Regional Directional Waves/Sediment Transport Applications
The role of SEACOOS for the SE U.S.

Summary White Paper from the SEACOOS Spring Meeting (July 2005, Jacksonville FL) by G. Voulgaris

PREFACE

In January 2005, a small group of people interested in further development of wave measurement and forecasting capabilities for the SE United States met in Columbia, SC. A summary of that meeting is presented in Appendix A. Subsequently, during the SEACOOS meeting in Jacksonville, FL (July 2005) extensive discussions on the role of SEACOOS on Regional Directional Waves and Sediment Transport Applications took place. Prior to the meeting a document was prepared to facilitate the discussions in the meeting. This document (see Appendix B), prepared by G. Voulgaris and R. Jensen, was presented to the meeting participants at the Team Introduction and was extensively discussed during the Breakout Sessions. The minutes from Jacksonville meeting are presented in Appendix C. A summary of the most important outcomes of the meeting is presented below as two sections: (i) Background and (ii) the Role of SEACOOS.

BACKGROUND

Coastal erosion or accretion results from gradients in sediment transport rates. The morphological evolution of the coastal zone in response to short-lived but intense forcing (e.g., hurricanes, winter storms) and long-term (climatological) changes depends on sediment transport rates and direction, which are controlled by waves and currents. Sediment transport along the coastline is predominantly driven by longshore currents, which depend on the directional characteristics of the waves in the nearshore. Inner and mid-shelf transport is controlled by wave-current interaction and bed micro-morphology (bedforms). The latter depends on wave conditions. In addition to sediment transport, wave and current interactions with bedforms has implications for biogeochemical exchanges between the sediment bed and the water column, and thus potentially significant implications for ecosystem modeling. Furthermore, there are important societal and economic implications for improved monitoring and prediction of waves and nearshore circulation including the areas of coastal erosion/beach renourishment and forecasting of hazardous rip currents.

To date, a number of measurement techniques have been developed that can provide directional wave information as part of real-time monitoring systems. These are classified as in-situ point measurements (e.g., surface buoys, PUV systems, pressure arrays, ADCPs) and remote, spatial measurements (e.g., HF-Radar systems and X-band Radar systems). In addition, a number of numerical models have been developed that are used to simulate wave propagation and nearshore circulation. The integration of wave and circulation models with sediment transport modules have also advanced and recent efforts (e.g., NOPP, USGS) have started to generate models that integrate shelf and nearshore processes.

Given the importance of wave-driven processes in a variety of areas of societal importance, a number of federal, state, academic and private organizations have been engaged in measuring and/or predicting waves. The NOAA/National Data Buoy Center (NDBC) operates a number or stations that provide regional and offshore wave information. The NOAA National Centers for Environmental Prediction (NCEP) is charged with providing operational forecasts of wind and wave information. The US Army Corps of Engineers (USACE) is supporting wave data collection and data management activities that are pertinent to its mission. The US Navy Naval Research Laboratory (NRL) has been engaged in wave research for some time and forecasts wave information for navy operations (FNMOC, NAVOCEANO). The response of the coastline to wave

forcing has been monitored by a number of federal (e.g., US Geological Survey, LIDAR mapping and numerical modeling) and state (e.g., local coastal zone management offices) agencies. A broad sector of academia (including coastal engineers, oceanographers, and geologists) has been involved in the study of the effect of waves on the seabed and the coastline, while the local district offices of the USACE, along with various private consultants and companies, are routinely working on the mitigation of coastal erosion problems. The success of these mitigation efforts depends on accurate wave climatologies.

In summary, wave measurements and predictions are important links between offshore atmospheric / oceanic conditions and the nearshore. Waves impact a wide variety of coastal users ranging from recreational users (including surfers, beachgoers, sailors and boaters), to state and local municipalities (concerned issues such as coastal erosion and beach safety) to federal agencies (with responsibilities including safe navigation, fisheries management, and search and rescue).

THE ROLE OF SEACOOS

Although wave measurement and modeling has advanced considerably, the integration with sediment transport and coastal morphological evolution is still experimental. The latter requires more advanced models, along with a higher spatial resolution of the wave forcing, as dictated by the local shelf and coastline morphology. Given the current activities by federal organizations in wave forecast area at large (oceanic) scales, it appears timely, and complementary, to develop regional capabilities for accurate wave measurements and forecasts at the temporal and spatial resolution required to address coastline evolution and prediction of wave-related nearshore hazards.

Thus one of the long-term objectives for the SE USA is: *to establish a high resolution wave and sediment transport forecasting capabilities for the SE USA that address important societal needs, including the areas of coastal erosion and beach safety.*

SEACOOS is well positioned to contribute to this regional goal by providing a foundation of expertise, initial systems and resources. These include:

(i) SEACOOS has already established and operates regional real-time directional wave data collection systems along the continental shelf, landward of the NDBC backbone, and at various coastal sites.

(ii) SEACOOS is capable of providing increased spatial resolution of wave measurements through operation and evaluation of remote HF- and X-Band radar systems.

(iii) SEACOOS has developed the data management infrastructure and expertise for access and integration of coastal surveys from federal / state agencies (e.g. LIDAR, Beach Monitoring Programs) and their integration in regional GIS. This can also facilitate the updating of the present water depth digital database as this is regulated by the coastline position.

(iv) SEACOOS can create test-beds for evaluating wave propagation models to be integrated in regional high-resolution forecasting systems.

The development of high-resolution nowcasting and forecasting systems for the nearshore requires a number of high-resolution wave transformation models. While these models can be maintained by regional or sub-regional associations, the boundary conditions need to be obtained by larger scale nowcasting / forecasting models operated by federal agencies (NDBC, NCEP). Reasonable resolution models can be developed and become operational by regional associations and the private sector, including SEACOOS partners and collaborators from federal and state affiliates. This organizational scheme needs to be flexible and inclusive in order to take

advantage of additional observational data and improved estimates of wind forcing as these become available.

The short-term goals for the surface wave / sediment transport application theme within SEACOOS are:

i. Selection of area(s) – test bed(s) in the SE coastal ocean that provide a range of wind, wave and circulation forcing, and varied bathymetry, for extensive measurements and evaluation of wave and sediment transport model(s) that may eventually serve for operational high-resolution regional forecasting.

ii. The development the procedure, protocol and technology for making these wave and sediment transport forecasting systems transferable to different areas throughout the SE.

Critical elements for the implementation of the short-term goals and the sustainability of the plan include:

(i) Identification of user community and information requirements.

(ii) Identification of assets for making directional wave measurements in the region and the present numerical modeling efforts (e.g., NWS JAX WFO wave forecast, Community Sediment Transport Model, USACE, MORPHO, etc).

(iii) Identification of regional – sub regional gaps in wave data collection programs, based on environmental forcing gradients.

(iv) Design and execute an evaluation program of existing wave measurement technologies and develop a standard procedure for QA/QC that makes wave data inter-operative.

(v) Evaluate the new, emerging land-based technologies for wave measurements (WERA, Microwave radars).

(vi) Develop a unifying data product through collaborative efforts with other organizations (e.g., CDIP).

(vii) Greater integration of the Wave Measurement, Modeling and Data Management efforts within SEACOOS, to create a cross-cutting and cohesive “Wave Group” to further the implementation of the waves initiative.

APPENDIX A

SEACOOS 1st Waves Meeting
University of South Carolina, Columbia, S.C.
January 26, 2005

Participants: George Voulgaris, University of South Carolina (Co-Chair)
Bob Jensen, USACE (Co-Chair)
Madilyn Fletcher, University of South Carolina
Brian K. Haus, University of Miami
Dan Kennedy, UNC Wilmington
Jeff Marshall, UNC Wilmington
Jim Nelson, SKIO
Stephanie Obley, University of South Carolina
Hector Perales, University of South Carolina
Harvey Seim, UNC Chapel Hill
Richard Styles, University of South Carolina
Chung-Chu Teng, NOAA/NWS/NDBC
Lauren Wetzell, USF

Executive Summary

A one-day meeting took place at the University of South Carolina, Columbia, SC to discuss the issue of Wave Measurements and Forecasting within the region of SEACOOS. Federal affiliate representatives from NOAA/NDBC and USACE ERDC/CHL were present. Also, the importance of NOAA/NWS as an additional affiliate with great interest in wave prediction was recognized but no representative was present at the meeting. From the local research groups, representatives from the University of South Florida, University of Miami, Skidaway Institute of Oceanography, University of South Carolina, University of North Carolina at Wilmington and University of North Carolina at Chapel Hill were present.

Having realized that surface wave parameters are very important quantities in issues of coastal erosion and navigational hazard, SEACOOS has initiated a program of wave measurements and is planning to proceed with a wave forecasting program. Prior to further developing these plans within the region, this meeting was a first attempt to review existing wave measurement and modeling efforts both at a national and regional (within the SEACOOS region) level in order to better plan future activities utilizing an approach that is cost effective, avoids duplication of efforts and leverages resources.

During the meeting, presentations were given that described the USACE ERDC/CHL activities in the area of wave measurements. USACE is very interested and supportive of any wave initiative for the east coast in general and southeast in particular, especially since the latter is an area frequently influenced by the development of tropical storms and hurricanes. The USACE / NDBC / Univ. of California CDIP collaboration was referred to as a productive collaborative effort that works well for the state of CA. Some of the ingredients that have made this a success are the support by the state of CA and by congressional representatives, as well as an appreciation of the importance of waves in controlling coastal erosion. The latter has been the result of long–term research in that part of the nation. It could be

summarized that the user groups in CA (including state and private citizens) have been instrumental in the success of that cooperation.

NOAA/NWS/NDBC is federally responsible for providing operational wave measurements and has set as immediate goals to convert non-directional buoys into directional wave sites. Also, the target is to include ocean currents and salinity measurements in existing locations. NDBC is maintaining existing sites and the agency's funding does not allow for additional sites to be developed. NDBC is capable and willing to add new sites when the funding is provided (e.g., through USACE or private industry). There is expertise in R&D in sensor development and data analysis and transmission within the NDBC and there is willingness for close collaboration. Already NDBC acts as a portal for wave and other data collected by regional associations to be displayed through the NDBC web portal.

The role of NOAA/NWS, although not present in the meeting, is important in a wave effort both in the area of wind and wave forecasting (through NCEP) but also as a user through the mandate for the WFOs to provide the public with forecasts of sea state, surf, and rip current conditions.

Local research associations within the SE US are already making wave measurements in various locations, in particular, in the nearshore (SC, NC, GA, FL.). Most stations further offshore are limited by data transmission as they are employing systems that generate data at a high rate. The development of in-situ processing units is promising in eliminating this problem.

Physical Process	Deep Ocean	Shelf Seas	Shoaling Zone	Harbors
Diffraction	Negligible	negligible	minor inportance	Dominant
Shoaling/Refraction	Negligible	significant	dominant	significant
Current Refraction	Negligible	minor inportance	significant	negligible
4-Wave Interaction	Dominant	dominant	minor inportance	negligible
Triad Interaction	Negligible	minor inportance	significant	minor inportance
Atmospheric Input	Dominant	dominant	minor inportance	negligible
White capping	Dominant	dominant	minor inportance	negligible
Depth Breaking	Negligible	minor inportance	dominant	negligible
Bottom Friction	Negligible	dominant	significant	negligible

Table 1. Relative Importance of Various Physical Mechanisms in Different Domains From Young, (1999)

In the area of numerical modeling, it was recognized that the state of CA has been the pioneer in wave forecasting especially in the area of swell waves. A number of numerical models (STWAVE, SWAN, WAM/WaveWatch III, REF-DIF(S), CREST, etc) exist and have been used by a variety of researchers. Some of them are more widely used than others and individual organizations and/or researchers have their favorite numerical models.

For example, in southern California REF-DIF is employed for predicting swell conditions, while in the Jacksonville, FL a local wave forecasting system was developed by NRL with funds from NWS (Coastal Storms Program). It was clear during the meeting that currently there is not a consensus on model use and protocol and that this is something that will need to be established

Wave Model	Equation Used	State	Mechanisms	Application
WaveWatch III	Action Balance	TD	Advection/Source Terms	Deep – Shelf
WAM CY 4.0	Action Balance	TD	Advection/Source Terms	Deep – Shelf
STWAVE	Spectral Wave	SS	Advection ~Source Terms	Shelf / Shoaling Zone
SWAN	Action Balance	TD/SS	Advection /Source Terms	Shelf / Shoaling Zone
REF-DIF	Mild Slope	TD/SS	Advection	Shelf / Shoaling Zone
CREST	Energy Balance	TD	Advection / Source Terms	Shelf / Shoaling Zone

Table 2. Wave Models (note: TD=Time Dependent, SS =Steady State)

Furthermore the wave forecasting issue is constrained by the required resolution that in turn is constrained by the user of the product. Although no explicit recommendations came out of the meeting the need for some organization and further action was established. These could be summarized as follows:

1) Wave measurements and predictions are important links between offshore atmospheric and oceanic conditions and the nearshore. Waves impact a wide variety of coastal users ranging from the recreational user (surfer, beachgoers, sailors and boaters), the local municipality (e.g., coastal erosion, beach safety) to the federal level (navigation, fisheries, search and rescue etc).
2) NOAA/NDBC has good experience in maintaining offshore sites for the measurement of waves and it might be the best suited organization for providing wave information that can facilitate data assimilation / verification of large scale domain operational numerical wave models
3) Nowcasting and forecasting of nearshore wave conditions requires increased resolution as dictated by the gradient in offshore wave and wind patterns and by bathymetry and coastline morphology. The high resolution creates the need for a number of high-resolution wave transformation models operating for particular areas. These models could be maintained and run by regional associations but obtain boundary conditions from the larger scale federal backbone model/measurements activities.
4) Based on the above, a straw man list of activities is recommended to be presented in the next SECOORA/SEACOOS meeting that addresses the following issues:

    a) NWS is responsible for measurements in the open ocean (deep water waves) and for integrating meteorological models to provide the large-scale wave forecast.
    b) The transformation of waves from the offshore (boundary conditions from (A)) to the mid-shelf at a reasonable resolution is carried out by specific modeling groups within the regional associations or the private sector. These groups can include SEACOOS partners and collaborators from the federal affiliates.
    c) Sub-regional associations run high-resolution models that obtain their boundary conditions from (b).

The above presented conceptual model for an operational wave forecasting system requires a very close collaboration amongst different entities and groups but also some preliminary R&D work that should be the goal for the next 5 years that should include:

I. Evaluate existing wave measurement technologies and determine whether wave parameters from different systems mean the same thing. Urge support of ongoing measurement programs and develop new ones in order to start building climatologies and wave prediction capability in a variety of areas that can be used later to evaluate model performance.
II. Assure all wave modelers and model users participation. This includes, NOAA/NCEP, US Navy/FNMOC and NAVOCEANO, NRL-SSC, USGS, and academia.
III. Develop a unifying data product capitalizing on the CDIP experience.

IV. Select two or three areas – test beds along the SE with different wind/wave forcing and different bathymetry to be used for extensive measurements and wave model evaluation. The results of such an exercise will be that a single or a suite of models might emerge as suitable for use in routine operational forecasting mode.

V. Develop the procedure, protocol and technology for making these wave- forecasting systems transferable to different areas throughout the SE with the ultimate goal (10 year plan) to have the whole SE covered.

VI. Assess and report on the wave inter-comparison study off of Miami and seek other opportunities such of this kind at next meeting.

APPENDIX B

Regional Directional Waves/Sediment Transport Applications

- **What are the coastal ocean/atmosphere information needs to support this application?**

Accurate sediment transport estimates are dependent on the accuracy of the hydrodynamics, whether these are directional wave spectra, wind, and wave or tide- driven currents, and the effects of changing water level (surge and tides). Point source measurements of directional wave spectra (surface buoys, bottom mounted pressure arrays, PUV's etc) and estimates derived from spatial covering HF (CODAR, WERA) and X-Band Radar systems provide input to sediment transport applications and would aid in estimating, the sediment budget. Furthermore, use of acoustic intensity routinely measured by various acoustic current meters can be used as proxies of sediment load in the water column. The hydrodynamics (waves, surge, and circulation) can also be estimated from a modeling effort, provided the methodology has been rigorously tested and verified. However, driving the hydrodynamics is the meteorology and accurate wind fields. This includes, meso- and very local scale weather patterns that influence waves, and circulation patterns. Certain 3-D atmospheric models (COAMPS, ETA, MM5, and WRF) have the potential of generating storm scenarios at spatial and temporal scales required to drive local conditions. For sediment transport at or near the sea floor, input requirements include benthic boundary layer dynamics, substrate geology (morphology), and particle type with related dynamics.

- **Which federal and state agencies and private sector entities play which roles?**

Regional and offshore directional waves are operated and maintained by NOAA's National Data Buoy Center, supported in part by the USACE, Engineer Research and Development Center's Coastal and Hydraulics Laboratory under a long-term collaborative effort. There is an expansion of the Coastal Data Information Program along the Atlantic coast, supported by the USACE, and the US Navy (Kings Bay, GA). NOAA's Coastal Storms Program has been instrumental in new pilot studies along the Florida coast and the Pacific Northwest. USGS is actively involved in the coastal zone, from LIDAR surveys (collaboration with USACE's SHOALS surveys) mapping pre- and post-tropical storm effects of shoreline erosion, the classification coastal areas and also through the development of sediment transport model (Community Sediment Transport model). The US Weather Prediction Centers, NOAA's NCEP and the Navy's FNMOC also NAVOEANO produce forecast information of winds, waves, physical attributes of the ocean water (SST) and large-scale circulation such as the Gulf Stream. State agencies also support geological surveys. The private sector, and academia support the broad scale of this problem from the generation of wind and wave fields (Oceanweather, Inc.) consultation with the USACE on cost-reimbursable projects, from basic, applied research tasks, to providing guidance on coastal works using their in-house technical expertise in the field of sediment transport.

- **Who are the interfaces to/from the above?**

Governmental support and activities in directional wave measurements, the key staff elements at NDBC would be Drs. Chung-Chu Teng, Don Conlee, William Burnett, and Landry Bennard. The USACE's Coastal Field Data Collection Program contact is Mr. William Birkemeier, or Dr. Robert Jensen. The Coastal Data Information (USACE point of contact Robert Jensen), and at Scripps Institution of Oceanography is Ms. Julie Thomas. Government supported wave modeling efforts include Dr. Robert Jensen, USACE, Dr. Hendrick Tolman (NOAA/NCEP), Paul Wittmann (FNMOC), Steve Hauger (NAVOCEANO), NRL-Stennis Space Center Erick Rogers, and Dr. Jim Kaihatu. There is an active

international group of wave modelers, Waves in Shallow Water Environments (WISE), where Dr. Hans Graber/RSMAS is the co-chairman as well as the Principal Investigator of a National Ocean Partnership Program project Forecasting Winds, Waves, and Water Levels for Land-Falling Hurricanes. The USACE is actively involved in sediment transport in basic to applied research activities and applied to specific Corps of Engineers projects. Mr. Ty Wamsley, Chief of the Coastal Processes Branch is the point of contact at CHL for open coastal sediment transport issues. There are Corps of Engineer district and division offices located in the area of consideration that can benefit from information derived from this area (Corps of Engineer district offices Wilmington, NC , Charleston, SC, Savannah, GA, Jacksonville, FL should be contacted and a list of participants in Appendix B). NOAA's NWS offices are responsible for the safety of private (commercial boats), and the public, The local WFOs in particular are charged with rip-current and surf-zone condition predictions and they need additional input from wave forecasting programs, local WFO contact officers include Frank Alsheimer (Wilmington, NC), Peter Mohlin (Charleston, SC), Randy Lascondy (East Central Florida Rip Current program, Melbourne, FL). NOAA/NWS. Several other NOAA programs include state Sea Grant, Undersea Research Center at UNCW (Southeast Region), The Center for Coastal ocean Service (NCCOS), and Coastal Services Center (CSC). USGS offices that deal with the wave and sediment transport issues addressed in here are mainly in Woods Hole, MA (sediment transport community model and mapping, John C. Warner, Rich Signell, and Chris Sherwood) and in St. Petersburg (coastline mapping and processes, Abby Sallenger). Each state generally employs a resident geologist within the State Department of Natural Resources or Coastal and/or Ocean resources office, (e.g., Bill Eiser, SC DHEC/OCRM).

- **In the short term what can SEACOOS provide that is otherwise not available at the present?**

One significant contribution of SEACOOS is the provision of Directional wave data from new real-time stations along the continental shelf, landward of the NDBC backbone and at various coastal sites. These stations enhance the currently operational systems of NDBC but also expand the wave measurement toward shallower waters in areas important for sediment transport applications and coastal wave forecasts that are of importance for a variety of organizations (i.e., USACE, NWS, USCG, USGS). Use of HF- and X-Band radar systems that can estimate wind, currents, and waves. Fully instrumented glider support for site-specific measurement projects. Interface with state and federal agencies to access and integrate coastal surveys (side-scan, seismic). Critical to any modeling effort in the coastal area is knowledge of the offshore hydrography. Understanding the coordinated effort between USGS and the USACE mapping the coast means little if the current water depth digital databases are not updated to the regularity the coastline position. Detailed hydrographic surveys of the littoral zone (say to 20m depths) and not covered by NOAA's CSC or NOS in a timely fashion. Comprehensive regional GIS focused on this issue, develop in a partnership with existing systems or strongly recommend a federally sponsored portal to coordinate and disseminate the information. In general, the needs for measurements expressed by federal, state and local governments are one in the same. Identification of a test site (or sites) that is strongly coordinated with participation of SEACOOS could potentially become a success story.

Modeling the hydrodynamics (waves and water levels) also requires wind and pressure fields that are commensurate with temporal and spatial resolutions of the meteorological events. This along with accurate estimates of the far-field wave energy and accompanying large-scale circulation patterns (i.e., Gulf Stream) are needed to drive any local integrated wind, wave, and water-level system. Present Weather Prediction Centers (NCEP, FNMOC and NAVOCEANO) are not providing this information to the region. SEACOOS is providing near-real time currents with WERA and CODAR systems as well as the result of numerical simulations of the Florida Current. These efforts may enable improved wave forecasts through the use of realistic current fields.

There was a collaborative effort between NOAA's NWS-Jacksonville and NRL-Stennis Space Center through the Coastal Storms Program to routinely produce high-resolution wave estimates in the Jacksonville, FL area. Information gathered from this study (E. Rogers, NRL-SSC, and P. Welsh now from UNF) would be extremely useful in the generation of alternate sites and/or establish any forecasting system.

- **What steps need to be taken to make this information available to identified users?**

Regional GIS, new integrated web site, extensive data mining effort (data and meta data) on the SEACOOS end. Determine the functionality and paradigm federal, and state agencies work under and synthesize any information (whether it is measurements, model results) so that it can be easily uploaded into their particular system. Find the user base, determine their needs and fashion the information that would be most useful to them. The significant wave height is of great value to those who know and understand what the number means while might not be easily comprehended by the layman. Therefore, a variety of formats might need to be developed based on the user base. Surveying the public for useful products may be an alternative, and thus minimize efforts of generating something that is not of any use. CDIP maintains statistics of the most popular products where there are about 6,000 unique site hits per day, along with downloading of information from 230 commercial companies per ½ hour.

- **What are some ideas on longer-term actions in support of the application?**

Initial costs of wave, current, measurement devises can be considerable, however long term deployment of these systems also requires yearly maintenance, data processing, and replacement. What generally occurs, once funding runs out, and/or the gauge is lost, damaged the site, no matter how important and useful to the public is lost. This may then threaten the safety of these commercial, and public boaters. So, long-range strategies maintaining the operation of key assets need to be a first priority. One needs to be kept abreast of new technological approaches (similar to LEO15 of New Jersey) with the integration of observatory. Remote sensing data derived from shore based stations, fixed aircraft, and satellites), AVN's. The Long Term Environmental Observatory LEO 15 site is one example integrating these approaches off a beachfront experiencing extreme erosion problems. The CHL's Field Research Facility is another example of long-term, integrated observations. Also, within the last few years SEACOOS PIs have established and operate nearshore wave measurement sites (e.g., Springmaid Pier, SC, Folly Beach, SC, Tybee Island, GA, off Pass-a-Grille inlet in Pinellas Co, FL and elsewhere), that their continuing maintenance and expansion in areas not sampled could support this application

There also has to be an avenue that will foster new ideas, improve our modeling technology. The key here would be from the strong collaboration between the observational community providing wave data not only for verification and validation, but also for data fusion and assimilation. Placement of point source measurements in areas of high erosion potential, tropical storm susceptible coastal reaches, designing short-term field experiments such as studying the effects of wave attenuation/focusing along the continental shelf could yield sufficient data for model improvements. Such studies as the Wave Information Study (USACE/CHL) could be used to determine large-scale changes in the wave climate could be a location of interest for a new directional wave buoy. A focused attempt to uncover where, and under what conditions present models are deficient are more important than where they compare favorably. This again requires long-term wave data in very differing environmental, physical and meteorological situations.

Based on the Columbia meeting (see Appendix) we propose to discuss the following straw man plan at the July 25028, 2005 SEACOOS- SECOORA meeting:

i) Identify the user community and their requirements.

ii) Design an evaluation of existing wave measurement technologies and determine whether wave parameters from different systems mean the same thing. Also, evaluate the emerging of new, land based technologies (i.e., WERA, Microwave radars) for wave measurements.

iii) Identify regional – subregional gaps in wave data collection programs.

iv) Develop a unifying data product capitalizing on the CDIP experience.

v) Select two or three areas – test beds along the SE with different wind/wave forcing and different bathymetry to be used for extensive measurements and wave model(s) evaluation to be used for operational forecasting purposes.

vi) Develop the procedure, protocol and technology for making these wave- forecasting systems transferable to different areas throughout the SE with the ultimate goal (10 year plan) to have the whole SE covered.

In all of the above actions it is important that we are inclusive and assure a wide community involvement from government (NOAA/NCEP, US Navy/FNMOC and NAVOCEANO, NRL-SSC, USGS), state, academia and private entities.

APPENDIX C

SEACOOS Spring 2005 Meeting
Jacksonville, FL, July 2005

Meeting Minutes

SEACOOS Spring 2005 Meeting – Jacksonville, FL, July 2005

I. TEAM INTRODUCTION

Regional Directional Waves/Sediment Transport Applications
(Presenter: Voulgaris)

1st Wave Group Meeting – Jan 2005, Columbia, SC

- Wave measurements and predictions are important links between offshore atmospheric/oceanic conditions and the nearshore – involve societal relevance
- Waves impact a wide variety of coastal users: recreational, local municipality, to federal level
- NOAA/NDBC has good experience in maintaining offshore sites and might be best suited for providing wave information
- Nowcasting and forecasting of nearshore wave conditions requires increased resolution – requires new models. Could be run by regional associations but obtain boundary conditions from federal entities.

Issues:

- NOAA/ NDBC and NCEP are responsible for measurements in open ocean
- Transformation of waves from offshore to mid-shelt is carried out by modeling groups in RAs or private sector
- Sub-regional associations run high-resolution models that obtain boundary conditions from RAs.

Charge for the meeting. Answer:

- What are the coastal ocean/atmospherical information needs (directional waves, currents, bed morphology – sediment transportation, nearshore circulation)
- Which fed, state, private agencies
    - NOAA (NDBC, NCEP)
    - USACE- Coastal Data Information Program
    - US Navy: FNMOC (Forecast info), NAVOCEANO, NRL-SSC
    - USGS: LIDAR surveys, coastal zone mapping and modeling
    - Private sector & academis: Oceanweather, Inc.; consultation, research, guidance, expertise
- Who are interfaces
- What can SEACOOS do
    - Directional wave data from real time stations
    - Use of HF and X-Band radar systems
    - Access and integrate coastal surveys from fed/state agencies, e.g. LIDAR, Beach Monitoring Programs

- Update the present water depth digital database regulated by the coastline position
- Comprehensive regional GIS
- Test beds (data) for evaluating wave propagations models.

Next steps

- Identify users beyond the obvious ones
- Define wave parameters, i.e. swell vs wind waves. Common Wave Parameter Definition – need of working group? Document the findings through a paper in the peer reviewed literature.
- Uniform data visualization tailored to specific wave users.
- Synthesize information of easy access – a number of entities have been collecting wave data – take advantage of that.
- Consult with other entities with experience (e.g. NDBC, CDIP)
- Development of added-value products (hybrid of measurements and modeling)

Long term actions

- Long term strategies for operating assets
- Building of wave climatology
- Inclusion of remote sensing data derived from shore based stations, fixed aircraft, satellites
- Creation of long-term integrated environmentatial observatories to put directional wave information in context
- Collect directional wave data in different environments, i.e. identify gradients in physical and bathymetric forcing
- Be flexible

Proposed discussion topics for this workshop

Seim:	Need to identify state agencies now and get the contacts at the table
Weisberg:	Counties are also a likely partner
Fletcher:	This seems like a good area for IM focus, particularly with respect to Eval Rep recommendation to target users
Mooers-	Needs to be link to circulation model
Art Allen:	What are the wave conditions at inlets? This needs to be considered by both MEM and DW.
Voulgaris:	it's a high resolution problem
Sullivan:	Need interaction with other regional COOS groups. Is this happening?
Voulgaris:	Interaction currently occurs at scientific level and conferences. It needs to be enhanced and to be inclusive.

II. CASE STUDY PRESENTATIONS

National Weather Service Marine Products
(Presenter: Frank Alsheimer, Science and Operations Officer, Charleston SC)

NWS Mission cuts across many groups and includes data base creation, forecast service, and outreach service.

The participants are :

WFOs
National Centers for Environmental Prediction
Ocean Prediction Center
Tropical Prediction Center

Environmental Modeling Center
Others

WFO Marine Products
Coastal Waters Forecast (Text)
- Out to 20 NM offshore from Maine to SC
- Out to 60 NM offshore from GA to TX
- 5 day forecast of winds, seas, weather, other hazards
- Headlines for anything that goes on beyond 3 hours

Current trend is toward Graphical forecasts
NWS is moving away from text products to graph products. Provide more options of what users can do with forecast data.
-Plan view depiction of forecast winds, waves, clouds, and weather out 5 days.
-CWF text product actually derived from graphics produced by WFO forecasters

Long-fused warning/advisories:
Small craft advisories- winds of 21-33 knots
Gale warning- winds
Storm-winds of 48 knots of greater

Short fused warning/statements
Issued for short duration (< 3 hours)
Special Marine Warning- wind gusts to 34 knots, waterspouts
Marine Weather Statements- wind gusts of 25 to 33 knots (stand alone), add more information to an ongoing special Marine Warning

Surf Zone Forecast
Nearshore wave height forecast
rip current thread
winds and weather
water temperature

Incident Response
-Support NOAA HAZMAT: provide “spot forecasts” of winds, waves, and weather for spills; role in incidents likely increasing with time (e.g. Columbia recovery support).

Ocean Prediction Center
High Seas Text for N Atlantic/N Pacific
Offshore waters forecast,
Etc.

Tropical Prediction Center
Tropical Analysis and Forecast Branch, for area south of Ocean Prediction Center

Data used for forecasts: buoys/platforms, ships/beach reports, land stations, models, satellite, radar, airplane, webcams.

The future for NWS is for:
More accurate forecasts.
Increased resolution.
New communication methods for getting information out.
Additional graphic capabilities.
Integration of new science into the data collection and forecast process.
Continue to build partnerships to leverage resources for improve service.

Williams: Where do you pull data from?
Alsheimer: lots of places, including regional systems data via Internet.
Williams: can COOSs help to develop consistent data bank.

US Army Corps of Engineers
(Presenter: Freda Zifteh, Jacksonville, FL, USACE District Office)

Initiatives
Local districts caver an extensive area;
Include diverse workforce, and range of activities:
beach erosion control,
emergency response,
environmental restoration,
flood control, etc.

Regional Sediment Management: goal to keep appropriate material in the littoral zone.
Shore Protection Project Performance Improvement Initiative: evaluation of shore protection projects.
Program Level Efforts: Strategic communications, data back development, assessment of Hurricane Isabel
Big Product: 3D Morphological Model Development:
JALBTCX – Airborne LIDAR
Will go into eCoastal/GIS Implementation – data management approach to provide baseline data.

USACE Local District Offices data needs and deficiencies
List of data needs, as well as list of primary locations where data are needed.
Defined formats.
Also data needs for navigation projects and beach renourishment.

Luther: How does eCoastal tool interface with other FL efforts.
Zifteh: Not sure, as it's in design right now.
Voulgaris: Where do you get directional wave data?
Zifteh: Use of wave hindcast data.
Seim: Do you maintain long term directional wave data.
Johnson: We haven't been able to do much of that and are now trying to get funds in place.

III. BREAKOUT SESSION

Session Goal: Develop Short Term Objective for next few years.

1. Identify the user community and their requirements.
2. Design an evaluation of existing wave measurement technologies and determine whether wave parameters from different systems mean the same thing.
3. Evaluate the emerging of new, land based technologies , e.g. WERA, Microwave radars) for wave measurements
4. Identify regional – sub regional gaps in wave data collection programs – define by user needs and by gradients.
5. Develop a unifying data product capitalizing on the CDIP experience. Can utilize some of their developments, but also need to make a number of changes. All their products were tailored for their west coast environment. Bob Jensen can facilitate the transfer of products and software. The product is very focused on waves – this has advantages and disadvantages. Cothran: examined the CDIP site. Is able to provide the format for feeding the data into whatever site is identified. Across the board, need definitions for the

various terms. This is a good product to work on collaboratively. Discussion: the web site currently doesn't work well is showing the general public what is meant by "wave height."

6. Select two or three areas – test beds along the SE with different wind/wave forcing and different bathymetry to be used for extensive measurements and wave model(s) evaluation to be used for operation forecasting purposes. This is a prime area for collaboration where observations and modeling activity feed each other.
7. Develop the procedure, protocol and technology for making these wave-forecasting systems transferable to different areas throughout the SE with the ultimate goal (10 year plan) to have the whole SE covered.

The Coastal Data Information Program (CDIP) is an extensive network for monitoring waves along the coastlines of the United States, with a strong emphasis on the Pacific coast. Since its inception in 1975, the program has produced a vast database of publicly-accessible environmental data for use by coastal engineers and planners, scientists, mariners, and marine enthusiasts. The program has also remained at the forefront of coastal monitoring, developing numerous innovations in instrumentation, system control and management, computer hardware and software, field equipment, and installation techniques. CDIP is operated by the Ocean Engineering Research Group (OERG), part of the Integrative Oceanography Division (IOD) at Scripps Institution of Oceanography (SIO).

Welsh: Setting up atmospheric model (forecasting winds) which is used to force a wave model. Their model improves the wind forecast that drives the wave forecast. Wave forecast models can be run at the WFO level; is being done in Jacksonville. JAX's task is to make the system transportable. Not yet done at Charleston – waiting to see how it works.

NOAA is currently responsible for measurements in the open ocean (deep water waves, NDBC) and for integrating meteorological models to provide larger scale wave forecast (NCEP). But this needs to be improved to provide better boundary conditions for our regional wave model. NCEP doesn't include the Gulf Stream – this is a problem for us. This is where we leverage other SEACOOS products, i.e. the circulation modeling.

Shoreward component of model can be improved – this should be SEACOOS's goal. SEACOOS should follow the development being done in JAX WFO and build on that.

Recommendation:

SEACOOS should monitor and augment the current efforts of the NWS to develop SWAN wave modeling in the Coastal WFOs, providing third party verification with additional nearshore wave observations. SEACOOS should continue research to improve both modeling and data systems for operational use by the WFOs.

In Melbourne area, there is a lot of wave gauge data, but the data are not where needed for the model. There's a concern that there needs to be a convergence of waves forecasting and waves measurements.

Agreement on the statements and analysis in the white papers and the identification of the objectives listed above. First need inventory of activities, within SEACOOS and other partners/potential partners.

New gauges might be cost-shared via cost reimbursable projects. Position can be determined on basis of joint criteria.

Waves is a really good success story – have shown it at CDIP. Opportunity to join with PORTS system – they need waves. Are in CO-OPS, but funded locally.

Next step:

Identify group to do inventory of activities and resources focused on wave issue. What are the formulations available and how do you do the QA/QC. Information on instruments is being collated by IOOS – QARTOD. Presentations and documentation on line at www.qartod.org.

Discussion of to what extent we should use CDIP software for SEACOOS presentations.

Jensen: it can be made available.

Community sediment transport model is available, so we might want to address sediment transport component. This may depend on the target region and whether sediment transport is a significant issue.

IV. PLENARY SUMMARY
(Presenter: Voulgaris)

Introduction

- Wave measurements and predictions are important links between offshore atmospheric / oceanic conditions and the nearshore.
- Waves impact a wide variety of coastal users ranging from the recreational user (surfer, beachgoers, sailors and boaters), the local municipality (e.g., coastal erosion, beach safety) to the federal level (navigation, fisheries, search and rescue etc).
- Waves make an fast, guaranteed success story.

Long-Term Objective

- High resolution wave and sediment transport forecasting capability for the SE USA that address important societal needs (i.e., safety, coastal erosion, etc)

Organization

- The high resolution of the nowcasting and forecasting of the nearshore requires a number of high-resolution wave transformation models. Regional or sub-regional associations can maintain these models but the boundary conditions need to be obtained by larger scale federal agencies.
- Regional associations and the private sector, including SEACOOS partners and collaborators from federal affiliates, can develop reasonable resolution models.
- NOAA is responsible for measurements in the open ocean (deep water waves, NDBC) and for integrating meteorological models to provide large-scale wave forecast (NCEP).
- Incorporate any additional efforts that might improved wind forcing (see Univ. of North Florida)

Short-Term Objectives

- Select area(s) – test bed(s) along the SE with different wind/wave and circulation forcing and different bathymetry to be used for extensive measurements, wave and sediment transport model(s) evaluation to be used for operational forecasting purposes.

- Develop the procedure, protocol and technology for making these wave and sediment transport forecasting systems transferable to different areas throughout the SE.

Critical Elements

Critical elements that should be careful considered in order to achieve our goals are:

- Identify the user community and their information requirements.

- Identify assets on directional wave measurements in the region and present numerical modeling efforts (e.g., NWS JAX WFO wave forecast, Community Sediment Transport Model, MORPHO)

- Identify regional – sub regional gaps in wave data collection programs, based on environmental forcing gradients.

- Design an evaluation of existing wave measurement technologies and determine whether wave parameters from different systems mean the same thing. Develop QA/QC

- Evaluate the emerging of new, land based technologies (i.e., WERA, Microwave radars) for wave measurements.

- Develop a unifying data product capitalizing on the CDIP experience.

Discussion

Mooers: How do we plan to engage CDIP?
Voulgaris: what we're proposing that we might take advantage of their software. Also, there is one station on the east coast – Julie Thomas is very eager to collaborate.
Mooers: they've been working the west coast and have a broad spatial view – isn't there something we could learn from them. We need to be promoting cross-talk between RAs to take advantage of distributed expertise.
Seim: He suggested we settle on wave parameters very soon.