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Sea Surface Temperatures Along the Continental Shelf-Hamilton Bank to Cape Hatteras

by

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Introduction

The water temperature at any given coastal site is the result of both local processes (heat exchange across the sea surface and mixing) and advection operating on a range of geographic scales. For any given month (or even a year) temperature anomalies, between sampling sites even with a separation of only a few tens of kilometers, may be of different magnitude and sign (Akenhead, 1981). When averaged over several years, however, the mean anomalies generally become comparable. Despite the relatively high small-scale variability there is increasing evidence that there are large scale processes operating over a scale of perhaps several thousand kilometers that can produce coherent temperature shifts (Trites, 1982, Trites and Drinkwater, 1983, Loucks and Trites, 1984).

The large sea surface temperature (SST) data base, derived principally from ships radio weather messages and transmitted to the U.S. Fleet Numerical Oceanography Center (FNOC), is routinely analyzed by the Pacific Environmental Group (PEG) of the National Marine Fisheries Service, by month and one-degree squares (e.g., McLain and Ingham, 1984). Such analyses show areas and times when major anomalies are present. However, the relatively high, small-scale spatial and temporal variability, combined with a limited amount of data for single one-degree squares, often make it difficult to identify large scale shifts and differences. On the assumption that a major variation in shelf temperatures should be coherent over areas much larger than a one degree square, and that the waters of neighbouring areas along the continental shelf are generally linked advectively, it was decided to group SST data, for a coastal strip of the Continental Shelf between southern Labrador and Cape Hatteras, into a set of contiguous subareas.

Data grouping and analyses

The area chosen for study consisted of a "strip" of the Continental Shelf extending from Hamilton Bank in the north to an area just north of Cape Hatteras in the south (Fig. 1). This strip of Continental Shelf was subdivided into a set of 19 subareas. Each subarea consisted of at least 3 (and usually 4) one degree squares (of latitude and longitude) contiguous with each other in an east-west direction. All SST data acquired by FNOC for the period March 1971 to December 1983 were used in this analysis. Monthly averages were computed for each month in the period and for each subarea. In accordance with NAFO recommendations (NAFO Redbook, 1983, p. 75) a 10-year base period was used (March 1971 - December 1980) to establish monthly "normals" and the standard deviation about the 10-year average.

Results

A space-time plot of the 10-year monthly averages (Fig. 2) displays the general cycle of heating and cooling for the entire area. A plot of the between year standard deviation is shown in Figure 3. This figure shows that the standard deviation reaches a maximum in the May-July period and that its magnitude is highest in the area off northeast Newfoundland. The smallest seasonal variation in the standard deviation appears in the Gulf of Maine area and may be related to the increased tidal mixing. It is perhaps reasonable to expect that standard deviations should be highest during the heating season, because a given number of calories transferred across the sea would tend to produce a larger temperature change owing to the stratifying effect. It is not immediately obvious why the deviation ought to be highest in the more northern areas.

Monthly SST anomalies (using mean for March 1971-December 1980 as normal) are shown in Figure 4. In order to simplify the presentation, only anomalies in excess of $1^{o}C$ and which occurred in at least two adjacent time or space steps were contoured. A number of points should be noted: anomalies tend to be coherent over large space scales and often for several months at a time; in 1972 a large area extending from southern Labrador to the Laurentian Channel was warmer than normal (by about one standard deviation) during the late spring and early summer months; temperatures in 1972-73 appeared near normal, whereas in 1974 the entire area from Hamilton Bank to the Gulf of Maine had below normal temperatures in the late spring-early summer period, July temperatures in the area between northeast Newfoundland (subarea 16) and Laurentian Channel (subarea 11) were nearly 3°C below normal; the area south of Cape Cod had above normal temperatures in the January-June period, and thereafter near normal temperatures for the remainder of 1974; the general pattern of cold in the north and warm in the south continued in 1975; the years 1976, 77, 78 appeared as near-normal transition years, but with below normal temperatures tending to occur in the Cape Cod-Cape Hatteras areas; by 1979 the trend to above normal temperatures in the north in spring and summer months appeared to be well established; above normal temperatures in the northern areas continued in each subsequent year (1980, 81, 82, and 83) with anomalies exceeding 3°C in some months and areas.

Evidence of large scale events with a time scale of several years and with opposite phase to the north and south of a region approximately coincident with the Gulf of Maine area and reported previously by Trites and Drinkwater (1983) is also apparent in the temperature anomaly pattern of Figure 4. Work has recently commenced to further study SST anomalies by using empirical orthogonal functions (EOF) to identify major features in SST patterns and their relationship to large scale meterological variations (Loucks and Trites, 1984).

REFERENCES

Akenhead, S.A., B.D. Petrie, C.K. Ross and D.M. Ware. 1981. Ocean climate and the marine fisheries of Atlantic Canada: an assessment. Bedford Institute of Oceanography Rept. Ser. /BI-R-81-8/June 1981. 121 p.

Loucks, R.H. and R.W. Trites. 1984. Environmental variability in the northwest Atlantic. 1984. NAFO SCR Doc. 84/VI/66.

McLain, D.R. and M.C. Ingham. 1984. Sea surface temperatures in the northwestern Atlantic in 1983. NAFO SCR Doc. 84/VI/14.

Trites, R.W. 1982. Overview of oceanographic conditions in NAFO subareas 2, 3, and 4 during the 1970-79 decade. NAFO Sci. Coun. Studies, 5: 51-78.

Trites, R.W. and K.F. Drinkwater. 1983. Overview of Environmental Conditions in 1982 within the NAFO area. NAFO SCR Doc. 83/VI/23. 42 p.

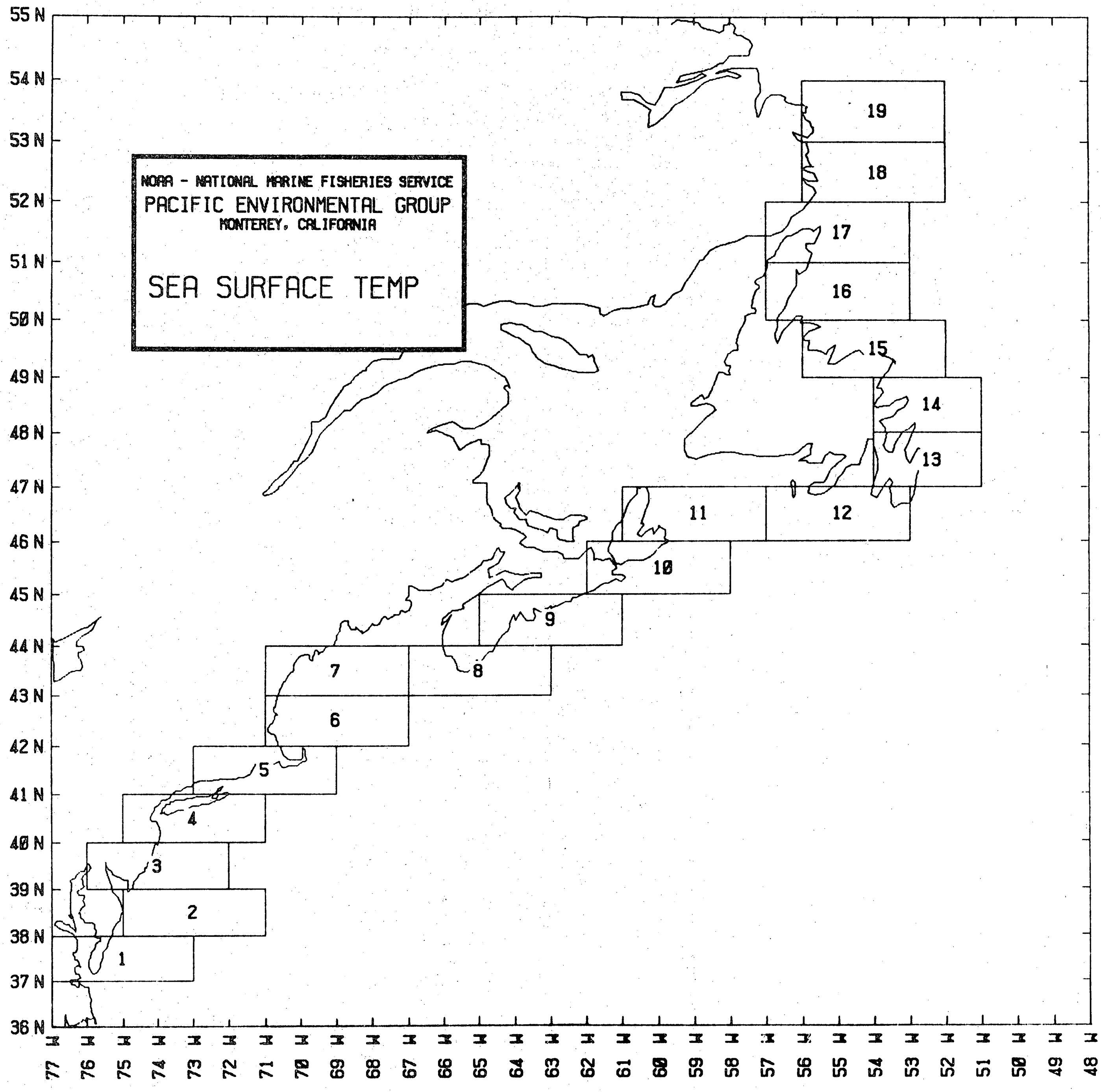

Fig. 1. Map showing the geographic location of the 19 subareas where sea surface temperatures have been grouped.

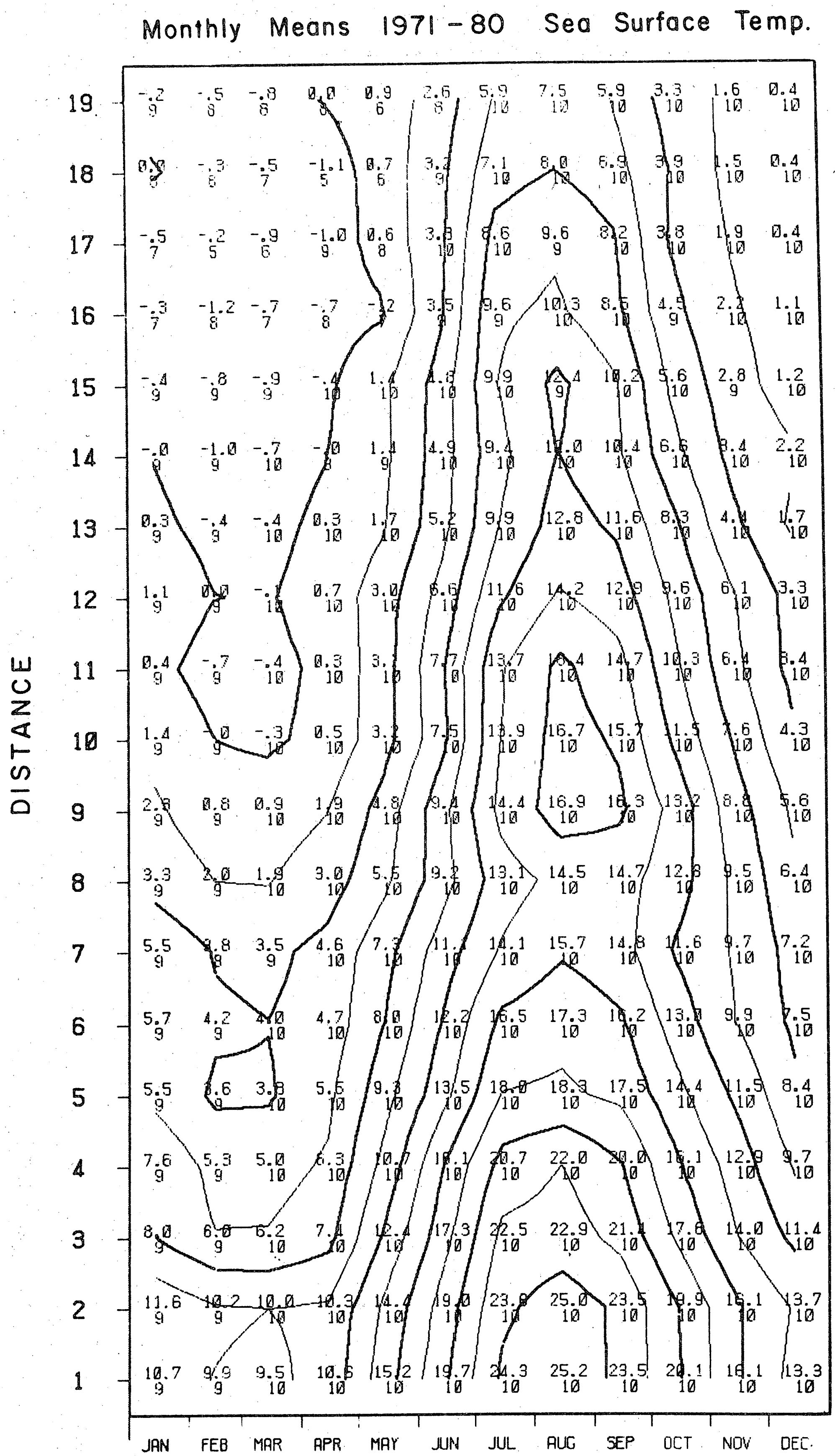

Figure 2. Plot of the mean monthly sea surface temperatures for the period March 1971-December 1980 for the 19 subareas along the coast. Within the plot upper number is the temperature in ^{O}C, lower number is the number of years for which data were available.

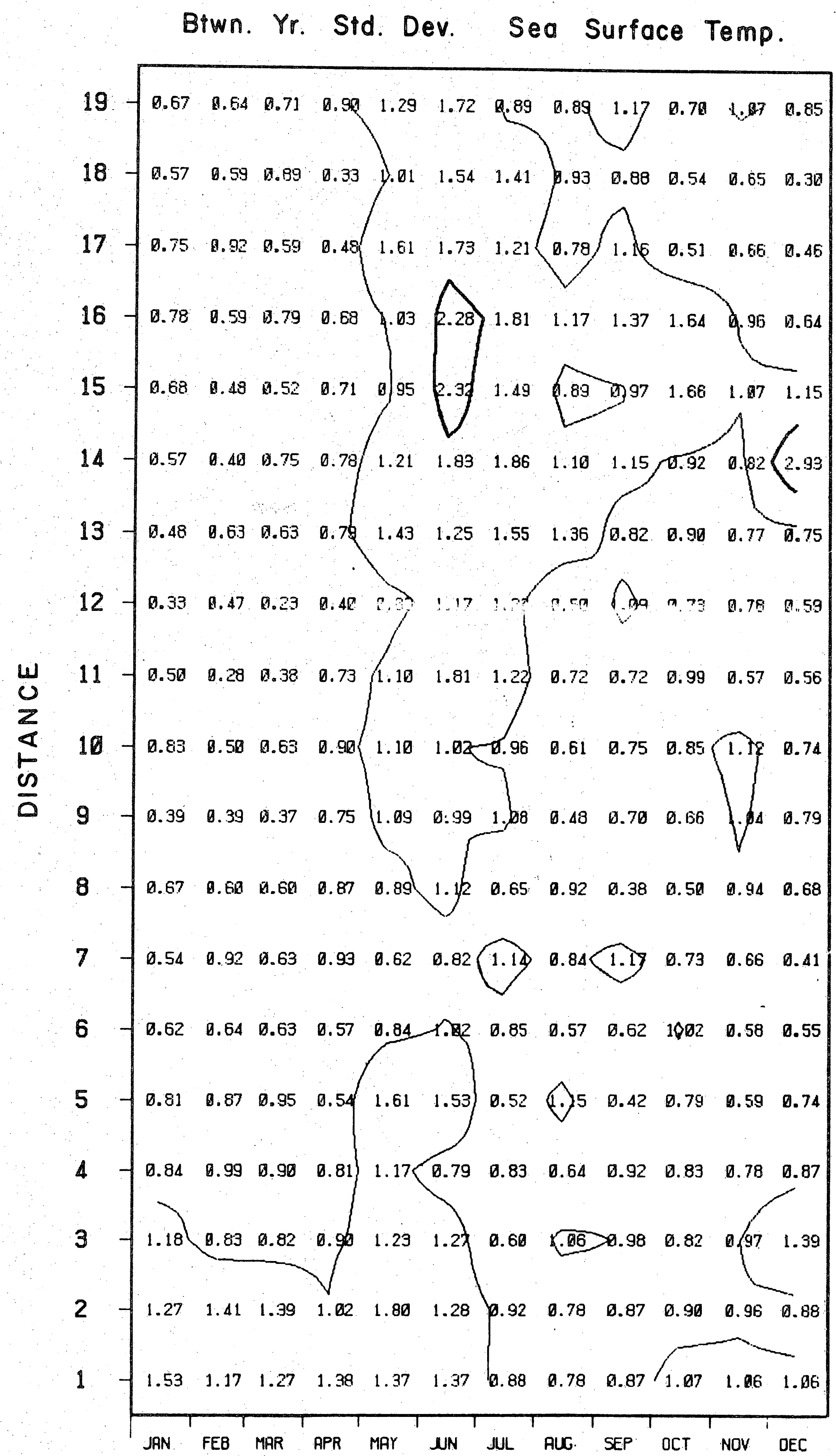

Figure 3. Between year standard deviation for each month and subarea.

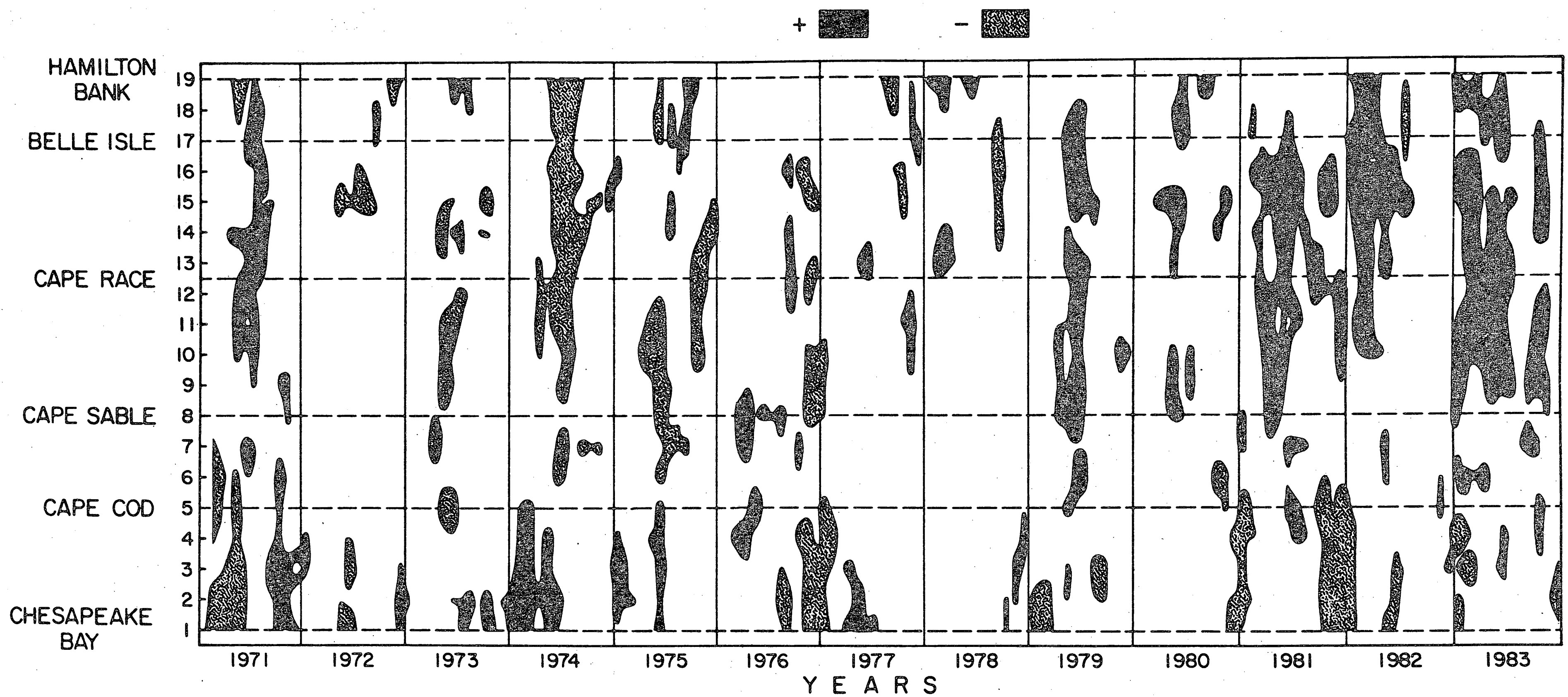

Figure 4. Monthly sea surface temperature anomaly (using mean for March 1971-December 1980 as normal) for each subarea. Only anomalies in excess of 1°C and extending in space through at least two neighbouring areas or in time for at least two consecutive months have been contoured.