

Reference Concentration for Shelf Sediment Transport Models

Yogesh C. Agrawal
Sequoia Scientific, Inc.
2700 Richards Road
Bellevue, WA 98005

phone: (425) 641-0944 x-106 fax: (425) 643-0595 email: yogi.agrawal@sequoiasci.com

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<http://www.sequoiasci.com>

LONG-TERM GOALS

My long-term goals are to advance understanding of sediment transport processes. In this context, the long-term goal of this project is to advance understanding of the *reference concentration*, i.e. concentration of suspended sediments at a small distance above the seafloor. The scientific interest is in relating this *reference concentration* to the forcing conditions of waves and currents and the bed morphology. The new contribution in this effort has been to observe the *reference concentration* using a new instrument MSCAT.

OBJECTIVES

My objective within this project is to obtain field data on *reference concentration* and its variability as determined by variations in wave-current forcing conditions. Additionally, I shall characterize the size distribution and suspended velocity distribution of suspended sediments in the field. Complementary data on hydrodynamics have been acquired by Dr Dave Cacchione, and similarly, acoustic sediment concentration profiles were obtained by Dr. Peter Thorne (both reports are included in this volume).

APPROACH

A complete suite of laser diffraction sensors was deployed for measuring the suspended particle size distribution and concentration, settling velocity distribution, and the *reference concentration* at the Santa Cruz pier in California. The water depth was nominally 10. These measurements were made using, respectively, the LISST-100, LISST-ST and MSCAT systems. The first two of these instrument systems were developed by this PI with ONR-MG funding over the years (Agrawal & Pottsmith, 2000; Agrawal & Traykovski, 2001). These instruments are commercial products of this company now. The MSCAT is a new instrument that has just been proven in the field. The instrument suite was mounted on a tripod and the tripod was left on the seafloor for a period of 2 weeks. Coincidentally, a powerful storm swept through the area during the latter part of the deployment (March 2003). All instruments recorded data. This has provided a significant event for data processing. Supporting data were also obtained by Drs. Cacchione and Thorne. The hydrodynamic data of Dr Cacchione will be employed to estimate bottom stresses, which are required for completing the formulation of the reference concentration. The acoustic data of Dr. Thorne provides continuous sediment concentration profiles in the bottom meter, along with less detailed size distribution than the LISST and MSCAT instruments. This last data pair – acoustics and laser – permits studies in calibrations of the acoustics for sizing purposes.

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WORK COMPLETED

The principal work completed this year has been the full preparations and launch of a tripod at the Santa Cruz pier in California. The tripod contained LISST-100 instruments at 0.8 and 1.8 meters above bed, a LISST-ST instrument that measures settling velocity at 0.8m above bed, and the MSCAT at approximately 10 cm above bed.

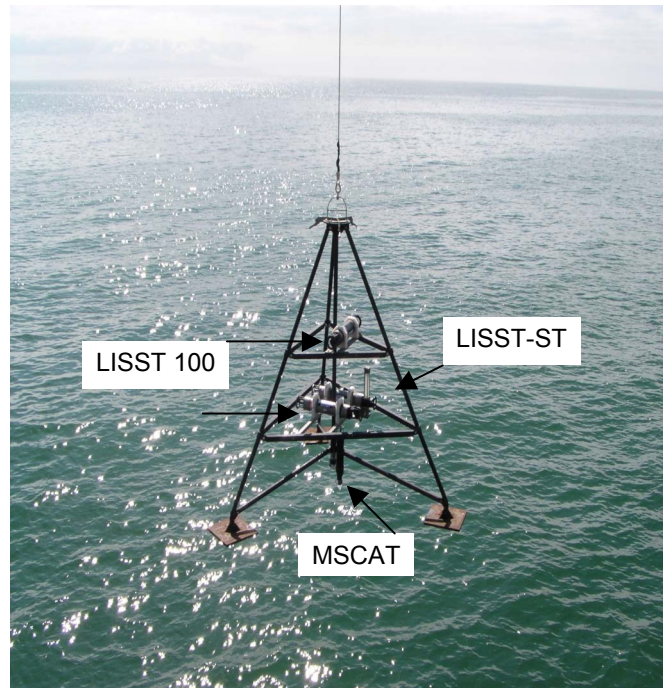


Figure 1: The tripod used from the pier at Santa Cruz, California. All LISST instruments are indicated. The tripod was deployed in about 10m depth.

The deployment was co-ordinated with an instrument suite containing capability to map the velocity field, ripple field on the bed, and a 3-frequency acoustics system for sediment observations. These were managed by co-PI's David Cacchione (see this volume), and British scientist Dr. Peter Thorne.

Data processing is in progress at the time of this writing. It is the object of the present work to combine bottom stress estimates that are derived from a combination of a model and actual velocity measurements, with our measurements of suspended sediments and their settling velocities, to present an improved formulation of the *reference concentration*.

RESULTS

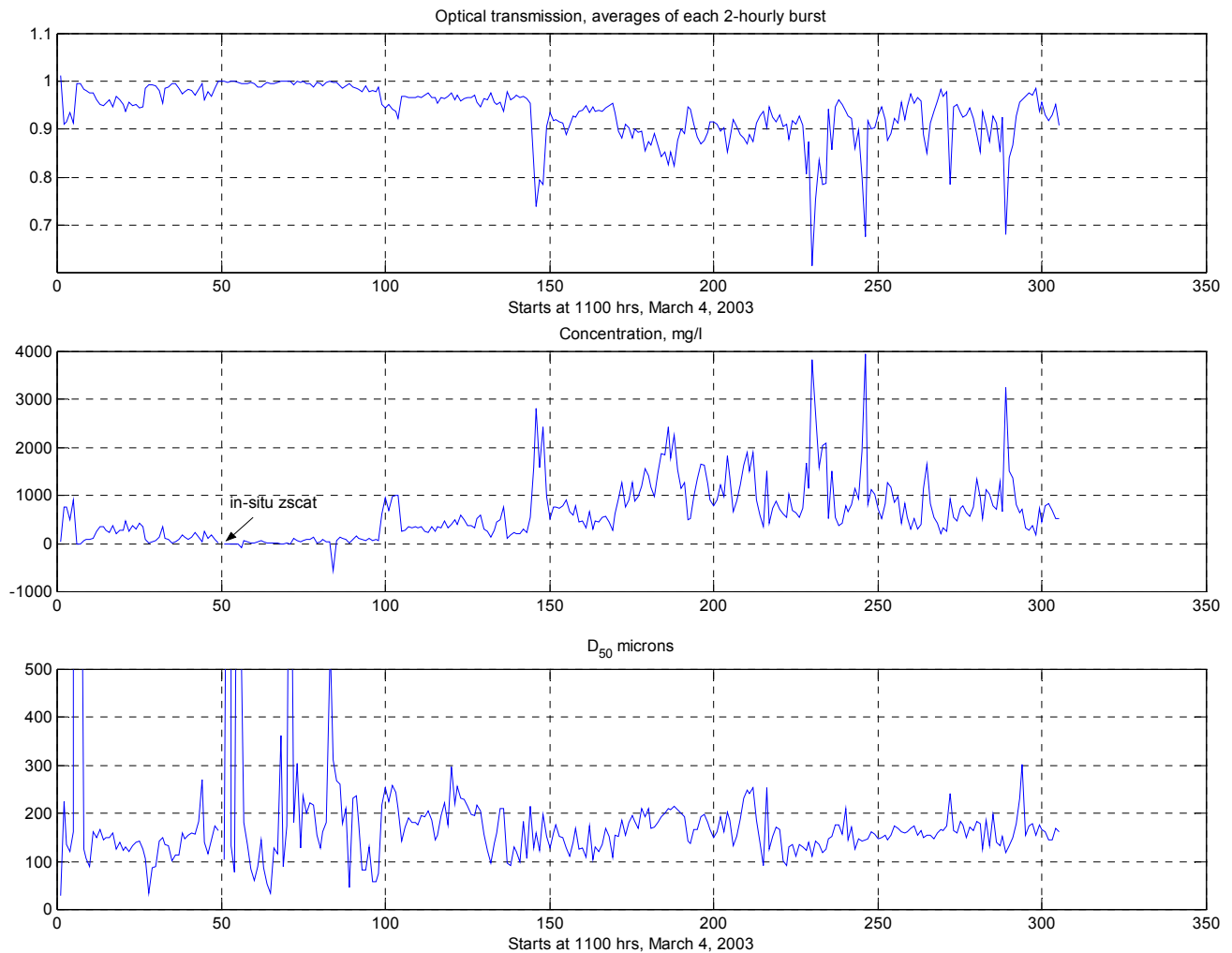


Figure 2: Measured optical transmission on the top panel shows several dips due to storm passage. The concentration and mean size (D_{50}) are shown in the second the bottom panels. Note that the size in quiet times remains noisy, probably affected by flocs. In contrast, concentration mirrors the storm events, so that the entire transmission signal is from resuspension of bed material whose size remains constant throughout. All data are from the MSCAT instrument.

Details of the size distribution measured with the MSCAT were shown in the 2003 annual report. Current effort is focused on combining the size distribution measurements with data on bottom stresses (Dr Cacchione, this volume) and derivation of a size-dependent estimate of the resuspension parameter γ_0 . This parameter has, until now, been estimated with an uncertainty of orders of magnitude.

Early results of estimates of the reference concentration are reported by our co-investigator Dr. Cacchione in his report in this volume. This work is continuing with refinements expected when size-dependent values of γ_0 are explored.

IMPACT/APPLICATIONS

The specification of the bottom boundary condition, i.e. the concentration of suspended sediments at the bottom in response to motions induced by currents and waves is one of the most fundamentally difficult and intractable problems in sediment transport. The present data will help in tightening the specifications of this *boundary condition*. Furthermore, the combined measurements of size distribution, settling velocity distribution, and reference concentration makes for a rich data set to examine established boundary layer models.

TRANSITIONS

The newly tested MSCAT sensors will be rapidly transitioned to the scientific marketplace so that the study of *reference concentration* can become broadly driven.

RELATED PROJECTS

This PI is also involved in sediment dynamics research in the ONR funded HYCODE project. In that project, temporal behavior of size distributions has been studied in the bottom boundary layer over a month long deployment. Furthermore, the entire water column was studied from a profiling LISST-100. The instruments used in the present work and HYCODE are ONR funded. A new program, also funded by ONR's Ocean Optics and Biology program will permit study of the light scattering properties of natural particles in near-forward and -back regions, which is relevant to sediment studies.

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PUBLICATIONS

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