Wilford D. Gardner, Mary Jo Richardson
Texas A&M University
WDG Dept. of Oceanography
MJR Depts. of Oceanography and Geology
College Station, Texas 77845

Phone: 409, 845-3928, 409, 845-3651

Fax: 409, 845-6331

SCIENCEnet MailBox: W.Gardner

Other E-Mail Mailbox: wgardner@ocean.tamu.edu mrichardson@ocean.tamu.edu

Optical Variability in the Equatorial and Southeast Pacific

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Research Goals:

The ultimate goal of this research is to obtain global coverage of the three-dimensional spatial distribution of beam attenuation. These data will be combined with hydrographic data and available satellite data to identify the physical and biogeochemical processes responsible for the observed optical distributions. These interpretations will help to divide the oceans into biohydrographic provinces to which different algorithms can be applied to extrapolate from satellite signals to estimate values of various oceanic parameters.

Objectives:

Our objectives were to obtain beam attenuation profiles across a wide latitudinal region of the Central and Southern Pacific on three WOCE cruises

Approach:

A Sea Tech 25 cm transmissometer (660 nm light source) was interfaced with Scripps' CTD and WHOI's CTD to obtain hydrographic/optical sections along portions of WOCE lines P16, 17 and 19 during three cruises in the central and southern Pacific during the summer and fall of 1991.

Tasks Completed:

Three cruises have been completed. We received the data for one cruise (TUNES 1) from SIO/ODF in June, 1992, for a second cruise in Oct. 1992 (TUNES 2) and from the third cruise from WHOI in June, 1994 (TUNES 3). The TUNES 3 data were in a different form and format from the SIO/ODF data and it has taken considerable effort to put those data into a form that we can deal with in our programs. The TUNES 1 and 2 data have been reduced, plotted and analyzed. The Tunes 3 data reduction is nearing completion.

Scientific Results:
Surface values of beam attenuation due to particles (Cp = c (0.364) are very low in the North and South Pacific gyres(0.03-0.06 per m), but are higher in the equatorial region between 10 N and 15 S (Cp = 0.07 to 0.12). At the equator and to 5 N and S, beam c is elevated slightly throughout the water column compared to further north and south, presumably due to settling of and dispersion of particles from the productive surface waters. The maximum in beam attenuation is near the surface in the equatorial region and to the south, but the maximum is subsurface between 7-13 N at a depth of 60-100 m, below satellite detection depths. This correlates with a drop in surface nutrients to near undetectable levels as the upwelling and poleward movement of nutrient-rich water decreases and the nutrients are utilized. Features of this section at 150 W in July-August of 1991 correlate well with the sections at 140 W obtained during the Joint Global Flux Study (JGOFS) in January and September of 1992. A curious feature of the cross-equatorial sections is a slight sub-surface maximum around 400-700 m that extends from 6 S to at least 17 N. This was observed in post-El-Nino period of 1992 (September), but not in the El-Nino period of 1992 (January). Final analysis will be completed in 1994 as a student completes her thesis.

Accomplishments:
We have shown that we can successfully interface transmissometers with SIO/ODF and WHOI CTDs in the WOCE program to obtain beam attenuation data with wide spatial coverage. Including the three cruises funded here, we have obtained beam attenuation data on about 10 WOCE cruises in the Pacific in the last few years. This interaction has allowed a major expansion in the global data base or this inherent optical parameter. Long transects show distributions that are consistent with our understanding of oceanic conditions; e.g. low beam c in the oligitrophic gyres and high beam c in the productive equatorial region. We have now shown for the first time that in the productive equatorial region the value of this optical property is increased throughout the water column. Other regional features with subsurface maximums and minimums have been observed in the data at deeper depths than can be observed by satellite optics. These features are also seen in the optics sections made during JGOFS Equatorial Pacific study. While some of the features can be explained, others (e.g. the small maximum at 400-700 m) may be providing new information about particle recycling in the water column. The large-scale coverage of these sections should also help to differentiate between different biohydrographic provinces.

ONR-Sponsored Publications:
References here relate only to the WOCE transmissometer data in the Pacific, not the North Atlantic Bloom transmissometer data that was part of the early years of this ONR contract. See ONR report in 1992 for those 12 references

C - Colgan, A. R., M. J. Richardson, and W. D. Gardner, 1994, Beam attenuation sections in the central subtropical Pacific. EOS, Trans. Amer. Geophys. Union, v. 75:83.

R- Colgan, A. R. Beam attenuation in the central subtropical Pacific. M.S. Thesis. Texas A&M University.

0 Papers published, refereed journals
0 Papers submitted, refereed journals
0 Books or chapters published, refereed journals
0 Books or chapters submitted, refereed journals
0 Invited Presentations
1 Contributed presentations
1 Technical reports and papers, non-refereed journals
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EEO/Minority Support
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0 Asian post-docs

Patents and Awards
Dr. Mary Jo Richardson received the National Science Foundation's Faculty Award for Women in 1991, granted to only 3 Oceanographers (only 10 Geoscientists) that year. The award was for $250,000 over five years to continue the type of research that was funded in this ONR Optics grant. She is now in the third year of that award.