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OCEANOGRAPHIC APPLICATIONS OF LASER TECHNOLOGY

by

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Oceanographic activities with the AOL for the past several years have primarily been focussed on using active (laser induced pigment fluorescence) and concurrent passive ocean color spectra to improve existing ocean color algorithms for estimating primary production in the world's oceans. The most significant results in this research thrust have been the development of a technique for selecting optimal passive wavelengths for recovering phytoplankton photopigment concentration and the application of this technique, termed active-passive correlation spectroscopy (APCS), to various forms of passive ocean color algorithms. Included in this activity is use of airborne laser and passive ocean color for development of advanced satellite ocean color sensors.

The field missions used to gather the active-passive ocean color spectra essential to this research are conducted as part of large, multi-institutional, oceanographic field studies. These past (and some ongoing) field programs involve numerous government agencies, universities, and oceanographic institutions. These studies involve the cooperative exchange of AOL and shipboard data and information. This exchange of data has been mutually beneficial, providing ship truthing observations essential to the interpretation of the airborne

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remote sensing chlorophyll and phycoerythrin pigment fluorescence data, while furnishing oceanographers on board the ships with wide area, nearly synoptic information about the regional distribution of the phytoplankton pigments and temperature information gathered with the AOL.

Airborne laser-induced chlorophyll and phycoerythrin fluorescence data are supplied to cooperating investigators shortly after the conduct of the field experiments. Corroboration with participating scientists in the analysis of the data and publication of important findings is an ongoing activity.

Promising on-wavelength subsurface scattering layer measurements were recently obtained and have been submitted for publication. A partial summary of these results are shown in figure 1a. The submerged marine scattering layer field experiment was conducted in the Atlantic Ocean southeast of Assateague Island, Virginia. NASA's AOL was operated in the bathymetric mode to acquire depth-resolved on-wavelength (532 nm) backscatter signals from shelf/slope waters. Unwanted laser pulse reflection from the air-water interface was minimized by spatial filtering. The presence of thermal stratification over the shelf was verified by the deployment of airborne expendable bathythermographs. Optical beam transmission measurements acquired from a surface truthing vessel indicated the presence of a layer of turbid water near the sea floor over the inner portion of the shelf. These results indicate the ultimate potential for making depth-resolved

chlorophyll concentration measurements. These measurements would involve the use of a second laser operating in the blue spectral region.

It has been shown that significant potential exists for the satellite detection of the accessory pigment phycoerythrin using recently developed APCS techniques. During the past several years, the symmetric three-band (460, 490, 520 nm) spectral curvature algorithm (SCA) has demonstrated rather accurate determination of chlorophyll pigment concentration using low-altitude airborne ocean color data. It has recently been shown that the in-water asymmetric SCA, when applied to certain recently proposed OCI (NOAA-K and SPOT-3) and OCM (ERS-1) satellite ocean color bands, can adequately recover chlorophyll-like pigments. These airborne findings suggest that the proposed new ocean color sensor bands are, in general, satisfactorily but not necessarily optimally, positioned to allow space evaluation of the SCA using high precision, atmospherically corrected, satellite radiances. This analysis indicated that pigment concentration recovery was not as good when existing Coastal Zone Color Scanner bands were used in the SCA. The in-water asymmetric SCA chlorophyll pigment recovery evaluations were performed using: (a) airborne laser-induced chlorophyll fluorescence, and (b) concurrent passive upwelled radiances. Data from a separate ocean color sensor aboard the aircraft were further used to validate these findings. Global satellite detection and mapping of phycoerythrin could lead to better primary production

estimates and improved understanding of phytoplankton species variability. A sample of the application of the APCS methodology to airborne data for the passive detection of phycoerythrin is shown in figure 1b.

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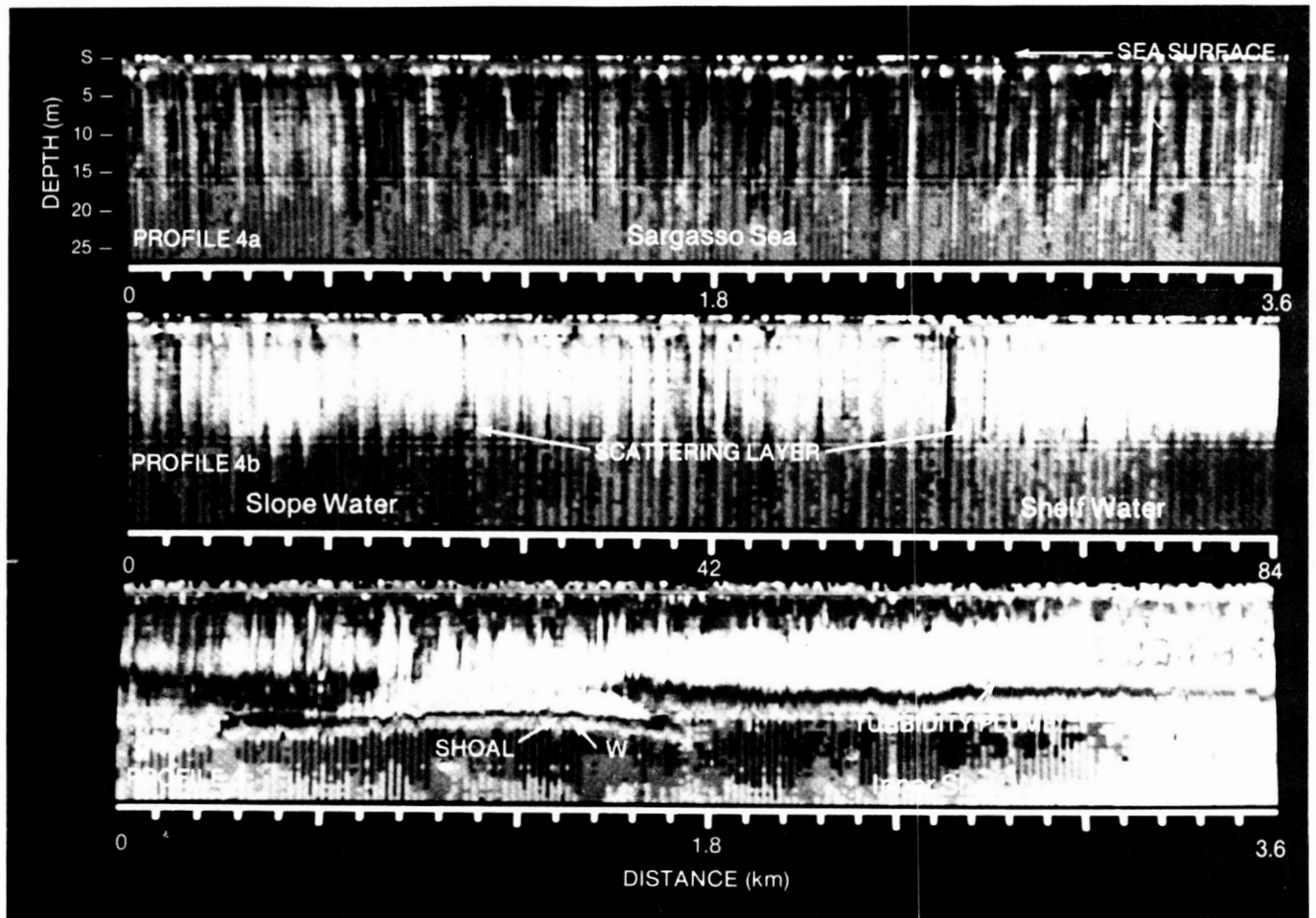


Figure 1a. On-wavelength 532nm laser backscatter profiles obtained from beneath the Atlantic Ocean surface southeast of Wallops Island, Virginia. Specifically, depth-resolved particulate backscatter was observed in shelf/slope and in inner-shelf waters.

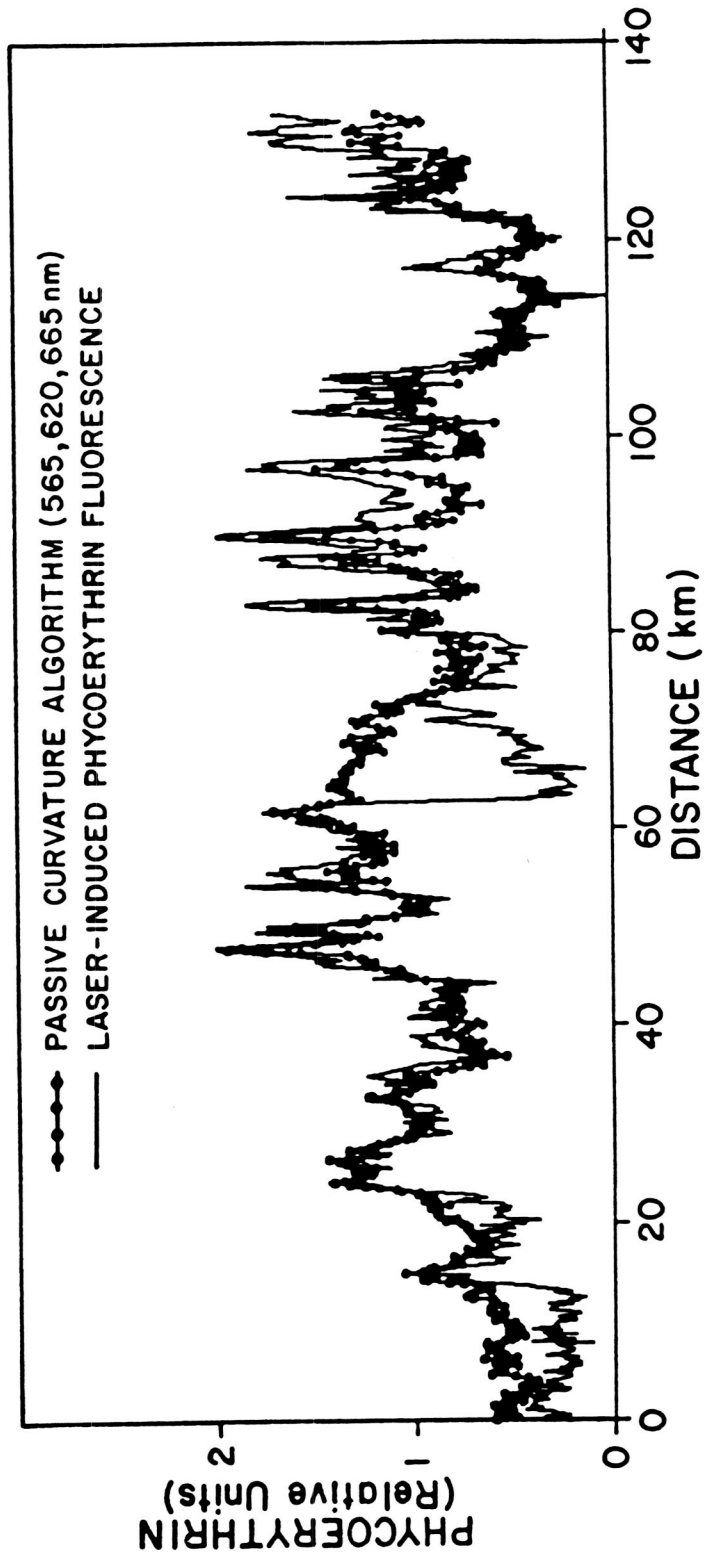


Figure 1b.