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Biscayne Bay Data Quality Assurance Report

By

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Submitted September 9, 1999

Introduction

In accordance with the Work Statement, Rev. 3.0, describing the eventual analysis and interpretation of the Biscayne Bay data base, the first deliverable was a Quality Assurance Report. Accordingly, the purpose of this report is to describe the suitability of the acoustic doppler profiler (ADP), water level recorder and weather station data for model validation purposes. Data analysis and interpretation will follow, and a Final Report will contain text, tables and plots. The Work Statement requires that the Quality Assurance Report be submitted during or before October, 1999, and that the Final Report be submitted by mid May 2000.

This report follows a close inspection of the ADP, water level and weather data, and it includes comments on the suitability of each part of the data base. Generally speaking, the weather data are continuous and well suited for an analysis. Only one of the water level records contained a gap, but there are questions surrounding the start and end times of each record. This is discussed further below. ADP records are fragmented in most cases, but segments from each of the five study sites are suitable for analysis. In the following three sections, water level, ADP and weather data are discussed separately within the restricted context of pre-analysis data manipulation and editing, and post-analysis model validation.

Before data were put on a compact disk, ADP and weather records were broken into monthly segments. While this may be useful for some users or purposes, our first task was a time-consuming concatenation of the monthly records to obtain the longest time series possible between breaks. We noted that in the process of constructing monthly segments, the final observation of each month was dropped.

Water Level Data

Water level records were collected at eleven locations (see Table 1) in Barnes Sound, Card Sound and Biscayne Bay. Data were collected at 15-minute intervals, but for comparison with wind records and tidal analyses the water level data were sub-sampled at

hourly intervals. Only Station TG-7 had a break, but the segment following the gap is suitable for analysis

Timing errors of two kinds were found in the water level data. All records starting before approximately mid July are apparently annotated in Eastern Daylight Time; those records starting after mid July are apparently annotated in Eastern Standard Time. This change became apparent when results of harmonic analyses were compared with results of harmonic analyses made by the National Ocean Service, using data collected at nearby study sites. Only when daylight-to-standard time changes were made did spatial patterns of local phase angles fall into place. Without these changes, phase angles indicated unrealistic patterns of M_2 tidal wave propagation. We will make an attempt to get copies of the field notes taken when water level recorders were installed, downloaded and recovered. We assume that annotations made in the field will refer specifically to EST or EDT.

The second kind of timing error in the water level records results from dropped observations. The time stamps on the files were apparently added to the raw data after the records had been downloaded. Thus the time stamp does not indicate missing data. Both the analog plots of the data and the local phase angles of the tidal constituents, however, indicate missing data. We have added a single hourly observation where it appeared to be missing in the analog plots, and when local phase angles were inconsistent throughout a given record. It is not clear, however, whether one hour (four quarter-hourly observations) is the appropriate correction. Given that the observations were made quarter-hourly, three or five quarter-hour observations, for example, could be the appropriate correction.

Acoustic Doppler Profiler (ADP) Data

Four of the five ADP records are fragmented, data from Station ADP-1 begins midway through the study, the data from Station ADP-5 was badly fragmented (resulting in six segments) and the data from Station ADP-4 are largely missing. Short segments are suitable for harmonic analysis if they are more than 29 days long, however. Short segments can also be used in spectral analyses, but little information is obtained over the longer time scales. In particular, spectral resolution is poor in the 1-2 week range of periodicities where wind forcing is usually most important.

No independent check can be made on the ADP time annotations. Given the questions surrounding EST vs. EDT annotations in the water level, we cannot be confident that a time stamp of "1200" in the ADP data indicates noon EST. This is separate from any timing errors that might arise from internal clocks running fast or slow. Again, field annotations may be helpful. Clearing up the EST-EDT timing question is important, because the model will be run in EST. If flow patterns at any given time are to match observations, both must be on EST. Model results, in EST, that perfectly match observations, in EDT, are incorrect.

The ADP data at Station 2 were recorded at intervals of 20-minutes, while the sampling interval in all other ADP records was 15 minutes. This required modifications in several of the programs used to patch gaps and standardize the sampling interval at one hour. Time spent in re-programming is time unavailable for analysis and interpretation.

A puzzling feature of the ADP data is the (apparent) decision to program the ADP loggers to record data at different times. For example, some ADPs were taking "top-of-the-hour" readings at eight minutes before the hour, while others were taking readings at four minutes before the hour or six minutes after the hour. We don't know if this reflects a conscious decision to correct for known internal clock errors, or if this was unintentional. In the latter case, it would degrade comparisons between wind forcing and currents. Our approach was to assume that the observations nearest the top of the hour represented conditions at the top of the hour. All observations were time-shifted accordingly before plotting, and these time-corrected records will be used in our analyses.

Weather Data

Weather data appear to be in good shape, although there are minor problems associated with both the Convoy Point and the Fowey Rocks data. A short segment of the Convoy Point data included unrealistic air temperature readings, and at those times air density could not be quantified in wind stress calculations. Data from Fowey Rocks did not contain timing errors, but there were several short breaks in the record. All gaps were patched to form continuous records for analysis.

Convoy Point weather data arrived on the compact disk in two forms. Data were in a comma-separated free format for the most part, but parts of the record had apparently been put through a spreadsheet. These observations were in columns, but with embedded special characters (tabs) that could not be read by the fortran programs used to analyze the data. The special characters were eventually removed, but the time spent doing this could have been put to better use in an analysis or interpretation of the data. Especially troubling were data from August, 1997, which started in comma-separated form but then ended in tabbed form.

Even with a uniform format, the EDT-EST question applies to the Convoy Point weather data just as it applies to the water level data. We have assumed that all data were recorded in EST. If this is incorrect, weather data fed into the model in EDT will not result in simulated flow patterns that match observations--unless the observations are in EDT as well.

Executive Summary

The data base should be suitable for model validation, in spite of uncertainty in timing, frequent data gaps, different sampling intervals and formats and incorrect time stamps. The uncertainty surrounding the observations translate into uncertainty in comparisons involving observed and simulated conditions. The observational database will be suitable for confirming that the model is a close approximation of reality, but "how close" cannot be determined.

The following pages contain plots of the data with a brief statement of the suitability. A table, summarizing station locations and study periods, concludes the report.

Figure 1. Analog plot of water levels (m) recorded at study site TG-1 (Manatee Bay) from June 6 to October 22, 1997. Preliminary analysis indicated a missing observation at 1600 July 8. An interpolated value was inserted and it was assumed the time series began at 1200 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

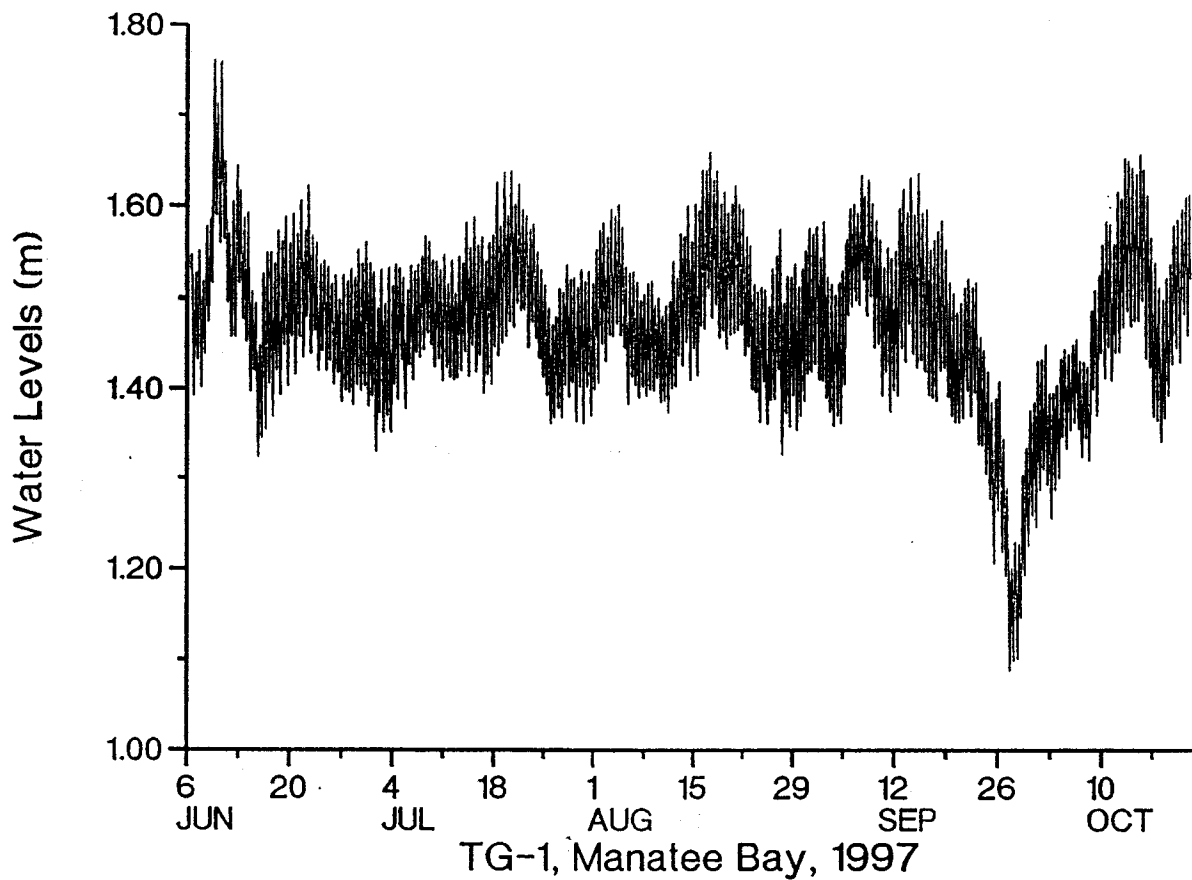


Figure 2. Analog plot of water levels (m) recorded at study site TG-2 (Card Sound Bridge) from June 13 to October 22, 1997. Preliminary analysis indicated a missing observation at 1500 July 8. An interpolated value was inserted and it was assumed the time series began at 1200 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

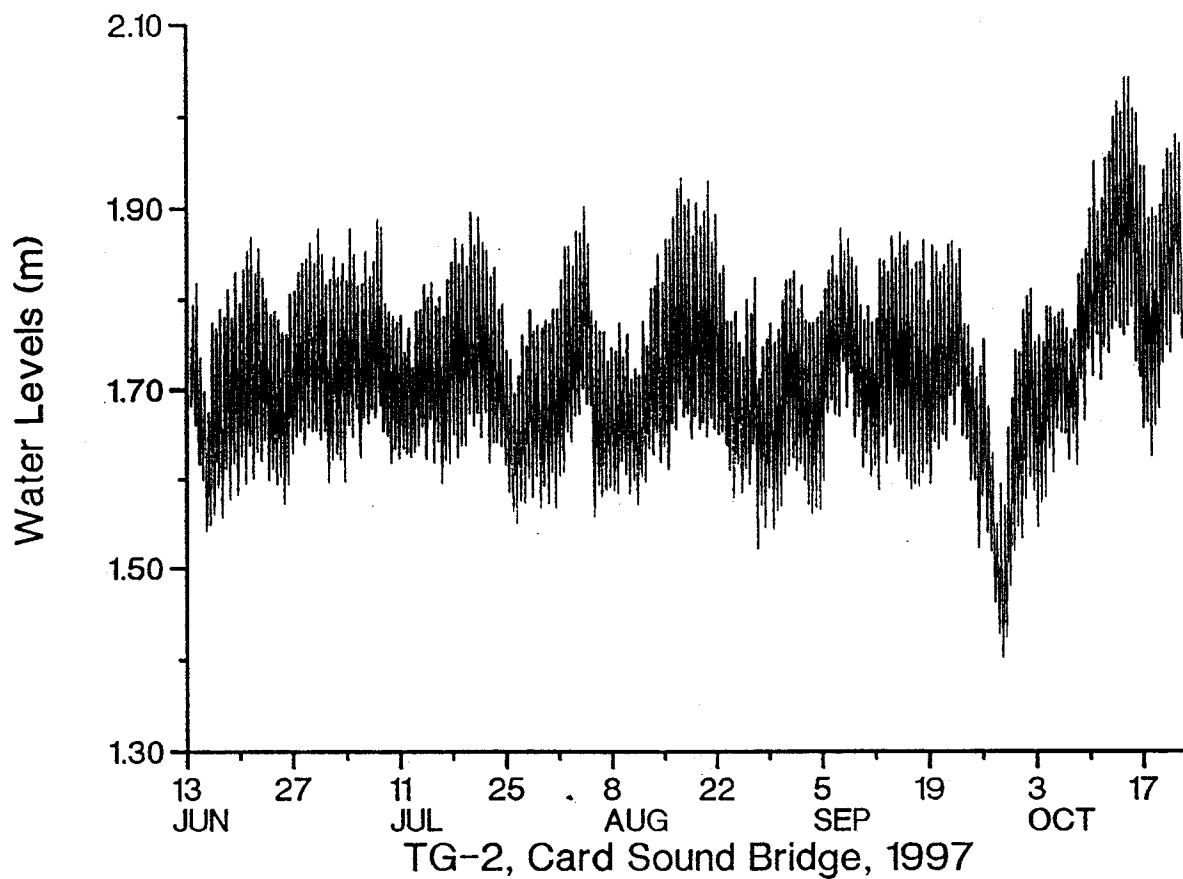


Figure 3. Analog plot of water levels (m) recorded at study site TG-3 (Angelfish Creek) from June 6 to October 22, 1997. Preliminary analysis indicated a missing observation at 1400 July 2. An interpolated value was inserted and it was assumed the time series began at 1300 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

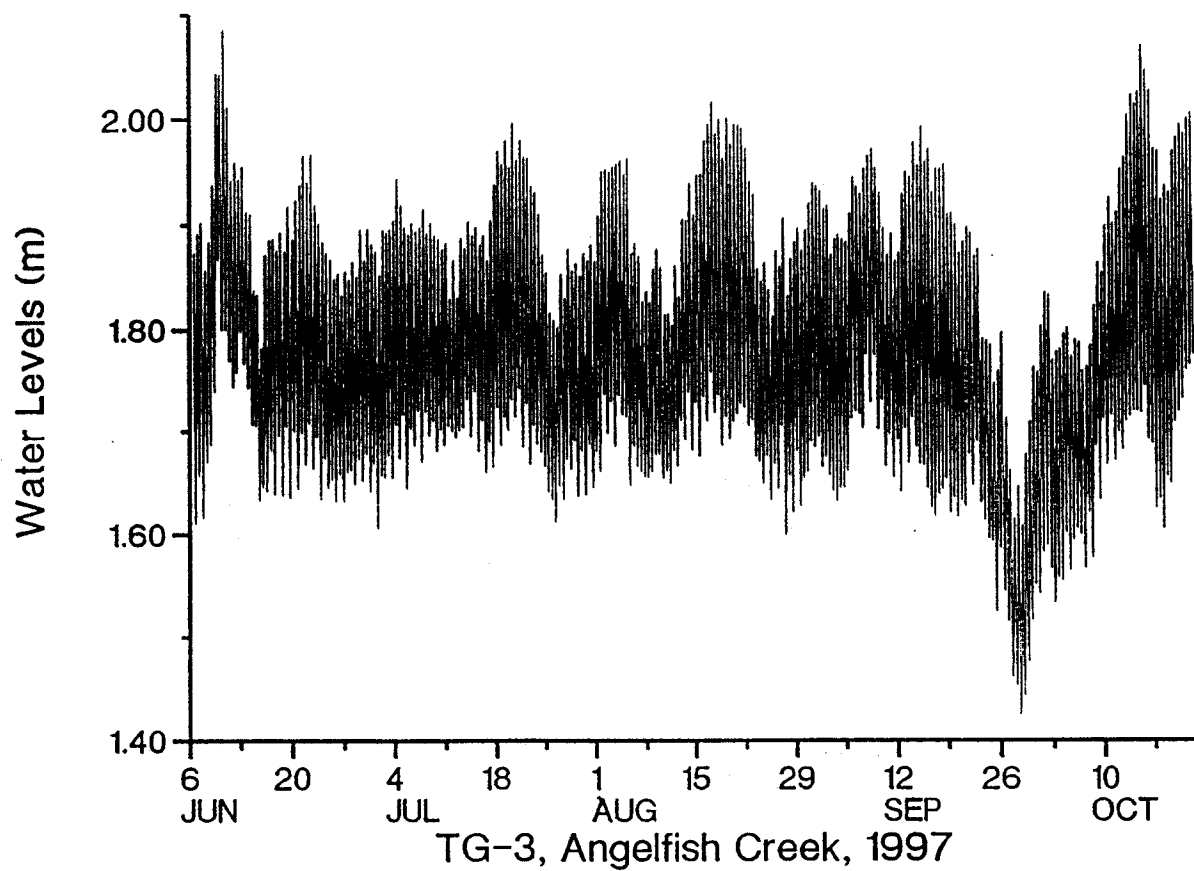


Figure 4. Analog plot of water levels (m) recorded at study site TG-4 (Military Canal - East) from June 6 to October 23, 1997. Preliminary analysis indicated a missing observation at 1100 July 10. An interpolated value was inserted and it was assumed the time series began at 1400 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

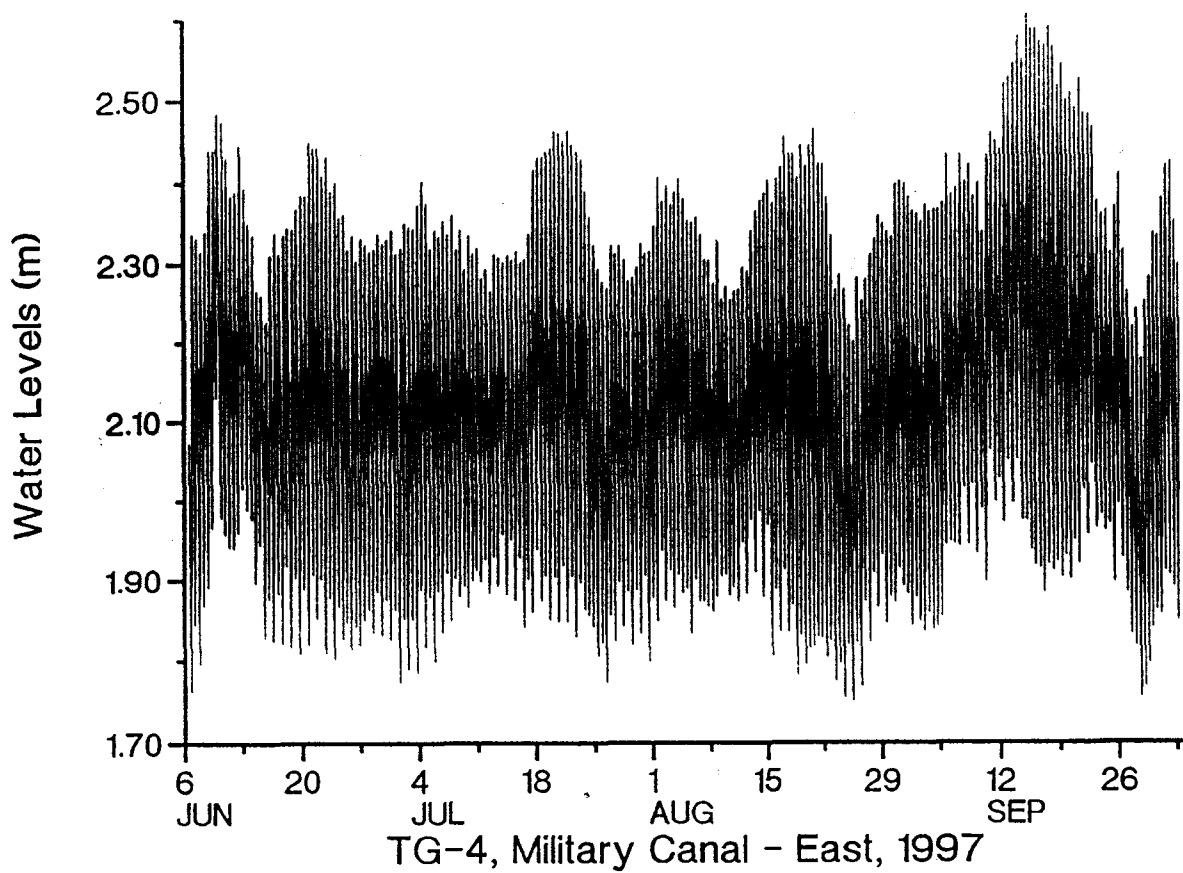


Figure 5. Analog plot of water levels (m) recorded at study site TG-5 (Military Canal - West) from July 10 to October 3, 1997. It was assumed the time series began at 1400 Eastern *Standard* Time. The raw data from this study site are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

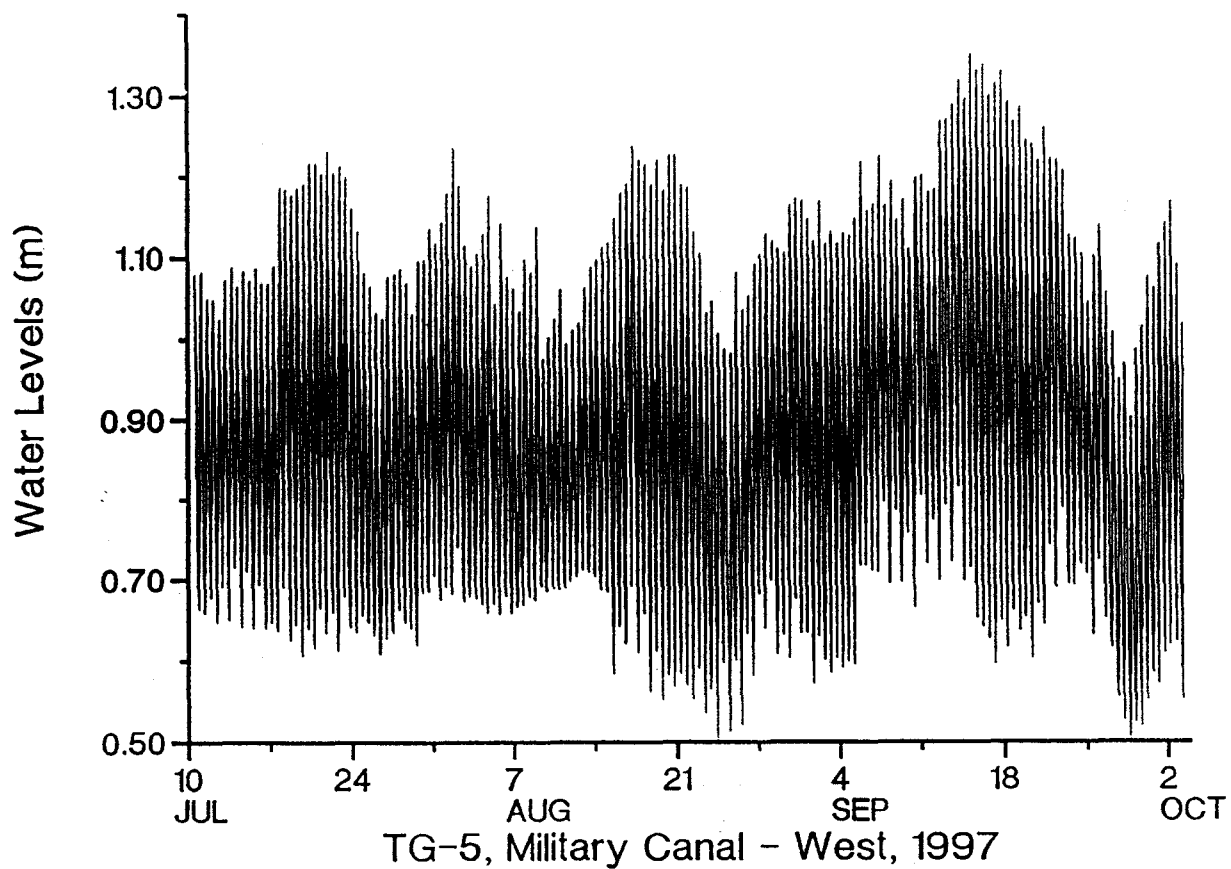


Figure 6. Analog plot of water levels (m) recorded at study site TG-6 (Black Point Marker 8) from June 6 to October 3, 1997. Preliminary analysis indicated a missing observation at 1200 July 10. An interpolated value was inserted and it was assumed the time series began at 1400 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

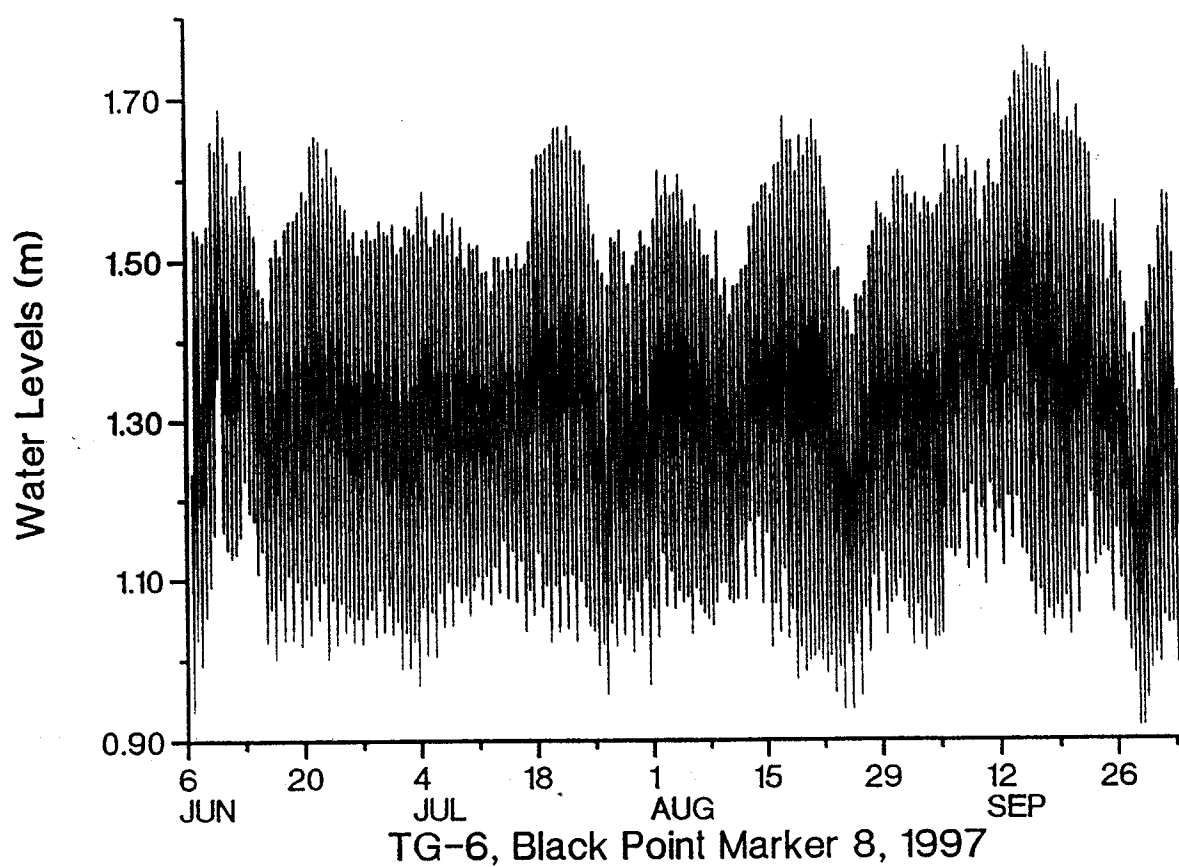


Figure 7. Analog plot of water levels (m) recorded at study site TG-7 (Snapper Creek) from July 10 to July 29 and September 10 to October 8, 1997. It was assumed that start times for both segments from this site were in Eastern *Standard* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

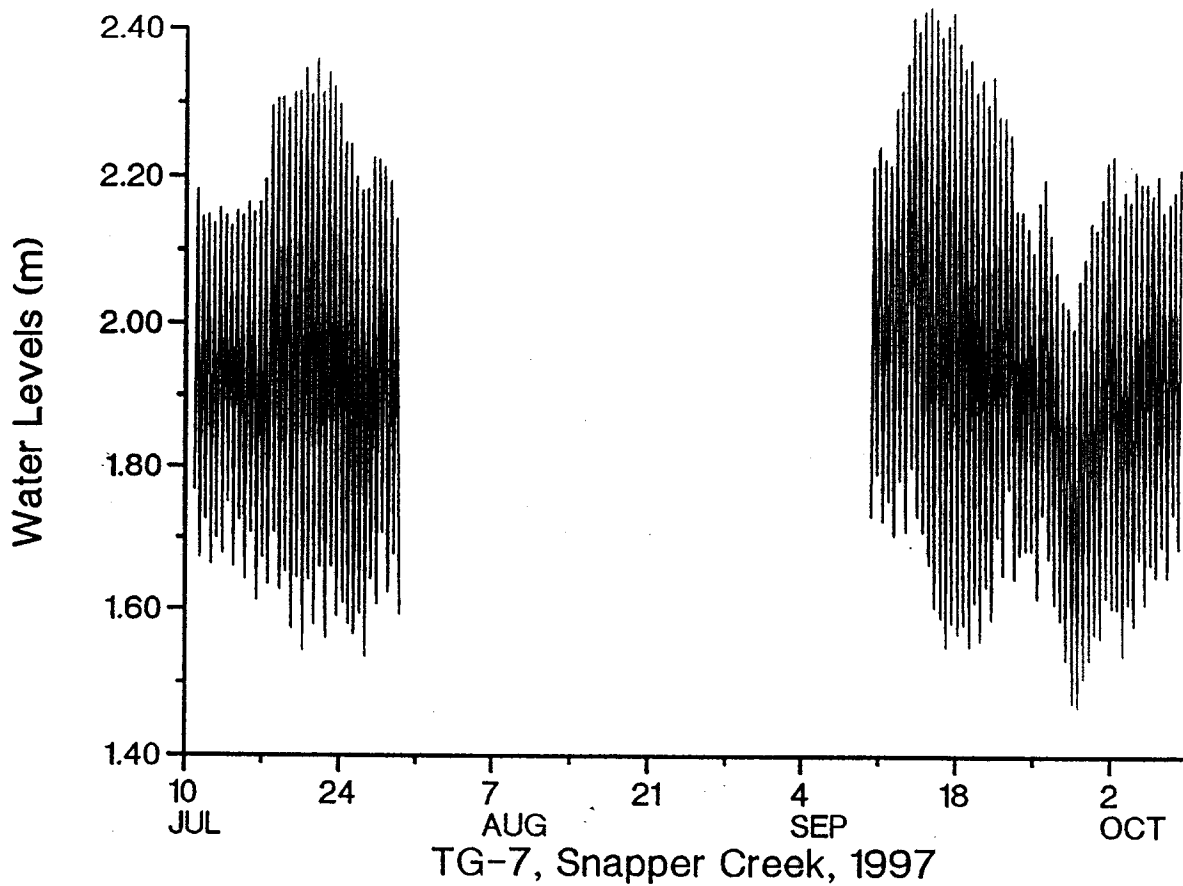


Figure 8. Analog plot of water levels (m) recorded at study site TG-8 (Gables by the Sea) from June 12 to October 8, 1997. Preliminary analysis indicated a missing observation at 1500 July 15. An interpolated value was inserted and it was assumed the time series began at 1200 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

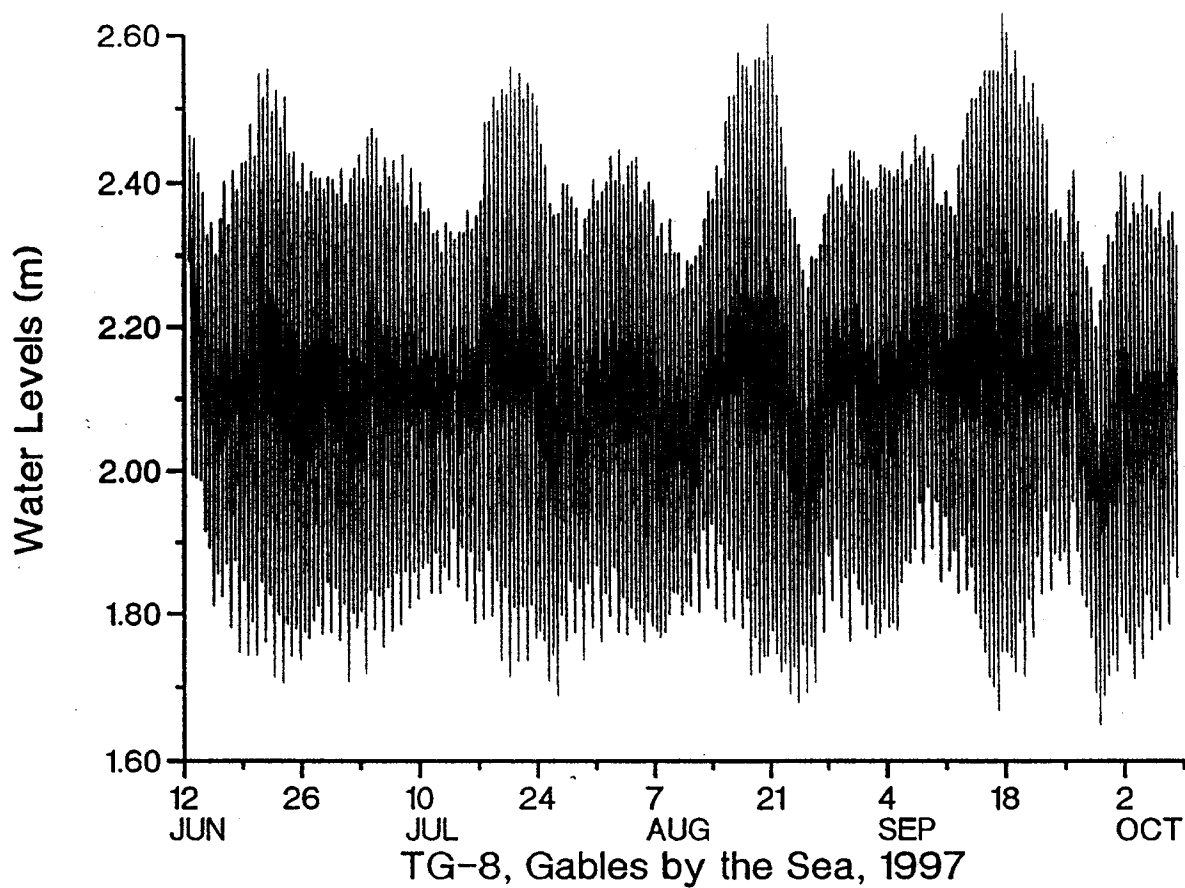


Figure 9. Analog plot of water levels (m) recorded at study site TG-9 (Biscayne Channel Marker 10) from June 12 to October 9, 1997. Preliminary analysis indicated a missing observation at 1400 July 15. An interpolated value was inserted and it was assumed the time series began at 1300 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

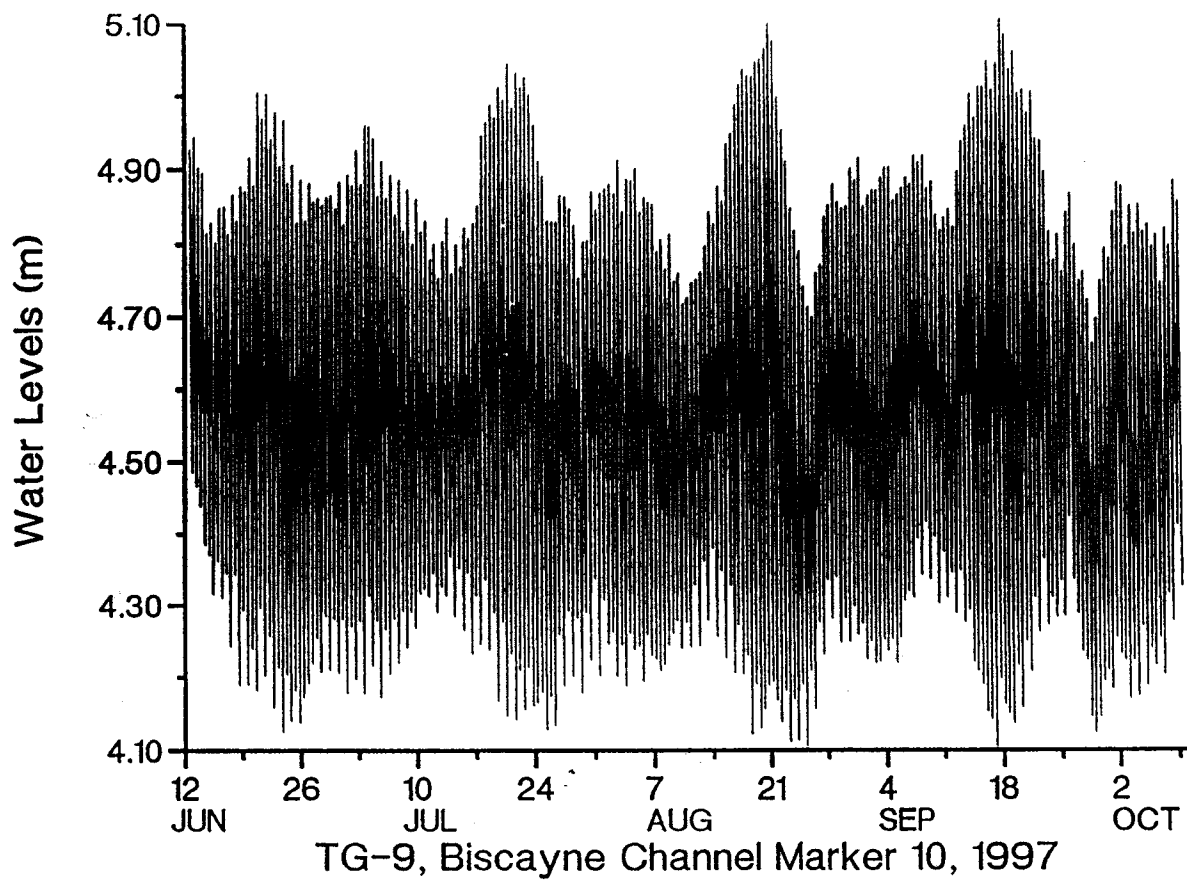


Figure 10. Analog plot of water levels (m) recorded at study site TG-11 (Julia Tuttle Causeway Marker 35) from August 1 to October 20, 1997. It was assumed the time series began at 1300 Eastern *Standard* Time. The raw data from this site are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

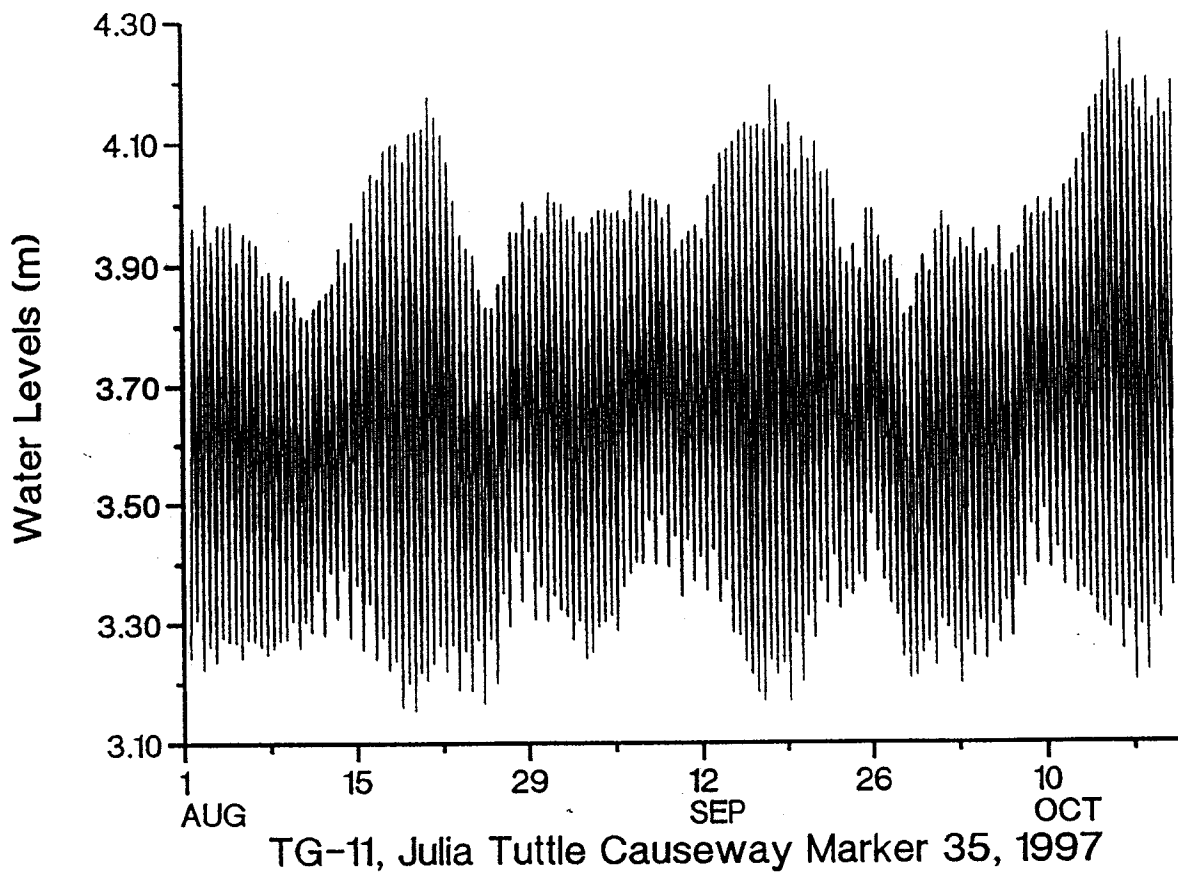


Figure 11. Analog plot of water levels (m) recorded at study site TG-12 (Broad Causeway Marker 13) from June 18 to October 20, 1997. Preliminary analysis indicated a missing observation at 1300 July 15. An interpolated value was inserted and it was assumed the time series began at 1400 Eastern *Daylight* Time. With these changes, the raw data are suitable for harmonic analysis to quantify the tidal signal and spectral analysis with weather data from the Fowey Rocks C-MAN Station to quantify the response to wind forcing.

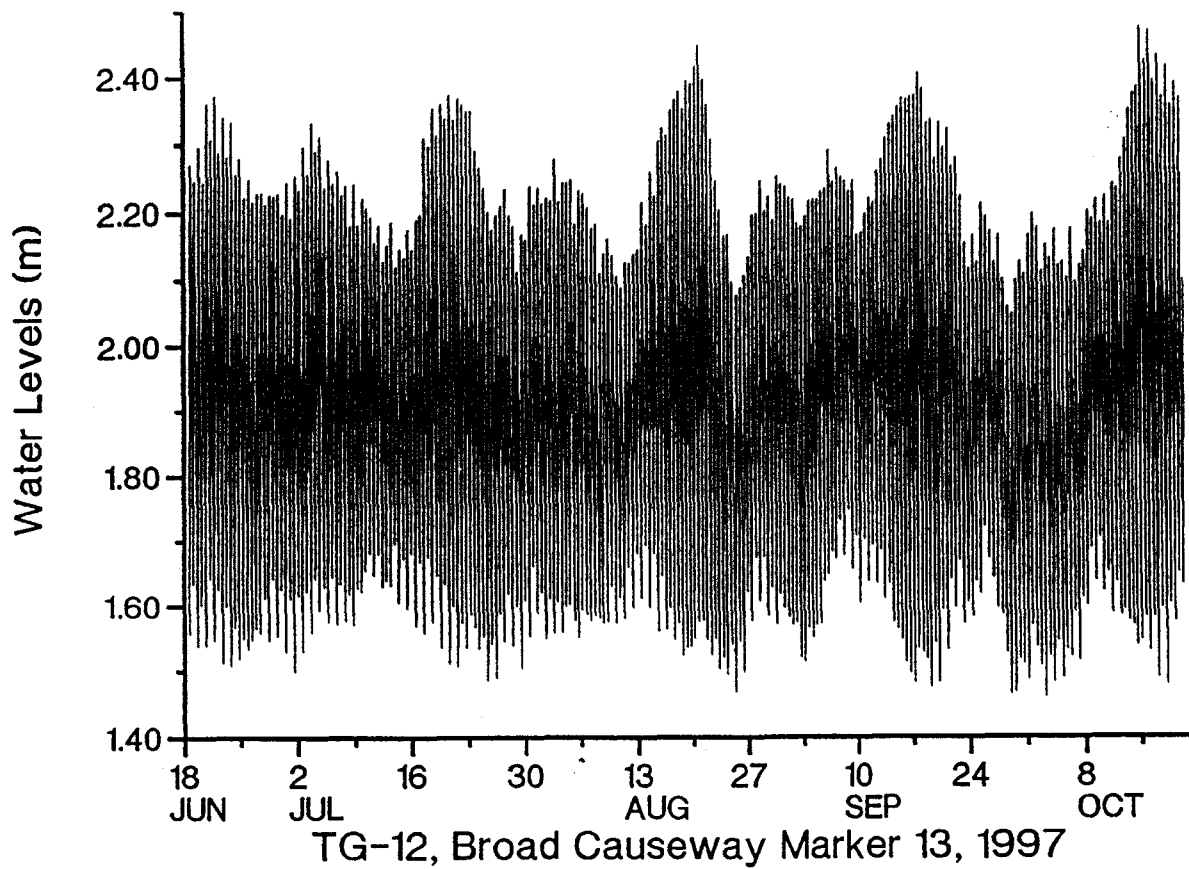


Figure 12. Acoustic doppler profiler data from Station ADP-1 in northern Card Sound near the mouth of Angelfish Creek. A single continuous record is available from December 21, 1997 to July 12, 1998. Shown here are vertically-averaged north-south (top) and east-west (bottom) current components. The data look good, and the entire time series should be suitable for an analysis of tidal conditions, and for a comparison with Convoy Point weather data to quantify the response to wind forcing.

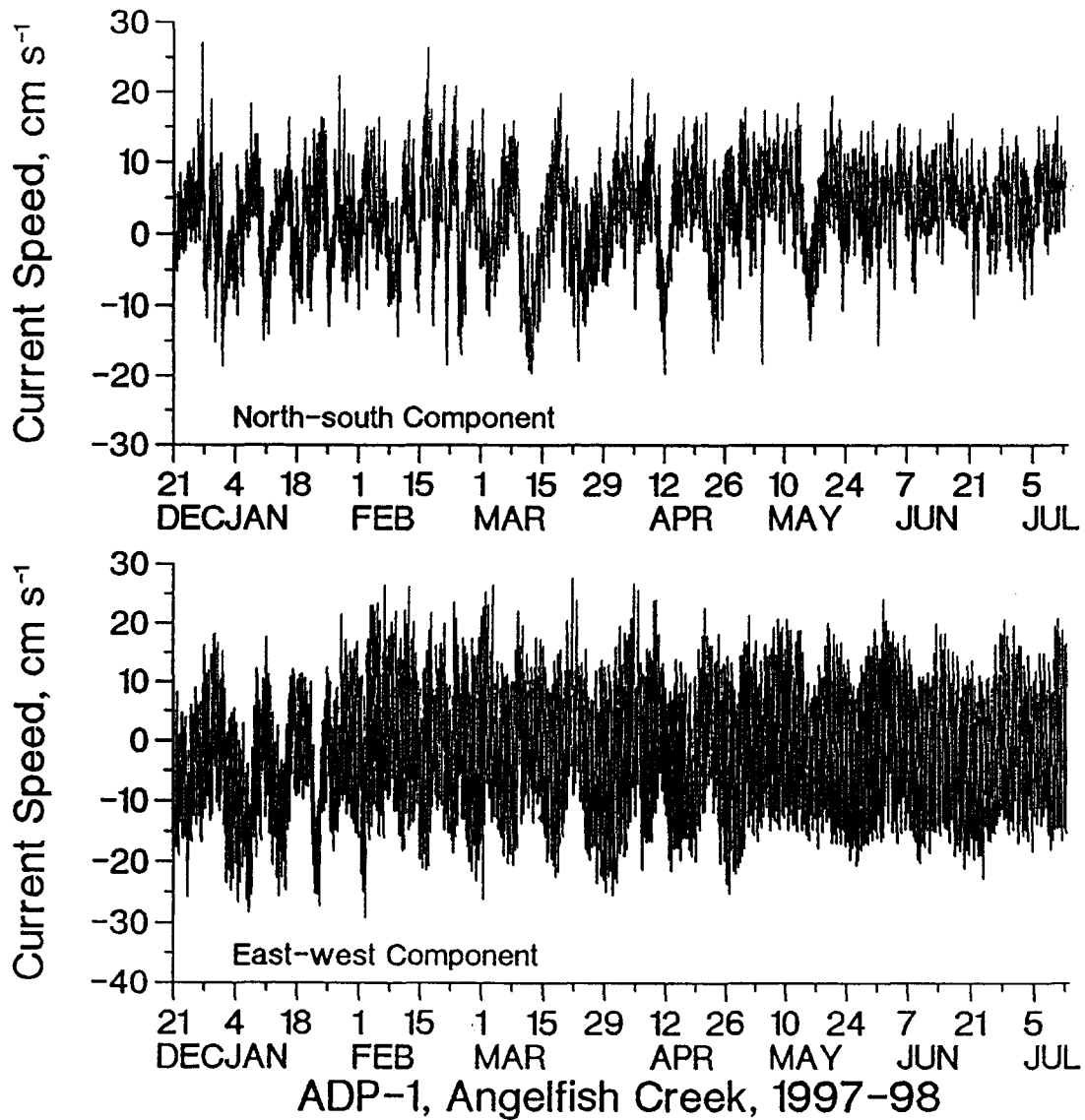


Figure 13. Acoustic doppler profiler data from Station ADP-2, in south-central Biscayne Bay. Data are available from three time periods during the June 27, 1997 to June 10, 1998 study. Shown here are vertically-averaged north-south (top) and east-west (bottom) current components. The middle data segment is too short for a spectral analysis, but the first and third segments will be suitable for analysis of tidal conditions, and for a comparison with Convoy Point weather data to quantify the response to wind forcing.

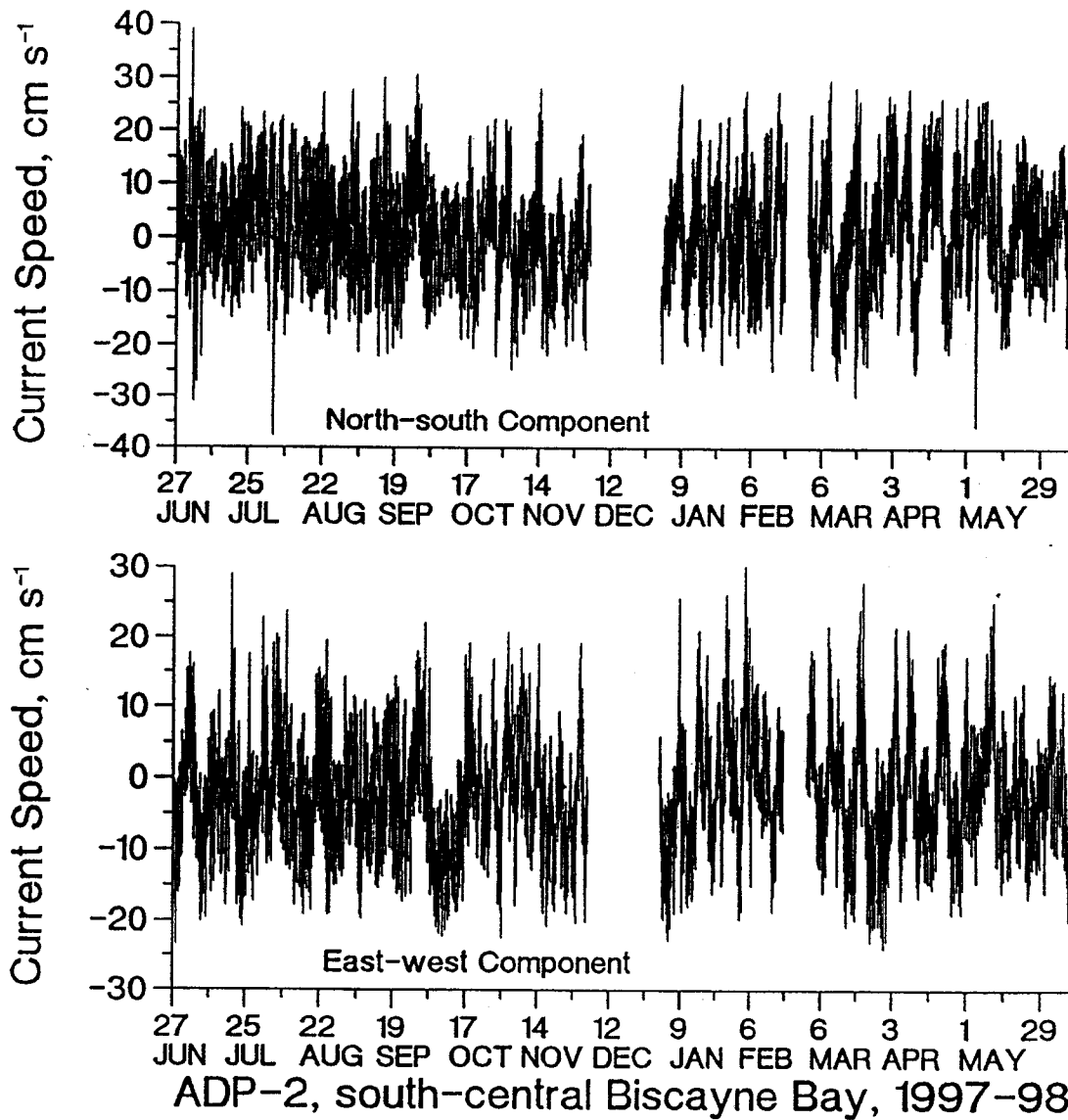


Figure 14. Acoustic doppler profiler data from Station ADP-3 in north-central Biscayne Bay, just west of the Safety Valve at Marker 1A. Data are available from three time periods during the June 26, 1997 to July 31, 1998 study. Shown here are the vertically-averaged north-south (top) and east-west (bottom) current components. The middle data segment is too short for a spectral analysis, but the first and third segments will be suitable for an analysis of tidal conditions, and for a comparison with Convoy Point weather data to quantify the response to wind forcing.

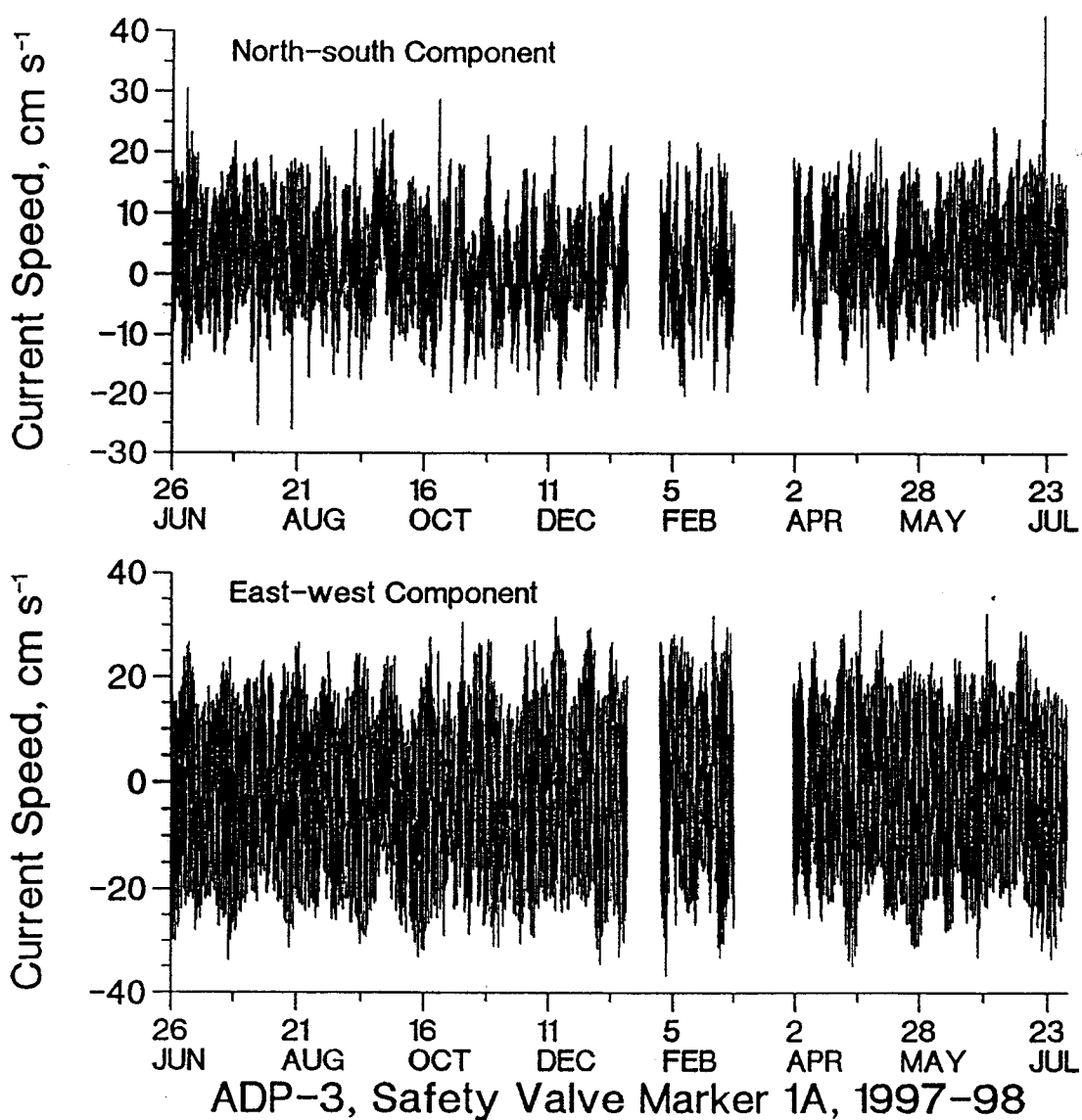


Figure 15. Acoustic doppler profiler data from Station ADP-4 in northern Biscayne Bay and just north of West Point at Bear Cut Marker 1. Data are available from three short time periods during the June 26, 1997 and March 21, 1998 study (a fourth data segment, from May 1-6, was fragmented and has not been plotted). Shown here are the vertically-averaged north-south (top) and east-west (bottom) current components. All three segments are very short, but the east-west components can be used for an analysis of tidal conditions. A comparison of the north-south components suggests that the first segment (June 26 to August 12) should not be used in either a harmonic analysis or a spectral analysis. North-south component currents in that segment are generally $\pm 10 \text{ cm s}^{-1}$, while north-south components in the second and third segments are 3-4 times larger. The second and third segments (both current components) can be used in harmonic analyses to characterize tidal conditions, but neither is suitable for a meaningful spectral analysis to investigate the response to wind forcing at this location.

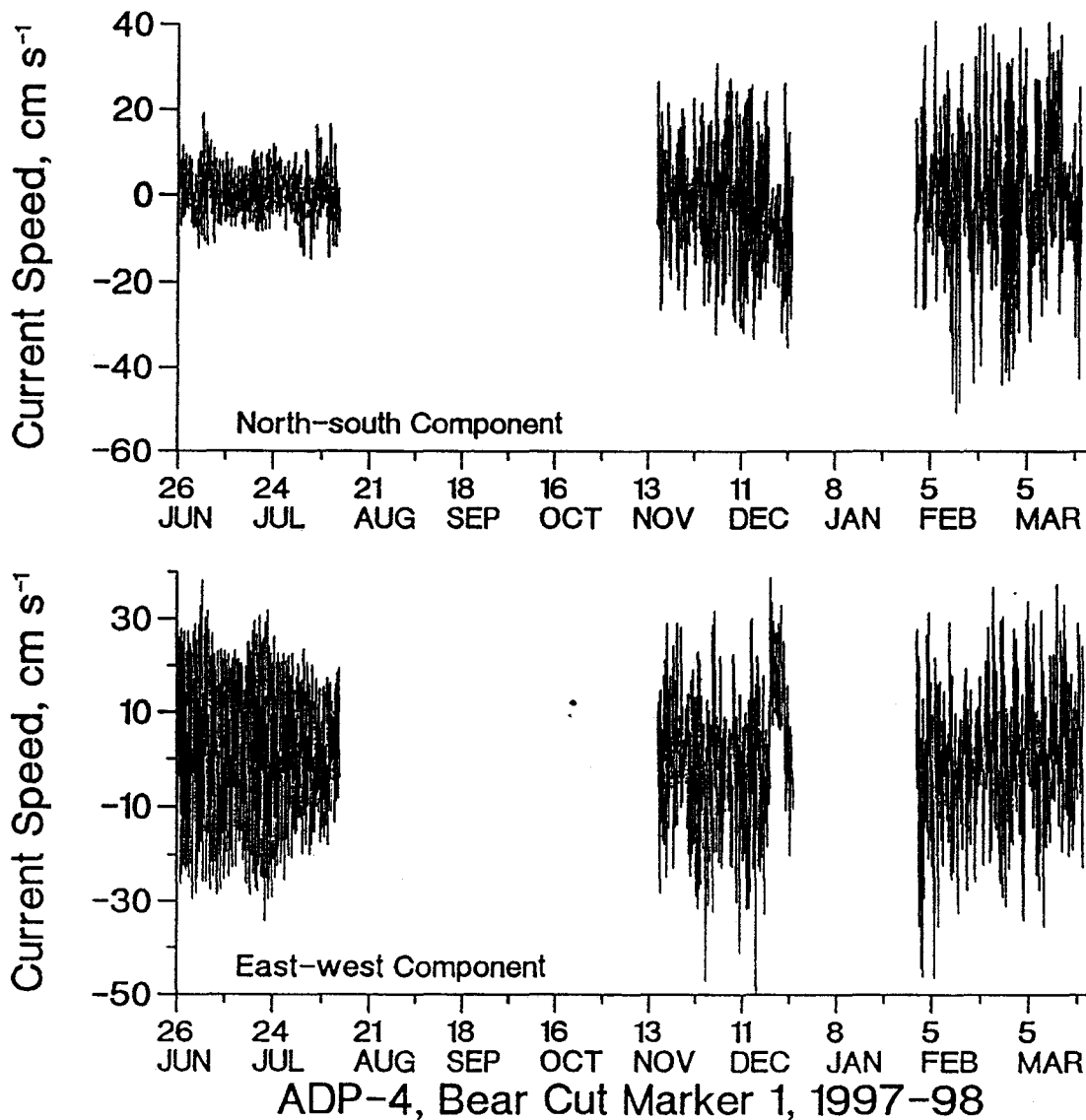


Figure 16. Acoustic doppler profiler data from Station ADP-5 in northern Biscayne Bay, at the Julie Tuttle Causeway Marker 35. Data are available from six time periods during the June 28, 1997 to July 31, 1998 study. Shown here are the vertically-averaged north-south (top) and east-west (bottom) current components. The second, fourth, fifth and sixth data segments are too short for spectral analyses, but only the second segment is too short for a tidal analysis. The first and third data segments will be compared with weather data from Convoy Point to investigate the response to wind forcing.

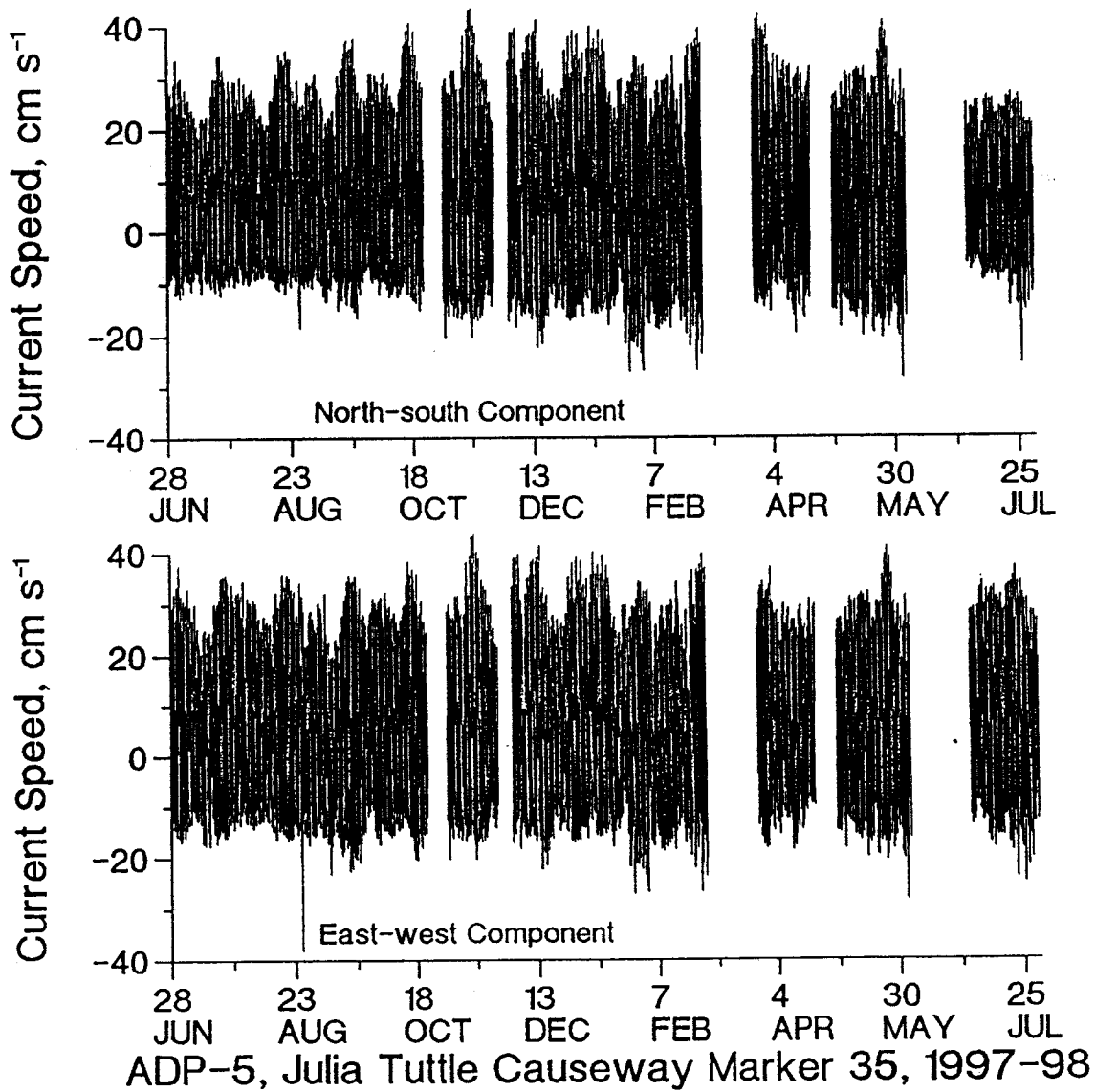


Figure 17. Wind stress data, calculated from weather observations made at Convoy Point from July 17, 1997 to July 8, 1998. Shown here are north-south (top) and east-west (bottom) components. A single continuous record is available for comparison with overlapping segments of ADP data from throughout Card Sound and Biscayne Bay.

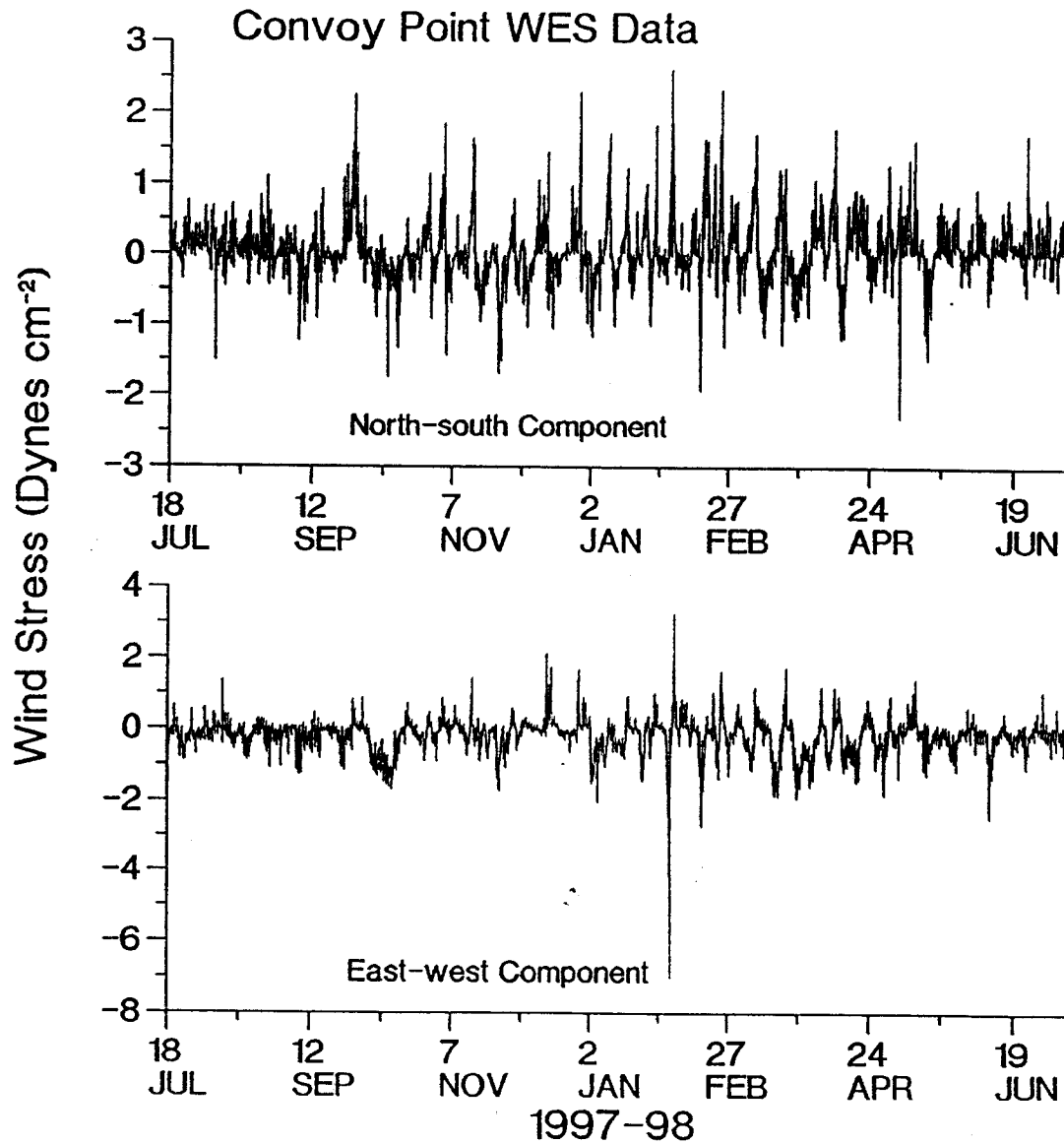


Figure 18. Wind stress data, calculated from weather observations made at Fowey Rocks from June 6 to October 22, 1997. Shown here are the north-south (top) and east-west (bottom) components. Data gaps during this time period were short, and with interpolations a continuous record is available for comparison with overlapping segments of water level data from throughout Card Sound and Biscayne Bay.

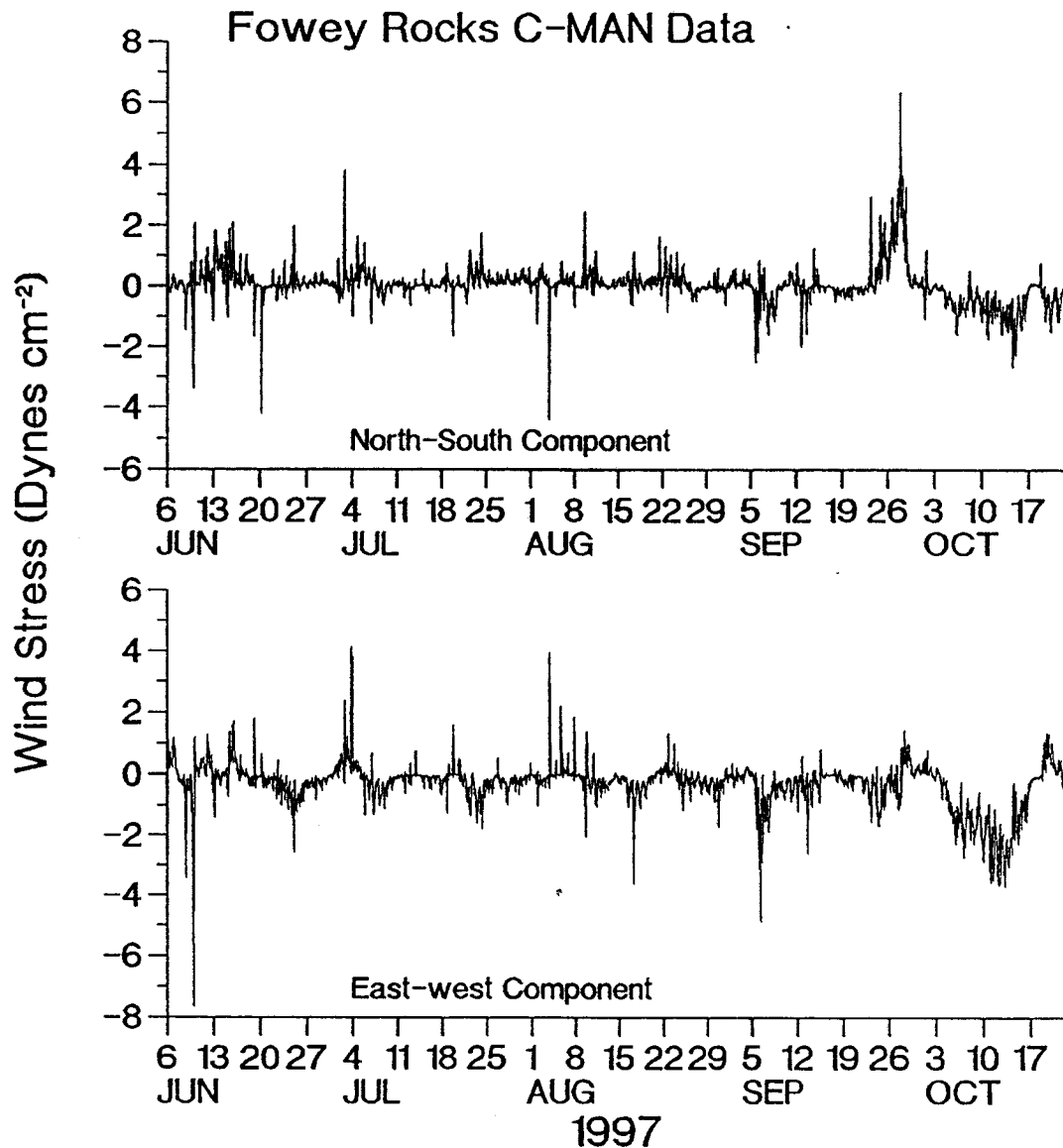


Table 1. Locations of WES study sites in Biscayne Bay and time periods for which data are available from those sites. Included is the NOAA C-MAN station at Fowey Rocks.

Type of Data	Location	Latitude (N)	Longitude (W)	Start	End
Water Levels	TG-1, Manatee Bay	25° 14.208'	80° 24.671'	06/06/97	10/22/97
	TG-2, Card Sound Bridge	25° 17.304'	80° 22.122'	06/13/97	10/22/97
	TG-3, Angelfish Creek	25° 20.164'	80° 16.817'	06/06/97	10/22/97
	TG-4, Military Canal – East	25° 29.681'	80° 16.698'	06/06/97	10/03/97
	TG-5, Military Canal, West	25° 29.778'	80° 19.526'	07/10/97	10/03/97
	TG-6, Black Point Mkr 8	25° 31.638'	80° 18.244'	06/06/97	10/03/97
	TG-7, Snapper Creek	25° 36.244'	80° 17.359'	07/10/97	10/08/97
	TG-8, Gables by the Sea	25° 39.076'	80° 15.570'	06/12/97	10/08/97
	TG-9, Biscayne Channel Mkr 10	25° 39.269'	80° 09.567'	06/12/97	10/09/97
	TG-11, Julia Tuttle Cswy Mkr 35	25° 48.823'	80° 10.489'	08/01/97	10/20/97
	TG-12, Broad Causeway Mkr 13	25° 53.413'	80° 08.384'	06/18/97	10/20/97
Currents	ADP-1, Angelfish Creek	25° 21.167'	80° 16.816'	12/21/97	07/12/98
	ADP-2, Center of Biscayne Bay	25° 29.091'	80° 15.424'	06/27/97	06/10/98
	ADP-3, Safety Valve Mkr 1A	25° 37.013'	80° 11.550'	06/26/97	07/31/98
	ADP-4, Bear Cut Mkr 1	25° 42.886'	80° 10.630'	06/26/97	05/10/98
	ADP-5, Julia Tuttle Cswy Mkr 35	25° 48.828'	80° 10.492'	06/28/97	07/31/98
Weather	WS-1, Convoy Point	25° 27.894'	80° 20.048'	07/17/97	07/08/97
	Fowey Rocks C-MAN	25° 35.417'	80° 05.800'	06/06/97	10/22/97