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Abstract for the European Symposium on Environmental Sensing III.

1. Abstract Title:

A Flexible, Fibre-Optic Based, Underwater Spectrometer for Oceanographic Research.

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5. Abstract Text:

Background: Airborne remote sensing platforms have indicated that there is a significant information content in wideband, high resolution measurements of ocean colour. New remote sensing platforms are due for deployment in the near future, such as the Medium Resolution Imaging Spectrometer (MERIS) scheduled for the ESA Envisat mission in 1999. Analysis of remotely sensed spectral data requires in-situ measurement of the inherent optical properties (absorption and scattering) of the water and their relation to water quality parameters such as chlorophyll and suspended sediment. This will aid the development of optical closure models, in which remotely sensed data can be related to the water quality parameters. Most existing commercial instruments for measuring the properties of the underwater light field use one or more discrete channels, having typical spectral bandwidths of 10 to 20 nanometres. The bulk of these instruments presents a problem as shading may interfere with the measurement of the ambient light field. New underwater optical instruments with smaller overall size and higher spectral resolution are also required.

Materials and Methods: The Southampton Underwater Multi-parameter Oceanographic Spectrograph System (SUMOSS) was developed between 1993 and 1995. It measures the optical properties of water in the visible region of the spectrum from 350 to 700 nanometres with a resolution of 4 to 6 nanometres. The instrument incorporates a fixed grating spectrograph and scientific CCD camera enclosed in a pressure housing enabling deployment to a depth of 200 metres. Light collected by external sensors is fed through the pressure housing to the spectrograph using optical fibres. Up to seven spectra can be recorded simultaneously using spectrographic imaging methods. The use of optical fibres permits a reduction in the size of the sensors used to measure the ambient underwater light field. Furthermore, these sensors can be deployed at a distance from the pressure housing, thus reducing the effects of instrument shading. The instrument is currently configured to measure both the ambient irradiance of the underwater light field and beam attenuation and scattering. The external sensors are detachable, so that the instrument can be reconfigured to make other measurements.

Results: The instrument has been tested for the first time in an estuarine environment in Southampton Water during the summer of 1996. Although the maximum depth of deployment was only 5 metres, the irradiance data showed the expected spectral profile characteristic of absorption by phytoplankton and by yellow substance (Gelbstoff) produced by decaying vegetable matter. The data from beam attenuation and scattering measurements varied as expected with the concentration of suspended sediments. In November and December the instrument has been deployed to depths of 40 metres from the research vessel Discovery in the western Mediterranean between Spain and Algeria. (OMEGA Cruise, November/December 1996).

Discussion: The instrument has achieved the required reduction in sensor size and increase in spectral resolution. It has also demonstrated the feasibility of using this type of instrument in the field. Plans for 1997, include the deployment of SUMOSS in the Baltic.

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A Flexible, Fibre-Optic Based, Underwater Spectrometer for Oceanographic Research.

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ABSTRACT

The need for new instruments to measure the optical properties of natural waters, at higher spectral resolutions than existing commercial instruments, has become apparent in recent years. Such instruments will be required to support the calibration of the next generation of remote sensing platforms by providing in-situ measurements of the optical light field. In addition, high resolution spectral measurements will also support the development of optical closure models which are used to relate the observed optical properties of the water to it's biological and geological content. This paper describes the design and construction of a flexible, general purpose, high resolution underwater spectrometer which can be re-configured to perform a variety of optical measurements using interchangeable, optical fibre based sensor heads. Typical results obtained during the first deployment of the instrument at sea are also presented.

Keywords: Visible-band, underwater, optical fibre, spectrometer, radiometer.

1. INTRODUCTION

Images obtained from the Nimbus-7 Coastal Zone Color Scanner (CZCS) mission of the early 1980s have demonstrated that airborne remote sensing platforms can be used to provide significant information about ocean productivity and biological and geochemical quantities such as the concentrations of marine phytoplankton, coccoliths , suspended sediment and dissolved organic material. New remote sensing platforms for wideband, high resolution measurements of ocean colour are due for deployment in the near future, such as the Medium Resolution Imaging Spectrometer (MERIS) scheduled for the ESA Envisat mission in 1999. Periodic in-situ measurements will be required during the lifetime of such a platform in order to monitor the calibration and stability of the optical sensors and to validate the atmospheric correction algorithms used in the interpretation of the recorded data [1].

Remote sensor images, corrected for atmospheric and sea state effects, provide a map of the water leaving radiance over the area of sea in the field of view. Interpretation of these images in terms of the parameters such as the concentration of chlorophyll and suspended sediment will require the development of optical closure models [2]. This is turn will require high resolution, in-situ, spectral measurements of the inherent optical properties (absorption and scattering) of natural waters.

Most existing commercial instruments for measuring the properties of the underwater light field use one or more discrete channels, each channel having a single, large area detector element behind a pressure window. The waveband is selected by a filter and typical spectral bandwidths are in the range from 10 to 20 nanometres. The bulk of these instruments presents a problem in that they can obstruct the downward light field which may interfere with the accurate measurement of the upward light field [3]. The effects of self-shading becomes more noticeable in turbid coastal waters.

An instrument capable of meeting the requirements above would have to be able to measure both the underwater light field under natural illumination and the inherent optical properties of the water at a high spectral resolution. Furthermore, the sensors used for measuring the underwater light field should be as small as possible in order to minimise the effects of self-shading.

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