QUARTERLY REPORT
July-September, 1992

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MODIS UPN: 429-21-01

A. Near Term Objective: MODIS North Atlantic Test Site Establishment and Characterization

As reported previously, the MODIS North Atlantic Test Site has been established as originally proposed. The Test Site includes the New York Bight/Mid-Atlantic Bight/Gulf Stream/Sargasso Sea and is conveniently located north and east of GSFC/WFF. No reasons have yet been found to alter the location of the test site as established. The site contains coastal, shelf, slope, Gulf Stream, and Sargasso Sea water masses. This diversity of water masses so near to GSFC/Wallops is a distinct scientific and economic advantage to the project. Characterization has been initiated by ship sampling, aircraft overflights, and analysis of historical data available from within the NASA AOL project since 1980. New in-situ and airborne MODIS Test Site characterization data are continually being acquired as ships of opportunity become available. These new data will also be used for MODIS algorithm development. The primary instrument used to acquire the airborne active-passive ocean color spectra used in our MODIS Science Team algorithm development is the NASA Airborne Oceanographic Lidar.

1. Medium-Term/Long-Term Objective: Extension of MODIS Test Site Results to Global Oceans

In-situ and airborne data are also being acquired outside the MODIS Test Site in order to (1) validate the MODIS Test Site and to (2) provide for accurate extension of the results of the algorithm to the global oceans. As subquently discussed herein, in-situ and airborne data have been acquired in the South Atlantic Bight, the Gulf of Mexico, and the Pacific Ocean (both coastal and deep ocean).

B. Task Progress

1. In Situ Optical Characterization of the MODIS North Atlantic Test Site.

During the present reporting period (July, August, and September 1992) additional sample collection, laboratory dissolved organic matter (DOM) spectral absorption/fluorescence runs, and data analyses have been conducted to further characterize the MODIS Test Site.

Through the cooperation of Dr. George Luther of the University of Delaware, additional samples were gathered from within the MODIS North Atlantic Test Site (New York Bight/Mid-Atlantic Bight/Gulf Stream/Sargasso Sea) during a cruise of the Research Vessel Cape Henlopen on March 4, 1992. An overflight of the vessel by the Airborne Oceanographic Lidar was conducted on March

4, 1992. These, and all samples are being used to study the retrieval of the absorption coefficient of chromophoric dissolved organic matter (DOM), aCDOM. Then, when the spectral fluorescence of the dissolved organic matter is measured aboard ship (or remotely aboard aircraft) it can be used to rapidly and accurately infer the aCDOM. When applied to shipboard and aircraft laser fluorometers, this retrieval methodology and the resulting DOM absorption coefficients will be used in ocean color models and associated satellite sensor/algorithm developments directly aimed at the proposed phycoerythrin retrieval. The work to date suggests that absorption coefficients in the near ultraviolet can be directly retrieved from measurements of the fluorescence emission of CDOM. The errors in the laboratory fluorescence measurements were minimized through the combined use of the water Raman scatter as an internal radiometric standard and quinine sulfate as an external reference. While the a CDOM retrieval appears feasible, the relationship to CDOM emission is susceptible to changes in fluorescence yield, so the continued temporal study of marine samples from many diverse oceanic locations is needed in addition to the 5 locations already studied. The DOM is important since it is a major interferant to the detection and quantification of chlorophyll and chlorophyll accessory pigments (CAP) such as phycoerythrin. Likewise, it is a contributor to the carbon cycle itself. A manuscript titled: "Inherent Optical Properties of the Ocean: Retrieval of the Absorption Coefficient of Chromophoric Dissolved Organic Matter from Fluorescence Measurements" is in the final stages of revision based on the fluorescence/absorption work to date.

2. Extension to Global Oceans

Additional ship samples were collected from the North Atlantic Ocean east of Cape Hatteras, east of Savannah, west of Tampa in the Gulf of Mexico, and in the Monterey Bay/Pacific Ocean regions. Ship data will also be available to compare with Airborne Oceanographic Lidar active-passive (laser-solar) overflight data acquired during NSF's Joint Global Ocean Flux Study (JGOFS) Central Equatorial Pacific (EQPAC) field missions. The Monterey Bay sampling was performed at the conclusion of (and during transit back to Wallops from) the JGOFS EQPAC field missions. Preliminary analyses suggest that the aCDOM recovery will be possible (within specific error bounds) in other global oceanic regions by using the water Raman normalized DOM spectral fluorescence.

Team Member used the NASA/GSFC Airborne Oceanographic Lidar during participation in Dr. Kendall Carder's TAMBEX II cruise of the Suncoaster in the Gulf of Mexico during the week of May 11, 1992. (Note that Dr. Carder is both a MODIS and a HIRIS Science Team Member). Overflights of the Suncoaster were conducted over several ship cruise lines. One of the prime objectives of this cruise was to obtain the necessary in situ ocean color data to address the CDOM algorithm development of Dr. Carder. Our participation in the cruise was undertaken to allow us to

directly address the quantification of the phycoerythrin signal as outlined in our own MODIS proposal. To assist us in this endeavor, Dr. Maria Vernet of the Scripps Institution of Oceanography was asked to participate aboard the Suncoaster. She is recognized for her work with phycoerythrin pigment. Additional CDOM data was successfully obtained but the first-time ship calibration of the airborne phycoerythrin-to-water Raman signal could not be completed since the numbers of phycoerythrin-bearing organisms were not sufficiently high to provide an adequate laser-induced fluorescence signal.

In general, the ship samples are filtered (0.45 um) to remove scatterers and absorbers other than the dissolved organic matter (DOM). Spectral absorbance of the filtered samples are acquired at Wallops by Dr. Tony Vodacek, a NRC Resident Research Associate at Wallops. Cross-validation of the absorption and fluorescence is then frequently performed at Woods Hole Oceanographic Institution in cooperation with Dr. Niel Blough.

3. In-situ and Airborne Optical Characterization of MODIS North Atlantic Test Site.

Continued cooperation by Dr. George Luther of the University of Delaware is expected during his on-going series of cruises with the Research Vessel Cape Henlopen onto the Atlantic shelf south east of Delaware Bay. Additional cooperative ship-aircraft experiments are planned with Dr. Niel Blough (WHOI) in the MODIS Test Site during four seasons beginning August 1993 with a cruise of the R.V. Cape Henlopen and overflights of the AOL from Wallops.

C, Anticipated Activities During Next Quarter.

1. Phycoerythrin Algorithm Development Activities

Efforts are being directed toward a new field experiment to quantify the phycoerythrin signal. It is anticipated that new validation experiments will be established in conjunction with the ship-aircraft DOM experiments with Dr. Niel Blough (WHOI)

2. Chlorophyll Pigment and CDOM Corrections to the Algorithm.

Major perturbations or influence to the ocean color spectrum are provided by chlorophyll and CDOM. These oceanic constituents significantly impede the retrieval of phycoerythrin pigment from the upwelled radiances. Accordingly, they must be dealt with in a systematic way in order to understand their effects and the impact on the retrieval of phycoerythrin and its ultimate quantification. In situ and airborne data gathered to date will be used to model the effects to ascertain the extent that they can be removed and/or quantified.

D. Problems/Corrective Actions.

1. The lack of a 600nm band on MODIS-N is the biggest problem facing the retrieval of the phycoerythrin pigment on the first sensor launch. Plans to synthesize a 600nm band from other surrounding bands will be performance tested using data obtained

over actual oceanic phycoerythrin pigment using the 32-band AOL passive ocean color subsystem (POCS) in combination with laser-induced fluorescence of the phycoerythrin pigment obtained with the AOL using 532nm excitation.

2. The oppressive imposition of Division/Directorate administration taxes upon HQ-approved science funding levels continues to be a fiscal and morale-depressing thorn in the side of efficient conduct of this research.