VARIABILITY OF OPTICAL ATTENUATION AND FLUORESCENCE IN COASTAL ENVIRONMENTS

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LONG-TERM GOALS

Our primary long-term scientific goal in this program has been to develop an understanding of the physical and chemical processes affecting CDOM (colored dissolved organic matter) and the resultant changes of attenuation of ultraviolet and visible radiation in seawater. The chemical constituent of seawater which absorbs most of the incident solar radiation is collectively referred to as colored dissolved organic matter (CDOM). CDOM is a complex aggregate of various organic compounds derived from marine and terrestrial origins. The two major sources of the CDOM are the marine biota (e.g. exudates and recycling products) and terrestrial humic material which is introduced to the oceans mainly by rivers. It is the photochemically active fraction of these two major sources that initiate most of the photochemical reactions in seawater. Such reactions not only alter the CDOM, but also initiate reaction chains which affect the chemical speciation of oxygen, transition metals, and various organic compounds. These reactions can have profound effects on the chemical characteristics of seawater and also on biological and physical properties such as optical absorbance and luminescence.

OBJECTIVES

The emphasis in this program has been placed on the study of the factors affecting the optical characteristics of seawater. Particular emphasis has been placed on developing a better understanding of the differences and similarities between CDOM of marine and terrestrial origin and the impact these properties have on the chemical and optical characteristics of coastal environments, where the effects are most pronounced. There were two principal objectives during the past year: the first was to commence the development of a new method involving the application of Flow Field Flow Fractionation (FFFF) to characterize the optical properties of coastal CDOM ,and the second was to complete and disseminate the results of two graduate student studies on the photochemical formation of various low molecular weight gases from DOM . This work is supported by ONR Biological Oceanography and Ocean Optics.

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APPROACH

A combination of short cruises to local coastal environments around South Florida coupled with intensive post-cruise laboratory experiments have been the principal mode of operation during the last year. The cruises were used to obtain samples for return to the laboratory and to characterize the environment from which the samples were obtained by measuring a variety of optical, chemical, biological, and physical properties. With the availability of the FFFF during the latter part of the year more time was devoted to developing and utilizing this technology.

WORK COMPLETED

As the result of a DURIP award for this year the components for a FFFF system have been purchased and assembled. That system is now operational and method development for the characterization of CDOM is currently underway. A coastal cruise aboard the R. V. Calanus was successfully conducted during the last year to provide samples for the FFFF system and field data for two Ph.D. dissertations. One of the students successfully defended his dissertation (Pos, W. H. 1997a) earlier this year and the other is scheduled to defend in December of this year. Papers were presented at the San Francisco AGU meeting and the Santa Fe ASLO meeting in early 1997. During the last year we have 4 published or in press papers related to our ONR work and 5 presentations.

RESULTS

Early results from the application of the technique of FFFF for the characterization of colored dissolved organic matter (CDOM) samples indicate that very different results are obtained when compared to other more traditional separation techniques (e.g. gel permeation chromatography). Work is underway to determine optimal separation conditions and to establish procedures for producing detailed optical characterization of the fractionated CDOM from various environments. Both optical absorption and fluorescence properties are being measured. This should prove to be a novel and very useful technique for understanding the complex optical properties of aquatic CDOM.

Studies on the volatile photochemical breakdown products of DOM (i.e. CO, CO_2, COS and hydrocarbons) have been completed and will appear in two Ph.D. dissertations (Pos, W. H. ,1997a and Riemer, D. 1997). The details of these results are being disseminated in the literature and in national meeting presentations (Pos et al., 1997b, c,d,e; Pos et al. 1996; Riemer et al., 1997; Riemer et al., 1996; Zika et al., 1997). Of particular interest is the observation that substantial amounts of CO_2 are photochemically generated from DOM in coastal environments (Pos et al., 1997c).

IMPACT

Aside from developing an understanding of chemistry and physics of light in the ocean there are other more applied goals. The most important of these is the development of new analytical techniques and processing capabilities which provide for high frequency sampling with near real time data acquisition and data processing. This has been accomplished through the development of computer applications that involve interfacing various simultaneous data channels into a shipboard network, including in-the-water sampling micro-processors, and ship laboratory computers (which process and display the incoming data).

TRANSITIONS

The results from this work and other related studies show that our understanding of CDOM and its effects on the optical properties of the ocean and particularly coastal ocean are marginal. The lack of such information dramatically limits the application of strategic approaches to remote and in situ observational methods such as satellites or submerged detection systems. Understanding the chemical and physical characteristics of the CDOM is essential for the development of accurate optical methods and modeling tools. This is particularly true for coastal environments.

RELATED PROJECTS

The cruise during the last year involved ONR funded investigators from optical physics, marine biology and marine chemistry. A thorough understanding of the nature of CDOM in the oceans requires a multi-disciplinary approach. Future endeavors should also include the area of remote sensing.

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