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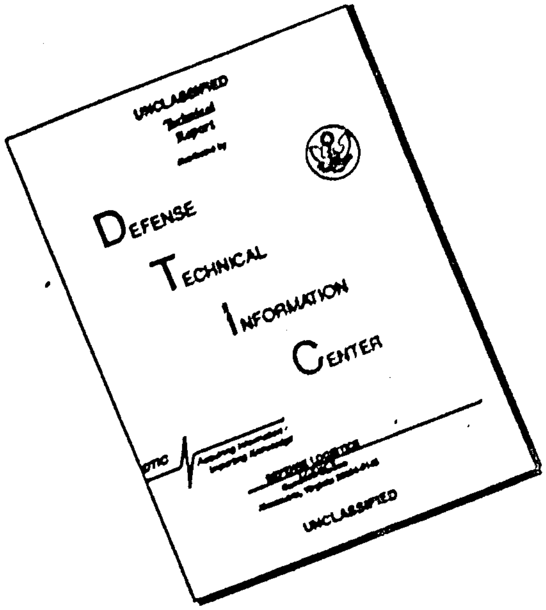

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(14) CERC-REPRINT-78-1

(12)

(6) VISUAL SURF OBSERVATIONS/MARINELAND EXPERIMENT

By

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(11) Feb 78

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ABSTRACT

During November-December 1975, a complex research experiment was conducted at Marineland, Florida. The experiment was sponsored by the National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL), and was designed to test instrumentation that will be used onboard the SEASAT-A satellite to be launched in 1978. This satellite is designed to provide all-weather global monitoring of sea-surface temperature, significant wave height and surface wind speed and direction.

As a part of this larger SEASAT-A experiment, it was decided to obtain wave and nearshore current data collected in accordance with techniques developed under the Littoral Environment Observation Program (LEO). It was hoped that these visually obtained data could be compared with wave data obtained from both a wave rider and a seasled and that measurements obtained at one LEO site could be correlated with observations taken at similar nearby sites. Also, it was hoped that the validity of timewise extrapolation to determine surf conditions for the period prior to and/or subsequent to a given visual observation could be established. A number of observers were recruited in an attempt to gather information on the influence of observer bias on the resulting data.

The site selected for the experiment prevented accomplishment of all of the original objectives of the LEO portion of the experiment. The four relatively close observation sites were notably different in their physical characteristics making the correlation of observations between adjacent sites extremely poor. When instrument wave data were obtained, there was generally fair agreement between observations and measurements. Surf conditions were observed to change appreciably over fairly short periods of time, a fact borne out by available instrument measurements. Consequently, the use of a single observational data set to characterize surf conditions over a one day period was not found to be a satisfactory representation.

INTRODUCTION

A pre-launch experiment of the SEASAT-A satellite system was conducted in the coastal area of Marineland, Florida located on a barrier island approximately 60 miles south of Jacksonville, Florida. The

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experiment was sponsored by the National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL) and was designed to test instrumentation that will be launched in 1978 aboard SEASAT-A. This satellite is designed to provide all weather global monitoring of sea surface temperature, sea surface topography and surface wind speed and direction. (Dunne, 1976).

The Coastal Engineering Research Center (CERC) was requested to participate in the experiment by representatives of JPL with the objective of collecting information on waves, currents and winds in the nearshore zone. For CERC to accomplish this objective two programs were used in the offshore zone from a point seaward of the breaker zone to the limits of the continental shelf. The first, used a sea sled with instrumentation to measure wave heights and currents across three profiles from the shoreline to a depth of 30 feet approximately 1/2 mile from shore. The second program was the use of local observers to visually estimate breaking wave characteristics and nearshore currents at several locations along the shoreline. These visual estimates were made using techniques developed under the Littoral Environment Observation (LEO) Program (Berg, 1968; Bruno and Hiipakka, 1973). This report addresses the data collected under the LEO phase of the field experiment. Particular emphasis is given to the comparison of LEO data collected at several observation points.

Observations made under the LEO techniques include estimates of breaking wave height, wave period, wave direction at breaking and breaker type; wind speed and direction at the shoreline; and longshore current speed and direction.

OBJECTIVES

To evaluate the reliability and variability of data collected using LEO techniques, this short experiment was intended to make as many concurrent observations as practical at selected sites during the period 1 to 14 December 1975. The original objectives were to analyze the collected data to:

a) compare results of equally qualified observers making measurements under nearly identical conditions;

b) determine the variation or accuracy that could be expected in extrapolating one LEO measurement up to approximately 8 hours from the time of the measurement;

c) determine the variation in results that could be expected if the LEO site had been established some distance upcoast or downcoast from the established position of the site; and

d) compare results of instrument measured breaker characteristics and currents based on sea sled measurements versus visually observed breaker characteristics and currents.

SITE LOCATIONS

Normally, unless a special need can be demonstrated, LEO sites are located in areas where there are no natural or manmade structures that may locally influence the behavior of waves and currents. However, for the present experiment it was not possible to select unobstructed sites.

After an inspection of the study limits, it was determined that four LEO sites would be established for purposes of the experiment. The location of these sites, termed "North", "Stadium", "Quality", and "South" are shown in Figure 1.

The "North" site was located 800 feet north of the "Stadium" site and was the site farthest away from any coastal obstructions. This site has a gently sloping beach backed by sand dunes 15 feet in height. A groin approximately 300 feet in length which was completely exposed at low tide, was located 600 feet to the south.

The "Stadium" and "Quality" sites were located in an area compartmented by a rubble-mound seawall and a rubble-mound groin system. There were numerous stones on the beach at the "Quality" site due to failure of the rubble-mound seawall. The distance between the "Stadium" and "Quality" sites was 1385 feet.

At the "South" site, located 1000 feet downcoast of the "Quality" site there was a natural outcrop of coquina rock on the beach.

Twelve volunteer LEO observers were trained and their performance monitored in an attempt to insure proper and uniform collecting methods. The experiment design called for observations at 2 hour intervals beginning at 0800 and ending at 1800. However, the availability of trained observers reduced the actual schedule of simultaneous observations to 1000, 1200 and 1400 hours.

DATA COLLECTION

Wind observations included both speed and direction. At the "North", "Quality" and "South" sites, wind speed was determined by using a hand-held wind meter. The meter was held at eye level and into the wind. Direction was measured by noting the octal compass direction from which the wind was blowing. At the "Stadium" site wind speed and direction were measured with a anemometer mounted approximately 30 feet above mean sea level.

Observers were instructed to determine average breaker height by using the "horizon sighting method" described by Bascom, 1964. Observers measured the distance from the estimated still water level (SWL) to eye level, when the level line of sight to the horizon just touched the top of the average breaker. The recorded breaker height was this measurement plus ten percent, to account for trough depth below the SWL.

Breaker period was recorded as the time (in seconds) it took for 11 wave crests (10 complete waves) to pass a fixed stationary point. The first crest was the starting time and the 11th crest the stop time.

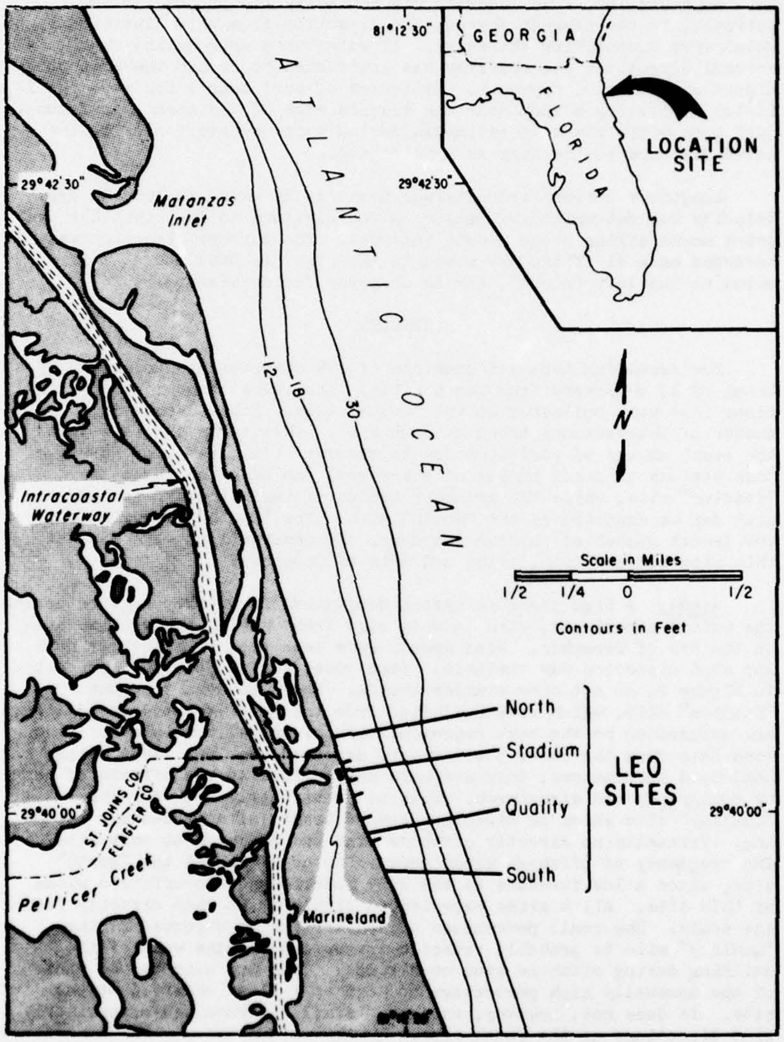

FIGURE 1: Site Location Map

The angle of wave approach at breaking was determined by using a protractor, held horizontally with the 0°-180° line oriented parallel to the shoreline. The observer sighted along the protractor to estimate, to the nearest degree, the direction from which the breaking waves were approaching the shore. If waves were approaching from several directions the observer was instructed to record the most prominent direction of approach. Estimates of surf zone width were facilitated by placing a buoy near the seaward edge of the normal surf zone. Surf zone width was then estimated during each observation using the known distance to the buoy as a reference.

Longshore current velocity was measured by using fluoresein dye. Velocity was determined by measuring the distance in feet that the dye patch moved during a one minute interval. The current direction was recorded as a +1 if the dye moved to the right (south) and a -1 if it moved to the left (north), for an observer facing seaward.

RESULTS

The resulting data set consists of 199 observations collected by a total of 12 observers from the 4 sites. The fewest number of observations (24) were collected at the "South" site. Table 1 summarizes the number of observations taken at each site. This table suggests that the least amount of variation due to observer bias (ratio of number of observations to total number of observers) can be expected at the "Stadium" site, while the greatest amount of variation due to observer bias can be expected at the "South" site. The "South" site also has the fewest number of observation days. No observations were made at this site for the 10th, 11th, and 12th of December.

Winds. A high pressure system dominated the weather pattern during the entire experiment, with a weak cold front moving through the area on the 8th of December. Wind speeds were less than 15 miles per hour and wind direction was variable. Wind roses for the 4 sites, presented in Figure 2, do not show similar trends. The wind data from the "Stadium" site, which were collected from the tower-mounted anemometer, are assumed to be the best representation of actual conditions. Since wind data from the other 3 sites were measured near sea level using hand held anemometers, they are more susceptible to the effects of nearby topography and structures. This is particularly true for the "Quality" site which is directly seaward (east) of a five-story building. Virtually no directly offshore wind was measured at this site. The frequency of offshore winds appears to be higher at the "North" site, since a low foredune is the only interference to offshore winds at this site. All 4 sites experienced little or no wind directly from the south. The small percentage of southerly wind observed at the "Quality" site is probably caused by turbulence in the wake of the building during offshore wind conditions. This may also be the cause of the unusually high percentage of northerly winds observed at that site. It does not, however, explain a similar percentage of northerly wind directions at the South site.

The longshore vector component (speed times the cosine of the direction angle) was computed for each wind velocity measurement at the "Stadium" site and compared with the longshore component of

TABLE 1: SUMMARY OF OBSERVATIONS

SITE	1 NUMBER OF OBSERVATIONS	2 NUMBER OF OBSERVERS	3 RATIO 1 to 2	4 NUMBER OF DAYS	5 AVERAGE OBSERVATIONS PER DAY
North	81	7	12	14	5.8
Stadium	48	3	16	13	3.7
Quality	46	5	9	13	3.5
South	24	4	6	10	2.4
TOTAL	199	12*			15.4

*More than one site covered by some observers.

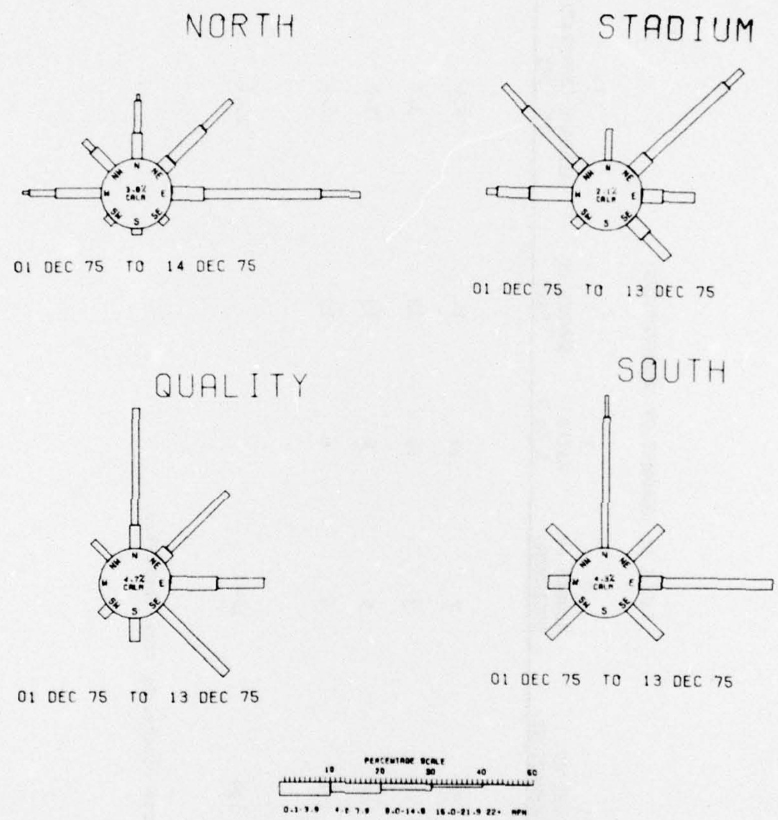

FIGURE 2: Monthly Wind Roses at Marineland, Florida

simultaneous measurements at each of the other three sites. The best correlation was observed between the "Stadium" and "South" sites (0.75) and the worst was between the "Stadium" and "Quality" sites (0.53).

Waves. The horizon-sighting method used for measuring breaker height resulted in nearly identical estimates when simultaneous, independent observations were made of a single wave at a site. However, when independent estimates of the "average" breaker height using the same technique were compared, the results were more variable. Nearly simultaneous estimates of "average" breaker height varied by more than a factor of 2 between sites. Computed correlation coefficients indicate that there was little or no correlation between sites for simultaneous "average" breaker height observations (-0.27 to 0.10). Correlation was also poor between simultaneous wave period observations (-0.28 to 0.46).

Daily averages of breaker height, period and direction are plotted in Figures 3, 4, and 5, Mean values for the 2 weeks are listed in Table 2. Breaker heights over the two weeks ranged from 1.5 to 6.5 feet with a two week average height of 3.6 feet. Breakers tended to be somewhat higher at the "South" site.

On 4 of the days when LEO data were being taken, concurrent wave measurements were made using a differential pressure wave gage mounted on the seasled (Teleki, Musialowski and Prins, 1976). Measurements were made in the nearshore region, including the breaker zone, along range lines located at the "South" and "Quality" sites and 350 feet south of the "Stadium" site. Significant wave height and period were obtained from spectral analysis of 5 minute-records (154 data points each). These data are included on Figures 3 and 4. Instrument data confirm the variability recorded by the LEO observers. Significant heights measured at the "Stadium" site varied from 8.5 feet to 2.4 feet in less than 1 hour. Significant period measurements, which were made varied by as much as 67% in an interval of only 10 minutes. A qualitative assessment of breaker conditions during the experiment indicated that the variability in the visually observed breaker height is real, although there is undoubtedly observer bias in selecting which wave, or set of waves, to measure as the "average" breaker height. Due to the interaction of multiple wave-trains, waves were generally observed in sets of six or seven higher crests followed by a series of lower waves. The larger waves tended to break some distance from shore and reform to break again closer to shore. These re-formed secondary waves would often interfere with initially-breaking lower waves and result in confused surf conditions.

Wave direction at breaking was generally observed to be within 10° of a shore-normal approach (Figure 5.) There was a notable shift in wave direction to the northeast, on 10 December with breakers reported at 20° to 30° from a shore-normal approach at the "Stadium" site.

Longshore Current. In an attempt to study the effects of site variability for longshore currents, simultaneous individual measurements of the longshore current velocity at each station were compared. Since this is a direct measurement of the rate at which a dyed patch of water is moving, it was felt that these data would be least susceptible to observer bias. If individual current observations were highly correlated

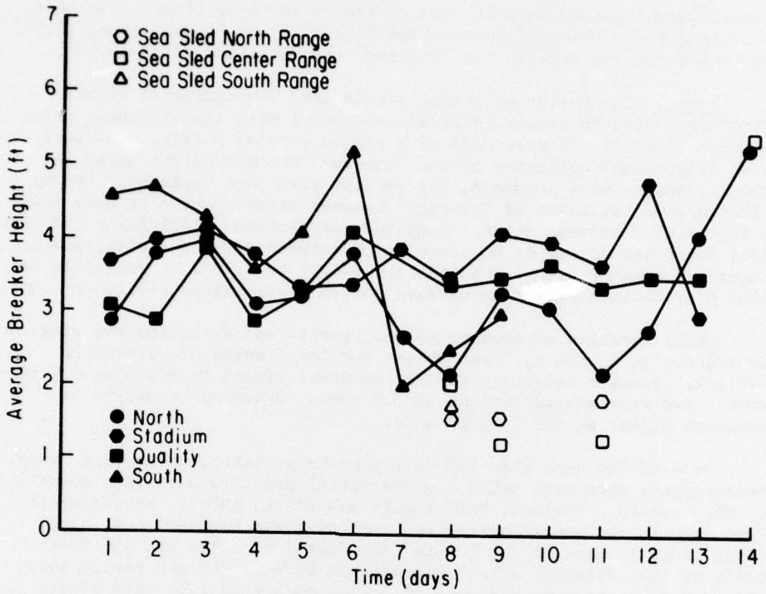

FIGURE 3: Average Breaker Height VS Time

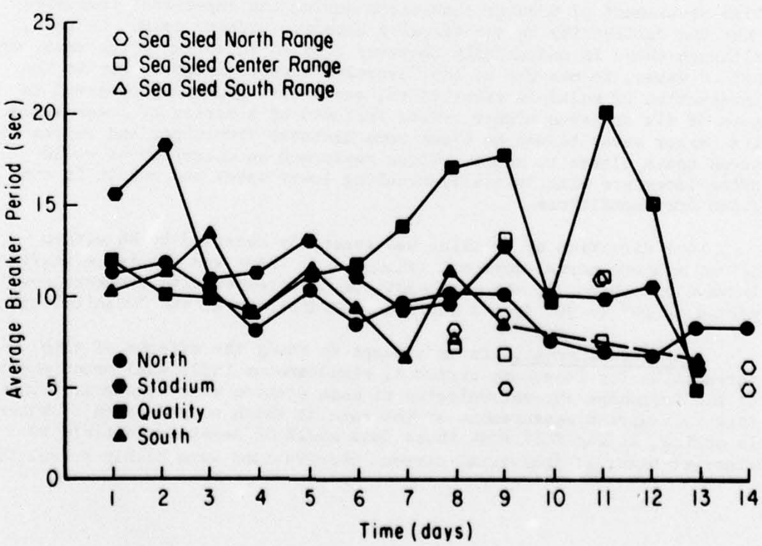

FIGURE 4: Average Breaker Period VS Time

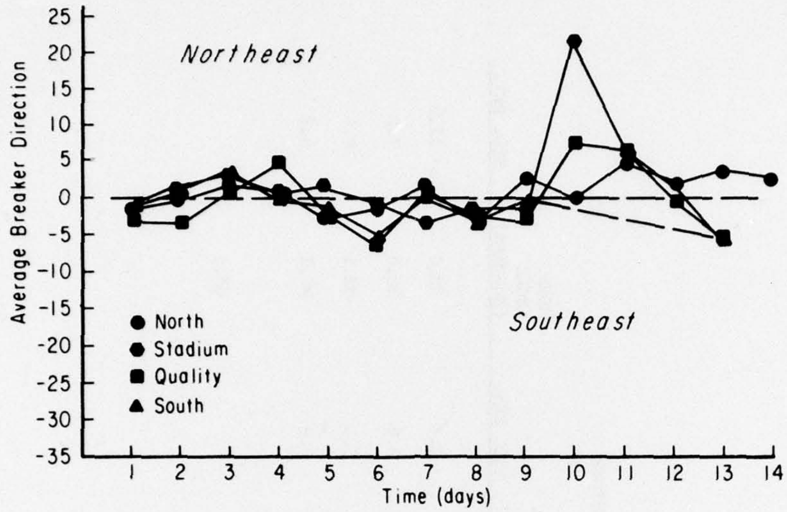

FIGURE 5: Average Breaker Direction VS Time

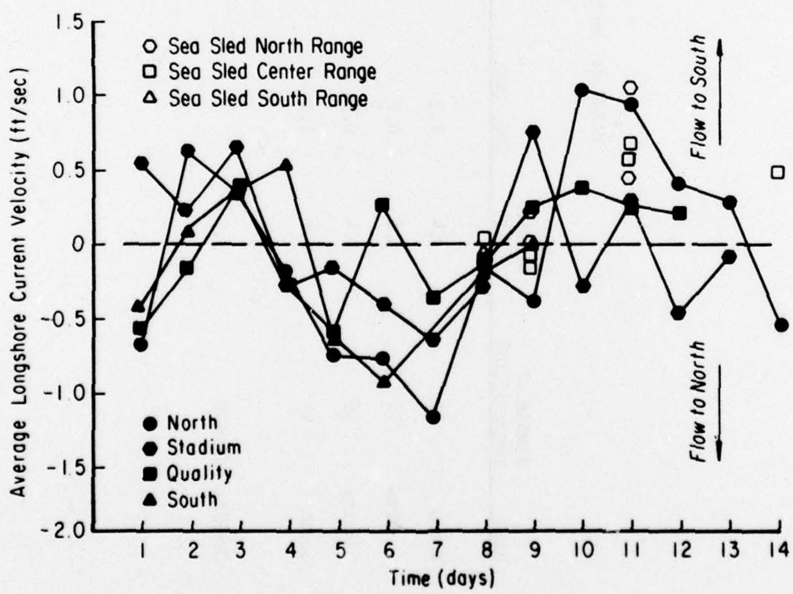

FIGURE 6: Average Longshore Current Velocity VS Time

TABLE 2: WAVE OBSERVATIONS

SITE	NUMBER OF OBSERVATIONS	MEAN HEIGHT (FT)	STD. DEV.	MEAN PERIOD (SEC)	STD. DEV.	MEAN ANGLE (DEGREES)	STD. DEV.
North	81	3.4	1.2	9.7	2.7	88.0	11.0
Stadium	48	3.8	0.6	11.8	3.8	86.8	7.2
Quality	46	3.4	0.5	13.0	5.1	88.1	14.4
South	24	4.1	1.1	10.8	2.9	90.1	4.2
OVERALL AVERAGE		3.6		11.1		88.0	

between sites, then the influence of site variability on the nearshore observations could be assumed to be small. The observed correlation between simultaneous observations was quite low, however. Correlation coefficient ranged from a low of -0.08 between the "Stadium" and "South" site to a high of 0.37 between the "Quality" and "Stadium" site.

When daily mean current velocities are computed for each site, some trends are apparent. These data are shown in Figure 6. The average current direction reversed at least 3 times during the experiment; on the 2nd, 4th and 7th of December. A total of 15 individual reversals in direction were observed at the"North" site.

The average current speed (regardless of direction) for the three sites was 0.49 ft/sec. The higher currents were measured at the "North" site and were directed northward. Speeds at the "North" site were 65 to 89 percent higher on the average than those measured at the 3 other sites. The highest velocity measured during the experiment was 2 ft/sec to the north at the "North" site. The lowest current speeds were measured at the "Quality" site, averaging 0.35 feet/sec.

A problem noted by one observer was that the beach slope was so low at Marineland (about 2°) that it was often difficult to throw the dye packet far enough out into the active surf zone. The observer concludes that the dye probably indicates the direction of the longshore current flow, but does not accurately reflect the average current speed.

Shore-parallel currents were also measured by sled-mounted current meters. These data are included on Figure 6. With the exception of longshore current data measured on the 14th, there is close agreement between those currents measured from the beach and those measured farther from shore. Average current speed measurements on the 14th were the same for the LEO and seasled observations, but directions are apparently reversed. Breaker direction observations were conflicting at the "North" site, which was the only LEO site active on the 14th, and ranged - alternately - from 10 degrees north of shore-normal to 5 degrees south of a shore-normal approach angle. The southeasterly approach angle is believed to be a more reliable observation. A comparison of individual observations of breaker direction and longshore current velocity resulted in no apparent correlation for the four sites (correlation coefficient of -0.008). The correlation between longshore current velocity and an energy flux factor (including breaker height and direction) was only slightly improved (correlation coefficient of 0.02). A tabulation of average daily breaker directions and concurrent longshore current directions is presented in Table 3.

SUMMARY & CONCLUSIONS

The LEO measurements described herein were taken in conjunction with a larger experiment designed to test the instrumentation for SEASAT-A; consequently, factors other than the present experiments' needs governed the selection of a test site. As it turned out, the four observation stations at the Marineland site were poor locations to carry out a definitive LEO experiment to meet the orginally proposed

TABLE 3. DISTRIBUTION OF BREAKER ANGLE AND LONGSHORE CURRENT DIRECTION DATA

LEO SITES	BREAKER ANGLE OBSERVATION <0°-90°	LONGSHORE CURRENT DIRECTION		BREAKER ANGLE OBSERVATION 90°	LONGSHORE CURRENT DIRECTION			WAVE OBSERVATION >90°-180°	LONGSHORE CURRENT DIRECTION	
		Upcoast North	Downcoast South		No Current	Upcoast North	Downcoast South		Upcoast North	Downcoast South
NORTH	25	13	12	31	7	17	7	17	14	3
STADIUM	16	9	7	22	4	13	5	9	7	2
QUALITY	10	0	10	17	2	7	8	13	5	8
SOUTH	3	0	3	12	5	3	4	6	6	0
TOTAL	54	22	32	82	18	40	24	45	32	13

objectives. The presence of groins at two of the observer locations and the outcrop of coquina limestone at a third made the spatial variability of observed breaker heights and nearshore, wave induced currents very high. The presence of groins especially influenced the characteristics of the longshore currents and resulted in poor correlation between observations at adjacent observation sites.

Measurements of breaker height taken using LEO techniques compared well with measurements taken using a pressure type wave gage mounted on a sea sled. The fact that the LEO breaker heights were usually greater than the gage wave heights could be attributed to some extent to wave shoaling between the gage and the breaker zone.

The observed variability in surf conditions over short periods of time (on the order of a few hours) indicate that only one observation per day at a given site may not be sufficient to adequately describe the wave conditions characteristic of that day. That this variability is real and not the result of observer error, was borne out by comparison of the LEO data with gage data for those time periods when the gages were operable. The variability would not, however, preclude using the data in a statistical sense, that is, a uniformly-spaced-in-time sampling of a randomly varying phenomenon.

No conclusions regarding observer bias can be drawn from the experiment. Individual observers at various sites changed during the course of the experiment due to uncontrollable circumstances and a given observer may have taken observations at a number of different sites.

There is a need for additional experiments of this type if visually observed data are to be a useful tool for coastal investigations; however, tighter control over experimental conditions needs to be exercised, particularly in the selection of a test site.

ACKNOWLEDGEMENTS

The author wishes to extend special thanks to: Allan DeWall and Richard Bruno for their assistance during the data analysis. Volunteer observers: Dean Murrough P. O'Brien, Ziya Celanli, David Nelson, Albert Zamba, Bill Casey, Charles Carter, Delbert Cawley, Gerry Ortagus, Abby Little, Roxanna Way, Sally Little, and Bobbi Manucy. Recruitment of observers: Cecil Walker. During the course of writing useful comments were given by Mr. D.W. Berg and Dr. J.R. Weggel.

REFERENCES

Bascom, W.N., "Waves and Beaches," Ch. IX, Doubleday, New York, 1964, pp. 184-212.

Berg D.W.,"Systematic Collection of Beach Data," Proceedings of the 11th Conference on Coastal Engineering, London, Sept. 1968.

Bruno, R.O., and Hiipakka, L.W., "Littoral Environment Observation Program in the State of Michigan," Proceedings, 16th Conference on Great Lakes Research, International Association of Great Lakes Research, 1973, pp. 492-507.

Dunne,J.A. "The SEASAT-A Project: An Overview", Oceans 76 Conference Record. (1976)

Teleki, P.G., Musialowski, F.R., and Prins, D.A., "Measurement Techniques for Coastal Waves and Currents" CERC MR 76-11, November 1976.

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4. TITLE (and Subtitle) VISUAL SURF OBSERVATIONS/MARINELAND EXPERIMENT		5. TYPE OF REPORT & PERIOD COVERED Reprint
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Christine Schneider		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of the Army Coastal Engineering Research Center (CEREN-EV) Kingman Building, Fort Belvoir, Virginia 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS D31181
11. CONTROLLING OFFICE NAME AND ADDRESS Department of the Army Coastal Engineering Research Center Kingman Building, Fort Belvoir, Virginia 22060		12. REPORT DATE February 1978
		13. NUMBER OF PAGES 15
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
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Breakers
Currents
Littoral Environment Observation program
Marineland, Florida
SEASAT-A satellite
Waves

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During November-December 1975, a complex research experiment was conducted at Marineland, Florida. The experiment was sponsored by the National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL), and was designed to test instrumentation that will be used onboard the SEASAT-A satellite to be launched in 1978. This satellite is designed to provide all-weather global monitoring of sea-surface temperature, significant wave height and surface wind speed and direction.

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