One of the most attractive and interesting features of beaches is their complexity. An important research objective is to explain the patterns of beach surface variability that may be expressed in both cross-shore and alongshore directions. It is also important to explain how these patterns evolve in time. Many approaches to explaining morphologic variability have focused on reduced-dimensional representations, such as neglecting the variations in one physical dimension. This paper investigates the consequences of neglecting alongshore variability to modeling beach surface evolution.

A coupled hydrodynamic/sediment transport model is investigated that aims to predict changes in the alongshore-uniform component of a beach. Systematic deviations between the model predictions and observed alongshore-averaged profiles may be due to the missing physics associated with the missing dimensionality of the model. This hypothesis is tested by comparing model error to observed alongshore variability, characterized from an alongshore-extensive data set that was obtained from ongoing, long-term field observations at Duck, NC. The results are used to suggest a more consistent modeling approach.

OS52E-09 1600h

Rip Currents and Rip Channels on non-barred beaches: A Secondary Morphodynamic Feedback? Field Evidence and Model Results

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Modelers treat the development of rip channels on barred beaches as a morphodynamic feedback. Slightly lower parts of an alongshore bar concentrate offshore-directed flow, and as this flow moves into shallower water approaching the bar crest the velocity tends to diverge, causing erosion that further concentrates the flow. However, observations suggest that this is not how rip currents develop on non-barred beaches. Video observations collected from on top of a cliff above Torrey Pines Beach in S. California show that strong, jet-like rip currents can occur without associated rip channels. On this beach, strong rip currents, which tend to last from minutes to tens of minutes (depending on wave characteristics), can be identified in video images by plumes of sediment and/or foam outside the surf zone, and by the refraction of wave crests around the current. Time averaged and rectified video images of times within 20 minutes of rip current occurrences, but when no rip currents were obvious, show approximately alongshore-uniform wave breaking, indicating that any bathymetric nonuniformities were quite subtle. Plots of rip current locations through time show a lack of the clear clustering that would be expected for bathymetrically controlled rips. These plots also suggest alongshore migration of rip currents (a phenomenon familiar to S. California life guards).

On this beach, if wave conditions producing visually obvious rip currents persist for days, visually obvious rip channels can develop. When these cross-shore oriented troughs in the otherwise approximately planar beach exist, rip currents no longer appear in apparently random locations, but are restricted to the channels. These qualitative observations suggest that non-bathymetrically driven rip currents can begin to dig channels. Then, presumably, because of local variations in wave forcing and depth, incipient channels make rip currents more likely to reoccur in those locations, forming a secondary morphodynamic instability (secondary because it does not seem to be essential for producing rip currents).

However, analysis suggests that this feedback may not be straightforward on non-barred beaches. The velocity of a current moving into deeper water tends to converge. With sediment transport treated as a function of flow velocity, flow convergence tends to produce sediment accumulation. If sediment flux is assumed to vary linearly with local mean velocity (and if the oscillatory component of surf-zone velocities that suspends sediment is assumed to be constant across the surf zone, consistent with data collected during the nearshore transport study at Torrey Pines, 1978), ridges, not channels, would form under rip currents. If sediment flux varies nonlinearly with mean velocity, analysis produces an ambiguous result.

Numerical modeling of sediment transport driven by an approximately realistic flow field (produced by a model of non-bathymetric rip currents) suggests that with the above assumptions, rip currents would initially produce sediment accumulation, creating a negative morphodynamic feedback. However, a lag in the adjustment of suspended-sediment concentrations as they are advected through varying local hydrodynamic conditions will tend to increase the flux of sediment advected out of the surf zone (shown by the plumes of sediment evident in aerial images), inhibiting deposition under a rip current. Including non-local sediment transport in the model (using a treatment that is consistent with both an advection-diffusion equation and a commonly used energetics-based formula for local transport) produces erosion under rip currents, and a positive morphodynamic feedback.

OS52E-10 1615h

Quantification of Surf Zone Bathymetry from Video Observations of Wave Breaking

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Cost-efficient methods to quantify surf zone bathymetry with high resolution in time and space would be of great value for coastal research and management. Automated video techniques provide the potential to do so. Time-averaged video observations of the nearshore zone show bright intensities at locations where waves preferentially break. Highly similar patterns are found from model simulations of depth-induced wave breaking, which show increasing rates of wave dissipation in shallow areas like sand bars. Thus, video observations of wave breaking - at least qualitatively - reflect sub-merged beach bathymetry.

In search of the quantification of this relationship, we present a new model concept to map sub-merged beach bathymetry from time-averaged video images. This is achieved by matching model-predicted and video-observed rates of wave dissipation.

First, time-averaged image intensities are sampled along a cross-shore array and interpreted in terms of a wave dissipation parameter. This involves a correction for the effect of persistent foam, which is visible at time-averaged video images but not predicted by common wave propagation models. The dissipation profiles thus obtained are used to update an initial beach bathymetry through optimisation of the match between measured and modelled rates of wave dissipation. The latter is done by raising the bottom elevation in areas where the measured dissipation rate exceeds the computed dissipation and vice versa. Since the model includes video data with high resolution in time (typically multiple images over a tidal cycle), it allows for virtually continous monitoring of surfzone bathymetry .

Model tests against a synthetic data set of artificially generated wave dissipation profiles have shown the models capability to accurately reconstruct beach bathymetry, over a wide range of morphological configurations. Maximum model deviations were found in the case of highly developed bar-trough systems (bar heights up to 4 m) and near the shoreline. Model performance strongly benefits from an increase of wave heights and tidal ranges.

At the moment, the model is subject to validation against a data set of multiple-barred beach profiles, surveyed during a 3 week period of stormy wheather in the course of the Coast3D field experiments at Egmond (The Netherlands). Although the video-based estimates of bar bathymetry show a shoreward off-set of the location of the inner bar and vertical deviations of 0.5 (0.8) m near the outer (inner) bar crest, these preliminary results show a promising match in terms of profile shape and the migration of the seaward bar face. Model application at the time scale of months to years is subject to present research.

This work was supported by the DIOC Earth Observations of Delft University of Technology, the Delft Cluster program at Delft Hydraulics, the Dutch Ministry of Public Works Rijkswaterstaaat and the EU-funded Coastview project.

OS52E-11 1630h

Model Parameterization and Experimental Design Issues in Nearshore Bathymetry Inversion

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We present a general method for approaching inverse problems for bathymetric determination under shoaling waves. We run the Korteweg-de Vries (KdV) model for various bathymetric representations while collecting data in the form of free-surface imagery and time-series. A sensitivity matrix is developed that provides information on the range of influence of data on the parameter space. We develop three metrics based on the model sensitivity that can be systematically used to make choices in experiment design and model parameterization. This analysis provides insights that are useful, irrespective of the minimization scheme chosen for inversion. We identify the characteristics of the data (time-series versus snapshots, early time measurements versus long-duration measurements, nearshore measurements versus offshore measurements) and model (bathymetry parameterizations) for inversion to be possible.

We show that *Bruun/Dean* and *Exponential* bathymetric parameterizations are the most conducive for inversion for both timeseries and snapshot data. Also, snapshots that are late in time and time series that are collected close to the shore are ideally suited for bathymetric inversion.

OS52E-12 1645h

Remote Sensing of Radiation Stress Gradients From Optical Imagery

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Radiation stress, the excess momentum due to the presence of waves, is a function of wave energy. Thus, as waves break in the surf zone, gradients in radiation stress are created with this excess momentum providing a force that is typically of order 10^2 dynes/cm^2, several orders of magnitude greater than wind forcing. These gradients drive all nearshore currents and subsequent sediment transport. Currently, there is no method for direct measurement of radiation stress gradients; all estimations are based on simple differences between pairs of spatially separated sensors. In addition, in-situ sampling is difficult in the hostile environment of the nearshore surf zone. On the other hand, the distinct optical signature of wave breaking has lead to interest in a possible remote sensing technique for direct estimation of radiation stress gradients.

For a beach with plane parallel contours, it can easily be shown that the diagonal element of the radiation stress gradient can be given by:

$$\frac{\partial S_{xy}}{\partial x} = <\epsilon> \frac{\sin\alpha}{c},$$

where $<\epsilon>$ is the dissipation of the wave field due to breaking, $\sin\alpha$ is the local angle of incidence, and c is the wave celerity. Remote optical measurements of wave direction (Lippmann & Holman, 1991) and wave phase speed (Stockdon & Holman, 2000) have already been shown to be viable techniques. In addition, Lippmann and Holman (1989) and others have suggested a relationship between modeled wave dissipation and patterns of image intensity from ten-minute time-exposure images. However, no comparisons were made in that work with actual in-situ energy flux measurements. Our current work will focus on better development and testing of this relationship, based on in-situ wave energy measurements collected during the 1997 Sandy Duck field experiment. Emphasis will be on a direct comparison of dissipation measurements computed by finite difference from adjacent sensors and the spatial mean optical intensity between the sensors.

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OS52F MCC: 274 Friday 1330h

Coastal Geology of the Carolinas: Linking the Shelf and Shore I *(joint with T)*

Presiding: **E R Thieler,** U.S. Geological Survey**; D J Mallinson,** East Carolina University

OS52F-01 1330h INVITED

The North Carolina Coastal Geology Cooperativea Model of Federal, State, and Academic Cooperation

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In June 1999, The U.S. and N.C. Geological Surveys hosted a meeting of coastal geologists and engineers to identify coastal geological issues of greatest importance to North Carolina and to explore the possibility of initiating a cooperative research program to address these issues. Several factors came together to allow a coordinated program to develop: keen state interest in coastal hazards following several significant hurricanes, interest on the part of the USGS in combining work in North Carolina with a similar program in South Carolina, and recognition of the strong knowledge base that existed within the coastal scientific community in N.C.

The meeting resulted in a strong consensus for comprehensive study of the entire coastal system and for initiating work in the northern coastal region (the Quaternary section east of the Suffolk Scarp, focusing on the barrier-island and estuarine system). Among the most important issues to be addressed by the data and knowledge developed from this program are: coastal and estuarine shoreline erosion (controls on erosion rates, sediment transport, response of wetlands to sea level rise); sand resources (location, quality, and quantity of offshore, estuarine, or onshore sand); storm impacts (barrier island/inlet migration, estuarine water movement, relative stability of barrier island segments); sea level change (history and potential impacts); water resources (surface and groundwater); habitat (ability to sustain uses, trends, threats).

The cooperative will provide a strong science foundation for management of the N.C. coastal zone. Endorsements, support, and cooperation have come from the N.C. Coastal Resources Commission, several state and federal resource agencies, and local government units who all have an interest in information the program is producing. Supplemental federal appropriations have resulted from such support and the National Park Service has provided partnership funding. Additional partnership opportunities exist and are being pursued with the Army Corps of Engineers (two feasibility studies are active in the project area), the N.C. Outer Banks Task Force, and U.S. Minerals Management Service.

OS52F-02 1345h INVITED

Transgressive Shoreface Architecture Within a Sediment Starved Arcuate Strand: Long Bay, South Carolina

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A regional geophysical mapping survey of Long Bay provides a comprehensive image of sea-floor character, bathymetry and shallow subbottom stratigraphy within the shoreface and across the inner shelf along 90 kilometers of the northern South Carolina coast. Chirp subbottom profiles, sidescan-sonar imagery and interferometric swath-bathymetry imaged the shallow stratigraphy and the geometry of the Holocene transgressive surface developing within the modern shoreface.

Along a 20 km section of central Long Bay, across the shoreface and inner shelf, centered on Myrtle Beach, SC, oceanographic processes are actively eroding older Tertiary- and Cretaceous-age strata exposed at the sea floor. Long beach profiles are interrupted by these outcrops and deviate substantially from typical concave-up geometries. The modern (mobile) sediment lens is restricted to the surf zone.

Along an adjacent area, near North Myrtle Beach, the Holocene erosional unconformity surface continues to exhibit an irregular character eroding into older Cretaceous-age deposits. Within the shoreface, however, a relatively continuous cover of modern mobile sand covers the upper- to mid-shoreface. Cretaceous-age strata crop out across the inner shelf and locally within the lower shoreface. Beach profiles are relatively smooth and linear across the mid-shoreface and become disrupted by strata cropping out near the base of the shoreface and inner shelf.

Further north, near the North Carolina border, three planar marine unconformities are visible underlying the shoreface and inner shelf and define seaward thinning wedges of Quaternary deposits. Beach profiles in this area exhibit a low slope and generally define a concave-up low slope profile geometry. The modern mobile sediment lens is more continuous in this area and the Holocene erosional surface can be observed to have eroded previous highstand deposits.

The detailed resolution of the chirp subbottom data allows the geometry of the developing marine unconformity surface within the shoreface and overlying mobile sediment lens to be resolved along a broad reach of the coast. Numerous erosional and burial events integrate to form an irregular erosional surface within the shoreface. The net result of erosion within the shoreface is the relatively planar marine transgressive unconformity found on the inner shelf. Substantial variation in the continuity and thickness of the mobile modern sediment lens and geometry of the erosional surface developing within the shoreface exists along the coast. This exerts a strong influence on the geometry and degree of variability in elevation and shape of profiles along the coast.

OS52F-03 1400h

Habitat Distribution on the Inner Continental Shelf of Northern South Carolina Based on Sidescan Sonar and Submarine Video Data

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Assessment of the extent and variability of benthic habitats is an important mission of biologists and marine scientists, and has supreme relevance in monitoring and maintaining the offshore resources of coastal nations. Mapping hard bottoms, in particular, is of critical importance because these are the areas that support sessile benthic habitats and associated fisheries. To quantify the extent and distribution of habitats offshore northern South Carolina, we used a spatially quantitative approach that involved textural analysis of side scan sonar images and training of an artificial neural network classifier. This approach was applied to a 2 m-pixel image mosaic of sonar data collected by the USGS in 1999 and 2000. The entire mosaic covered some 686 km^2 and extended between the ∼6 m and ∼10+ m isobaths off the Grand Strand region of South Carolina. Bottom video transects across selected sites provided 2,119 point observations which were used for image-to-ground control as well as training of the neural network classifier. A sensitivity study of 52 space-domain textural features indicated that 12 of them provided reasonable discriminating power between two end-member bottom types: hard bottom and sand. The selected features were calculated over 5 by 5 pixel windows of the image where video point observations existed. These feature vectors were then fed to a 3-layer neural network classifier, trained with a Levenberg-Marquardt backpropagation algorithm. Registration and display of the output habitat map were performed in GIS.

Results of our classification indicate that outcropping Tertiary and Cretaceous strata are exposed over a significant portion of northern South Carolinas inner shelf, consistent with a sediment-starved margin type. The combined surface extent classified as hard bottom was 405 km^2 or 59 % of the imaged area-, while only 281 km^2 or 41 % of the area were classified as sand. In addition, our results provided constraints on the spatial continuity of nearshore benthic habitats. The median surface area of the regions classified as hard bottom (n= 190,521) and sand (n= 234,946) were both equal to the output cell size (100 m^2), confirming the patchy nature of these habitats and suggesting that these medians probably represent upper bounds rather than estimates of the typical extent of individual patches. Furthermore, comparison of the interpretive habitat map with available swath bathymetry data suggests positive correlation between bathymetry highs and the major sandy-bottom areas interpreted with our routine. In contrast, the location of hard bottom areas does not appear to be significantly correlated with major bathymetric features. Our findings are in agreement with published qualitative estimates of hard bottom areas on neighboring North Carolinas inner shelf.

OS52F-04 1415h INVITED

Role of Geologic Framework, Paleotopography, Sediment Supply, and Human Modification in the Evolutionary Development of the Northeastern North Carolina Barrier Island System

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The NE North Carolina coastal system contains an exceptionally thick and well preserved Quaternary stratigraphic record that is the focus of a five-year Cooperative Coastal Geology Program between the USGS, several academic institutions, and state agencies. The major goal is to map this Quaternary section on the inner continental shelf, Outer Banks barrier islands, Albemarle-Pamlico estuarine system, and adjacent land areas. The program objectives are to define the geologic framework, develop the detailed evolutionary history, and understand the ongoing process dynamics driving this large, complex, and rapidly changing, high-energy coastal system.

Preliminary data synthesis demonstrates that the major controls dictating the present health and future evolution of this coastal system include the following. 1) The regional late Pleistocene morphology constitutes the underlying geologic framework that the Holocene system has inherited. 2) The controlling paleotopography is a series of lowstand drainage basins consisting of trunk and tributary streams and associated interstream divides that are being drowned. 3) Three major sediment sources dictate the highly variable sand resources available to specific barrier segments and include riverine channel and deltaic deposits associated with lowstand trunk streams, the large cross-shelf cape shoal sand deposits, and sand-rich units occurring within the adjacent shoreface and inner-self strata. 4) Wherever large sand supplies have historically been available, the barrier segments occur as complex islands with large sand volumes producing high and wide barriers, whereas barrier segments without adequate sand supplies are sediment starved and occur as simple overwash barriers. 5) Human modification of the barrier islands over the past seven decades represents a major force that has significantly changed the barrier island dynamics and evolution. 6) The Albemarle Embayment appears to have a slightly higher rate of sea-level rise than adjacent regions due to a slow rate of regional subsidence.

Consequently, if the ongoing pattern of storm activity and sea-level rise either continues or increases during the next few decades to centuries, several simple overwash barrier segments on the Outer Banks, that are currently disintegrating, will ultimately collapse into Pamlico Sound. These barrier segments will likely back-step across the open marine Pamlico Embayment and reform on the landward side. A few sand-rich complex barrier segments will persist as isolated, but perched and eroding islands for some longer period of time. In contrast, simple overwash barrier segments that have received minimal human modification and are associated with narrow and shallow back-barrier sounds, appear to be maintaining themselves in their upward and landward migration in response to ongoing storms and sea-level rise.

OS52F-05 1430h

Neogene Seismic Stratigraphic Framework and Fill History of the Northeastern Albemarle Embayment, North Carolina

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Seismic and chirp sonar surveys were conducted in the eastern Albemarle Sound and adjacent tributaries and the inner continental shelf to define the geologic framework and evolution of the North Carolina coastal system. Surveys were utilized to target paleofluvial channels for drilling and core recovery for the assessment of sea level and climate change during the Quaternary. Lithostratigraphic and chronostratigraphic data are derived from eight drill sites on the Outer Banks, and the Mobil #1 well in the eastern Albemarle Sound. Within the study area, parallel-bedded, gently dipping Miocene beds occur at 100 to >180 mbsl, and are overlain by a southward-thickening Pliocene unit characterized by steeply inclined southward-prograding beds. The Quaternary section unconformably overlies the Pliocene unit, and consists of at least five depositional sequences exhibiting numerous incised channel-fill facies. The Quaternary section is 55 to 60 meters thick. Shallow stratigraphy (0-50 mbsl) is dominated by complex fill-stratigraphy within the incised paleo-Roanoke River valley. Radiocarbon and amino acid racemization (AAR) dates indicate that the valley-fill is late Pleistocene to Holocene in age. At least 6 distinct valley-fill units are identified in the seismic data based upon reflection geometry. Cores reveal a 3 to 6 meter thick basal fluvial channel lag that is overlain by a 15-meter thick unit of interbedded freshwater muds and sands. Organic materials within the freshwater deposits have ages of 13-11 cal. ka, and are overlain by several units comprised of shallow marine sediments. Shallow marine sediments within the valley are silty, fine- to medium-grained sands containing abundant neritic forams, suggesting that this area was an open embayment during much of the Holocene. Seismic data reveal that initial infilling occurred from the north and west during the late Pleistocene and early Holocene. Later infilling occurred from the east and is characterized by a large shoal body (Colington Island and Shoals; radiocarbon dated to 8.6 cal. ka) and adjacent inlet fill. Establishment of a continuous barrier island system resulted in the deposition of a final phase of fill characterized by estuarine organic-rich muds.

URL: http://core.ecu.edu/geology/RIGGS/ECU_USGS/Chirp.html

OS52F-06 1445h

A Preliminary Evaluation of ohe Sediment Dynamics in the Albemarle Estuarine System, North Carolina

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The Albemarle estuarine system (AES) drainage basin covers an area of approximately 45,500 km^2 within Virginia and North Carolina, and is comprised of the Roanoke River Basin, Chowan River Basin, and Albemarle Sound Basin. The AES, a product of rising sea level (eg. drowned-river estuarine system), covers approximately 2,340 km^2 and includes several major and minor embayed (lateral) tributaries. As earlier studies have pointed out, the estuarine system is the settling basin for sediments, organic matter, and anthropogenic waste from these three major drainage basins. The most abundant sediment within the AES, forming the benthic habitat for nearly 70% of the estuarine system, is a chemically active organic-rich mud (ORM). This sediment type has been shown to be important to the water quality, contaminant characteristics, and potentially the ecosystem dynamics.

During the summer of 2001, several short cores (~ 50 cm) were collected in the AES, and downcore measurements for radiochemical tracers (^{210}Pb, ^{137}Cs) and organic matter signatures (^{13}C, ^{15}N, C:N, LOI) were conducted. These organic matter signatures have been used to elucidate potential temporal changes in fluxes and cycles of organic matter in the AES. Pb-210 analyses indicate temporal and spatial variations in sediment deposition rates (0.05 - 0.50 cm/yr). Sedimentation rate variations are potentially associated with dam construction on the Roanoke River and increased estuarine shoreline erosion along many banks of the Albemarle Sound. Sediment deposition varies spatially in the AES and is highest near its western limit relative to the rest of the estuary. δ^{13}C and δ ^{15}N concentrations from cores collected in the AES range from -21.7 to -28.3 $^{o}/_{oo}$ and 0.4 to 4.6 $^{o}/_{oo}$, respectively. The variation signatures indicate typical mixing between terrestrial and marine end members, as well as potential influences associated with increased agriculture over the last century.

OS52F-07 1530h

A Decade of Research at the Cape Lookout Cuspate Foreland: New Insights Into Longshore Transport, Shoal Evolution, Spit Growth and the Regional Sediment Budget

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The Cape Lookout cuspate foreland is one of the most prominent features on the North Carolina coast. Composed of two barrier island limbs joined at right angles, a 16-km long shoal complex and a spit that progrades an average of 37 m/yr, the cuspate foreland sequesters an enormous amount of sediment derived from adjacent barrier islands and possibly from the shelf. A program of research was initiated in the Cape Lookout region in the early 1990s to provide insight into the processes of headland-generated eddies and cross-shore transport on the shoal and, in the late 1990s, to examine wave-driven littoral processes and their role in spit growth and the regional sediment budget. Cape Lookout provides an excellent field laboratory because, as a National Seashore, it is largely unaltered by human impacts. Aerial photographs were used to depict the history of change over the past 60 years. Bathymetric surveys, instrument deployments, sediment sampling, and numerical modeling were undertaken at time scales sufficient to capture process-response relationships ranging from tidal to annual, and at spatial scales sufficient to gain a fundamental understanding of how the various environments of the cuspate foreland are linked as a sedimentary system. Results indicate that the shoal, which contains approximately 3.5 billion cubic meters of sediment, gains an additional 510-590,000 cubic meters of sand supplied from the littoral system of Core Banks each year, and provides significant protection to downdrift regions of the Cape Lookout littoral cell by interfering with shoreward propagation of waves. Measurements show that near-bottom oscillatory and mean currents, observed under a wide range of environmental conditions, result in gross sediment transport that is greatest in the across-shoal direction, and net sediment transport that is greatest in the along-shoal, seaward direction. Wind events, either from the SW or NE, enhance the seaward flow down the axis, increasing the magnitude of mean flow by 2-3 times. REF/DIF model output indicates that, under certain conditions, sediment can be transported north and released from the shoal to the west side of the system, thereby supplying the downdrift spit which accumulates approximately 200,000 cubic meters of sediment per year. Modeling also suggests that Cape Lookout point can be a sensitive morphologic indicator of longshore transport direction, extending and contracting in relation to wind events. The long-held, but largely unsubstantiated, assumption that littoral cells necessarily converge at the apex of a cuspate foreland clearly does not apply at Cape Lookout. Sediment that escapes the shoal and supplies the spit provides a textbook example of how spits prograde and widen through swash bar attachment, leaving a well-defined record of dune ridges that mark former shoreline positions.

OS52F-08 1545h

Linking Geologic Framework to Nearshore Processes and Shoreline Change: Results from the Outer Banks of North Carolina

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Within the coastal geology community, a consensus appears to have developed that the geologic framework of the inner-shelf plays an important role in shoreline change. It has yet to be determined, however, whether geology exerts a first-order control on shoreline dynamics and, if so, across what time and spatial scales. Furthermore, principal mechanisms that may link underlying geology and shoreline behavior remain poorly understood and untested. To this end, an extensive survey of the seafloor surface and shallow sub-bottom utilizing an interferometric swath bathymetry sonar system and a chirp sub-bottom profiler mounted on an amphibious vessel was conducted across the surf zone of the Outer Banks of North Carolina.

Recent findings from a small region near Duck, North Carolina suggest a connection between partial exposure of pre-modern, non-sandy substrates in the surf zone and bar morphodynamics leading to the repeated occurrence of shoreline hotspots. Support from the US Geological Survey, US Army Corps of Engineers, and the Army Research Office has expanded this work to include a 40 km length of surf zone extending from Duck to Nags Head, North Carolina. Preliminary results from the larger survey are consistent with earlier findings at Duck which show: 1) an underlying ravinement surface with very irregular relief across the surf zone; 2) a thin cover of modern sand, ranging from 0 to a maximum of 2.5 m thick, with a surface morphology that does not necessarily mirror the underlying topography; 3) the presence of large transverse bars located beside exposures of non-sandy substrate; and 4) a spatial correlation between hotspots and regions with exposed non-sandy substrates and transverse bars in the surf zone.

Future work will examine shoreline behavior and bar morphodynamics associated with the geologic framework of the nearshore over event and seasonal time scales. These observations will be designed to provide insight into the processes responsible for hotspot formation and to identify key geologic variables that could be incorporated into, and ultimately, improve shoreline evolution models.

OS52F-09 1600h

Are There Connections Between Erosional Hot Spots and Alongshore Sediment Transport Along the North Carolina Outer Banks?

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Recent, high-definition measurements taken along the northern North Carolina Outer Banks reveal that the shoreline moves in a surprisingly alongshore-heterogeneous way over time scales ranging from storms to decades. SWASH is a shoreline measuring system developed by the USGS that utilizes Global Positioning System measurements to determine the location of the shoreline (List and Farris, Coastal Sediments, 1999). Surveys taken before and after storms, as well as at monthly intervals, have documented zones of accentuated erosion or deposition, or hot spots. We classify hot spots into three general categories: 1) Short-term Reversible Hot Spots, consisting of alongshore nonuniform patterns of storm erosion that are erased during post-storm accretion; 2) Medium-term Hotspots, occurring over hundreds of meters and persisting for months while often shifting in the alongshore direction; and 3) Long-term Hotspots, which can be couplets of shoreline erosion and accretion occurring over decadal time scales.

Recent research (Ashton, et al., Nature, 2001) has indicated that when waves approach at an angle greater than the one that maximizes alongshore sediment transport (approximately 45 degrees in deep water, which we call high-angle waves), any plan view perturbations on a nearly straight coastline will grow. This growth involves erosion in seaward-concave shoreline segments and accretion in convex areas. (Similarly, low-angle waves produce accretion where the shoreline is concave, and vice versa.) Simple numerical simulations using wave distributions weighted towards high angle waves show shoreline features that migrate in the direction of net sediment transport.

Hot spots are likely to be influenced by many factors, including variations in shoreface lithology, offshore bathymetry that concentrates wave energy, the configuration of alongshore bars, and variations in cross-shore sediment transport. However, evidence that hotspots migrate, occur in different locations at different times, and can range across many scales suggests that they may be partly related to variations in alongshore sediment transport due to changes in shoreline

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orientation. If alongshore transport is related to hot spot behavior, shoreline curvature will correlate with shoreline change. Preliminary analyses of field measurements indicate a surprisingly high correlation between shoreline curvature and the local rate of shoreline change.

Simplified numerical simulations reveal information about what combinations of shoreline orientation, wave climate, and shoreline perturbations will produce migrating zones of erosion and accretion over the monthly to annual time scales of medium-term hot spots. For long-term (decadal) hot spots, we have performed numerical simulations based on the measured northern Outer Banks shoreline and wave climates. The goal is not to quantitatively predict rates of shoreline change, but to compare model predictions of general regions of long-term erosion and accretion to the observations. Initial tests of these predictions are encouraging.

The dominantly low-angle wave climate of the northern Outer Banks should result in long-term coastline smoothing. This shoreline contains subtle undulations occurring over many scales, verifying that controls or processes other than gradients in alongshore sediment flux affect coastline shape. However, we have preliminarily identified links between erosional hot spots and alongshore sediment transport.

OS52F-10 1615h

Hindcasting Storm-Induced Erosional Hazards for the Outer Banks, NC.

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The spatial variability of dune response along a section of the NC Outer Banks has been examined for the 1999 Hurricane Dennis. Dennis generated some of the largest wave heights recorded in the past 20 years along the Outer Banks of North Carolina, reaching 6.3 meters (measured at the U.S. Army Corps of Engineers Field Research Facility at Duck, North Carolina). Pre and post-storm topography was measured as part of a joint USGS-NASA program using lidar technology. These data were used to calculate changes in the elevation and location of the dune crest and dune base (Dhi and Dlo). Roughly 66% of the region from Cape Hatteras to Ocracoke Inlet experienced some dune erosion. The spatial variability in dune response is compared to hindcast erosion hazard predictions. Observations of maximum wave conditions are used as input to SWAN, a 3rd generation and shoaling wave model, output from which is used to drive empirical relationships for wave runup. Estimates of hazard potential are derived from Sallengers recently proposed storm impact scale. The hindcast hazard potentials are then compared to direct observations.

OS52F-11 1630h

Wind-Driven Flow and the Maintenance of a Rippled Scour Depression: Wrightsville Beach, North Carolina, USA.

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Current observations across the inner-shelf of North Carolina are used to assess sediment transport potential and the physical mechanisms responsible for the maintenance of large subtle bedforms identified in high-resolution seafloor mapping studies of the geological framework at this setting. Analysis of the recorded data shows that tidal flows account for a small percentage (less than 15 percent) of the current variability such that wind driven flows dominate current patterns. Observations at the inshore site located in 10 m of water within 0.8 km of the coastline illustrate that currents closer to shore are more often aligned in the alongshore direction compared to the measurements acquired farther offshore. Near-bed measurements 2.5 km offshore in 13 meters of water show that the flows are more often directed in the alongshore direction to the southwest, yet flows causing the highest shear velocities are directed mostly in the cross-shore direction. These instances of increased shear velocities exclusively coincide with wind events driving coastal upwelling. The majority of elevated horizontal wave orbital velocities also occur mainly during upwelling episodes. Comparison of 33-hour low pass filtered observations from the two current meters over a 45-day period show that the inshore station varies with the wind while the current at the offshore measurement location takes between 22-31 hours to reflect the wind forcing. Although there is an overall alongshore-current alignment, wind-driven upwelling contributes significantly to the sediment transport events indicated by the offshore current sensor. These findings contradict earlier hypotheses that suggested that these features could be the result of storm-induced set-up and associated down-welling. This illustrates the importance of wind driven flows in controlling the maintenance of the large bedforms noted offshore of Wrighsville Beach on the inner-shelf of Onslow Bay, NC.

OS52F-12 1645h

Physical Processes and Sediment Transport in Onslow Bay, NC

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As part of the Coastal Ocean Research and Monitoring Program (CORMP) at the University of North Carolina at Wilmington, a quadrapod frame with a downward looking Pulse-Coherent Acoustic Doppler Profiler (PC-ADP), two optical backscatter sensors (OBS), and an upward looking Acoustic Doppler Current Profiler (ADCP) has been maintained on the continental shelf at approximately 30 m depth since May of 2000. The instruments are moored 27 nautical miles off the coast of Wilmington, NC in Onslow Bay (33° 59'N, 77° 21'W) adjacent to a productive marine hardbottom. Simultaneous measurements of flow velocities from the surface to the seabed, along with turbidity measurements at 30 and 80 cm above the seabed, have been obtained over the past two years. Measurements of seabed elevation, temperature, conductivity, and pressure were also collected at the site. Critical bed shear stresses were calculated using the Grant-Madsen model (1994) and compared with bed stresses from measured waves and currents to evaluate sediment transport. The objective of this study is to identify and quantify the magnitude, frequency, and duration of physical forcing mechanisms resulting in significant sediment mobility on the continental shelf from May to December, 2000. During the study period, 3 small noreaster storms were observed. Sediment mobilization was initialized during these small storm events when wave orbital velocities of 25-30 cm s-1 and mean currents of 15-20 cm s-1 were reached. Usually, these events resulted in net erosion at the site on the order of 2-3 cm. Significant sediment transport also occurred during fair weather when southwesterly winds of 15-25 knots were sustained for 3 or more days. Two of these type events were identified during the study period where currents exceeded 20 cm s-1 and interacted with longer period waves from the south resulting in sediment transport and net accretion of up to 3 cm at the site. Extensive sheets of fine-grained sands exist to the southwest of the study site and it is likely that these materials are being mobilized by southwesterly flows to result in the accretion patterns observed during this study.

OS61A MCC: Hall D Saturday 0830h

Nearshore Processes II Posters *(joint with T)*

Presiding: **N Plant,** Naval Research Laboratory**; A Reniers,** Naval Postgraduate School

OS61A-0181 0830h POSTER

Site Survey of the Martha's Vineyard Coastal Observatory: Backscatter, Grain Size and Temporal Evolution of Rippled Scour Depressions

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The Office of Naval Researchs Mine Burial Prediction program has chosen the Marthas Vineyard Coastal Observatory (MVCO) as a natural laboratory for experimental observations of object burial by nearshore processes (e.g., bedform migration, scour). In support of this program, the MVCO has been subject to an intensive site survey program, involving, since early 2001: (1) three swath backscatter and/or bathymetry surveys; (2) three high resolution seismic surveys; (3) ultra-high resolution sector-scanning sonar on pole mounts; (4) in situ geotechnical (velocity and resistivity) measurements, (5) grab sampling, and (6) vibracoring. These efforts are concentrated in water depths between ∼8 and 18 m, centered on the site of the MVCO permanent node at ∼12 m water depth

Rippled scour depressions (RSDs) are pervasive within the MVCO. RSDs are ∼shore-perpendicular bands of coarse sands separated by overlying fine sands. The term itself implies that the coarse sands are heavily rippled (∼0.5-1 m wavelength, ∼0.1 m amplitude) and slightly depressed relative to the fine sands which, in the MVCO, are generally just a few 10s of cm thick. The RSDs are clearly evident on sidescan data as bands of high backscatter. For the most part, grain size measurements confirm a strong positive correspondence between mean grain size and backscatter intensity. However, a critical exception is seen in deeper water where, well within the area of fine sands, backscatter increases noticeably as mean grain size decreases from ∼150μ to ∼130μ. Topographic expression related to the RSDs is confined primarily to evident scour depressions at the edges. The RSDs are highly asymmetric: backscatter is higher, the coarse/fine transition is more sharply defined, and the scour depression is deeper on one side than the other. This pattern changes within the survey: the higher backscatter edge is always to the west in the western part of the survey, and vice versa to the east. The strike of the RSDs also changes, from being slightly east of north in the western part of the survey to slightly west of north to the east.

The MVCO site survey work establishes a baseline set of observations against which physical changes in the seafloor with time can be measured. Early evidence of significant change has been provided by comparison of the first two sidescan surveys, which indicates a shift in the RSD boundaries by as much as 50 m between February and September of 2001. Continued seafloor evolution is evidenced by the August 2002 grab sampling and sector scanning sonar. This dynamic setting will continue to be monitored by additional swath mapping and sampling in conjunction with the planned winter 2003/2004 mine burial experiment.

URL: http://www.mbp.unh.edu/

OS61A-0182 0830h POSTER

In Situ Measurement of Sediment Properties and Relationship to Backscatter: An Example From the ONR Mine Burial Program, Martha's Vineyard Coastal Observatory

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In support of the Office of Naval Researchs Mine Burial Program (MBP), in situ acoustic and resistivity measurements were obtained using ISSAP (In situ