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OFFICE NOTE 267

A Comparison of Regional Sea Surface Temperature Climatologies for the Northwest Atlantic

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1. INTRODUCTION

This note is being written to address the problems of sea surface temperature monthly climatology in the coastal and off-shore areas of the Gulf Stream which are highly variable in both time and space. Also, of interest is the ocean region centered near Bermuda, the Sargasso Sea, which exhibits little variation in winter temperatures. A comparison of large-scale sea surface temperature climatologies is not the purpose of this note, such a comparison is being prepared by Reynolds (1982).

A SST climatology is needed to determine anomalous water temperatures. During the past 6 years several monthly mean SST climatologies have been used by the Ocean Services Group. These climatologies are compared in this note.

2. BACKGROUND ON CLIMATOLOGIES

A. The Use of the NAVOCEANO Climatology

Up to December 1980, monthly mean sea surface temperature (SST) and anomaly charts were produced on a 1° x 1° latitude/longitude guadrangle for the Western North Atlantic. These charts were produced by the U.S. Naval Oceanographic Office in The Gulf Stream during 1966-1975, and by the National Weather Service during 1976 to 1980, in Gulfstream. During that time, the method of preparation for monthly mean SST and anomalies remained the same. Monthly ship and buoy SST data were simply averaged by 1° guadrangle. The anomaly chart was the difference between the monthly mean and the monthly climatological mean. The regional climatological means were originally developed by the U.S. Naval Oceanogrpahic Office (1969) on a 1° x 1° grid, using marine decks based on observations obtained from 1854 to 1956.

B. The Use of the RAND Climatology

Beginning in 1979, global SST analyses were produced routinely. These analyses were based on two days of ship, fixed and drifting buoy and XBT data and also satellite data. The analysis was performed objectively (Gemmill and Larson, 1979) on a polar stereographic projection with a grid mesh of 190.5 km at 60°N (102 km at the equator). Semi-monthly and monthly mean charts are produced from the mean of the analyses. The anomalies were established using the climatology of Alexander and Mobley (1976). This climatology (referred to as RAND) was originally developed from the combination of coarse resolution SST climatologies and interpolated to a 1° x 1° grid for use by General Circulation Models of the atmosphere, not for high-resolution coastal and regional oceanographic work. Because of the original coarse resolution of the RAND climatology it was unsuitable for ocean regions with strong temperature gradients such as the Gulf Stream. It should be stated the RAND used here was not the original 1° x 1°, but one interpolated from a 2° x 2° version residing in the NMC operational system. However, a close check between the original and the interpolated values showed little difference (~0.1°C).

C. The Use of the Robinson-Bauer Climatology

Also, a suite of high-resolution coastal and regional analyses were being generated on a polar stereographic grid (20-23 km mesh length) twice weekly based on 5-days of ships, fixed buoy, drifting buoy, and XBT data and current satellite data. The regional analyses cover the Northwest Atlantic, Gulf of Mexico, and the Northeast Pacific from Alaska to Baja (Gemmill and Auer, 1981). Monthly mean analyses are determined from the average of the twice weekly analyses over the month and interpolated to a 1° x 1° latitude/longitude grid.

Beginning in January 1981, a high-resolution 1° x 1° global SST monthly climatology was obtained from Bauer, similar to the one's displayed in the atlas of the North Pacific (Robinson, 1976) and the North Atlantic and the Indian Ocean (Robinson, Bauer, Schroeder, 1979). This climatology will be referred to as Robinson-Bauer. This SST climatology was made using only vertical profile temperature data for the world's oceans. However, the data set is about 4% of the data available from marine decks, and required some "subjective" interpretation to the final monthly means. Further, the bulk of these data have been collected from the mid-1940's through the mid 1970's. Therefore, when comparing the Robinson-Bauer SST climatology to the NAVOCEANO SST climatology, it must be remembered that the observation methods differ as well as the time interval for data collection.

3. COMPARISONS

Comparison of the RAND, Robinson-Bauer and NAVOCEANO climatlogies for the Western North Atlantic will be shown for February and August. Other months shows similar results, but lie somewhere between the two extreme months.

A. Winter Comparison

February comparisons will focus on difference between analyses with emphasis on the U.S. coastal regions, the Gulf Stream and the Sargasso Sea.

(1) Robinson-Bauer minus NAVOCEANO

Both the Robinson-Bauer (Figure 1) and NAVOCEANO (Figure 2) climatologies were designed for 1° x 1° latitude/longitude grid, but there are some notable differences as shown in Figure 3. The February Robinson-Bauer climatology indicated much colder water occurs along the coastal area from Florida to Maine, generally 2°C, than indicated by NAVOCEANO. Also, the Robinson-Bauer

temperatures are much colder off the Carolina's by up to 4°C. The placement of the core of the Gulf Stream does not differ between the analyses, except east of 65°W where in Robinson-Bauer the 18°C isotherm clearly defines the Gulf Stream core. However, the Robinson-Bauer climatology is warmer by 2°C along the gradient north of the Gulf Stream. Further, Robinson-Bauer is as much as 1°C warmer in the Sargasso Sea compared to the NAVOCEANO climatology.

(2) Robinson-Bauer minus RAND

A comparison was made also between the Robinson-Bauer and RAND. The coarseness of the RAND (Figure 4) is easily noted in comparing the analyses and the difference field between the climatologies (Figure 5). The RAND climatology along the coastal areas is warmer by 3°C; the gradient of the Gulf Stream has been spread out, with a shift off-shore of the Gulf Stream being colder by 3-4°C along its axis as compared to Robinson-Bauer. The Sargasso Sea of Robinson-Bauer was warmer than RAND, but only by 0.5°C.

Table 1 shows the distribution of grid point temperature differences between Robinson-Bauer and NAVOCEANO climatologies; and between the Robinson-Bauer and RAND climatologies. The total number of grid points do not match for each climatology, because values at common grid points were not always available from each climatology . It is observed that although Robinson-Bauer and NAVOCEANO are more similar than RAND, the magnitude of difference between Robinson-Bauer and NAVOCEANO is nearly 50% that anticipated for the magnitude of anomalies within the Gulf Stream.

Also, estimates of horizontal temperature gradients were made for the three climatologies. The magnitude of the gradient was calculated by taking the temperature difference diagonally across the corner points of the 1° x 1° guadrangles. The gradient distribution are summarized for February in Table 2. It is evident that Robinson-Bauer depicts the strongest gradients

whereas RAND lacks strong gradients.

B. Summer Comparisons

(1) Robinson-Bauer minus NAVOCEANO

The August thermal structure differs considerably from that in February. Horizontal temperature gradients along the Gulf Stream south of Cape Hatteras are imperceptable, and are weak east of Cape Hatteras.

The comparison of Robinson-Bauer climatology (Figure 6) and NAVOCEANO (Figure 7) are shown by the difference in Figure 8. Temperatures are cooler in the Robinson-Bauer as compared to NAVOCEANO along the U.S. coast especially off New Jersey by 2°C and in the Gulf of Maine by 2°C. Robinson-Bauer identifies the Gulf Stream but the actual difference are small. Robinson-Bauer is also warmer in the southern Sargasso Sea by 1°C.

(2) Robinson-Bauer minus RAND

Inspection of the RAND climatology (Figure 9) again shows much smoother thermal structure. The comparison against Robinson-Bauer is shown in the difference shown in Figure 10. The Robinson-Bauer is colder in the Gulf of Maine by 2°C, and along the New Jersey coast similar to the differences noted in February. However, the displacement of the Gulf Stream in RAND shows temperature colder by 2°C along the Gulf Stream. Again Robinson-Bauer is warmer in the Sargasso Sea by 1°C.

The distribution of differences between climatologies for August (Table 3) are not as dramatic as for February. However, Table 4 does show that the RAND again is too coarse to contain the more representative gradients of both Robinson-Bauer and NAVOCEANO.

4. SUMMARY

The purpose of this note was to compare the RAND, NAVOCEANO and Robinson-Bauer SST climatologies. The three climatologies were compared along the U.S. coastal areas, the Gulf Stream and the Sargasso Sea. The Robinson-Bauer was the most detailed along U.S. coast line and comparable to NAVOCEANO along the Gulf Stream. But, temperature differences were 50% of anticipated anomalies. Robinson-Bauer is warmest in the Sargasso Sea by up to 1°C. Finally, the comparisons showed the RAND to be too coarse and not suitable along coastal regions.

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Table 1. Distribution of Grid Point Temperature Differences Values Between Climatologies for February

	-6.5	-5.5	-4.5	-3.5	-2.5	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5	(°C)
Robinson-Bauer minus RAND		1	2	1	4	9	29	177	114	30	23	8			
Robinson-Bauer minus NAVOCEANO		1		1	2	7	28	194	140	19	2				

Table 2. Distribution of Horizontal Temperature Gradients by Climatology for February

	0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	>6.5	(°C)
Robinson-Bauer	144	150	23	24	17	16	12	8		
NAVOCEANO	126	166	23	26	25	20	7	1		
RAND	149	130	42	70	7	0	0	0		

Table 3. Distribution of Grid Point Temperature Difference Values Between Climatologies for August

	-6.5	-5.5	-4.5	-3.5	-2.5	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5	(°C)
Robinson-Bauer minus RAND					4	9	19	202	154	10					
Robinson-Bauer minus NAVOCEANO						7	20	266	94	5	1				

Table 4. Distribution of Horizontal Temperature Gradients by Climatology for August

	0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	(°C)
Robinson-Bauer	269	65	32	19	7	2			
NAVOCEANO	244	89	38	16	5	2			
RAND	266	78	52	2					

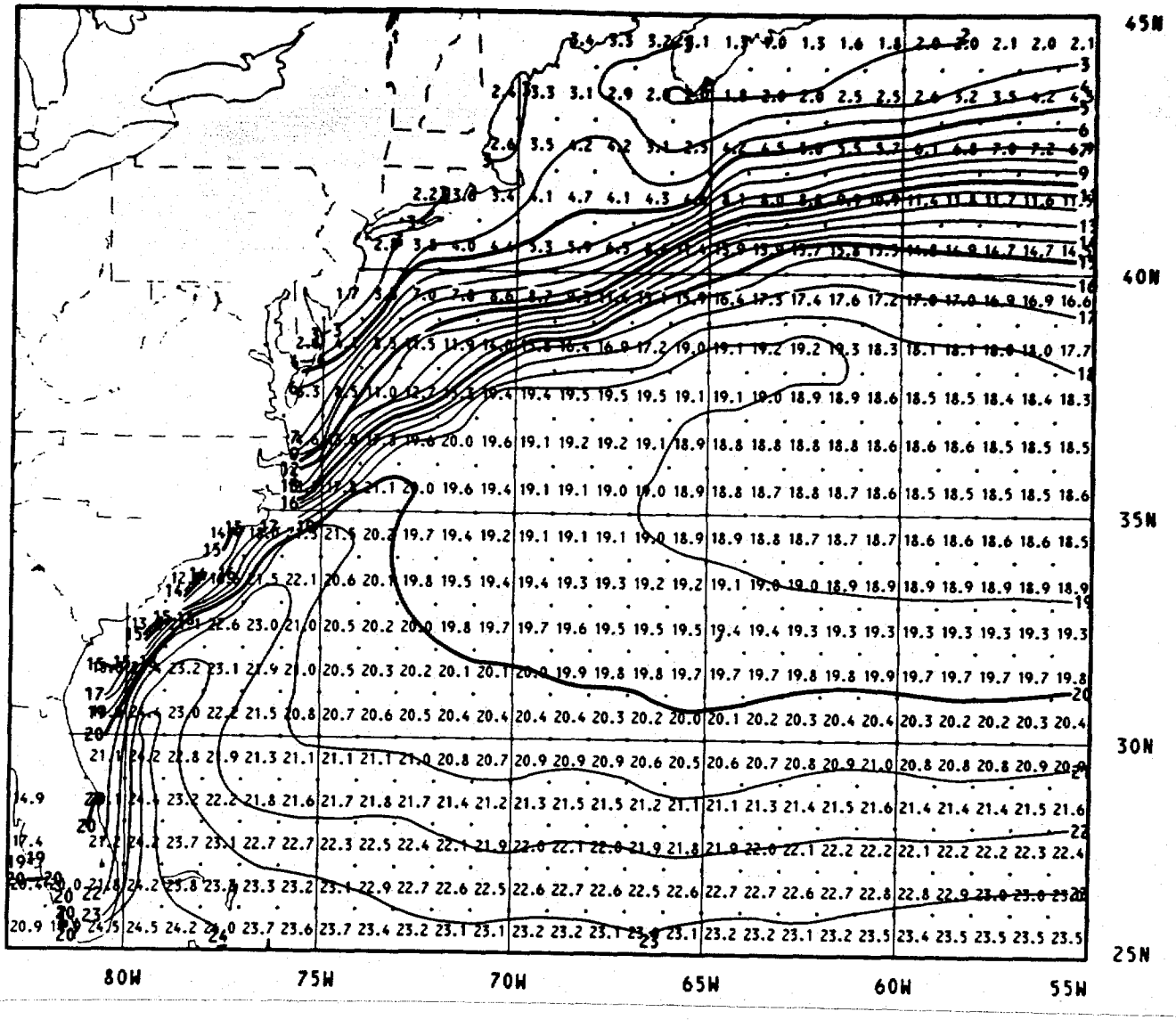

Figure 1. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for February from Robinson-Bauer

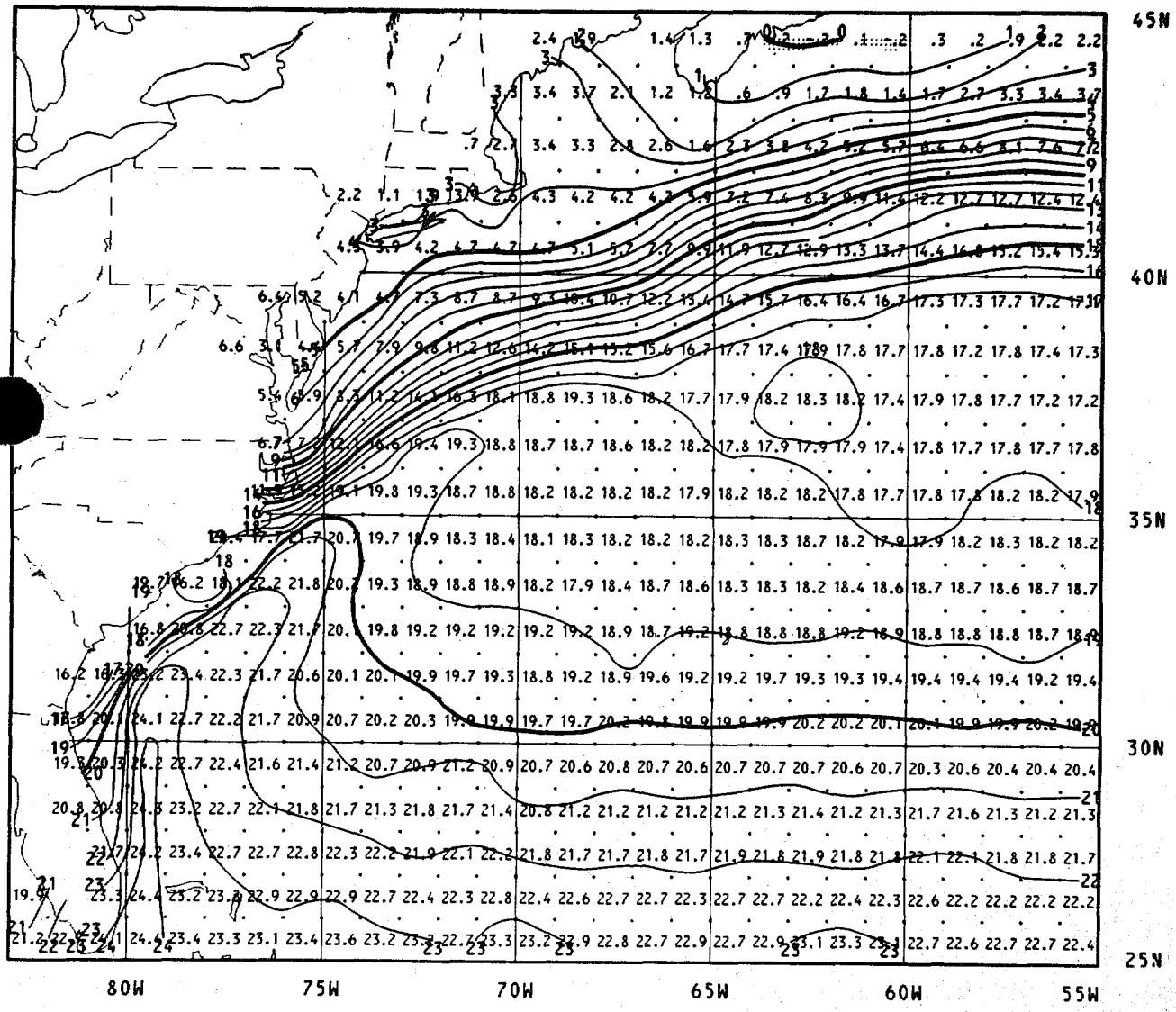

Figure 2. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for February from NAVOCEANO

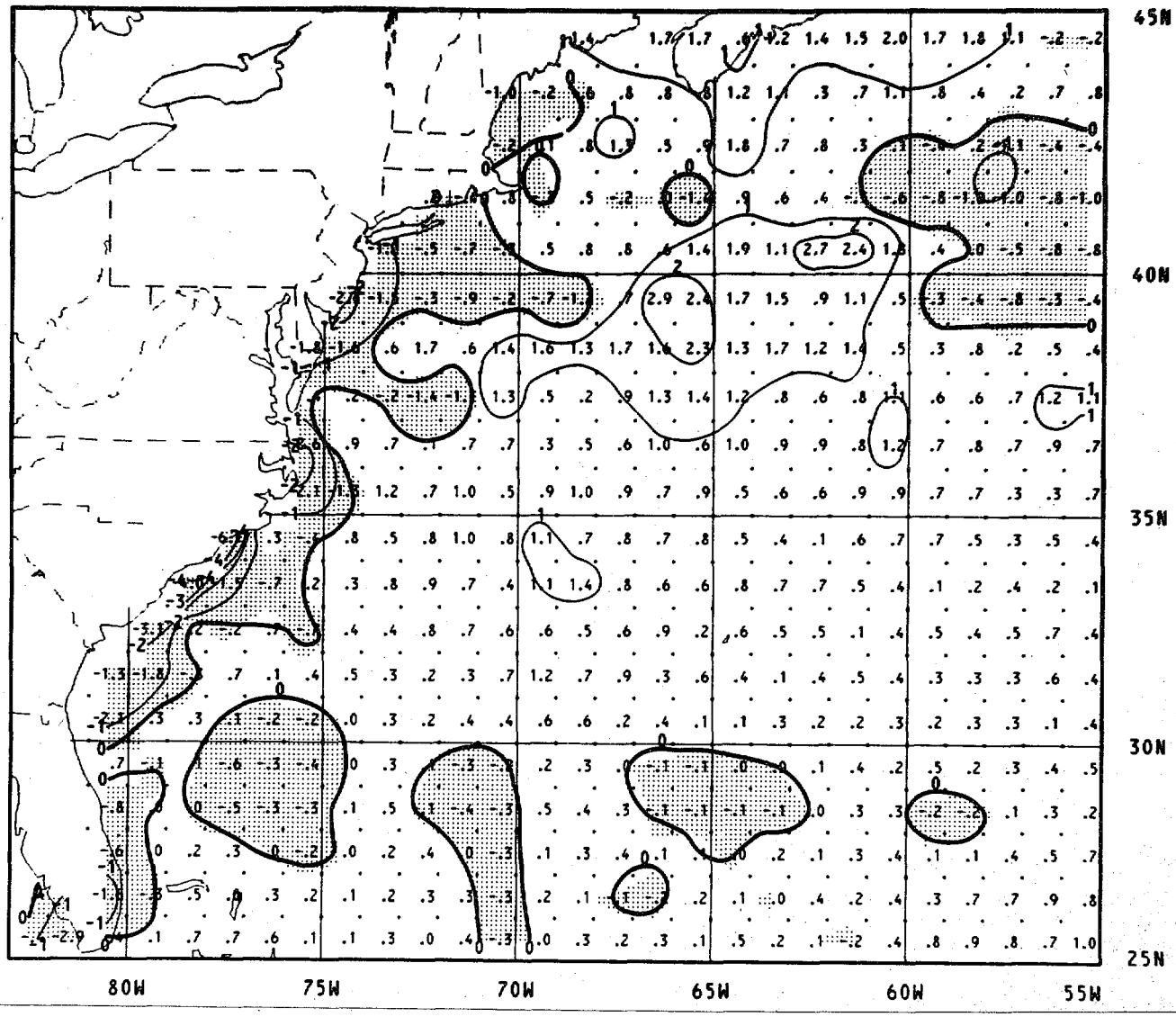

Figure 3. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology difference for February for Robinson-Bauer minus NAVOCEANO.

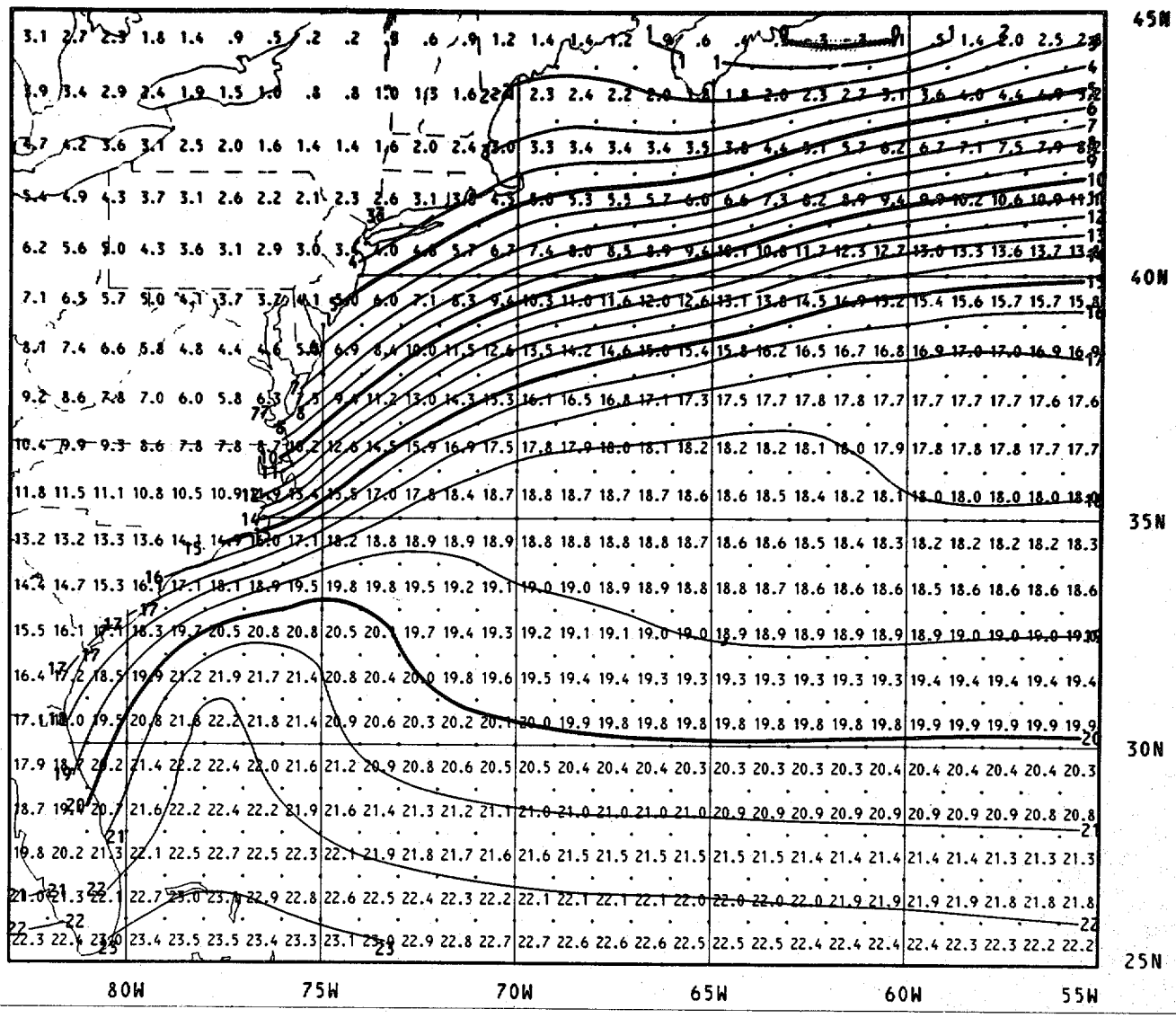

Figure 4. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for February from RAND

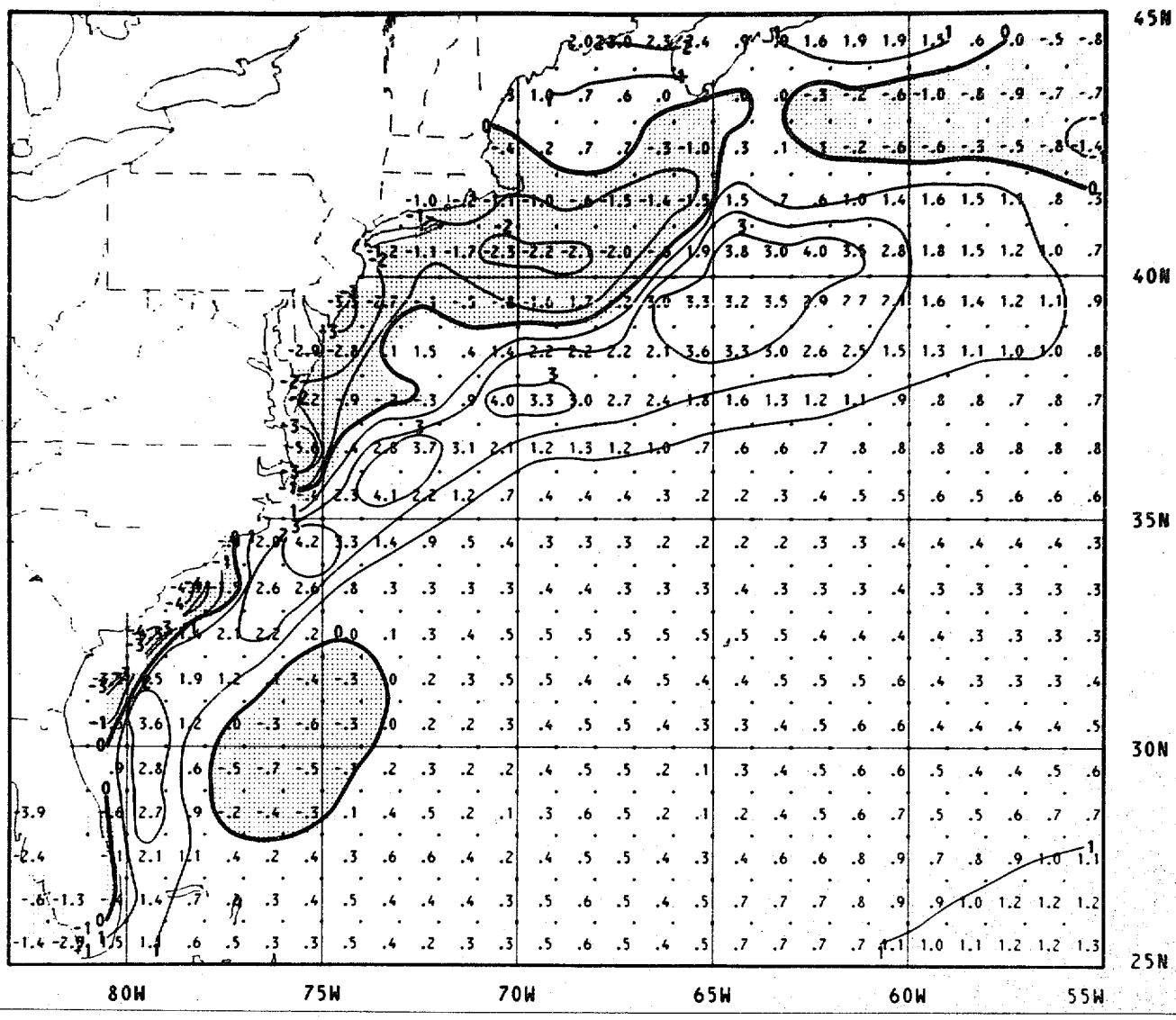

Figure 5. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology difference for February for Robinson-Bauer minus RAND

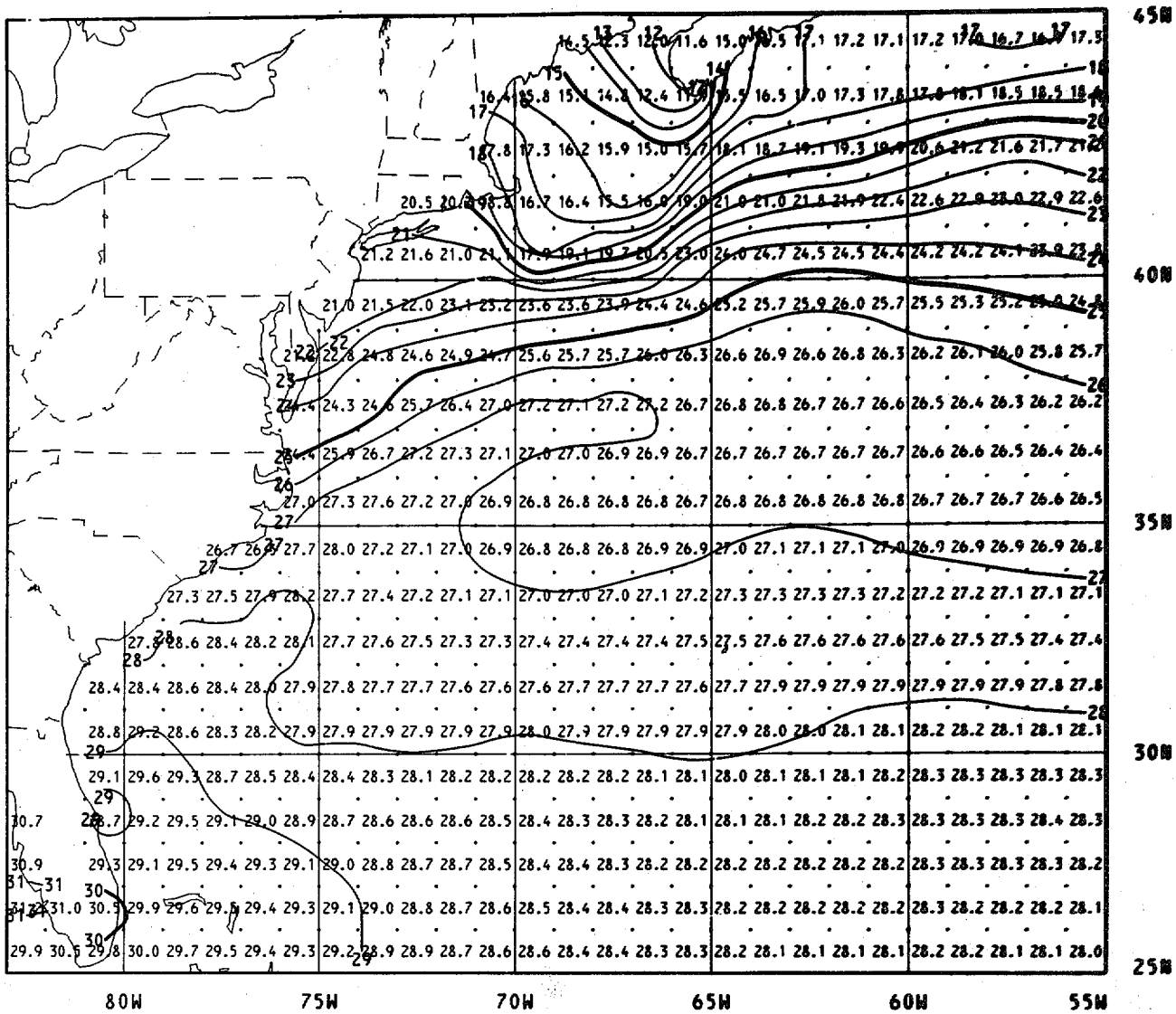

Figure 6. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for August from Robinson-Bauer

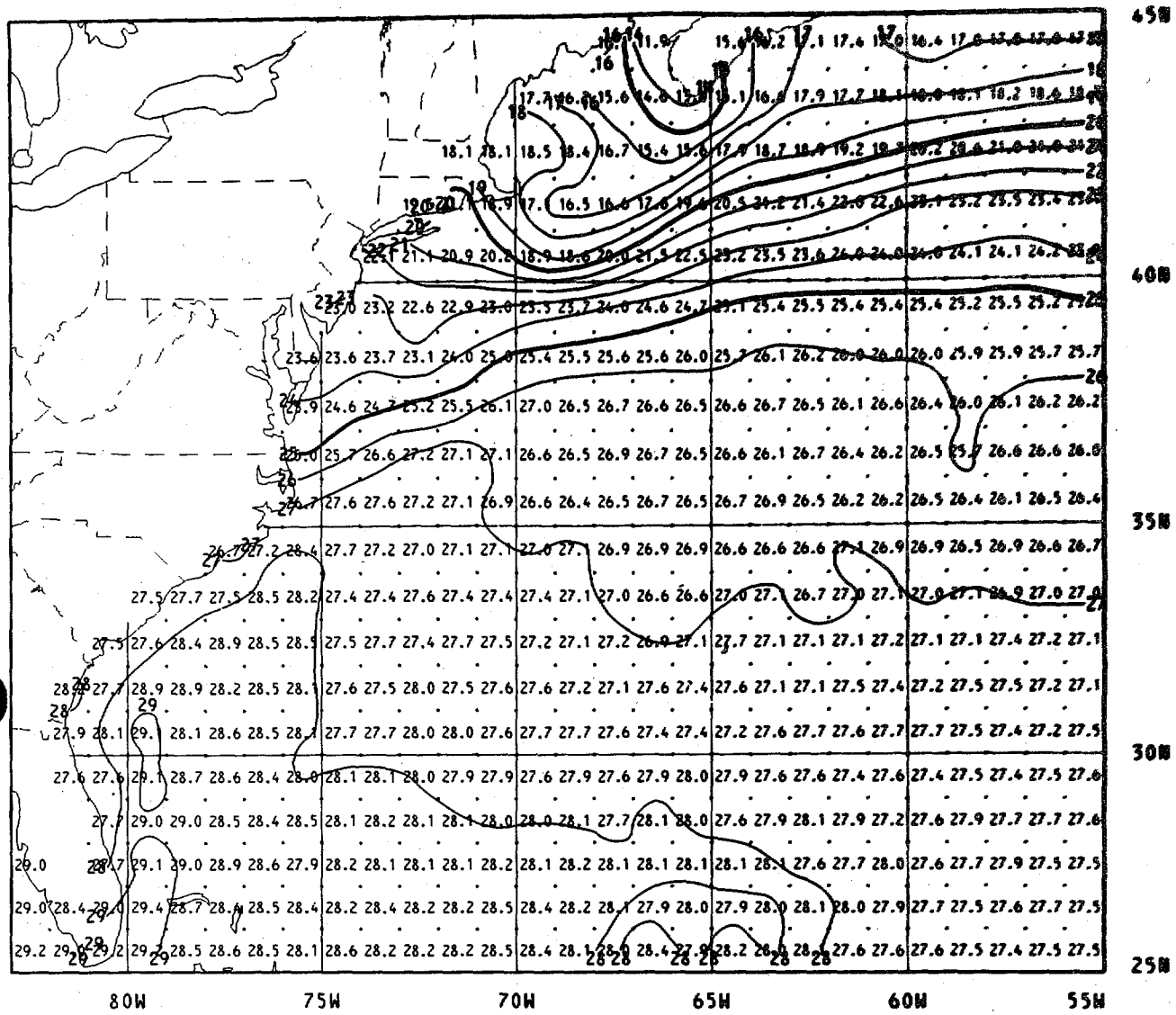

Figure 7. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for August from NAVOCEANO

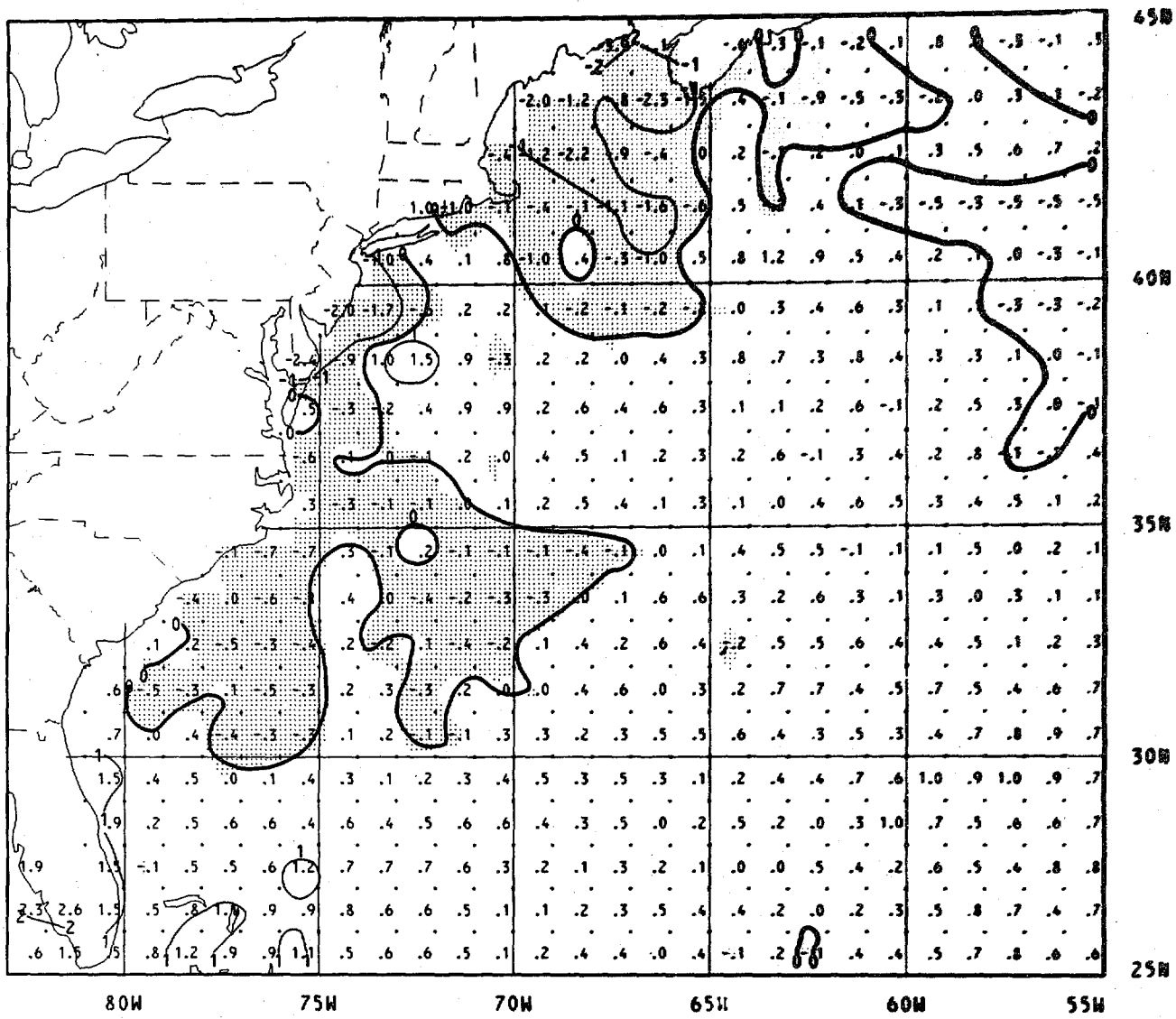

Figure 8. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology difference for August for Robinson-Bauer minus NAVOCEANO

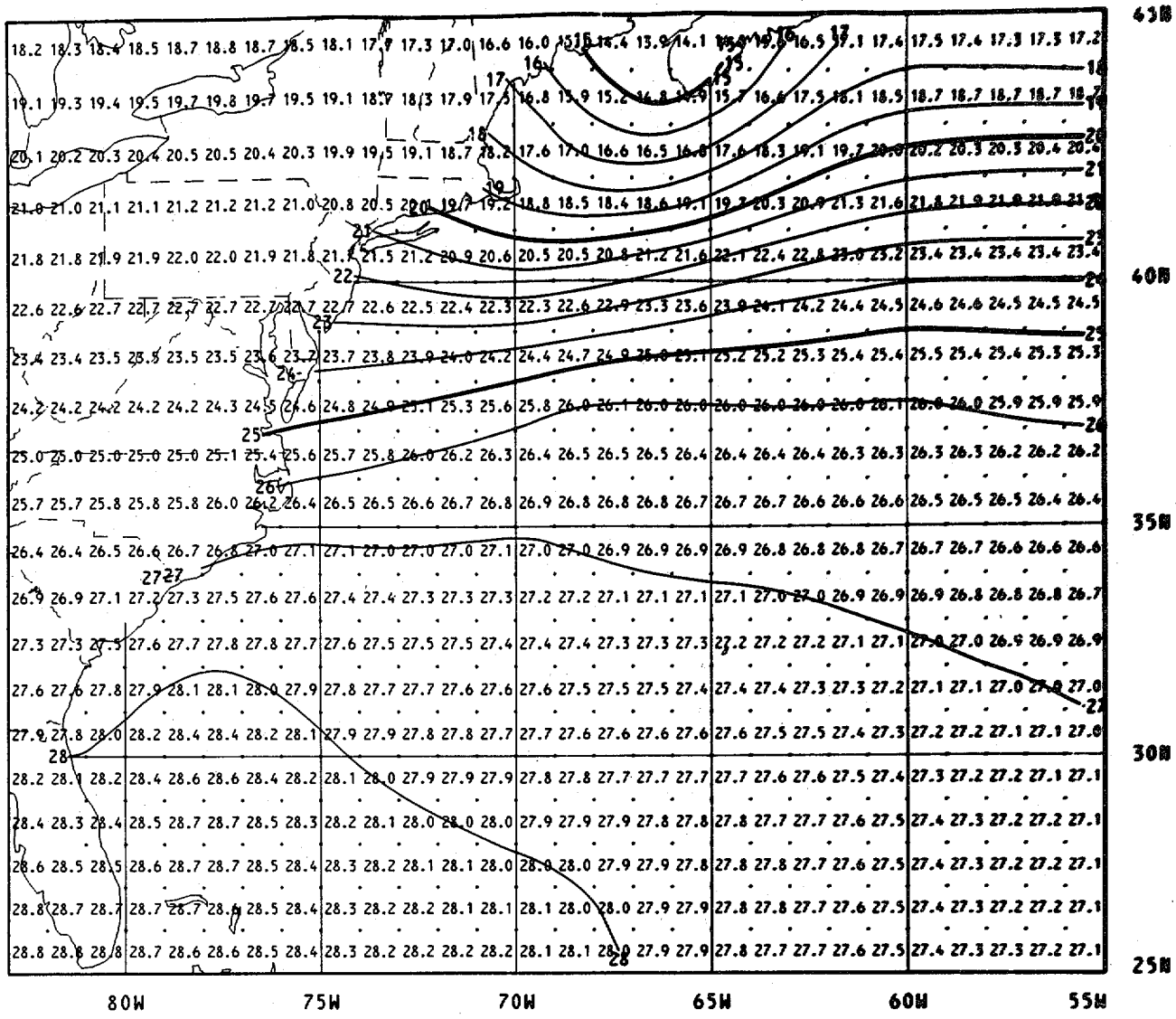

Figure 9. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology for August from RAND

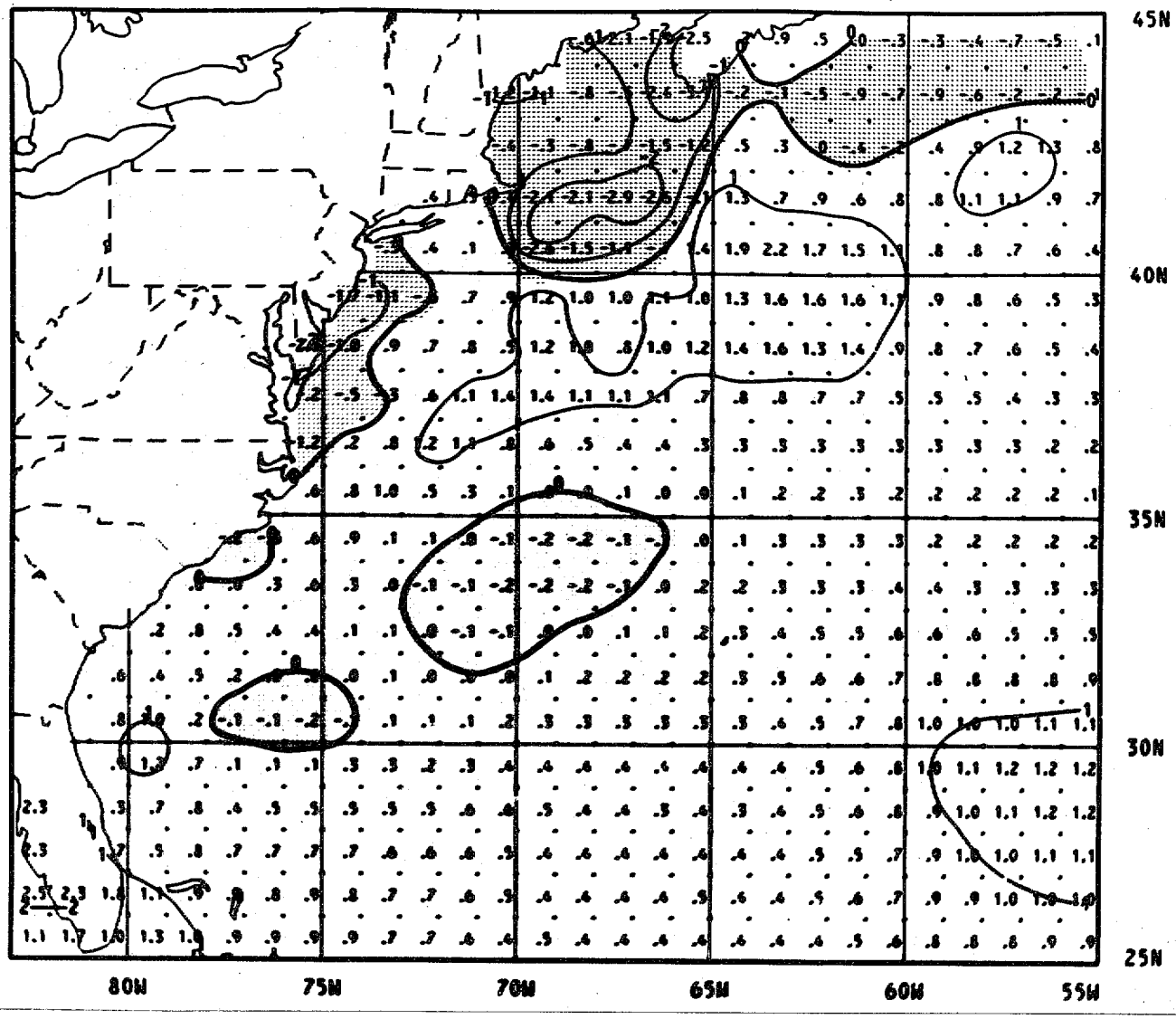

Figure 10. NW Atlantic Ocean Sea Surface Temperature (°C) Climatology difference for August for Robinson-Bauer minus RAND