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SEDIMENT SIZE DISTRIBUTION IN THE COASTAL MIXING AND OPTICS EXPERIMENT

Yogesh C. Agrawal
Sequoia Scientific, Inc.,
9725, SE 36th St., #308
Mercer Is., WA 98040
phone: (206)230-8166 ext. 106; fax: (206)230-8175; email:yogi@sequoiasci.com
Award #: N00014-95-C-0101

LONG-TERM GOAL

The long-term goal of this project is to advance the dynamics of suspended sediments in the water column through the direct measurement of previously unmeasured quantities: size distribution of particles, settling velocity distribution, and the size-resolved sediment 'reference concentration' established at the bed in response to fluid forcing.

SCIENTIFIC OBJECTIVES

The year FY97 was a year of intense data collection using field instruments developed in prior years of this program. Specifically, the particle size distribution was to be measured at a number of elevations above the seabed, the settling velocity distribution was to be measured at one location above bed, and the 'reference concentration' was to be measured in response to fluid forcing.

APPROACH

We have developed 3 new instrument systems for the above measurements. Previous measurements of sediments in the water column have relied on single-parameter estimates via optical transmission or acoustic scattering. These instruments measured the integrated response to all size classes. In our sensors, multi-angle laser scattering by the ensemble of particles in a collimated laser pencil beam is recorded. These data are inverted to obtain particle size distribution. Two such instruments, LISST-100, were employed in the CM&O experiment, mounted on a single tripod. A third instrument, the LISST-ST, was employed for measuring the settling velocity distribution. In this device, a sample of water is captured in a multiple opening and closing Settling Column. The particles are allowed to settle, built for minimal turbulence. The evolution of size distribution is used to determine settling velocity in 8 size classes, each 1 φ wide. The settling experiment was carried out once a day. For obtaining the 'reference concentration', a 4th instrument MSCAT was used. This device measures size distribution only, but at the end of a small sensor head that is placed a few cm above the bed. The sensor head uses a short 5-mm path length, in order to withstand the high particle concentrations encountered near the seafloor. All instruments were mounted on a single tripod. Each is internally recording. Data were stored internally on each instrument, along with time. The tripod also served as a vehicle for 2 other investigators, Drs. Paul Hill and Tommy Dickey.

WORK COMPLETED

In all, 4 deployments of the instruments were carried out during the period August 1996 through June 1997. This period included hurricanes Edouard and Hortense, and lesser events subsequently. 3 Papers are in various stages, please see below under references.

RESULTS

- Only during vigorous bottom stirring with the passage of hurricanes, the size distribution displayed large particles in the 100 micron size range;
- During these events, a strong vertical gradient developed for the larger size classes, as postulated by theory for over 5 decades, not previously reported;
- The LISST-ST revealed a settling velocity distribution consistent with a particle density of 1.1 g/cm^3. Further analysis is in progress;
- The MSCAT instrument obtained the reference concentration. It also revealed that only when wave forcing is strong, a modulation in size distribution of particles is observed at short distances above the bed.

IMPACT/APPLICATION

The detailed size distribution, settling velocity and reference concentration measurements obtained in this program make fresh advances in evaluating sediment transport models possible. Two papers, one accepted, the other in advance stage of preparation are listed.

TRANSITIONS

Two of the instruments, LISST-100 and LISST-ST are now products marketed by us.

RELATED PROJECTS

The PI is involved in similar research at the LEO-15 site operated by Rutgers University.

REFERENCES

Agrawal et al., 1997: Instruments for Particle Size and Settling Velocity Observations in Sediment Transport (accepted with revision), Marine Geology;

The CM&O Sediments Group 1997: Sediment Resuspension in the Wakes of Hurricanes Edouard and Hortense (to be submitted to Nature).

Agrawal, Y. and H. C. Pottsmith: 1997: Particles in Coastal Mixing & Optics, (in prep.).