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NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 4/2
WEATHER AND CURRENTS IN THE VICINITY OF 23 DEG N, 46 DEG W, NOR--ETC(U)
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Weather and Currents in the Vicinity of
23°N, 46°W, North Atlantic Ocean

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10 Peter Fleischer

Technical note

Sea Floor Division
Ocean Science and Technology Laboratory

11/25/80

11 September 1980

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EXECUTIVE SUMMARY

This note is a review of climate, sea conditions, and currents in March at Deep Sea Drilling Project Site 395A. The site is located on the upper west flank of the Mid-Atlantic Ridge. Weather is favorable for hole re-entry and related operations. Frequencies of storms, high winds, high seas, and low visibility are well below 5%. Normal surface current speeds are 0.34-0.66 kn; intermediate and bottom current speeds are 0.19-0.29 kn, with infrequent maximum speeds to 0.78 kn.

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INTRODUCTION

This report is a compilation and summary of March weather conditions and currents at and in the vicinity of 22°45.35'N, 46°04.90'W, Deep Sea Drilling Project site 395A (henceforth referred to as "the site"), in the south-central North Atlantic Ocean. All conditions described are averages for the month of March only, unless otherwise noted. Point values reported for the site are generally interpolated or interpreted from contoured or plotted data. More extensive data compilations are presented for a 5° square in which the site lies. The 5° square covers 20°-25°N, 45°-50°W. Data compilations are presented from two additional areas, a so-called Ocean Area centered at 17°N, 56°W, and OSV "E" at 35°N, 48°W. Although these areas are somewhat remote from the site, certain types of data collected there are unavailable for the vicinity of the site. Due to the general constancy of climate and circulation in this region of the North Atlantic, extrapolations from those two areas to the site are possible. Locations of the site, the 5° square, the Ocean Area, and OSV "E" are shown in figure 1.

ATMOSPHERIC PRESSURE

Average atmospheric pressure corrected to sea level is 1020-1021 mb [1], [3],[4]. The site lies on the edge of a broad 1020-1022 mb high centered at 28°N, 35°W (Fig. 2). On the average, two highs per month pass over the site, and are centered over the site 10% of the time. These highs follow a west-to-east course along the axis of the average high shown in Figure 1 [4].

No low pressure centers pass within 15° of the site from December to May [1],[4]. No storm tracks or hurricane tracks pass in the vicinity of the site [1],[4]. Storm frequency is well under 5% [3].

WINDS

The site lies 3° north of the average limit of the NE trades [3]. Prevailing winds are NE, Force 4, with 26-50% constancy [3]. Average wind speed is 6 m/sec (11.7 kn) [4]. The percentage frequency of winds of Beaufort Force 3 or less is 55% [1]; Beaufort Force 4 or greater is 55% [2]; winds of Beaufort Force 8 or more have a percentage frequency well under 5% [1],[2].

Average winds for the 5° square [3] are tabulated below:

<u>Direction</u>	<u>% Frequency</u>	<u>Mean Beaufort Force</u>
N	7	3
NE	33	4
E	26	4
SE	9	3
S	7	3
SW	8	3
W	5	data not given
NW	5	data not given
Calm	4	---

A somewhat more detailed wind rose for the 5° square [9], and is shown in Figure 3. Values are slightly different, but the overall wind pattern is the same.

AIR TEMPERATURE

The mean sea surface air temperature is between 21.1^o-23.3^oC (70^o-74^oF) [1], [2], [3], [4]. Average maximum temperature is 28^o (82^oF); average minimum temperature is 12^oC (54^oF) [4]. Maximum and minimum air temperatures of record are given as 78^oF (25.6^oC) and 63^oF (17.2^oC), respectively [2]. Frequency of temperatures under 0^oC (32^oF) is under 5%, presumably 0% [1].

A more detailed temperature distribution for the Ocean Area is shown in Figure 4. Mean air temperature here is 1-3^oC higher than at the site, but the temperature distribution should be nearly identical.

WATER TEMPERATURE

The mean surface water temperature is 22.2-23.6^oC (72-74.5^oF) [2], [3], [9].

RELATIVE HUMIDITY

Relative humidity at the sea surface in February is 75% [4]. A similar value may be expected for March.

PRECIPITATION

Frequency of observations reporting precipitation ranges from 5-9% [1], [2], [4], whereas precipitation frequency has been estimated at less than 1% [3]. In any case, precipitation is infrequent, and presumably occurs as local showers. Of observed precipitation, about 80% is weak and 20% is intense [4]. No solid precipitation has been observed [1], [2], [4].

The relationship between winds and rain is minor: 6% of winds from all directions are accompanied by rain; 4% of NE winds, 7% of E winds, and 3% of SE winds are accompanied by rain at the Ocean Area [1]. Conditions at the site should be similar.

CLOUDINESS

Percentage frequency of total cloud amounts of 2/10 or less is 28% [1]; 2/8 or less, 35%; 5/8 or more, 30% [2]. Percentage frequency of low cloud amounts of 7/8 or less is 98%; 4/8 or less, 80%, 6/10 or more, 20% [1], [2]. Values of 30% for clouded sky frequency and 33% for clear sky for February have also been reported [4]. Frequency of total cloud cover is 4.5% [4].

More detailed cloud cover data for the Ocean Area is compiled in Figure 5. Cloudiness is associated with winds from the NE quadrant [1]. The area is generally partly cloudy. Conditions at the site should be similar.

VISIBILITY

The frequency of visibility over 5 nm (9.26 km) is well over 95% [1], [2]. The frequency of visibility under 2 nm (4.63 km) is less than 0.5% [2]. Fog frequency (visibility under 1 km (0.54 nm)) is estimated from well under 5% to less than 1% [3], [4].

A detailed compilation of visibility observations at the Ocean Area (Fig. 6) indicates high visibilities at all times and with all wind directions. Conditions should be similar at the site.

TIDES

The tidal range at the site is about 0.4 m [4].

WAVE CONDITIONS

Waves

Average wave height is 1.1 m (3.6 ft) and average wave period is 5 sec [4]. Maximum height of waves (highest 1%) is 8 m (26 ft) and maximum average wave period is 12 sec [4]. Detailed wave data for the 5° square [9] are shown in Figure 7 for winter (January, February, March) and spring (April, May, June) [9]. Typical wave conditions for March should fall between the winter and spring conditions. Predominant wave direction is from the ENE with wave periods of 6-9 sec predominating. Wave heights for March [9], interpolated from Figure 7, are:

<u>Wave Height Equal or Exceeding</u>	<u>Percentage of All Waves</u>
4 ft	48%
8 ft	11%
12 ft	2%

Sea State

Predominant sea direction is from the NE, with a constancy of 40-60% [9]. Frequency of seas by height [9] is:

<u>Sea Equal or Exceeding</u>	<u>Percent Frequency</u>
5 ft	20%
8 ft	5%
12 ft	2%
20 ft	1%

Sea state for the 5° square [9] is shown in detail in Figure 8. Highest seas come from the northeast and east.

Persistence of seas [9] is illustrated in Figure 9 for OSV "E" during winter (January, February, March) and spring (April, May, June). Values for March should be intermediate between winter and spring. Values at the site should also be similar, with somewhat lower winter values.

Swell

Predominant swell direction is from the NE with less than 40% constancy [9]. Percent frequency of swell greater than 12 ft is 5% [9]. A swell rose for the 5° square [9] is shown in Figure 10. Note the substantial component (20%) of swell from the NW.

CURRENTS

Except for surface drift, data on currents at the site are scarce and current conditions must be largely inferred. The following water masses are found at the site [7]:

0-500 m	Surface water (North Atlantic Central Water)
500-1500 m	Atlantic Intermediate Water and northernmost portion of Antarctic Intermediate Water
1500-4500 m	North Atlantic Deep and Bottom Water
<4500 m	Antarctic Bottom Water

Depths within a range of 0.25° of the site are about 2900-4500 m [6]. Antarctic Bottom Water would therefore not normally be found at the site. The rugged relief, however, may cause some local fluctuation in the water masses. Currents below 500 m are nonseasonal and the information presented applies to the entire year.

Surface Currents

The site lies within the North Equatorial Current [3]. Current direction is W to WNW; current speeds are 0.25-0.5 kn (13-26 cm/sec), with a constancy of 33-66% [3]. A current rose for the 5° square (Fig. 11) shows the predominant current to be westward, but significant NW and SW components are present. Resultant currents (Fig. 11) for 1-degree squares near the site have been reported as high as 15-16 nm/day (28-30 km/day) [10]. These drift speeds suggest that 1-2 kn (100-200 cm/sec) currents may be expected occasionally, but that currents in excess of 2 kn (200 cm/sec) would be rare and would occur only in association with extreme winds.

Intermediate Currents

Since the site does not lie within a strong oceanic current system, currents are generally sluggish, but subject to short-term fluctuations. Between 100 and 500 m average annual current speeds are less than 10 cm/sec (0.2 kn) to the SW and WSW [4]. Based on transport calculations, long-term average current flow is 1-3 cm/sec northward on the upper west flank of the Mid-Atlantic Ridge at 13° N, 10° S of the site [13]. On a profile located at 50° W, $20-35^{\circ}$ N, long-term total E-W velocity is less than 1 cm/sec [12].

Short-term fluctuations in current speed may be expected, however. These are caused by passing eddies and by tidal forcing due to the topographic expression of the Mid-Atlantic Ridge. Root-mean-square speeds of 10-15 cm/sec (0.19-0.29 kn) and occasional maximum speeds of 30-40 cm/sec (0.58-0.78 kn) may be expected at the site (Albert W. Green, personal communication). Typically, maximum speeds may have durations of several hours and occupy only a portion of the water column.

Bottom Currents

No specific data exist on bottom currents near the site, but some general information can be gained by examining the character of the bottom. Several bottom-photograph stations on the west flank of the Mid-Atlantic Ridge show no evidence of sediment ripples or scour, suggesting that bottom currents over

20 cm/sec (0.39 kn) are uncommon. Seismic profiles in the area show horizontally stratified sediment ponds filling lows, and a thin sediment cover on highs [6], [8]. Similarly, these profiles show no evidence of sediment scour on drifts; thus indicating an absence of strong and continuous bottom currents. The presence of horizontal stratification in the ponds, however, indicates that sediments have slumped or were transported from the highs to the ponds by turbidity currents. Pleistocene sediments in cores at Site 395A are foraminiferal sands varicolored by size sorting and containing basalt grains [8], [11]. Both characteristics are indicative of turbidity current transport. Some foraminiferal sand layers are very uniform, suggesting size sorting by other bottom currents [8], probably in the range of 20-40 cm/sec (0.39-0.78 kn). Turbidity currents in the sediment ponds would be relatively small but could produce current pulses in excess of 200 cm/sec (4 kn). However, annual turbidity current frequency for a pond is probably around 10^{-3} and thus should not be a problem.

SUMMARY AND CONCLUSIONS

March weather in the vicinity of the site ($22^{\circ}45.35'N$, $46^{\circ}04.90'W$) is favorable for drilling and related shipboard operations. Climatic conditions are moderate. The probability of large weather fluctuations and extreme conditions is small. Current speeds are low and should not cause difficulties.

During March, the site lies on the southeastern edge of a broad high that covers much of the central North Atlantic Ocean. The northern boundary of the NE trades lies just $3^{\circ}S$ of the site; as a result, prevailing winds are NE, with moderate constancy. Winds of Beaufort Force 8 or more are rare, probably of 2% or less frequency. No hurricane or major storm tracks pass within range of the site during winter or spring.

Air temperature is comfortable; humidity is high. The March mean at the site is $72^{\circ}F$ ($22^{\circ}C$). Diurnal fluctuations are typically less than $10^{\circ}F$ ($5.5^{\circ}C$) from the mean. No freezing temperatures have been observed. Rainfall is generally weak and sporadic, and occurs with a frequency well under 10%. No solid precipitation has been observed in the area.

Cloudiness in March is moderate. Clear, partly cloudy, and overcast skies occur with approximately equal frequency. Low clouds are principally associated with NE and E winds. Visibility is excellent almost all of the time. Fog frequency is less than 0.5%.

March wave conditions are usually moderate, but a small probability of unfavorable seas must be taken into account. Average wave height is 3.6 ft (1.1 m), but 11% of waves are over 8 ft (2.4 m). Seas come predominantly from the NE. Seas under 8 ft (2.4 m) occur 95% of the time, and seas over 20 ft (6 m) occur with less than 1% frequency. Persistence of seas over 9 ft (2.7 m) for more than two days may typically be expected twice from January through May; thus, extended periods of unfavorable conditions are possible, but not common. Unlike winds and waves, swell approaches not only from the NE, but also from the NW. Swells over 12 ft (3.7 m) occur with a 5% frequency. A combined NW swell and NW sea could create unfavorable conditions if both were large, but frequency of occurrence of this condition is probably low.

Typical surface currents in March were westward at 0.34-0.66 kn (17-34 cm/sec),

and currents over 1 kn (51 cm/sec) should be rare and related only to severe weather. Typical currents in the water column are 0.19-0.29 kn (10-15 cm/sec) with a maximum expected speed of 0.58-0.78 kn (30-40 cm/sec). Bottom currents of similar magnitude may be expected; there is no evidence for a significant frequency of strong bottom currents.

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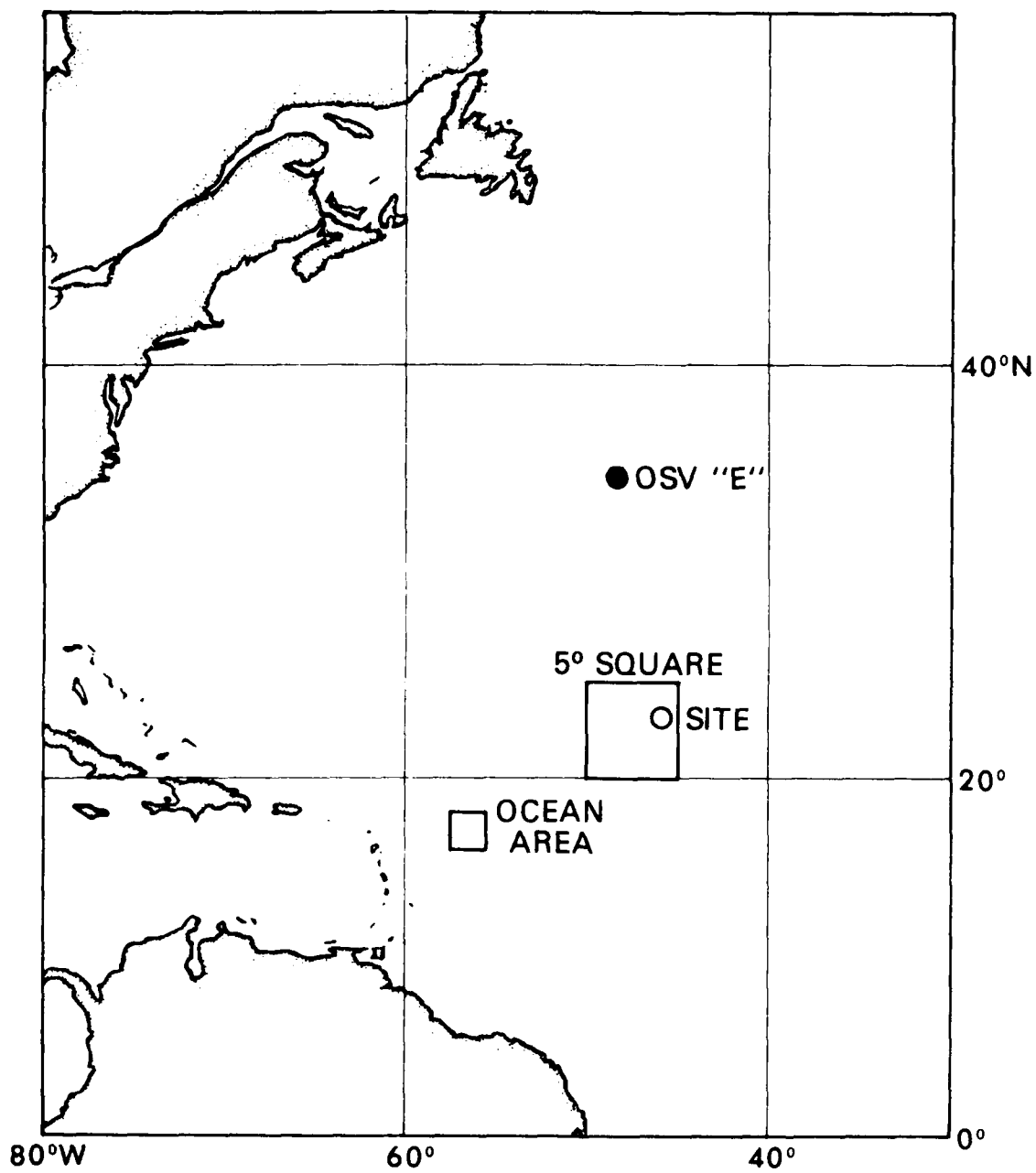


Figure 1. Location map showing site and areas of data compilation

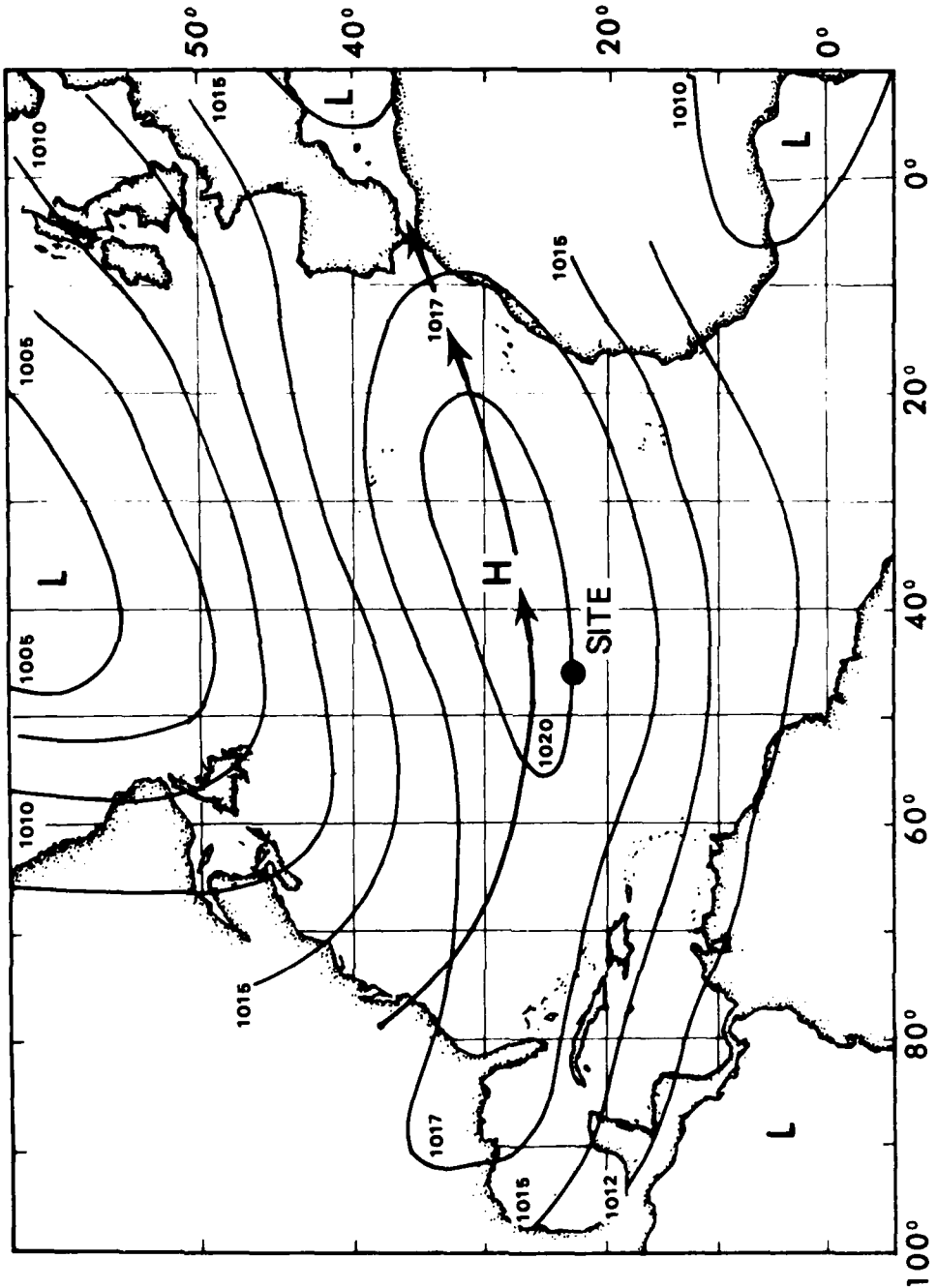
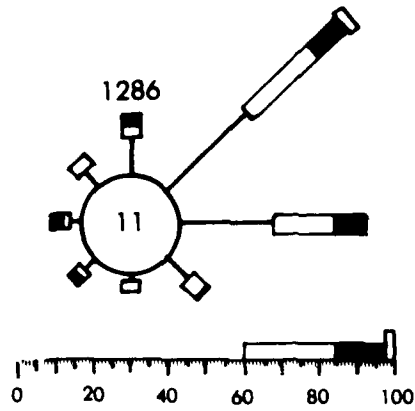
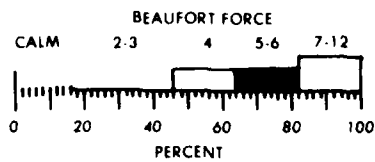
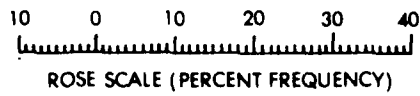
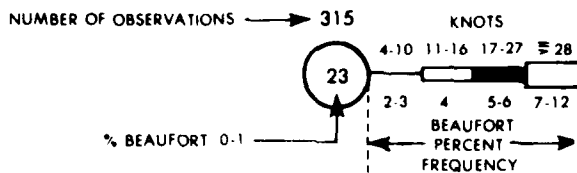


Figure 2. Average sea level in March, North Atlantic Ocean. H, high; L, lows.
 Arrow is average track of highs in March. Modified from Refs. 3 and 4.

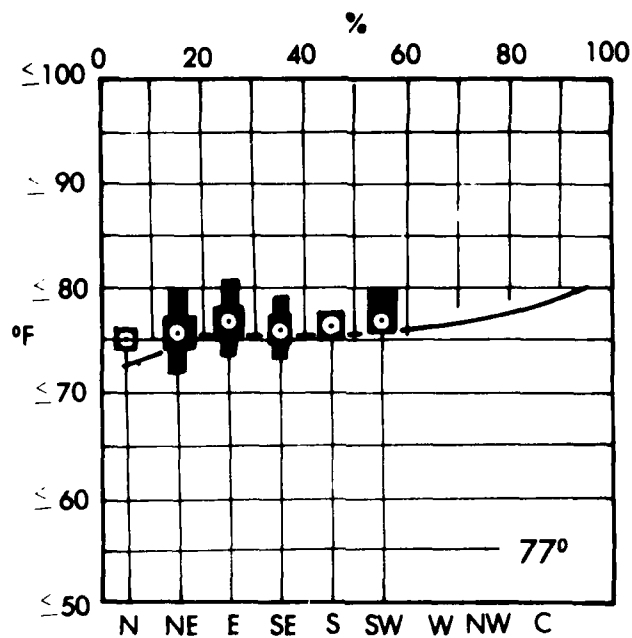


LEGEND



WIND SPEED SUMMARY (ALL DIRECTIONS)

Figure 3. Surface Winds in March, 5° square. From Ref. 10.



LEGEND

Cumulative Frequency Distribution of Observed Temperatures:

Percentage frequency of temperatures equal to or less than the temperature intersected by the curve.

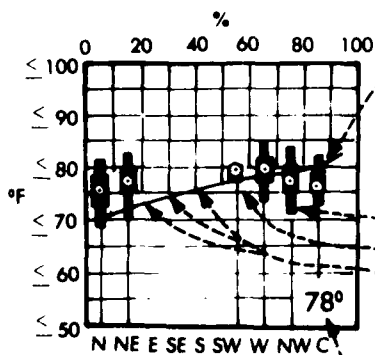
(90% of all temperatures were 82°F or less.)

Distribution of Temperatures Observed with Each Wind Direction:

(a) Mean

(b) 95%, 75%, 25%, and 5% of all temperatures were equal to or less than the temperatures indicated by:

(With NW winds, the mean temperature was 78°, 5% of the temperatures were 71°F or less, 25% were 75°F and less, etc.)

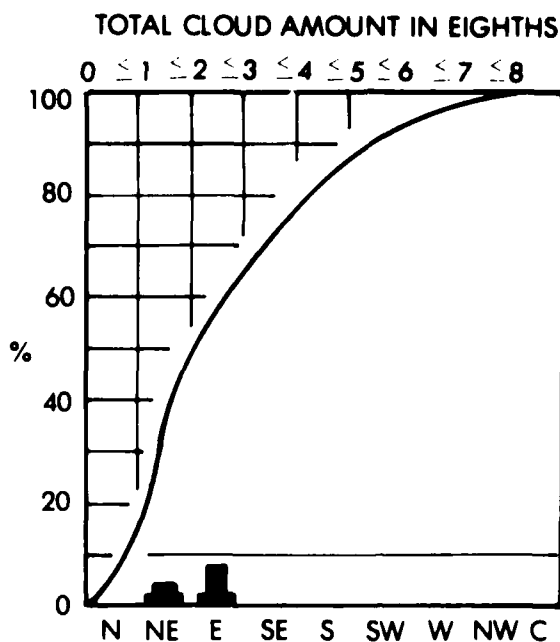


Only the mean, 25%, and 75% temperatures are given when the number of observations for a wind direction was 11-30.

The mean temperature and the percentage frequencies are omitted when the number of observations for a wind direction was 10 or less.

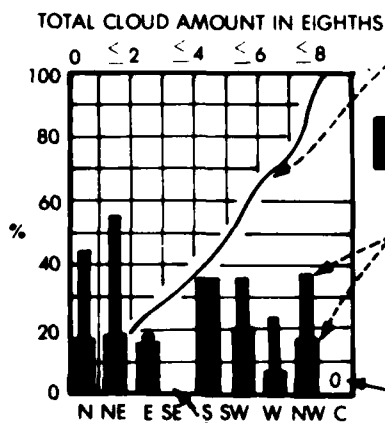
Mean Water Temperature

Figure 4. Surface air temperature in March, Ocean Area.
From Ref. 1.



LEGEND

Total Cloud Amount: Percentage frequency of total cloud amounts equal to or less than the amount intersected by the curve.
(65% of all total cloud amounts were 6/8 or less.)



Low Cloud Amount: Percentage proportions of winds from each direction that were accompanied by low cloud amounts greater than 5/8 and greater than 7/8.

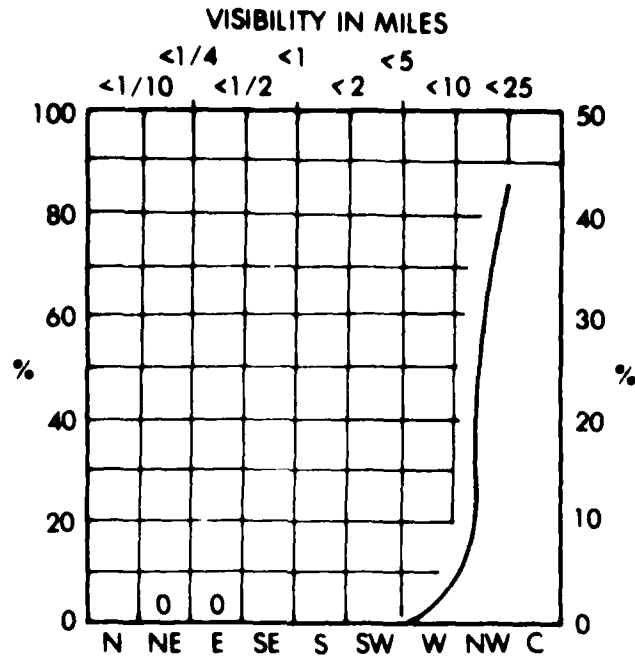
(38% of all NW winds were accompanied by low cloud amounts >5/8 and 17% by low cloud amounts >7/8.)

["Low Cloud" includes all clouds with bases 8000 feet or lower
 ">5/8" includes 6/8-8/8 and 7/10-10/10; ">7/8" includes 8/8 and 9/10-10/10.]

"0" replaces the bar graph when no low cloud amounts >5/8 were observed with winds from a direction.

Bar graph (or "0") is omitted when the number of observations including both wind direction and low cloud amount was 10 or less for a direction.

Figure 5. Cloudiness in March, Ocean Area.
 From Ref. 1.



LEGEND

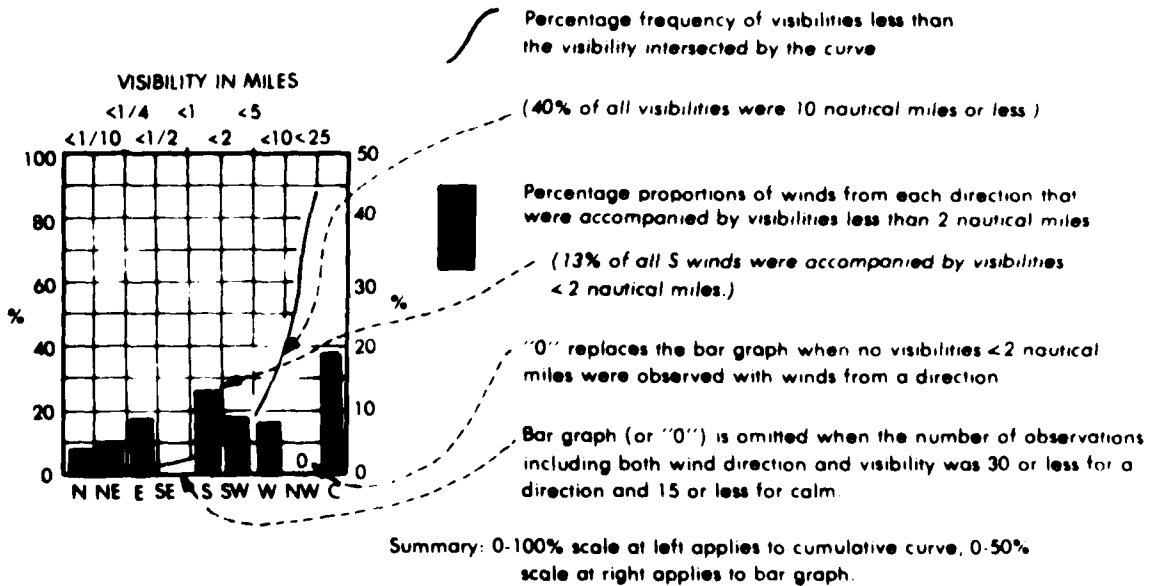
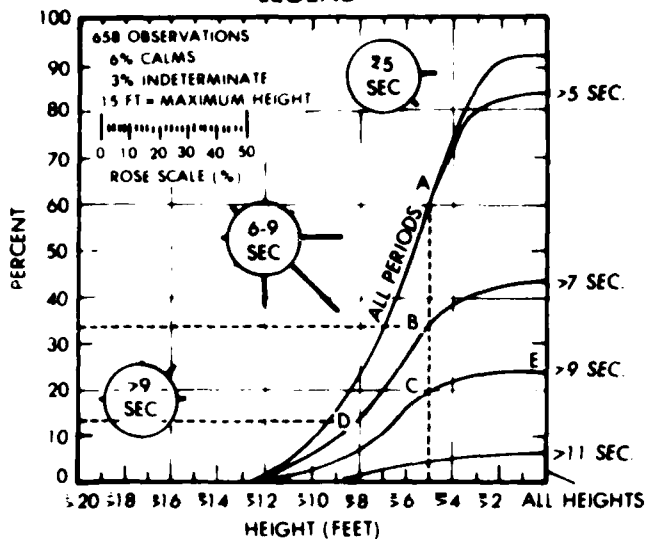


Figure 6. Visibility in March, Ocean Area.
From Ref. 1.

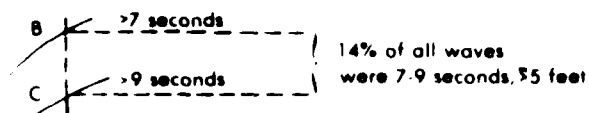
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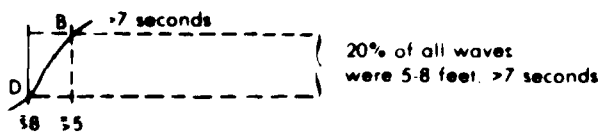
A point on the graph shows the percentage of all waves observed with periods exceeding, and heights equal to or exceeding, certain values:

- Point A 60% of all waves were 5 feet
- B 34% of all waves were >7 seconds 55 feet
- E 23% of all waves were >9 seconds

An interval between two points of the same height category shows the percentage of all waves of that height category within a certain range of periods:



An interval between two points on the same period curve shows the percentage of all waves represented by the curve within a certain range of heights:



An arm of a rose indicates the percentage of all observations which are in the given period-direction category:

25% of all waves observed had periods of 6-9 seconds and came from the southeast

15% of all waves observed came from the south 12% of these waves had periods of 6-9 seconds and 3% had periods >9 seconds.

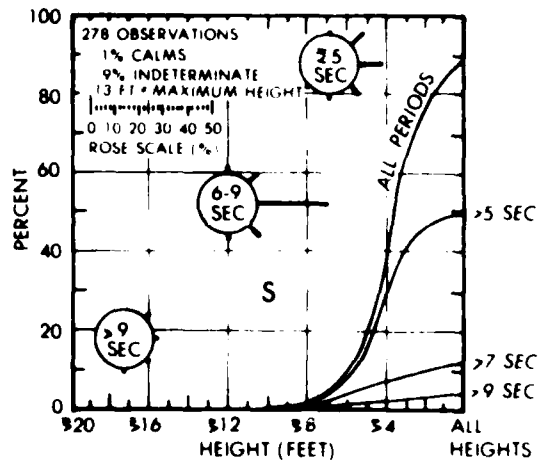
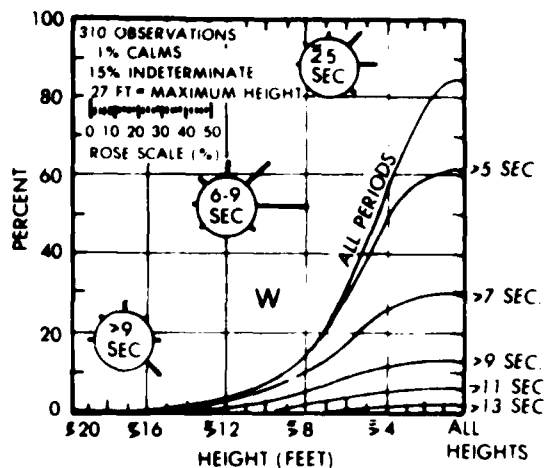
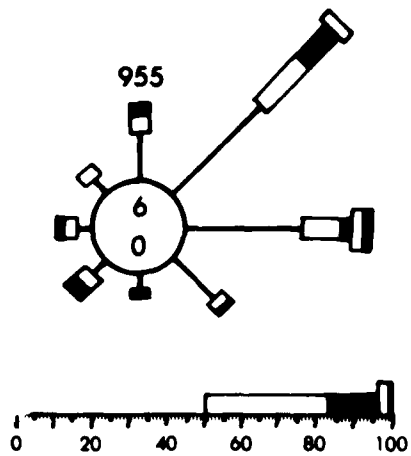


Figure 7. Waves at 5⁰ square. W, winter (January, February, March); S, spring (April, May, June). From Ref. 10.



LEGEND-SEA

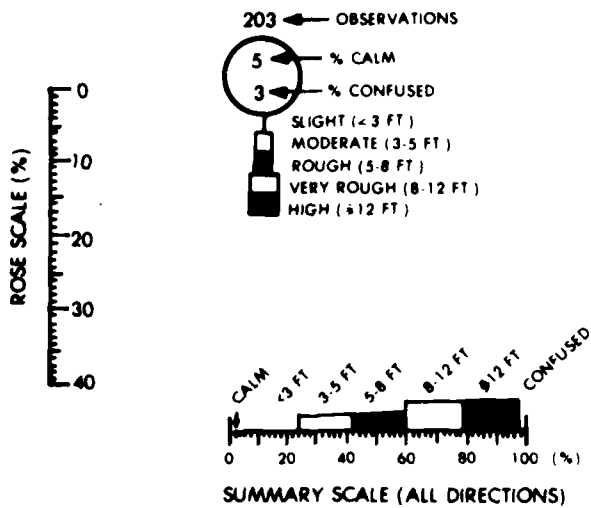


Figure 8. Sea state in March at 5° square.
From Ref. 10.

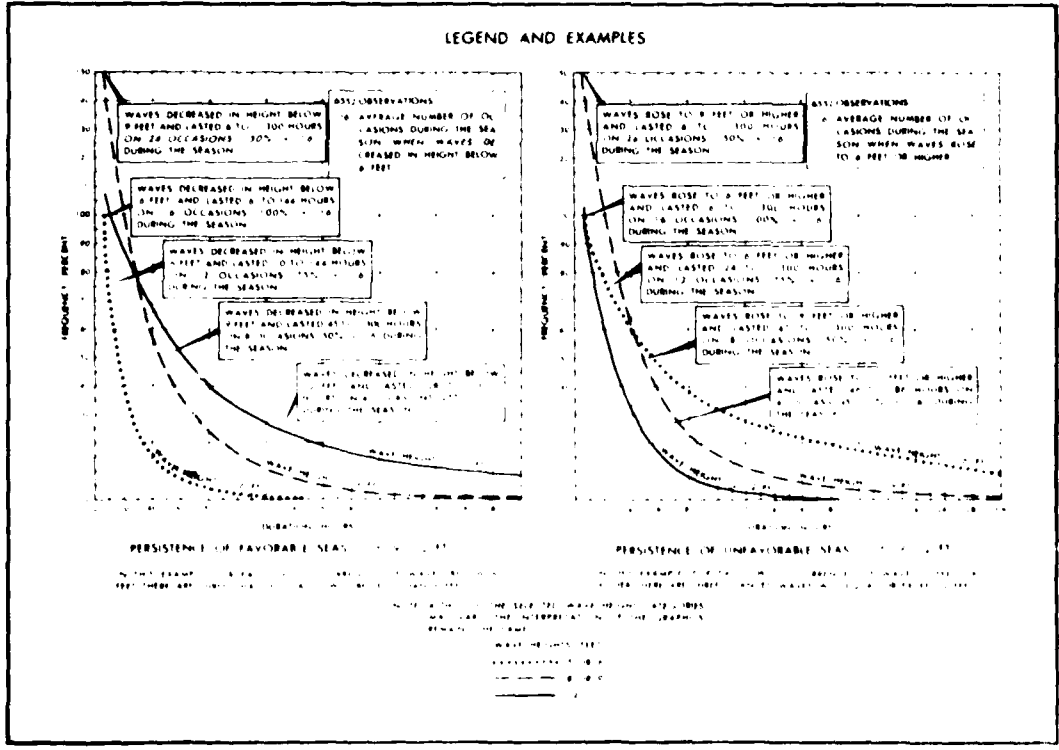
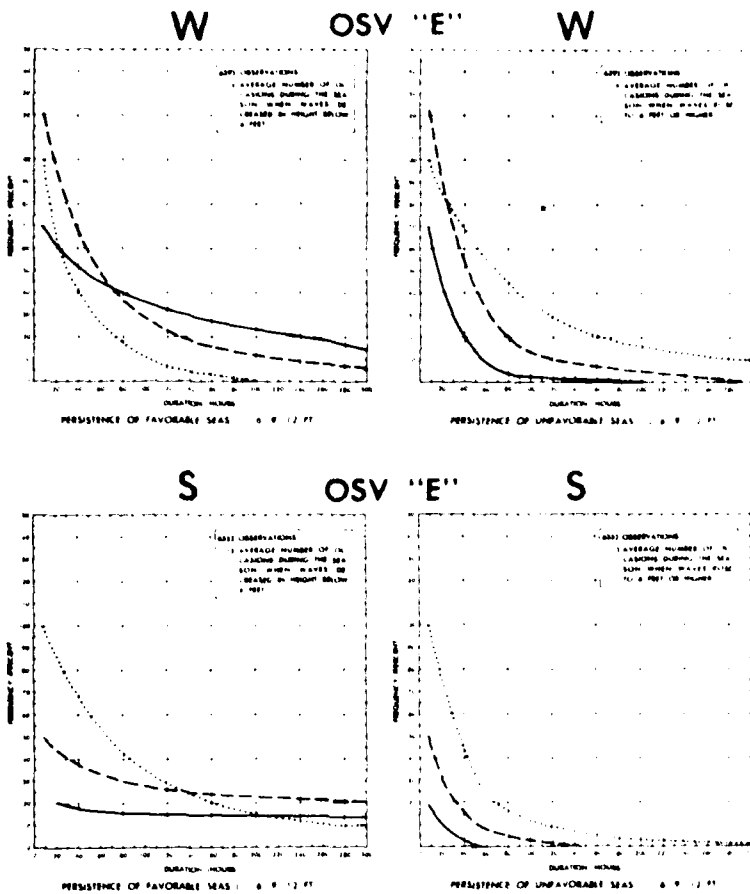
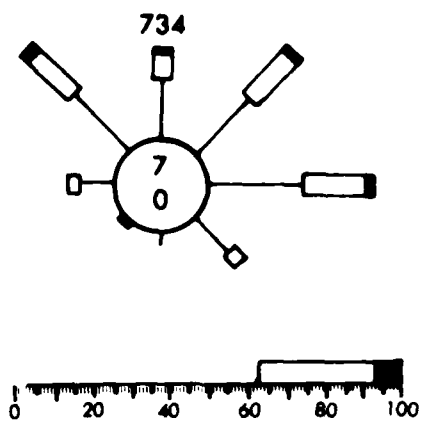


Figure 9. Persistence of seas at OSV "E". W, winter (January, February, March); S, spring (April, May, June). From Ref. 10.



LEGEND-SWELL

- 203 ← OBSERVATIONS
- 5 ← % NO SWELL
- 3 ← % CONFUSED
- LOW (1-6 FT)
- MODERATE (6-12 FT)
- HIGH (>12 FT)

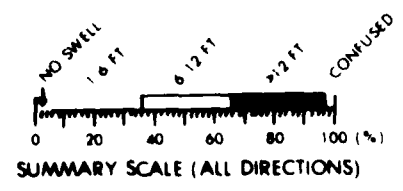
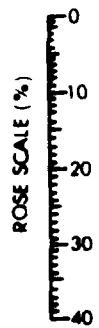
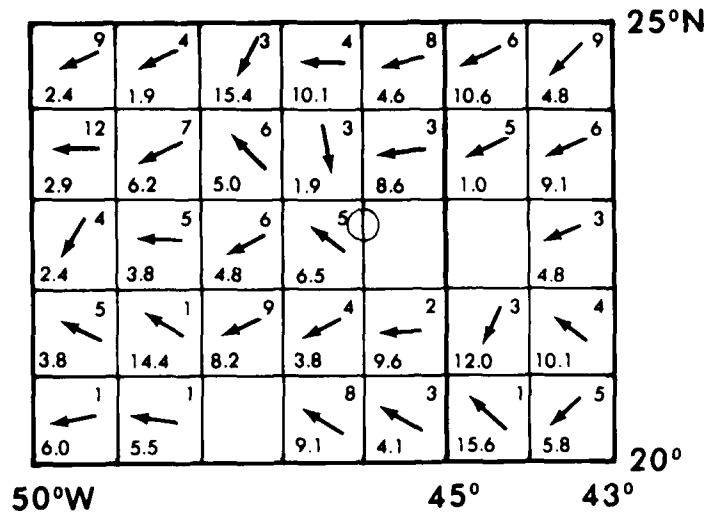
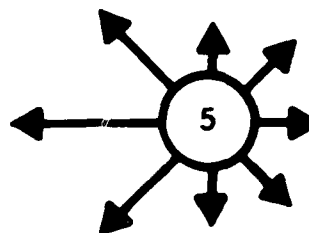
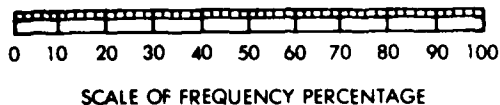


Figure 10. Swell in March at 5⁰ square.
From Ref. 10.



RESULTANT CURRENTS



PREVAILING CURRENTS

Figure 11. Resultant and prevailing currents in March. From Ref. 9. Resultant currents: shown for 1° squares. Site is located by circle. Total current observations, upper right corner. Resultant drift, nm/day, lower left corner. Arrow shows direction of resultant set. Prevailing currents: Current rose is based on 5° square, 20-25°N, 45-50°W, and computed from 1° resultants. Length of arrow from inner edge of circle to base of arrow head gives percent frequency. Frequency percent of zero current given in circle. All arrows on rose are drifts of 0.34-0.66 kn.

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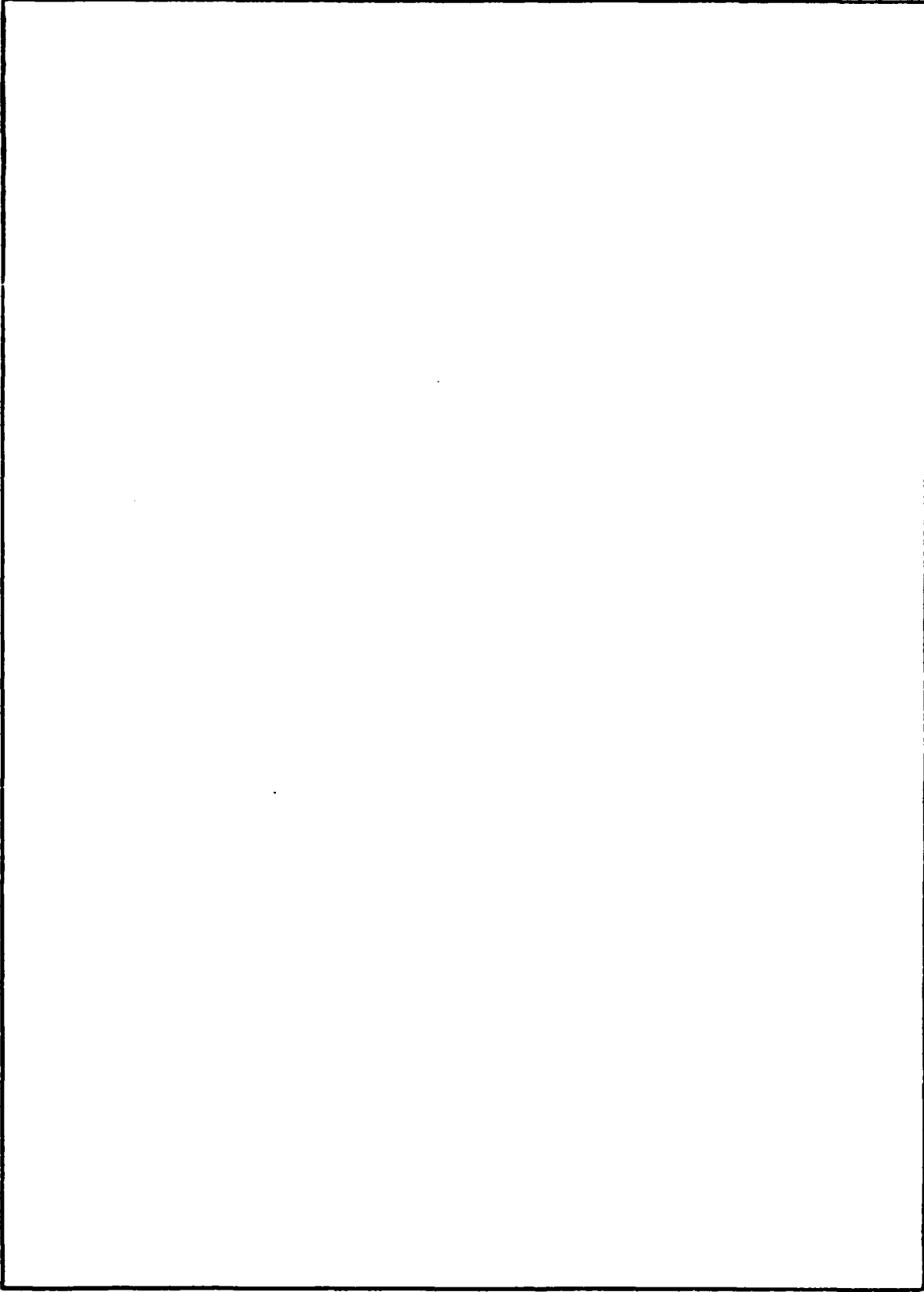
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