OS12B HC: Hall III Monday 1330h

Application and Assessment of Coastal Sediment Transport Models I

Presiding: **C Harris,** Virginia Institute of Marine Science**; C Sherwood,** USGS MS-999

OS12B-146 1330h POSTER

Comparison of Wave-Generated Bottom Shear Stress Distributions on the Shelf Calculated From Spectral Wave-Buoy Data and Global Wave Hindcasts and Forecasts.

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In most continental shelf environments, sediment transport depends strongly on wave conditions. High wave-generated bed shear stresses are commonly responsible for initiating transport events and govern their duration. Wave-generated bed shear stresses are almost always calculated from values of near-bed wave orbital velocity. Near-bed wave orbital velocity can be measured directly by instrumented bottom tripods or calculated from records of surface wave-height spectra. In regional and larger-scale models of coastal marine sediment transport, records of surface wave height spectra, either measured by surface wave buoys or hindcast from wind fields using wave models, are most likely to be used to calculate near-bed wave orbital velocities and associated bed stresses.

Previous field studies on the California continental shelf have shown that near-bed wave orbital velocities calculated from surface wave spectra recorded by NOAA wave buoys are in good agreement with values determined from bottom tripod measurements at depths ranging from the shelf break to 50-m or less. In this study, we compare wave-buoy-derived values of near-bed orbital velocity and bed shear stress to values determined from the regional and global Wave Watch III (WW3) wave hindcasts and forecasts. We focus on three sites, near NDBC buoys 44008 (southeast of Cape Cod), 42036 (northeast Gulf of Mexico), and 46022 (Eel shelf, California). Time series and statistics of wave height, near-bed orbital velocity, and wave-generated bed shear stresses are compared. The results are interpreted in terms of uncertainties in transport calculations associated with the differences in buoy and WW3 wave conditions.

OS12B-147 1330h POSTER

Interpretation and 1-D Modeling of OBS Response to Mixed Grain-Size Suspensions in the the Nearshore During SandyDuck'97

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During the SandyDuck experiment in October 1997, near-bed pump samples were collected from the nearshore during a storm utilizing the US Army Corps Field Research Facility's Sensor Insertion System. The pump-sampled data on sediment concentration and size distribution are used here to (i) to improve estimates of suspended sediment concentration in the presence of multiple grain sizes by remote sensing time-series such as optical backscatter (OBS) and (ii) to test theoretical model predictions of friction velocity and the shape of the suspended sediment concentration profile. Pumping results show that the lowest 1 to 5 percentile of OBS response during a given burst was proportional to the pumped concentration of suspended particles smaller than 63 microns. OBS response after the removal of fines was found to be consistent with pumped sand concentration as long as corrections were made for the varying size of suspended sand and noise in the OBS records. An automated procedure is presented to correct OBS records for likely sand size and noise levels in the absence of ground-truthing by pump samples. Observed estimates of friction velocity are then derived from the shape of the corrected OBS concentration profiles within the mean current log layer. These estimates of shear velocity are compared to standard models for mean current shear velocity. Possible reasons for observed disagreement between simple models and the observed shape of the concentration profile are discussed.

OS12B-148 1330h POSTER

Modeling of Suspended Sediment Concentrations Affected by Resuspension of Bottom Sediments in a Shallow Reservoir

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Water quality in shallow lakes and reservoirs is highly influenced by resuspension of bottom sediments. Physical disturbance on bottom sediments causing resuspension seems to influence the nutrient dynamics in shallow water body. We have developed a numerical simulation model to describe water quality change in a shallow reservoir, focusing on the resuspension of bottom sediments by wind-generated waves. Physical model is made of modified Princeton Ocean Model. Transport and sinking of suspended particulates is modeled and combined into the physical model. Wind wave height and period are calculated using fetch, wind speed, and water depth at each grid successively independent of the output of the physical model. Information of wave is then used to calculate the shear stress at the bottom of the reservoir and entrainment rate of bottom sediments is calculated using the shear stress. This entrainment rate of bottom sediments is used as the source of sediment at the bottom boundary of the physical model.

The model was calibrated using data sets obtained by field measurements. We have investigated sediment resuspension flux by deploying sediment traps and monitored turbidity change in a shallow reservoir (Watarase reservoir, Japan). The model successfully simulated a rapid increase of turbidity caused by the resuspension of bottom sediments following a typhoon. During this event, wind blew from northeast direction, for which the reservoir has longest axis. The model calculation showed that the magnitude of resuspension of bottom sediments was affected by water depth, wind direction and wind velocity. Due to the reservoir configuration, the northeastern wind can cause intensive resuspension. Water depth is drawn down to 3 m for flood control purpose from July to September in this reservoir. The model results suggested that this reservoir operation and frequently blown northeastern wind enhance resuspension of bottom sediments causing increase in turbidity, total phosphorus and chlorophyll-a concentration in the reservoir in summer.

OS12B-149 1330h POSTER

Sediment Transport Study in Kyunggi Bay, Korea

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Field study and numerical modeling approach have been conducted to study the sediment transport in macro-tidal Kyunggi Bay in Korea. The area of the Kyunggi Bay is approximately 20,000 square Km, where underwater sand mining has been conducted to supply the construction material to coastal cities in Korea. Approximately more than 19 million cubic meter of underwater sand have been mined every year, leaving significant pits deeper than the adjacent athymetry. As part of environment impact assessment, we carry out a sediment transport study.

The purpose of this study is to increase our ability to predict the horizontal and vertical dispersion of the turbid plume in surface and bottom layers from the mining vessels, and to predict the recovery of the artificially deepened seabed.

We have conducted a field experiment that is exclusively for this study, including experimental underwater sand mining ,and associated hydrodynamic and sedimentary processes in undisturbed area. Using the field data, we are doing comparative study of numerical modeling. The numerical study demonstrates the applicability of the EFDC, COHERENS and DIVAST to major sediment transport processes in the study area.

Preliminary result of numerical modeling and phenomenological results of the field experiment will be presented.

OS12B-150 1330h POSTER

Tide-induced Sediment Resuspension and the Bottom Boundary Layer in an Idealized Estuary

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Sediment transport and bottom boundary layer in an idealized estuary were studied by numerical simulations. The focus was placed on description and prediction of the dynamics of nepheloid layer (a fluid-mud layer) developed in the estuary due to the coupling effect of the seawater density and resuspended sediment concentration. Princeton Ocean Model was coupled to a sediment transport model to conduct the numerical experiments. A semi-diurnal tide with a spring neap cycle was used to force the model at the estuary entrance. A stability function was introduced to the bottom drag coefficient Cd for a slip bottom boundary condition in order to consider the effects of sediment induced stratification.

When the seawater density is not affected by the resuspended sediments, spring tides resuspend sediments to the sea surface near the estuary entrance where the bottom stress is larger than the critical stress value. The sediment distribution in the BBL near the entrance is dominantly affected by the vertical eddy diffusion and the time series of the sediment concentration presents two high value peaks within a tidal cycle. Above the BBL the sediment concentration is primarily controlled by the horizontal tidal advection thus a semi-diurnal oscillation in sediment concentration is predicted.

When the seawater density and the sediment concentration is coupled, the sediments resuspended by the spring tides are only distributed in the bottom layer with a thickness of a few metres. A lutocline is developed above a nepheloid layer where the vertical sediment concentration gradient is of maximum. The settlement of the nepheloid layer gives rise to the resuspension events that are characterized with abnormally high value in sediment concentration near the seabed. These resuspension events may be referred as "resuspension hysteresis" with respect to the tidal forcing frequency. The frequency of the resuspension hysteresis is controlled by both the sediment settling velocity and the turbulence intensity. An hyperpycnal plume is also established near the entrance generating a cross-estuary tidal mean flow in order of 1 cm/s there. Variability in the bottom drag coefficient Cd between the spring and neap tides is predicted due to the sediment induced stratification and the prediction agrees with the observation by Cheng et al. (1999) in South San Francisco Bay.

URL: http://www.ge.adfa.edu.au/hwres.html

OS12B-151 1330h POSTER

Storm bed to Sequence: the Numerical Upscaling from Event beds to Stratigraphy

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The geologic record at continental margins is the result of multiple processes, operating at varying scales, that distribute and remobilize sediment, and that create and modify the space that enables strata to be preserved. Event strata are the basic building blocks of all larger scale sedimentary units. On event-dominated margins, such as the Eel sector of the Northern California shelf, sediments are resuspended by wave- and wind-generated currents associated with extra-tropical lows during winter. These storms may also flood associated rivers creating turbid, coast-hugging, low-salinity plumes which facilitate the formation of fluid muds on the inner shelf floor. Under the force of gravity, these muds slide seaward onto the middle shelf or over the shelf edge. Seismic records and cores, together with numerical simulations, indicate that the Holocene deposits on the Eel margin consist of a succession of

back-stepping, storm-generated event beds, the time-lines (bedding planes) of which dip more gently than do their gradational facies boundaries. Three transgressive shelf facies can be identified in seismic records and cores; an Amalgamated Sand Facies on the inner shelf (sand beds on sand beds), an Interbedded Sand and Mud Facies on the central shelf, and an offshore Laminated or Bioturbated Mud Facies. The environments in which these facies are formed migrate in response to large-scale environmental changes outside the system.

In simulating this evolution from the formation of event beds (time scales of seconds to days) to that of depositional sequences (time scales of thousands to millions of years) process-based forward numerical modeling must solve the technical and conceptual problems of upscaling. Probabilistic methods of computing sediment transport must replace its direct modeling and geodynamical forces acting on the resulting stratigraphy must be translated into their morphodynamical expression. The integration of the FACIES model with the SEQUENCE model, which operates at the geologic time scale, establishes the feedback loop that exists between transport and morphology and provides details of the stratigraphy that lies between timelines. A series of simulations encompassing 10,000 years are presented for a variety of sea level regimes. Results show that event stratigraphic patterns vary systematically as a function of the systems tracts in which they are found. The most complete record of events is found in the lowstand systems tract (LST). Analysis of multiple transects with the ARC/INFO geographic information systems (GIS) package provides an initial approximation of the three-dimensional facies structure.

OS12B-152 1330h POSTER

Analyzing the Sedimentary Processes Responsible for the Shallow Stratigraphy of the Eel River Shelf, Northern California

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The Eel River Shelf has been studied in detail by various investigators in the STRATAFORM Project. The rates of sediment supply, distribution of surface sediment types, and composition and geometry of the shallow sedimentary facies are known. There are also data for the oceanographic processes including long term wave data, mooring and bottom tripod current data and some hydrographic information.

We have analyzed the short-term and long-term sedimentary processes with a numerical model to understand the hierarchy of processes that combine to produce the observed shallow (<10m) stratigraphy across the whole shelf. The model, SLICE, is a 2DV time-dependent process-based approach that solves coupled hydrodynamic, sediment dynamic and morphodynamic equations. Because the model was designed from the onset to address problems in marine sedimentation and morphological changes, it resolves details of boundary layer dynamics and tracks sediment bed evolution in a highly refined manner. Also, it was designed to allow long duration (multi-year) simulations without undue computational time. These provisions permit simulations over time periods of centuries that are meaningful over the time scales of shelf morphological adjustments and the accumulation of shallow strata.

In this modeling effort, it has been possible to explore the time-averaged effects of composited event-scale processes. The build-up and destruction of temporary surficial strata on the shelf is an important feature of the long-term processes. The sum of time- averaged shelf sedimentation and bypassing must be balanced with the rate of nearshore sediment supply. As a consequence, both the coastline-averaged supply rate and the rates of shoreline migration need to be properly represented. With the inclusion of these factors, it is possible to demonstrate a stable depth profile across the whole shelf that persists while several meters of sedimentary strata develops. The grain size compensation and relative thickness of the preserved sediment beds provide an additional constraint in assessing the modeling results.

OS12B-153 1330h POSTER

Event Stratigraphy on the Northern California Continental Shelf: Role of High-concentration and Dilute Suspensions Analyzed by Numerical Modeling

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Seaward of its nearshore zone, the Eel River sector of the Northern California shelf is mantled by a seaward-fining pro-delta wedge of Holocene mud, the upper portion of which is accessible by box coring. X-radiographs reveal a sequence of thin to very thin muddy beds and laminae deposited by storm-related currents during or shortly after flood episodes ("flood beds"), intercalated with sandier beds and laminae reworked from the flood beds. While most beds are of more or less recent flood provenance, most of this material has undergone multiple resuspensions, and is storm packaged. The beds are thus "tempestites" but their sediment is in various stages of textural maturity, depending on the number of resuspensions to which it has been subjected.

Observations of fluid motion and sediment transport from the Eel River sector of the Northern California Shelf during two storms in the winter of 1996 have been assembled, and observations of box cores that penetrate the 1996 have been collected by participants in the STRATAFORM Project of the Office of Naval Research. A two-dimensional, across-shelf suspended sediment transport model and a across-shelf fluid mud transport model have been developed to study the sediment transport, deposition and bed evolution. The observations and simulations show that rather than dividing beds into "flood" and "storm" beds, it is more meaningful to divide the event beds into the deposits of high concentration regimes and low concentration regimes. Coast-hugging surface flood plumes occur on the inner shelf during the winter season. The plumes generate dense, near-bottom suspensions, which may attain fluid mud concentrations (>5 g/l) as particles settle. The period of storm-heightened waves may continue into the flo od period, leading to gravity-driven seaward displacement of the bottom suspension, or the wave regime may ameliorate, leaving the suspension to consolidate as a short-lived inner-shelf flood bed. Such beds tend to be resuspended within days or weeks by subsequent storm events that may recreate the original high concentrations, leading to renewed gravity transport. In either case, the sediment is deposited as a muddy "flood bed" on the central shelf. In contrast, low concentration regimes occur during storm periods when there has been no recent flood deposition on the inner shelf. The shelf floor is better consolidated than in the previous case, and the resulting suspended sediment concentrations are lower. As a consequence, beds deposited are thinner and sandier. In multi-year event bed successions, flood beds stand out, not only because more and finer material has been supplied to them, but because the change in the rate and character of supply has itself altered the dynamics and shifted the regime to ward accumulation.

OS12B-154 1330h POSTER

Sediment Redistribution in the New York Bight: Influence of Wind-forced Currents, Energetic Waves, and Topography

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Bathymetry and coastline configuration appear to influence circulation and sediment dispersal in the New York Bight. The most prominent feature in this area is the Hudson Shelf Valley, a topographic depression that runs across the shelf. Surface sediment on the New Jersey and Long Island shelves is dominantly sands, while muds and silts are found within the shelf valley. Concentrations of heavy-metals decrease with distance from historical dump-sites located near the head of the shelf valley, but remain high for 100s of kilometers down the valley axis, implying down-valley transport (see http://pubs.usgs.gov/factsheet/fs114-99).

Observations made from December, 1999 - April, 2000 indicate that sediment flux occurs within the Hudson Shelf Valley during both up-valley and down-valley directed events. Winds from the northwest and moderate waves were associated with times of up-valley transport. Down-valley events coincided with northeast winds and energetic waves. Up-valley currents occurred frequently, and, in contrast to the geochemical evidence, net transport was directed shoreward within the Hudson Shelf Valley. The measurements, however, do not fully account for sediment dispersal because they cover only one winter, and do not resolve sediment redistribution or convergence.

A three-dimensional numerical model that links suspended sediment transport, erosion, and deposition accounts for the complex bathymetry, and provides a larger spatial and temporal context than the observations. Using such a model, sediment redistribution is predicted for typical up-valley and down-valley events. During the up-valley event sediment is resuspended within the shelf valley (where currents are highest), transported towards shore, and dispersed over the Long Island shelf. A typical noreaster is predicted to remove fine-grained sediment from shallow shelf environments and deliver it to the shelf valley. Over time-scales longer than the two storm events considered here, these dispersal patterns might be consistent with both geochemical and water column observations. Future work will investigate the dispersal patterns associated with seasonal effects, and long-term climatic conditions

OS12B-155 1330h POSTER

Particle Transport Observations in the New York New Jersey Harbor

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A major goal of the New Jersey component of the Contaminant Assessment and Reduction Program in New York-New Jersey Harbor is the identification of the transport pathways for contaminated sediments within the estuary. Monitoring efforts have been established within three waterways (Newark Bay, the Arthur Kill and the Kill van Kull) to provide validation data for upcoming modeling studies. Between March 5th and April 2nd, 2001, moorings equipped with a small suite of monitoring elements were deployed within each of these three waterways. Sensors included a LISST (Laser In Situ Scattering and Transmissometer), an Optical Backscatter Sensor (OBS) and an Acoustic Doppler Profiler (ADP) to measure suspended particle concentrations, particle size distributions and current/backscatter profiles. Results from these moorings indicate that total suspended particle concentrations vary substantially, in both time and space, over the one-month deployment. The highest concentrations across all particle sizes occur during maximum flood tide with lower concentrations during the weaker ebb tide. This pattern is modulated by the spring-neap tidal cycle, where total concentrations during spring tide are increased an order of magnitude.

One potential advantage of the LISST is that it measures particle concentrations in 32 size classes. Acoustic backscatter from the bottom bin of the ADP was highly correlated with the largest LISST particles (400-500 microns), while correlations between the LISST and the OBS were much smaller for all size classes. At the northern end of Newark Bay, acoustic backscatter, optical backscatter, and the large LISST size class concentrations were approximately symmetric with respect to flood and ebb, leading to a net transport in the same direction as the residual flow. The smaller particle sizes observed by the LISST in the range 70-90 microns (um), however, where found to be significantly larger during the maximum flood tide, leading to a net transport of fines opposite the residual flow. In the southern reach of the Arthur Kill, flood tides produced the highest concentrations with larger sediments in the 200 300 um range. Particle concentrations in the Kill van Kull are much lower than in the other two systems, and are not well correlated with the tide at any particle size range.

OS12B-156 1330h POSTER

Cross-Shore Variations in Wave Forcing and Bottom Sediment Response in Southeastern Lake Michigan

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We deployed three instrumented moorings in southeastern Lake Michigan along a cross-shore transect off Muskegon, MI from 13 September through 30 October 2000. The transect was approximately 10 km long, and the moorings were located at depths of 16, 26, and 56 m, roughly 3, 4, and 11 km offshore. Each mooring included a near-bottom-mounted pressure sensor, temperature sensor, and transmissometer. The deeper moorings also had transmissometers and temperature sensors higher in the water column (10 meters above bottom [mab] at the 26-m station, 10 mab and 25 mab at the 56-m station), and the two shallower moorings had near-bottom-mounted current meters. All instruments were sampled in burst mode at half-hour intervals. One large storm, several shorter periods of high winds, and three coastal upwelling events occurred during the observation period. Bottom sediment resuspension was observed at the two shallower stations during the large storm but not at the deep station, consistent with the hypothesis that local sediment resuspension in Lake Michigan is driven primarily by surface waves. We used the Great Lakes Environmental Research Laboratory wave model, implemented on a 2-km grid, to simulate surface wave conditions at each station and used the modeled waves to force an empirical near-bottom sediment concentration model. We found that the agreement between the model results and the observed sediment concentrations was very good and relatively insensitive to the derived set of model parameters related to the properties of the bottom sediment type. Although resuspension was not clearly associated with the upwelling events, the net horizontal onshore sediment flux, estimated by integrating the near-bottom current velocity scaled by the magnitude of the near-bottom sediment concentration, was negative (toward deeper water) at both of the shallower stations. The alongshore component of the horizontal sediment flux was positive (toward the northwest), in the direction opposite the area of maximum sediment accumulation in Lake Michigan.

OS12B-157 1330h POSTER

Morphodynamics and Burial/Scouring of Cobbles in a Coastal Zone

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The evolution of an initially flat sandy beach and the dynamics of large disk-shaped and cylindrical objects (cobbles/mines) emplaced on it are studied in a laboratory wave tank, 32 x 0.9 x 1.8 m, under simulated surf conditions. The present work extends our previous studies [1-4] of rigid obstacles along solid impermeable beaches with artificial roughness to the more realistic (and complicated) case of a sand bottom. Upon initiation of wave forcing, the initially flat beach undergoes bedform changes before reaching a quasi- steady morphology characterized by a system of sand ripples along the slope and a large sand bar near the break. Although the incoming wave characteristics are held fixed, the bottom morphology never reaches a strictly steady state, but rather slowly changes due to the migration of ripples and bar transformation. When the wave characteristics are changed, the bedform adjusts to a new quasi-steady state after a suitable adjustment time. Studies conducted by placing model cobbles/mines on the evolving sandy beach subjected to wave forcing show four distinct scenarios: (i) periodic cobble oscillations with zero mean displacement and scour, (ii) mean onshore motion of relatively light cobbles, (iii) periodic burial of relatively heavy cobbles when their sizes are comparable to those of sand ripples, and (iv) the burial of relatively large cobbles under the bar, when the bar migrates due to changes of incoming waves. Another interesting result is related to the ripple migration. On an initially flat bottom, ripples are formed first near the break point and then propagate as a front down the slope. After a quasi-steady state is achieved, ripples migrate along the slope with velocity that has two components: stochastic (zero net displacement) and unidirectional. Quantitative data on the background flow, the characteristics and dynamics of the bedform and the behavior of cobbles are presented and physical explanations are provided. For more detail see [5]. This research was supported by the ONR.

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OS12B-158 1330h POSTER

Elevated Strandlines on Lanai, Hawaii- Not Megatsunami Deposits

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Outcrops of shell hash and coral at elevations of up to 190 m have been previously described from the south coast of the island of Lanai, Hawaii (Stearns, 1978) and have been cited as evidence for deposits left by giant tsunami waves (Moore and Moore, 1984 & 1988).

Recent detailed mapping of these units at elevations between 100 and 200 m by the authors has identified ledge-like deposits and wave-cut notches containing marine fossils at specific elevations that are best explained by elevated strandlines rather than scattered deposits swept up by giant wave activity. Fossil assemblages, in-situ coral heads, and internal stratigraphy within well exposed portions of these units, are best explained by normal sedimentologic processes in reef, lagoon and beach environment. Moreover, the consistent elevation of these units along several kms of the south flank of Lanai leads to the inescapable conclusion that the units between 98 and 200 m are uplifted marine strandline deposits rather that deposits of a chaotic process such as transport by giant waves.

We interpret these deposits as elevated units originally formed at sea level. Lanai is currently at the same distance from the active Hawaiian hotspot as is the arch to the east and west of the hotspot. Thus we interpret the strandlines to be ancient sea level lines that were formed during glacial and interglacial periods during the last 400,000 years. The limited age dates available are consistent with this interpretation and the maximum elevation is consistent with the uplift of the seafloor along the arch in the deep oceans surrounding the island of Hawaii.

OS12B-159 1330h POSTER

A New Quantitative Model for the Emplacement, Bioturbation, and Preservation of Fine-Scaled Sedimentary Strata

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Sediment fabric and structures constitute some of the most easily accessed and tangible forms of information in the sediment record, but quantitative use of this information is hampered by our inadequate understanding of the governing physical and biological processes, and how they interact. In particular, quantitative understanding of the role of infaunal bioturbation with respect to the formation and destruction of sedimentary strata is extremely poor, largely limited to studies of littoral organisms. For decades, geologists have studied short-term (seasonal-centennial) rates of sediment deposition/erosion, and bioturbation, but no quantitative approach has existed to predict the stratigraphic consequences of these interacting processes. Our central goal in this paper is to develop a model allows predicting the degree to which primary sedimentary fabric is preserved or destroyed as a function of rates and scales of sediment deposition, erosion, and bioturbation, all of which can vary in space and time.

We have developed a new quantitative framework that allows testing of complex hypotheses for interacting bioturbation and sediment dynamics, to assess the preservation potential of sedimentary strata, and to predict preserved fabric. We propose an analytical solution to an advection-reaction equation that represents deposition and erosion as advective processes that occur in finite steps, and bioturbation as an irreversible reaction. Once an organism has "interacted" with physical fabric, that fabric becomes irreversibly biogenic, unless reworked or eroded by physical processes. This model tracks the volumetric transformation of sedimentary fabric in discrete event layers from physical to biogenic, rather than tracking sediment particles or a geochemical tracer, and is uniquely suited to examining the origin and destruction of sedimentary structure.

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Nonlinear Three-Dimensional Shear Instabilities of Alongshore Currents in the Nearshore Surf Zone.

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A hydrostatic primitive equation model, the Princeton Ocean Model (POM), has been adapted for studies of three-dimensional wave-averaged circulation in the nearshore surf zone. The model is applied here to studies of nonlinear shear instabilities of wave-driven alongshore currents for conditions appropriate to the Duck94 field experiment off Duck, NC. POM has been modified for application to nearshore flows by incorporating forcing from gradients in the radiation stress tensor and by including effects of wave-induced mass flux through appropriate boundary conditions on the vertical velocity at the surface. In addition, boundary conditions on turbulence quantities that reflect effects of breaking surface waves are implemented and a bottom-boundary layer submodel that represents the effects of wave-current interactions is embedded. Numerical experiments for simulations of observed flows at high, mid and low tide on 12 October 1994 are discussed. Measured beach bottom topography is utilized and the forcing is calculated from measured across-shore wave height variations. Steady, two-dimensional solutions (variation across-shore and with depth) are obtained initially with the assumption of alongshore uniformity. Model-produced alongshore and across-shore velocities agree favorably with three hour time-averaged current measurements from the DUCK94 fixed array. The two-dimensional solutions are utilized as initial conditions for forced flow in an alongshore periodic three-dimensional domain with alongshore uniform beach topography. The alongshore currents in these flows are unstable and develop nonlinear, finite amplitude shear instabilities with alongshore scales of order 100m. The nature of the instabilities vary depending on the tide height, with stronger instabilities found at high tide. Of particular interest here is an investigation of the effects on the instabilities of the momentum shear dispersion mechanism of Svendsen and Putrevu (1994). This mechanism results from the depth-dependent across-shore transport of alongshore momentum in combination with vertical turbulent mixing and is explicitly resolved (rather than parametrized) in these three-dimensional calculations. These effects are evaluated by direct comparisons with solutions without resolved across-shore circulation, e.g., from the widely used depth-independent shallow-water equations. The comparisons show significant differences in the nature of the instabilities. The alongshore velocities in the three-dimensional solutions have sharp across-shore gradients that are favorable for the development of instabilities. On the other hand, the momentum shear dispersion mechanism provides a strong diffusive effect that ultimately limits the growth of the instabilities resulting in non-linear shear wave equilibration.