requirements are met.

BOX 2

Statement of Task

To assess lessons learned in global ocean color remote sensing from the SeaWiFS/MODIS/MERIS era to guide planning for acquisition of continuous global ocean color radiance data to support U.S. research and operational needs. In particular the committee was tasked with the following:

- Identify research and operational needs and the associated high-level requirements for a sustained ocean color observations from space;
- Review the capability of current and planned national and international sensors in meeting these requirements;

- Identify and assess the observational gaps and options for filling these gaps between the current and planned sensor capabilities and timelines; and
- Identify minimum requirements for a sustained, long-term global ocean color program within the United States for the maintenance and improvement of associated ocean biological, ecological, and biogeochemical records, which ensures continuity and overlap among sensors, including plans for sustained, rigorous on-orbit sensor inter-calibration, vicarious calibration, and data validation program; algorithm development and evaluation; data processing, re-processing, distribution and archiving.

BOX 6

Key Requirements for Continuous Climate-Quality Ocean Color Data

1. Sensor characteristics, such as band-set and signal-to-noise, need to be equivalent to or better than the combined best attributes from SeaWiFS and MODIS;
2. Pre-launch sensor characterized and calibrated;
3. Post-launch vicarious calibration using a MOBY-like approach;
4. Monitoring the sensor stability using monthly lunar looks;
5. ≥ 6 months sensor overlap to produce continuous climate data records;
6. Support for on-going development and validation of atmospheric correction, bio-optical algorithms, and ocean color products;
7. Periodic data reprocessing; and
8. A system to archive, make freely available, and distribute rapidly and efficiently all raw and processed data, and documentation related to all aspects of the mission. "Raw data" refers to imagery to which new calibration factors can be applied during reprocessing.

Acronym List

ACE	Aerosol-Cloud-Ecosystems	MERIS	Medium-Resolution Imaging Spectrometer	OCM	Ocean Colour Monitor
CZCS	Coastal Zone Color Scanner	MODIS	Moderate Resolution Imaging Spectroradiometer	OCM-2	Ocean Colour Monitor on-board Oceansat-2
GCOM-C	Global Change Observation Mission for Climate Research	NASA	National Aeronautics and Space Administration	OCTS	Ocean Color and Temperature Scanner
GEOCAPE	Geostationary Coastal and Air Pollution Events	NOAA	National Oceanic and Atmospheric Administration	OLCI	Ocean Land Colour Instrument
GLI	Global Imager	NOAA	National Oceanic and Atmospheric Administration	ONR	Office of Naval Research
HypSIIRI	Hyperspectral Infrared Imager	NPP	NPOESS Preparatory Project	PACE	Pre-Aerosol-Clouds-Ecosystem
JPSS	Joint Polar Satellite System	NSF	National Science Foundation	S-GLI	Second-Generation Global Imager
				SeaWiFS	Sea-viewing Wide Field-of-view Sensor
				VIIRS	Visible Infrared Imager Radiometer Suite

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