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OCEANOGRAPHIC FEATURES IN THE LEE OF THE WINDWARD AND LEEWARD ISLANDS: ERTS AND SHIP DATA

Kirby J. Hanson, Frank Hebard,¹ and Richard Cram,² *Atlantic Oceanographic and Meteorological Laboratories, National Oceanic and Atmospheric Administration, Miami, Florida*

ABSTRACT

Analysis of the ERTS data in portions of the eastern Caribbean are presented for October 1972 showing features which are, as yet, not explained.

Ground truth data obtained in that area during November 1972 are presented. These include vertical temperature structure in the mixed layer and thermocline, and surface measurements of salinity, temperature, and chlorophyll.

1. INTRODUCTION

In previous work in this area, Ingham and Mahnken³ found that tuna schools and bird flocks were concentrated in an area west of St. Vincent Island, Lesser Antilles. They also noted that plankton and primary productivity in the mixed layer were higher in this area than in the Atlantic, and that horizontal temperature differences existed in the upper thermocline in this area which suggested the presence of eddy-like features in the ocean. They suggested the possibility that the increased productivity of this area is a consequence of downstream turbulence on the Caribbean side of St. Vincent Island.

2. ERTS-1 DATA

NASA has collected ERTS-1 MSS Channel 4-7 data over portions of the eastern Caribbean on four cycles in the September-November, 1972 period. For the two ERTS cycles of best photographic coverage, the ERTS photos have been

¹ National Marine Fisheries Service, NOAA, Washington, D. C.

² Rosensteil School of Marine and Atmospheric Science, University of Miami, Coral Gables, Florida

³ Turbulence and Productivity near St. Vincent Island, B.W.I., A Preliminary Report, Contribution No. 42, Tropical Atlantic Biological Laboratory, Bureau of Commercial Fisheries, Miami, Florida 33149

Original photography may be purchased from
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10th and Dakota Avenue
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mosaicked and are shown in Figures 1 and 2. The island arc is visible in many of these ERTS photos.

In comparing Figure 1 (October 13-16, 1972) and Figure 2 (Nov. 17-21, 1972), it is clear that there are horizontal differences in the upward spectral radiance from the ocean surface during the October 13-16 period, but such differences are only slightly apparent in the November 17-21 period. These horizontal differences appear in the lee (west side) of each of the major islands of the Lesser Antilles. Figures 1 and 2 have been presented as negative prints of MSS Channel 4.

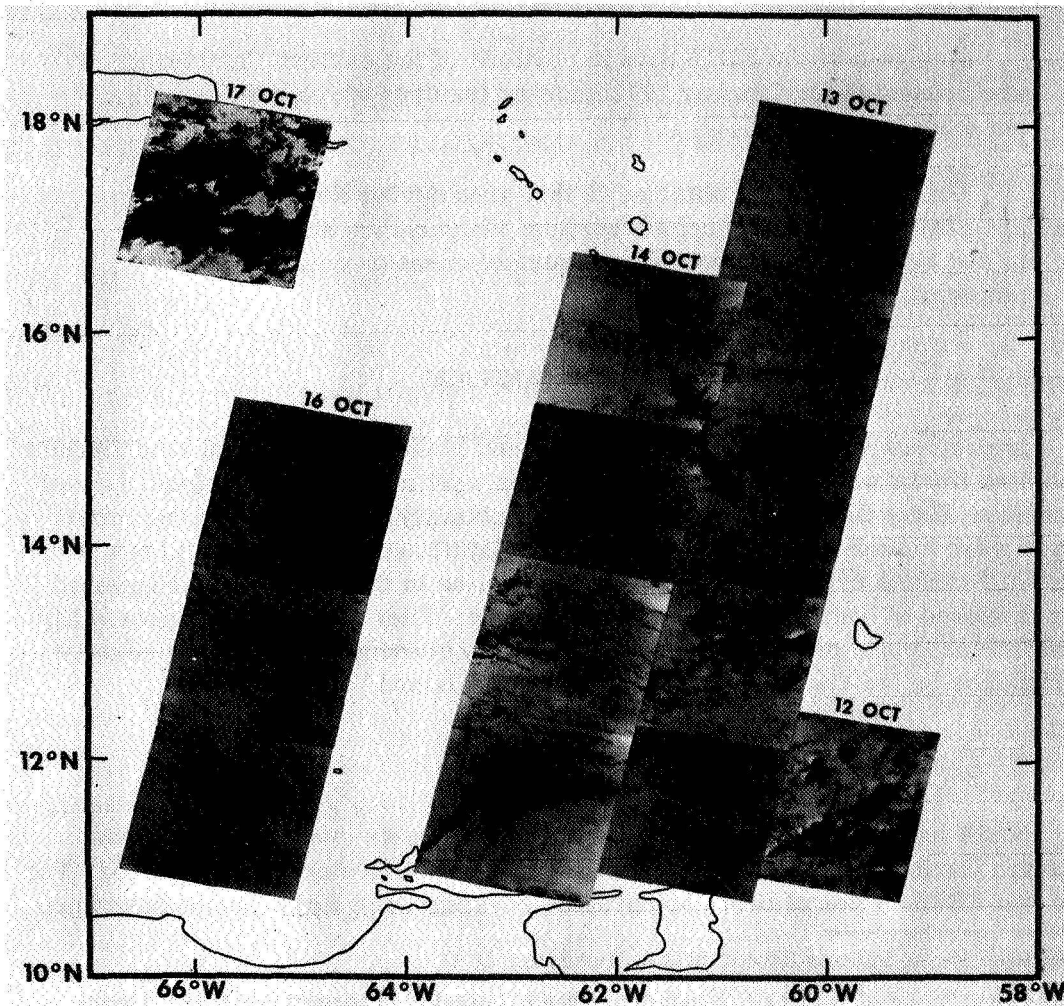


Figure 1. ERTS MSS Channel 4, 13-14, 1972

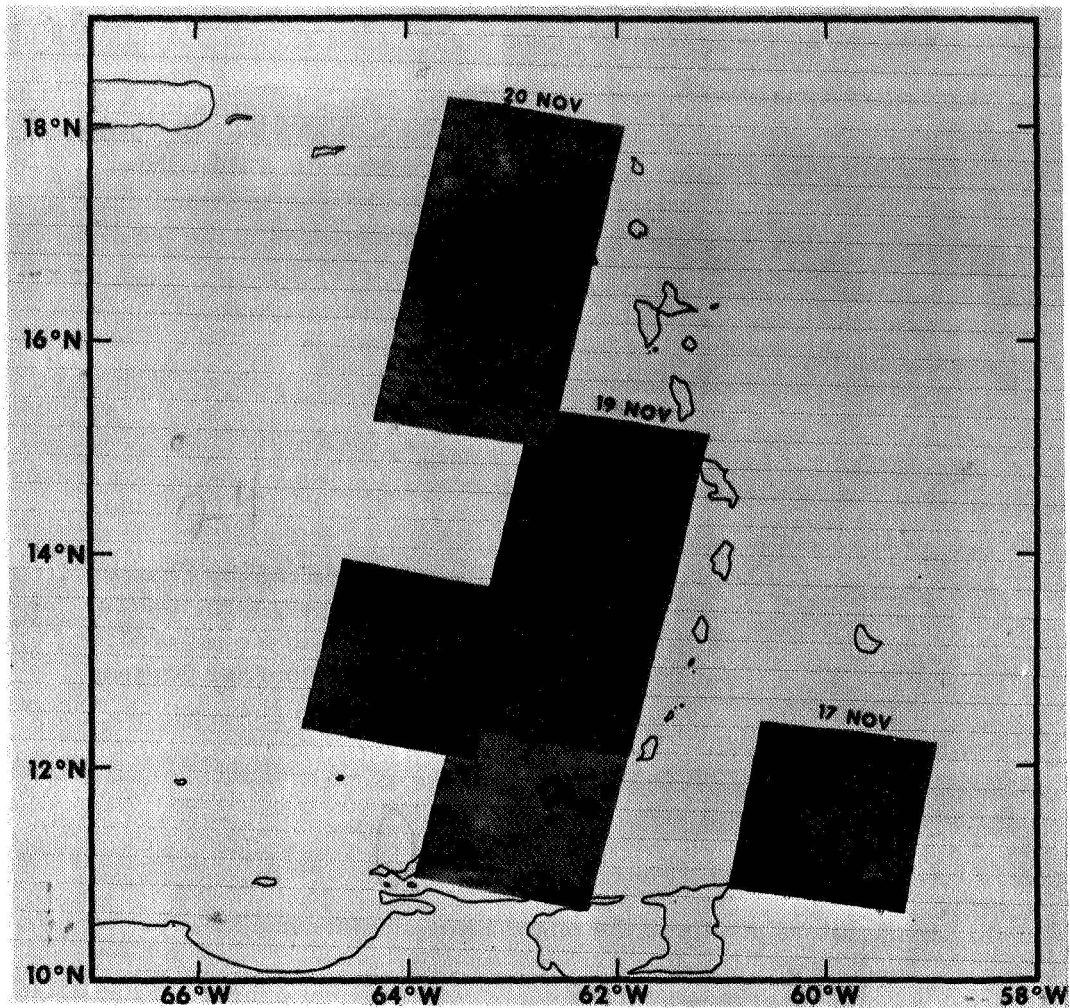


Figure 2. ERTS MSS Channel 4, Nov. 17-21, 1972

The ocean area west of Guadeloupe and Dominica is shown in more detail in Figure 3 and the ocean area west of Grenada and St. Vincent is shown in Figure 4 from the October 14, 1972, MSS Channel 5 data. These same ocean features are visible in MSS Channels 4-7.

3. GROUND TRUTH DATA (Nov. 15-16, 1972)

Ground truth information was obtained in the eastern Caribbean on the NOAA/CARIB cruise of the NOAA ship DISCOVERER. The ship track and times are shown in Figure 5; the hours are GMT. The ocean variables measured were:



Figure 3. ERTS MSS Channel 5, October 14, 1972. Shows Guadeloupe and Dominica and features in the lee of the islands.

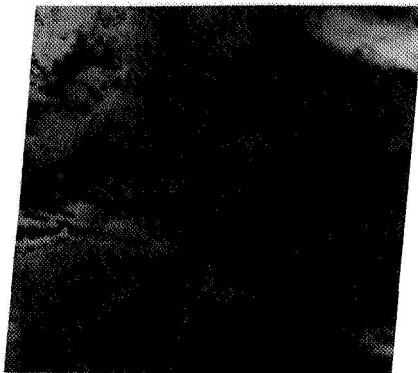


Figure 4. ERTS MSS Channel 5, October 14, 1972. Shows features in the lee of St. Vincent (top) and Grenada (bottom).

1. temperature profile in the mixed layer and thermocline,
2. surface salinity,
3. surface chlorophyll,
4. surface nutrients,
5. upward spectral radiance at the sea surface.

The first three variables have been analyzed and are presented in Figures 6 through 9.

4. DISCUSSION

At the time of collection of ground truth data in the Eastern Caribbean in mid-November, 1972, ERTS data were not yet available to give an indication of

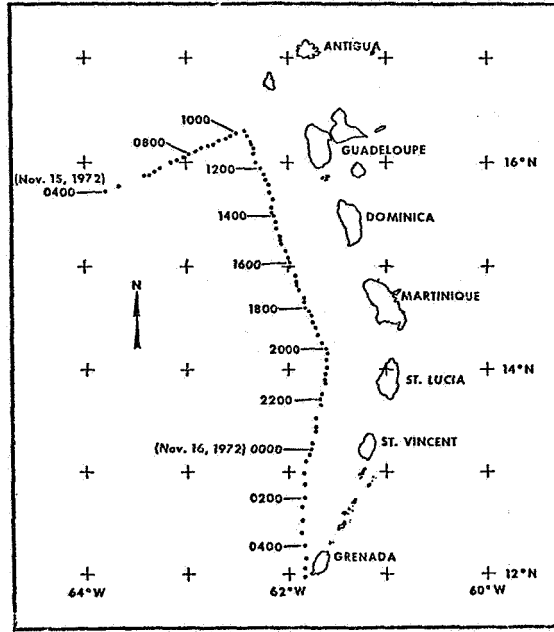


Figure 5. Cruise of DISCOVERER, Nov. 15-16, 1972

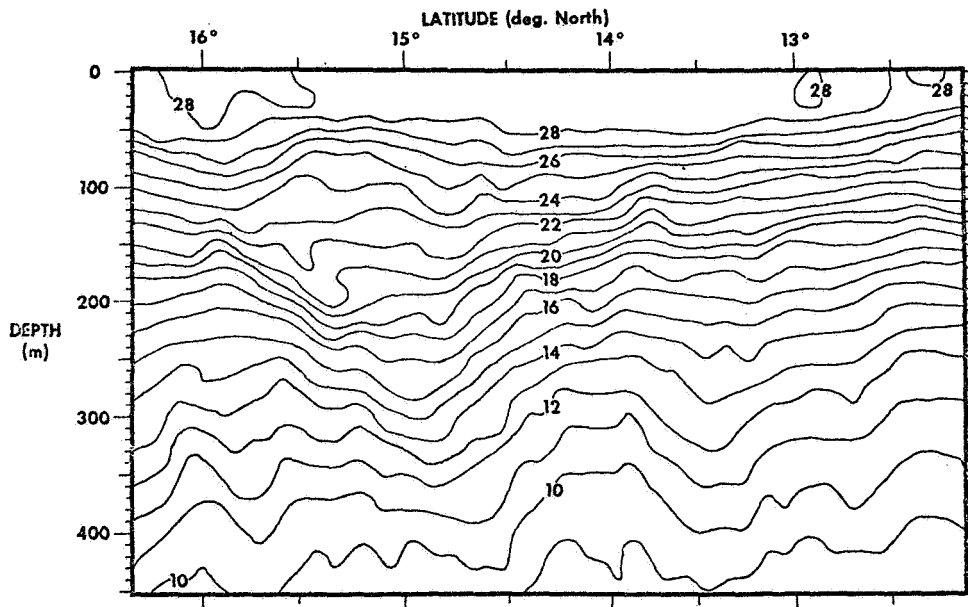


Figure 6. Temperature cross-section along ship track of Figure 5.

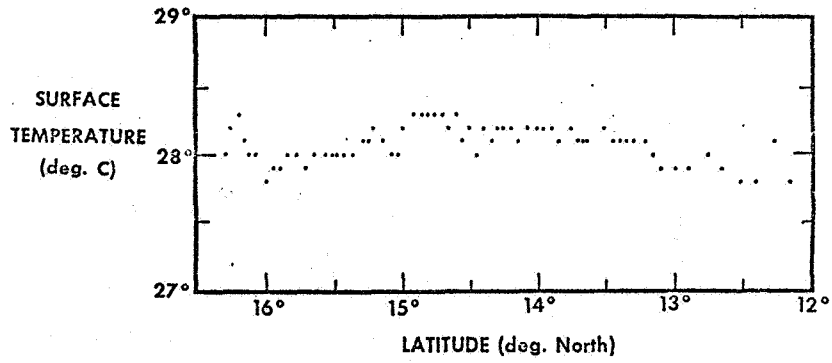


Figure 7. Surface temperature along ship track of Figure 5.

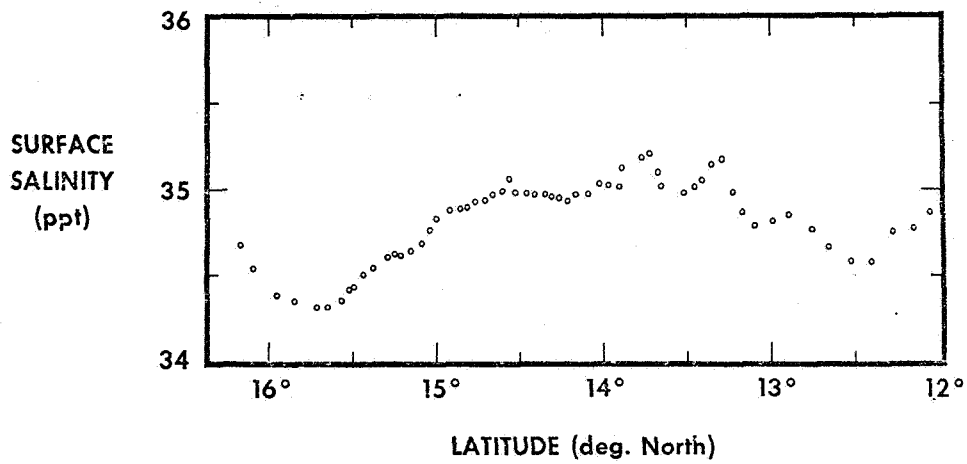


Figure 8. Surface salinity along ship track of Figure 5.

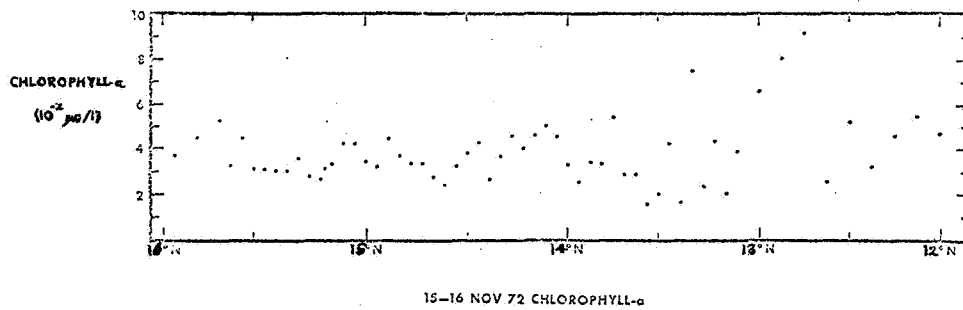


Figure 9. Surface chlorophyll along ship track of Figure 5.

the size and spatial distribution of the features which were apparent in ERTS data, occurring in the lee of each major island in the Antilles arc (Figure 1). Because of this lack of information when the ground truth were collected, only a single north-south cross section was obtained which paralleled the Antilles Island arc.

In the November 19-20, 1972 ERTS data (Figure 2), there are only very small horizontal gradients in image density in the lee of Martinique and Grenada compared to the October 13-14 period. The ground truth data (Figures 6 - 9) obtained four days earlier in that area do not reveal a pattern similar to that of the ERTS data of November 19-20, 1972.

Unfortunately, there were no ground truth taken during the October 13-14, 1972 period which is the only time these ocean features have been clearly apparent in the ERTS data. The features visible in the October 13-14, 1972 ERTS data (Figure 1) may result from one or a combination of causes associated with the atmosphere or ocean. Some possibilities are:

1. The sea state and/or swell is modified in a wind shadow of the island,
2. The run off of island rainfall carries high turbidity water in the mixed layer downstream of the island,
3. The phytoplankton in the mixed layer of the ocean has increased due to increased nutrients associated with upwelling.

We have compared the surface wind observations on the islands during the October 13-14 period with the November 17-21 period and found that the easterly winds were lighter during the October 13-14 period than the November 19-20 period. Thus, the wind observations at the island stations do not support the possible explanation in (1) above, that the sea state is modified due to wind shadow of the island.

In examining the ocean features which are visible in Figure 1, we find that the features are most apparent in channels 5 and 6, and are somewhat less apparent in channels 4 and 7.

Based on the present information, it is not possible to reach a firm conclusion about the cause of the features visible in Figure 1. It is hoped that in the future ground truth in coincidence with the ERTS data, and adequate ERTS data coverage, will resolve the question of the cause of these features.