Characterizing Chromophoric Dissolved Organic Matter in Marine Environments Using New Analytical Technology

CDR Christopher L. Butler, USN
Office of Naval Research International Field Office - Europe
Ocean, Atmosphere and Space S&T Focus Area
223 Old Marylebone Road, London NW1 5TH
Tel. 44-171-514-4948, Fax. 44-171-514-4980
Email: metoc@onrifo.navy.mil
http://www.onrifo.navy.mil

Dr. Piotr Kowalczuk
Institute of Oceanology, Polish Academy of Sciences
55 Powst. Warszawy str.; 81-712 Sopot, Poland
Tel. +(48 58) 551-72-81, Fax: +(48 58) 551-21-30
Email: piotr@iopan.gda.pl
http://www.iopan.gda.pl/

Ocean, Atmosphere and Space S&T – MetOc Newsletter 02-06

Keywords: *Marginal Seas, Bio-Optics, Dissolved Organic Matter, 3D fluorometry*

OP – Site Visit Report News Headlines

Comprehensive Baltic Sea bio-optical database, and new analytical technology enables the characterization of Chromophoric Dissolved Organic Matter in marine environments.

INTRODUCTION

The Baltic Sea is a typical marginal sea with high riverine inflow, and optical properties that are affected by 'Chromophoric Dissolved Organic Matter' (CDOM) absorption. The CDOM sampling is a routine procedure for the 'Institute of Oceanology', Polish Academy of Science (IOPAS) 'Bio-Optical programs', and has been carried out on all cruises since September 1993. Recently, the Office Of Naval Research International Field Office (ONRIFO) conducted a Science & Technology Liaison visit at the (IOPAS) to assess their ongoing research in the area of CDOM measurements and modeling. IOPAS has proposed to use Baltic Sea CDOM samples as comparison material (*i.e., fluorescence properties, and changes along salinity gradient*) with data that has been collected at the Southeastern U.S. coast, to characterize differences in 'coastal ocean' environment and 'marginal seas' environments.

A 'fluorometer' is an instrument for measuring fluorescence and related phenomena such as a measure of intensity of radiation. The University of North Carolina, Wilmington (*UNCW*), has specialized equipment to make 3D fluorometry measurements. Dr. Piotr Kowalczuk from IOPAS, has collaborated with scientists from UNCW to develop skills in '3D fluorometry measurements',

and offers a comprehensive 'Baltic Sea Bio-optical' database for validation and comparison studies. The ONR Environmental Optics program has an opportunity to leverage off the IOPAS/UNCW efforts by networking this research and large CDOM database with ONR Principle Investigators.

This newsletter is designed to inform national and international scientists, research and governmental institutions, and international organizations about potential research collaboration.

LONG TERM GOALS

The long-term goal of this program is to develop a prognostic primary production model in the Baltic Sea basin scale, which includes the specific environmental condition of the sea.

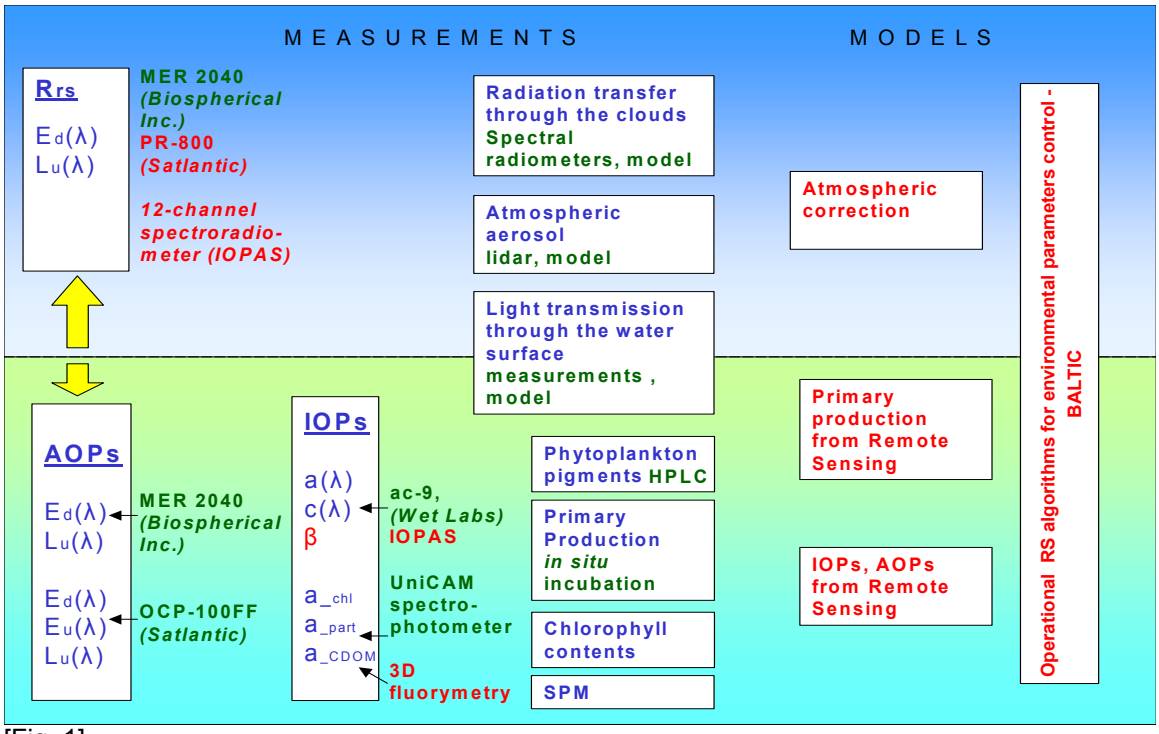
OBJECTIVES

This particular project is aimed at:

a. Applying new analytical techniques and approaches to study CDOM changes (3D fluorometry technique, Wet-labs nine-channel absorption and attenuation meter (AC-9) measurements),
b. Setting up experiments to observe the CDOM net removal in-situ (AC-9 measurements) and
c. Linking this research with existing geochemical programs in the Baltic Sea area for better understanding of local production and degradation of CDOM.

APPROACH

The techniques consist of standard spectrophotometric measurements to derive CDOM absorption, AC-9 measurements, and utilization of the 3D fluorometry technique experience gained at UNCW. Researchers will take Inherent Optical Property (IOP) and Apparent Optical Property (AOP) measurements to link the CDOM absorption with optical properties and remote sensing observations. Empirical modeling will be utilized to relate CDOM. The overall measurement and modeling process is depicted below in figure [1].



[Fig. 1]

WORK COMPLETED

IOPAS and UNCW have already characterized fluorometric properties of two CDOM end members in the Black River and the Gulf Stream. They have established a Cape Fear River plume and Onslow Bay database, containing spectrophotometric scans and 3D fluorometry of samples, to track changes in absorption and fluorescence peaks along the salinity gradient. The research team used advance post-processing software developed by Wade Shaldon (University of Georgia) to integrate whole spectra and selected peaks, and than to derive the “peak” ratios. This information enables them to observe relative changes in CDOM composition, see how quickly the dominant CDOM fraction is removed, when the marine source of CDOM becomes important, and determine what other chemical groups contribute to the fluorescence. The IOPAS/UNCW team has learned that tryptophane is a very resistant CDOM fraction and traces of the T peak are clearly visible in the Gulf Stream, when other peaks are diminished. The preliminary results from 3D fluorometry CDOM samples from a Baltic Sea cruise in May 2002, shows that the T peak contribution to the total fluorescence spectrum increases with increased salinity. However, the remained 3 major CDOM fluorescence peaks A, C and M show different behavior along the salinity gradient, when compared with South Atlantic Bight (SAB) data. This may suggest; (1) photo-bleaching processes in the Baltic Sea and SAB occur at the different rate, or (2) different fractions of CDOM are subject of photochemical reactions in The Baltic Sea and SAB. This information will form the basis for laboratory experiments to observe CDOM changes due to selected chemical or physical processes in controlled conditions.

IMPACT / APPLICATIONS

Understanding the variability in the CDOM signal will help quantify the environmental impact of CDOM on naval remote sensing, acoustic, and non-acoustic sensors and systems.

TRANSITIONS / FUTURE RESEARCH INITIATIVES

The Cape Fear River is the largest backwater riverine system on the eastern coast of the United States and acts as a point source of CDOM to the coastal ocean. The 'Dissolved Organic Matter' (*DOM*), 'CDOM' photochemistry group at the Chemistry Department of the UNCW, led by Dr. Robert Kieber and Dr. William Cooper, is using the '3D fluorometry technique' to study changes of CDOM driven by chemical and photochemical forcing.

Dr. Kowalczuk would like to use the ONRIFO Visitor Support Program (*VSP*) to bring CDOM samples from (several bio-optical Baltic Sea cruises) to UNCW for a collaborative effort aimed at defining and describing the conditions and processes responsible for CDOM changes in the coastal ocean.

ASSESSMENT AND POTENTIAL COLLABORATION

IOPAS is a 'Regional Center of Excellence', with programs and efforts similar to ONR and NRL. The Institute's uniqueness is a function of location, and availability of Baltic Sea environmental data. The 'bio-optic laboratory' has collected over 9 years worth of CDOM absorption measurements in the Baltic Sea (*40 cruises, with accompanied optical, bio-optical, and physical parameters*). The IOPAS database includes CDOM measurements at Spitsbergen fjords, the North Sea, and off west coast of Ireland (*see: http://www.iopan.gda.pl/rbdo/index.html*). IOPAS has expressed a desire to collaborate with geochemical scientists working on photo reactivity of the CDOM - DOC. Particularly, IOPAS wants to work with geochemical working groups that have well equipped laboratories and access to the field study areas. IOPAS offers to share their expertise in laboratory and field optical measurements (*in regards of CDOM*) in the Baltic, a recognized hydrological regime of temporal and spatial variability. IOPAS could provide additional resources for data comparison and model validation. Comparison of different estuaries can enhance our understanding of coastal processes that affect the source and fate of CDOM in the littoral environment.

ONR 'Environmental Optics' program has an opportunity to leverage off this IOPAS/UNCW 3D fluorometry effort by networking the research and large CDOM database with ONR Principle Investigators (PIs). Dr. Kowalczuk's VSP proposal efforts will not only result in an exchange of information between IOPAS/UNCW

and ONR/NRL PIs, but could establish long-term relationships between the Department of the Navy and 'next-generation' international S&T leaders.

The 'Office of Naval Research International Field Office-Europe' is dedicated to providing current information on science and technology development in European countries. Our World Wide Web home page (*www.onrifo.navy.mil*) contains information about European and international activities, conferences, and newsletters. The opinions and assessments in this report are solely those of the authors and do not necessarily reflect official U.S. Government, U.S. Navy or ONRIFO positions.