Florida Coastal-Forcing Project

- Waves and Winds in the Nearshore -

Progress Report #3

submitted to

The Florida Department of Environmental Protection
Office of Beaches and Coastal Systems

and

The Beaches and Shores Resource Center

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1. Wave Gage Network

1.1 Development of Network Test Site

The formal request to Patrick Air Force Base for use of their tracking station in Melbourne Beach was submitted on February 19, 2001. S.E.S. has since made contact with PAFB personnel several times in attempts to speed up the approval process. At present, they indicate that a permit for use of the facility has been drafted for circulation amongst the PAFB contractors that use the station, as well as FDEP council and staff. However, it appears that it will still be several weeks before the permit is submitted to the Base Commander for final approval.

Although use of the Melbourne Beach Tracking Station remains uncertain, in order to position ourselves so that the shore-connected wave gauge can be installed as soon as possible after permission is granted, the power and communications cable is being ordered. Prices have been gathered from several companies, specifying a 3,000 ft long, 7-lead, doubled-armored cable, complete with strain relief attachments and potted connector ($5,000-$6,000). Although longer than may be ultimately needed, if it turns out that an alternate test site must be used, this cable length should be workable.

1.2 Wave Gauge Mount

A prototype mounting structure has been designed and fabricated to specifically service the RDI Sentinel wave gauges that are now expected to be deployed in the FDEP network. This anchoring/mounting system consists of a 10 ft long, 4 in diameter stainless steel pipe ('spud') that is fitted with a coupling flange on one end. The coupling enables it to be attached to a boat-based pumping system so that the spud can be jetted into a sand or mud bottom. The wave instrument is clamped inside a specially designed aluminum 'can', which is then bolted to the top of the jetted spud. Plastic and rubber sleeves are used to isolate the dissimilar metals. With the spud jetted in place, the special clamping system enables a diver to deploy or retrieve the instrument, found to require less than 2 minutes of bottom-time.

A jetted spud is used so that the instrument can be located well above the bed, thereby avoiding burial by sediment. This elevation can be tuned to local site conditions, and can be adjusted later if required. The mounting can and relatively thin spud present a minimal drag surface, thereby reducing scour potential. As opposed to a bottom-resting frame or weight, the spud always maintains its vertical orientation and will not settle into the bed.

1.3 Wave Gauge Deployment at Sebastian Inlet

The wave gauge mount was installed and the RDI Sentinel instrument was deployed for the first time on March 8, 2001 near Sebastian Inlet. The mount was located approximately 25 ft to the south of the existing PUV gauge maintained by SITD, so that a side-by-side comparison could be made. The mean water depth at the site is nominally 26 ft, and the instrument is located approximately 5 ft above the bed. Although swell surge was notable, divers were able to locate the PUV, jet the mount and install the gauge in less than 2 hours. In self-record mode, test data were collected in 20 min bursts once per hour, for a total of three hours. The gauge was then retrieved, the data downloaded, and the instrument redeployed. Subsequent processing of the data back at the office indicated that the gauge had worked properly during the initial test sequence.

Upon return to the gauge on March 14 the mount and instrument were found to be in good order, although biofouling by barnacles had already begun. The gauge was retrieved successfully, but when connected to the computer for downloading, no new data were found. An exchange of cell-phone calls with RDI from the boat identified the problem, which was the now-apparent necessity of reprogramming the gauge after each data download. The gauge was reprogrammed and then redeployed.

On March 25, i.e. 11½ days later, the gauge was once again retrieved and this time data successfully downloaded and analyzed, as described below. The instrument was redeployed on April 1 and, at the writing of this report, is still in the water. It will be retrieved within about two weeks, as the battery pack is expected to be exhausted about that time. Other than the one misfortune caused by unclear documentation, the gauge thus far appears to be performing to expectations.

1.4 Findings from Initial Deployment

For the time period from March 14 to March 25, 2001, wave and wind measurements have been assembled from several sources, including the RDI gauge, the Woods Hole Group PUV, the closest NDBC buoy (#41009) located due east of Cape Canaveral, and the weather station situated at the end of the north jetty of Sebastian Inlet. These data shed light on several issues that are key to the FDEP Coastal Forcing Project.

In order to track the behavior of the waves in response to the winds, Figure 1 presents measured speed both from the north jetty and at Buoy 41009, whereas Figure 2 presents wind direction (defined from which the wind is blowing; 70^o is onshore-directed, 250^o is offshore-directed). Note the strong onshore winds during March 18-19, which then turn offshore and abate slightly by the middle of March 20. The winds remain offshore until March 22. As might be expected, when they are directed onshore the winds at the inlet closely track those in deep water, but when offshore-directed, the deepwaters winds are stronger.

In regard to waves, Figure 3 presents energy-based significant wave height, Figure 4 presents spectral peak period, and Figure 5 presents spectral peak direction (from which waves approach; 70^o is roughly normally incident). In Figures 3 and 4 the RDI acoustic gauge and the Woods Hole Group electromagnetic PUV instrument are compared, along with Buoy 41009. Two important features are immediately apparent:

a) Although the collocated RDI and WHG instruments mimic each other, the RDI consistently reports heights greater than the WHG, particularly during low-energy conditions. The discrepancy is greatest during the initial growth phase of the storm on March 18-19, when winds are onshore and peak period is smallest. The discrepancy disappears however as the peak period lengthens and winds turn offshore, but then returns between March 22-25 when winds are once again onshore. The persistent difference is attributed to the fact that the WHG has a cut-off frequency of <u>0.25</u> Hz, whereas the RDI has a higher cut-off at 0.42 Hz. It would appear that the RDI gauge is able to capture more of the energy in the wave spectrum because it senses motion far up in the water column. As a consequence it is not as susceptible to the pressure response factor problem that accompanies near-bottom measuring instruments, which are required to have lower cut-off frequencies.

b) The nearshore RDI gauge tracks the offshore buoy closely except during the peak and waning phases of the waves, during which the buoy is more than *double* the RDI. Recalling Progress Report #2, similar differences were seen between the deepwater AES boundary condition waves and the SITD gauge - differences that could not be modeled using STWAVE. In light of these measurements, it now appears that the reduction in storm-generated wave energy is real, and not due to some problem with the SITD gauge.

In examining Figures 4 and 5, peak period and peak direction , although apparently noisy parameters for either gauge, are somewhat better behaved for the RDI than the WHG instrument. For peak period the two gauges track each other well except for March 16-18, when the RDI reports smaller periods. It is during this time that the RDI reports peak directions from the northeast, whereas the WHG reports more normally incident waves.

2. Wave-Hindcast Database

2.1 Additional STWAVE Comparisons to PUV Data from Sebastian Inlet

Since the last progress report, additional wave modeling for the Sebastian Inlet area has been conducted for the entire year of 1998, and comparisons made to the available PUV record. Although the measured record contains some lengthy gaps, findings are consistent with those previously reported for the latter part of 1996. Example results for January and February, 1998, are presented in Figures 6, 7, and 8, showing significant wave height, peak period and peak direction respectively. As before, STWAVE does not account for the significant energy losses between the AES40 waves, used as a boundary condition, and the nearshore wave gauge (Figure 6). Now however, based upon the findings with the RDI gauge, there is reasonable confidence in the veracity of the PUV data. Also as before, gaps are present in the STWAVE record when the boundary condition waves are headed out of the model domain. In Figure 7, peak period from the gauge and from STWAVE track reasonably well, as does peak direction in Figure 8, until the electromagnetic current meter malfunctioned at the end of January.

2.2 Contrast of STWAVE with Previous WISWAVE Modeling

Contrast of the STWAVE results for September through December, 1996, discussed in the previous progress report, with those found in an earlier WISWAVE application with nested grids for the same time period (Dally, W., Grosskopf, W., and Harris, L., 1998, "Wave Climate Studies for Sebastian Inlet," *Proc. 5th International Workshop On Wave Hindcasting and Forecasting*, pp.56-70) revealed that WISWAVE too was prone to overpredicting energy levels for the larger storms as compared to the SITD gauge. However it was also found that agreement during storms could be improved by reducing the input wind speed, but such 'tuning' was at the expense of the agreement during quiet periods, where the adjusted model actually underpredicted the measured energy levels.

An important advantage of nested WISWAVE modeling is that, although more complicated to set up and run, the WISWAVE model is quite capable of handling waves that are outgoing from the modeling domain, thereby obviating gaps in the modeling record. In developing a hindcasted wave database for Florida as part of the Coastal Forcing Project, at this point it would appear that either some version of WISWAVE or similar full-plane, unsteady model should be used, or else a better means of applying STWAVE must be developed. In either case, based upon the findings of the work performed thus far, it would appear that both models are missing an energy-reduction process that is important, at least in the Central Florida region . Obvious candidate processes are losses due to bottom friction or due to percolation. However, based on the short-duration experiment conducted this past March, the effect of an offshore-directed wind on the incident waves is also a possibility. It is recommended that this issue be one of the focal points of future FCFP work, both in modeling and in field measurement.