Quarterly Report
Third Quarter 1994
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MODIS UPN: 229-01-04

Task Objectives: (a) MODIS Product Validation and (b) Algorithm Development for Global Mapping of Phycoerythrin Pigment, Dissolved Organic Matter, and Chlorophyllous Pigment

I. MODIS Ocean Products Validation

A. Validation Plan.

1. Background. As a result of brief individual discussions with Dr. Michael King, Dr. Wayne Esaias, and Dr. Vince Salomonson, the objectives of this MODIS UPN 229-01-04 Task were expanded: (a) to include the development of the MODIS Ocean Products Validation Plan and to (b) to initiate methods to address the validation of a limited number of the products using airborne active-passive techniques developed during the past 17 years by this MODIS Science Team member using NASA Airborne Oceanographic Lidar and associated instrumentation.

2. Work Acomplished. A draft outline a proposed table-of-contents of a MODIS Product Validation plan was produced during this quarter. This draft outline is attached herein as Appendix A and is subject to considerable modification after consultation with other MODIS Science Team Members. The Validation Plan will be produced and updated as a continual living document.

B. Product Validation Using the Airborne Oceanographic Lidar (AOL).

1. Products to be Validated.

a. The entire MODIS Product List is attached herein in Appendix B. Therein, the subset of MODIS Oceans Products proposed at this time for validation by this MODIS Science Team member using the NASA Airborne Oceanographic Lidar and associated instrumentation is marked by symbols to the left of the corresponding product. The absorption of chromophoric dissolved organic matter (CDOM) is highlighted with multiple symbols and validation by airborne retrieval is specifically discussed below.

2. Work Accomplished.

a. Airborne Validation of CDOM Absorption.

A. Background Information on CDOM. CDOM is the principal light-

absorbing constituent in the world's oceans when the spectral breadth, ubiquitous presence, and decadal time scales of endurance are considered. CDOM is thus the primary interferant to the accurate retrieval of chlorophyllous pigment. Finally, CDOM is in its own right a fundamental contributor to the global carbon budget especially in ocean margins.

B. CDOM Validation Results. It has been shown that CDOM absorption coefficient, $a_{CDOM}(\lambda)$, can now be retrieved from airborne laser-induced and water Raman normalized CDOM fluorescence [Hoge et al submitted]. Previously, it had been shown that the absorption coefficient of CDOM could be retrieved from ship measurements of spectral fluorescence [Hoge et al 1993b].

2. Other MODIS Product Validation.The AOL system upgrades necessary to accomplish the validation of other MODIS Ocean Products was initiated during this quarter. In particular the participation in the SeaWiFS round-robin calibration and other laboratory efforts suggested that the AOL laser fluorosensor possessed a small calibration nuance that could be alleviated by replacing the light-guides with fiber optics. This is now in progress. Additionally, the internal light-emitting-diode (LED) ground-to-inflight calibration transfer subsystem has been upgraded and will be provided with new software to allow more frequent calibration during field missions.

3. Work to be Performed. The airborne validation feasibility of sea surface temperature (SST) will be specifically be addressed in addition to the other ocean products listed in Appendix A.

II. Algorithm Development for Global Mapping of Phycoerythrin Pigment, Dissolved Organic Matter, and Chlorophyllous Pigment

A. MODIS North Atlantic Test Site Establishment and Characterization

As previously reported, 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. Characterization has been initiated by ship sampling, aircraft overflights, and analysis of historical data available from within the NASA AOL project since 1980. Much of the data obtained in the northwestern portion of the test site will be used for algorithm development in Case 2 waters.

Analytical activities in the MODIS North Atlantic Test Site during this Quarter included:

No airborne flights were conducted during this reporting period since the GSFC P-3B was in heavy use by the LITE shuttle underflight team. Flight data from previous missions were

analysed as reported below and in section I.2.B.1 above.

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

As reported in a prior report, the continued characterization of the North Atlantic Test Site is partially described in a recent publication [Hoge et al 1993a]. Much of the data within this paper was obtained during cruises described above.

B. Selection of Case 1 Data Sets.

As listed in the semi-annual report, airborne active-passive ocean color data acquired within Case 1 oceanic regions with the NASA Airborne Oceanographic Lidar have now being screened for use in algorithm development. Several promising candidate data sets were been identified. In particular, AOL active-passive data in the northwestern Atlantic Ocean east of St. Johns , Newfoundland (obtained in 1989 as part of the Joint Global Ocean Flux Study of the North Atlantic Bloom Experiment) has displayed remarkable quality and freedom from non-chlorophyllous backscatterers. As described below, this data is being used to establish the baseline radiance model to be used for the retrieval of phycoerythrin pigment (as well as DOM and pigment).

C. Work Accomplished

1. The Baker-Smith [1982] model of the diffuse attenuation coefficient of phytoplankton as been eliminated as a serious contender for use in the oceanic radiance model retrieval of phycoerythrin pigment absorption. At this time the specific absorption coefficient model, $a_{\underline{phytoplankton}} = a^* C$, has been shown to have higher accuracy especially in the 1 to 6 mg/m^3 range [Hoge et al submitted to Applied Optics 1994].

2. For the MODIS North Atlantic Test Site during August, 1993 and April 1994 cooperative overflights of EOS Interdisciplinary Team member, Dr. N. Blough, were conducted and the data has been analysed. There was excellent agreement between the airborne laser-induced DOM fluorescence and the ship-derived fluorescence. The August 1994 data have been used for algorithm development and a manuscript detailing the satellite retrieval of CDOM absorption has been submitted [Hoge et al, submitted to Journal of Geophysical Research, 1994]

Additional validation of the retrieval of the absorption coefficient from DOM fluorescence is expected using this ship/airborne data. Previously, the DOM absorption from prior cooperative ship experiments (see below) was used to establish the levels of DOM fluorescence measured with the NASA Airborne Oceanographic Lidar in both the Atlantic and Pacific Oceans. These results have been published [Hoge et al 1993a].

D. Anticipated Activities During Next Quarter.

1. During the next quarter, airborne overflight of the Land Margins Ecosystems Research (LMER) project is planned for November, 1994. The field experiment involves cooperative investigations by scientists from the Horn Point Environmental Laboratory (Cambridge, MD), University of Maryland (College Park,MD) and NASA/GSFC/Wallops Flight Facility.

E. Other Findings

1. The lack of a 600nm band on MODIS-N is no longer considered a major problem. The phycoerythrin absorption bands occur at 495 and 545nm and can be satisfactorily covered by available MODIS bands as described below.

2. During the preparation of the ATBD, studies of available models, suggested that the retrieval of the phycoerythrin pigment at the absorption peaks of 495nm (phycourobilin, PUB) and 545nm (phycoerythrobilin, PEB) may possibly be achieved using the 490nm and 555nm MODIS bands. Such retrievals will require a highly accurate model to account for the significant amounts of chlorophyll and DOM absorption occurring simultaneously with the phycoerythrin absorptions.

APPENDIX A

*****DRAFT CONTENTS*******DRAFT CONTENTS*****DRAFT CONTENTS********

Validation Plan

for

MODIS Ocean Products and Algorithms

produced by the

MODIS Oceans Discipline Group

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TABLE OF CONTENTS

ABSTRACT..... i

1.0 Introduction..... x
1.1. Scope..... x

22.0 Use of Pre-Established Oceanic Test Sites..... x
2.1. MODIS Middle Atlantic Bight Test Site..... x
2.1.1. MODIS/Aircraft/Ship/Buoy Experiments..... x
2.1.2. Design of MODIS Validation Methods using Surrogate Sensors: SeaWiFS/Aircraft/Ship/Buoy Experiments..... x
2.1.3. Design of MODIS Validation Methods using Surrogate Sensors: OCTS/Aircraft/Ship/Buoy Experiments..... x
2.2. Other MODIS Test Sites x
1.3.1. MODIS/Aircraft/Ship/Buoy Experiments..... x

3.0 Airborne Validation..... x
3.1. GSFC P3-B Airborne Platform..... x
3.1.1. Deployment..... x
3.1.2. Range..... x
3.1.3. Communication to Ships..... x
3.2. Airborne Ocean Measurement Laboratory..... x
3.2.1. Airborne Oceanographic Lidar..... x
3.2.1.1 Passive Ocean Color Subsystem..... x
3.2.1.2 Single Channel PAR Radiometer (Downwelled PAR)..... x
3.2.1.3 Sea-State/Wave Profiler..... x
3.2.2. 256-Channel Radiometer (Upwelled Spectral Radiance)..... x
33.2.2.1. Path Radiance Correction Measurements..... x
3.2.2.2. Sky Radiance Correction Measurements..... x
3.2.3. 256-Channel Radiometer (Downwelled Spectral Irradiance)..... x
3.2.4. Sea Surface Temperature Radiometers..... x
3.2.4.1. E.G. & G./Heimann Radiometers..... x
3.2.4.2. Back-up PRT-5 Radiometers x
3.2.5. Global Positioning System (GPS)..... x
3.2.5.1. Ashtech Global Positioning System (GPS)..... x
3.2.5.2. Alternate Global Positioning System (GPS)..... x

3.2.6. Aircraft-to-Ship Telemetry Data System..... x
3.2.6.1. Airborne Transmitter..... x
3.2.6.2. Shipboard Receiver and Data System..... x
3.2.7. Airborne Expendable Bathythermographs (AXBT's)..... x
3.2.7.1. Launcher..... x
3.2.7.2. Receiver and Data System..... x
3.2.8. Calibration Sphere..... x
3.2.8.1. Round Robin Calibration x
3.2.8.2. Use of NIST Radiometer for Calibration x
3.2.9 TV Cameras and VCR's..... x
3.2.9.1. Down-looking TV Camera x
3.2.9.1.1. Foam Identification x
3.2.9.2. Up-Looking TV Camera x
3.2.9.1.2. Cloud Identification x

3.3. MODIS Ocean Product Validation: Airborne..... x
3.3.1. Water Leaving Radiances x
3.3.2. Chlorophyll-a (Case 1)..... x
3.3.3. Chlorophyll-a (Case 2)..... x
3.3.4. Chlorophyll Fluorescence x
3.3.5. Chromophoric DOM Absorption..... x
3.3.6. Phycoerythrin x
3.3.7. Sea Surface Temperature x
3.3.8. Primary Production x
3.3.7.1. Airborne Laser Pump-and-Probe (Proposed)..... x

4.0 MODIS Ocean Product Validation: Ship..... x
4.1. TBD..... x
4.2. TBD..... x
4.3. TBD..... x

5.0 MODIS Ocean Product Validation: Bouy..... x
5.1. TBD..... x
5.2. TBD..... x

6.0 Satellite Cross-Validation..... x
6.1 Potential Ocean Colors Sensors..... x
6.1.1 SeaWiFS..... x
6.1.2 OCTS/POLDER..... x
6.1.3 GLI..... x
6.1.4 EOS Color..... x

6.1.5 MERIS..... x
6.1.6 (TBD)..... x

7.0 Discussion..... x

8.0 References..... x

9.0 Figures..... x

Appendix A SeaWifs Cal/Val Documentation..... x
Appendix B (TBD)..... x

APPENDIX B

	PRODUCT ID	PRODUCT NAME
	MOD01	Level 1A Radiances
	MOD02	Level 1B Calibrated MODIS
	MOD03	Geolocation Fields
	MOD04	Aerosol Product
	MOD05	Precipitable Water
	MOD06	Cloud Product
	MOD07	Ozone Total Burden
	MOD08	Stability (Lifted Index), Atmospheric
	MOD09	Surface Reflectance
	MOD10	Snow Cover
	MOD11	Land sfc Temperature/Emissivity
	MOD12	Land Cover Type
	MOD13	Vegetation Indices
	MOD14	Thermal Anomalies
	MOD15	Leaf Area Index and FPAR
	MOD16	Evapotranspiration
	MOD17	Vegetation Production, Net Primary Productivity
*	MOD18	Water Leaving Radiance
	MOD19	Pigment Concentration
*	MOD20	Chlorophyll Fluoresence
*	MOD21	Chlorophyll a Pigment Concentration
	MOD22	PAR
	MOD23	Suspended Solids Conc., Open Ocean
####	MOD24	Organic Matter Concentration
	MOD25	Coccolith Conc., Detached
	MOD26	Ocean Water Attenuation, Concentration
	MOD27	Ocean Productivity
*	MOD28	Sea Surface Temperature
	MOD29	Sea Ice Max Extent
	MOD30	Temperature and Moisture Profiles

*	MOD31	Phycoerythrin Conc.
	MOD32	Calibration Data, MODIS
	MOD33	Gridded Snow Cover
	MOD34	Gridded Vegetation Indices
	MOD35	Classification Masks
	MOD36	Absorption Coeff. Total
	MOD37	Ocean Aerosol Properties
	MOD38	Water Vapor, Atmospheric (Thermal IR)
	MOD39	Clear Water Epsilon
	MOD40	Gridded Thermal Anomalies Summary
	MOD41	Land Surface Resistance
	MOD42	Gridded Sea Ice Cover
	MOD43	Land Surface BRDF, AM-PM Asymmetry

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