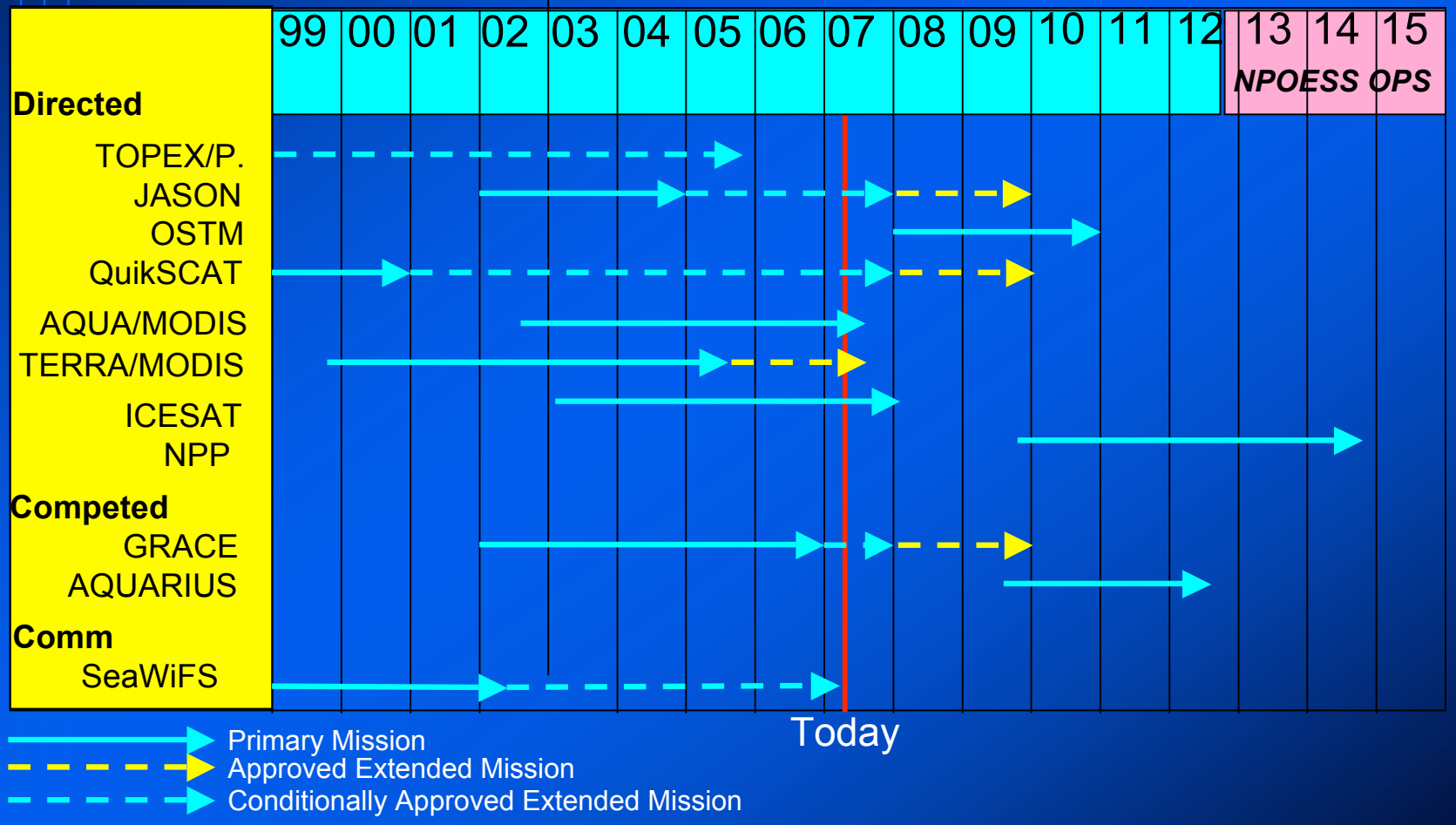
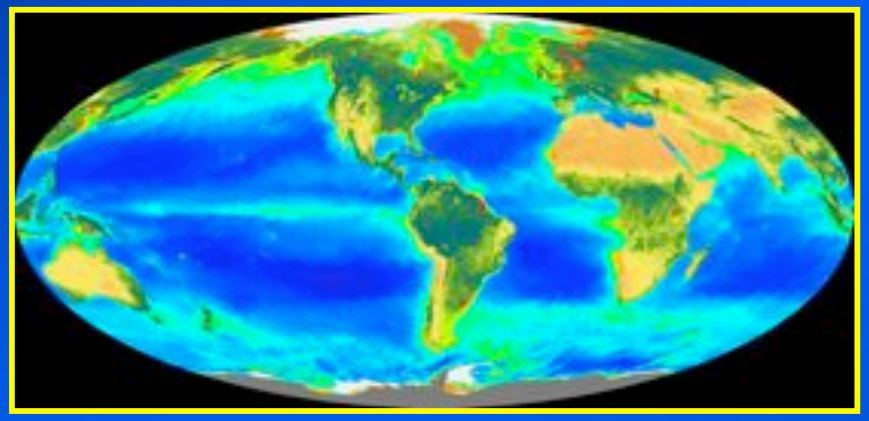
NASA Current and Approved Oceans and Ice Missions

Beyond OSTM (2008) and Aquarius (2009), there are no approved NASA oceanographic satellite missions



Earth's Living Ocean: The Unseen World



NASA Ocean Biology and Biogeochemistry Program

NASA Ocean Biology & Biogeochemistry Program

Team from April 2005: Michael Behrenfeld, Heidi Dierssen, Paul DiGiacomo, Steve Lohrenz, Chuck McClain, Frank Muller-Karger, Dave Siegel, (Paula Coble)

May 2006-October 2006: Posted for Public Comment

Reviewers: Tony Freeman, Norm Nelson, Jim Yoder

March 2007: Briefed to NRC

Emerging Scientific Questions in Ocean Biology and Biogeochemistry Research

- How are ocean ecosystems and the biodiversity they support influenced by climate or environmental variability and change, and how will these changes occur over time?
- How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do these biogeochemical fluxes impact the ocean and Earth's climate over time?
- How (and why) is the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?
- How do hazards impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?

Timeline / Mission Themes	Immediate (1 – 5 Years)	Near-Term (5 - 10 Years)	Long-Term (10 - 25 Years)
Global Separation of In-water Constituents & Advanced Atmospheric correction	**Advanced radiometer & scattering lidar** • 5nm resolution from UV through visible • Ozone & extended NIR atmosphere bands • Atmosphere & subsurface particle scattering profiles	**Ocean radiance and atmosphere aerosols** • Advanced radiometer • Scattering lidar for aerosol speciation • Polarimeter for global aerosol coverage •500 m passive resolution	**Radiometry, aerosols, and physiology lidar** • Global radiometry system • Aerosol height & species • Midnight/noon obs of variable stimulated fluorescence
High Spatial & Temporal Resolution Coastal	**Coastal carbon – GEO** **Support analysis of current satellite data** **Landsat DCM partnership** **Development of suborbital sensor systems**	**High-res coastal imager** • 20 bands from UV - NIR • 10 m res – 100 km swath **GEO carbon mission** **Deployment of suborbital systems**	**Constellation of imaging spectrometers** • High temporal res • LEO, MEO or GEO • Include SAR **Continued deployment of suborbital systems**
Plant Physiology & Functional Composition	**Support analysis of global passive data** • Assess functional groups using hyperspectral data • Estimate algal carbon & chlorophyll to characterize physiology	**Support analysis of global & GEO data**	**Variable fluorescence lidar constellation** •Map physiological provinces at different times of day • Dawn/dusk variable fluorescence lidar • Noon/midnight lidar
Mixed Layer Depth	**Synthesis/analysis of observational forecast fields & on orbit remote sensing** **Mixed layer model development**	**Prototype mixed layer sensor development** • field testing of novel approaches for remote detection of mixed layer depth & light availability	**Mixed layer depth mission** •Space-borne proof-of-concept mission for global mixed layer depth mapping

Bold Green Text Represents Satellite Missions

Bold Blue Text Represents Development Activities leading to Missions

Cross-hatch indicates secondary contribution to Mission Theme

Top Priority Science Question	Color Code	Example of Benefits to Society
How are ocean ecosystems and the biodiversity they support influenced by climate or environmental variability and change, and how will these changes occur over time?		Improved management of ecosystem goods and services
How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do biogeochemical fluxes impact the ocean and Earth's climate over time?		Information based policy on greenhouse gas emissions and nutrient loading
How (and why) is the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?		Mapping and assessment of coastal habitats for future development plans and tourism
How do hazards and pollutants impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?		National security and improved forecasting of natural and human-induced hazards

Mission Themes/Science Requirements

- Global separation of in-water constituents and advanced atmospheric corrections
- High temporal and spatial resolution coastal measurements
- Active assessments of plant physiology and functional composition
- Mixed layer depth

Science Requirements Lead to Observational Strategies

- Global Hyperspectral Imaging Radiometer
- Geostationary Hyperspectral Imaging Radiometer(s)
- Multi-Spectral High Spatial Resolution Imager
- Portable Sensors from Suborbital Platforms
- Variable Fluorescence Lidar
- Mixed Layer Depth and Illumination Sensor
- Ocean Particle Profiler and Aerosol Column Distributions

Science Requirements Lead to Observational Strategies

- Global Hyperspectral Imaging Radiometer
  - Aerosol-Ocean-Cloud (polarimeter, lidar, ocean radiometer, radar)
- Geostationary Hyperspectral Imaging Radiometer(s)
- Multi-Spectral High Spatial Resolution Imager
  - Plant Physiology and Functional Types
- Portable Sensors from Suborbital Platforms
- Variable Fluorescence Lidar
- Mixed Layer Depth and Illumination Sensor
- Ocean Particle Profiler and Aerosol Column Distributions

Sample Mission Concept Study (1)

Study Name: Global Ocean Carbon, Ecosystems, and Coastal Processes (GOCECP)

Mission Scope: Global mission focused on **ocean biology** and **biogeochemistry**

Technology Advancement: Apply technology ready to support new scientific measurements of ocean systems and their optical signatures to answer science questions of National interest that remain…

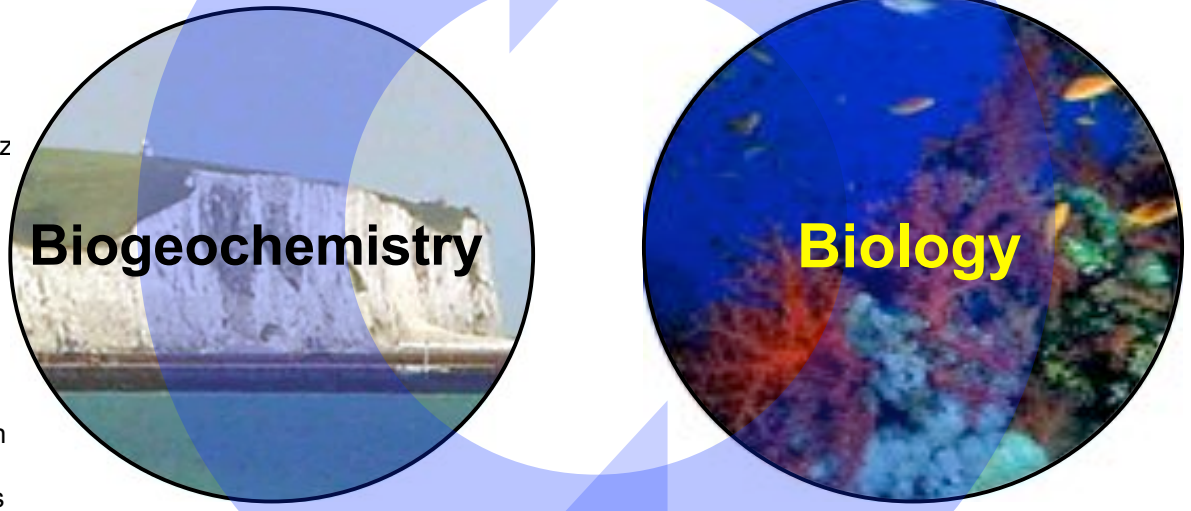
unresolved by heritage and planned sensors

Approach: Unprecedented spectral range and resolution of ocean measurements to quantify key missing ocean biogeochemical and ecosystem components

New Science: Close carbon cycle budgets, habitat health, global impact of ocean/land/atmosphere interactions on biogeochemistry and ecology, improve climate-carbon and climate-ecology modeling

Basis of Study: Refinement of mission concept developed over past three years by GSFC to observe global ocean carbon cycle and ecology

Science Objectives



Key Processes & Properties…

- Organic and inorganic particle abundance and siz
- Plant species-specific bio- and chemical markers (e.g., calcite)
- Carbon species
- Export carbon
- Photosynthesis
- Coastal processes
- Land-ocean carbon transport
- Air-sea interactions

… and GOCECP Products

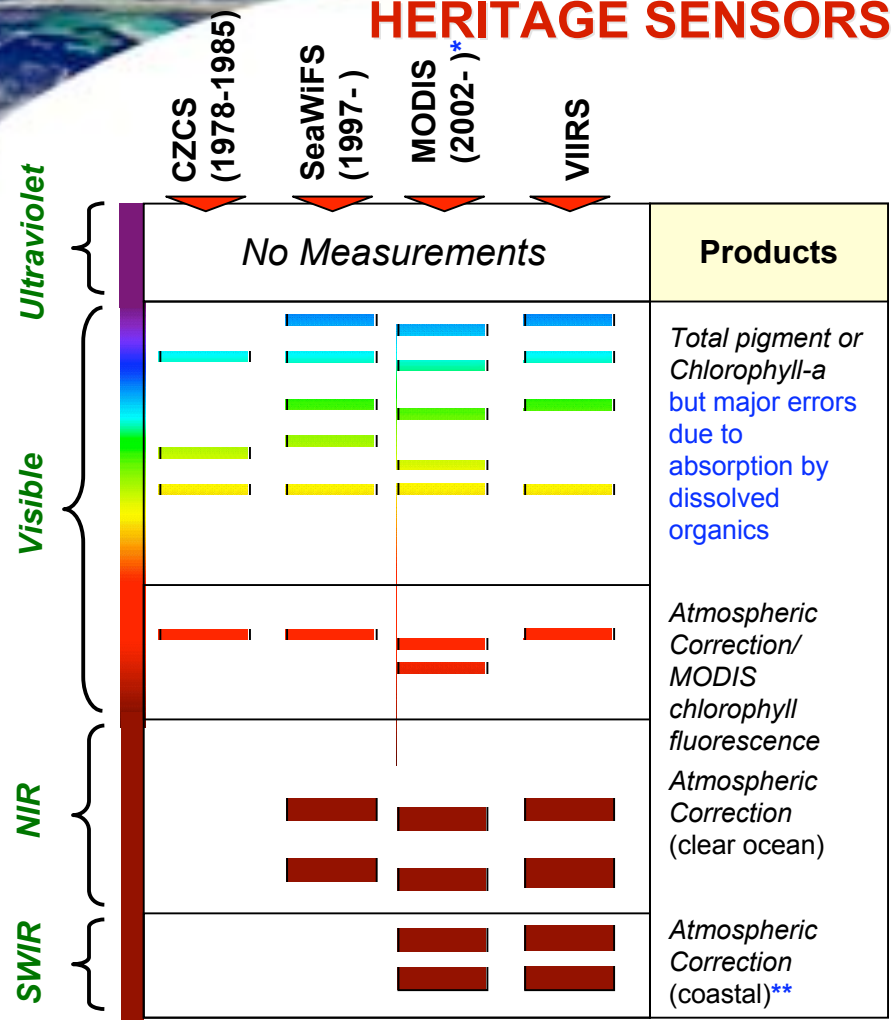
Key Processes & Properties…

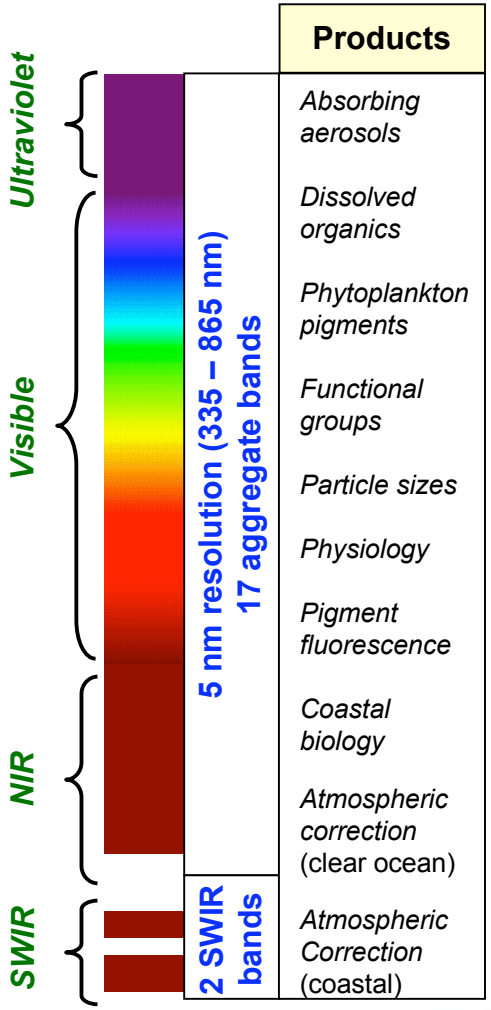
- Photosynthesis
- Phytoplankton (plant) biomass
- Plant physiology/ growth rates
- Harmful algal blooms
- Plant functional groups
  - nitrogen fixers
  - carbon exporters
  - calcium carbonate
  - microbial loop
- Ecosystems and habitat health
- Climate-biology interactions

… and GOCECP Products

GOCECP provides new measurements that advance ocean biogeochemistry and biology that heritage missions cannot.

Heritage Sensors and GOCECP

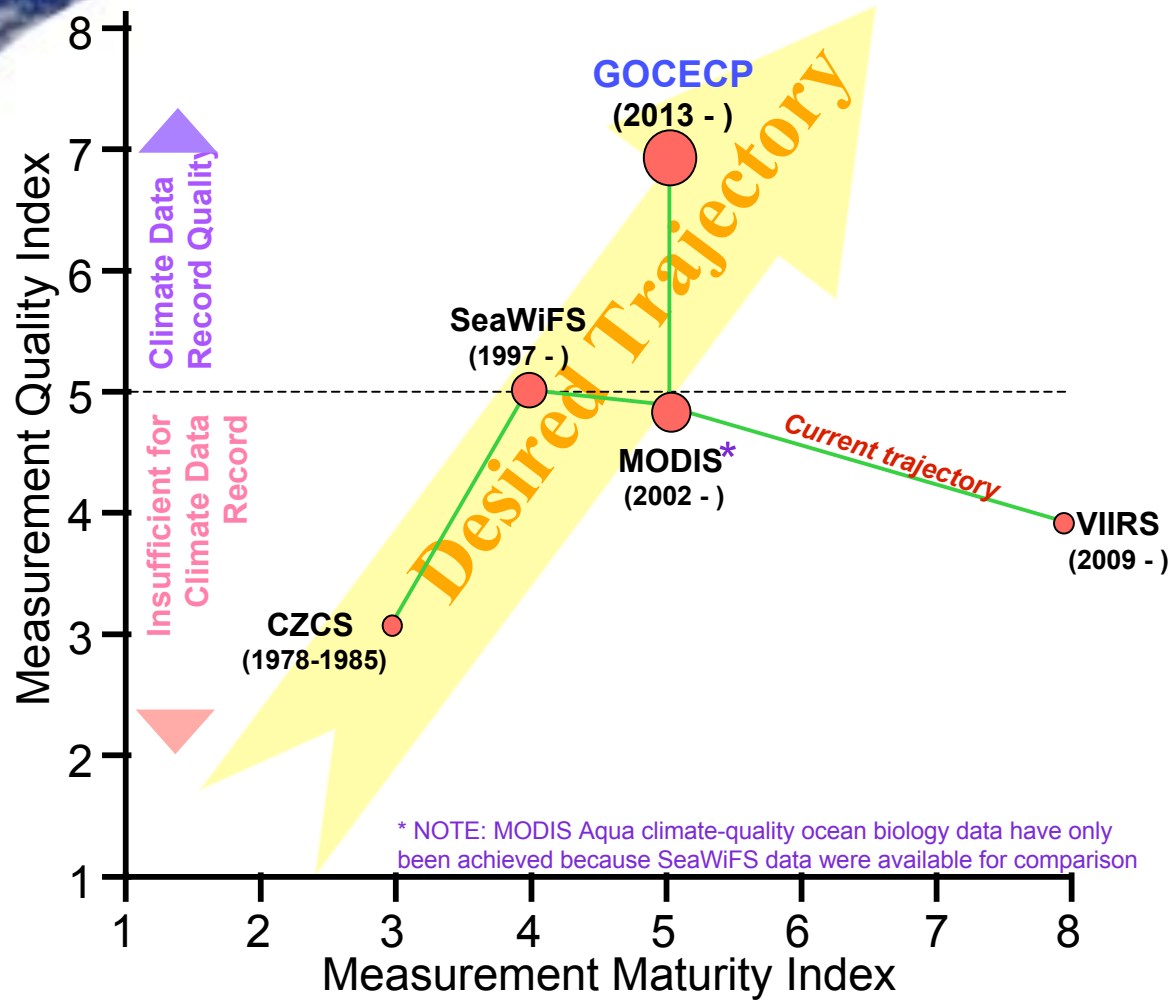




* MODIS on Terra was launched in 2000, but does not yet provide science quality ocean data

** MODIS/Visible Infrared Imaging Radiometer Suite (VIIRS) SWIR bands are not optimized for oceans

Ocean Biology Heritage Missions/Measurement Progress



Key

- Few science products
- Extensive science products

Maturity Index *
- 1= no known use for measurement
- 8= measured operationally

Quality Index *
- 1= potential science return
- 8= approaches limits on performance

* See definitions on next chart

Science | Instrument/ Mission | Satellite | Launch | Cal/Val | Programmatics | Summary

Goddard Space Flight Center

Earth's Living Ocean: The Unseen World

- NASA seeks to advance understanding of the Earth's living ocean through global research, observations and predictive models
- Community Feedback Welcome:
  - paula.s.bontempi@nasa.gov
- 4 April 2007- Draft plans (Advance + Cal/Val) available on-line
- 11-13 April 2007 – NASA Ocean Color Research Team Meeting – (Seattle, WA)
- 1 May 2007 – Draft and Plan for review with NRC OSB and SSB
- Plan – Living Document
- Carbon Cycle & Ecosystem Focus Area and ESD Advance Plan ; Decadal Survey