not require a mechanically stabilized platform, thereby making it cost effective and reliable. The aerosol optical thickness is computed continuously from the direct-normal component of irradiance using calibration constants obtained using the Langley technique. The FRSR has been deployed on numerous cruises of opportunity (over 20) and is semi-permanently deployed on several operational research vessels. The data base of cruises has reasonable global coverage and the current FRSR data base contains years of data. In addition to routine cruises, the FRSR database includes data from the following field experiments: Aerosols99, INDOEX, Nauru99, and ACE-Asia.

The FRSR data base have been analyzed for the purpose of classifying the various aerosol regimes over the world's oceans and quantifying the aerosol optical properties in these regimes. Uncertainties in the measurements have been quantified and are used as filtering criteria. Data from the instrument, after significant processing, are combined with aerosol chemical classifications, when available, to provide a unique view of aerosol structure over the world's oceans. Different aerosol regimes have been identified and their characteristics determined from the FRSR measurements. The FRSR can distinguish differences between the aerosol radiative properties, namely the aerosol optical thickness, the angstrom exponent, and the diffuse irradiance, in different aerosol regimes. Differences in the aerosol characteristics in different regimes are delineated in the FRSR data and interesting patterns are documented.

URL: http://www.gim.bnl.gov/

OS51E-11 1120h

Comparison of Satellite Estimates of Aerosol Optical Thickness and Cloud Cover with Shipboard Measurements

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An important component of the data calibration and validation programs for the ocean color satellite missions, such as NASA SIMBIOS, is the validation of the algorithm for the atmospheric correction. Correction of satellite radiance for the impacts of the intervening atmosphere is necessary because atmospheric aerosols scatter incoming solar radiation in the same blue and green wavelengths that contain scattered light from the ocean surface layer. Only about 5% of the radiance measured at the satellite has been scattered from within the ocean (water-leaving radiance); the vast majority has been scattered by the turbid atmosphere. Atmospheric correction is accomplished by measuring the aerosol optical thickness in two near-infrared channels that contain no radiance contribution from the underlying ocean. These two near-infrared measurements are used in conjunction with aerosol and radiative transfer models to infer the aerosol scattering properties in the blue and green wavelengths. Once these characteristics are estimated, the radiance due to aerosol scattering can be subtracted from the total satellite radiance leaving the water-leaving radiance as a residual.

Validation of the aerosol component of the atmospheric correction algorithms actually involves answering several important questions: (1) Is the sky clear in the satellite pixel?; (2) Does the satellite accurately measure the aerosol optical thickness in its near-infrared reference channels?; and (3) is the model used to estimate the aerosol optical thickness in the blue and green wavelengths from the aerosol properties in the near-infrared wavelengths adequate?

As part of our NASA SIMBIOS work and with additional support from the Department of Energy's (DOE) Atmospheric Radiation Program (ARM) program, we developed and deployed a new instrument during the past two years: the ship-board Fast-Rotating Shadowband Spectral Radiometer. This instrument makes continuous, semi-automated shipboard measurements of the direct-normal, diffuse, and global irradiance in seven channels (415 nm, 500 nm, 610 nm, 660 nm, 862 nm, 936 nm, and broadband) and does not require a mechanically stabilized platform, thereby making it cost effective and reliable. The aerosol optical thickness is computed continuously from the direct-normal component of irradiance using calibration constants obtained using the Langley technique. This instrument has been deployed extensively during the past three years traversing parts of all three oceans.

Comparisons between FRSR-measured aerosol properties and the satellite aerosol properties deduced from a combination of near-infrared radiance measurements and models have been performed. These comparisons are a mechanism to evaluate the integrity of current atmospheric correction algorithms. The comparisons include FRSR and satellite measurements of the aerosol optical thickness in the near-infrared wavelengths, FRSR measurements and satellite-based estimates of the aerosol optical thickness in the blue and green wavelengths, and tests of the cloud filters used in the satellite algorithms.

URL: http://www.gim.bnl.gov/

OS51E-12 1135h

Maritime Aerosol Optical Model Based on the Aerosol Robotic Network (AERONET) Measurements.

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The quality of bio-optical products of satellite ocean color sensors is strongly dependent on the accuracy of atmospheric correction algorithms. Atmospheric correction of ocean color imagery requires better aerosol modeling. Aerosol optical properties over the oceans vary considerably. In order to simulate aerosol optical conditions over the oceans three major sources should be considered, which we can define in terms of generalized source trajectories: continental air, pure oceanic air, and desert dust. In the current study we consider primarily pure oceanic air. To retrieve a "pure maritime" component we?ve considered the data set with the aerosol optical depth smaller than 0.15 and Angstrom parameter less than 1. Aerosol optical model include information about optical (aerosol optical depth and its spectral and diurnal dependence, phase function and single scattering albedo) and microphysical (size distribution and its parameters, refractive index) characteristics and eigen vectors of covariance matrix. Day-to-day variations, diurnal variations, frequency of occurrences are presented for Bermuda (Atlantic Ocean), Lanai, Hawaii (Pacific Ocean) and Kaashidhoo, Maldives (Indian Ocean). Daily averages and instantaneous measurements are considered in the analysis. Comparison of the columnar volume size distributions for each site is presented. Derived "maritime" component in the size distribution appeared to be very similar for the sites considered. Estimates are made for the fractional contribution of the fine and coarse modes to aerosol optical depth and total concentration. The intercorrelation of aerosol optical depth values at different wavelengths reveals that correlation factors are generally high for both instantaneous and daily averaged measurements. Spectral dependence of the first two eigen vectors of covariance matrix is similar. For all three sites the first vector explains about 92-93% of the total spectral variance of optical depth and the second vector explains 6-7%. The first two eigen vectors are clearly sufficient to simulate the principal features of the optical depth spectral behavior.

OS52A MC: Hall D Friday 1330h

Calibration and Validation Efforts Under Way by the Ocean Color Missions III *(joint with B)*

Presiding: **G S Fargion,** NASA / Goddard Space Flight Center**; C R McClain,** NASA / Goddard Space Flight Center

OS52A-0512 1330h POSTER

SeaWiFS On-orbit Calibration Changes Derived from Four Years of Lunar Measurements

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Lunar measurements are an integral part of the calibration of the Sea-viewing Wide Field-of View Sensor (SeaWiFS). The first measurements of the moon were made on 14 November 1997. Regular, monthly lunar measurements have continued since then, providing a four year data set. The SeaWiFS Project uses the moon as a stable reflectance target over the lifetime of the mission. However, corrections must be made to the lunar measurements for geometric factors, such as the lunar phase angle. The four year lunar data set shows the greatest calibration change to occur at 865 nm. The changes decrease with decreasing wavelength to a minimum near 500 nm. There is a small increase in the calibration change in the blue at 412 and 443 nm. The sensitivity of the lunar technique is sufficient to detect small annual oscillations in some of the bands due to improper correction factors for the temperatures of the focal planes. Over time, the rates of the calibration changes in the SeaWiFS bands are decreasing, based on the lunar measurement set. At the next SeaWiFS reprocessing, these changes will be fitted to exponential time series.

OS52A-0513 1330h POSTER

A Three Year Intercomparison of Oceanic Optical Properties from MOS and SeaWiFS

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Since 1996, following in the success of CZCS, a fleet of space-borne sensors with ocean color capability have been put into operation by various research institutions throughout the world. The NASA SIMBIOS Project has been funded to evaluate the consistency of oceanic optical properties retrieved by these different sensors, with the ultimate goal of merging data from multiple missions to enhance temporal, spectral, or spatial resolution of the global dataset. The work presented here is a long-term comparison between two such missions: Germany's Modular Optoelectronic Scanner (MOS), and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) operated by NASA and the OrbImage Corporation.

While the MOS sensor is a technology demonstrator with limited geographic coverage, it is unique among the latest generation of space-borne ocean color instruments in that it has been in operation since early 1996, and thus spans the lifetime of all the global ocean

color sensors launched after CZCS. MOS therefore has the potential to act as a consistent calibration source between the global missions, including the Japanese OCTS mission which failed in June of 1997, and SeaWiFS which launched shortly thereafter in August of 1997.

In 1998, Wang and Franz presented a cross-calibration between MOS and SeaWiFS at the 2nd International Workshop on MOS-IRS and Ocean Color in Berlin, Germany. Since that time, a groundstation was established at NASA Wallops to collect MOS data along the Atlantic coast of North America. The SIMBIOS Project now has an archive of approximately three years of MOS data, with the ability to perform automated scene matching and extraction from the SeaWiFS data archives. In the work presented here, we use this match-up capability to examine the long-term relative stability of the ocean color retrievals between MOS and SeaWiFS, while applying the intercalibration established in 1998 and a consistent atmospheric correction approach.

URL: http://simbios.gsfc.nasa.gov/

OS52A-0514 1330h POSTER

Merger of Ocean Color Information of Different Spatial Resolution: SeaWiFS and MOS.

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One objective of the SIMBIOS Project at NASA's Goddard Space Flight Center is to integrate information from different satellite ocean color sensors and with in situ observations when available. This merger will improve ocean color spatial and temporal coverage, increase confidence in extracted geophysical parameters, and enable the definition of climatological information and long-term time series. One goal is to produce daily chlorophyll concentration and aerosol optical thickness maps at the highest feasible spatial resolution, using data merged from the available sensors. This study examines the possibilities of merging chlorophyll concentration products from sensors of different spatial resolutions and the prospect of enhancing oceanic features in lower resolution imagery through the use of higher resolution data. Level 2 scenes from Sea-viewing Wide Field-of-view Sensor (SeaWiFS) are applied as the lower 1km resolution data and combined with overlapping Modular Optoelectronic Scanner (MOS) scenes with a resolution of 0.5km. The merger of datasets with different spatial resolutions requires a number of steps. First, the scenes are spatially binned at their corresponding resolutions. Then, the bins are projected onto a rectangular latitude/longitude grid map. Missing grid points are approximated using an algorithm that minimizes image frequency anomalies associated with the missing data. The merger of the SeaWiFS and MOS chlorophyll maps uses a weighted addition of multi-resolution space and frequency coefficients extracted from the wavelet transforms of the scenes. Finally, the addition of the highest frequency coefficients from the MOS scene enables the creation of the merged result at the MOS resolution. The final product benefits from the fusion of multi-sensor chlorophyll concentration retrievals spread over different spatial resolutions and provides an overall enhanced resolution. Problems encountered by the algorithm include chlorophyll retrievals with high frequency content, which produce noisy merged data, and isolated high chlorophyll peaks which result in noticeable ringing effects in the final products. These problems are tackled by employing soft thresholding on the wavelet-decomposed scene coefficients and using a median of the results provided by a number of different wavelet functions.

OS52A-0515 1330h POSTER

Comparisons of SeaWiFS, MODIS, Oceansat, FY1-C, and PHILLS to In Situ Measurements in the Coastal Ocean

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During the summer of 2001, the Rutgers University Longterm Ecosystem Observatory was the focus of an intense satellite/ in situ ocean optics research program (HyCODE). Ocean color data from SeaWiFS, MODIS, Oceansat, Fy1-C and the PHILLS hyperspectral scanner were compared and contrasted to each other and in situ measurements from ships, moorings and AUVs. Early results will be presented here.

URL: http://marine.rutgers.edu/cool

OS52A-0516 1330h POSTER

Coupling MODIS and SeaWIFS Optical Products

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Bio-optical products from SeaWIFS and MODIS (terra) were compared from coastal and open ocean waters in the Gulf of Mexico and the US East Coast. Near coincident (1 hour) overpasses of these satellites were processed with similar methods to determine the inherent optical properties (absorption and scattering), diffuse attenuation coefficient (k) and the chlorophyll concentration. The similar spectral and spatial resolution and repeat cycles of these sensors provide methods to determine temporal changes in the coastal processes. We evaluate the satellite bio-optical products using coincident shipboard measurements and we assess the variability and regional dependence of the algorithms. Processing of MODIS and SeaWIFS imagery was performed on modified U. of Miami (modcol) software on a LINUX operating system. We compared the standard processing code for these satellites with Near-IR atmospheric correction methods and determined the differences in optical properties within the coastal zone. The MODIS predicted coastal bio-optics were elevated relative to the SeaWIFS and shipboard values and were linked to the NIR correction. We noted largest differences in the high sediment estuarine regions and river discharge regions and smaller differences offshore. Because of the importance of atmospheric correction in bio-optical estimates, we examined the effects due to differences in the aerosol models and optical depths that were used by the two satellites.

OS52A-0517 1330h POSTER

MODIS Ocean Color, SST and Primary Productivity Products at the NASA Goddard Earth Sciences DAAC

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The Goddard Earth Science (GES) Distributed Active Archive Center (DAAC) plays a major role in enabling basic scientific research and providing access to scientific data for the user community through the ingest, processing, archive and distribution of MODIS data. MODIS is part of the instrument package on the Terra (formally AM-1) satellite that was launched on December 18. 1999. Global scale ocean products are derived from many of the 36 different wavelengths measured by the MODIS/Terra instrument and are archived at a rate of about 230 GB/day.

This paper will provide a description of the MODIS Ocean data products and associated geophysical parameters, data access, data availability and tools. The full suite of ocean products is grouped into three categories: ocean color, SST and primary productivity. The amount of MODIS ocean data being archived at the DAAC will increase dramatically in the near future when the data from the MODIS instrument onboard the Aqua (formally PM-1) spacecraft begins transmission. This will result in a significant increase in the volume of ocean data being ingested, archived and distributed at the GES DAAC. The current suite of products will be generated for both Terra and Aqua. In addition, joint Terra/Aqua ocean products will be derived. The challenge, to distribute such large volumes of data to the ocean community, is achieved through a combination of GES DAAC Hierarchical Search and Order Tool known as, WHOM, and EOS Data Gateway (EDG) World Wide Web (WWW) interfaces and an FTP site that contains samples of MODIS data.

The MODIS Data Support Team (MDST) continues the tradition of quality support at the GES DAAC for the ocean color data from CZCS and SeaWiFS by providing expert assistance to users in accessing data products, information on visualization tools, documentation for data products and formats (HDF-EOS), information on the scientific content of products and metadata. Visit the MDST website at http://daac.gsfc.nasa.gov/CAMPAIGN$_DOCS$/$MODIS/index.html$

OS52A-0518 1330h POSTER

Global Ocean Color Measurements From the NPOESS/VIIRS Instrument

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The VIIRS instrument is one of several instruments currently being designed for the National Polar Orbiting Environmental Satellite System (NPOESS), as part of a joint effort between the Department of Defense, NASA, and NOAA. The Ocean Color product, developed using the VIIRS sensor, contains chlorophyll concentration retrieved from remote sensing reflectances derived from VIIRS measurements. A retrieval algorithm for chlorophyll concentration has been developed for Case I waters (characterized by having a strong correlation between scattering and absorbing substance concentrations and chlorophyll a concentration, i.e. open ocean) and Case II waters (characterized by having a lack of correlation between scattering and absorbing substance concentrations and chlorophyll a concentration, i.e. coastal waters). For Case II waters a chlorophyll a algorithm developed by Carder et al. (1997) was implemented. This algorithm was based on a semi-analytical, bio-optical model of remote sensing reflectance. For Case I waters a chlorophyll a algorithm developed by Gordon and Morel (1983) was employed. It is an empirical equation and is dependent upon the ratio of the reflectances at wavelengths 488 nm and 555 nm. Algorithm performance has been evaluated using both the in situ SeaBAM data sets and simulated remote sensing reflectances. The sensor and algorithms together meet the NPOESS sensor requirements on chlorophyll precision and accuracy thresholds for chlorophyll concentrations typical for open ocean waters. NPOESS is an integrated operational system and this benefits the VIIRS ocean color product. The high spatial resolution of the VIIRS imagers from visible to infrared bands provides accurate cloud mask and sun-glint mask products. Sea surface wind vectors derived from the NPOESS Conical Scanning Microwave Imager/Sounder will allow for correction of the ocean surface roughness effect. Additionally, the ozone product was derived from the NPOESS Ozone Mapping and Profiling Suite and is expected to be an accurate correction for the ozone absorption. References Gordon H.R., and A. Morel (1983). Remote assessment of ocean color for interpretation of satellite visible imagery. A review. New York: Springer. Carder, K.L., S.K. Hawes, Z. Lee, and F.R. Chen (1997). MODIS: Case 2 chlorophyll a algorithm. MODIS ATBD-19, URL http://eospso.gsfc.nasa.gov/atbd/modistables.html.

OS52A-0519 1330h POSTER

Atmospheric Correction of Ocean Color Measurements For the NPOESS/VIIRS Sensor

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Measurements of ocean color from space are challenging because about 90% of the radiation reaching a satellite sensor come from atmospheric scattering and sea-surface reflection. Removal of these effects is crucial to the retrieval of accurate ocean color information. This atmospheric correction procedure takes into account sea-surface reflection along with atmospheric scattering and absorption. The US National Polar-orbiting Operational Environmental Satellite System Visible/ Infrared Radiometer Suite (NPOESS/ VIIIRS) is currently being developed and ocean color measurements will be generated as one of the VIIRS data products. The atmospheric correction methods for the VIIRS ocean color data are adapted from those developed for the Moderate Resolution Imaging Spectrometer (MODIS) and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). The multi-spectral bands, from visible to infrared wavelengths, from the VIIRS sensor are expected to provide an accurate cloud mask. The sea surface wind vector based on NPOESS' Conical Scanning Microwave Imager/ Sounder (CMIS) is used to determine whether any pixel is contaminated by sun glint and to correct for the effects of whitecaps, including the spectral dependence of whitecap reflectance. The ozone absorption is corrected based on information derived from the ozone product of the NPOESS Ozone Mapping and Profiling Suite (OMPS). The Rayleigh scattering effect is removed based on the surface pressure from NCEP data. An aerosol model is selected based on near infrared 751nm and 865 nm reflectances, then used to remove the effects of single and multiple aerosol scattering on the visible VIIRS bands. Results of NPOESS/ VIIRS algorithm tests are presented.

OS52A-0520 1330h POSTER

Validation of Satellite-Derived Ocean Color: Theory and Practice

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Satellite validation is the process of determining the spatial and temporal errors of a given biological or geophysical data product, including the development of match-up data sets, i.e., field observations and satellite data coincident in time and location. The primary objective of NASA's Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project is identifying biases between similar products generated by various ocean color missions. The utility of satellite- derived ocean color data is strongly dependent upon the validation of these data. The temporal and spatial scales of the phenomena being measured by a satellite borne sensor, along with the resolution of the sensor, must be considered when trying to validate a data product using a single point in situ measurement. To facilitate this validation process, the SIMBIOS project in conjunction with the SeaWiFS Project have developed a database of radiometric, phytoplankton pigment, and other oceanographic and atmospheric data: the SeaWiFS Biooptical Archive and Storage System (SeaBASS). A theoretical framework and practial application of satellite valiation is discussed.

OS52A-0521 1330h POSTER

Dominance of Colored Dissolved Organic Material in Determining Light Availability in the Sea.

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The bio-optical assumption relates the optical properties of the upper ocean to a single index, the chlorophyll a concentration (Chl). However, other materials, such as colored dissolved organic matter and detrital particles, are often important to visible light absorption. An analysis of the contribution of different components to the absorption coefficient budget is presented based primarily on observations from the NASA SIMBIOS program taken from a variety of oceanic conditions. Component absorption coefficients increase with pigment biomass demonstrating the fundamental basis for the bio-optical assumption. However for low Chl waters, dissolved matter absorption at 440 nm, ag(440), is often larger than phytoplankton absorption, aph(440). Further, values of ag(440) are larger those for detrital particulates, adet(400). For Chl observations less than 1 mg m-3, the absorption budget at 440 nm is dominated by ag(440). Values of adet(440)/at(440) are always small (< 20%). Results from the global, in situ database are compared with the estimates derived using a semi-theoretical approach. Based on these results, the capabilities and limitations of the bio-optical assumption and their implications on ocean color remote sensing are discussed.

OS52A-0522 1330h POSTER

Bio-Optics from Moorings: Satellite Validation and Ecosystem Dynamics

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Radiometric and bio-optical measurements that transcend the spatial and temporal boundaries of classical shipboard methods are becoming increasingly important to the oceanographic research community. Moored platforms provide high temporal resolution data that describe important episodic and periodic processes that are difficult to observe from conventional methods. Further, optical moorings deliver essential data for validation, calibration and algorithm development efforts in support of ocean color imaging satellites. Although the data from optical moorings clearly offer a powerful tool for ocean color observers, clear and rigorous sampling and data processing strategies are necessary in order to optimize their technique and maximize data quality. The focus of this presentation is to report the radiometric measurements retrieved from moorings in the equatorial Pacific and Monterey Bay, California, to describe the ecosystem variability, and to offer considerations for protocols towards future deployments. Specifically, the ability to accurately estimate downwelling irradiance (Ed), water leaving radiance (Lw), and normalized water-leaving radiance (Lwn) will be quantitatively assessed. The study describes specific considerations for future deployments of optical moorings.

OS52A-0523 1330h POSTER

Observations of UV-A Irradiance and Diffuse Attenuation Coefficient Spectra in the Sargasso Sea: The Bermuda Bio-Optics Project

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Observations of spectral irradiance in the UV-A band (325 nm, 340nm, 380 nm) have been recently added to the 9-year time series of ocean color properties from the Bermuda Bio-Optics Project. Light energy availability in this waveband is thought to be controlled by absorption from chromophoric dissolved organic matter (CDOM), which is also the major determinant of ocean color in open ocean regions. CDOM also mediates the rate of photochemical reactions in the surface waters and can play a role in microbial ecology through its role in UV light availability and transformations of dissolved organic matter. However, the relationship between UV-A irradiance and ocean properties is not well understood. Here, observations of the diffuse attenuation coefficient spectrum for UV-A and the absorption CDOM are used to address seasonal changes in the Sargasso Sea light environment and to develop simple parameterizations of UV-A light availability in the sea. Calibration issues relevant to the particular instruments used in the present study will also be discussed.

URL: http://www.icess.ucsb.edu/bbop/bbop.html

OS52A-0524 1330h POSTER

Merging Data from Ships, Satellites and Moorings to Understand Biological-Physical Coupling in the Equatorial Pacific

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Answering oceanographic questions relating to coupling between physics, biology and chemistry increasingly requires that we understand a variety of processes acting over a range of temporal and spatial scales. No single observational platform can provide the necessary data for achieving this goal. Ships provide the opportunity to conduct detailed process studies, but the spatial and temporal coverage of measurements is relatively sparse in time and space. Satellites, on the other hand, offer exceptional spatial and temporal coverage, but cannot quantify vertical variability in the water column. Moorings and drifters give excellent temporal coverage, but are limited to an Eulerian or Lagrangian spatial context, respectively. The various strengths and weaknesses of these techniques illustrate the potential benefits of combining measurements across several platforms. This presentation will focus on biological-physical coupling in the equatorial Pacific, during the 1997-99 El Niño - La Niña. The physical processes that will be described include Kelvin waves, remote and local wind forcing of the thermocline, tropical instability waves, upwelling variability and the dynamics of the equatorial undercurrent. The multi-platform approach has yielded significant new insights into the physical control of phytoplankton dynamics in the equatorial Pacific, and can be readily applied to other systems in the future.

OS52A-0525 1330h POSTER

Time Series Measurements and Algorithm Development at the FRONT Site on the New England Continental Shelf

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The optical properties of case II coastal ocean are influenced by a complex mixture of seawater constituents and a wide variety of physical processes. Especially in regions where formation of physical and optical fronts is frequent, but temporally and spatially variable, this complexity makes interpretation of ocean color signals subject to large uncertainty. The goal of the our research is to determine which processes and optically important constituents must be considered to explain ocean color variations associated with coastal fronts on the New England continental shelf. To accomplish this goal we have implemented extensive time series sampling and will perform algorithm development and evaluation in collaboration with the NOPP-supported FRONT program. FRONT is a three-year multi-disciplinary effort initiated in late 1999 aimed at understanding and modeling physical and biological processes associated with frontal formation and persistence at a study site located at the mouth of Long Island Sound. The observational network includes an array of acoustically linked physical moorings and the Autonomous Vertically Profiling Plankton Observatory (AVPPO, a profiling mooring), which we have equipped with a suite of optical sensors. Our efforts are focused on the collection of a complete set of optical property observations and constituent analysis necessary for evaluating bio-optical algorithms for retrieving inherent optical properties and phytoplankton characteristics. These include band-ratio algorithms, semi-analytical radiance inversion algorithms and algorithms which incorporate chlorophyll fluorescence.

OS52A-0526 1330h POSTER

Seasonal Evolution and Variability of the Biological Activity in the Upwelling of Mauritania Using SEAWIFS Imagery (1998-2000)

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The monitoring of chlorophyll concentrations in the north western tropical Atlantic from space is very difficult during spring and summer, because of the quasi-permanent export of massive amounts of mineral dust from Africa. These absorbing aerosols yield the failure of the present operational atmospheric correction algorithms, which are necessary to retrieve chlorophyll concentrations from ocean color measurements. We used an improved atmospheric correction algorithm, the Spectral Matching Algorithm (SMA), together with a set of realistic dust optical properties to process three years (from 1998 to 2000) of SEAWIFS imagery in this highly dust-contaminated region. Moulin et al. (2001) showed that this combination performs well even for high dust optical thickness (up to 0.8).

We processed about 1900 SEAWIFS orbits to get the monthly mean maps from 1998 to 2000. The comparison with the standard NASA/GSFC monthly products shows that our method leads to comparable results outside of the dust zone and to a much better coverage of the biological activity during spring and summer in the dust-contaminated region. Our results thus enable for the first time to monitor the evolution and the development of the enriched oceanic region related to the upwelling of Mauritania. We will also comment on the important differences found in this region between 1998 and the two-year period 1999-2000. The chlorophyll concentrations during the latter period are indeed found to be significantly lower than during 1998. We will discuss the possible explanations to this phenomenon, in particular the dust fertilization hypothesis, by comparing this variability to that of the intensity of the African dust export and of some relevant climatic parameters such as the surface wind speed and the sea surface temperature.

OS52A-0527 1330h POSTER

Prediction of pCO2 in the Ross Sea, Antarctica Using Ocean Color Data

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A time series of the surface partial pressure of CO2 (pCO2) made from underway samples on the R/V N. B. Palmer from the austral spring of 1996 through mid-summer of 1999 in the Ross Sea, Antarctica are compared with the predicted pCO2 derived from climatological mixed layer depths and estimated primary productivity using observations of ocean color (OCTS and SeaWiFS). Both insitu measurements and predicted values of pCO2 indicate a large net biological drawdown in CO2 which is responsible for pCO2 values of more than 200 uatm below saturation. In addition, both measured and predicted values of pCO2 demonstrate large inter annual variability in the biological draw down of CO2 in the Ross Sea. While it is clear that remotely sensed ocean color data may be essential tool for monitoring inter annual variability in surface pCO2 throughout the world oceans, a better parameterization of mixed layer depths, upwelling and diapycnal diffusion from below the mixed layer and biological precipitation and dissolution of calcium carbonate are essential.

OS52A-0528 1330h POSTER

Variation in the Projected Surface Area of Suspended Particles: Implications for Remote Sensing Assessment of TSM

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Bale et al. (1994) showed that, for turbid waters, water-leaving reflectance was not controlled by the concentration of total suspended matter (TSM), but by the net cross-sectional area (target area, TA) of the suspended matter.

Here, it is demonstrated that the TA (hence reflectance) of suspended particulate matter is by no means related to TSM in a predictable manner. It is shown that the TA varies as a function of the size distribution, TSM and mean effective density of the suspended particles. Therefore, a range of values for TA (hence reflectance) can exist for any given value of TSM, if particle size and density vary.

This will always be the case in coastal waters and estuaries, where fine-grained sediments are known to aggregate into flocs, with a size much larger and a density much lower than the constituent grains. The potential errors associated with this uncertainty when deriving TSM from reflectance measurements are estimated and discussed.

Bale, Tocher, Weaver, Hudson and Aiken (1994): Laboratory measurements of the spectral properties of estuarine suspended particles. Neth. J. Aquat. Ecol. 28:237-244.

URL: http://oam.homepage.dk/reprints.htm

OS52A-0529 1330h POSTER

Evaluation of SeaWIFS Bio-Optical Products in Coastal Regions.

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Optical properties derived from SeaWIFS were evaluated for 10 cruises in coastal and open ocean waters in the Gulf of Mexico, US East Coastal and the Japan/East Sea. The inherent optical properties (absorption and scattering)were derived from SeaWIFS processing using a Near-IR correction with a coupled ocean- atmosphere algorithm. Coastal optical properties are more complex and differ greatly from chlorophyll - dominated open-ocean waters. The coupled algorithms improved results and extend SeaWIFS optical properties well into bays and estuaries where high sediments and CDOM absorption dominate the optical signature. We assembled a database in situ optical properties to evaluate SeaWIFS-derived properties collected from 1998 to present in a variety of coastal regions (Mississippi Bight, and Miss. River, West Florida Shelf, Loop Current, New Jersey). The data cover a broad range of absorption (.4 - 15), scattering (.01 - 3) coefficients and remote sensing reflectance. The in situ data were used to estimate the error associated with in-water optical algorithms based on remote sensing reflectance. We then estimated the error associated with satellite optical products for a variety of different optical regimes (CDOM rich, sediment rich, and chlorophyll rich). As a whole, we noted higher error is associated with coastal waters than open ocean.

OS52A-0530 1330h POSTER

Improved Algorithms for Retrieving Optical Properties in Coastal Waters from Ocean Color Sensors

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We developed improved SeaWIFS coastal ocean color algorithms to derived inherent optical properties, based on relationships between absorption, scattering and remote sensing reflectance. The linear remote sensing reflectance to scattering: absorption ratio (bb/a) is the basis for open ocean algorithms where absorption (predomoninantly from chlorophyll) is greater than backscattering. In coastal waters, where backscattering from sediment can dominate absorption, a non-linear and spectral dependence occurs between the reflectance and the backscatter: absorption ratio. These nonlinear influences affect not only the in water optical algorithms, but they are also coupled with the atmospheric correction in coastal waters. The removal of water leaving radiance in the near-IR (765 and 865 nm) is especially necessary in coastal waters. The non-linear relationship is used in estimating the water leaving radiance in the near-IR through an iterative pixel-by-pixel process using the 670 nm water leaving radiance. We used SeaWIFS imagery and insitu measurements to evaluate the effects the non-linear relationships have on coastal algorithms where backscattering dominates the absorption. We compare these new products with the more standard NASA products and we highlight areas where regional differences are greatest (bays, estuaries).

OS52A-0531 1330h POSTER

Aerosol Properties derived from the PREDE POM-01 Mark II Sun Photometer

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The Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project is dedicated to ensure the comparison and possible merging of data products from multiple ocean color missions. The correction of the atmospheric contribution is a crucial procedure in the analysis of the ocean color imagery. In situ measurements of atmospheric and bio-optical components are, therefore, needed for comparing and validating satellite measurements. Aerosol optical thickness and sky radiance measurements from hand-held and shipboard sun photometers have been made by SIMBIOS investigators on many experiment cruises. The SIMBIOS project manages and maintains the instrumental pool for the ocean and atmospheric measurements including two PREDE POM-01 Mark II radiometers, one MPL LIDAR, one SIMBAD and two SIMBADa, twelve MicroTops, and twelve CIMEL sun photometers. This report describes the aerosol properties derived from measurements using the marine version of the PREDE sun/sky radiometer stabilized for ship deployment. The features of the PREDE ship version take into account the movements of the ship enabling the direct and diffuse sky radiation measurements. The characterization and calibration of the instrument managed by the PREDE Company in Japan and by the SIMBIOS project at Goddard Space Flight Center are presented. Two PREDE Mark II units were deployed during ACE-ASIA campaign in March and April 2001. The aerosol properties derived from the PREDE measurements are compared with other in situ measurements. Retrieval of the aerosol size distribution from the PREDE sky measurements is also possible and presented for the ACE-ASIA campaign.

URL: http://simbios.gsfc.nasa.gov

OS52A-0532 1330h POSTER

Microtops II Hand-Held Sun Photometer Sun Pointing Error Correction for Sea Deployment

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Hand held sun photometers, such as the Microtops II (manufactured by Solar Light, Inc.), provide simple and inexpensive means to measure in situ Aerosol Optical Thickness (AOT). Hand held sun photometers require that the user manually points the instrument at the sun. Unstable platforms, such as a ship at sea, can make this difficult, causing pointing errors. A poorly pointed instrument mistakenly records less than the full direct solar radiance, so the computed AOT is much higher than reality, and can be mistaken as cloud contamination or used incorrectly for validation with satellite derived AOT measurements.

The relatively low sampling rate (3Hz) of the Microtops II leaves this instrument especially prone to this problem. Two steps were taken to reduce pointing errors. First, the measurement protocol was changed to keep the maximum (rather than average) value of a sequence of measurements. Several sets of these sequences are made for each intended data point. Once on shore, statistics are computed for each group of measurements. If the normalized variance of a group is above a threshold, the highest AOT measurement is discarded as a pointing error. The normalized variance is then recalculated. This is repeated until the normalized variance is reduced below the threshold or the number of points becomes too small to calculate variance.

Several versions of this protocol were tested on a recent California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruise, and a post processing algorithm was developed to remove pointing errors. These results were compared to concurrent measurements using the old protocol. Finally, a separate post processing algorithm was created for data already gathered with the old protocol, based upon statistics calculated by the instrument at the time of capture.

OS52A-0533 1330h POSTER

The Architecture and Utility of SeaBASS: the SeaWiFS Bio-optical Archive and Storage System

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The accumulation and evaluation of in situ data is a critical aspect of both satellite ocean color sensor validation and algorithm development. NASA's Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Sensor Intercomparison and Merger for Biological and Oceanic Studies (SIMBIOS) Projects designed the SeaWiFS Bio-optical Archive and Storage System (SeaBASS) to be a local repository of radiometric, phytoplankton pigment, and other oceanographic and atmospheric data, collected using well-defined and consistent measurement protocols. These data have been used by the SIMBIOS Project to validate SeaWiFS, Ocean Color and Temperature Scanner (OCTS), and Modular Optoelectronic Scanner (MOS) data products, to develop and evaluate bio-optical algorithms used to generate such products, for data merger studies, and to characterize the calibration history and stability of the field instruments used to build validation data sets.

Data archived in SeaBASS were collected using a number of instrument packages on a variety of different platforms. The archive consists of an organized directory structure where physical data files and documentation are stored and a relational database system for managing and controlling these data and metadata. A series of World Wide Web-based search engines provide the user community direct access to data files, metadata, and geophysical data products. Additionally, other online utilities are available for generating maps and plots of data archived in SeaBASS. Historically, to protect the publication rights of contributors' data and to limit user-support to active participants, access to SeaBASS has been limited to contributing researchers and to members of the SIMBIOS and other NASA-affiliated Science Teams. As of August 2001, however, data collected prior to December 31, 1999 are available to the public at large. These data are available online and via the National Oceanographic Data Center.

This report elaborates on the architecture of SeaBASS and on the methods employed by the SIMBIOS Project for radiometric and pigment data storage, quality control, distribution, and preparation for satellite ocean color sensor validation analyses.

OS52A-0534 1330h POSTER

Results from a Round-Robin-Comparison of Radiance Calibrations at Oceanographic and Atmospheric Research Laboratories

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The activities of the SIMBIOS (Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies) Project Office include calibration round-robin intercomparison experiments. The laboratories participating in these round-robins include academic institutions, government agencies and instrument manufacturers that are involved in oceanographic or atmospheric research programs. The purpose of these comparisons is to measure the light levels in the participating laboratories used for the calibration of field radiometers, and to detect and correct problems at any individual laboratory in a timely fashion.

The first SIMBIOS calibration round-robin took place in 1997/1998 as part of the SeaWiFS Intercalibration Round-Robin Experiment series (SIRREX 6). An uncalibrated radiance and an uncalibrated irradiance sensor were used to compare the calibrations of national and international laboratories. A new series was started in 2001 called SIMBIOS Radiometric Intercomparison (SIMRIC 1), during which SIMBIOS staff visited 7 laboratories (NRL, Scripps, Biospherical, UCSB, HOBI Labs, NASA GSFC Code 920.1, Satlantic, see affiliations) with a NIST designed and calibrated radiometer, the SeaWiFS Transfer Radiometer II (SXR-II). The radiances produced by the laboratories for calibration were measured in six channels from 411 nm to 777 nm. This report describes the results of the comparison, which show that most of the radiances measured by the SXR-II agree within about 2 % with the radiance values provided by the laboratories.

URL: http://simbios.gsfc.nasa.gov/

OS52B MC: 120 Friday 1330h

The Caribbean Sea System: Its Physical Oceanography and Role in Northern Hemisphere Climate Variability II *(joint with A, GC)*

Presiding: **R C Wajsowicz,** University of Maryland**; D B Enfield,** AOML/NOAA

OS52B-01 0130h INVITED

Physical Oceanography of the Caribbean Sea: Some Recent Observations

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Recent oceanographic observations in the Caribbean Sea and Gulf of Mexico (the Intra-Americas Sea) have contributed to our understanding of IAS circulation, the dynamics forcing the circulation, and the role of the IAS in hemispheric ocean processes. Specifically, recent results from several programs will be presented and discussed:

The Windward Islands Passages Program, designed to measure upper ocean transport and water mass properties of the exchange between the Atlantic Ocean and the Caribbean Sea, is entering its tenth year of observations. Mean transport estimates based on 10 to 20 sections now exist for the major passages between Trinidad and the Virgin Islands. Approximately 19 of the estimated 32 Sv in the Florida Straits enter through these passages, of which approximately 12 enter south of Dominica, 6 in the Grenada Passage.

The Caribbean Inflow Variability Experiment is designed to continuously monitor the transport through the Grenada Passage. Plans are in place to monitor a submarine telephone cable between Grenada and Trinidad to estimate transport; at present several shipboard velocity sections and year-long pressure gauge records are available as part of the program. Dominant low-frequency signals in the cross-passage pressure difference are 30 60 days.

The NOPP Year of the Ocean Drifting Buoy Program placed over 150 WOCE-style surface drifting buoys in the IAS during 1998 2000. Analysis of drifter tracks shows the best picture to date of IAS surface currents, including well-resolved gyres in the SW Caribbean (Panama-Colombia) region.

Monitoring of Florida Straits transport via submarine cable is once again active, complemented by quarterly CD and transport cruises. Analyses of historical transport data (Baringer & Larson, 2001) have shown correlations between low frequency transport variability and climate indices (e. g., NAO). Additionally, full-depth velocity profiles across the straits are available weekly from the 38 kHz ADCP mounted on the Explorer of the Seas cruise ship.

Availability of these and other observational resources, its semi-enclosed and well-bounded geography, and its significance to downstream North American oceanic and atmospheric conditions make the IAS an excellent region for model development and validation.

URL: http://www.iaslinks.org

OS52B-02 0150h INVITED

On the Flow Through Yucatan Channel

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Measurements of the exchange between the Caribbean Sea and the Gulf of Mexico show that a net transport of $24 \pm 1Sv$ ($1Sv = 10^6 m^3 s^{-1}$; 95% confidence interval) flowed through the Yucatan Channel from the Caribbean Sea into the Gulf of Mexico, during the period between September 1999 and June 2000, and 23 Sv flowed between June 2000 and May 2001. The mean transport over the two years of measurements is 23.5 Sv, with less than 5% variation from one year to the next. This confirms that the exchange through Yucatan Channel is about 20% less than the 30 Sv commonly accepted as the nominal transport of the Florida, and less also than the 28 Sv normally assumed for Yucatan in closing the transport budgets for Caribbean passages. This means that transports through other passages of the Caribbean need to be better determined, especially the Old Bahama and Northwest Providence Channels. Our data corroborate that the flow through the Yucatan channel consists mainly of the northerly surface Yucatan Current and its southerly undercurrent along the coast of Mexico, and of the southerly surface Cuban Countercurrent off Cuba; but previously unobserved currents at depth persist over the two years of measurements, especially on the eastern side of the channel. The pathways of the circulation in the Western Subtropical Atlantic should be revised considering these new results and additional observations made at selected passages of the system.

OS52B-03 0205h INVITED

Real-Time Eddy-Resolving Ocean Prediction in the Caribbean

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