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Invited Paper

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A SUMMARY OF WIND AND WAVE CONDITIONS FOR 28 SEPTEMBER 1978
EXTRACTED FROM "CONVENTIONAL" DATA SOURCES

ABSTRACT

Waves of almost two meters significant wave height propagated through the ocean region seaward of Cape Hatteras during SEASAT overpass number 1339 which occurred at 1520 GMT, September 28, 1978. Wind waves from the northeast were associated with a fetch near a high pressure ridge oriented roughly parallel to the United States East Coast on September 27. As the high pressure ridge moved northeasterly, winds seaward of Cape Hatteras were associated with a low pressure trough and were generally northeasterly. Longer period swell from the southeast was associated with a low pressure trough several hundred miles southeast of Cape Hatteras. Wave height spectra measured by a NOAA data buoy illustrated wave spectral peaks between 10 and 11 seconds and significant wave heights averaging 1.8 meters. Directional ocean wave spectral forecasts prepared by the Fleet Numerical Oceanographic Center (FNOC) at Monterey, California, were consistent with observed wind waves from the northeast and longer period swell from the southeast. Infrared imagery from the Geostationary Operational Environmental Satellite (GOES) illustrated location of thunderstorm activity associated with weather from the southeast.

Background

This paper presents a summary of weather conditions, including ocean surface waves, observed during SEASAT pass number 1339. SEASAT passed almost parallel to the East Coast on September 28, 1978 at 1520 GMT. Wind and wave conditions described here are intended to support the analysis of Beal (1980) and Ross (1980) presented at this Congress. These two papers describe observations made during pass 1339 using data from the synthetic aperture radar (SAR), one of the sensors on SEASAT.

Local Weather - Northeast Winds

Figure 1 illustrates a northeast-southwest elongated high pressure ridge situated over the United States East Coast at 0600 GMT (or 0600Z) on September 27, 1978. Surface winds were generally north-easterly with 20 knots (approximately 10 m. sec^{-1}) observed at Cape Hatteras. Generally northeasterly winds at these speeds is shown clearly in Figure 2, which illustrate the surface wind and atmospheric pressure field 20 minutes before overpass.

Wave Spectra Observations

Wave spectra observed by NOAA Data Buoy 41001 (35 N., 72 W.) are illustrated in Figure 3. Spectral peaks observed at this buoy ranged from .09 to .10 hz (10 to 11 second spectral periods). As shown in the paper by Beal (1980) these values are well-correlated with observations by the SAR. Significant wave heights (the average height of the one-third highest waves) for these spectra ranged from 1.7 to 1.9 meters, and these height values are fairly consistent with the wind field illustrated in Figure 2. For example, fully-developed spectra of Pierson-Moskowitz (1964) predict a 2.2 meter significant wave height associated with a wave spectral peak of 7.5 seconds for the 20 knot (10 m. sec^{-1}) wind field illustrated in Figure 2. However, spectra shown in Figure 3 exhibit well-defined peaks between 10 and 11 seconds and such spectral periods usually require winds of about 13 to 14 m. sec^{-1} persisting for almost a day over a fetch of several hundred miles. Thus, spectra shown in Figure 3 are a composite of locally-generated sea together with advecting swell from a distant source. As shown in the next section, the 10-11 second swell can be associated with wind fields which developed hundreds of miles to the southeast.

Winds and Waves from the Southeast

Available evidence suggests that longer period swell from the southeast was associated with late stages of a low pressure system which evolved from Tropical Disturbance Number 12. Figure 4 illustrates the surface pressure field at 1200 GMT, 24 September, 1978, four days before overpass. The closed low pressure center denotes the position of Tropical Disturbance Number 12 which had been identified several days earlier about 500 miles east of the position shown in Figure 4. The counter-clockwise circulation around this low, augmented by the pressure gradient associated with the high pressure cell to the north, resulted in a general strengthening of southeasterly flow directed toward the SEASAT overpass region. Figure 5 illustrates the synoptic situation on 1200 GMT, September 26, two days before overpass. Wind flow from the

southeast associated with the low pressure trough (indicated TROF on Figure 5 is the most likely cause of longer period swell from the southeast.

Weather observations from ships are scarce in this area resulting in considerable uncertainty in the strength and locations of weather systems which could have been generating areas for observed longer period waves. Evidence for intense thunderstorm activity associated with the trough, however, is presented in Figure 6 which shows a portion of the GOES infrared imagery for 1200 GMT, September 27. Figure 6 shows the location of thunderstorm activity associated with the surface trough of low pressure. Persistence of this trough activity for several days before overpass provides additional evidence for the origin of longer period waves from the southeast.

Directional Wave Forecasts

Figure 7 illustrates sample wave forecasts from the southeast, for grid points 222 and 223, prepared by Fleet Numerical Oceanographic Center, Monterey, California. This forecast was for 0300 GMT, September 27, 1978 which was 36 hours before overpass. For example, these two grid points illustrate waves from the southeast associated with wavelengths of 140 meters to 230 meters, corresponding to wave periods between 9.5 and 12 seconds. The energy from such waves traveling at group velocity could easily have been propagating through the region of interest at overpass time. Consequently, the 10-11 second spectral peak observed by the NOAA data buoy (Figure 3) was propagating through the area many hours before and many hours after SEASAT passed.

References

Beal, R.C. Detection and tracking of low energy swell system off the U.S. East Coast with the SEASAT SAR. 14th Congress of the Internat. Soc. of Photogram., Hamburg 1980.

Pierson, W.J. and Lionel Moskowitz. A proposed spectral form for fully developed wind seas based on the similarity theory of S.A. Kitaigorodskii, Journ. of Geophys. Res., V69, pp. 5181-5190, 1964.

Ross, D.B. SEASAT surface wind measurements compared to aircraft underflight measurements. 14th Congress of the Internat. Soc. of Photogram., Hamburg 1980.

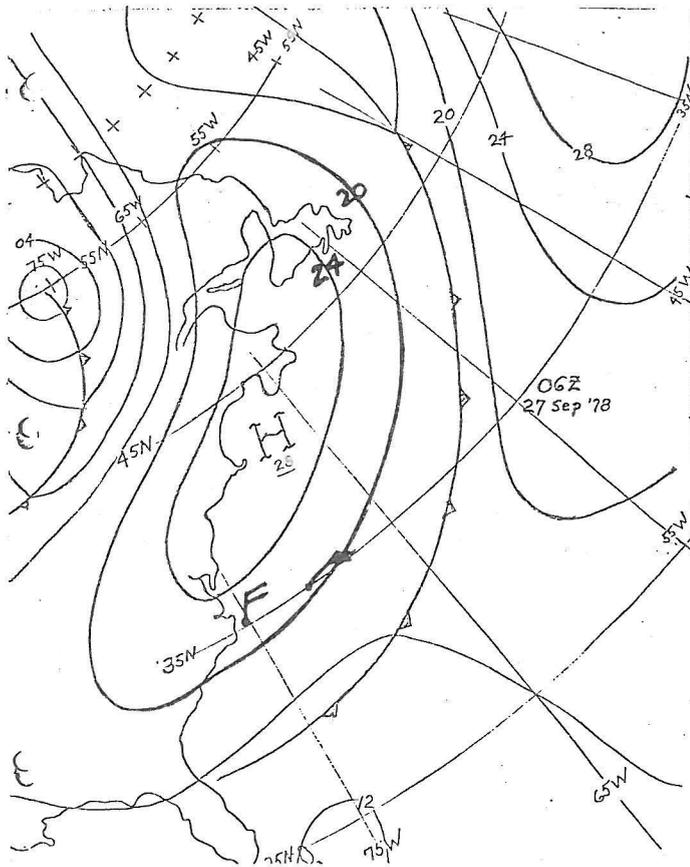


Fig. 1 - Surface weather map illustrating high pressure ridge off the East Coast of the United States at 0600 GMT (or 0600Z), September 27, 1978. Note northeasterly wind at Cape Hatteras, North Carolina.

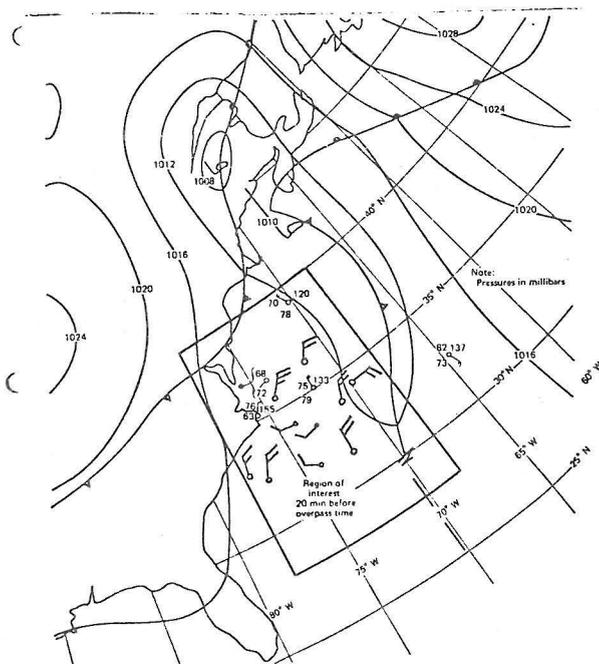


Fig. 2 - Surface weather map at 1500 GMT, September 28, 1978 twenty minutes before SEASAT overpass.

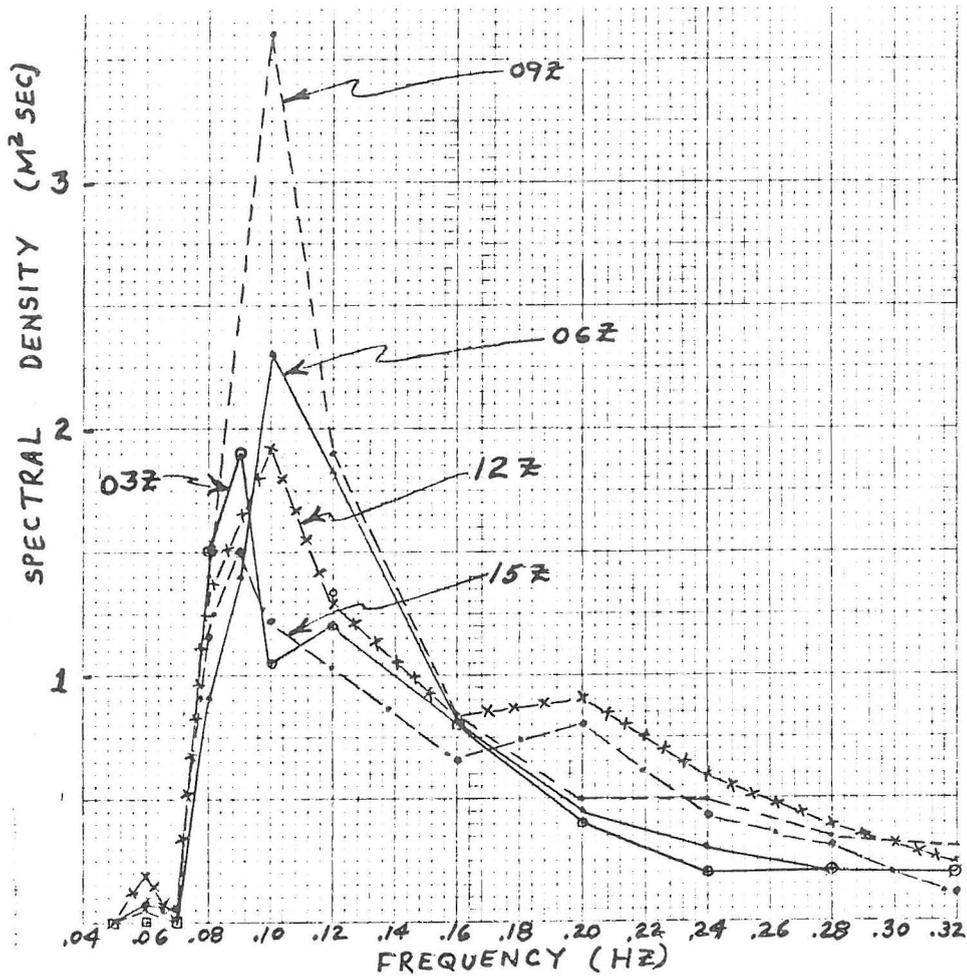


Fig. 3 - Wave spectra observed at NOAA Data Buoy 41001 (35N, 72W) on September 28, 1978. Numerals near curves represent Greenwich Mean Time.

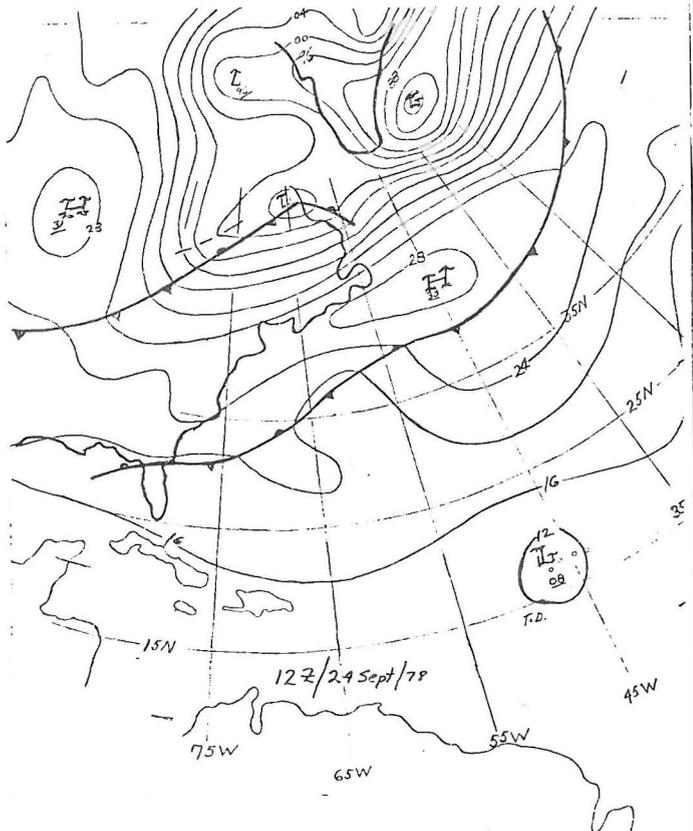


Fig. 4 - Surface weather map for 1200 GMT, September 24, 1978 illustrating source region for southeast swell.

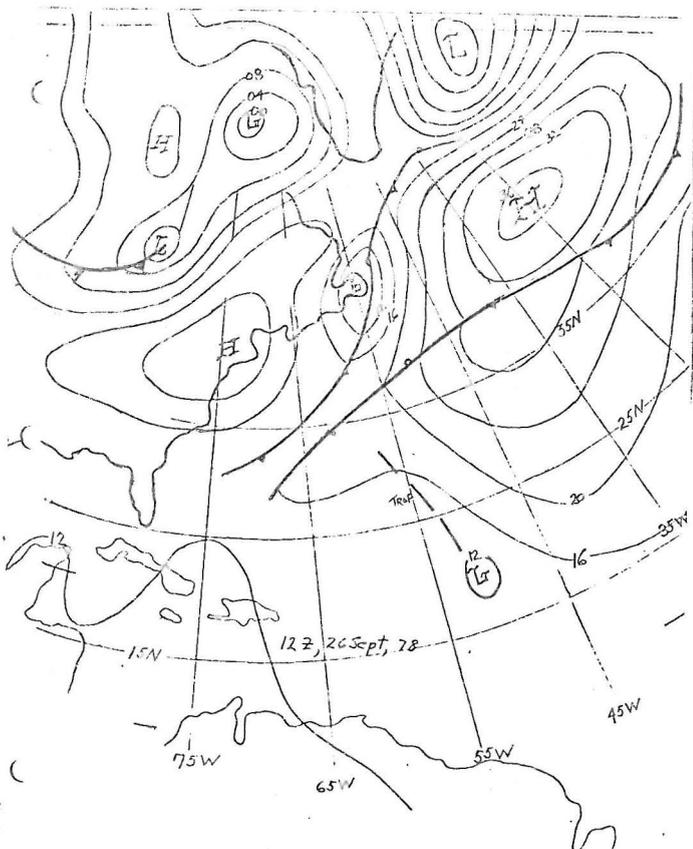


Fig. 5 - Surface weather map for 1200 GMT, September 26, 1978 illustrating likely position of low pressure trough.



Fig. 6 - Thunderstorm activity indicated on GOES infrared imagery for 1200 GMT, September 27, 1980.

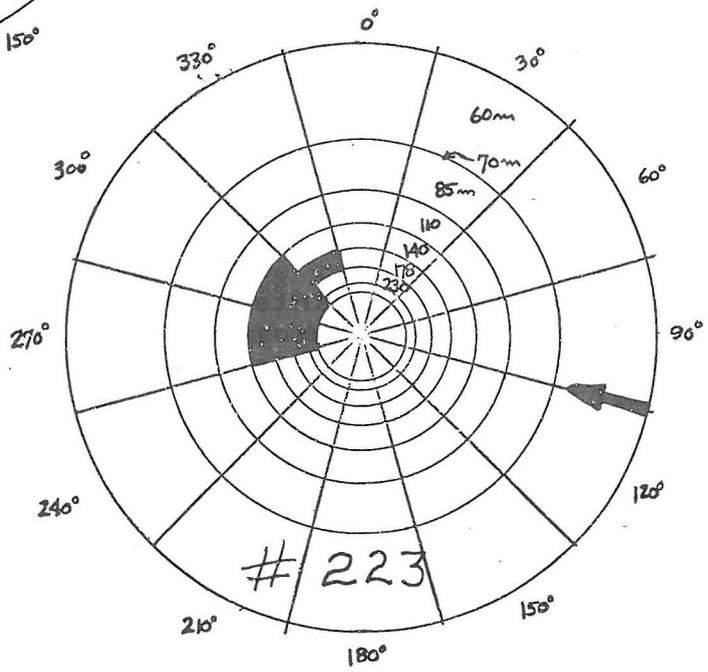
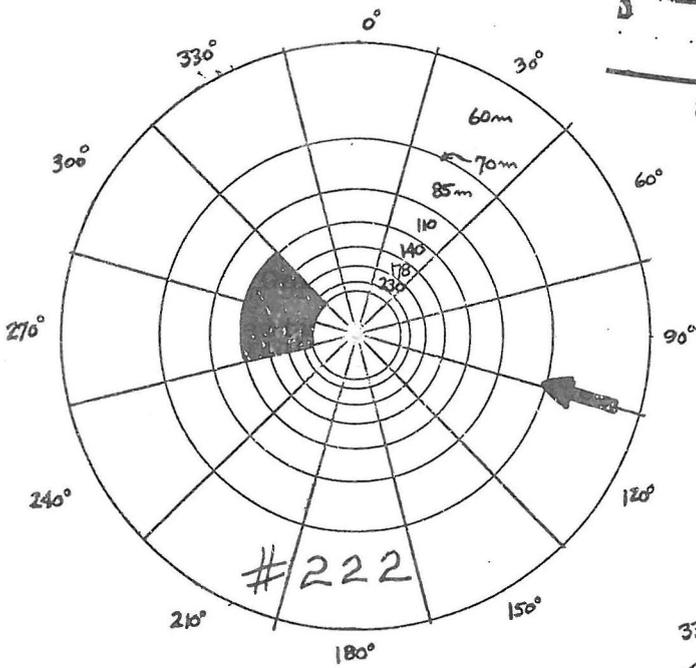
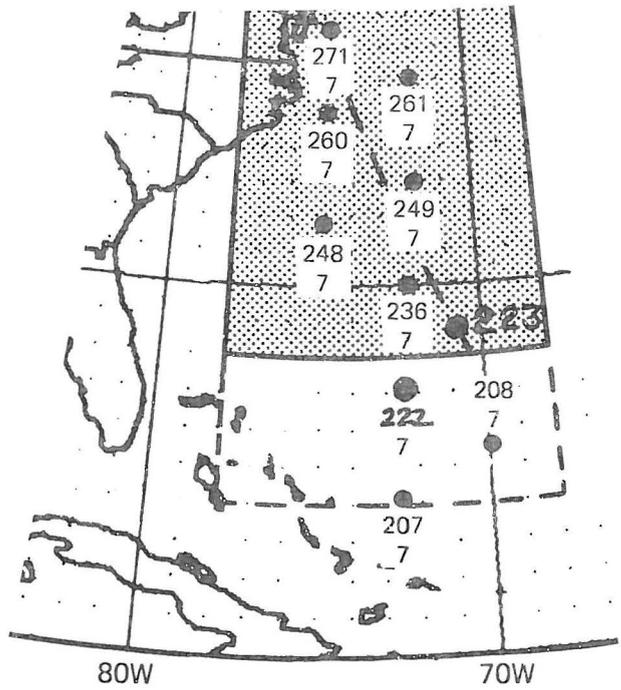


Fig. 7 - Polar plots illustrating southeasterly swell at FNOG grid points 222 and 223 for 0300 GMT, September 27, 1978, which was 36 hours before overpass. Numerals in concentric circles indicate wavelength (meters). Darker shaded area indicates more wave energy than lighter area.