Optical Assessment of Large Marine Particles: Development of an imaging and analysis system for quantifying large particle distributions and fluxes.

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Goals:

The central goal of DOE's Ocean Margin Program (OMP) is to determine whether continental shelves are quantitatively significant in removing carbon dioxide from the atmosphere and isolating it via burial in sediments or exporting it to the open ocean (Program Announcement, 1991). A major component of the OMP will be to measure carbon flux on the shelf and across the shelf to the slope and open ocean. We are developing a video and optical instrument package (LAPS: Large Aggregate Profiling System) and the analytical techniques to precisely measure a wide spectrum of the large aggregate population of particles in the shelf/slope environment. This particle population, encompassing the "marine snow" size particles (diameters > 0.5 mm), is thought to be the major pathway of material flux in the ocean (McCave, 1975; Asper, 1987; Walsh and Gardner, 1992). Our goal is to use aggregate abundance and size spectrum data along with the CTD, beam attenuation and fluorescence data collected with our instrument package to collect data rapidly, repeatedly and accurately such that it is both linkable to carbon flux and usable in biophysical models. Additionally, measurements of particle flux will be made with sediment traps deployed on the continental slope in conjunction with the physical oceanography program. The combination of profiles and sections of aggregate data along with the measured mass flux and chemistry from the sediment traps will allow for a robust estimate of the mass transport and flux of organic carbon via the aggregate pathway.

Spatial and Temporal Sampling Scales:

The LAPS can measure aggregate abundance with high spatial and temporal resolution. The camera/strobe settings are adjustable and can be set to accommodate deep casts or shallow casts. Generally, images will be acquired at a rate of 1 per meter on shallow casts, and 1 per 3 to 5 meters on deep casts (> 500 m). The length of time of the cast is dependent on the depth and the lowering rate. For casts < 400 meters an hour of ship time is required. Deeper casts are proportionally longer with > 3000 m casts requiring 4 to 5 hours of ship time. The LAPS package has a pinger and can approach within 5 m of the bottom. Multiple casts can be performed within short (e.g. 24 hour) time periods to acquire data on diel variability.

We envision sampling on cross-shelf and slope lines in conjunction with the CTD, chemistry and biological sampling, as well as sampling at mooring locations (particularly the two sediment trap moorings). Because the LAPS is autonomous with respect to power requirements and requires no special equipment, LAPS profiles can follow CTD casts on section lines.

Methods and Appropriate Platforms:

The LAPS as developed for the OMP is an autonomous system consisting of two major subsystems deployed on a rigid frame that is lowered from a ship using a hydrowire. One subsystem consists of a pair of video camera/strobe/battery systems which are independent

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of each other. The strobe light output is synchronized to its camera such that the camera records a full second of video (Hi-8, 400 line resolution) within which a single frame is illuminated by the strobe. The strobe light output is collimated and baffled to produce a defined slab of light oriented perpendicular to the camera. One of the cameras will be set to record the low range ($>250\text{ }\mu\text{m}$) of the particle field while the other camera will record the high end ($>1\text{ mm}$). These parameters can be adjusted to the conditions. The second subsystem consists of a Sea-Bird Seacat CTD mated to a Wet Labs ac-3 meter. This subsystem is used to measure physical parameters (T, S, pressure) as well as beam attenuation and fluorescence. Merging the data sets from the two subsystems is accomplished by time syncing. Any oceanographic research vessel capable of supporting a multidisciplinary research effort is sufficient as a platform for the LAPS.

Strengths and Limitations:

Video based systems for measuring aggregate abundance are necessary because aggregate resuspension ('rebound') occurs at benthic shear stresses significantly lower than required to resuspend sediment, resulting in a decoupling of aggregate transport from traditionally measured optical properties such as beam transmission, as observed on the slope in the Gulf of Mexico where aggregate nepheloid layers are found in the absence of a transmissometer nepheloid layer (Gardner and Walsh, 1990; Walsh and Gardner, 1992). In the shelf/slope environment rebound of aggregates and subsequent downslope transport and settling may be a significant mechanism for export of shelf organic carbon, potentially explaining the discrepancy between benthic oxygen demand on the slope and overlying production (J.J. Walsh et al, 1991; Janhke et al., 1993). The LAPS allows for the measurement of aggregate abundance and size distribution on spatial and temporal scales approaching synopticity (i.e. multiple profiles per day closely spaced along the ship track). This capability is required to assess the along shelf and cross shelf/slope variability of the OMP field area.

The major limitation of the LAPS is the time required for post-deployment processing of the imaging data. Current efforts to streamline the computing steps required (e.g. capture, thresholding, particle counting, data sorting and binning, data compilation) have reduced the overall time significantly. However, the total process still requires four to five hours per cast. On-board, post-cast processing and further refinements to the computer programs will reduce the amount of data that needs to be processed ashore. A further limitation on the LAPS is that profiles made during the day need more extensive image processing to account for the ambient light field. However, given that film based systems cannot produce profiles in an ambient light field at all, the ability to produce profiles under any lighting conditions is significant.

Status of Research:

The LAPS will be tested in the field area during a cruise in June/July 1994. Sediment traps will also be deployed on that cruise to make the first comparisons between measured flux and aggregate abundance in the field area. Efforts to streamline the image processing have resulted in a suite of programs to handle the data from capture to binned data.

REFERENCES

Gardner, W. D. and I. D. Walsh, 1990. The role of aggregates in horizontal and vertical flux across a continental margin. *Deep-Sea Res.*, 37: 401-412.

- Jahnke, R.A., C.E. Reimers and D.B. Craven, 1990. Intensification of recycling of organic matter at the sea floor near ocean margins. *Nature*, 348: 50-54.
- McCave, I. N., 1975. Vertical flux of particles in the ocean. *Deep-Sea Res.*, 22: 491-502.
- Walsh, I.D. and W.D. Gardner, 1992. Comparison of large particle camera profiles with sediment trap fluxes. *Deep-Sea Research* 39, 1817-1834.
- Walsh, J.J., D.A. Dieterle and J.R. Pribble, 1991. Organic debris on the continental margins: A simulation analysis of source and fate. *Deep-Sea Research* 38, 805-828.

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