Florida Coastal-Forcing Project

- Waves and Winds in the Nearshore -

Progress Report #4

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

Since submittal of the last progress report, PAFB personnel have indicated that permission to use the Melbourne Beach Optical Tracking Annex has been granted, although the signed agreement has not yet been received. Assuming that the final paperwork will come through eventually, work on development of the Test Site has proceeded:

- On May 30, S.E.S. personnel scuba-dived offshore of the Annex to explore the site. Working during low tide, the boat was positioned directly offshore of the Annex, at a water depth of 27 ft (considered optimal for wave gauge deployment). This location was approximately 2050 ft seaward of the dune line. Using a jet-probe, the sand bottom was probed to a depth of ~10 ft, in search for any underlying rock. Four probes were made in an area nominally 40 ft on a side, and no indication of rock or other obstructions was found. In addition, the divers swam along a transect towards the shore, performing a visual inspection of the sea floor. The inspection was terminated at a depth of 8 ft, nominally 200 ft from shore, due to deteriorating visibility. Up until this point, the entire transect had a sand bottom. Although there is no indication of rock above the low water line at the Annex site, there is a possibility of buried rock in the very-near shore. Further wading/swimming investigations will be conducted.

- The 3,000 ft long, 7-lead, doubled-armored cable has now been ordered, as well as connectors, strain-relief attachments, and other components. It has been decided to assemble the cable in-house, at a cost of about $6,000, because the price quoted by the gauge manufacturer's affiliate was nearly $15,000.

- The Orlando field office of FDEP has been contacted to arrange for permits to install the gauge and cable at the Annex site. Although it is hoped that the cable can be installed in the July-August time period with the intent of capturing subsequent hurricane swell data, concerns with sea turtle nesting may obviate this. Hopefully, with the aid of personnel from the appropriate agency, the cable can be installed without disruption of any nesting activities.

1.2 Second Deployment of the Wave Gauge at Sebastian Inlet

The RDI Sentinel instrument was redeployed on April 1, 2001 near Sebastian Inlet. All deployment activities were conducted without mishap, and the acoustic signal of the gauge could be heard by the divers before finishing the dive. Although the intended duration of this deployment was approximately 3 weeks due to battery limitations, a persistent Northeaster event precluded retrieving the instrument until May 11. Even with a substantial swell running, the gauge was successfully retrieved - a feat attributed to both the skill of the boat captain and the 'quick-release' design of the wave gauge mount. Upon downloading the wave data, it was discovered that about 60 Mb of data were collected before the batteries died. Analysis of these data is presented below.

1.3 Findings from Second Deployment

During its second deployment, the RDI gauge was able to collect 11 days of observations before battery power ran out, thereby establishing that the total battery capacity with a 20-min sampling burst at 1-hr intervals is approximately 23 days. Measurements from this deployment are presented in Figures 1-6, and findings are consistent with those of the first deployment. However, at the time this report was written the data from the Sebastian Inlet PUV and weather station were not yet available. Figures 1 and 2 present wind speed and direction measured at the NDBC buoy (Station 41009). Figure 3 displays energy-based significant wave height and Figure 4 presents peak spectral period for both the nearshore RDI and the offshore buoy. Nearshore energy levels fall below the offshore data at the beginning of the record when winds are offshore and wave periods reduced. The two records tend to agree towards the end of the record when the wave period grows. Figure 5 presents wave direction and Figure 6 presents mean water level elevation from the RDI gauge.

1.4 Additional Wave Gauge Issues

A meeting was held on May 24, 2001 with a representative of RD Instruments, in which findings from the first Sentinel deployment (see Progress report #3) were discussed. In addition, the goal of the FCFP to eventually operate a network of multiple gauges was reiterated, and price reductions driven by 1) competition with other manufacturers and 2) the potential for multiple orders, were discussed. We were advised to delay purchase of the second Sentinel instrument a few weeks to allow the new price-structure to take affect. The RDI representative also clarified several issues in regard to data collection, processing, and analysis, as well as sought our feedback as to recommended future improvements to their wave gauges.

The Sebastian Inlet Tax District has recently purchased a Sontek acoustic PUV-type wave gauge to replace its aged electromagnetic PUV equipment. It is intended that once this new gauge is installed and operating at the Inlet, the RDI acoustic profiler gauge will be redeployed there as well in order to conduct another side-by-side comparison of available wave measuring technologies.

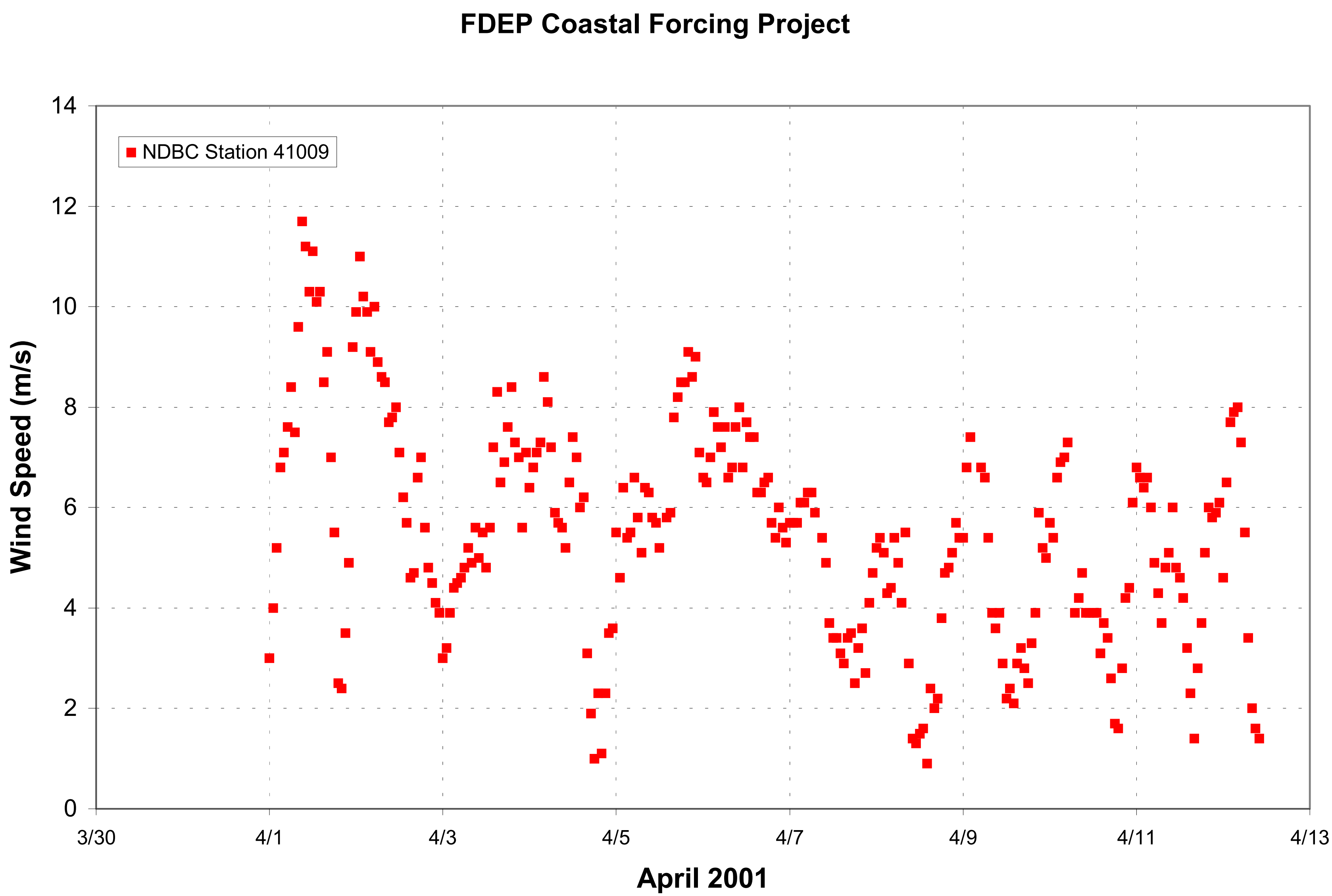

Figure 1 - Wind speed at NDBC Station 41009.

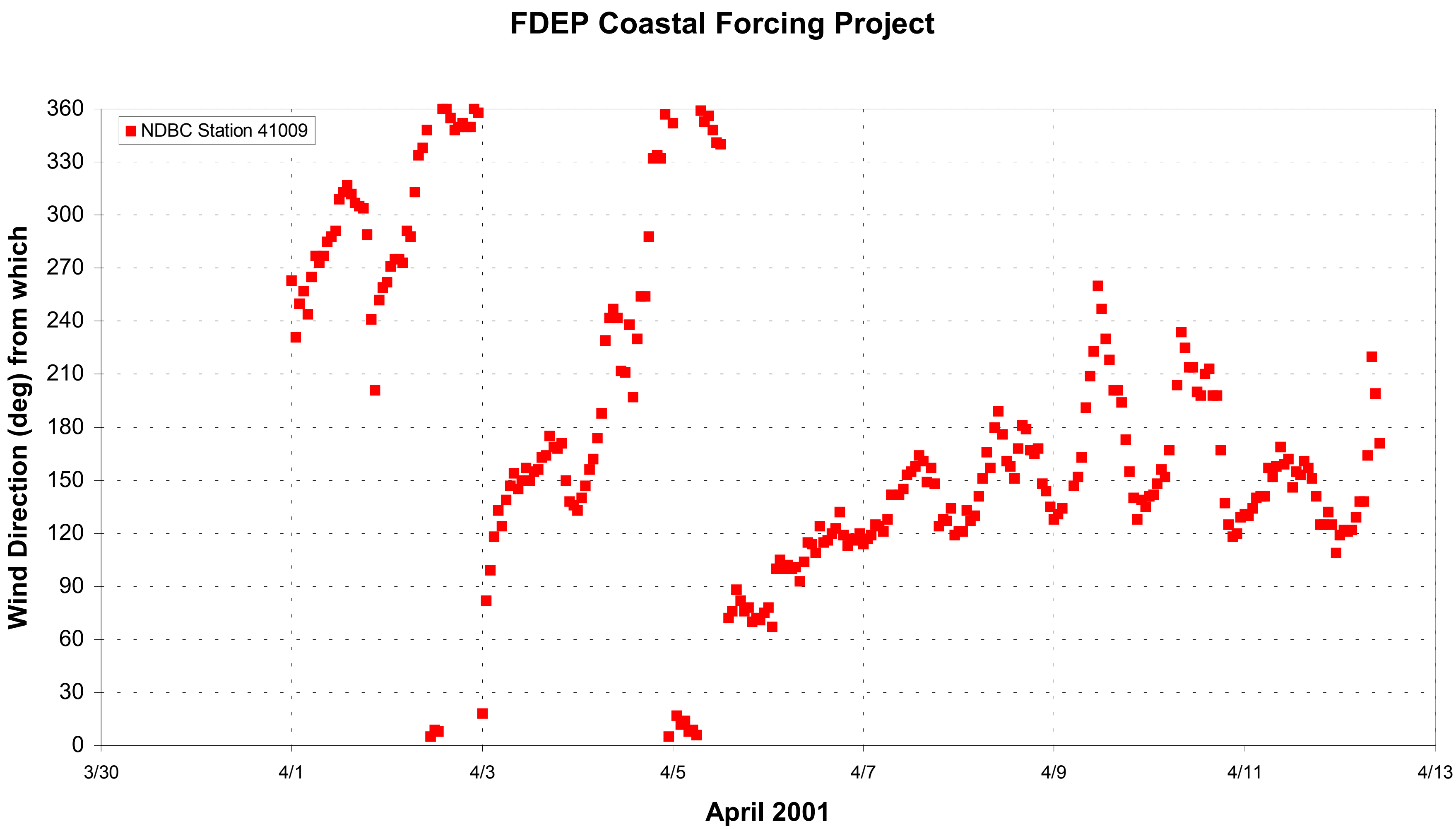

Figure 2 - Wind direction at NDBC Station 41009.

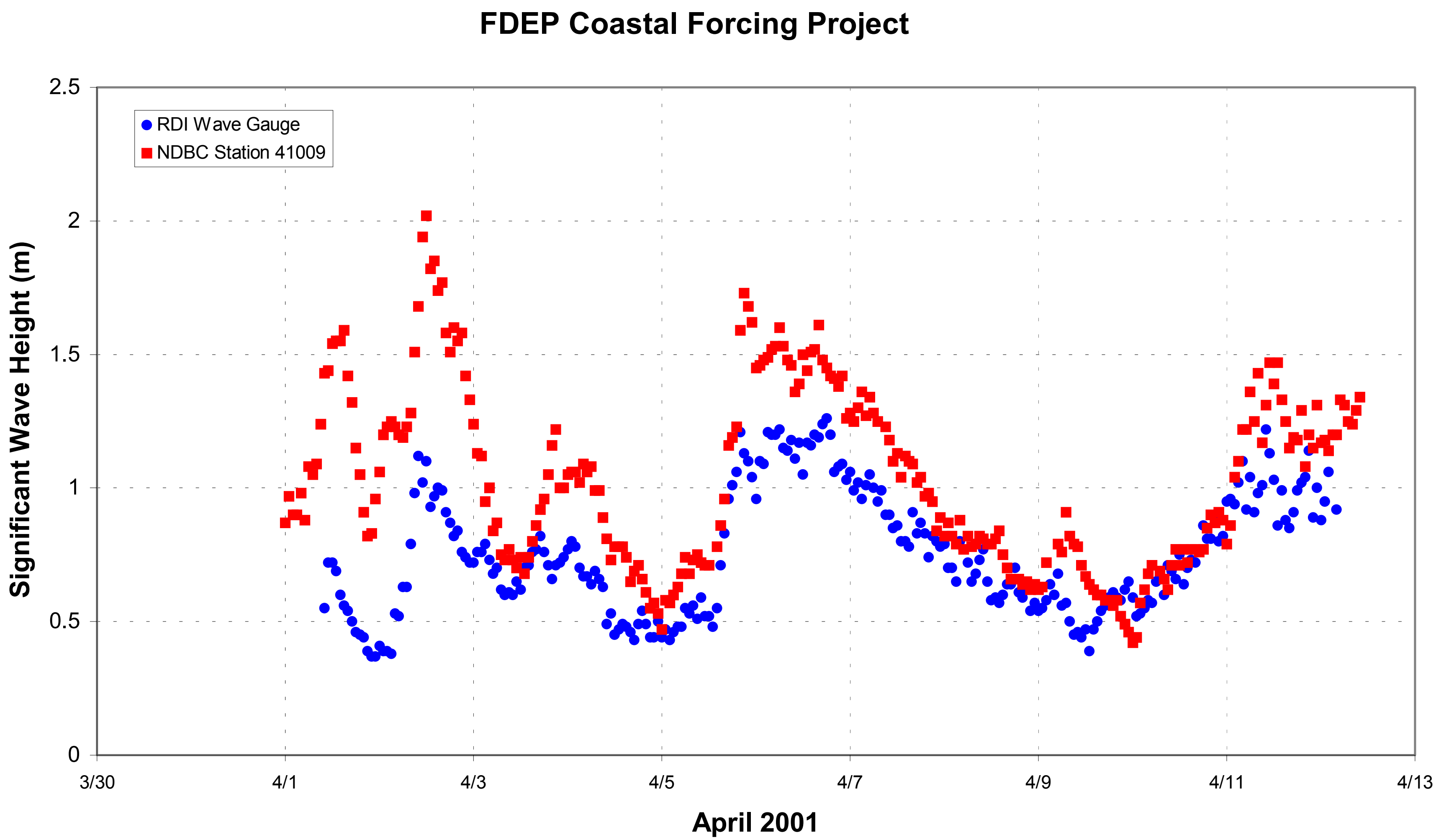

Figure 3 - Energy-based significant wave height at nearshore gauge and offshore buoy.

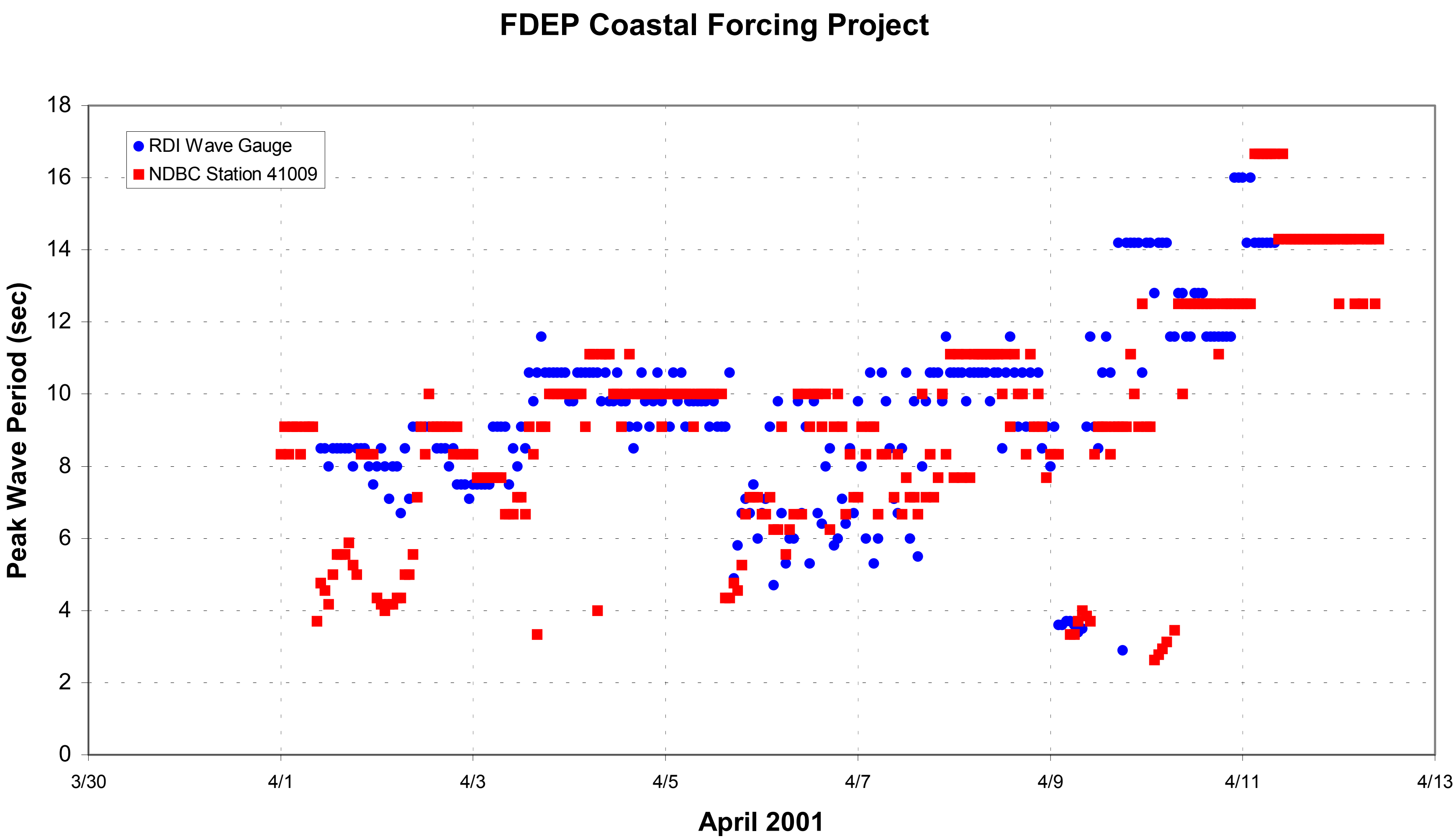

Figure 4 - Spectral peak period at nearshore gauge and offshore buoy.

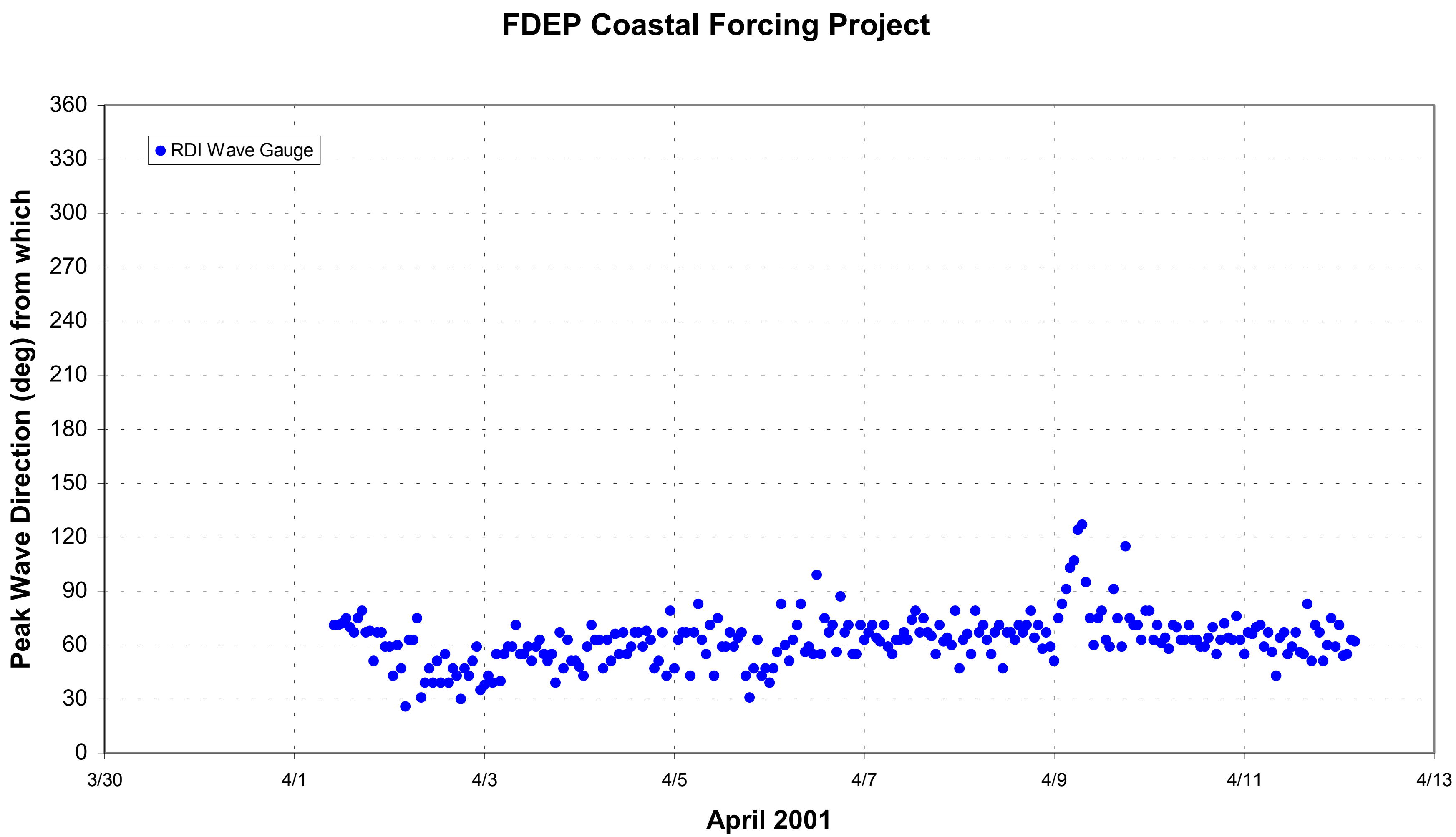

Figure 5 - Spectral peak direction at nearshore gauge.

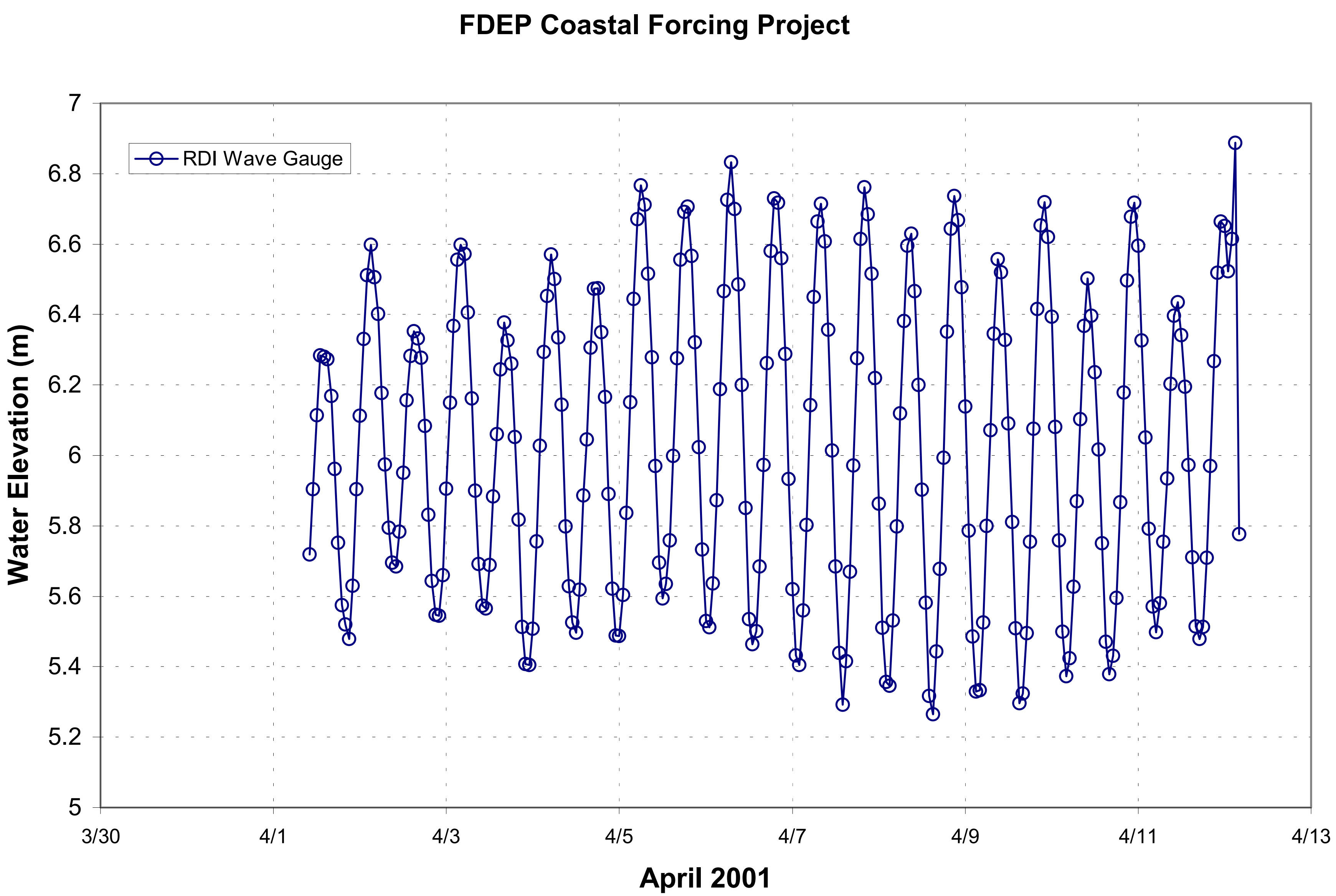

Figure 6 - Mean water level elevation at nearshore gauge.

2. Coastal Processes Modeling

One of the anticipated uses of the nearshore wave database to be developed by the FCFP is to drive computational coastal processes models that are used by FDEP and its university and private-sector contractors (e.g. GENESIS, REF/DIF, and the Dean dune erosion model). In addition, the development and utilization of new processes models is expected to place even greater demands on the database for reliable, detailed wave input information. In support of these modeling activities, it is the intent to eventually use the FCFP wave measurement and hindcasting infrastructure as a foundation from which proper, rigorous tests of processes models can be designed.

As an example, one such model presently under development at S.E.S. is a regional nearshore currents model. In brief overview, the model's governing equations for conservation of mass and momentum are quasi-3D, in that analytical depth-integration is split at the wave trough level so that fluxes associated with the organized wave motion and the breaking wave roller are separated from the underlying current. Presently the currents/set-up model is driven by a simple, period-averaged wave transformation model that describes shoaling, refraction, and depth-limited breaking, which is also used to drive a planform model for the breaking wave roller.

As a test case, a 9,000 ft long stretch of beach that is fronted by large expanses of submerged rock reef (R-10 to R-20 in Indian River County) is being used. Figure 7a shows the highly complex bathymetry owing to the rock reef, whereas Figures 7b, 8a, and 8b provide model demonstration results for wave height, set-up, and nearshore currents respectively. The grid size was 10 ft cross-shore by 200 ft longshore (i.e. ~5,500 cells), with solution requiring less than 30 seconds on a 200-Mhz personal computer. This indicates that the algorithm has potential for even larger-scale, long term applications.

With this background, the point is that there presently exists no data/infrastructure in Florida for rigorously testing such a potentially useful model. It is envisioned that once the Melbourne Beach permanent monitoring station is activated, additional instrumentation might be deployed (but limited in scope) to collect the data needed to validate the currents model. In addition, a comprehensive beach survey monitoring program could be conducted at the site to simultaneously acquire data needed to test beach and dune erosion/evolution models used by FDEP. As more permanent stations in the FCFP network are installed, each immediately provides a new option for testing models in a different wave, wind, and tidal climate.

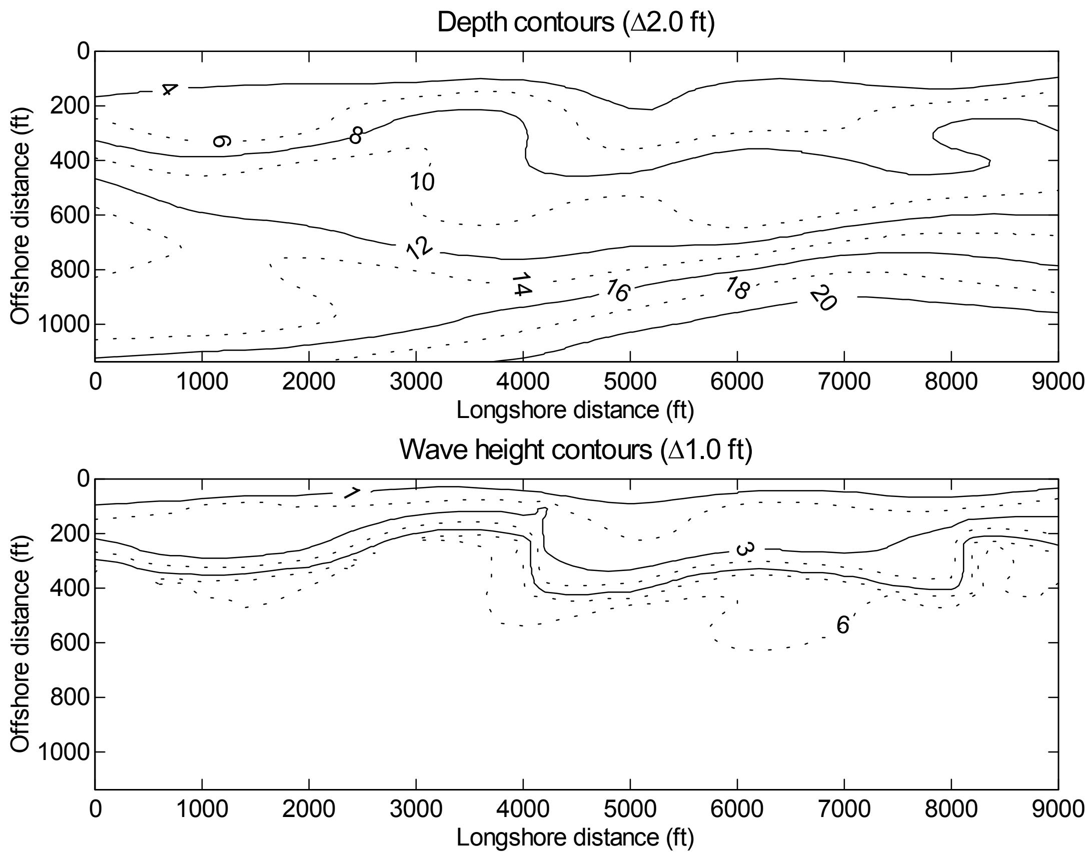

Figure 7 - Complex bathymetry (a) and model results for wave height (b) for test case. Deepwater wave conditions are H_o= 5 ft, T= 8 s , θ_o= 30°.

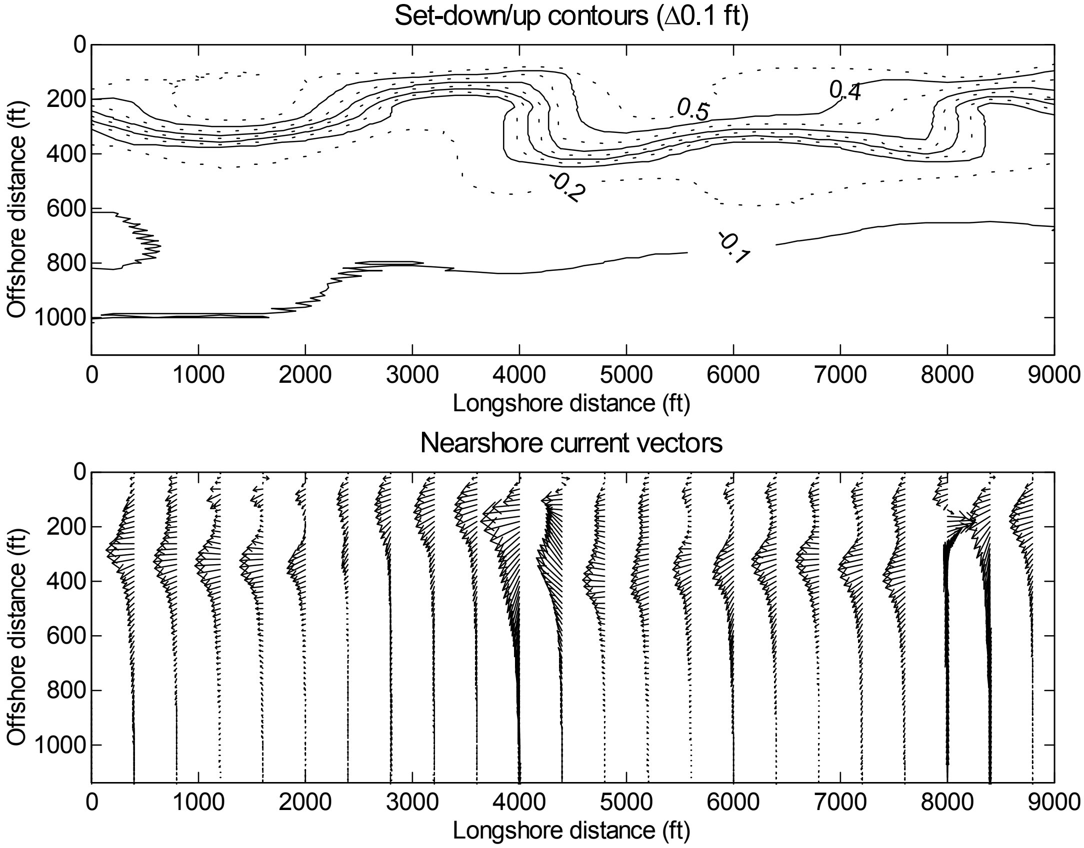

Figure 8 - Model results for set-down/up (a) and currents (b) for test case (H_o= 5 ft, T= 8 s , θ_o= 30°).