ACCESS NUMBER: 29094

STUDY TITLE: Gulf of Mexico Satellite Oceanography Study

REPORT TITLE: Gulf of Mexico Satellite Radar Altimetry

CONTRACT NUMBERS: BLM: IA0-11; MMS: 14-12-0001-29094

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREAS: Eastern Gulf of Mexico; Central Gulf of Mexico; Western Gulf of Mexico

FISCAL YEARS OF PROJECT FUNDING: 1980; 1981

COMPLETION DATE OF REPORT: August 1981

COSTS: FY 1980: $169,000; FY 1981: $54,000

CUMULATIVE PROJECT COST: $223,000

PROJECT MANAGERS: N. Huang

AFFILIATION: National Aeronautics and Space Administration

ADDRESS: Wallops Flight Center, Wallops Island, Virginia 23337

PRINCIPAL INVESTIGATORS*: R. Forsythe, C. Parra, C. Parsons

KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; physical oceanography; meteorology; satellite imagery; seasonality; wave height

BACKGROUND: The GEOS-3 satellite, the first dedicated radar altimeter used to obtain oceanographic data, was employed in an altimetry study of the South Atlantic Bight. Principal data products were ocean dynamic heights, significant wave heights, and surface wind speeds. In the present study, GEOS-3 in conjunction with another satellite, SEASAT, gathered similar information for the Gulf of Mexico.

OBJECTIVES: (1) To provide satellite altimetry information for the Gulf of Mexico; and (2) to compare results (sea surface elevation, significant wave heights, surface wave heights) from two satellites over the same area.

DESCRIPTION: Data from passes of each satellite over the Gulf of Mexico from Spring 1975 to Fall 1978 for GEOS-3 and from Spring to Fall 1978 for SEASAT were recorded and analyzed. GEOS-3 operates on a frequency of 13.9-GHz with both global and intensive mode. The intensive mode produces a compressed pulse of 12.5 ns and provides measurements with precision of about 20 cm for a 1-s average. This configuration yields a footprint 3.6 km wide and 11 km along the track from an orbit of 840 km in altitude, an inclination of 115°, and a period of 101.8 min. SEASAT was also designed to operate at a frequency of 13.9 GHz but was compressed to 3 ns providing a

precision of about 10 cm for a 1-s average. The SEASAT footprint configuration was 1.6 km wide and 12 km along the track from an orbit of 800 km in altitude, an inclination of 108°, and a period of 100.75 min. Analytic procedures and algorithms used for data reduction were essentially the same for both satellites; sea surface elevation profiles were resolved on a 30-minute geoid of the Gulf of Mexico; this method resulted in considerable resolution variability. To determine overall variability associated with the geoid, a three-year mean topographic map and a three-year standard deviation map were generated using all satellite passes over the Gulf of Mexico by both satellites. These topographic maps are then the average of the pass-by-pass variation calculated over a 15-minute grid over the entire Gulf of Mexico and processed seasonally. Significant wave height was computed aboard SEASAT at 10 s^{-1}, reduced to 4.6 s^{-1}, while GEOS-3 was computed on the ground at major frame rates of 3.2 s^{-1} for high data rates and 2.0 s^{-1} for low data rates. Surface wind speeds were calculated using two formulae; correction factors were applied for different wind speeds. Data rates for SEASAT and GEOS-3 were the same as for the significant wave height data. Anomalous GEOS-3 data passes recorded during July, August, September, and October 1975 were omitted from the final data set.

SIGNIFICANT CONCLUSIONS: The 30-minute grid contributed to appreciable lack of dynamic height geoid resolution and variation maps were biased by the large number of passes recorded during the last few months of the study. Only large dynamic height features could be determined. Significant wave height was generally small for the Gulf of Mexico; only in winter 1976 did mean wave height exceed 2 m. Surface wind speed data exhibited reduced variability, and distinct seasonal fluctuations were observed.

STUDY RESULTS: The gravimetric geoid method used to extract the residuals from the altimeter heights was inadequate; geoidal undulations of small horizontal scales but ranging in amplitude from 1 to 4 m were poorly modeled and caused inaccurate results in the dynamic height analyses. Surface topography maps were only accurate if a sufficient number of passes had been recorded for that particular map. Of 15 maps analyzed, 2 were totally unusable because of poor coverage, 8 showed sufficient coverage for the Eastern Gulf but not for the Western Gulf, and 5 were excellent with respect to coverage. Only large surface features could be accurately discerned; features in excess of 150 cm were due to dynamic heights. Significant wave height displayed relatively low values from April 1975 to October 1978. A mean value of 2.3 m recorded in January 1976 was the only instance where mean wave height exceeded 2.0 m. Variance was generally constant during the study period. Altimeter readings for waves smaller than 2.0 m tend to be noisy thus precluding quantitative representation of this data. Wind speed measurements were most reliable, and distinct seasonal variations were seen. Highest values were recorded during winter months (8.5 m s^{-1} in November 1977) and lowest values were recorded during summer months (3.3 m s^{-1} in July 1976). There were no appreciable differences in wind speeds between the Eastern or the Western Gulf of Mexico.

STUDY PRODUCT: Parra, C. G., R. G. Forsythe, and C. L. Parsons. 1981. Gulf of Mexico Satellite Radar Altimetry. A joint report by the National Aeronautics and Space Administration and the U.S. Department of the Interior, Bureau of Land Management

Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. N81-33760/2. Contract No. AA851-IA0-11. NASA Tech. Memo. 73295. 230 pp.

*P.I.'s affiliation may be different than that listed for Project Managers.