



MODIS OCEAN VALIDATION

Ocean Accuracy Goals

- **Water - Leaving Radiance** $\pm 5\%$
(0.4 - 0.7 m)
- **Chlorophyll a** $\pm 35\%$
(.01 - 50 mg m⁻³)
- **Sea Surface Temperature** ± 0.3 K



Sea Surface Temperature

- **Goal - SST \pm 0.3 K**
- **Primary Bands - 20, 31, 32**
- **Augmented with improved water vapor, cloud detection**
- **Focus on SS Brightness Temperature**



Sea Surface Temperature Validation

- **Top of Atmosphere Radiances**
 - **Comparisons with satellites, aircraft sensors**
 - **AVHRR, ATSR, OCTS, GLI**
 - **Modeling**
- **Sea Surface Brightness Temperatures**
 - **Focus Studies - ships, A/C, platform**
 - **M-AERI Observations (Marine - Atmospheric Emitted Radiation Interferometer)**
 - **Aircraft Sensors (MAS, HIS)**
- **Global Bulk Temperature Fields**
 - **Mooring and Drifting Buoy Observations**
 - **WOCE- TOGA**



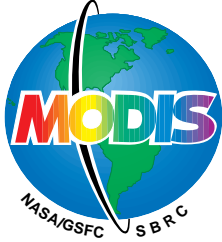
Ocean Color Validation

- **Validation of Atmospheric Correction**
 - **Sensor characteristics & calibration**
 - **Marine Aerosols**
 - **Continental Aerosols**
 - **Absorbing Aerosols (Lidars)**
 - **Whitecaps and Foam**
 - **Glitter**
- **Water-Leaving Radiance (Reflectance)**
 - **Basis for all bio-optical algorithms**



Ocean Color Validation (cont.)

- **Bio-optical Properties**
 - **Chlorophyll a**
 - **Colored Dissolved Organic Matter**
 - **Sediments**
 - **Phytoplankton Absorption**
 - **Regional, temporal bias identification**
 - **k -490**
 - **Phycoerythrin**
 - **Coccoliths, CaCO₃**
 - **Natural Chlorophyll Fluorescence, Fluorescence Efficiency**
- **Primary Production - Community Photosynthesis**

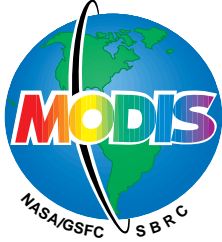


MAJOR OCEAN TEST SITES

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LEVEL OF COMMITMENT

MARINE OPTICAL BUOY (MOBY) - NASA Optics, Bio-Optics	HIGH
HAWAIIAN OCEAN TIME SERIES (HOTS) JGOFS Biogeochemistry & Physics	HIGH
BERMUDA ATLAN. TIME SERIES (BATS) JGOFS Biogeochemistry, Physics & Optics	HIGH
ANTARCTIC LTER Palmer Bio-Optics, Physics	HIGH
MIDDLE ATLANTIC BIGHT (MAB) Repeated Process Studies, Inst. Platforms	UNKNOWN
SOUTHERN CALIFORNIA BIGHT Multi-agency CalCOFI (30 year ship time series)	HIGH



MAJOR OCEAN TEST SITES (cont.)

MAJOR OCEAN TEST SITES

LEVEL OF COMMITMENT

EAST. GULF OF MEXICO NASA, Multi-agency Bio-optics, Case 2, River Plume

HIGH

CHESAPEAKE BAY & PLUME REG. - Multi-agency Case 2 - high variability, low predictability

MIXED

TOGA-TAO
Equatorial Pacific & Atlantic, Physics

HIGH

YAMATO BANK OPTICAL MOORING NASDA
Optics, Bio-Optics (OCTS Validation)

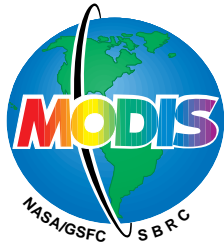
SIX MONTHS

EUROPEAN SITES, Baltic/North Sea, Eddystone, JRC Sites,

MEDIUM

TASMAN SEA AUSTRALIA
Physics, Bio-Optics

HIGH



MAJOR OCEAN TEST SITES (cont.)

MAJOR OCEAN TEST SITES

LEVEL OF COMMITMENT

WOCE LONG LINES & REPEAT SECTIONS WMO
Physics

UNKNOWN

ATLANTIC MERIDONAL TRANSITS UK
Bio-Optical, Physics

THREE YEARS

HARVEST PLATFORM, TIDE GAUGE NETWORK
Sea Level /Altimetry

HIGH

ARM SITES - DOE
Radiative Fluxes

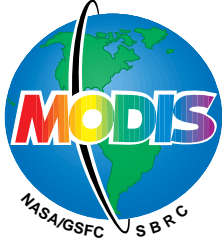
HIGH

AERONET - NASA
Maritime Aerosol Optics Sites

HIGH

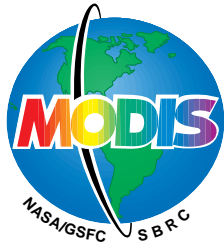
TASMAN SEA AUSTRALIA
Physics, Bio-Optics

HIGH



NON EOS FIELD ACTIVITIES

<i>Field Campaign</i>	<i>Sensors</i>	<i>Responsible Team Members</i>	<i>Purpose</i>	<i>Dates</i>
Tropical Western Pacific (ARM Site)	M-AERI	Brown & Minnett	SST	Continuing
Arctic Ocean (ARM Site)	M-AERI	Brown & Minnett	SST	Continuing
Atlantic Meridonal Transect	M-AERI	Brown, Minnett, MOCEAN	SST, Large-scale Bio-optics	9/98-4/99 9/99-4/00 9/00-4/01
Pacific Meridonal Transect	M-AERI	Brown & Minnett	SST	9/98-4/99 9/99-4/00 9/00-4/01



NEW EOS FIELD ACTIVITIES (BIO-OPTICS)

<i>Location</i>	<i>Product</i>	<i>MODIS Investigator</i>	<i>Purpose</i>	<i>Date</i>
Hawaii	Bio-optics, SST, Atmosphere Properties	Clark, MOCEAN	AM-1 Sensor Initialization	10/98
Gulf Mex. Sargasso	Bio-optics	Carder, MOCEAN	Alg. Initial. (Case 1/Case 2)	11/98
TOTO	Bio-optics	Carder, MOCEAN	Near-field scatter	3/99
NW Africa	Bio-optics SST	Clark, MOCEAN	Saharan Dust	6/99
Baffin Bay	SST	Brown, Minnett	Polar Atmosphere	8/99

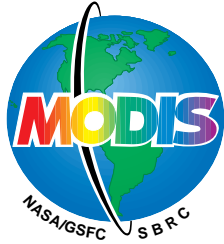


NEW EOS FIELD ACTIVITIES (BIO-OPTICS) (cont.)

<i>Location</i>	<i>Product</i>	<i>MODIS Investigator</i>	<i>Purpose</i>	<i>Date</i>
MAB	Bio-optics	Carder	Case 1 Case 2 Transition	10/99
Tasmania	Bio-optics	Clark, Parslow MOCEAN	High Latitude	2/00
MAB	Bio-optics	Clark, MOCEAN	Urban Aerosols	6/00
GOM Miss.	Bio-optics	Carder	CDOM	6/00
Hawaii	Bio-optics, SST, Atmospheric Properties	Clark, MOCEAN	PM-1 Sensor Initialization	3/01
Gulf of Maine	Bio-optics	Balch	Coccoliths	8/01

Wayne Esaias, MODIS Ocean Group Leader

September 1996



Measurement Suite for Typical MOCE Campaigns

Incident Spectral Irradiance
Upwelled Spectral Irradiance
Upwelled Spectral Radiance Distribution
Aerosol Vertical Distribution (MPL)
Whitecap Spectral Reflectance Aug.
Water-Leaving Radiance
Downwelling Irradiance Attenuation
Spectral Reflectance
Phytoplankton Pigments (HPLC)
Cyanobacteria Pigments (Exp. Fluorimetric)
Chl a Profiles
Trackline Temperature
Trackline Chlorophyll a
Inorganic Suspended Material
Detritus Spectral Absorption Coefficient
Particle Size Frequency Distribution
Particulate Organic Nitrogen
Phytoplankton Speciation Videos
Atmospheric Pressure
Wind Velocity

Downwelled Spectral Irradiance
Upwelled Spectral Radiance
Sky Radiance & Polarization Distribution
TIR Radiance (M-AERI) (Occasional)
Spectral Solar Atmospheric Transmission
Attenuation Coff. of Upwelled Irradiance
Attenuation Coefficients Radiance
Beam Spectral Attenuation Profiles
Phytoplankton Pigments (Fluorimetric)
Fluorescence Profiles
Trackline Salinity
Trackline Beam Attenuation (530 nm)
Total Suspended Material
Organic Suspended Material
Particle Spectral Absorption Coefficient
Particulate Organic Carbon
Primary Productivity (Occasional)
Secchi Disk Depth
Relative Humidity
Sea & Sky State Photographs



AUGMENTATIONS

- **Joint collection of physical and bio-optical observations at test sites.**
- **3-4 additional M-AERIE - equivalent instruments.**
- **Additional MOBY instruments for broader coverage.**
- **2 time-series stations at high latitudes (may be combined with MOBY sites).**
- **Aircraft instrument observations at MOBY site.**
- **Ship support for N. W. Africa Saharan Dust Input Experiment.**



INSTRUMENT DEVELOPMENT ACTIVITIES

- **Deployable fiber-optics based radiometers to minimize the effects of in-water instrument self shading.**
- **Portable reference lamps for rapid checking of calibration for in situ radiometers.**
- **Anti-fouling compounds or strategies for keeping the windows of unattended in situ radiometers clean.**
- **Small, inexpensive, stable, broad-band IR thermometers for rapid measurement of sea surface “skin” temperature.**
- **Portable Pump and Probe and Fast Repetition Rate Fluorometric systems for measurement of primary productivity.**
- **Standards for particle absorption.**