Florida Coastal-Forcing Project

- Waves and Winds in the Nearshore -

Progress Report #5

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 Permanent Test Site

Although at the time of submittal of the last progress report (June 8) PAFB personnel had verbally indicated that permission to use the Melbourne Beach Optical Tracking Annex was to be granted, a signed agreement was never received[1]. Follow-up conversations with PAFB indicated that both 1) a recent change in PAFB legal counsel and 2) their requirement for an 'Environmental Baseline Survey' were the reasons for the delay. Given the difficulties in finalizing arrangements with PAFB, coupled with the fact that access to the Tracking Annex would be restricted nonetheless, FDEP and SES agreed that an alternative site should be pursued. Brevard County Parks & Recreation officials were contacted by FDEP personnel, and a dialogue was initiated in hopes of establishing the wave gauge & shore station test site at Spessard Holland North Beach Park. In pursuit of this new site, the following tasks were completed:

- On June 25, a meeting with Brevard County Parks personnel was held at Spessard Holland North Beach Park, during which the scope of the FCFP was discussed and a potential location for the shore station identified.

- On June 28, formal request to the County for use of the Spessard Holland site was made.

- While the request for use of Spessard Holland was under consideration by the County, a permit application (exemption request) was made on July 19 to the Orlando Regional Office of FDEP to install a wave gauge in self-record mode offshore of the Park. State permits were granted on August 7 and a Federal permit was issued on August 16.

- A self-recording RDI Sentinel wave gauge was installed offshore of Spessard Holland on August 28, 2001, approximately 2,100 ft from the dune. The instrument was retrieved on October 3, and a fresh gauge deployed. Data collected are presented and discussed below. At the writing of this report, a gauge continues to collect data in self-record mode.

[1] On October 26, 2001, SES received a fax of the executed agreement from PAFB.

- Authorization from Brevard County to use Spessard Holland Park for the shore station and cable connection was granted on September 25, 2001, although a formal Memorandum of Understanding is still being finalized.

- On October 9, an easement survey was conducted at Spessard Holland Park by a Registered Professional Land Surveyor to gather the information needed to file for a FDEP Environmental Resource Permit (exemption) and Submerged Lands Easement to run a power and communications cable out to the wave gauge.

- On October 24, formal request for the cable permit exemption and easement was submitted to the Orlando Regional Office of FDEP. The request is presently under review.

1.2 Additional Deployments of the Wave Gauge at Sebastian Inlet

While the Park site was being pursued, the RDI Sentinel instrument was redeployed on June 26 at the site near Sebastian Inlet, with FDEP personnel on hand to observe. The gauge was then swapped with a newly purchased instrument on July 27, although the one retrieved had stopped recording on July 20 due to memory limitations. The replacement gauge was configured to sample waves once every two hours, and to measure currents continuously, so that the instrument could now monitor for approximately 33 days. The Sebastian gauge was retrieved on August 28, after the new installation at Spessard Holland Park was completed. All deployment activities were conducted without mishap. Analysis of these data is presented below.

1.3 Findings from the Third and Fourth Deployments at Sebastian Inlet

Nearshore wave measurements from the third and fourth deployments near Sebastian Inlet are presented in Figure 1 and 2, along with data available from the NDBC buoy at station 41009 offshore of Cape Canaveral. Figure 1 provides energy-based significant wave height, spectral peak period, and peak direction, whereas Figure 2 provides wind speed and direction from the Canaveral buoy, along with mean water level fluctuation at the nearshore gauge. Findings are consistent with those of the first two deployments, in that wave heights nearshore

are less than those in deep water, especially during two of the storms. In regard to peak wave period, the nearshore gauge appears to track the deepwater buoy even at times when this parameter is unstable, except during the July 10-15 time period when strong winds were directed offshore. It also appears that these offshore winds were responsible for a notable reduction in nearshore wave height that persisted until the winds turned onshore, with nearshore wave energy rapidly increasing thereafter.

1.4 Findings from the Initial Deployment at Spessard Holland

As mentioned above the new wave gauge installation at Spessard Holland Park was completed on August 28, 2001, and the gauge was swapped on October 3. It was during this initial deployment that Hurricane Gabrielle and a subsequent Northeaster (September 14-18) caused heavy erosion damage to the dune system in Brevard County, particularly in Melbourne Beach where several beachfront homes presently remain threatened. However, upon downloading the raw data from the instrument, it was discovered that the RDI memory card had malfunctioned at the peak of the storm on September 16. After conducting several days of diagnostic work, the gauge was shipped back to RDI where additional data were eventually extracted, extending the record to September 30, at which time the memory card had failed completely. These data are presented in Figure 3 along with 41009 buoy data. Figure 4 provides wind and water level information. The gauge was repaired by RDI and returned to SES.

Fortunately Hurricane Gabrielle and its follow-on Northeaster were fully documented before the memory card failed. Although the nearshore significant wave height during these storms did not exceed 2m (Figure 3), a wind-induced storm surge (~0.4m), superimposed on three consecutive days of spring high tides, is clearly evident in the data (Figure 4). These relatively moderate storms left the Melbourne beaches in worse condition then they were after Hurricanes Floyd and Irene in 1999, apparently because of their duration and the fact that they occurred during spring tides.

2. Wave Hindcast Database: Energy Loss Enigma

2.1 Prefatory Investigation

As first indicated by results of modeling work with the wind-wave generation model STWAVE and discussed in Progress Report #2, and subsequently confirmed by direct wave measurement and described in Progress Reports #3 and #4, wave energy losses between deep water and the nearshore are significant in the region south of Cape Canaveral. These losses are particularly significant during storms. In two instances (March 20 and September 16), storm waves originally over 4m in significant height at Buoy 41009 were reduced to 2m height before reaching the surf zone. Substantial effort has been devoted to a review of the literature and to background fact-finding in regard to this issue, and two opinions as to the likely cause have emerged thus far: 1) STWAVE did not properly replicate white-capping losses because the input spectra had to be synthesized (as JONSWAP spectra) from the gross parameters archived in the AES-40 database; 2) bottom friction, which is a process not included in STWAVE, is responsible for the unaccounted losses.

Review of the available literature on bed friction and percolation, and rudimentary computations of such losses based upon linear wave theory and using sand ripple characteristics typical for the Canaveral Bight reveal that, due to the locally broad (~30 km) and relatively shallow (14 - 24 m) nearshore shelf, bed friction is a rational explanation. Several accomplished wave modelers queried at the *Waves '01* conference, including some working on the shelf off of Duck, North Carolina, confirmed this opinion. Nonetheless, several other well-respected modelers maintain that the loss is due to wave-wave interaction and white-capping. In hopes of solving this mystery, three different activities are now being planned.

2.2 Additional Testing with STWAVE

To investigate the premise that the unrepresented energy losses are because input spectra were synthesized from gross hindcasted parameters rather than complete directional spectra, recently developed deepwater hindcast information from the Army Corps of Engineers Wave Information Study will be used. These hindcast results were generated using the same wind fields as those used in the AES-40 project, but have been archived as complete directional

spectra. STWAVE will again be set up and run for the shelf region at Sebastian Inlet, but using this less equivocal input, and new model results compared to selected months of the PUV data available from the Sebastian Inlet Tax District.

2.3 Bottom Friction Modeling Study

To investigate the premise that the unrepresented energy losses are due to bottom friction and/or percolation, an existing 2D wave transformation model that treats shoaling, refraction, and depth-limited breaking (see Progress Report #4) will be modified to include bed losses. Although air-sea interaction processes are not represented in this model, results of testing the model in the Canaveral Bight region should clearly indicate the likelihood of the importance of bed friction. Both the additional STWAVE and bottom friction modeling will be conducted in parallel with wave modeling work sponsored by SITD. If the simple modeling shows promise, future effort by the FCFP might be dedicated to modifying STWAVE to include bed friction, although such work would require the cooperation of the Army Corps.

2.4 Cross-Shelf Experiment

Finally, with the goal of addressing these wave modeling issues to the fullest, most unequivocal extent possible, a cross-shelf wave measurement experiment is now being planned. The basic idea is to exploit the permanent Spessard Holland nearshore installation, and deploy additional RDI Sentinel instruments along a cross-shelf transect for a limited period of time (e.g. a few months). For discussion purposes, a profile of the shelf near Floridana Beach in southern Brevard County is presented in Figure 5. This profile is typical for the Canaveral Bight, with the important feature being that at a distance of ~30 km offshore the water depth is only 24 m, after which the bottom drops rapidly. At this 24 m depth, it is still economically feasible to erect a short (~16 m tall), submerged tower to elevate an ADCP wave gauge to an optimal position below the sea surface, similar to the elevation of the Spessard gauge (~8 m). Two additional instruments would be deployed on even shorter towers (~ 6 m tall), one at ~14 km and one at ~3 km offshore, bringing the total number of gauges used in the transect to four. The key feature of such an experiment, in contrast to earlier cross-shelf wave measurement projects (e.g. ARSLOE), is that the waves would be measured at all four locations by fully exploiting the high-resolution capabilities afforded by ADCP wave gauges - and they would be measured consistently at all

locations. With concomitant wind information, the data collected would allow rigorous testing of wave transformation models without the uncertainties faced when using a) numerically hindcasted information, or b) buoy data of coarse directional resolution, as input at the offshore boundary. Because of higher priorities this fiscal year, budget restrictions, and the significant preparation that would be required, it is recommended that the cross-shelf experiment be conducted in the fall of 2002.

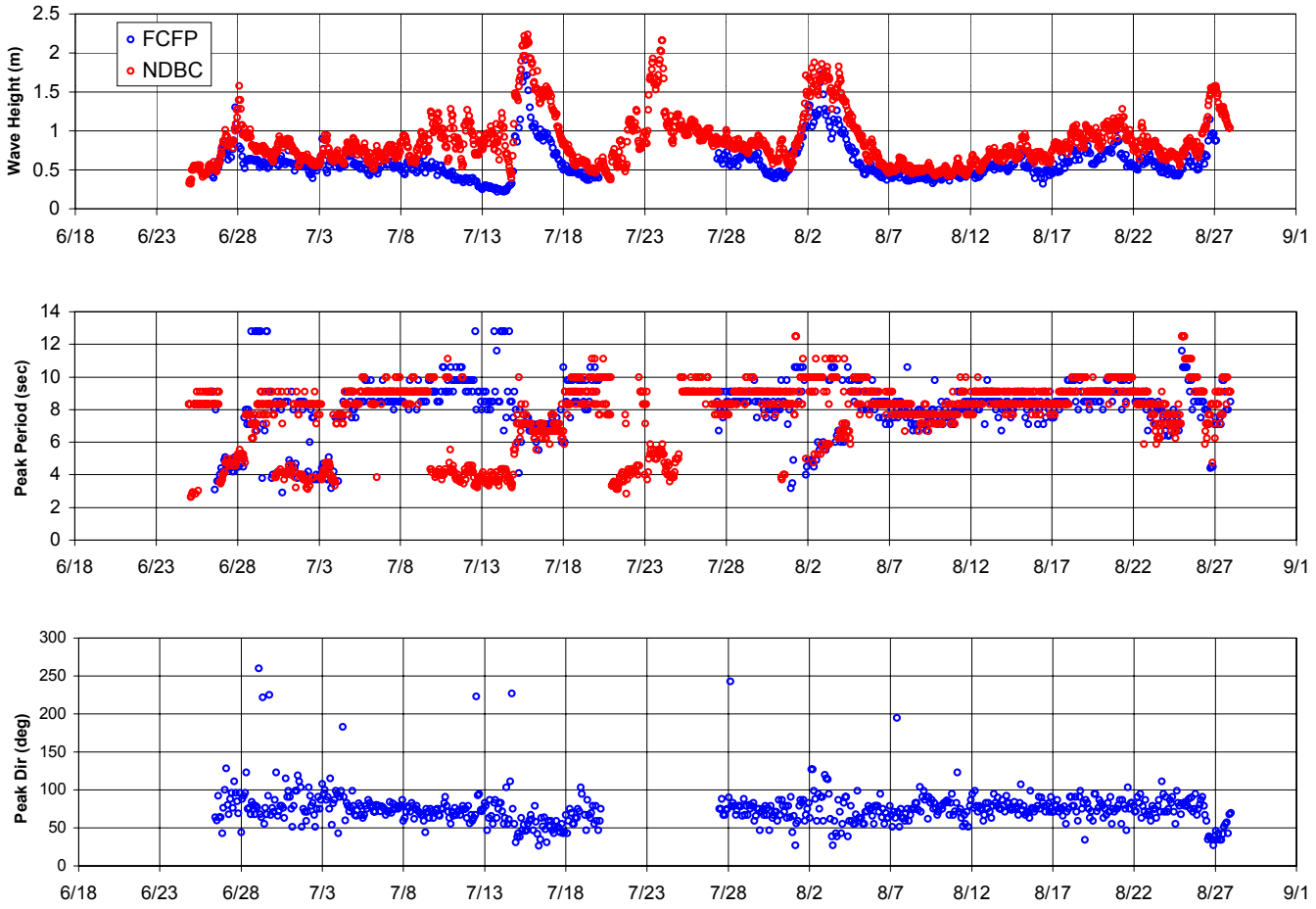

Figure 1 – Wave parameters measured at FCFP nearshore gauge located at Sebastian Inlet, and NDBC buoy #41009 located at Cape Canaveral (July-August, 2001).

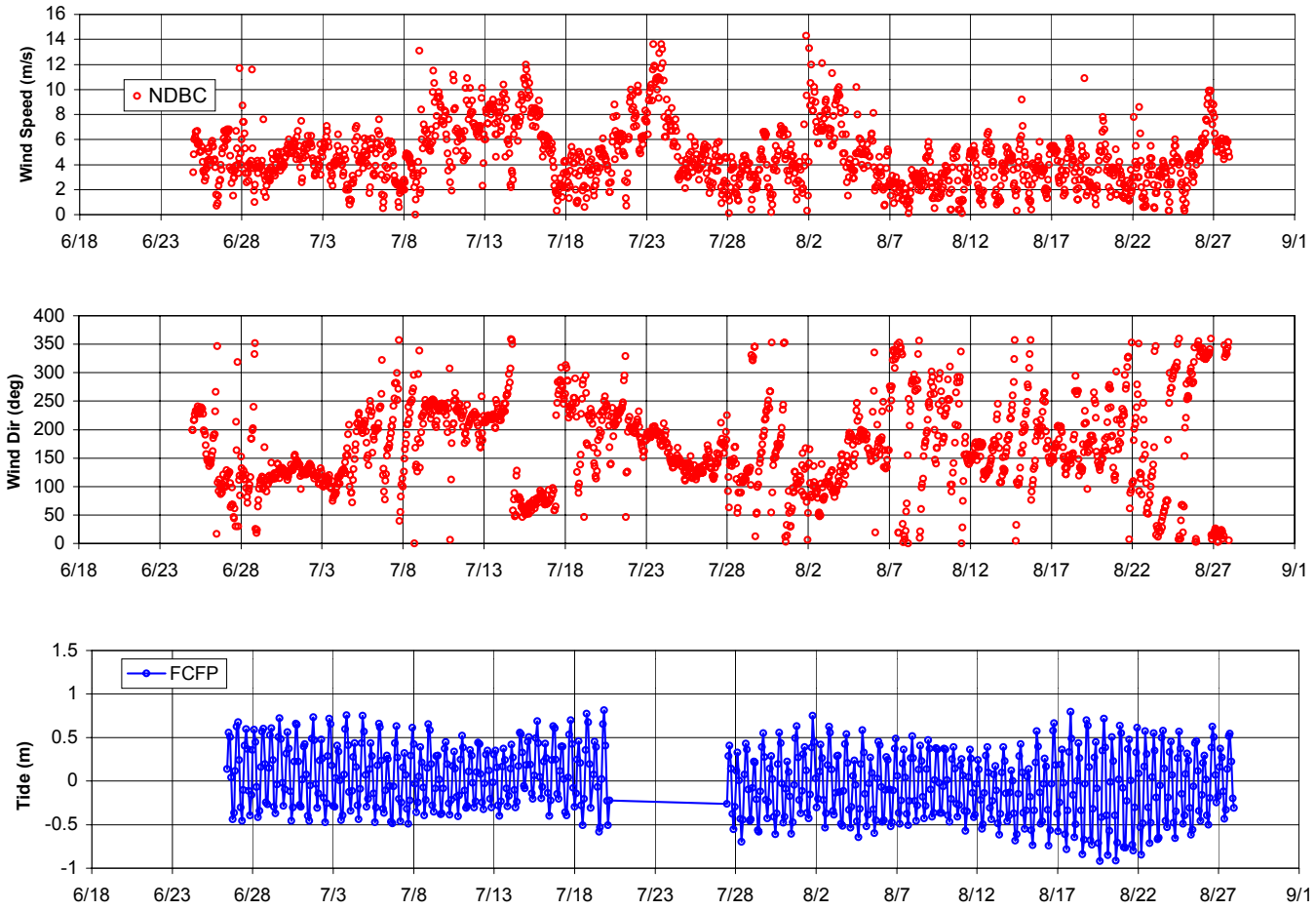

Figure 2 – Winds measured at NDBC buoy #41009 and water levels measured nearshore at Sebastian Inlet (July-August, 2001).

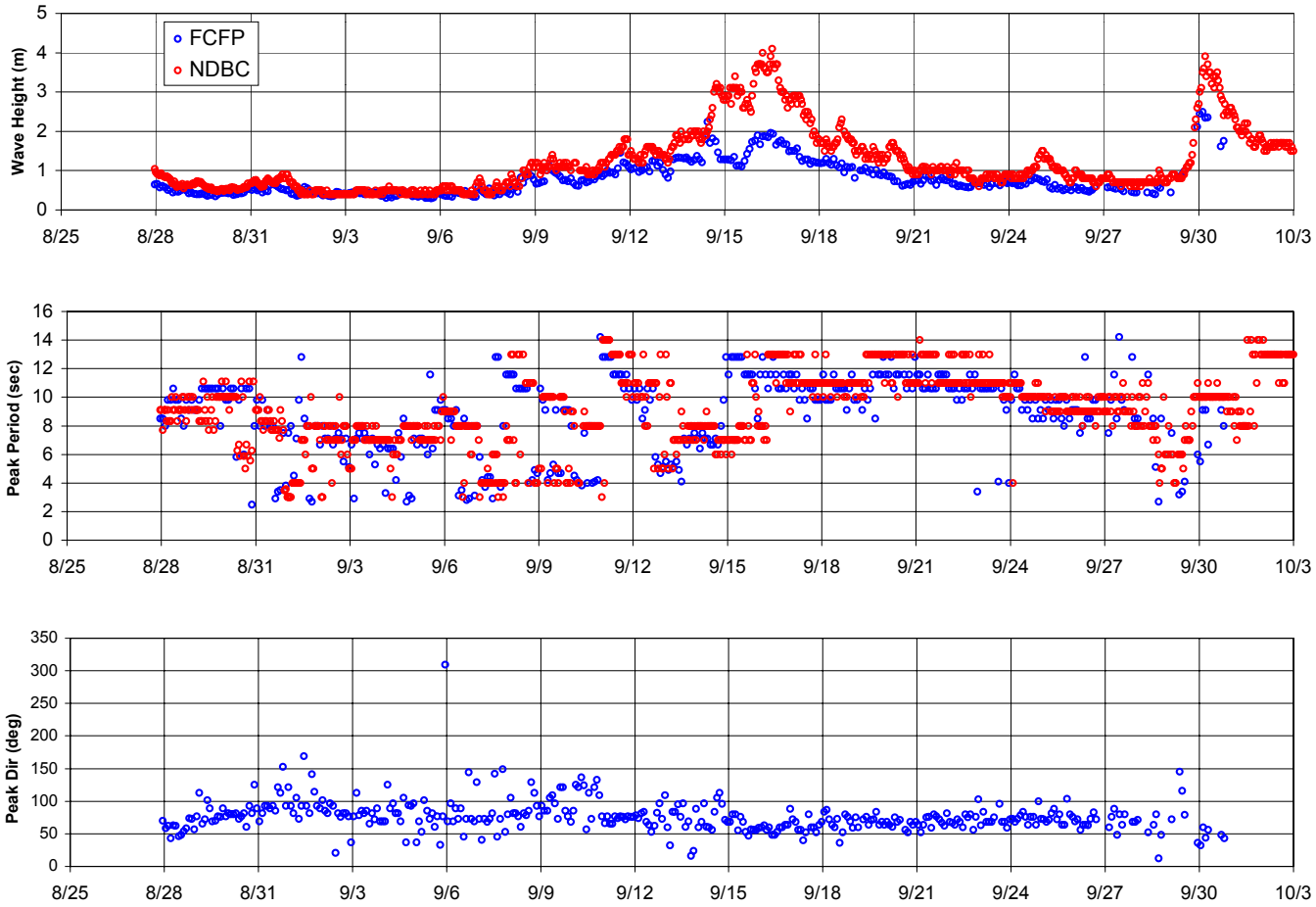

Figure 3 – Wave parameters measured at FCFP nearshore gauge located at Spessard Holland Park, and NDBC buoy #41009 located at Cape Canaveral (September, 2001).

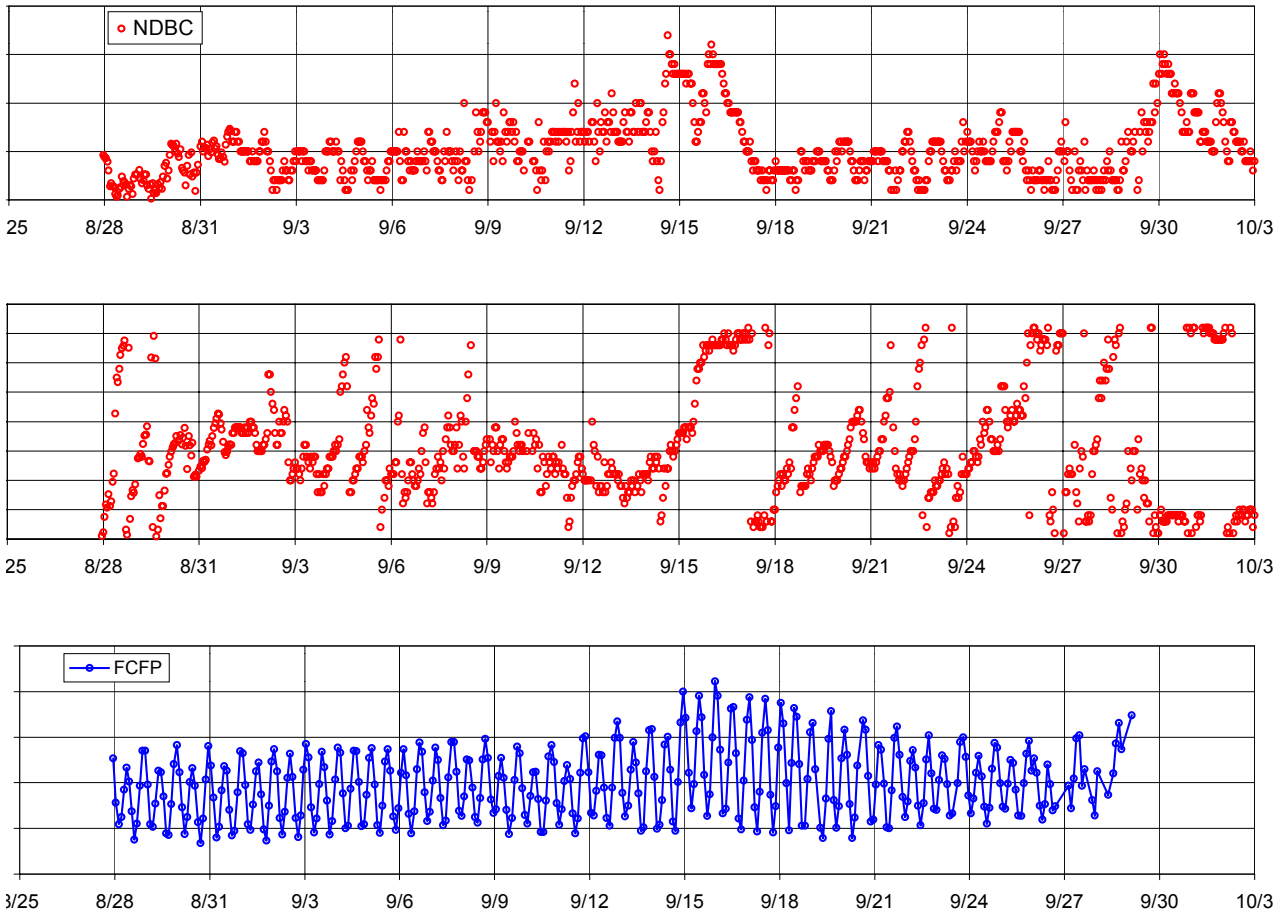

Figure 4 – Winds measured at NDBC buoy #41009 and water levels measured nearshore at Spessard Holland Park (September, 2001).

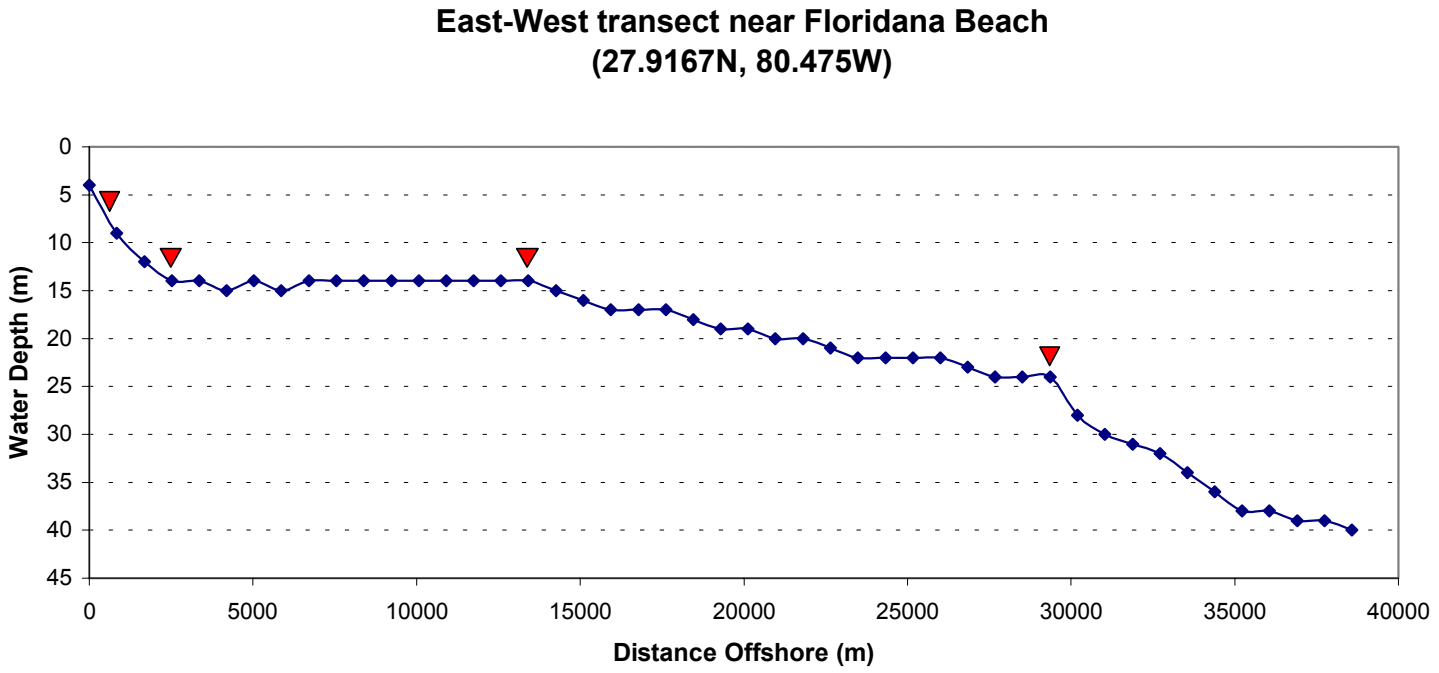

Figure 5 – Potential locations for ADCP directional wave gauges during proposed cross-shelf wave transformation experiment.