

Northwest Atlantic Ocean's SSTs

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ABSTRACT

In the southwestern North Atlantic Ocean, the area between the 80F isotherm and the equator, and between 30W longitude and the western most land boundary, is compiled for each month from a world atlas of sea surface temperatures. Between February and March, the area starts to increase from 100 units until a maximum of over 1000 units is reached in August, after which the area decreases. One unit equals one latitude/longitude square. While increasing by swelling to the north, the temperature inside the area essentially does not increase, in spite of the self-evident fact that absorption of solar heat increases the whole time in the top 100 m of the water column. It is proposed that sea level rises by thermal expansion, starting at the equator, producing a northward slope in sea level which in turn drives warm water in the surface layer northward. This proposition is consistent with the heat balance required of the North Atlantic.

1. INTRODUCTION

In terms of the North Atlantic Ocean's overall heat balance, the Gulf of Mexico presents a problem, because that sea is boxed in on the northern boundary, and in general the excess absorbed solar radiation needs to get from low to high latitudes in the northern hemisphere, especially in summer. To try to understand what is going on there and more broadly, the world atlas of sea surface temperatures [1] is brought into service, and previous work with the tropical northwestern Pacific Ocean provides guidance as well [2, 3].

It has been known for some time that the highest surface temperatures to be found anywhere in the North Pacific are always in the western tropics. Less familiar is the concept that the temperatures in that region are not significantly higher in summer than in winter, and the explanation for that fact has not spread widely. For this nearly constant surface temperature to be maintained over a large and growing area, a very efficient mechanism must be in place during the ever increasing absorption of solar radiation occurring as spring turns into summer.

2. DATA COMPILATION

In the World Atlas of Sea Surface Temperatures [1], H. O. 225, contours of constant temperature (isotherms) are drawn against a grid of one degree latitude/longitude squares on a chart, one chart for each month. Therefore, the warmth of a region of the surface can be evaluated by counting all the one degree boxes enclosed by the 80 F contour and the equator, for example. Also the eastern boundary is selected to be 30 W at the edge of the chart. Boxes are counted from the eastward limit west until they hit continental land. By warmth is meant the amount of surface area having a nearly constant temperature close to 80 F.

Figure 1 has the month (1 = January, etc.) on the horizontal axis, and the vertical axis depicts the total number of boxes when multiplied by 100. Significant is the fact that the area increases northward approaching summer but the temperature inside the area does not increase very much at all. (There is a sizable pocket of 82.5 F within the 80 F contour from July through October.) Whether or not this cap on the highest temperature has ever been stated in print for the North Atlantic is not known to me. M. F. Maury would certainly have been the first one to be in a position to remark on this characteristic, as his Figure 9 indicates [4].

However, a similar occurrence takes place in the western tropical North Pacific [3], where a big surface area never has temperatures less than 80 F and in the summer the sea never gets much hotter than 80 F (or 82.5 F) even though it is self-evident that more solar energy per unit time and per unit area is absorbed in summer than in winter. What happens there also is that the warm area expands in summer and in the northward direction.

3. DISCUSSION

To explain the northward migration of the isotherms in the western North Atlantic from spring into summer, the same hypotheses proposed for the western tropical Pacific can be used again. As the sun crosses the equator into the northern hemisphere absorption of solar heat starts first at the equator causing the sea surface to warm up as well as the water column down to about 100 m, which includes about 90% of the total absorption of heat. Sea level therefore rises first at the equator due to thermal expansion of the water column in the surface layer, and then the sea level slopes down to the north. That slope forces warm surface water to slowly move north, where slowly means roughly 15 cm/sec.

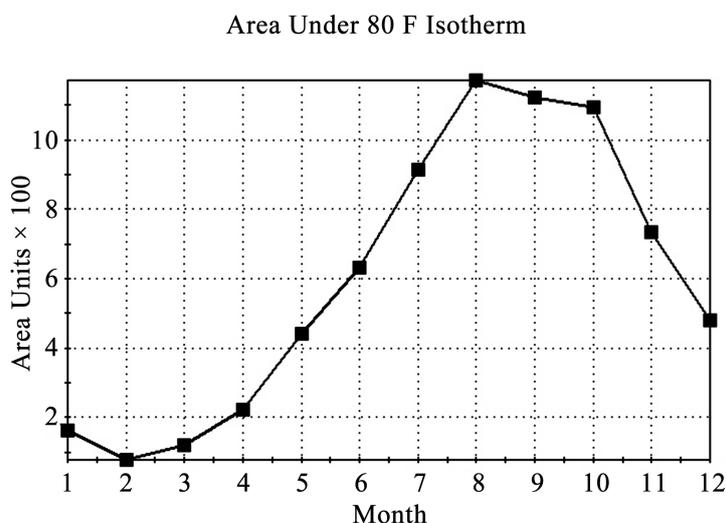


Figure 1. Area units times 100 between the 80 F isotherm and the equator, 30 W and continental boundary as a function of month (1 = January, etc.). One area unit equals one latitude/longitude square.

In the cooling season the 80 F sea surface isotherm recoils back to the south, but the interpretation of that fact could be confusing because evidence exists that there is a “large volume of warm water outside the Gulf Stream” that drifts off to the north at all times, to quote Maury [4]. More recent observations, of a kind unavailable to Maury, confirm his description [5]. Three east/west vertical sections from frequent BT and XBT drops at 16, 30 and 40 N in the cooling season (two in October, November and the other in February) show a continuous deep mixed layer 40 degrees of longitude wide, starting at Africa and going west. This is consistent with a warm surface layer moving north and being cooled from above. The retreat of the sun plus seasonal cooling of the surface layer water account for the return of the isotherms to the south.

As far as the Gulf of Mexico is concerned, the northward movement of the 80 F isotherm suggests that the heat from lower latitudes basically goes around the Gulf to the east on its way to higher latitudes in summer.

Central hypotheses that need future corroboration from new or available observations are: 1) the extent to which the month to month northward movement of an isotherm reflects the northward movement of the warm surface layer water, and 2) that sea level actually rises due to the thermal expansion from absorbed solar energy in the surface layer.

4. CONCLUSION

Surface areas under the 80 F isotherm for each month are made quantitative by measurements taken from charts in a classic sea surface temperature atlas of the southwest North Atlantic. By expanding northward the areas increase rapidly in spring, but the temperatures within them do not increase significantly. To explain that fact the following hypothesis is put forward: solar heat in the surface layer, absorbed first at the equator, raises the sea level there by thermal expansion, creating a downward slope to the north in sea level, thereby causing northward movement of warm surface water. Although consistent with the heat balance constraint placed on the North Atlantic Ocean, additional observational evidence could strengthen the hypothesis.

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CONFLICTS OF INTEREST

The author declares no conflicts of interest regarding the publication of this paper.

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