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Constraining Model Parameterizations of our governing equations for spectral reflectance and primary production: A 10 year concept

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Table 1. Required observations for initialization and system calibration for satellite product verification and radiative transfer (also ongoing calibration and atmospheric algorithm validation studies) and bio-optical algorithm development and validation.

	Product Verification	Radiative Transfer	Bio-optical Algorithms
Primary Optical Measurements			
Incident Spectral Irradiance, $E_d(0^-, \lambda)$	×	×	×
Downwelled Spectral Irradiance, $E_d(z, \lambda)$	×	×	×
Upwelled Spectral Radiance, $L_u(z, \lambda)$	×	×	×
Spectral Solar Atmospheric Transmission, $\tau_s(\lambda)$	×	×	×
Submerged Upwelled Radiance Distribution, $L(z, \theta, \phi)$	×	×	×
Spectral Sky Radiance Distribution	×	×	×
Upwelled Spectral Irradiance, $E_u(z, \lambda)$		×	×
Calculated or Derived Variables			
Water-leaving Radiance, $L_W(0^-, \lambda)$	×	×	×
Attenuation Coefficient Downwelled Irradiance, $K_d(z, \lambda)$	×	×	×
Attenuation Coefficient Upwelled Radiance, $K_L(z, \lambda)$	×	×	×
Spectral Reflectance, $R_L(z, \lambda)$	×	×	×
Ambient Properties			
Sea and Sky State Photographs	×	×	×
Wind Velocity	×	×	×
In Situ Fluorescence Profiles		×	×
Aerosol Samples		×	×
Temperature and Salinity Profiles			×
Secchi Depth			×

Primary Biogeochemical Measurements			
Phytoplankton Pigments (HPLC Technique)		×	×
Phytoplankton Pigments (Fluorometric Technique)		×	×
Total Suspended Material (TSM) Concentration		×	×
Colored Dissolved Organic Material (CDOM)		×	×
Inherent Optical Properties			
Spectral Beam Attenuation Coefficient, $c(z,\lambda)$		×	×
Spectral Absorption Coefficient, $a(z,\lambda)$		×	×
Spectral Backscattering Coefficient, $b_b(z,\lambda)$		×	×
Spectral Volume Scattering Function, $\beta(z,\lambda,\theta)$		×	×
Red Beam Attenuation, $c(z, 660\text{ nm})$		×	×
Algorithm Specific Research Measurements			
Airborne Fluorescence and Radiances		×	×
Coccolith Concentration			×
Detritus Absorption Coefficient		×	×
Humic and Fulvic Acids			×
Inorganic Suspended Material			×
Organic Suspended Material			×
Particle Absorption Coefficient		×	×
Particle Fluorescence			×
Particle Size Spectra		×	×
Particulate Organic Carbon (POC)			×
Particulate Organic Nitrogen (PON)			×
Phycobilipigments Concentration			×
Phytoplankton Species Counts			×
Primary Productivity (^{14}C)			×
Total Dissolved Organic Carbon (DOC)			×

× = Needed for the indicated effort.

Strategy To make comprehensive global measurements in support of ocean color satellite applications for

- •phytoplankton pigments
- •Carbon and nitrogen
- •suspended sediments
- •Mineral content
- •UV-visible attenuation coefficients
- •primary production

$R_{rs}(\lambda) = Lu / Ed$

$R_{rs}(\lambda) = f/Q\ bb(\lambda) / a(\lambda) + bb(\lambda)$

$P = chl \int a_{ph}^*(\lambda)\ E(\lambda)\ \phi(\lambda)$

ϕ and a_{ph}^* are functions of E, N, T; $\phi_{max} = \alpha / a_{ph}^*$

Above requires ~5-6 people at sea

Atmospheric transmittance and aerosol work requires ~2 people at sea

Need critical mass of 7-10 people on routine cruises and to strategic regions of the world's oceans

Update Table 1 of Ocean Optics Protocols
Work implied requires multi PI teams working together
Define funding levels and multi-PI teams
Define ship opportunities:

- Routine cruises
  - October 2004 R/V Revelle CalCOFI
  - Future CalCOFI?
  - HOTS/BATS
- Global cruises to strategically important provinces
  - WOCE repeat surveys
  - AMLR/Southern Ocean
  - Arctic??
  - Heavy aerosols western Pacific?
  - etc.