NOAA Technical Memorandum NWS NMC 68

COMPENDIUM OF MARINE METEOROLOGICAL AND OCEANOGRAPHIC PRODUCTS OF THE OCEAN PRODUCTS CENTER

National Meteorological Center
Washington, D.C.
September 1986

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

NOAA TECHNICAL MEMORANDUMS

National Meteorological Center
National Weather Service, National Meterological Center Series

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NOAA Technical Memorandums in the NWS NMC series facilitate rapid dissemination of material of general interest which may be preliminary in nature and which may be published formally elsewhere at a later date. Publications 34 through 37 are in the former series, Weather Bureau Technical Notes (TN), National Meterological Center Technical Memoranda; publications 38 through 48 are in the former series ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM). Beginning with 49, publications are now part of the series, NOAA Technical Memorandums NWS.

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Weather Bureau Technical Notes

TN 22 NMC 34 Tropospheric Heating and Cooling for Selected Days and Locations over the United States During Winter 1960 and Spring 1962. Philip F. Clapp and Francis J. Winninghoff, 1965, 18 pp. (PB-170-584)

TN 30 NMC 35 Saturation Thickness Tables for the Dry Adiabatic, Pseudo-adiabatic, and Standard Atmospheres. Jerrold A. LaRue and Russell J. Younkin, January 1966, 18 pp. (PB-169-382)

TN 37 NMC 36 Summary of Verification of Numerical Operational Tropical Cyclone Forecast Tracks for 1965. March 1966, 6 pp. (PB-170-410)

TN 40 NMC 37 Catalog of 5-Day Mean 700-mb. Height Anomaly Centers 1947-1963 and Suggested Applications. J. F. O'Connor, April 1966, 63 pp. (PB-170-376)

ESSA Technical Memoranda

WBTM NMC 38 A Summary of the First-Guess Fields Used for Operational Analyses. J. E. McDonell, February 1967, 17 pp. (AD-810-279)

WBTM NMC 39 Objective Numerical Prediction Out to Six Days Using the Primitive Equation Model--A Test Case. A. J. Wagner, May 1967, 19 pp. (PB-174-920)

WBTM NMC 40 A Snow Index. R. J. Younkin, June 1967, 7 pp. (PB-175-641)

WBTM NMC 41 Detailed Sounding Analysis and Computer Forecasts of the Lifted Index. John D. Stackpole, August 1967, 8 pp. (PB-175-928)

WBTM NMC 42 On Analysis and Initialization for the Primitive Forecast Equations. Takashi Nitta and John B. Hovermale, October 1967, 24 pp. (PB-176-510)

WBTM NMC 43 The Air Pollution Potential Forecast Program. John D. Stackpole, November 1967, 8 pp. (PB-176-949)

WBTM NMC 44 Northern Hemisphere Cloud Cover for Selected Late Fall Seasons Using TIROS Nephanalyses. Philip F. Clapp, December 1968, 11 pp. (PB-186-392)

WBTM NMC 45 On a Certain Type of Integration Error in Numerical Weather Prediction Models. Hans Okland, September 1969, 23 pp. (PB-187-795)

WBTM NMC 46 Noise Analysis of a Limited-Area Fine-Mesh Prediction Model. Joseph P. Gerrity, Jr., and Ronald D. McPherson, February 1970, 81 pp. (PB-191-188)

WBTM NMC 47 The National Air Pollution Potential Forecast Program. Edward Gross, May 1970, 28 pp. (PB-192-324)

WBTM NMC 48 Recent Studies of Computational Stability. Joseph P. Gerrity, Jr., and Ronald D. McPherson, May 1970, 24 pp. (PB-192-979)

(Continued on inside back cover)

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COMPENDIUM OF MARINE METEOROLOGICAL AND OCEANOGRAPHIC PRODUCTS OF THE OCEAN PRODUCTS CENTER

David M. Feit

National Meteorological Center
Washington, D.C.
September 1986

Ocean Products Center Contribution No. 5

UNITED STATES DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Administrator

National Weather Service
Richard E. Hallgren, Assistant Administrator

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PREFACE

The Ocean Products Center (OPC), established in January 1985, was formed in order to integrate the diverse activities taking place in NOAA with respect to the development and dissemination of marine meteorological and oceanographic guidance products. The OPC is comprised of personnel from the National Weather Service (NWS), National Ocean Service (NOS), National Environmental, Satellite, Data, and Information Service (NESDIS), and NOAA Corps (NC). It is located in the National Meteorological Center (NMC) of NWS at the World Weather Building, Camp Springs, Md.

This first edition of the Compendium of Marine Meteorological and Oceanographic Products is published to provide general information on analyses and forecast models and services of the OPC. Detailed scientific information on the products may be found in the publications cited.

ACRONYMS AND ABBREVIATIONS

AFOS	Automation of Field Operations and Services
AVHRR	Advanced Very High Resolution Radiometer
AVN	Aviation
AXBT	Airborne Expendable Bathythermograph
BATHY	Bathythermographic trace
BT	Bathythermograph
CAC	Climate Analysis Center
CE	Cold Eddy
DMSP	Defense Meteorological Satellite Program
FNOC	Fleet Numerical Oceanography Center
FOS	Family of Services
GAC	Global Area Coverage
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GS	Gulf Stream
GTS	Global Telecommunications System
h	hour
HIRS	High Resolution Infrared Radiation Sounder
HRPT	High Resolution Picture Transmission
IGOSS	Integrated Global Ocean Services System
IR	Infrared
JIC	Joint Ice Center
km	Kilometer
LAC	Local Area Coverage
LFM	Limited-area Fine-mesh Model

mb	Millibar
MCSST	Multi-Channel Sea Surface Temperature
MOS	Model Output Statistics
MSC	Military Sealift Command
NC	NOAA Corps
NDBC	National Data Buoy Center
NESDIS	National Environmental, Satellite, Data, and Information Service
NMC	National Meteorological Center
NMFS	National Marine Fisheries Service
NNODDS	Navy NOAA Ocean Data Distribution System
NOAA	National Oceanic Atmospheric Administration
NOS	National Ocean Service
NORDA	Naval Ocean Research Development Activity
NOW	NOAA Ocean Wave (model)
NSF	National Science Foundation
NWS	National Weather Service
OCNDAT	Ocean Data Facility
OMS	Oceanographic Monthly Summary
OPC	Ocean Products Center
OTS	Ocean Thermal Structure
PIPS	Polar Ice Prediction System
PMEL	Pacific Marine Environmental Laboratory
QUIPS	Quality Improvement Profile System
RJE	Remote Job Entry
RMS	Root Mean Square
S/W	Slope Water

SEAS	Shipboard Environmental (Data) Acquisition System
SHW	Shelf Water
SMMR	Scanning Multichannel Microwave Radiometer
SST	Sea Surface Temperature
TESAC	Temperature, Salinity, and Current
TOGA	Tropical Ocean-Global Atmosphere
TSO	Time Sharing Option
USCG	United States Coast Guard
vis	Visibility
VOS	Voluntary Observing Ship
WE	Warm Eddy
WWB	World Weather Building
XBT	Expendable Bathythermograph

Compendium of
Marine Meteorological and Oceanographic Products
of the Ocean Products Center

David M. Feit
National Meteorological Center

ABSTRACT

The Compendium provides a brief description of the operational and experimental marine meteorological and oceanographic products of the Ocean Products Center (OPC). Included is information on 1) marine meteorology, 2) ocean thermal structure, 3) ocean waves and 4) polar seas and Great Lakes ice.

I. Introduction

The primary responsibilities of the OPC are to:

-Prepare and disseminate operational marine guidance material to NOAA field forecast offices and the civil sector.

-Develop improved analysis techniques.

-Develop state-of-the-art numerical forecast model output products.

-Evaluate and improve the quality of the guidance products and develop new products to accommodate user needs.

-Collect and quality control marine data sets for dissemination.

-Prepare summary materials in predetermined formats for archiving.

-Provide special support for the quality control, analysis, and archival of data for research programs of national and international scope such as IGOSS and TOGA.

The OPC is co-located with NMC at the World Weather Building. A principal purpose of this co-location is to make it feasible for OPC staff members to exploit the capability of NMC to provide data bases, output fields from large scale meteorological models, and communications networks for use in research, development and operations. In addition, since the primary function of OPC is to produce operational guidance products, the emphasis is on applied research and technology transfer whenever possible. Hence, a concerted effort is made to keep an active liaison with other NOAA and U.S. Navy operational centers, as well as the research and academic communities. For convenience the activities dealing with the development and dissemination of products and the preparation of quality controlled data sets for archiving are carried out in the following broad areas.

-Marine Meteorology

-Ocean Wave Dynamics

-Ocean Thermal Structure

-Polar Seas and Great Lakes Ice Analysis and Forecasting

The ice analysis and forecasting activities are primarily conducted through the Navy/NOAA Joint Ice Center which is a part of the Naval Polar Oceanography Center.

Marine related product development and dissemination activities have been in progress in different parts of NOAA for some time. As a result, a number of products have already been made available for dissemination to the field. Many of these products, along with some new ones created since OPC's formation, are now distributed under the aegis of the OPC. While new efforts are underway at OPC to either improve existing products or develop new ones, it is felt that a compendium of the OPC product portfolio would serve a useful purpose as an information source for the marine community at large. Hence, this report, an outgrowth of NMC office note No. 286 (Bell, 1984), contains technical background information, descriptions of the existing product portfolio, including some experimental material, and gives information regarding the frequency and method of product dissemination. The OPC will provide updated information to recipients of this publication as conditions warrant.

II. Product Descriptions

A. Ocean thermal structure

1. Blended SST analyses

a. Global

A "blended" SST analysis has been developed using conventional *in situ* data and satellite data. Two distinct global analyses are generated 1) a 15 day running daily mean and 2) a monthly mean. The monthly product is the official analysis for TOGA and is produced in cooperation with CAC.

In situ data (from ships and fixed and drifting buoys) are used as benchmarks for temperature values in regions of sufficient data. Between the bench marks satellite data are used to define the shape of the temperature field. The blended SST analysis is produced as follows.

1. Ship data and satellite data are averaged independently on a 2 deg by 2 deg quadrangle.

2. The temperatures in quadrangles with insufficient data are obtained through extrapolation of anomaly fields (with respect to CAC climatology) computed from those quadrangle containing temperature values (Reynolds, 1982). The extrapolated anomaly values in all of the quadrangles, when added to the CAC climatology, will provide temperatures over the whole domain. Extrapolation of anomalies, rather than temperatures values, preserves the mean features of the global distribution.

3. A non-linear filter based on medians is then applied on each of the data fields to produce an *in situ* and satellite analysis.

4. The final product is obtained by solving Poisson's equation. In regions where there are 5 or more *in situ* observations the data are used as internal boundary values. Over the rest of the domain the Laplacian of the satellite analysis (based on 10 or more satellite observations) is used as a forcing function to preserve the shape of the field. Where there are less than 10 observations the Laplacian is set to zero. (Reynolds and Gemmill, 1984).

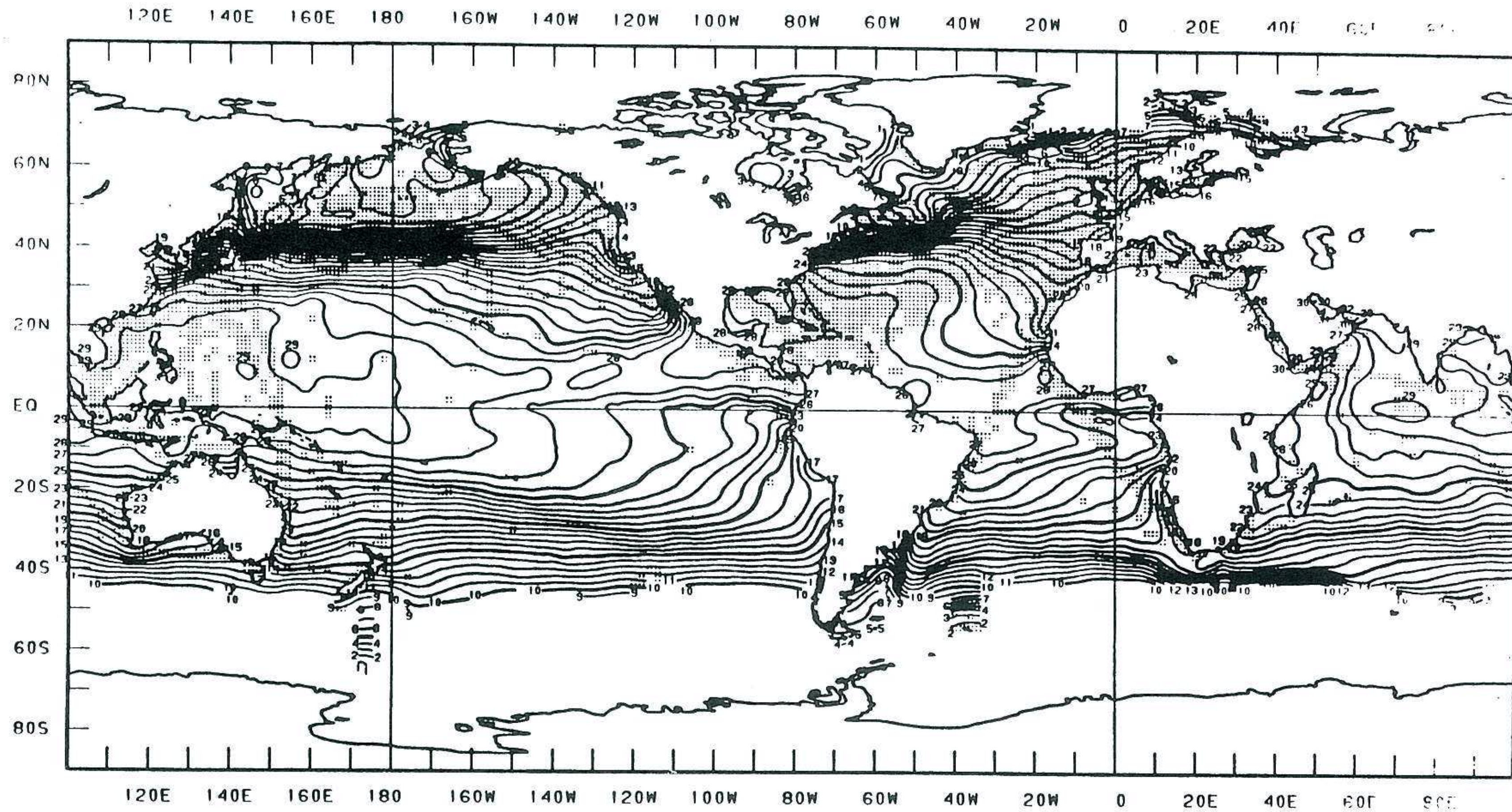
An example of the resulting mean fields and anomaly fields for the 15 day running mean are shown in Figs. 1 and 2. The stippling indicates regions where the SST field was fixed by the *in situ* data. Studies suggest that the blended analysis is an improvement over the fields obtained from either the *in situ* data or the satellite data alone. Each monthly blended field is monitored carefully using individual *in situ* and satellite analyses as diagnostic tools.

The daily SST analysis is disseminated by a number of standard methods including the GTS, facsimile and FOS. In addition it is distributed on a system unique to the OPC, viz., OCNDAT. OCNDAT is a dial up facility, for use by WFSO's with marine responsibilities to access products, in alphanumeric form, on the NMC computer system.

The area covered by these messages are shown in Table 1.

Table 1. Coverage of OCNDAT File

REGION	GEOGRAPHICAL LIMITS	NUMBER OF SUB-REGIONS
1. Atlantic	25N-65N, 25W-85W	3
2. Gulf of Mexico	00N-35N, 25W-100W	3
3. East Pacific	15N-65N, 100W-150W	2
4. West Pacific	15N-65N, 150W-160E	2
5. East Tropical Pacific	30S-30N, 70W-140W	3
6. Central Trop. Pacific	30S-30N, 140W-150E	3
7. West Tropical Pacific	30S-30N, 150E-100E	2
8. West Tropical Atlantic	30S-30N, 50W-100W	2
9. East Tropical Atlantic	30S-30N, 00 - 50W	2
10. Alaskan Waters	50N-75N, 120W-160E	3



BLEND SST FIELD (5/10) OPS 0Z JUN 23, 1986 TO 0Z JUL 8, 1986

Figure 1. Operational blended SST (deg C) daily analysis (15 day running mean).

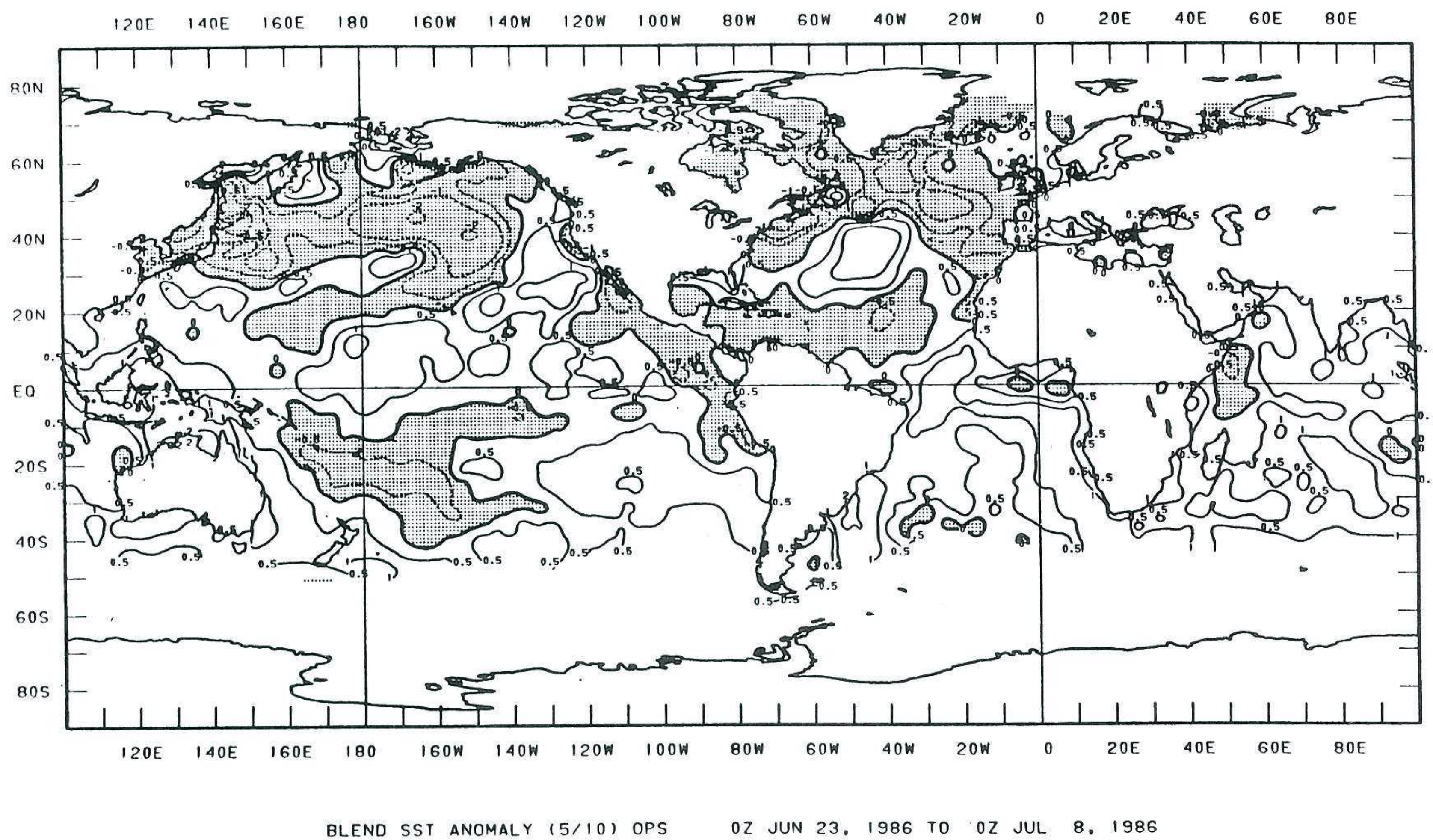
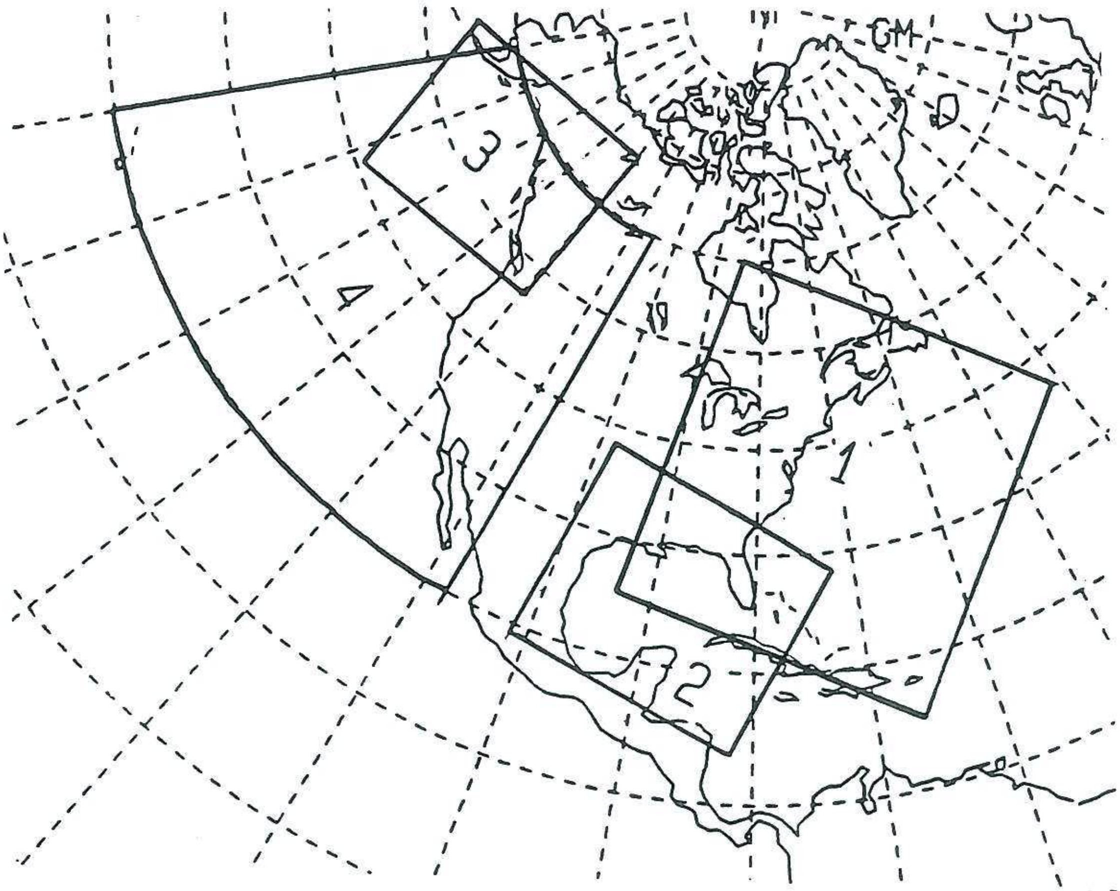


Figure 2. Operational blended SST (deg C) daily anomaly analysis (15 day running mean).

b. Regional

A series of regional thermal analyses are produced daily using objective analysis methods on a large-scale computer (Gemmill and Auer, 1982). These analyses are based on composite 5-day *in situ* SST data and one day satellite data. Figure 3 identifies these regions.

The analysis scheme (loc. cit.) is a variation of the successive approximation technique which has been used widely in meteorological analysis by Cressman (1959). The method attempts to provide the best value at a grid point by 1) accumulating good information within a radius of influence 2) eliminating erroneous data by comparing the data with the previous analysis and 3) a series of data scans to correct the first guess (previous analysis). Five scans are made with successively smaller radii of influence and discard limits. An example of a regional analysis is presented in Figure 4. These products are disseminated via facsimile and mail.



Region Number	Designation	Projection
1	Northwest Atlantic	Polar Stereographic
2	Gulf of Mexico	"
3	Gulf of Alaska	"
4	West Coast of North America	Mercator

Figure 3. Location of regional SST analyses.

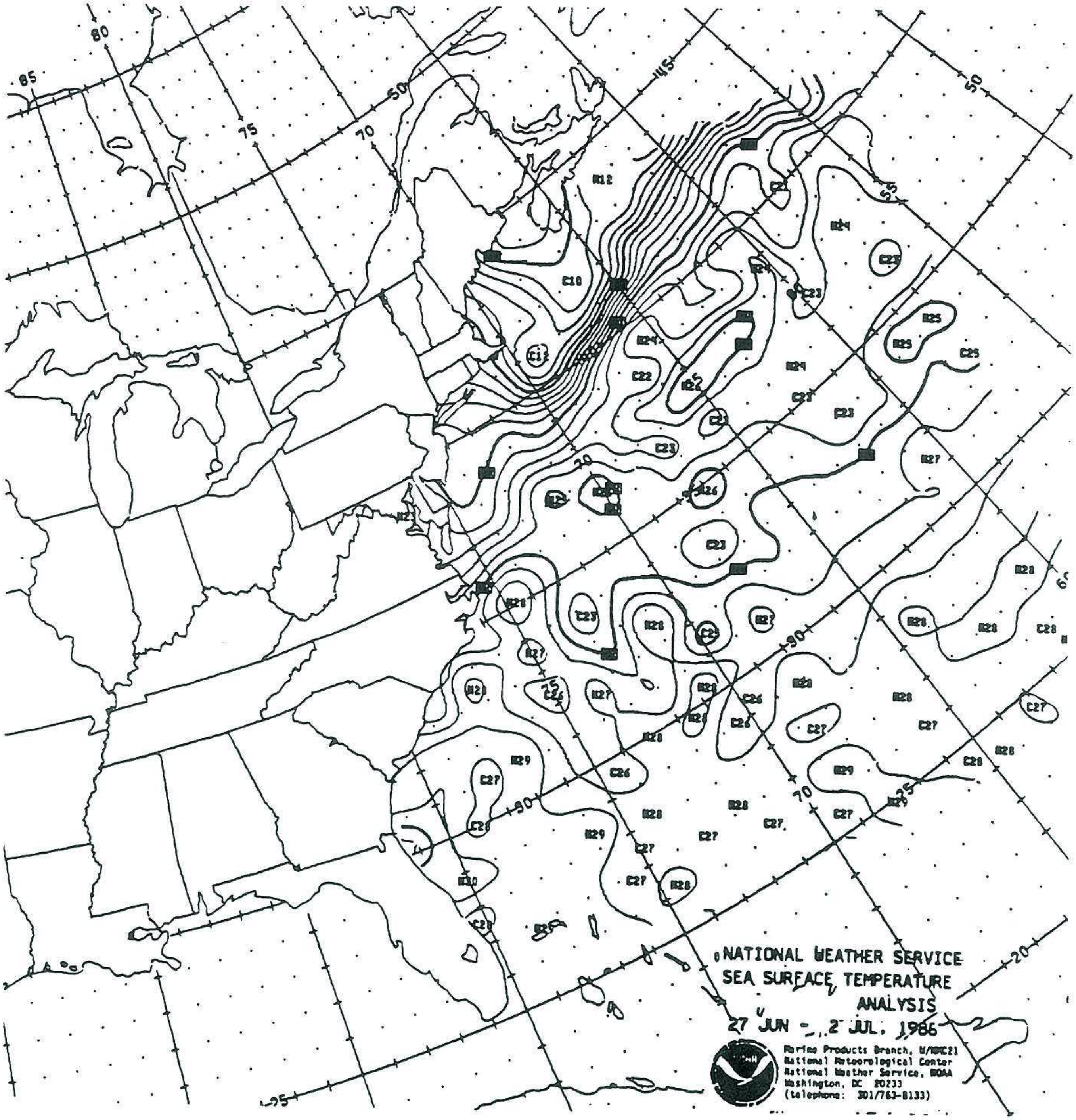


Figure 4. Northwest Atlantic regional SST (deg C) analysis.

2. MCSST analyses

a. Global, regional, and coastal

MCSST techniques do not depend on *in situ* data but rather make use of three thermal infrared (IR), one near IR and one visible band (or channels) (Cornillon, 1982) quantified by the Advanced Very High Resolution Radiometer (AVHRR) sensor aboard the TIROS series of polar orbiting satellites (Schwalb, 1982). Combinations of channel sums, differences, and ratios are used to screen for clouds and calculate SST's by means of algorithms described by McClain (1980) and McClain et al (1985).

Approximately 75,000 daytime and 25,000 nighttime SST observations are calculated daily, at a resolution of 8 km. Observations are located every 8 km (high density) along the coastal areas of the U. S and selected research areas, every 15 km (medium density) in the Eastern North Pacific and Western North Atlantic, and every 25 km (low density) elsewhere (see Fig. 5). Every 6 hours, SST observations calculated orbit by orbit are placed in a user accessible database. One observation from every 2 1/2 degree latitude-longitude square is transmitted twice each day in an alphanumeric bulletin on the GTS.

Satellite SST observations are objectively analyzed at a number of spatial and temporal scales to produce gridded fields of SST. A global analysis (100 km grid spacing) is updated daily and displayed as an isotherm contour chart (see Fig. 6). Regional analyses for the waters adjacent to the U. S. are currently produced weekly at 50 km grid spacing (see Fig. 7) and local analyses in the coastal areas of the contiguous U. S. are produced twice weekly at 14 km grid spacing (see Fig. 8). These contour charts are available by subscription from the NESDIS Satellite Data Services Division.

b. Great Lakes surface temperature analysis

During the ice free months on the Great Lakes, a surface temperature analysis is produced from high resolution picture transmission (HRPT) and local area coverage (LAC) data, Fig. 9. Manual analyses are produced twice a week as follows. Digital data from available LAC/HRPT satellite passes are processed in batch mode to produce a printer-plot of the satellite data. The surface temperature data are printed in letter coded form. The data on the computer listing are manually traced with respect to a superimposed latitude-longitude grid. Isotherms are subjectively drawn for each of the lakes and analyses are manually transferred to a separate base map for preparation of the final product. *In situ* temperatures from fixed buoys in the lakes are annotated on the analyses where appropriate. The final analyses are distributed to NESDIS, to the JIC during the spring and fall transitions, and to other users via mail and facsimile.

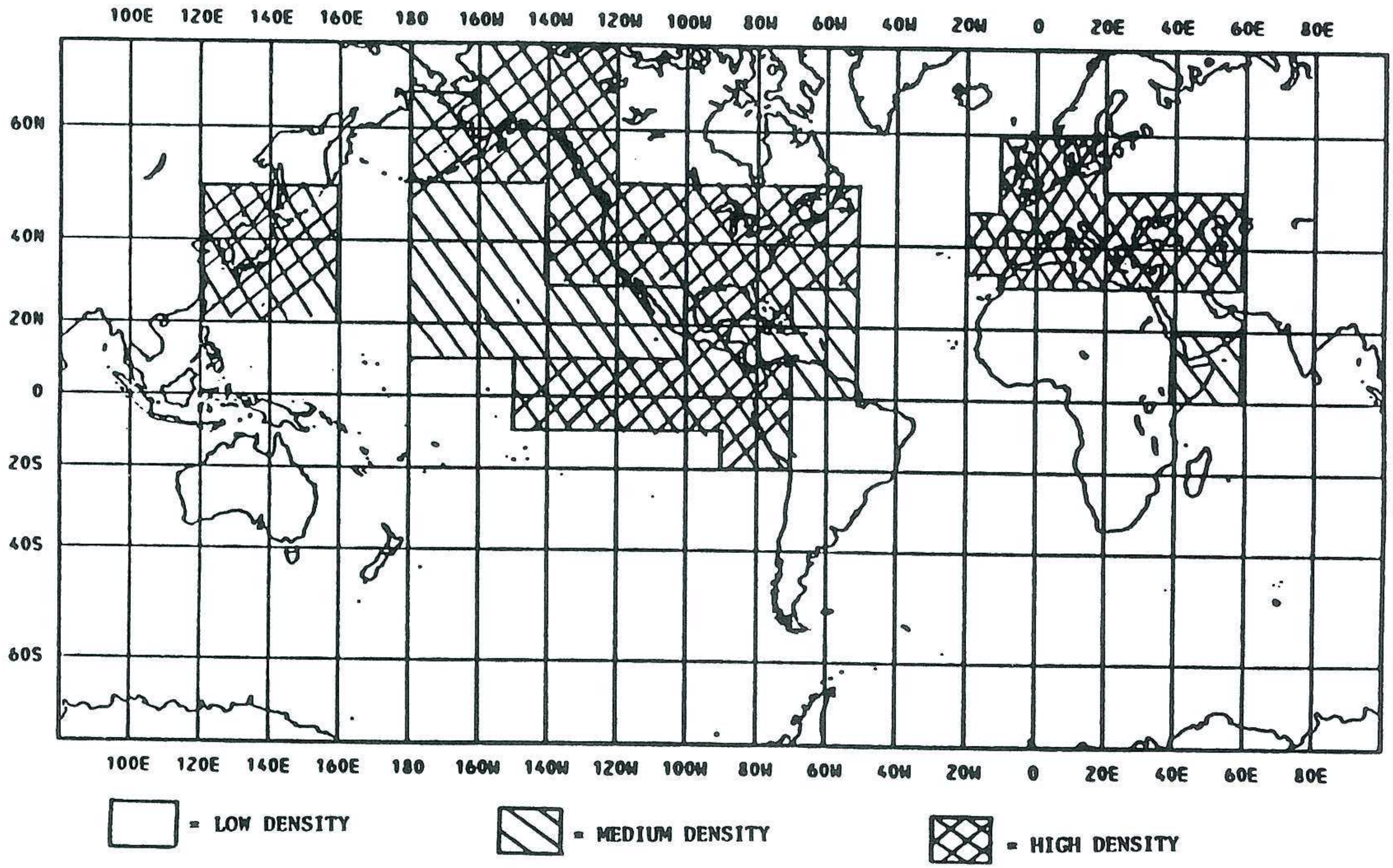


Figure 5. Geographical regions with associated SST observation sample densities.

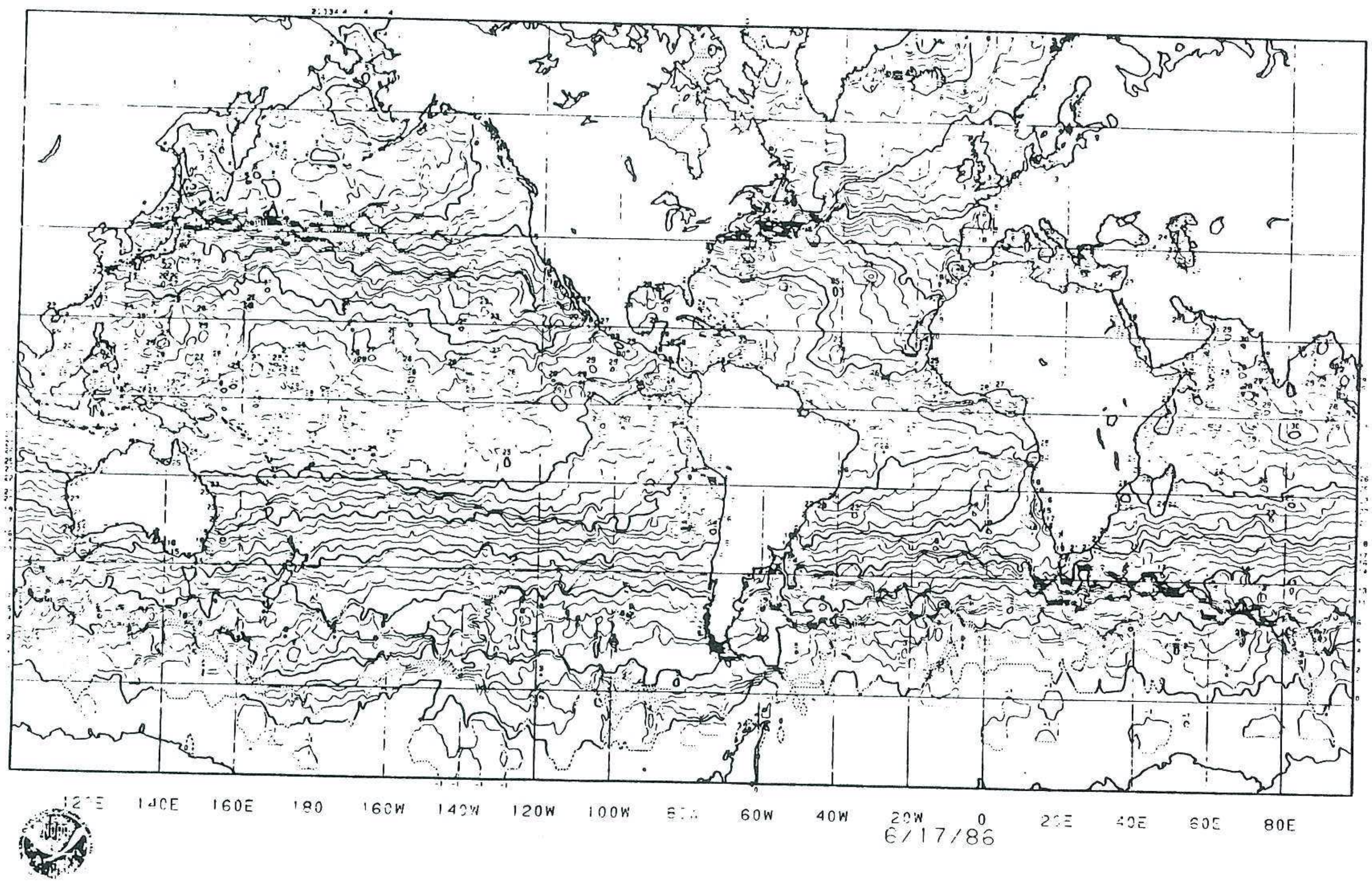


Figure 6. Satellite MCSST (deg C) global analysis.

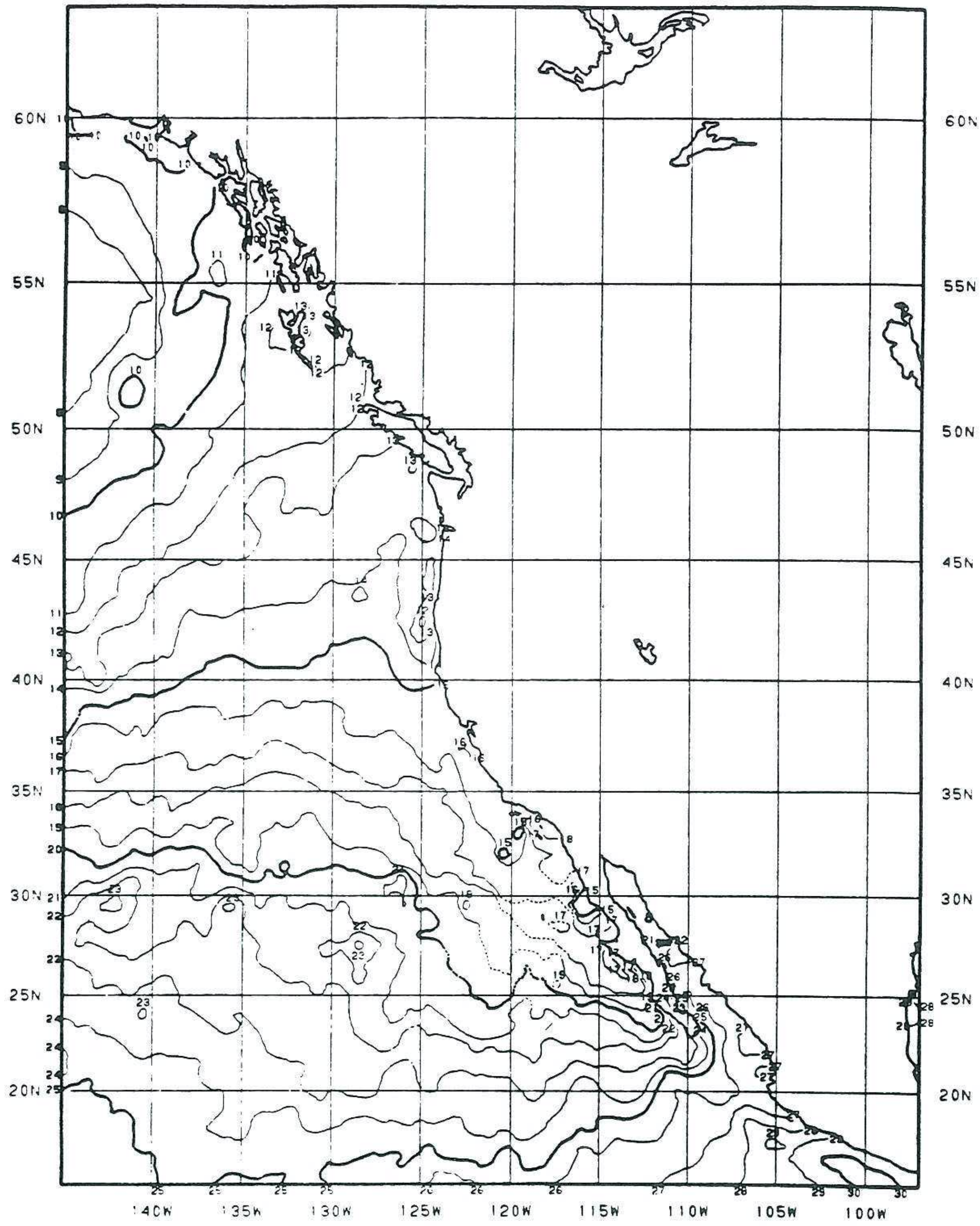
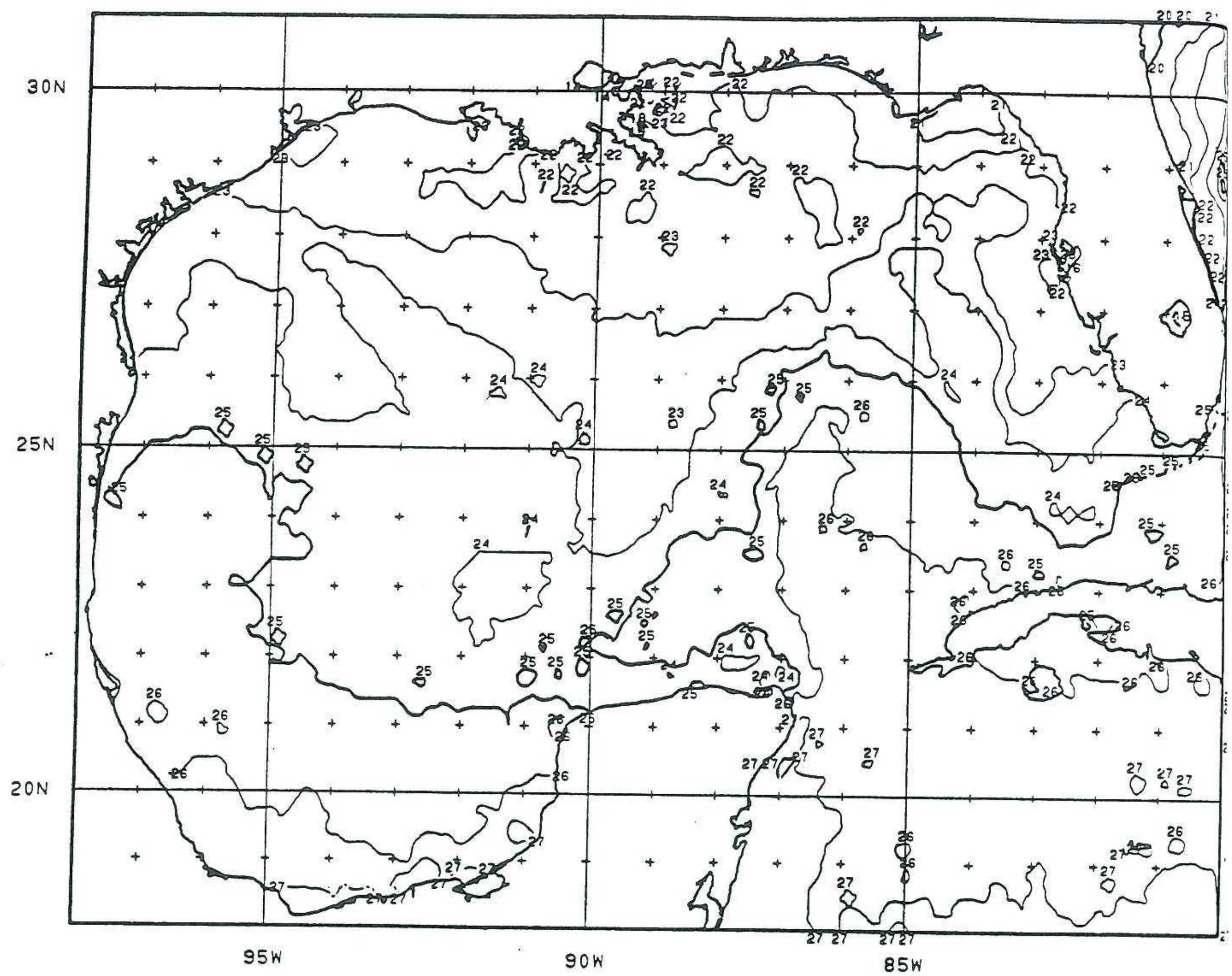


Figure 7. Satellite MCSST (deg C) regional scale analysis coverage.



GULF OF MEXICO 4/26/86

Figure 8 Satellite MCSST (deg C) local scale analysis coverage.

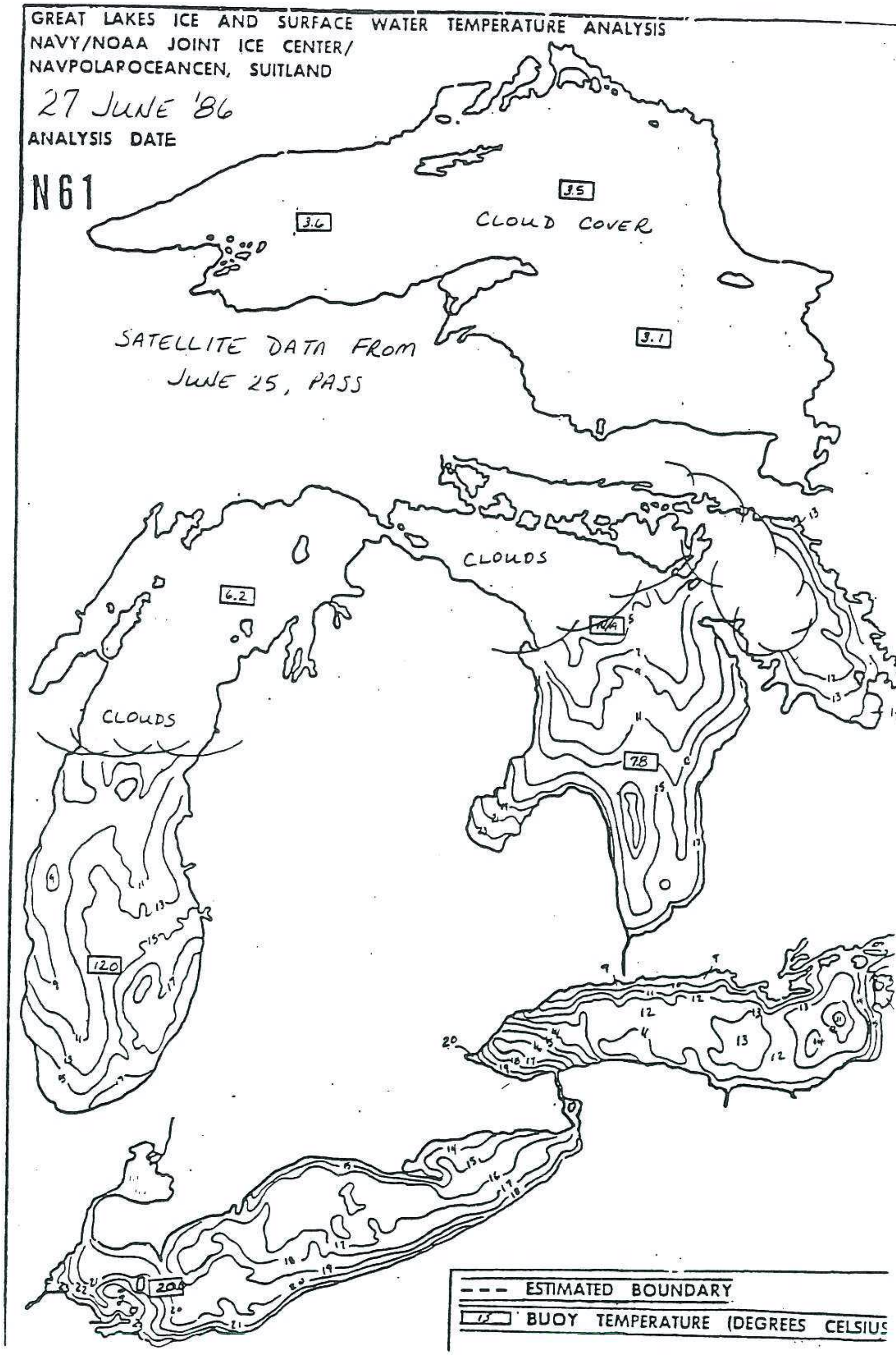


Figure 9 Great Lakes ice and surface water temperature (deg C) analysis.

3. Gulf Stream and Loop Current analysis

A synoptic oceanographic feature analysis is subjectively analyzed and disseminated on week days over the NWS facsimile system and by mail. The analysis is divided into two regional charts: 1) the southeast U. S. Atlantic coast and Gulf of Mexico chart showing the Loop Current and Gulf Stream from the Yucatan Peninsula to Cape Hatteras, North Carolina, (southern panel, see Fig. 10) and 2) the Northeast Atlantic coast chart showing the Gulf Stream from Cape Hatteras, North Carolina to the Grand Banks south of Newfoundland, (northern panel, see Fig. 11). The charts are updated twice each week and three times each week respectively. A monthly analysis of the eddies and Gulf Stream system is published in the Oceanographic Monthly Summary (OMS).

Infrared satellite imagery from NOAA's polar orbiters and *in situ* temperature reports are used to locate the ocean features. These features are seen as thermal contrasts in shades of gray. Analysis details include the position, flow direction, and relative SST of oceanographic features (viz., the Gulf Stream, the Loop Current, cyclonic and anticyclonic eddies, warmer and cooler slope and shelf waters, the shelf/slope front, the Sargasso water, and the subtropical convergence front). In addition 200 m temperature measurements from XBT's are used to locate eddies.

All imagery (3-6 images per day) collected since the previous analysis is analyzed subjectively by drawing the observed thermal feature boundaries. At least three well-spaced land points on the image must be identified for the analysis to be accurately earth located.

Often, the imagery may not provide complete coverage for the analysis area due to cloudy weather. This problem is especially prevalent in the Gulf Stream, east of 65W, during winter when the Stream may be obscured for weeks at a time. Further, a good Gulf Stream image can not be gridded if clouds have covered the identifiable land points.

During the summer months (June-September), problems with ocean thermal feature determination are often exacerbated by the formation of thin and relatively isothermal surface layers (especially in the Gulf of Mexico). These spatially large surface lenses of sun-warmed and unmixed water cause the true thermal structure only a few centimeters below the surface to be indistinguishable.

After analyzing all the satellite imagery, there are often conflicting feature positions plotted on the base map. The accepted feature positions are drawn as a solid line on the synoptic map, but the questionable existence or position of a feature is drawn as a dashed line.

The Gulf Stream (labeled GS in Figures 10 and 11) is shown as a band of warm water flowing northeasterly from Cape Hatteras toward an area south of Nova Scotia. The numbers on the chart are SSTs in degrees Celsius (C) which are extracted from reports from ships, expendable bathythermographs (XBT), buoys, and satellite digital data retrievals. A solid line indicates a front observed within the past three days. A dashed line indicates a front observed 4 to 7 days ago. A dash dot indicates a front observed more than seven days ago or as an estimated frontal location. An arrow indicates flow direction, not the current axis of the Gulf Stream or eddies.

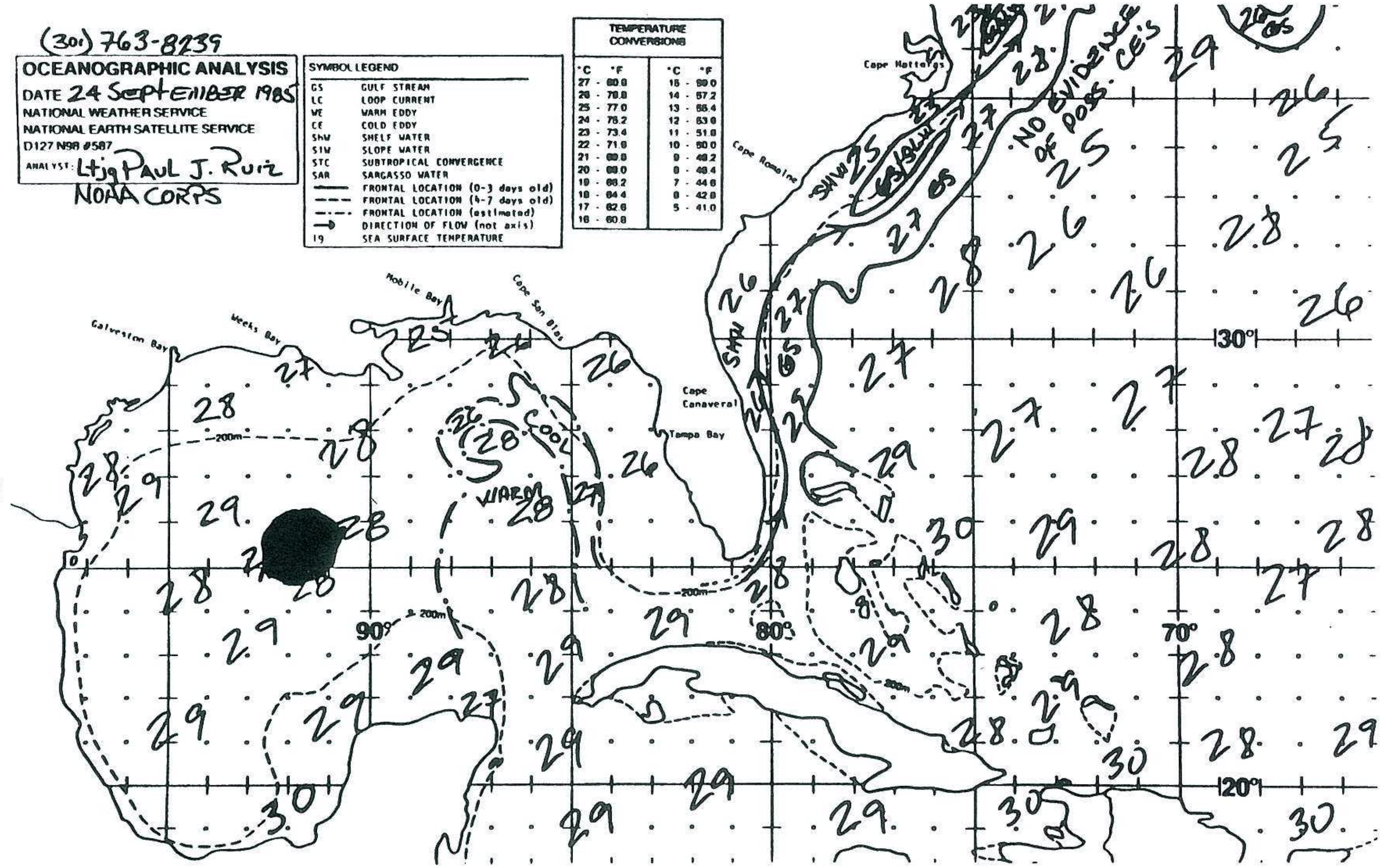


Figure 10. Oceanographic analysis chart of the southeast Atlantic coast and Gulf of Mexico.

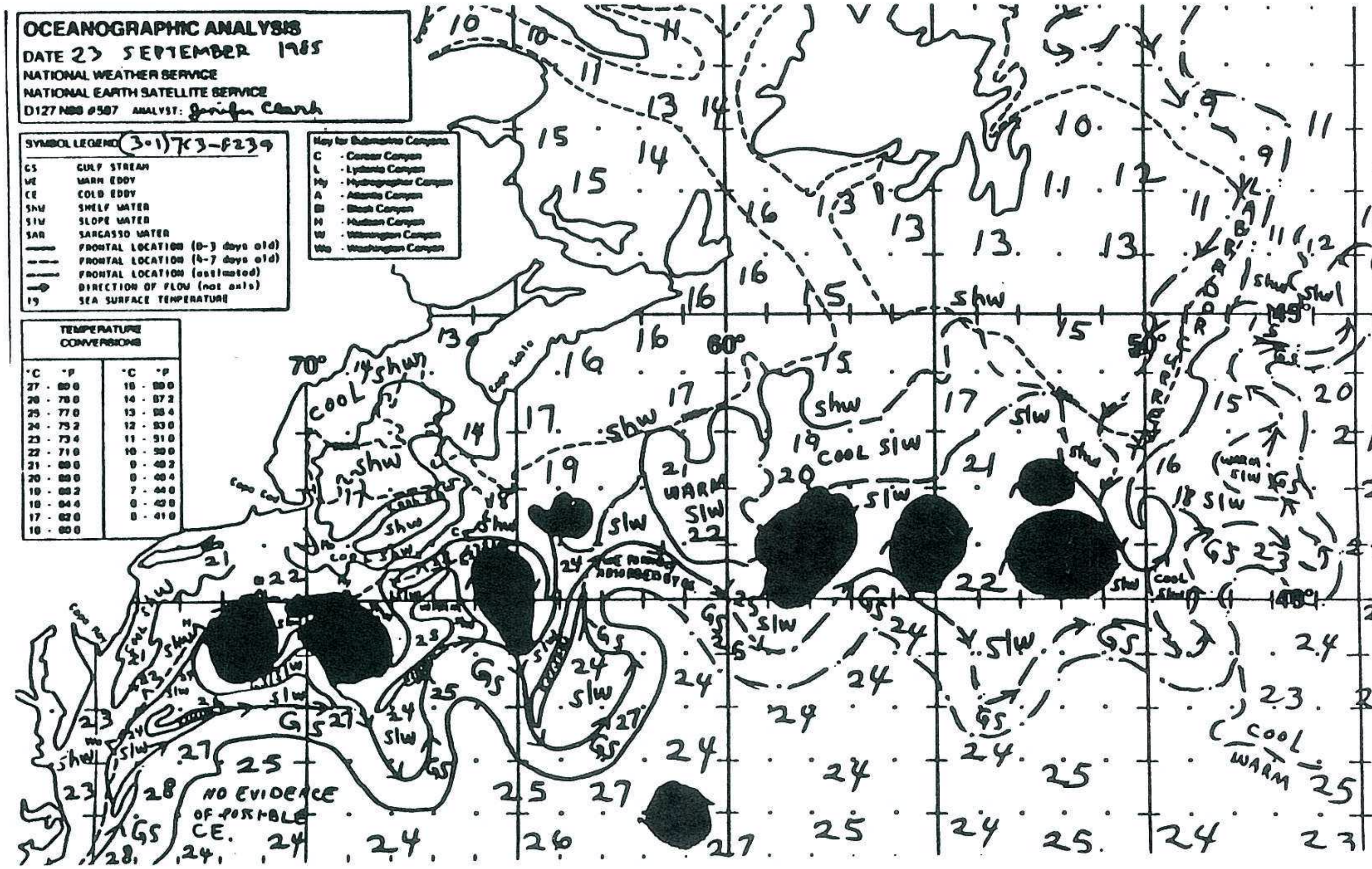


Figure 11. Oceanographic analysis chart of the northeast Atlantic coast.

4. XBT quality control program

The NMC has been designated a World Oceanographic Data Center (WODC) as well as a Specialized Oceanographic Center (SOC) by IGOSS (WMO/IOC). In these capacities it is responsible for receipt, quality control, archival, and transmission of oceanographic data. These activities are carried out by the OPC. Subsurface temperature and salinity data from the global oceans are collected from Voluntary Observing Ships (VOS), participating ships of opportunity, naval vessels, aircraft (AXBT), and research ships. These observations are relayed to the NMC either via coastal radio stations and the Global Telecommunication System (GTS) or via the GOES data collection system. Reports received at NMC and which are not on the GTS are assembled and retransmitted as collective bulletins on the GTS. Automated XBT reports taken from participating ships (SEAS data transmitted via GOES) are also directly routed to the FNOC. All real time BATHY messages received at NMC are routinely processed, quality controlled, and archived either on weekly, monthly, and yearly files, or on a rotating, 36-day NMC operational file. Tape copies of the edited BATHY data are sent to NODC and to FNOC. Real time depth-temperature salinity messages are processed in a "raw" form, quality controlled and archived.

Quality control of data is accomplished by examining the data, making corrections using the Quality Improvement Profile System (QUIPS). QUIPS is a microcomputer program designed to interactively edit subsurface and SST data messages. NMC mainframe computers provide screened, formatted, real-time, data base information as input to the QUIPS. At NMC, all XBT data received are put in daily files and are passed to QUIPS for review, weekly, using the QUIPS off line edit feature. The corrected data file is then transferred back to the mainframe. Each month the files are collected and sent to the National Oceanographic Data Center for archiving. Monthly data statistics are provided to IGOSS.

5. Subsurface temperature analysis

The OPC produces a 100 meter temperature chart for the Northeast Pacific Ocean, from 20-60 degrees north latitude and 108-155 degrees west longitude. This region was chosen because of its importance to commercial shipping and fishing activities and hence enjoys a relatively high BATHY concentration. To generate this product, the available BATHY data taken within the previous 15 days are examined, corrected, and transferred to a mercator base chart. The BATHY sea surface temperature data are subjectively contoured by comparing them to the NWS five day composite objective SST analysis, the previous weeks BATHY SST analysis, and the Robinson's Climatological Atlas (Robinson, 1976). This BATHY SST analysis is used to preserve vertical consistency between the surface and subsurface temperature, i. e. , at any given location the subsurface analysis value is not permitted to exceed the Bathy surface temperature. The 100 meter subsurface temperature data in combination with the FNOC's expanded ocean thermal structure 100 meter analysis, are subjectively contoured by comparing them to the BATHY SST analysis and the previous week's 100 meter subsurface analysis.

This product is distributed weekly by mail and facsimile.

6. Oceanographic Monthly Summary

The Oceanographic Monthly Summary (OMS) is a periodical whose prime purpose is to disseminate up to date monthly summaries of ocean surface properties. The OMS regularly contains contoured monthly mean SST and SST anomaly charts of the global oceans and regional oceans contiguous to the U. S. coast. Reports on the movement and features of the Gulf Stream and Loop Current, and sea ice conditions for the Bering Sea and the Alaskan Arctic Ocean are included as well as special feature articles on satellite imagery and oceanographic phenomena.

B. Marine meteorology

1. Ocean surface winds

Large scale numerical models cannot adequately account for the diabatic, frictional, and baroclinic effects within the marine boundary layer. Hence, diagnostic models were developed to derive ocean surface (i.e. 19.5 meters) winds from large scale meteorological fields at standard levels. The models are based on various techniques, *inter alia*, Prandtl and Ekman dynamics using input from NMC's large scale global atmospheric spectral model. The wind field generated by diagnostic models are more representative than simple extraplolation of the upper level winds to the sea surface. After examining several diagnostic methods (Gemmill, Yu, and Feit, 1986), a two layer analytical model (Cardone ,1969) has been adopted for use at the OPC to produce ocean surface winds and drive the NOAA Ocean Wave (NOW) model. Figure 12, is an example of such a wind field for the Northwestern Pacific using the Cardone (loc. cit.) diagnostic wind model. Alphanumeric messages containing forecasts based on this model are available on the OCNDAT (Fig. 13) data file. The areas covered by these messages are the same as shown in Table 1.

2. Superstructure icing

A nomogram which allows for the estimation of the rate of ice accretion on ship's superstructures was developed by Wise and Comisky (1980). The nomogram was designed for Alaskan waters and requires SST, wind speed, and air temperature.

In order to apply the nomogram as part of an objective forecast scheme a decision tree algorithm was developed which uses four tables of ice accretion rates (as a function of air temperature and sea surface temperature) based upon four categories of wind speed (wind speeds less than about 20 knots are found not to produce significant ice accretion). Each wind category is represented by a given wind speed shown in Table 2.

Table 2. Wind speed categories for superstructure ice accretion forecasts

Category	Wind range	Representative speed
1	21-30 kts	25 kts
2	31-40 kts	35 kts
3	41-53 kts	45 kts
4	> 53 kts	55 kts

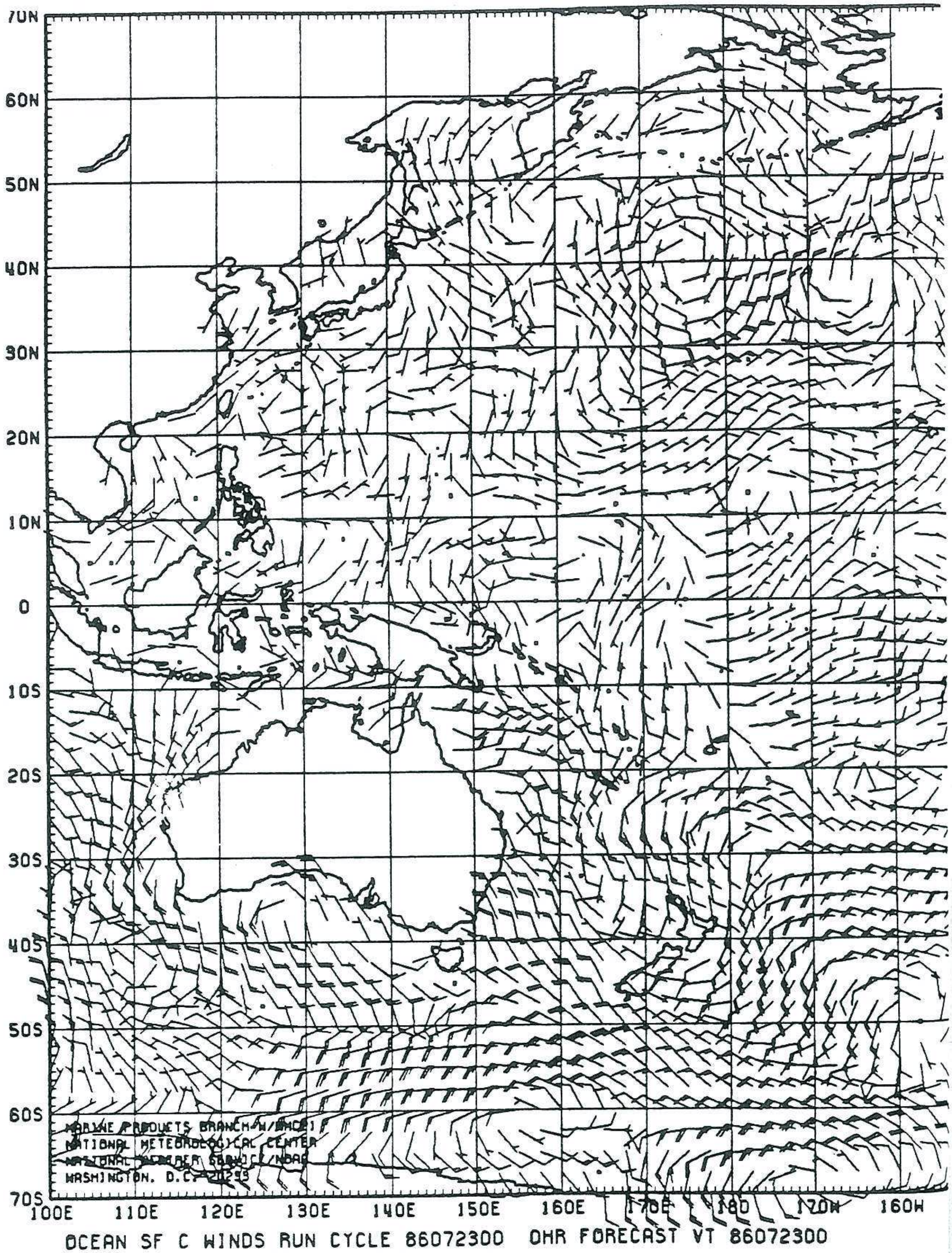


Figure 12. Northwest Pacific ocean surface winds (knots) based on Cardone (196
diagnostic wind model.

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NOAA OCEAN PRODUCTS CENTER (301-763-8133)
OCEAN WIND FORECASTS (DDFF)
DD IN TENS OF DEGREES. FF IN KNOTS
HEMISPHERE    WEST (-)    EAST (+)
REGION:WEST PACIFIC        / PART 1 OF 2
FORECAST TIME 86051500    /    TAU = 24
FILE CREATION  DATE - 86-516 2100Z
```

LONG LAT	160.0	162.5	165.0	167.5	170.0	172.5	175.0	177.5	180.0	-177.5	-175.0
65.0	9999	9999	9999	9999	9999	9999	9999	9999	9999	711	9999
62.5	9999	9999	9999	9999	9999	9999	9999	9999	9999	711	709
60.0	2912	9999	9999	9999	9999	3021	3117	3212	3407	303	804
57.5	9999	9999	2914	2915	2919	2923	2924	2922	2917	2811	2606
55.0	9999	9999	3011	9999	2915	2916	2918	2818	2719	2719	2618
52.5	1207	601	3106	3011	2912	9999	2815	9999	2617	2620	9999
50.0	1411	1505	2601	2906	2809	2711	2613	2613	2613	2715	2816
47.5	1511	1508	1703	2402	2614	2607	2608	2709	2809	2908	3009
45.0	1313	1211	1108	905	503	203	103	4	3506	3407	3408
42.5	1114	1014	913	712	612	510	609	609	509	310	110
40.0	1012	912	714	726	610	616	613	611	610	412	212
37.5	808	588	612	716	815	713	712	710	509	409	311
35.0	707	209	210	509	710	808	907	808	508	309	209
32.5	811	309	110	207	604	1106	1106	907	608	410	209
30.0	717	711	409	306	803	1107	1008	809	609	510	408
27.5	611	515	511	506	806	908	812	714	710	609	410
25.0	307	412	410	608	808	811	815	716	615	515	612
22.5	212	311	410	708	808	910	815	717	619	715	613
20.0	415	415	610	809	909	1010	717	620	715	614	410
17.5	519	519	714	711	811	811	616	518	713	510	511
15.0	620	621	520	712	617	509	509	510	611	611	612
	0			1		0			31546	86051500	

Figure 13. Alphanumeric wind (knots) message available on OCNDAT.

For each of these wind categories a matrix of ice accretion values was constructed. The matrices were filled by obtaining ice accretion rates from the nomogram for values of air temperature from 0-32 deg. F in 2 deg. intervals and values of sea surface temperature from 28-48 degree F also in 2 deg. intervals.

Inputs to the decision tree algorithm are the analyzed and forecast spectral model 1000 mb air temperature field and the spectral model 1000 mb geostrophic wind field. The sea surface temperature used is the NMC blended ship/satellite analysis.

By applying the nomogram at 2. 5 degree intervals of longitude and latitude in the Gulf of Alaska a chart of ice accretion rates may obtained and contoured. This is shown in Figure 14.

Recently a promising new statistical method for obtaining ice accretion rates has been developed by Overland et al (1986). The method is presently being evaluated under operational conditions and, if the results are positive, will replace the Wise and Comisky method for the winter of 1986-1987.

3. Coastal and Great Lakes MOS wind forecasts

These forecasts are made from statistically derived equations for 91 locations near the coast of the coterminous United States and Alaska (Burroughs, 1982) and for 12 sectors on the Great Lakes (Feit and Barrientos, 1974). The forecast equations were developed using a forward-selection screening regression program which relates observed ship and buoy data to LFM model output interpolated to each of the coastal locations and Great Lakes sectors. The development data were stratified into two seasons: warm (April-September) and cool (October-November). Separate sets of equations were derived for each model cycle (0000 or 1200 GMT), season (warm or cool), and projection (6-48 hours at 3 hr intervals for coastal locations and at 6 hr intervals for Great Lakes locations). Figures 15 and 16 show the locations of the stations and the Great Lakes sectors, respectively.

The forecasts are disseminated twice daily over AFOS, FOS, and several teletype circuits. Figure 17 shows a sample bulletin for the coastal winds along the northeast Atlantic U. S. coast. In each coastal bulletin the wind forecasts at 3 hour intervals from 6-48 hours are given for each station on two lines. The first line gives the projections from 6-27 hours, and the second gives the projections from 30-48 hours. The wind forecast format is ddff where dd is the wind direction in tens of degrees and ff is the wind speed in knots.

The bulletins for the Great Lakes locations are similar except the forecasts are at 6-h intervals, are on one line per location, and the dates are not included with the time headings for each column. Further information on the coastal wind forecast system may be found in NWS (1984) and for further information on the Great Lakes wind forecast system see NWS (1983).

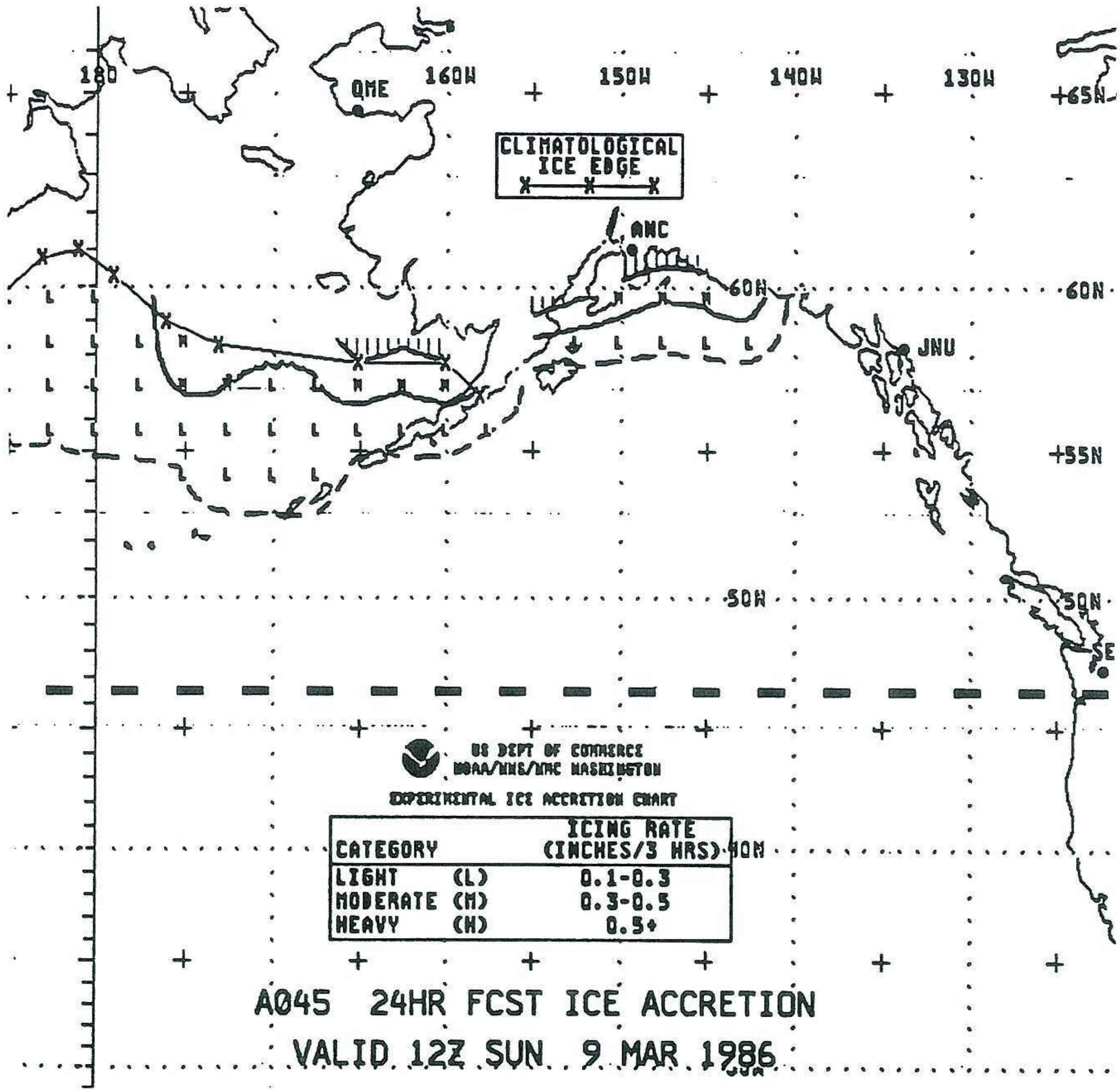


Figure 14. Example of 24 hour superstructure ice accretion forecast.

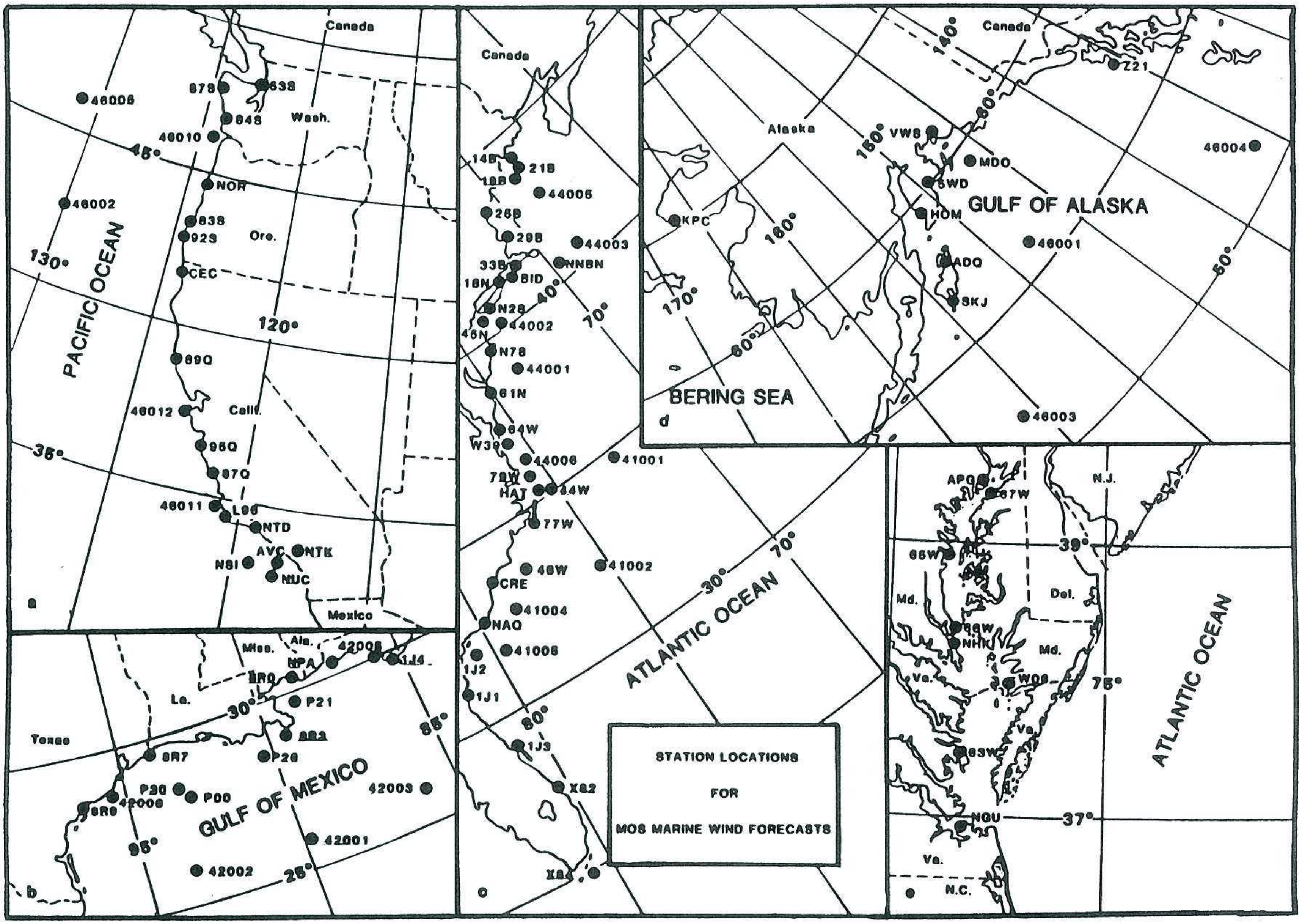


Figure 15. Coastal and offshore locations for MOS marine wind

Figure 15. Coastal and offshore locations for MOS marine wind forecasts.

Figure 16. Location of the 12 sectors for Great Lakes wind forecasts.

FZUS41 CSTL WND FCSTS-NEA 7/23/86 1200 GMT

D/GMT	2318 2418	2321 2421	2400 2500	2403 2503	2406 2506	2409 2509	2412 2512	2415
14B	2707 2307	2505 2407	2605 2510	2703 2609	2901 2511	2902 2509	2704 2509	2704
21B	2503 1905	2004 2007	2503 2013	2402 2111	0000 2112	0000 2109	1703 2109	2105
19B	2206 1906	2006 2009	2106 2011	2206 2512	2202 2115	2305 2213	1805 2111	1805
25B	1402 1504	1504 1506	1601 1608	0000 1706	0000 2003	0000 2103	0000 2103	1104
44005	2404 1404	2204 1706	1903 1808	1903 1908	0000 2008	1503 2009	0605 1910	1505
29B	1404 1506	1703 1607	1701 1908	1801 1906	1901 2007	1302 2005	1303 2006	1504
33B	1703 1708	1904 1806	1903 1807	1803 1905	1503 2006	1404 1906	1607 1907	1704
18N	1801 1701	0000 0000	0000 1703	0000 1704	0000 0000	0000 1402	0000 1204	0000
BID	1604 1605	1806 1706	1904 1705	1803 1906	1902 2005	0603 2005	0805 2006	1005
44003	2102 1004	2101 0904	1701 1202	1101 1503	0000 1502	0901 1504	0707 1604	0902
NNBN	1302 1205	0701 1304	2601 1303	1302 1504	1602 1907	1301 1706	1405 1705	1407
45N	1305 1507	1704 1606	1604 1707	1605 1806	1305 1906	0905 1906	0808 1906	1206
N28	1703 1807	1802 1808	1804 1908	1803 2109	1505 2004	1204 2103	1404 1802	1604

Figure 17. Coastal wind bulletin (speed knots, direction 10's of degrees) for the northeast Atlantic coast.

4. Santa Ana regime and wind forecasts

In October 1985, forecasts of Santa Ana regimes and the associated winds at 5 stations near the coast of southern California were implemented operationally (Burroughs,1986). Apart from its importance as a hazardous condition over land, Santa Ana winds create a dangerous situation to boating in the southern California coastal waters and to shipping activities in the San Pedro channel. Hence, the prediction of this event is a matter of great concern to marine interests in general. The regime forecasts are made from equations developed using discriminant analysis to relate the occurrence (or non-occurrence) of Santa Ana regimes to LFM gridpoint data over the southwestern U. S. When a strong Santa Ana regime is predicted wind forecasts are made from special MOS forecast equations which replace the routine MOS wind forecasts. Santa Ana regime forecasts are made only from October through May which is the normal season for Santa Anas.

the

C. Polar seas and Great Lakes sea ice

Ice analyses and forecasts are produced by the Joint Ice Center through a combined Navy/NOAA effort. This section describes those products available for civilian application.

1. Analyses

Sea ice analysis is the process of determining an up to date picture of sea ice distribution and development. It includes the location of the ice edge, the ice concentration and an estimate of the age of the ice (which implies thickness). Movements of the ice edge and large ice floes can be determined from successive satellite images.

The regular production of a worldwide sea ice picture is a formidible undertaking. The polar regions are extensive and ice conditions can change quickly. Consequently, data must be acquired over large regions on a daily basis and analyzed as quickly as possible. Furthermore, no single, satellite based, all weather, data source is available and a scheme of collecting information from several sources must be used to construct sea ice analyses on various scales. Table 3 lists the most commonly used data sources.

TABLE 3. DATA SOURCES USED IN SEA ICE ANALYSIS

DATA SOURCE	RESOLUTION	COVERAGE	ROUTINE	SPECIAL
SATELLITE				
NOAA AVHRR LAC	1 km	Regional	X	
" " GAC	4 km	Global	X	
" " HRPT	1 km	Regional	X	
GOES (VIS/IR)	1 km	Regional	X	
DMSP VIS/IR	5 km	Global	X	
NIMBUS-7 SMMR	40-60 km	Global	X	
GEOSAT ALTIMETER	6 km	Global	X	
LANDSAT MSS	80 m	Local		X
AERIAL RECONNAISSANCE	1 km	Local	X	X
U.S. NAVY	"			
CANADIAN (AES)	"			
DANISH	"			
PRIVATE INDUSTRY	"			
SHIP REPORTS (All Synoptic reports reporting ice)	N/A	Point	X	
SHORE REPORTS	N/A	Point	X	

The first step in sea ice analysis is to plot all observations from ships, shore sites and aircraft. Next, data from all NOAA and DMSP visible and infrared satellite imagery is plotted (both 1 km and 4 km resolution). Due to clouds, darkness, and lack of finer resolution data, gaps in the analysis will normally exist. These are filled with passive microwave data from NASA's NIMBUS 7 spacecraft where ever possible. Table 4 describes the current Joint Ice Center analysis capabilities under cloud covered and cloud free conditions.

TABLE 4 ANALYSIS CAPABILITIES (CURRENT)

PARAMETER	CLOUD FREE (AVHRR)	CLOUD LIMITED (SMMR) *	RECONNAISSANCE
ICE EDGE (LOCATION)	5-10 km	25-100 km	1 km
CONCENTRATION (1-10)	1-2 tenths	2-3 tenths	1 tenth
ICE ISLANDS/ (SIZE)	> 5-10 km	none	20 m
LEADS/POLYNAS (SIZE)	1-4 km	25 km	10 km
ICE MOTION	ARCTIC DRIFT BUOYS/ BUOY CLIMATOLOGY		
AGE	ESTIMATED AS NEW, YOUNG, FIRST YEAR OR OLD,		
THICKNESS (LEVEL)	LEVEL ICE THICKNESS INFERRED FROM ESTIMATED AGE		
RIDGING/KEELING FREQUENCY/SIZE	NO PRESENT CAPABILITY		

* RECEIVED 2-3 TIMES WEEK, DATA SET UP TO 3 DAYS Old

Sea ice analysis products are produced at the Navy/NOAA Joint Ice Center on three scales: global, regional and local. Global scale products make up the bulk of the products and are disseminated by mail and facsimile. Only the ice edge data from these global charts are disseminated in message format. Regional scale products are disseminated as charts by facsimile and mail. Local scale products are almost entirely disseminated as messages. Direct support to deployed units, limited to U. S. Navy, NOAA, USCG, MSC, NSF and cooperating foreign countries, will be regional or local scale products depending upon the data source available and are almost always disseminated by message.

Ice on the Great Lakes is analyzed from HRPT and GOES satellite data by the JIC in cooperation with the NWS forecast office at Ann Arbor. Lake ice concentration and extent is plotted from cloud-free portions of satellite images and ice thickness is estimated from the age of the ice and observed air temperatures. Particular attention is placed on ice near the constrictions of the shipping lanes and the forecast office receives ice observations directly from these areas.

2. Forecasts

Sea ice forecasts are produced using a variety of techniques including statistical, empirical, analog and numerical. Forecasts are issued for three general time scales: short term, 144 hours and less; middle term, 1-4 weeks; long term (seasonal outlooks), several months. Short term forecasts are closely related to the observed and predicted wind field through statistical and numerical modelling techniques. Sea ice drift vectors are derived from methods developed by Thorndike and Colony (1982) and Skiles (1968). These are plotted on charts for use by the ice forecaster. The forecaster uses the vectors, sea ice analyses, weather data and any available oceanographic data (especially sea surface temperature) in constructing the short term forecast.

For the Bering Sea specialized guidance is available to the forecaster in the form of a regional dynamic/thermodynamic model developed at PMEL by Pease and Overland (1984). This model, which runs operationally from approximately December through April, predicts the ice drift along 9 transects through the Bering Sea. Model input is derived from the NMC's global atmospheric model which allows the ice drift to be predicted 144 hours in advance in 24 hour steps. The primary forcing function for this model is the wind field. Lesser contributions are derived from thermodynamic and oceanographic effects. Lack of data limits the ability to account for oceanographic influence on short term ice drift.

A second numerical model, now being run experimentally by NORDA, is based upon Hibler's (1979) dynamic/thermodynamic model of Arctic sea ice. Called PIPS (Polar Ice Prediction System), this model is suitable for nearly all the ice covered waters of the Arctic and incorporates ice rheology in its dynamics to more accurately determine the ice thickness distribution. Like the PMEL model PIPS is limited by the paucity of oceanographic data and hence uses only climatological ocean currents and sea surface temperatures. Work is proceeding at NORDA on improving this model and making it operational.

Middle term forecasts are issued regularly for the Arctic and are based upon a statistical/analog approach. The forecast guidance in this case consists of over 20 years of past history and 30-day mean sea level pressure and temperature forecasts issued by CAC. Seasonal outlooks are prepared by an analog technique using ice climatology. In addition statistically derived guidance for the Beaufort Sea relates ice severity to mean sea level pressure and, for the Antarctic, to ice extent in October and January near McMurdo Sound.

D. Waves

1. NOAA Ocean Wave (NOW) model

Spectral ocean wave forecasts are routinely generated at the National Meteorological Center (NMC) using an experimental NOAA Ocean Wave model (Chin, 1985). The model is based on a two step numerical solution of the spectral energy balance equation.

The first step is a spectral growth/dissipation simulation where local wind driven seas are developed through a nonlinear parametric algorithm. Incremental fetch and duration growth rates and limits are controlled through a series of non-dimensional parameters. The algorithm provides for angular relaxation and high frequency spectral overshoot. In areas of opposing winds, wind wave dissipation is simulated by an Austausch analogue equation. Fields of directional frequency spectra in 15 frequencies and 24 directions are calculated at three hour intervals to 72 hours.

The second step simulates the propagation of energy at group velocity on a 2. 5 degree latitude by 2. 5 degree longitude grid according to a conservative downstream interpolation scheme. The grid is defined from 70S to 75N with an auxiliary land/sea table to preclude calculation over land.

Boundary layer wind fields to drive the model are computed from the 1000 mb u and v wind component fields of the NMC global atmospheric spectral model. Corrections are made for height above the sea surface and stability using the air-sea temperature difference. Input to the wave model are the forecast fields out to 72 hours in 12 hour intervals. These are interpolated to six intervals for computational purposes.

Wave model products include full global fields of combined wind wave/swell significant wave height (i.e. the average height of the one third highest waves) at three hour intervals, one line summaries of wave statistics at selected grid points, directional - frequency spectra at selected grid points, and marine boundary layer winds (at a height of 19. 5 m above the surface) at six hour intervals.

Figure 18 illustrates a typical 24 hour forecast of significant wave height. Labeled height contours are in units of feet. The most easily distinguished features in this example are the relatively high winter storm-generated wave systems in the southern hemisphere. The significant wave heights, primary wave period, and direction will be introduced on AFOS, in graphic form, shortly.

Selected fields of significant wave height were subdivided into ten regions for distribution over OCNDAT. The regional limits in terms of latitude and longitude are the same as for ocean surface winds and are listed in Table 1. Within each region, alphanumeric listings of significant wave height (in meters) are displayed at each 2. 5 degree intersection of latitude and longitude. Figure 19 is a sample OCNDAT message for the central tropical Pacific. The forecast origination time is labelled 0 and only one part of the three part message is shown.

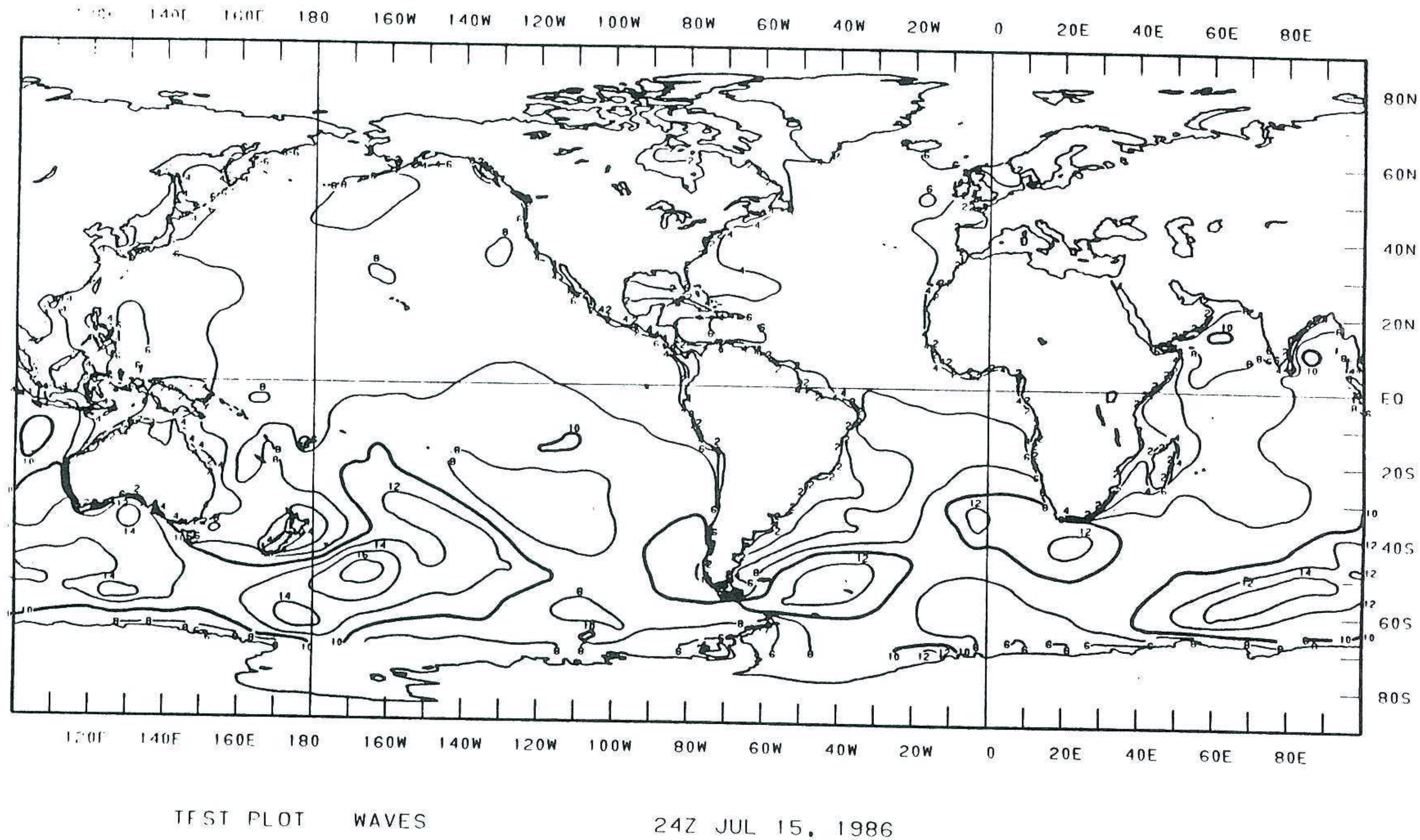


Figure 18. Global 24 hour forecast of combined wind wave/swell significant wave height (ft).

NOAA OCEAN PRODUCTS CENTER(301-763-8133)
SIGNIFICANT OCEAN WAVE HEIGHT FORECAST(METERS)
REGION:C TROP PAC / PART 1 OF 3
FORECAST TIME 0 / TAU = 72

LONG / LAT	150.0	152.5	155.0	157.5	160.0	162.5	165.0	167.5	170.0	172.5	175.0
30.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.1	[illegible]
27.5	0.8	0.8	0.8	0.8	0.3	0.8	0.8	0.8	0.9	0.9	0.6
25.0	0.8	0.8	0.3	0.8	0.3	0.8	0.8	0.8	0.8	0.8	[illegible]
22.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6
20.0	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5
17.5	0.6	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.4	[illegible]
15.0	0.7	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.3	0.3	[illegible]
12.5	0.8	0.6	0.6	0.7	0.6	0.6	0.6	0.5	0.3	0.2	[illegible]
10.0	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.4	0.3	0.4
7.5	0.4	0.3	0.3	0.2	0.3	0.3	0.4	0.5	0.5	0.5	0.5
5.0	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.5	0.6	0.6	0.6
2.5	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.5
0.0	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.2	0.3	0.3	0.5
-2.5	0.0	0.4	0.3	0.3	0.3	0.2	0.3	0.4	0.4	0.3	0.4
-5.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.4
-7.5	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.4	0.4
-10.0	0.3	0.4	0.5	0.5	0.5	0.6	0.4	0.3	0.3	0.4	0.4
-12.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.6
-15.0	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7
-17.5	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6
-20.0	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6
-22.5	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7
-25.0	0.0	0.0	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.6
-27.5	0.0	0.0	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.5
-30.0	0.0	0.0	0.2	0.3	0.5	0.5	0.4	0.4	0.7	0.7	0.7

Figure 19. Combined wind wave /swell significant wave height (m) message available on OCNDAT.

2. TDL wave models

A brief description of the TDL wave models is included in this compendium because they are the guidance presently disseminated to field offices over the AFOS and regional facsimile circuits. The NOW model described above is expected to replace the TDL wave guidance in the near future. The regional TDL wave models will continue to operate until OPC has developed suitable alternative models.

All ocean wave forecasts introduced by TDL use a modified Sverdrup-Munk-Bretschneider method (Pore and Richardson, 1969). This method yields a simple forecast value of wave height and period at each point of application. Wave height and wave period are computed at each grid point of the northern hemisphere NMC octagonal grid using wind speed and duration time from the NMC AVN model. In addition swell is also computed by saving and tracking wind waves previously forecast. The dissemination of these forecasts in a graphic form on AFOS and regional facsimile circuits may continue along with those generated by the NOW model for comparison purposes.

Wind wave forecasts for the Gulf of Mexico are also produced in graphic form using a method similar to the Northern Hemisphere wind-wave product. The difference is that the computation for the Gulf are made using NMC's Limited-Area Fine-Mesh (LFM) model.

Wave forecasts are also generated for the Great Lakes (Pore, 1977). The forecasts are made for 64 points using a modified Bretschneider method (Bretschneider, 1970,1973). Wind forecasts are computed from the LFM using MOS derived equations (Feit and Barrientos, 1974). The forecasts are produced in alphanumeric format and disseminated via AFOS.

Finally wave forecasts are produced for 6 points on the Chesapeake Bay using the Sverdrup-Munk-Bretschneider method (Bretschneider, 1970). Wind input is derived from the LFM interpolated to the 6 forecast locations. The forecasts are available on AFOS as an alphanumeric message.

3. AFOS wave spectra

Wave data from approximately 45 NDBC buoys moored off the coastal U. S. and in the Great Lakes are processed and transmitted in spectral form to NMC via a satellite communications link. These buoys are designed to report wave data on an hourly basis.

The large volume of these data precludes efficient direct transmission via AFOS in an uncompressed format. An abbreviated code has therefore been developed to transmit spectral wave bulletins containing both non-directional period and directional period (where available). These bulletins are sent over AFOS and a limited number of teletype circuits to NWS forecast offices and other users on a three hourly basis.

III. Product dissemination and examples

The guidance products and data sets described in this compendium are disseminated by a number of different modes ranging from electronic means to postal delivery. A complete list of OPC products is shown in Table 5. Further details concerning availability, status and procedures for accessing these products may be obtained by contacting the OPC directly. Immediately following is a complete set of product samples representing guidance products produced by the OPC.

TABLE 5. SUMMARY OF GUIDANCE PRODUCTS AVAILABLE THROUGH THE OPC

A. OCEAN THERMAL STRUCTURE

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
Satellite only SST analyses:				
100 km resolution				
Global	1/week	T	mail	
50 km Resolution (experimental)				
Pacific Islands	3/week	M,W,F	mail,FAX	
EPOCS	3/week	"	"	
Hawaii / Alaska	3/week	"	"	
Pacific coast	3/week	"	"	US Coast
Atlantic coast	3/week	"	"	"
14 km Resolution (experimental)				
Gulf of Cal.	3/week	M,W,F	mail,FAX	
SW Pacific coast	3/week	"	"	US Coast
NW Pacific coast	3/week	"	"	"
Gulf of Mexico	3/week	"	"	
SE Atlantic coast	3/week	"	"	"
NE Atlantic coast	3/week	"	"	"
Satellite, ship and buoy blended analyses:				
Global SST			OCNDAT,GTS,	2 deg res, 15
analysis	1/day	1600Z	mail,FAX,FOS	day running mean
anomaly	1/day	"	mail	
TOGA global		3rd day		2 deg resolution
SST analysis	1/month	of month	WDC's	30 day mean
anomaly	1/month	"	"	

Table 5. Cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
Regional SST analyses NW Atlantic	1/week	S	mail,FAX	5 day running mean
E Pacific	5/week	T,W,Th, S,Su	"	"
Gulf of Mexico	1/week	S	"	"
Gulf of Alaska	4/week	M,W,F,Su	"	"
Great Lakes sfc temp	2/week	W,S	mail,FAX	during ice free season
100 m sub-surface temperature analysis	1/week	F	"	NE Pacific
Ocean feature analysis	1/day	1400Z	FAX	GS/Loop alternate days
Oceanographic Monthly Summary	1/month	5th day of month	mail	
B. MARINE METEOROLOGY				
Global ocean surface wind forecasts	1/day	1000Z	OCNDAT	available on FOS, AFOS and regional TTY/FAX Fall 86
Coastal US wind forecasts	2/day	0330Z,1600Z	AFOS	MOS technique
Santa Ana wind forecasts	2/day	"	"	"
Great Lakes wind forecasts	2/day	"	"	"
Superstructure ice accretion forecasts	1/day	1100Z	FAX	Alaska region

Table 5. Cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
C. POLAR SEAS AND GREAT LAKES ICE				
Eastern/Western Arctic Analysis	1/week	W	FAX, NNODDS, Mail	
Antarctic Analysis	1/week	W,F	"	
Bering/Chukchi Ice Analysis	3/week	M,W,F	Mail FAX	
Alaskan North Slope Analysis	3/week	"	"	
Great Lakes Ice Analysis	2/week	W,S	"	
Tailored Ship Support	As req.		INMARSAT	U.S. Govt ships only
Routine Tail-ored Support	"		"	
Eastern/Western Arctic 7 day Forecast	1/week	T	NNODDS	statistical/ analog
Western Arctic 30 day Forecast	2/month	15th/30th	Mail	"
Eastern Arctic 30 day Forecast	2/month	"	"	"
Western Arctic Seasonal Outlook	1/year	May	"	
Eastern Arctic Seasonal Outlook	1/year	"	"	
Western Ross Sea and McMurdo Sound Seasonal Outlook	1/year	Sept	"	
Bering Sea ice edge forecast	1/day		FAX	dynamical/ thermodynamical

Table 5. Cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
D. OCEAN WAVES				
Global ocean wave forecasts	1/day	1000z	OCNDAT	NOW model, availabl AFOS and FAX Fall 8
Northern hemisphere ocean wave forecasts	2/day	0730Z,2030Z	AFOS,FAX	mod Bretschneider may be replaced by NOW model Fall 86
Regional ocean wave forecasts: Gulf of Mexico	2/day	0330Z,1600Z	AFOS,FAX	mod Bretschneider
Great Lakes	2/day	"	"	"
Chesapeake Bay	2/day	"	AFOS	"
NDBC buoy wave spectra	8/day	00Z,03Z,06Z,09Z 12Z,15Z,18Z,21Z	"	

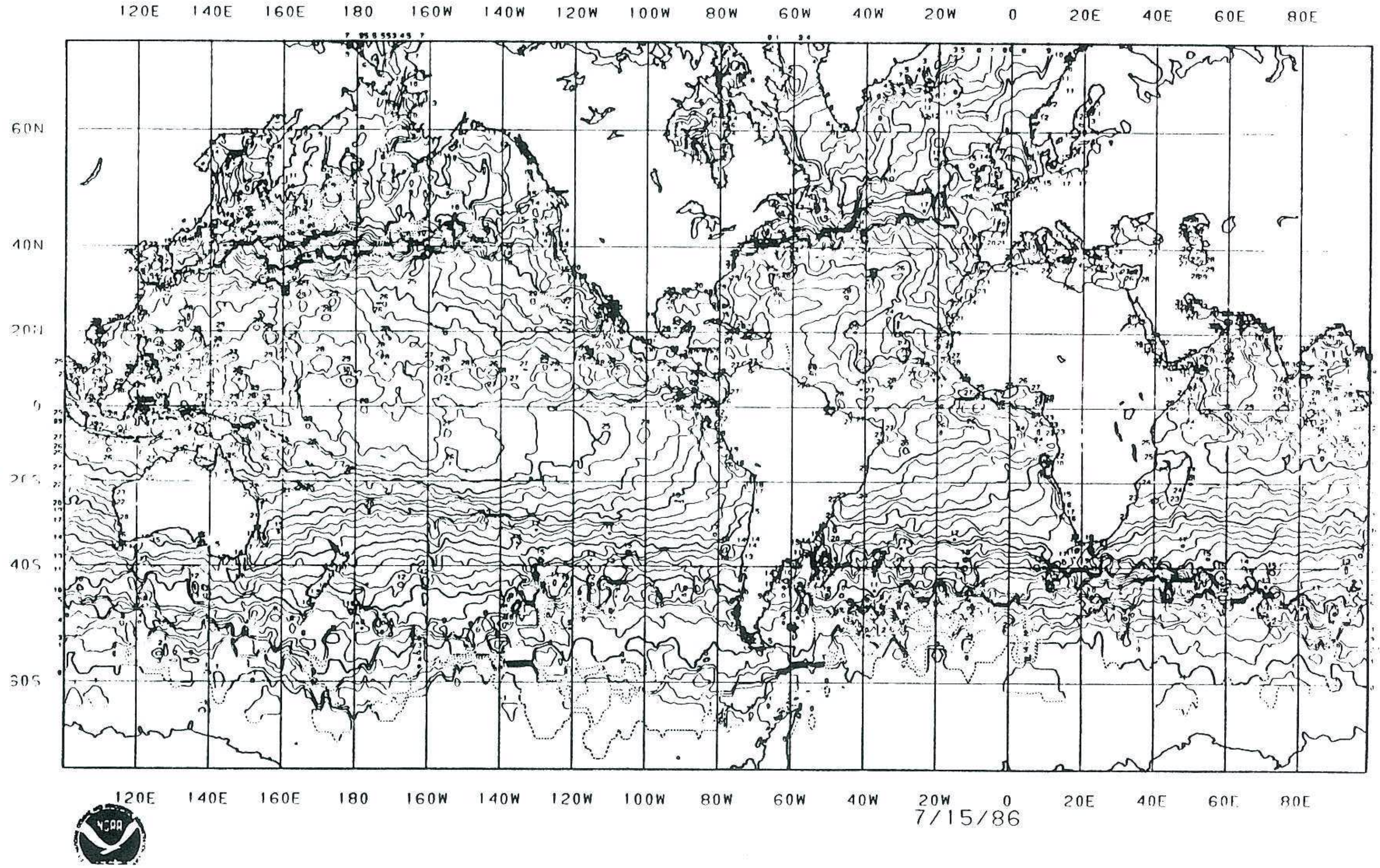


Figure 20. Global 100 km resolution satellite only SST (deg C) analysis.

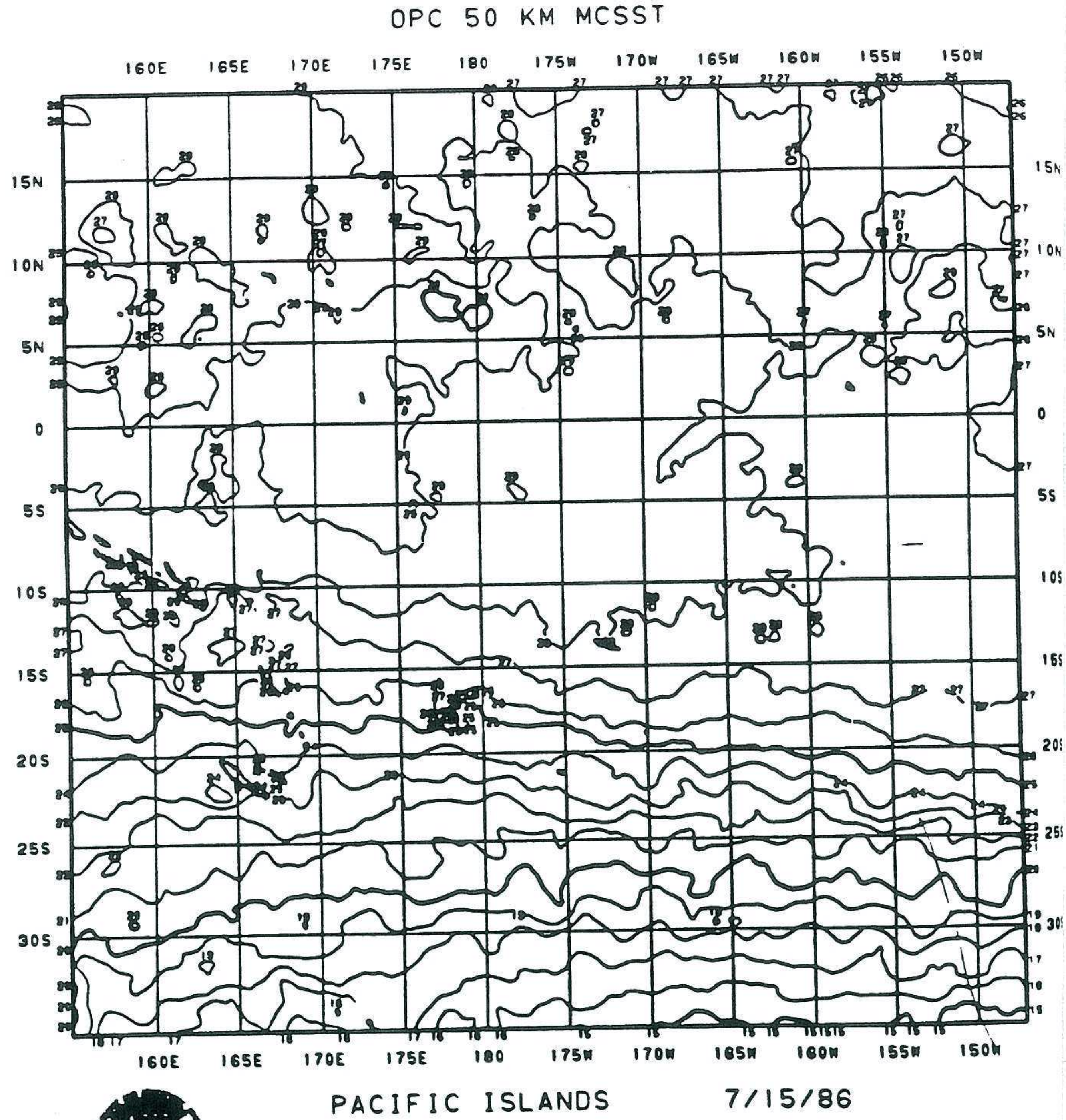


Figure 21. Pacific Islands 50 km resolution satellite only SST (deg C). analysis.

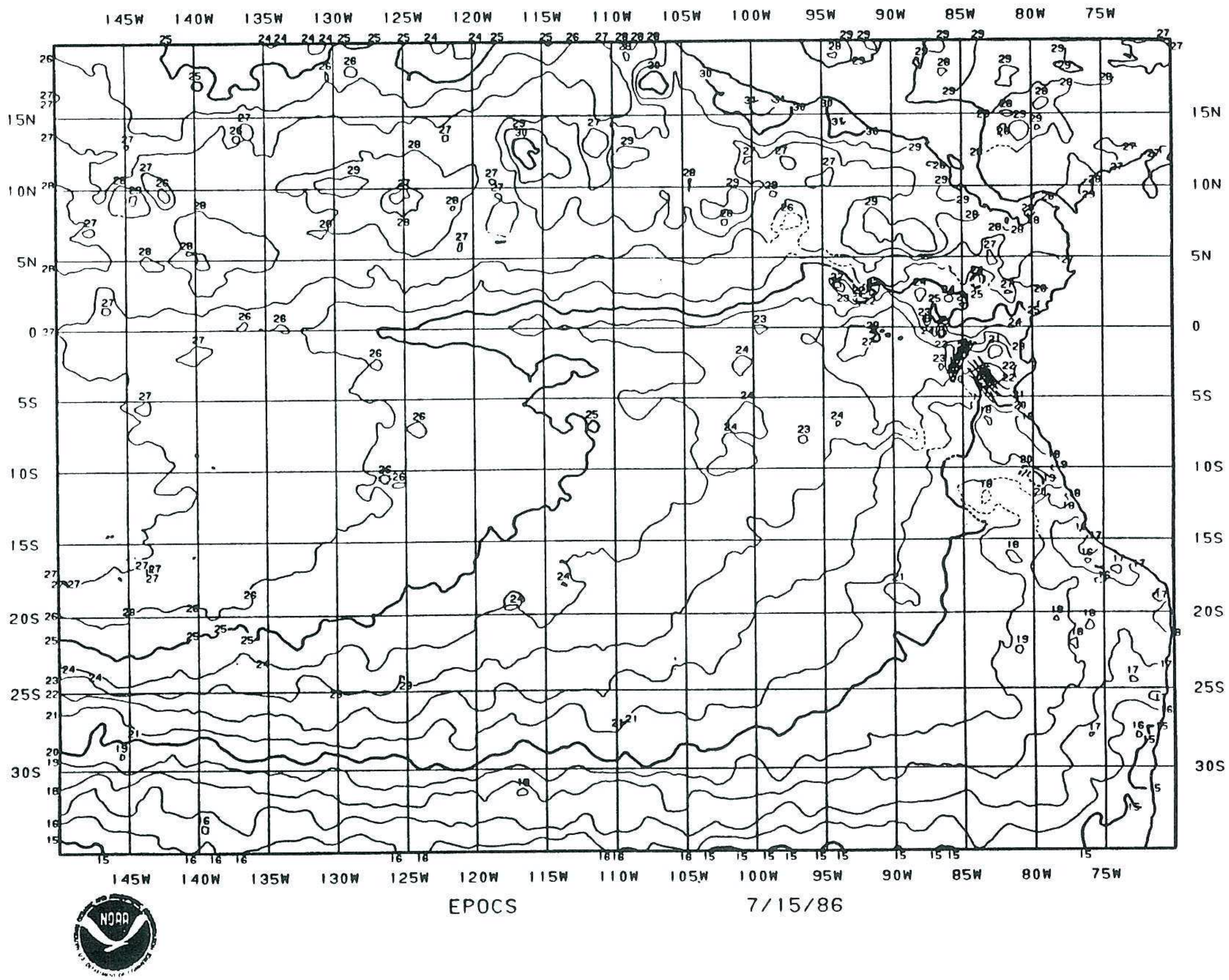


Figure 22. EPOCS 50 km resolution satellite only SST (deg C) analysis.

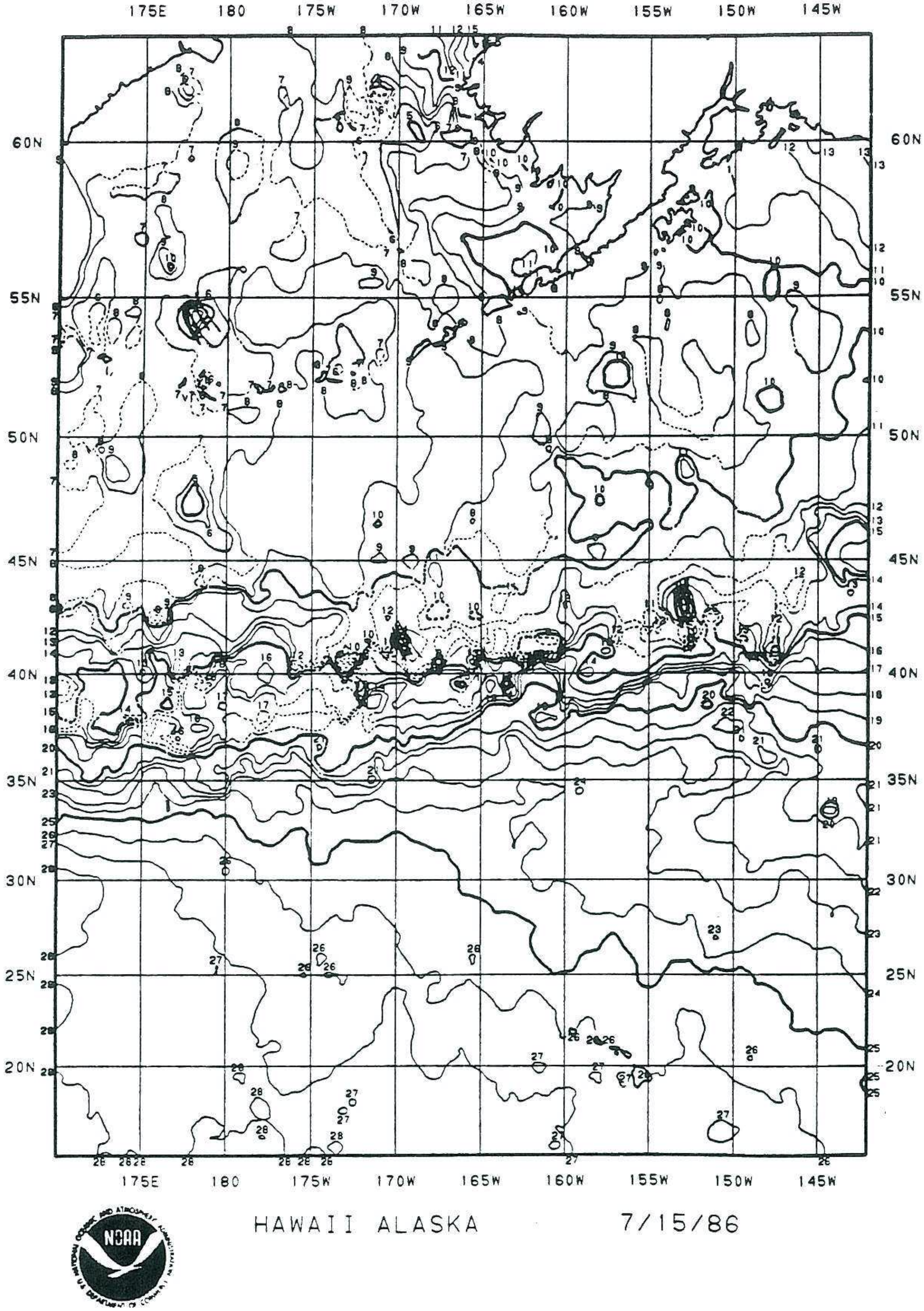


Figure 23. Hawaii/Alaska 50 km resolution satellite only SST (deg C) analysis.

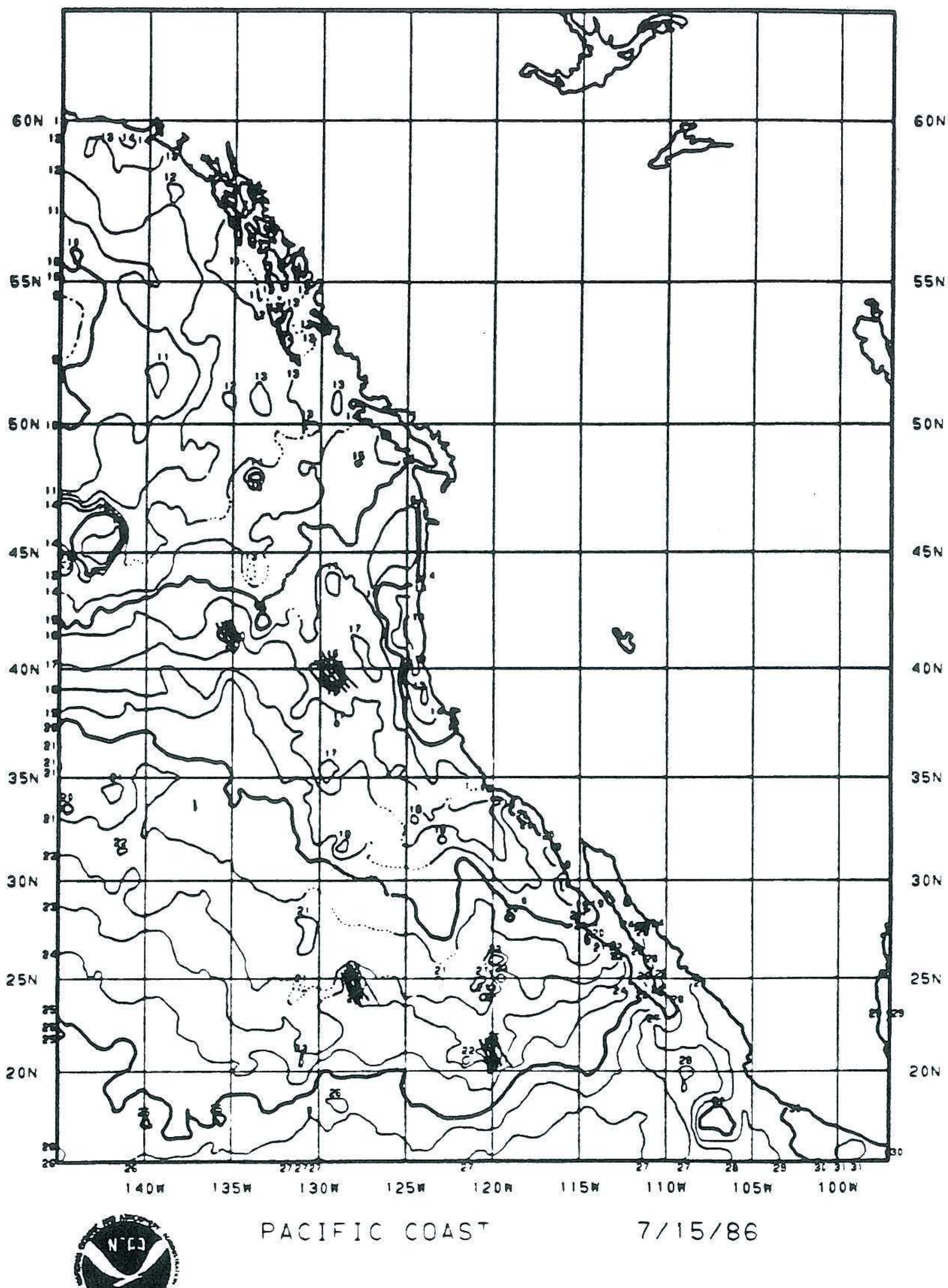


Figure 24. Pacific Coast 50 km resolution satellite only SST (deg C) analysis.

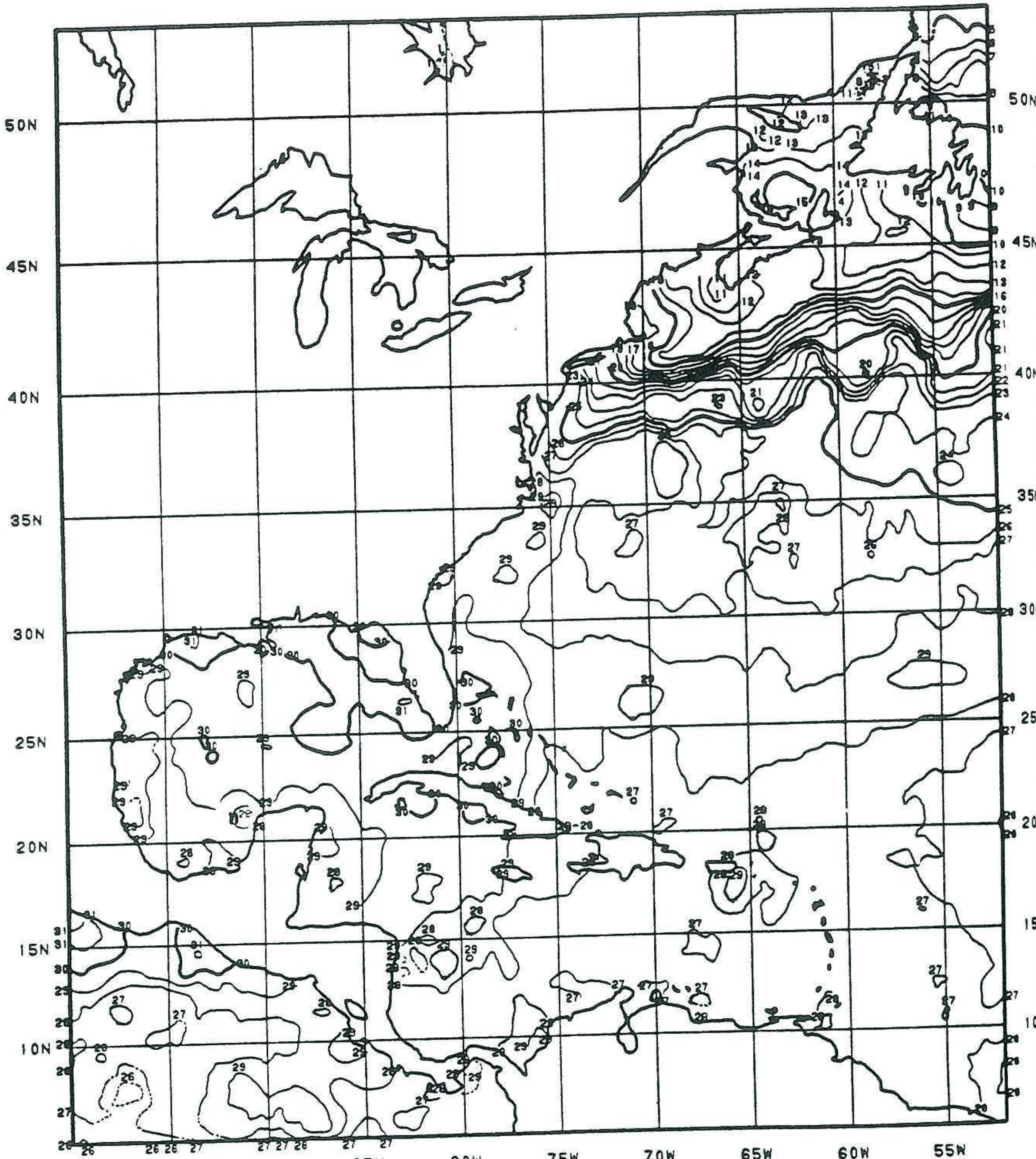


Figure 25. Atlantic Coast 50 km resolution satellite only SST (deg C) analysis.

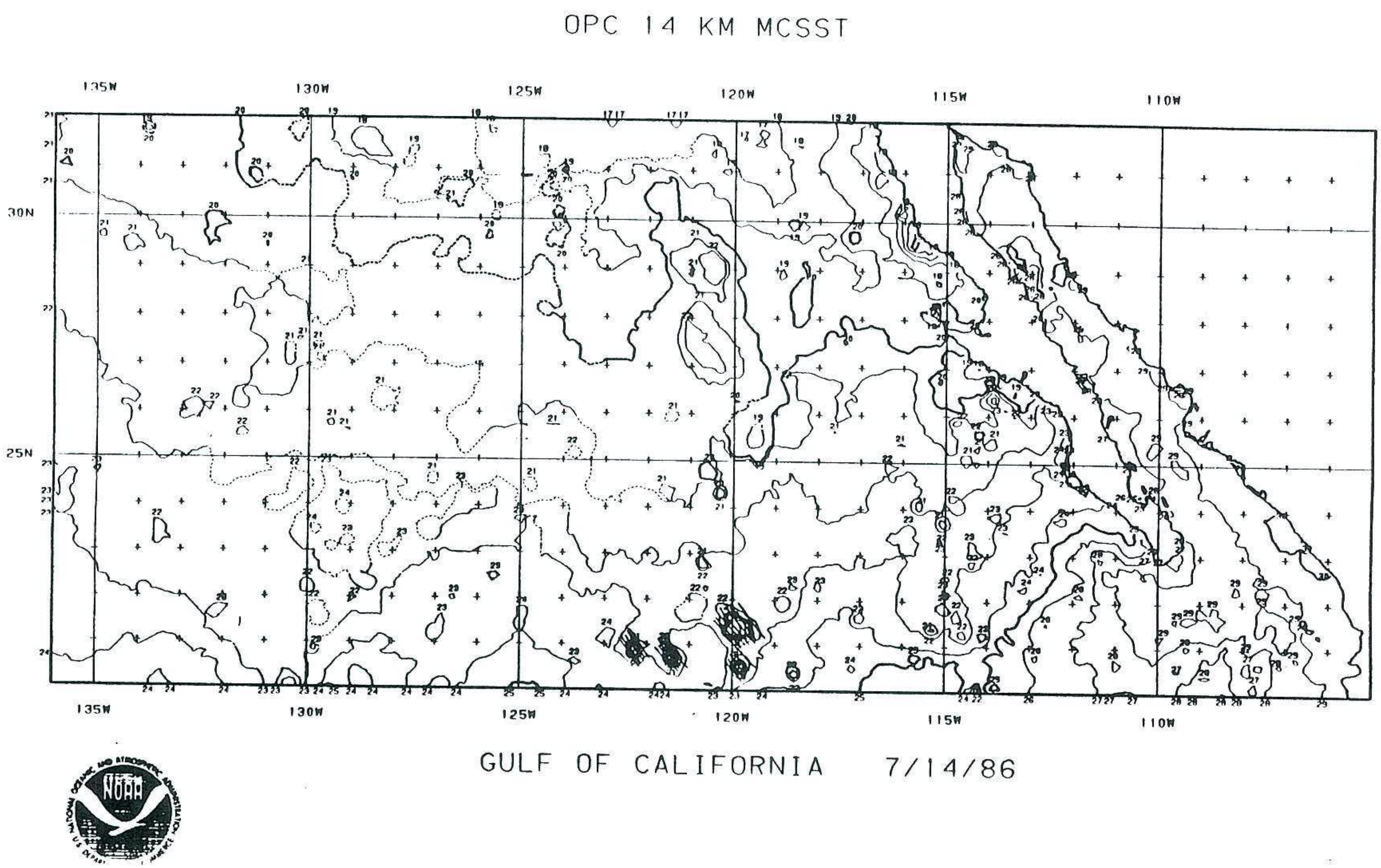


Figure 26. Gulf of California 14 km resolution satellite only SST (deg C) analysis.

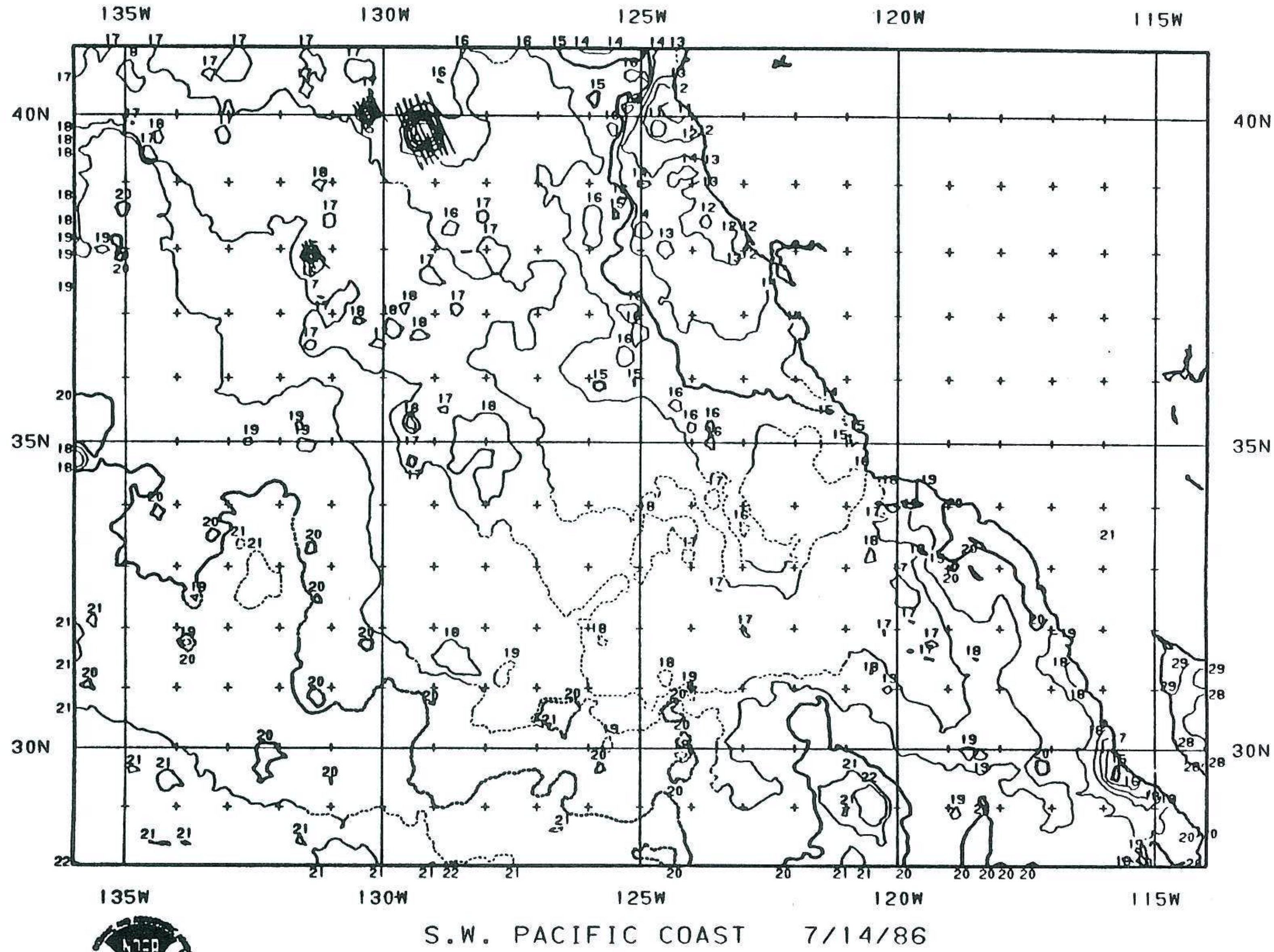


Figure 27. Southwest Pacific Coast 14 km resolution satellite only SST (deg C) analysis.

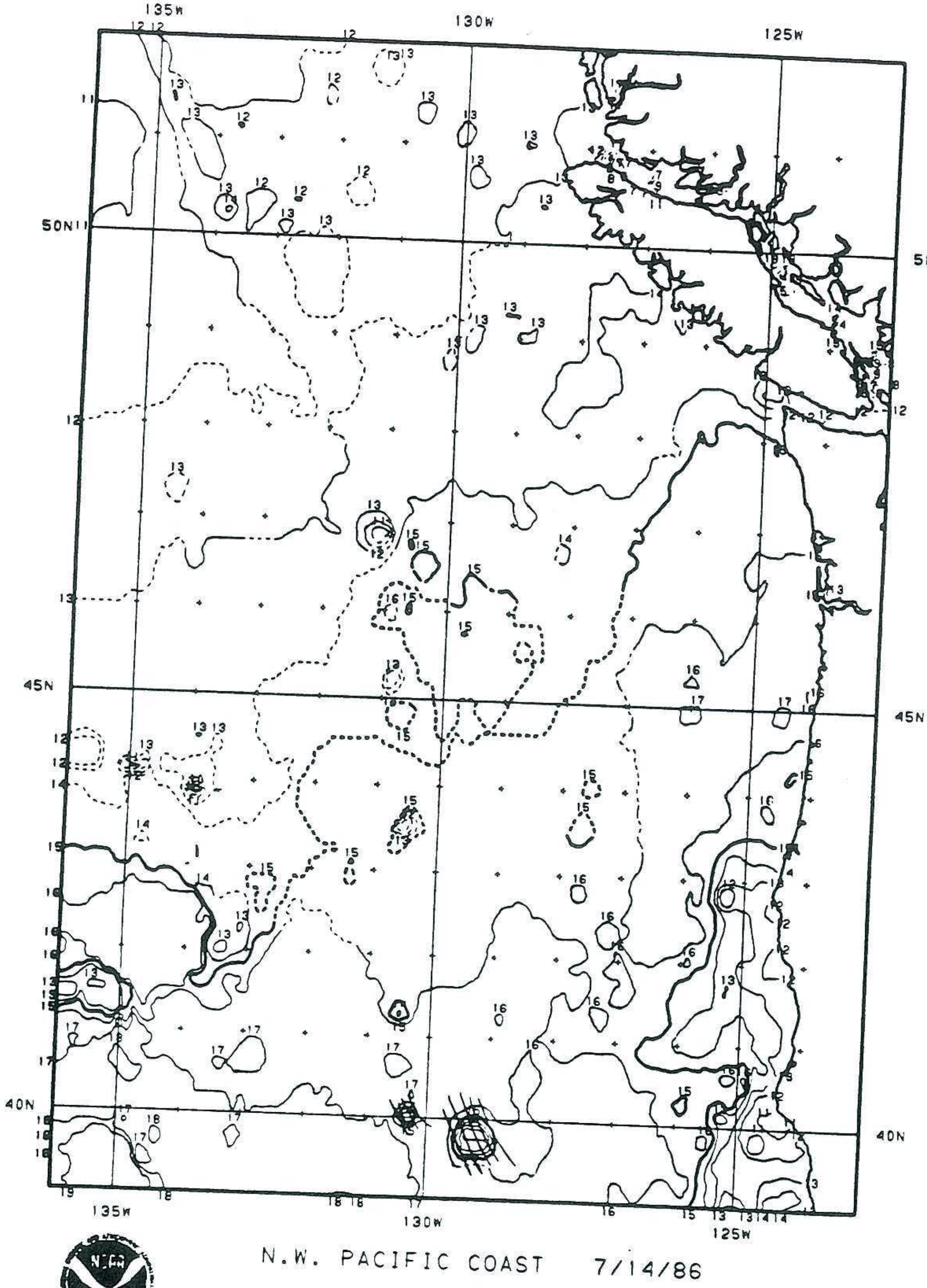


Figure 28. Northwest Pacific Coast 14 km resolution satellite only SST (deg C) analysis.

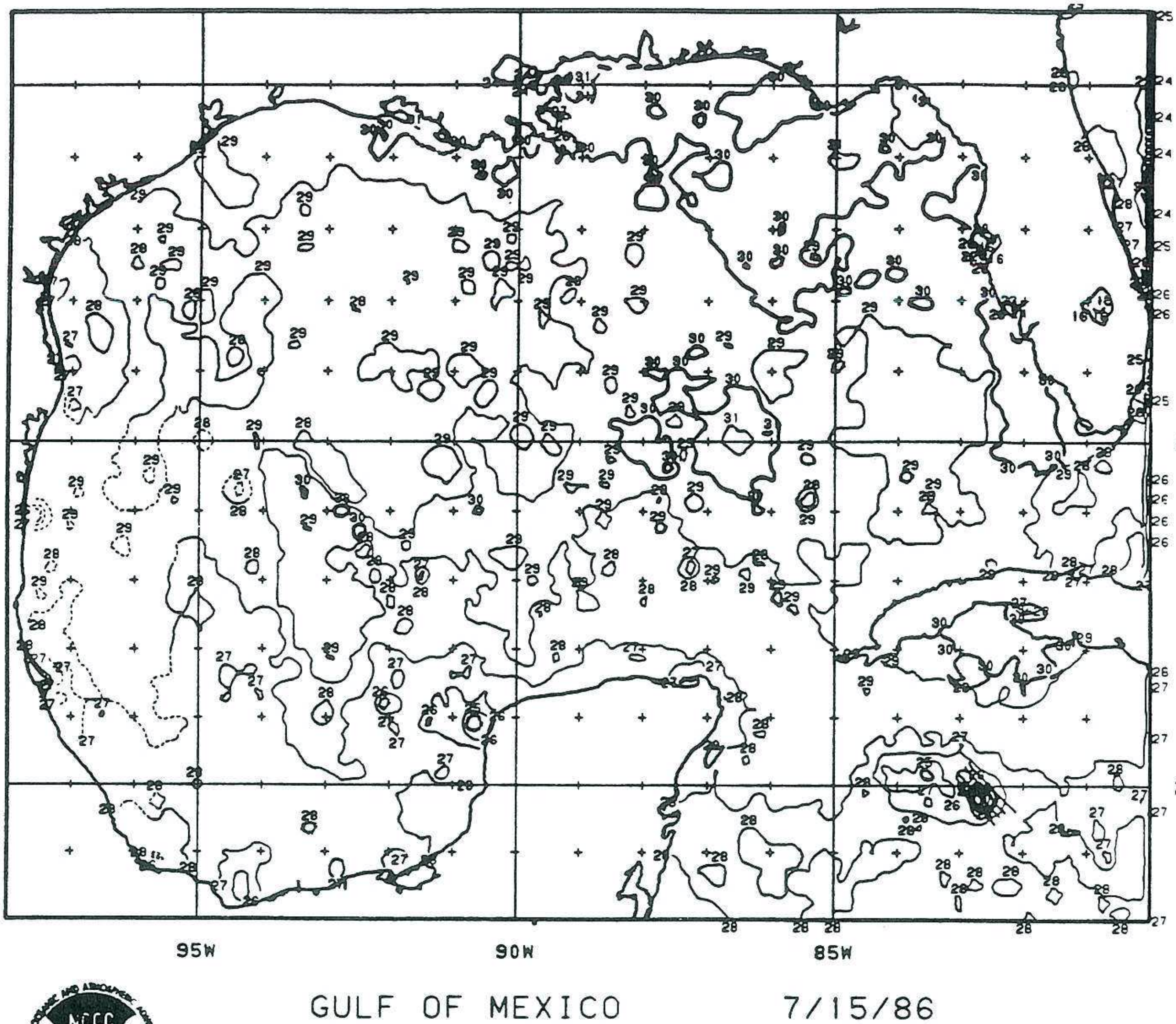


Figure 29. Gulf of Mexico 14 km resolution satellite only SST (deg C) analysis.

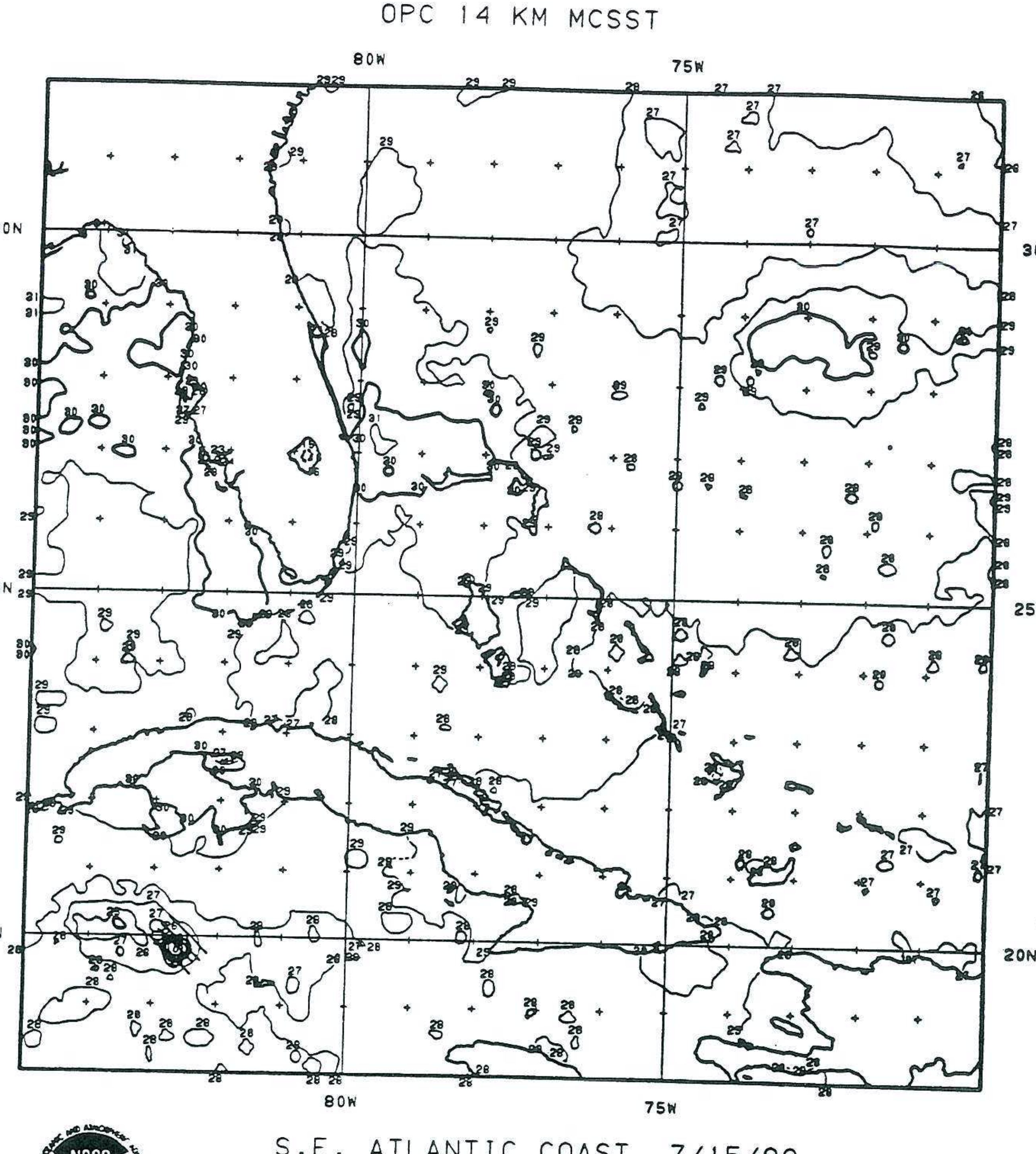


Figure 30. Southeast Atlantic coast 14 km resolution satellite only SST (deg C) analysis.

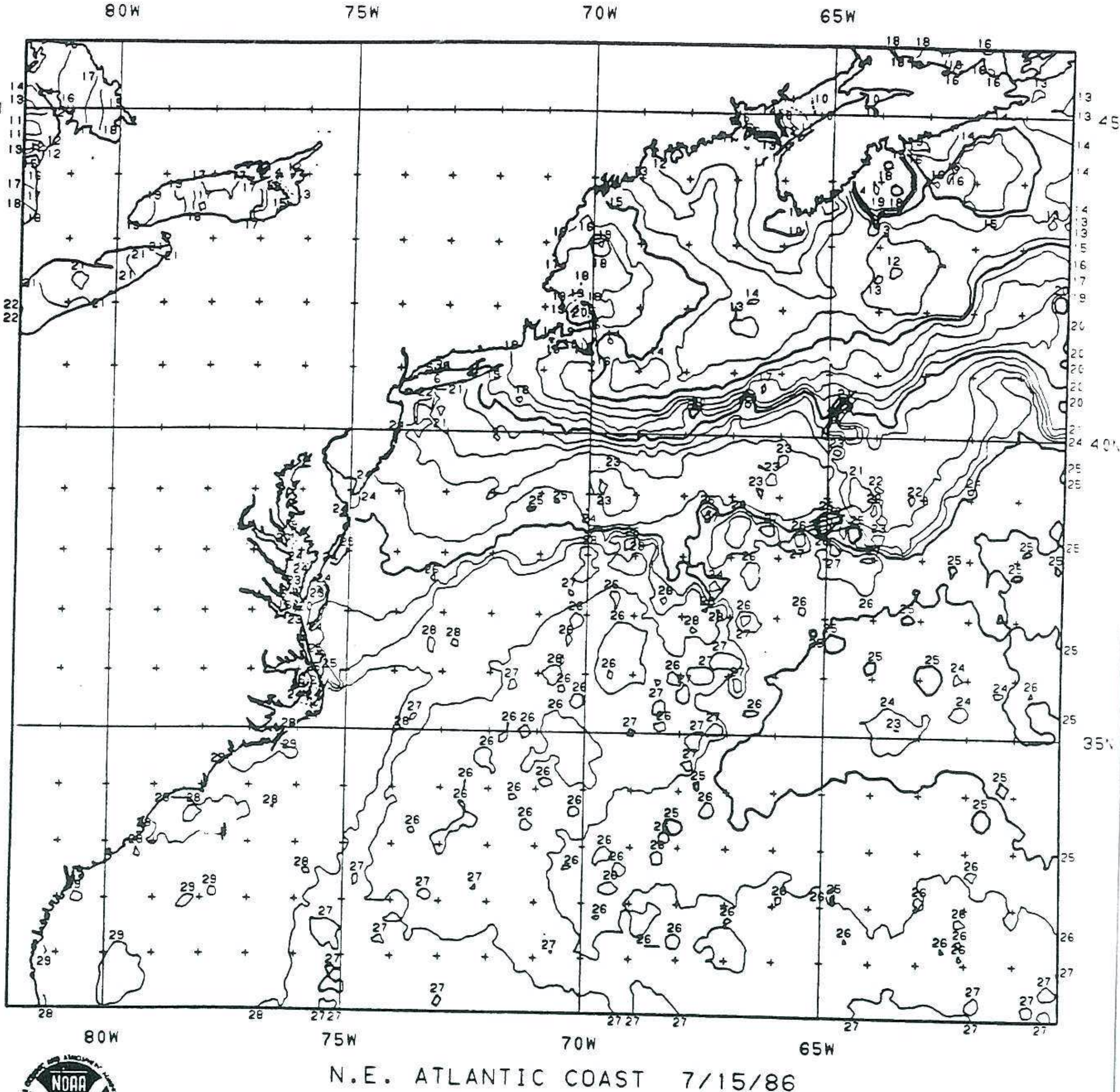
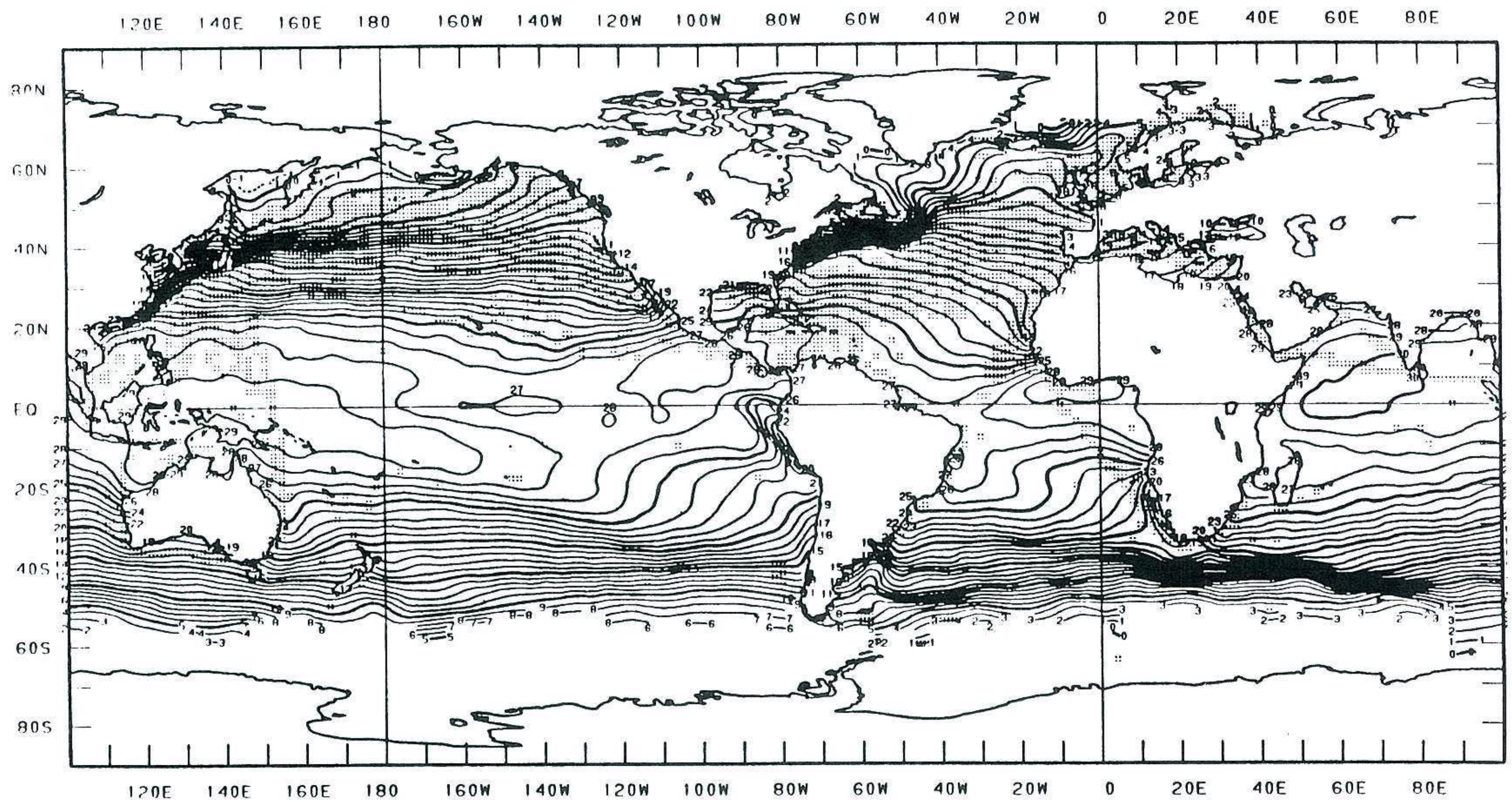
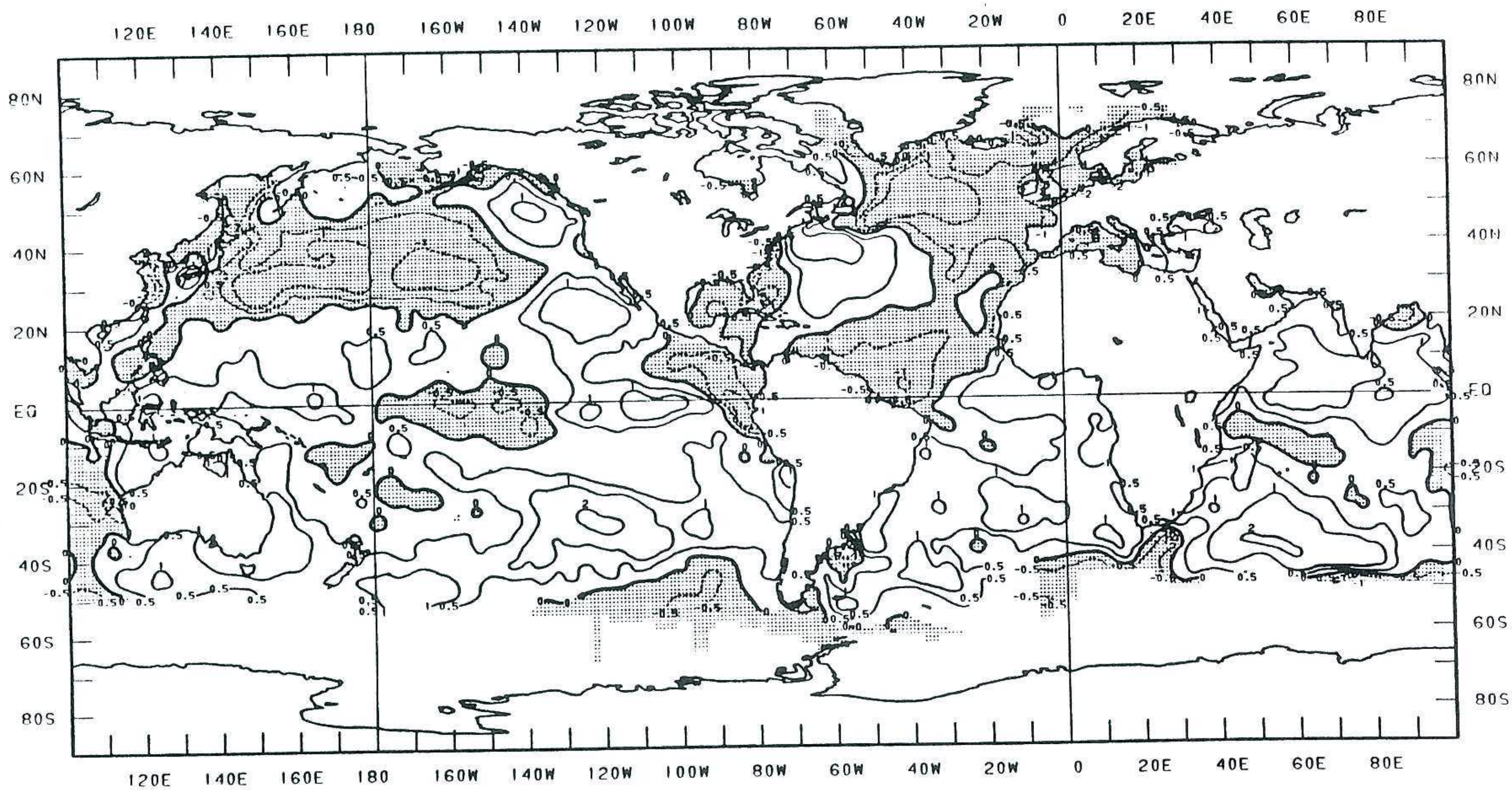


Figure 31. Northeast Atlantic Coast 14 km resolution satellite only SST (deg C) analysis.



BLEND SST FIELD (5/10) OPS 0Z APR 12, 1986 TO 0Z APR 27, 1986

Figure 32. Global satellite, ships and buoy blended SST (deg C) analysis. This product is based on a 15 day running mean with 2 degree resolution.



BLEND SST ANOMALY (5/10) OPS   0Z APR 12, 1986 TO 0Z APR 27, 1986

Figure 33. Global satellite, ships and buoy blended anomaly (deg C). This product is based on a 15 day running mean with 2 degree resolution.

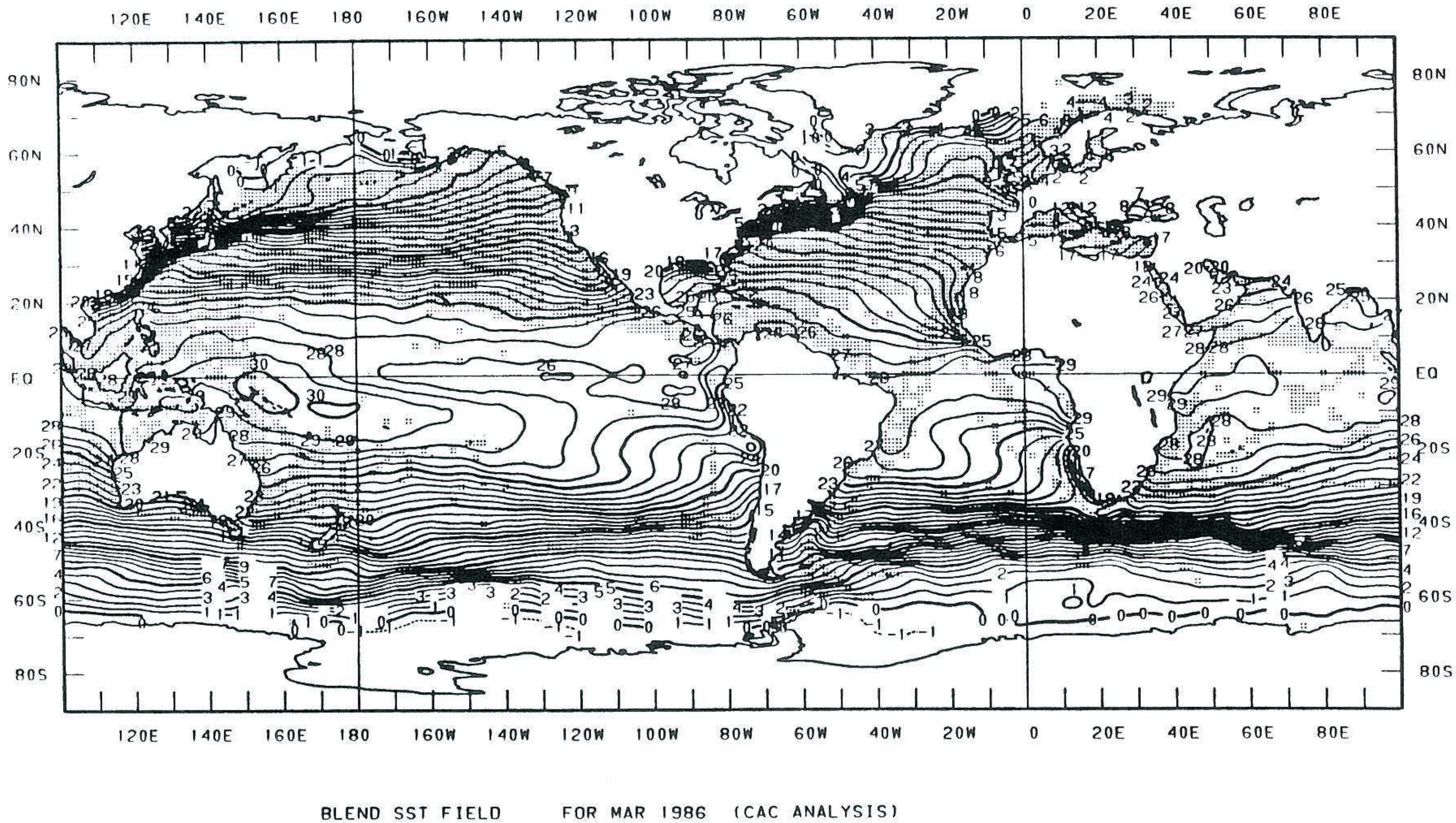
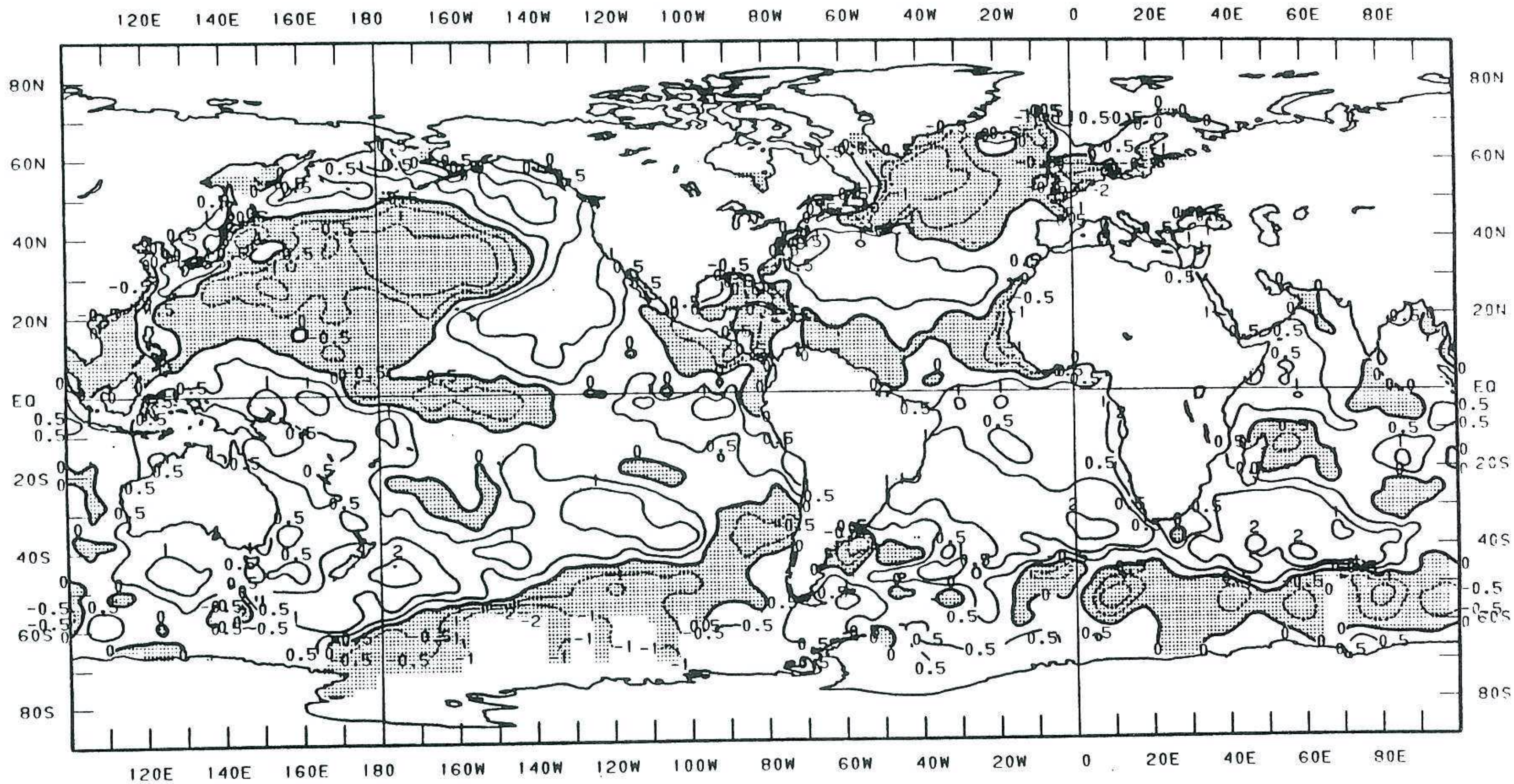


Figure 34. TOGA global satellite ship and buoy blended SST (deg C) analysis. This product is based on a 30 day mean with 2 degree resolution.



BLEND SST ANOMALIES FOR MAR 1986 (CAC ANALYSIS AND CLIMATOLOGY)

Figure 35. TOGA global satellite, ship and buoy blended SST (deg C) anomaly. This product is based on a 30 day mean with 2 degree resolution.

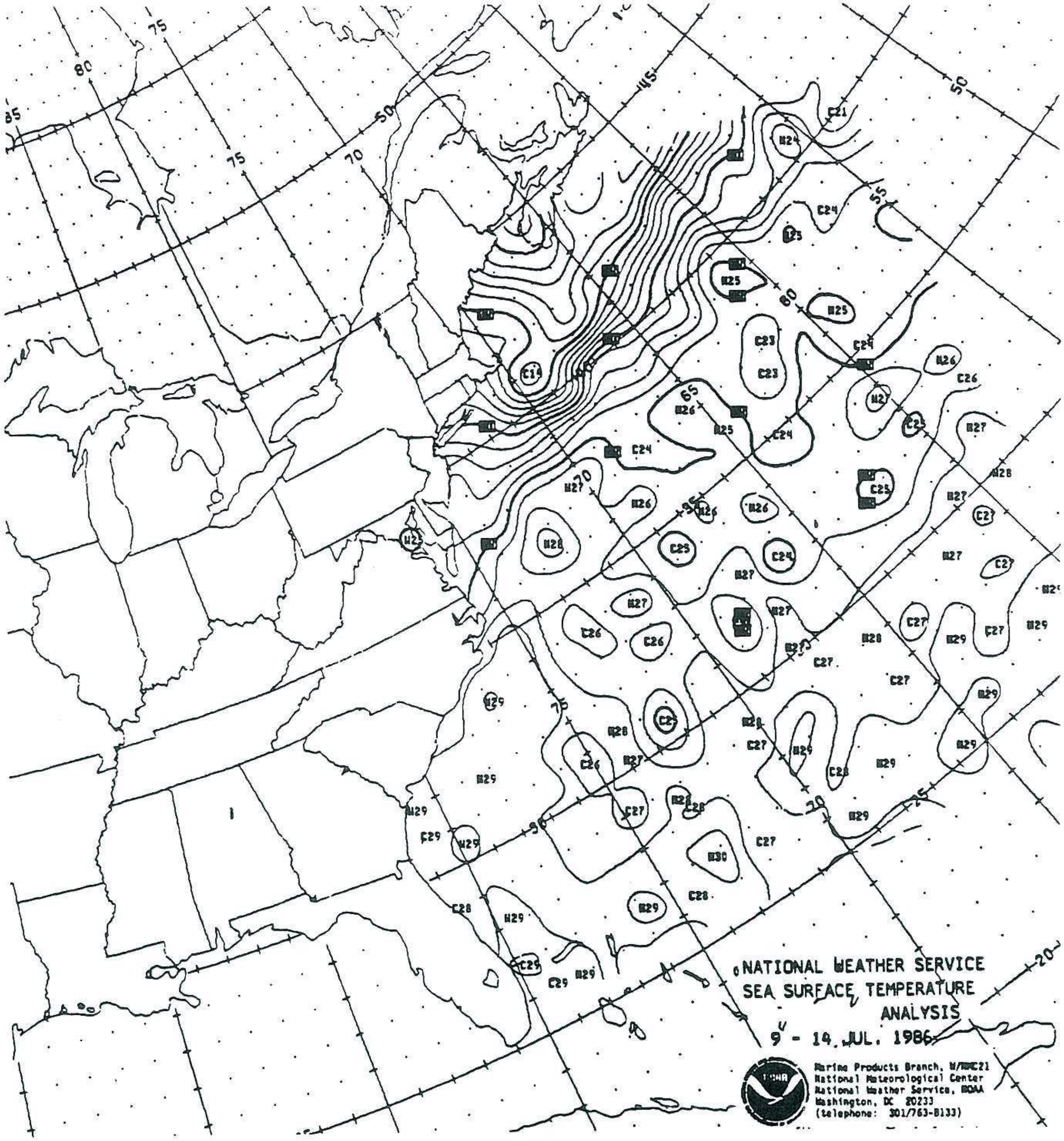


Figure 36. Northwest Atlantic satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

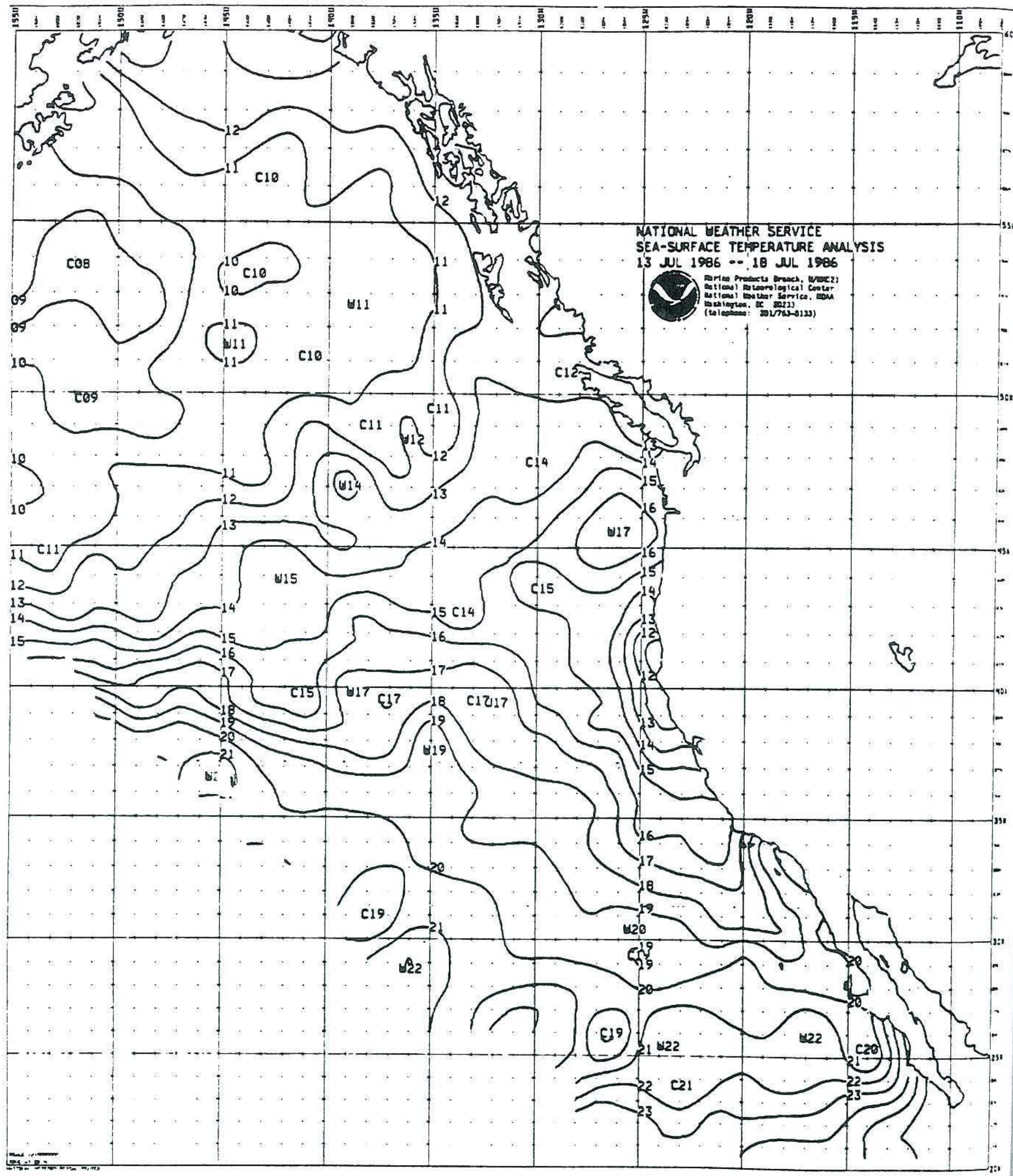


Figure 37. East Pacific satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

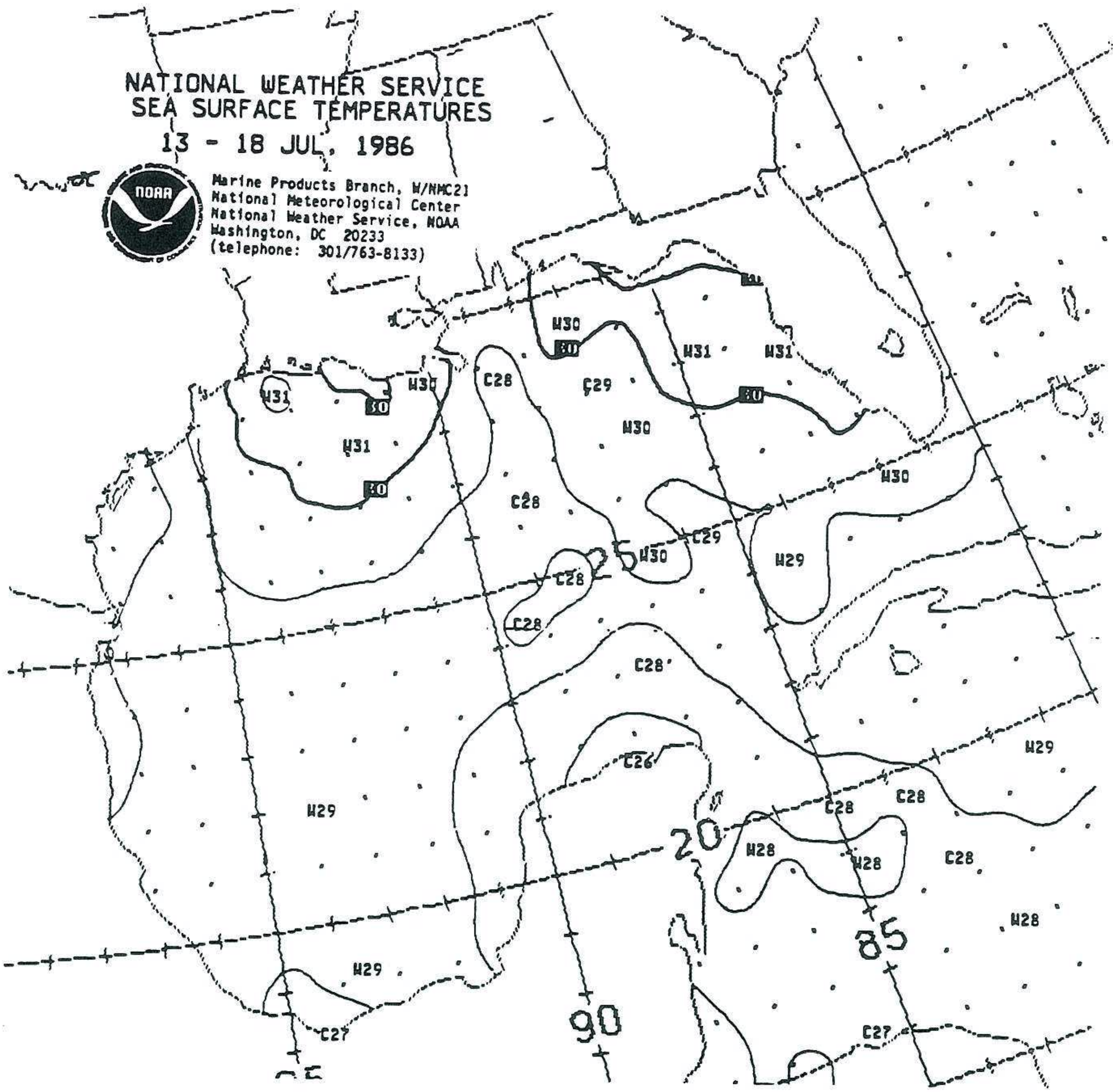


Figure 38. Gulf of Mexico satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

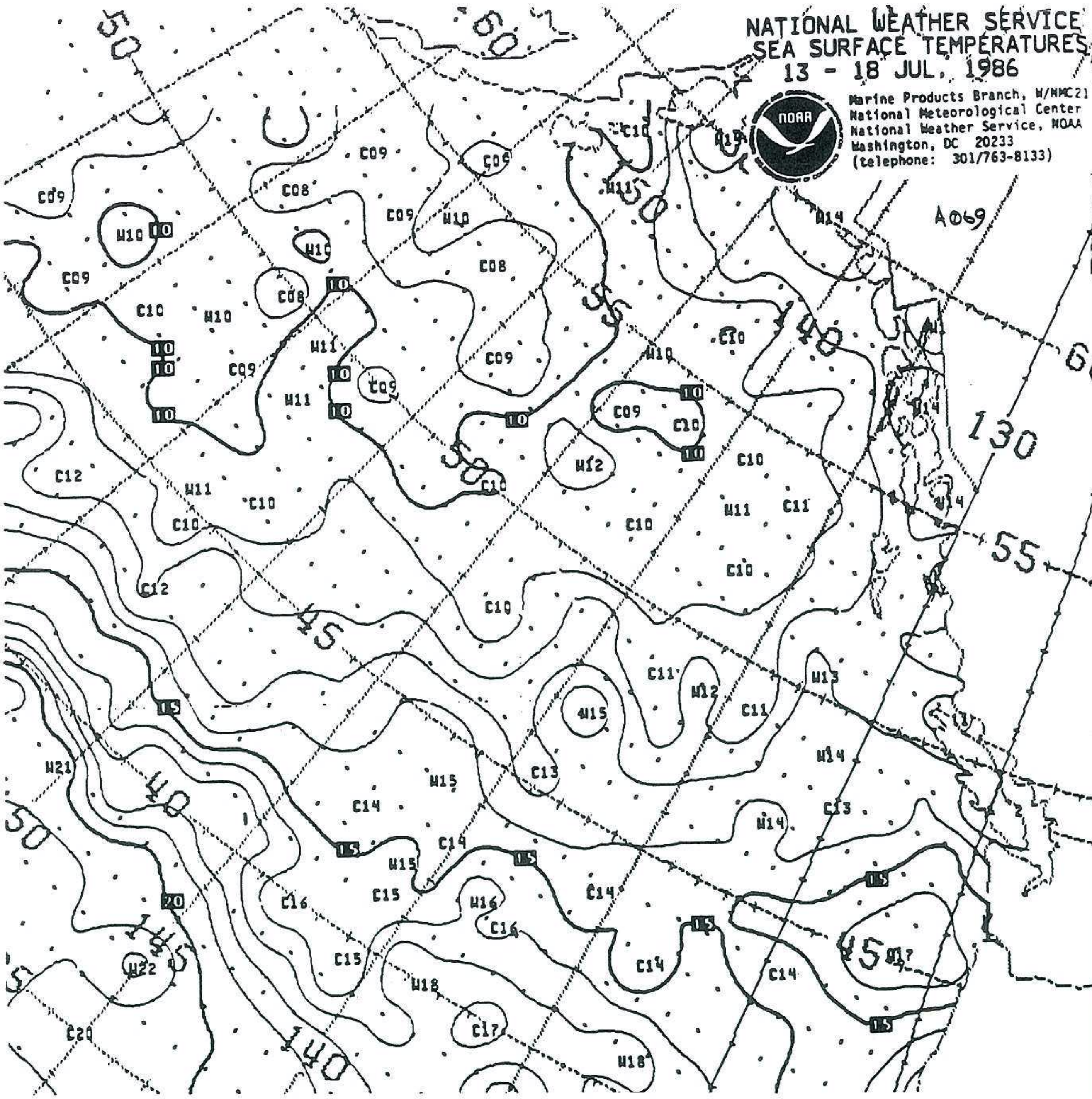


Figure 39. Gulf of Alaska satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

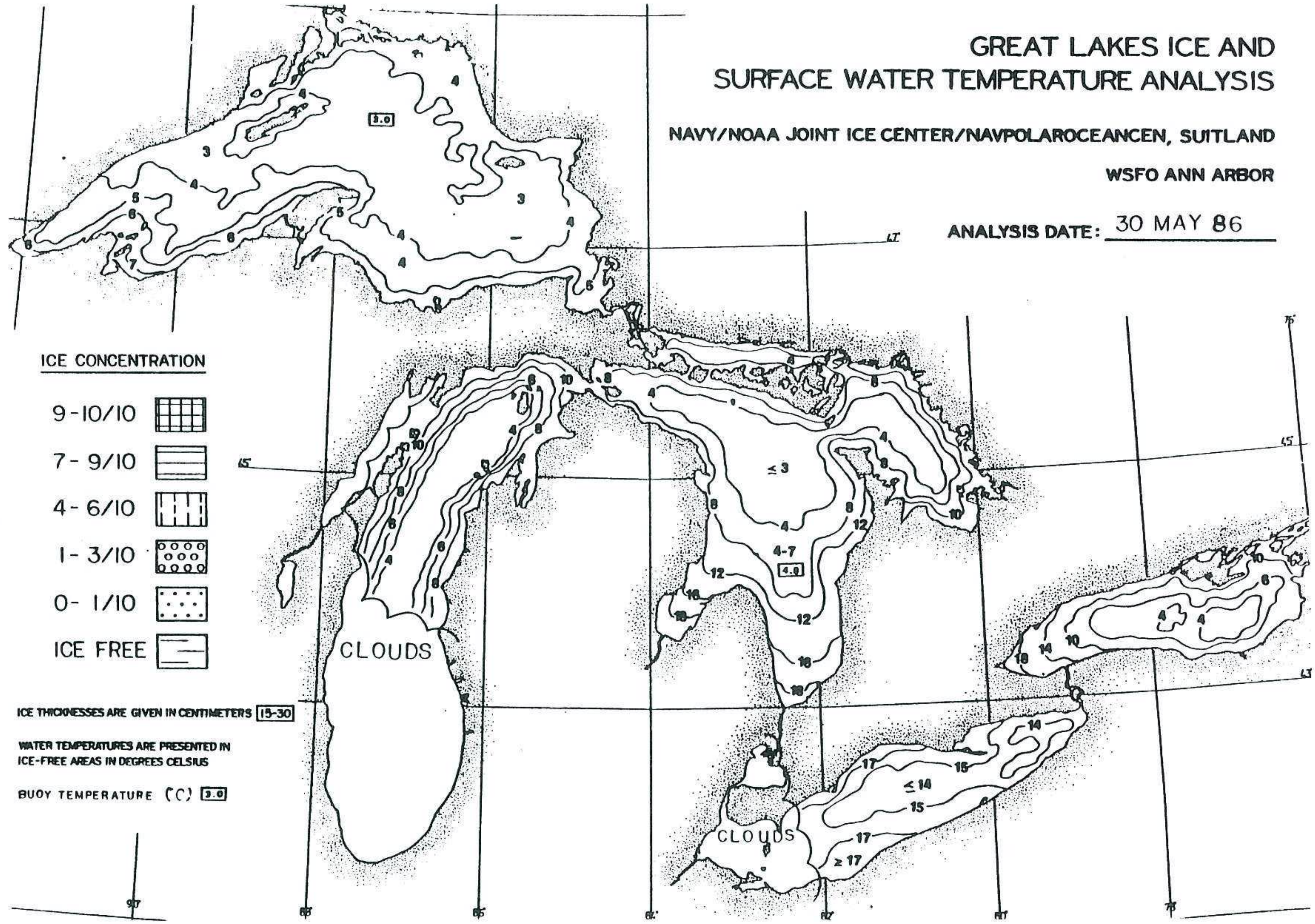


Figure 40. Great Lakes surface temperature (SST).

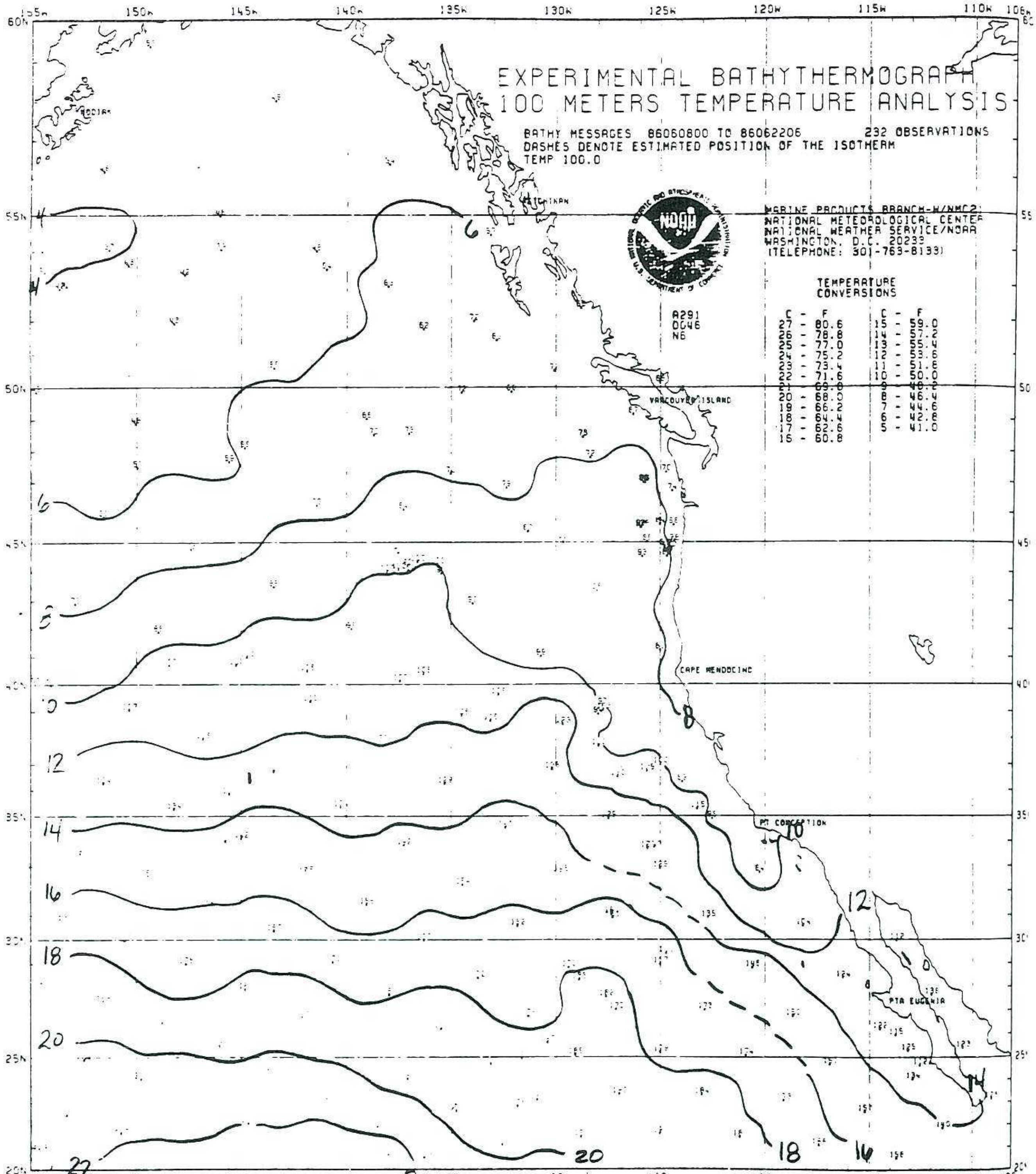


Figure 41. Northeast Pacific 100 meter subsurface temperature (deg C) analysis.

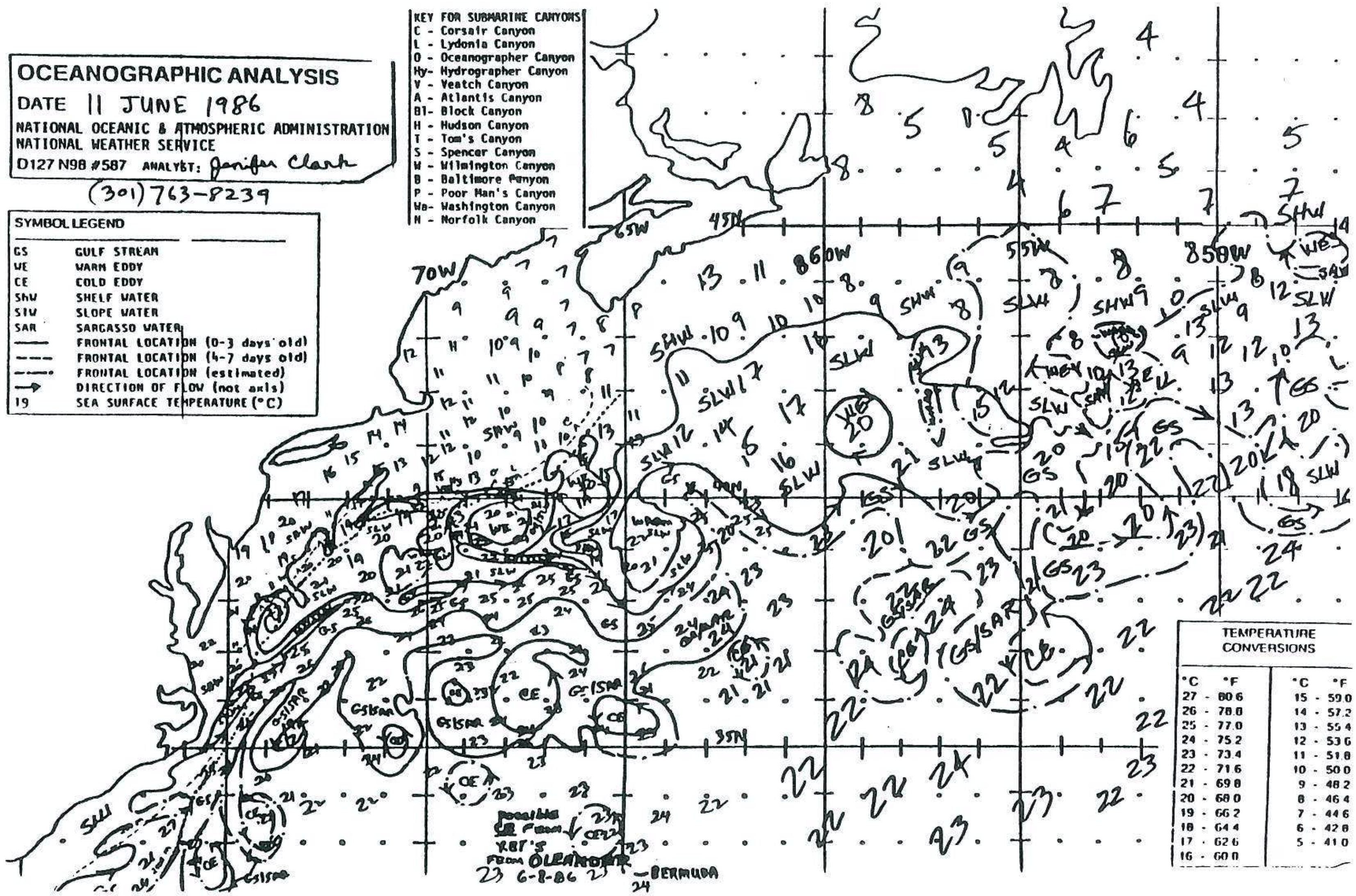


Figure 42. Northern panel of ocean feature analysis.

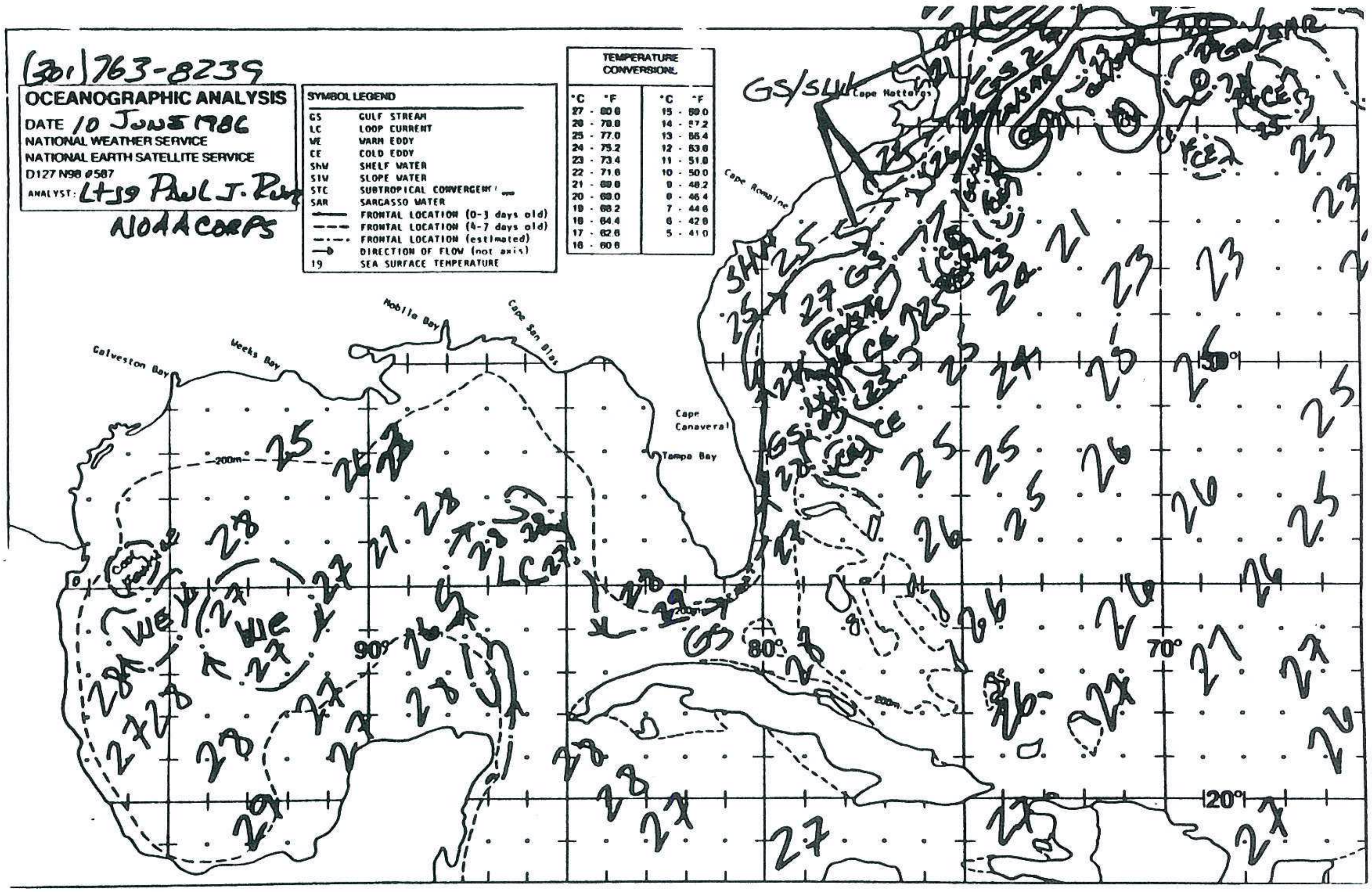


Figure 43. Southern panel of ocean feature analysis.

OCEANOGRAPHIC Monthly Summary

Volume VI Number 6 June 1986

Contents

U.S. DEPARTMENT OF COMMERCE • National Oceanic and Atmospheric Administration
National Weather Service
National Environmental Satellite, Data, and Information Service
National Ocean Service

Figure 44. Sample table of contents of Oceanographic Monthly Summary.

NOAA OCEAN PRODUCTS CENTER (301-763-8133)
OCEAN WIND FORECASTS (DDFF)
DD IN TENS OF DEGREES. FF IN KNOTS
HEMISPHERE WEST (-) EAST (+)
REGION:WEST PACIFIC / PART 1 OF 2
FORECAST TIME 86051500 / TAU = 24
FILE CREATION DATE - 86-516 2100Z

LONG LAT	160.0	162.5	165.0	167.5	170.0	172.5	175.0	177.5	180.0	-177.5	-175.0
65.0	9999	9999	9999	9999	9999	9999	9999	9999	9999	711	9999
62.5	9999	9999	9999	9999	9999	9999	9999	9999	9999	711	709
60.0	2912	9999	9999	9999	9999	3021	3117	3212	3407	303	804
57.5	9999	9999	2914	2915	2919	2923	2924	2922	2917	2811	2606
55.0	9999	9999	3011	9999	2915	2916	2918	2818	2719	2719	2618
52.5	1207	601	3106	3011	2912	9999	2815	9999	2617	2620	9999
50.0	1411	1505	2601	2906	2809	2711	2613	2613	2613	2715	2816
47.5	1511	1508	1703	2402	2614	2607	2608	2709	2809	2908	3009
45.0	1313	1211	1108	905	503	203	103	4	3506	3407	3408
42.5	1114	1014	913	712	612	510	609	609	509	310	110
40.0	1012	912	714	726	610	616	613	611	610	412	212
37.5	808	588	612	716	815	713	712	710	509	409	311
35.0	707	209	210	509	710	808	907	808	508	309	209
32.5	811	309	110	207	604	1106	1106	907	608	410	209
30.0	717	711	409	306	803	1107	1008	809	609	510	408
27.5	611	515	511	506	806	908	812	714	710	609	410
25.0	307	412	410	608	808	811	815	716	615	515	612
22.5	212	311	410	708	808	910	815	717	619	715	613
20.0	415	415	610	809	909	1010	717	620	715	614	410
17.5	519	519	714	711	811	811	616	518	713	510	511
15.0	620	621	520	712	617	509	509	510	611	611	612
	0			1		0			31546	86051500	

Figure 45. Global ocean surface wind forecast for the western pacific for the region bounded by 175W to 160E lon and 15 to 65N lat. Wind speed and direction are given in the body of the message as ddff (dd is direction in 10's of deg., ff is speed in knots, 9999 is land.)

FZOS43	CSTL	WND	FCSTS - CB		7/14/86	0000	GMT	
D/GMT	1406	1409	1412	1415	1418	1421	1500	1503
	1506	1509	1512	1515	1518	1521	1600	
APG	9999	9999	2892	2910	2811	2810	2406	9999
	9999	9999	3191	3595	3196	3997	3191	
67W	2303	2803	2907	2707	2807	2907	2806	2901
	1702	1801	3103	3103	0000	3204	3301	
65W	9999	2709	2609	2611	2609	2508	2708	9999
	9999	3405	3407	0307	1906	3305	0303	
66W	9999	9999	2804	3008	3306	3408	0000	0000
	9999	9999	3408	9999	9999	9999	9999	
NHK	2606	2708	2908	2908	2708	2708	2802	2602
	2903	3203	3104	3305	0103	0303	0701	
W06	9999	9999	3211	2811	2709	2711	9999	9999
	9999	9999	3109	3406	3106	2907	9999	
63W	3205	3202	0104	3506	3405	3505	0000	0000
	31010201		0000	0000	0306	0204	0302	
NGU	2511	2810	2808	2908	2807	2507	2104	2004
	2404	3003	3404	3503	0202	0703	0803	

Figure 46. Coastal wind forecasts for Chesapeake Bay. The first lines indicate the date/time. The wind forecast for each of the stations are given in the body of the message as ddff (dd is direction in 10's of deg., ff is speed in knots, 9999 is missing data).

```
FZUS45  KWBC  160000
FZUS45  SANTA  ANA  FCST  05/16/86  0000
SANTA  ANA  RGM  FCST
DTG  1600  1606  1612  1618  1700  1706  1712  1718  1800

     NONE  NONE  NONE  STNG  STNG  WEAK  WEAK  NONE  NONE
CSTL  WND  FCSTS-SC
DTG  1606  1609  1612  1615  1618  1621  1700  1703
     1706  1709  1712  1715  1718  1721  1800

NTD  2904  2903  0000  3302  0623  0107  3017  0000
     0601  0603  0604  0405  1710  2407  2604

NTK  1603  1504  1505  1502  0000  2501  2704  0505
     0000  0000  0000  0901  2308  2408  2506

AVC  9999  9999  9999  2006  9999  1906  0612  2106
     9999  9999  9999  1904  9999  0705  0605

NSI  9999  9999  9999  3208  3211  3311  3117  9999
     9999  9999  9999  3502  0000  3402  3202

NUC  2905  2602  2503  3002  2902  3208  3007  2501
     1900  0000  0000  0000  3402  2703  2802
```

Figure 47. Santa Ana wind forecast. The strength of the Santa Ana is indicated under the first date/time group (DTG). The direction and speed of the wind forecasts are given in the body of the bulletin as ddff (dd is direction in 10's of degrees, ff is speed in knots and 9999 indicates the forecast is not available).

DATE/TIME GROUP 86 7 17 12

GREAT LAKES WIND FORECAST

E ONTARIO	18	24	30	36	42	48
W ONTARIO	1909	2112	2612	2811	3110	310
E ERIE	2010	2213	2412	2512	2511	1510
W ERIE	2211	2213	2313	2413	2412	2011
S HURON	2112	2013	2213	2212	2212	1711
N HURON	2111	1912	1812	1911	1813	1511
S MICHIGAN	2013	2015	2116	2316	2213	2312
C MICHIGAN	1914	1915	2116	2215	2313	2312
N MICHIGAN	1912	1714	1814	2113	2213	2312
E SUPERIOR	1610	1313	1314	1613	1913	2812
C SUPERIOR	1312	1114	1314	1612	2813	3113
W SUPERIOR	814	914	813	2411	2412	2610

Figure 48. Great Lakes wind forecast. The first line indicates the forecast projection. The body of the forecast contains the wind direction in 10's of degrees and speed in knots (ddff).

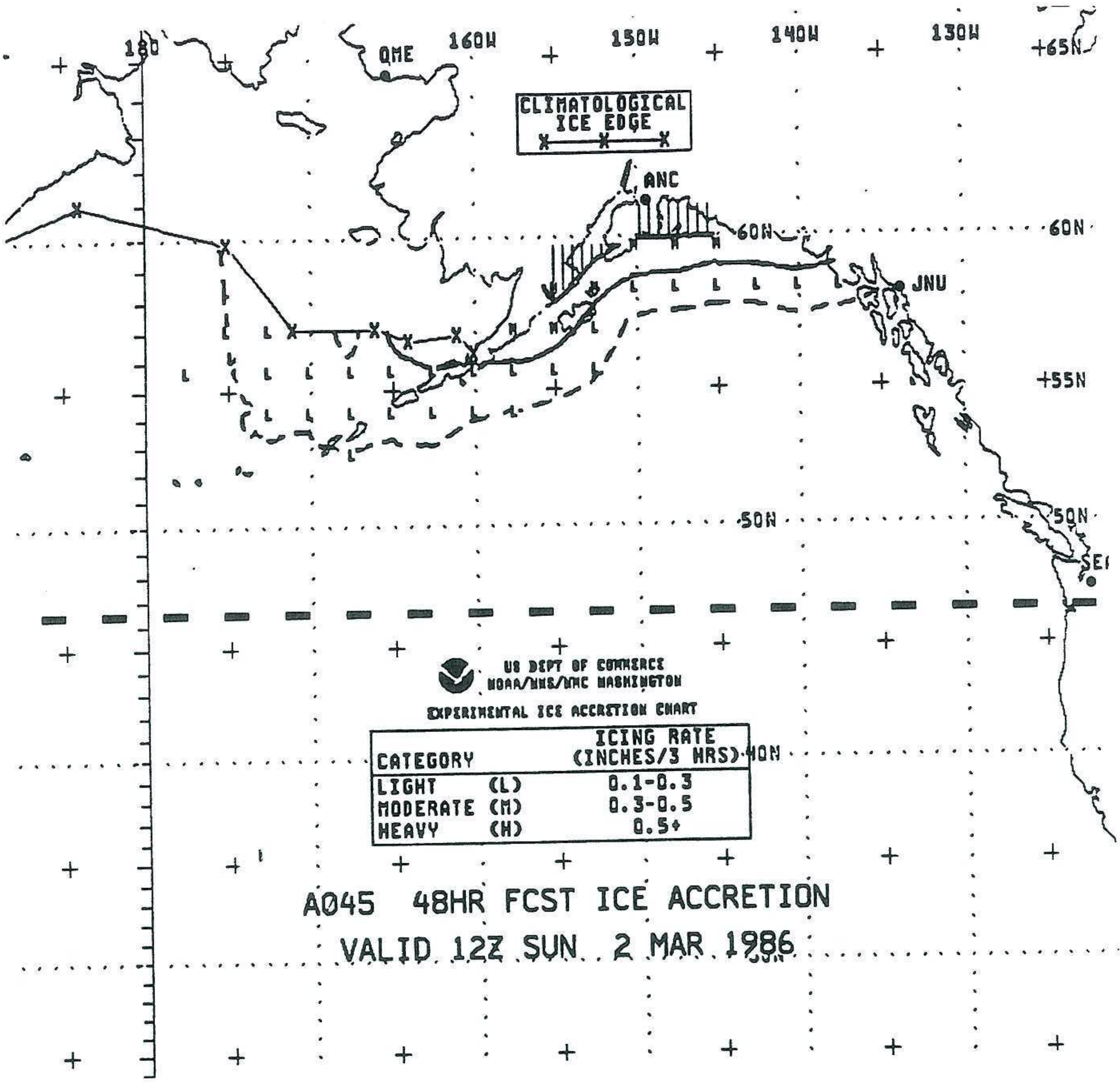


Figure 49. Superstructure ice accretion 48 hour forecast.

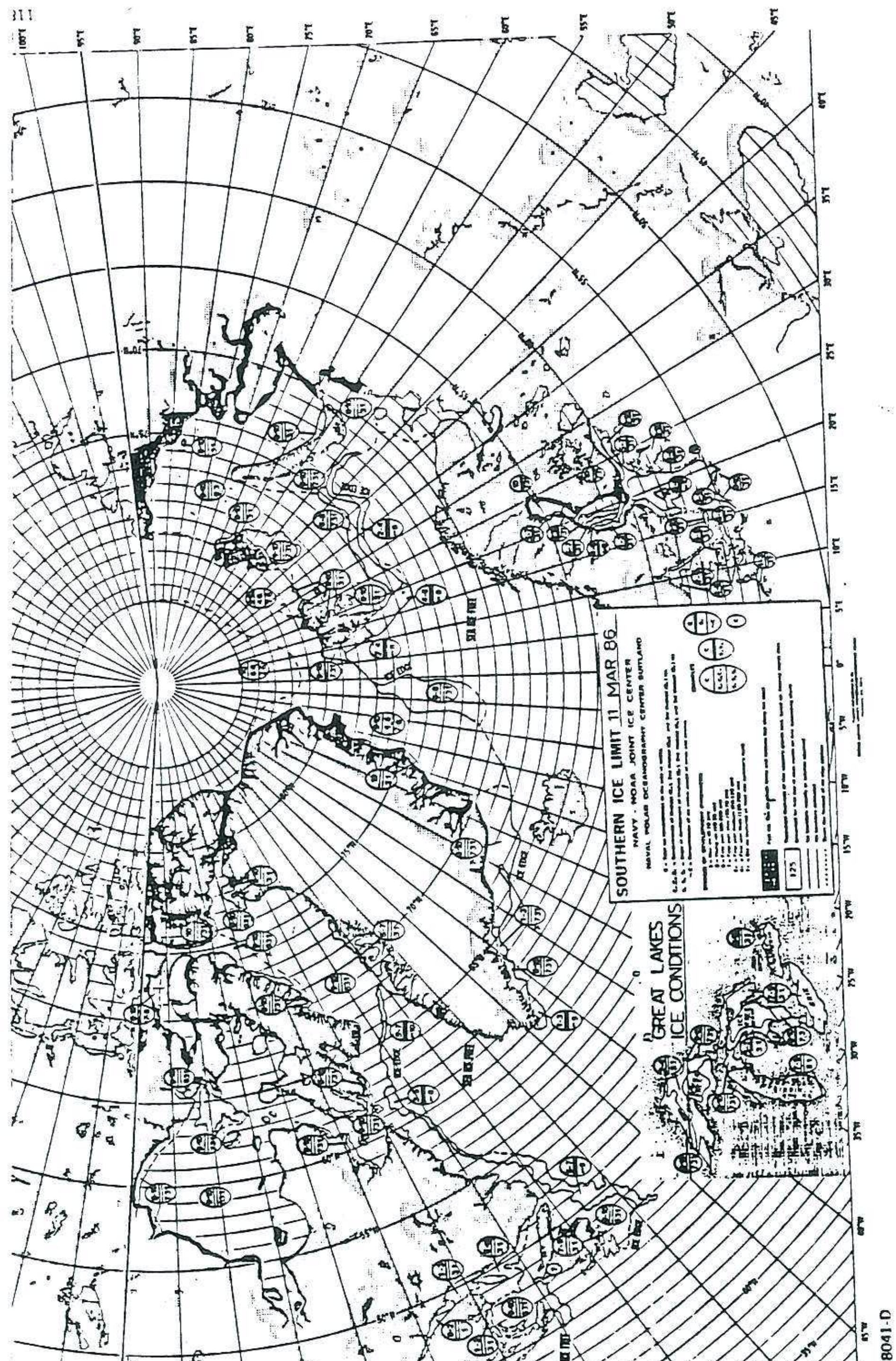


Figure 50. Eastern Arctic ice analysis.

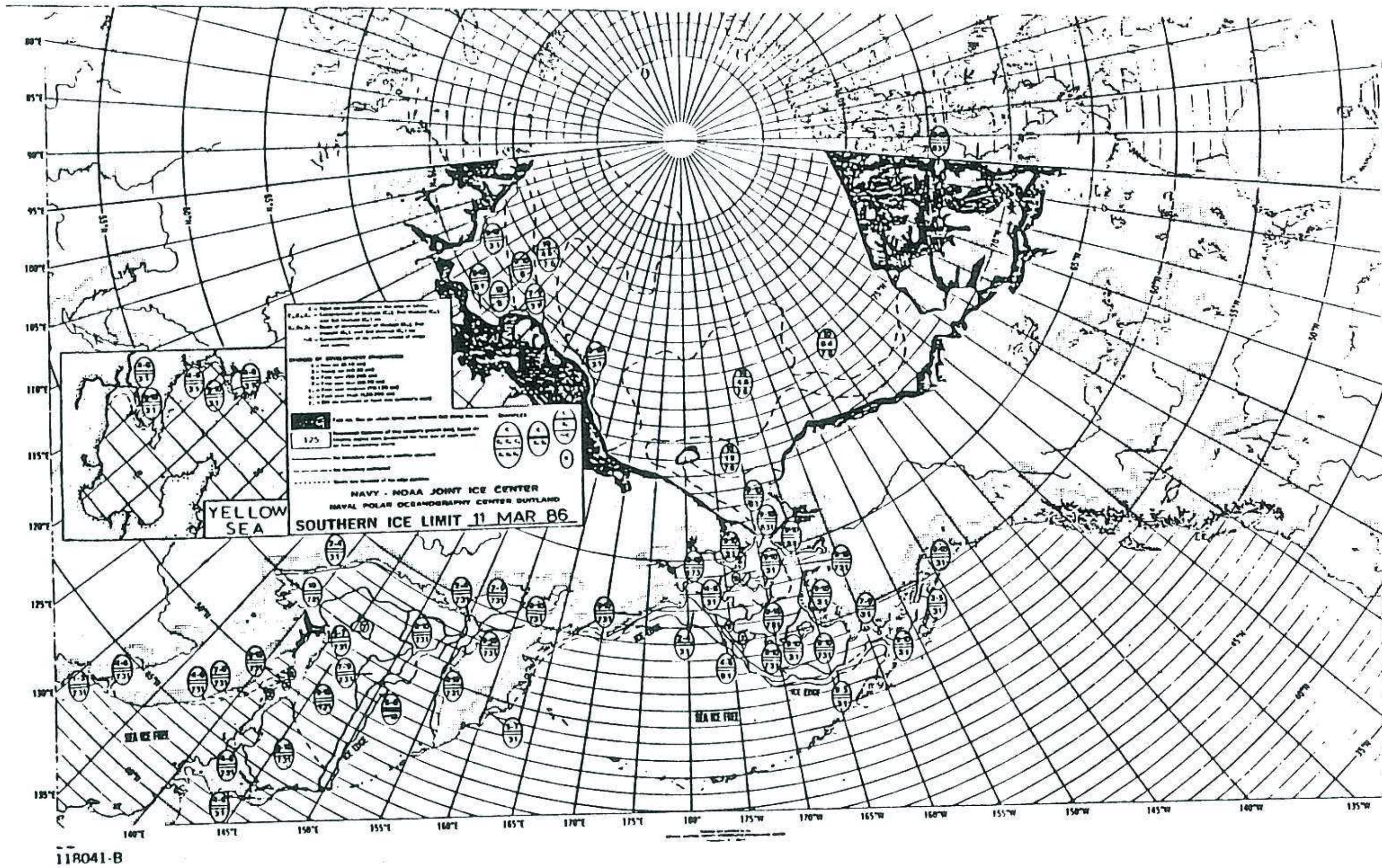
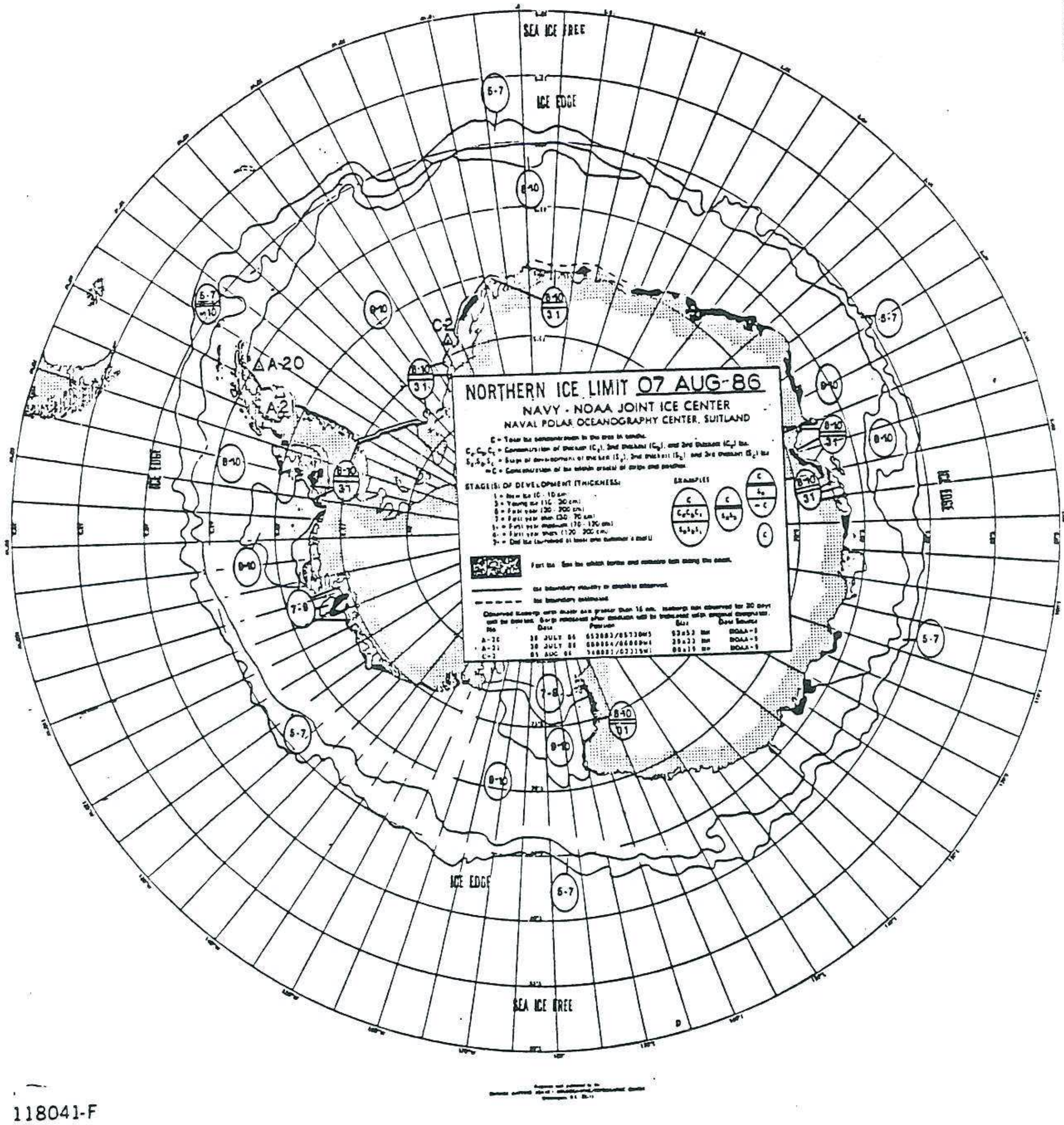


Figure 51. Western Arctic ice analysis.

118041-F



118041-F

Figure 52. Antarctic ice analysis.

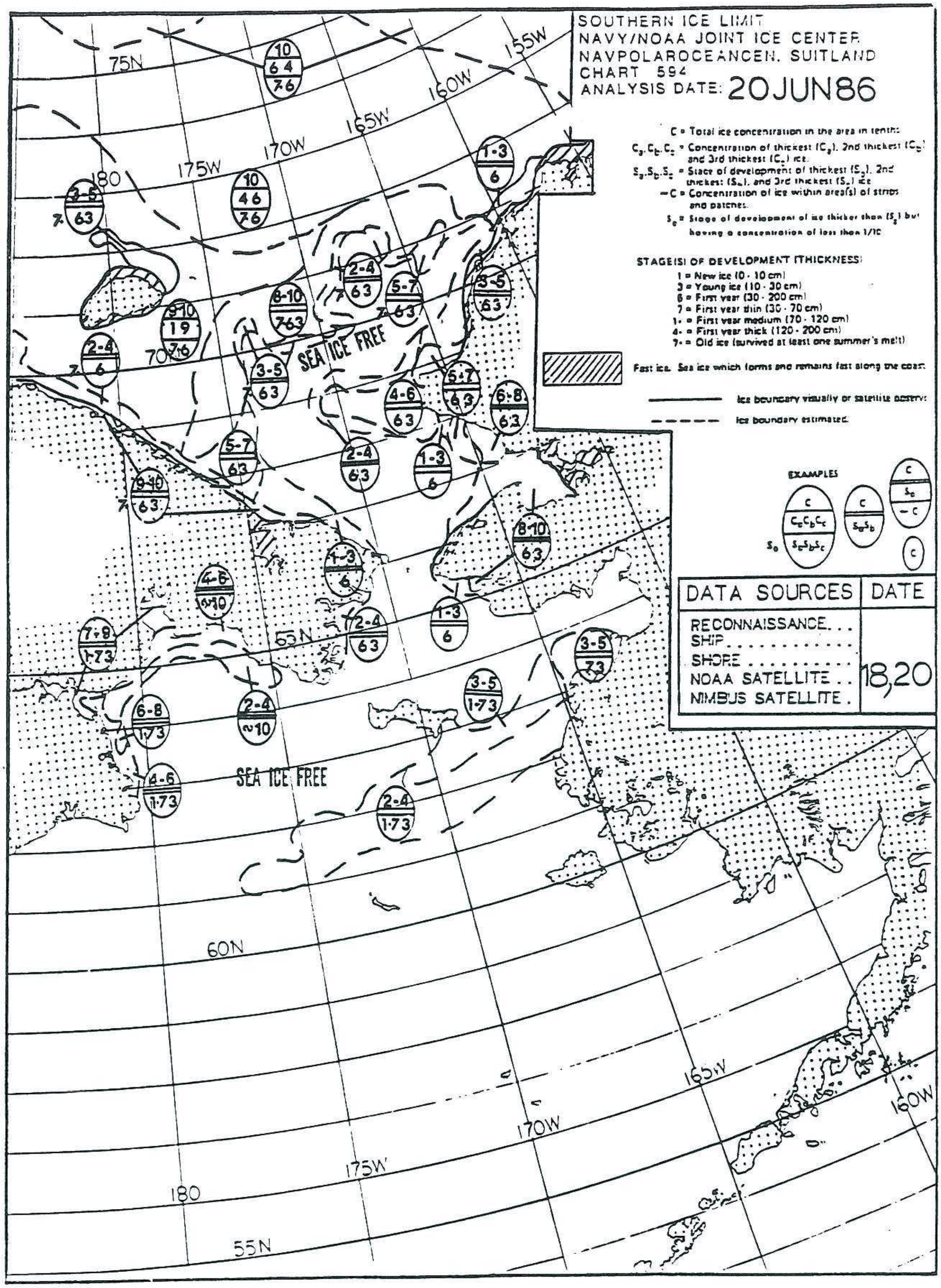


Figure 53. Bering/Chukchi seas ice analysis.

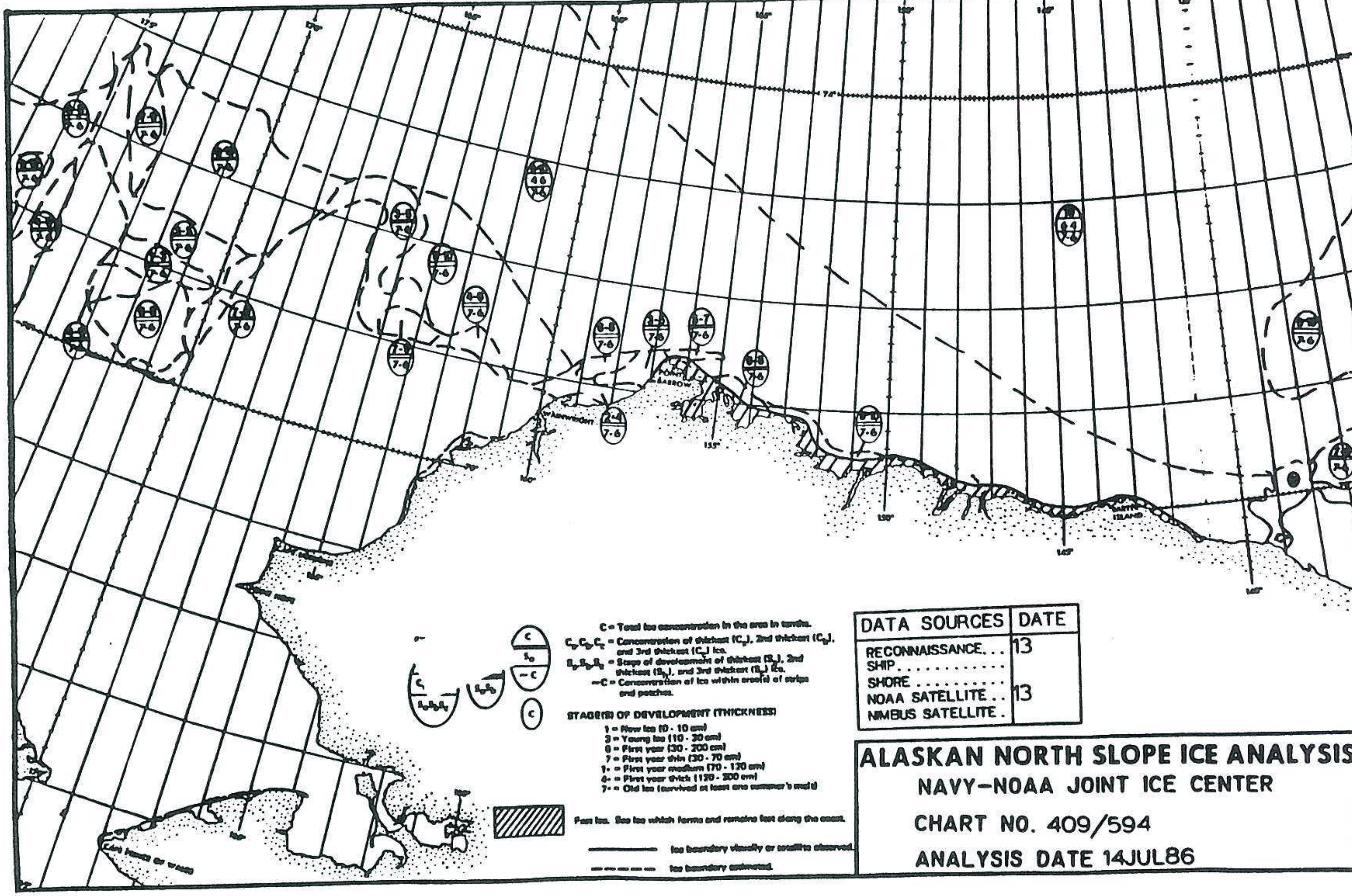


Figure 54. Alaskan North slope ice analysis.

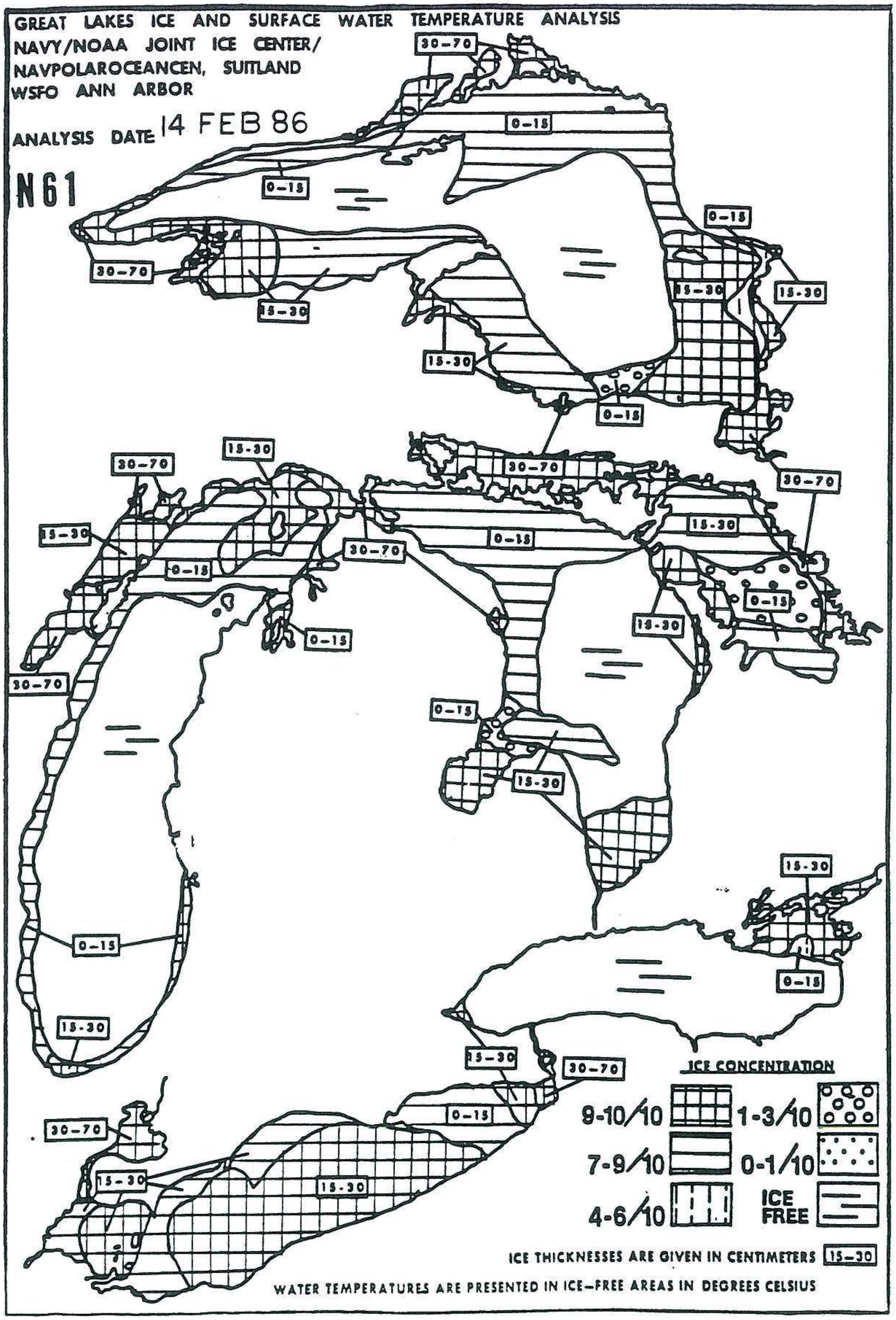


Figure 55. Great Lakes ice analysis.

P 1919132 MAY 86
FM NAVPOLAROCEANCEN SUITLAND MD
TO PALMER STATION ANTARCTICA
CINCFLEETWOC NORTHWOOD UK
USDAO SANTIAGO CI
INFO SERVITEL
BT
UNCLAS //N03140//
A. NAVPOLAROCEANCEN SUITLAND MD 081805Z MAY 86
SUBJ: SEA ICE CONDITIONS 90W - 20E
1. ICE EDGE FROM 6750S8/09000W2 TO 6740S7/08620W6 6825S1/08300W1
 6900S5/08110W0 6840S8/07640W7 6800S4/07250W4 6815S0/07035W5 TO
COAST VICINITY 6740S7/06900W5 RESUMING ESTIMATED FROM COAST VICINITY
6645S1/06730W6 TO 6515S7/06600W2 6400S0/06325W6 6340S3/06215W4
BECOMING ANALYZED TO 6100S7/05910W5 6025S3/05740W6 6030S9/05635W9
6120S9/05400W9 6130S0/05200W7 6100S7/05030W8 6130S0/04800W2
6130S0/04625W7 6425S7/03910W3 6430S3/03045W2 6430S3/02340W9
6530S4/01400W5 6545S0/00935W7 6600S2/00620W8 6635S0/00030W3
6610S3/00300E3 6610S3/00525E2 6640S6/00630E9 6600S2/00740E1
6630S5/00850E3 6600S2/00940E3 6530S4/01400E5 6620S4/01435E3
6645S1/01725E5 TO 6730S6/02000E7 . 04-06 TENTHS NORTH OF A LINE FROM
7000S7/09000W9 TO 6940S9/08800W6 6900S5/08600W4 7000S7/08300W1 TO
COAST VICINITY 7000S7/07545W1 RESUMING COAST EAST OF A LINE FROM
COAST VICINITY 6900S5/07010W8 TO ICE EDGE6815S0/07030W0 . 07-09
TENTHS SOUTH OF AN ESTIMATED LINE FROM ICE EDGE 6335S7/06215W4 TO
COAST VICINITY 6320S1/05735W0 . 02-04 TENTHS NORTH OF A LINE FROM
ICE EDGE 6130S0/05200W7 TO 6200S8/05125W3 6200S8/04945W2
6300S9/04535W7 6410S1/04300W7 6525S8/04125W2 6515S7/03720W2
6540S5/03150W9 6525S8/02535W5 TO ICE EDGE 6430S3/02325W2 RESUMING
ICE EDGE 6545S0/00930W2 TO 6700S3/00600W6 6700S3/00710E8
6630S5/01220E5 6720S5/01600E7 TO 6815S0/02000E8 . 05-07 TENTHS NORTH
OF A LINE FROM ICE SHELF VICINITY 6735S1/06010W7 TO 6525S8/05535W8
6515S7/05400W9 6430S3/05240W1 6440S4/05200W7 6600S2/05330W1
6700S3/05215W3 6700S3/05000W5 6550S6/04950W9 6500S1/05100W6
6415S6/05015W1 6430S3/04815W8 6600S2/04800W2 6620S4/04650W5
6550S6/04630W3 6500S1/04715W7 6430S3/04620W2 6330S2/04635W8
6445S9/04330W0 6530S4/04500W9 6635S0/04300W7 6620S4/04020W6
6620S4/02900W1 6645S1/01900W0 6625S9/00930W2 6750S8/00600W6
6800S4/00145E0 6725S0/00430E7 6735S1/01315E0 TO 6910S6/02000E7 .
REMAINDER AREA WEST OF 06500W1 09-10 TENTHS. REMAINDER AREA EAST OF
06500W1 07-09 TENTHS. FAS ICE REMAINS VALID REF A.
2. 96 HOUR FORECAST: EXPECT 20-30 NAUTICAL MILE (NM) EXPANSION
FROM 09000W9 TO 07000W7, 10-20 NM EXPANSION FROM 07000W7 TO 06000W
40-60 NM EXPANSION FROM 06000W6 TO 01000W1, 20-30 NM EXPANSION
FROM 01000W1 TO 02000E2.
BT
#7758

Figure 56. Routine tailored ship support message. Decoding information is available upon request from the JIC.

EASTERN ARCTIC 7 DAY FORECAST

7 DAY FCST: BAFFIN BAY/DAVIS STRAIT: EXPECT 10-15 NM RECESSION THRUT, CONTINUED DRIFT ICE DECAY; HUDSON BAY AND STRAIT: EXPECT 15-20 NM RECESSION THRUT; EAST GREENLAND: EXPECT 5-10 NM RECESSION FM 05000W5 to 03500W8, 15-20 NM RECESSION FM 03500W8 TO 01000E1; BARENTS: EXPECT 5-10 NM RECESSION FM 01500E6 TO 04000E4, 15-20 NM RECESSION FM 04000E4 TO 05000E5, 10-15 NM RECESSION FM 05000E5 TO 057002 SOUTH OF 8000N8.

Figure 57. Eastern Arctic 7 day forecast. Decoding information is available from the JIC.

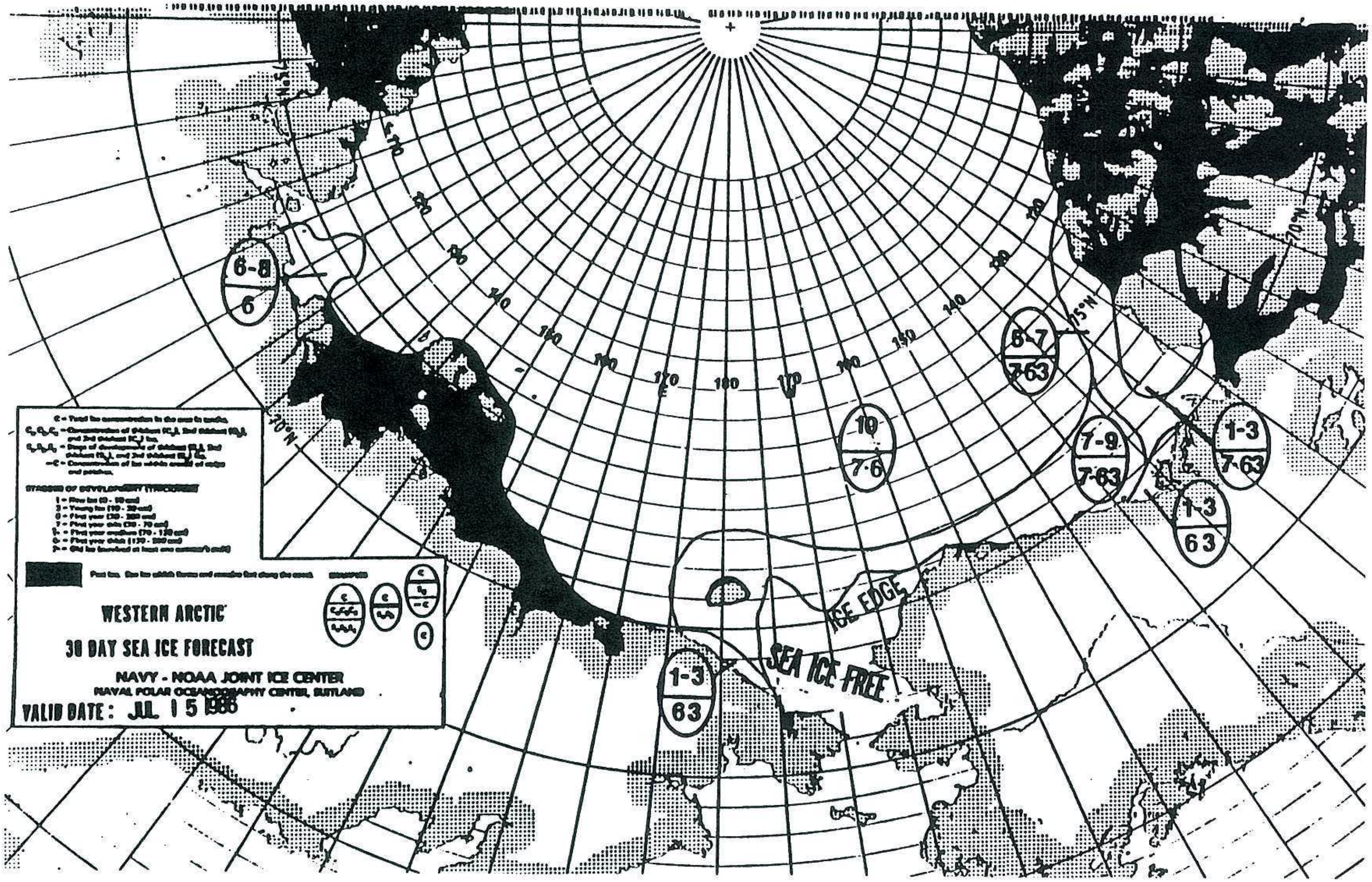


Figure 58. Western Arctic 30 day forecast.

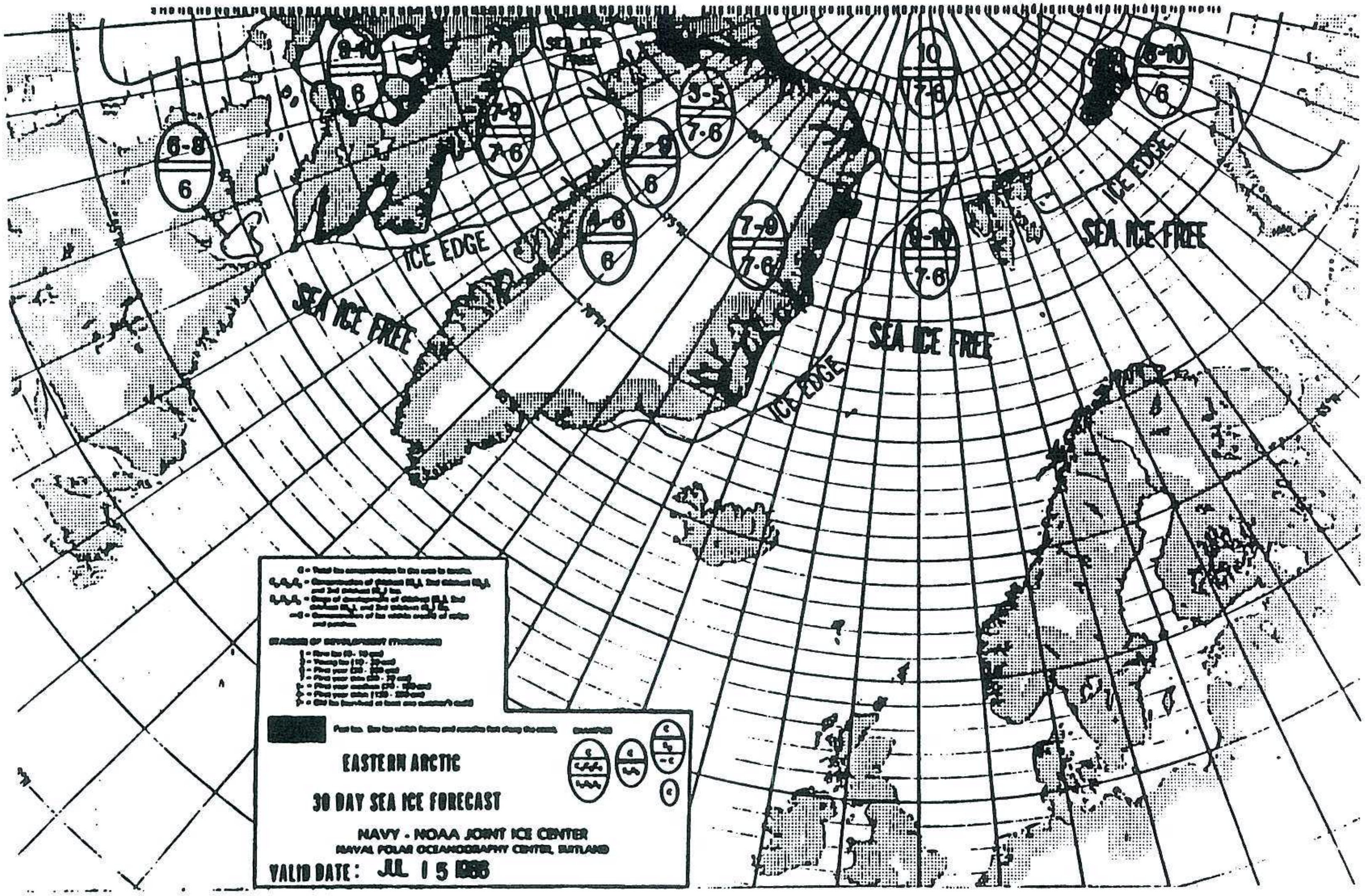


Figure 59. Eastern Arctic 30 day forecast.

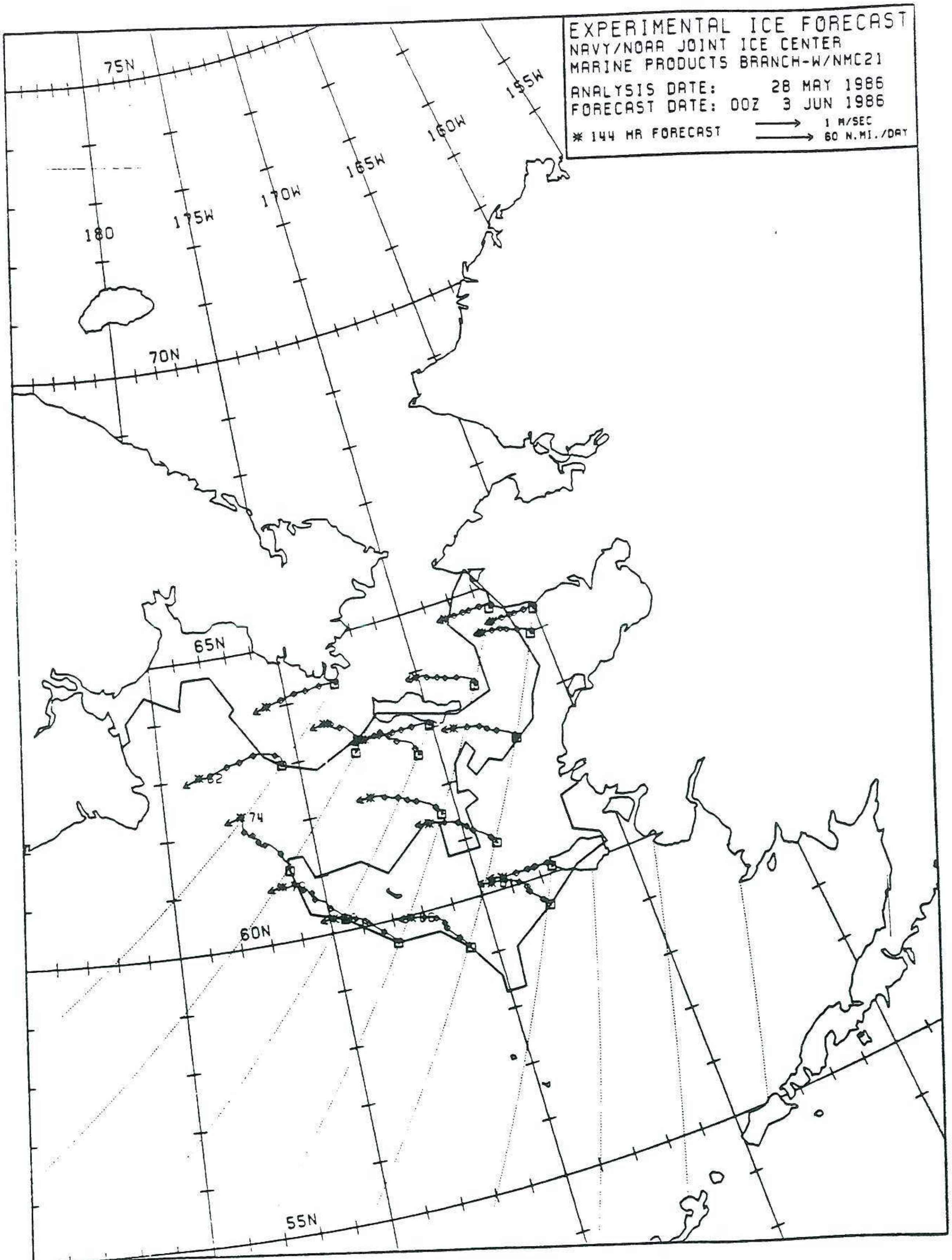


Figure 60. Bering Sea ice edge forecast.

NOAA OCEAN PRODUCTS CENTER (301-763-8133)
SIGNIFICANT OCEAN WAVE HEIGHT FORECAST (METERS)
REGION:E PACIFIC / PART 1 OF 2
FORECAST TIME 0 / TAU = 24

LONG / LAT	-150.0	-147.5	-145.0	-142.5	-140.0	-137.5	-135.0	-132.5	-130.0	-127.5	-125.0
65.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0	0.0	0.0	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57.5	0.4	0.4	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0
55.0	0.6	0.7	0.8	0.8	0.6	0.0	0.7	0.0	0.0	0.0	0.0
52.5	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.7	0.0
50.0	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.6	0.0
47.5	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.5	0.4	0.5
45.0	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.4	0.3	0.5
42.5	0.5	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.4	0.4	0.5
40.0	0.8	0.8	0.8	0.8	0.8	0.7	0.2	0.4	0.4	0.2	0.5
37.5	0.9	0.8	0.8	0.7	0.4	0.2	0.3	0.4	0.6	0.4	0.5
35.0	0.8	0.7	0.3	0.5	0.4	0.5	0.4	0.4	0.4	0.5	0.4
32.5	0.6	0.4	0.3	0.4	0.4	0.3	0.2	0.2	0.3	0.2	0.4
30.0	0.3	0.5	0.3	0.4	0.5	0.6	0.5	0.1	0.4	0.4	0.4
27.5	0.6	0.7	0.6	0.5	0.5	0.3	0.2	0.1	0.3	0.3	0.2
25.0	0.6	0.7	0.7	0.2	0.4	0.5	0.5	0.3	0.3	0.3	0.4
22.5	0.6	0.6	0.6	0.4	0.6	0.6	0.6	0.4	0.3	0.4	0.2
20.0	0.5	0.5	0.4	0.3	0.4	0.4	0.3	0.2	0.2	0.2	0.1
17.5	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.2	0.3	0.2	0.2
15.0	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.5

Figure 61. Global ocean combined wind wave/swell significant height (m) forecast. Eastern Pacific sector (125W to 150W lon., 15N to 65N lat.).

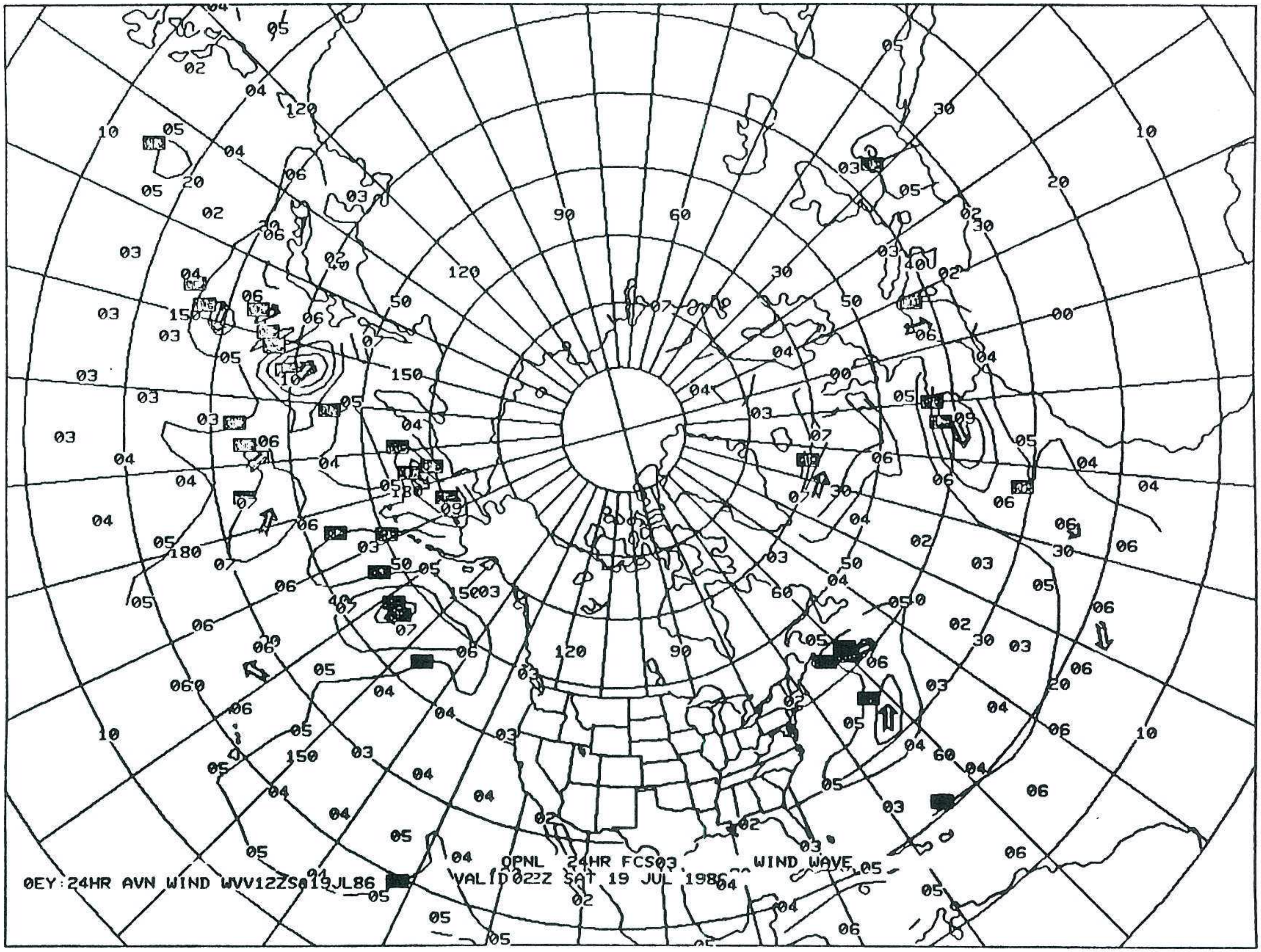


Figure 62. Northern hemisphere ocean wave forecasts (TDL). Wave heights are in

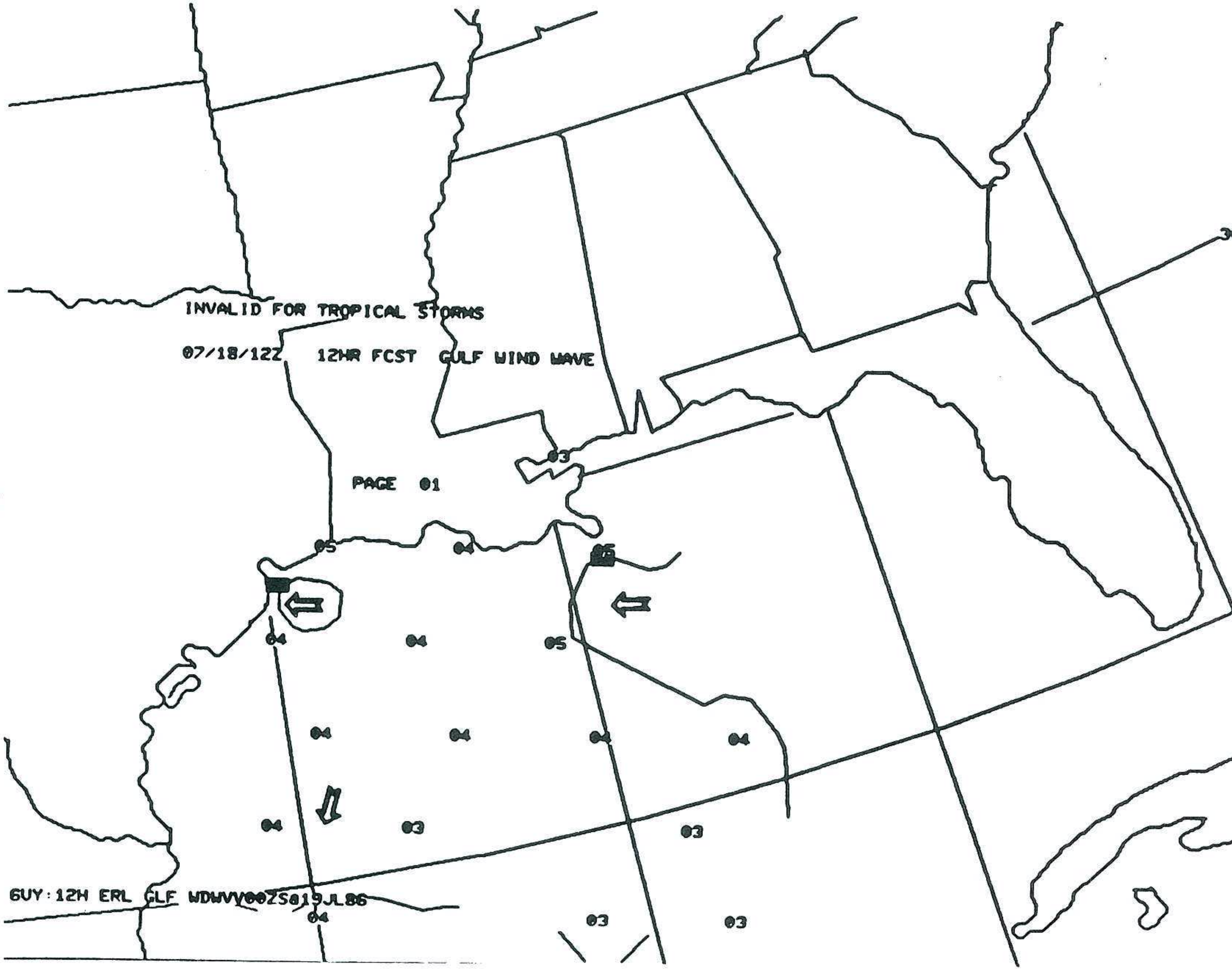


Figure 63. Gulf of Mexico regional ocean wave forecast. Wave heights are in feet.

DATE/TIME GROUP 86 7 17 12

GREAT LAKES WAVE FORECAST

0 HR																			
POINT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SUPERIOR	2	3	3	2	2	2	1	1	2	1	1								
MICHIGAN	2	2	1	2	3	3	2	3	3	1	3	3	2	2	2	2			
HURON	2	1	2	2	2	2	2	1	2	1									
ERIE	1	2	1	1	1	1	2	2	1	2	2	2	1	2	1	1	2	2	1
ONTARIO	1	1	1	1	1	1	1	1	1	1	2								

12 HR																			
POINT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SUPERIOR	2	4	3	2	2	2	2	2	2	1	2								
MICHIGAN	2	3	2	3	4	4	4	4	4	2	4	3	2	2	2	3			
HURON	2	1	3	2	2	2	2	2	2	1									
ERIE	1	2	1	1	1	1	2	2	1	2	2	2	2	2	2	2	2	2	2
ONTARIO	2	1	2	1	2	1	1	2	2	2									

24 H																			
POINT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SUPERIOR	1	1	1	1	3	2	1	1	3	1	2								
MICHIGAN	3	3	1	3	4	3	2	4	3	2	4	3	2	3	2	4			
HURON	2	1	3	2	3	2	2	1	2	1									
ERIE	1	2	2	1	1	2	2	2	2	3	3	3	3	3	3	3	2	2	2
ONTARIO	2	2	2	2	2	2	2	2	2	2									

24 HR																			
POINT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SUPERIOR	1	2	2	2	2	2	3	3	2	2	2								
MICHIGAN	3	3	2	2	3	3	1	3	3	1	3	3	2	2	2	2			
HURON	2	1	3	1	1	1	1	1	1	1									
ERIE	1	2	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1
ONTARIO	1	1	1	1	1	1	1	1	1	1									

Figure 64. Great Lakes wave forecast alphanumeric message.The message contains the location of predetermined point on each of the lakes. Wave heights are in feet.

CHESAPEAKE BAY FCST LFM WINDS WAVES IN FT

HR	N BWI	H	BWI-PAX		PAX-WMP		S WMP		PMAC	LK	PMAC	CB
0	2515	1	2616	2	2516	2	2517	2	2616	1	2616	1
6	2512	1	2512	1	2513	2	2514	1	2513	1	2612	1
12	2717	1	2717	2	2817	2	2717	2	2817	1	2817	1
16	2715	1	2714	1	2713	2	2712	1	2713	1	2713	1
24	2910	1	2710	1	2510	1	2412	2	2610	1	26 9	1
30	30 8	1	34 7	1	32 5	1	29 5	1	32 5	1	33 5	0
36	34 8	1	34 7	1	32 5	1	29 5	1	32 5	1	33 5	0
42	36 5	0	2 4	0	3 3	0	4 2	0	3 3	0	4 3	0
48	9 1	0	13 3	0	14 4	0	15 4	0	14 4	0	14 4	0

Figure 65. Chesapeake Bay wind and wave forecast winds are in 10's of degree wind speed in knots. Wave heights are in feet.

```
SXVX22 KWBC 171000##.
44008171022050408##.
5675210067201431350155515091235111OO=##.
440101710////0106##,
6435111013501280=##.
44005171024040306##,
180032101131131111817310337031B5=##.
44011171022060709##,
1370422076601651497110521732145237B1=##.
```

Figure 66. NDBC buoy wave spectra available on AFOS every 3 hours beginning at 0000 GMT. Decoding information is available upon request.

IV. Summary and future plans

A brief review of the methods involved in the generation of various OPC operational analyses and forecasts is presented. Availability, methods of dissemination and illustrations of each of the charts and messages is also presented. A more detailed description of the underlying physical and mathematical basis for the products may be found in the references.

The products presented in this publication are not expected to be static and unchanging; rather, they are expected to undergo periodic re-examination to determine their value to users and their validity in view of the latest technical advances. Plans for improving the existing material, developing new products, and methods of disseminating them are continually evolving and parallel the advances in the art of numerical weather and ocean prediction, improved analysis techniques and increased availability of data from future satellites.2

Highlights of plans for the near future in each of the product areas are given below. The working program of OPC, with respect to particular plan elements, will depend upon the available resources each fiscal year.

Ocean thermal structure-

Re-examination of the technique for blending *in situ* and satellite data for regional SST analysis.

Developing semi-automated techniques for analysis of Great Lakes surface temperature and ocean feature analyses.

Applying objective techniques to sub-surface thermal structure analyses.

Marine meteorology-

In addition to modifying the ice accretion forecasting scheme as noted in section II.B.2. future plans include:

development of a more comprehensive boundary layer diagnostic models which include the profiles of temperature and moisture variables in addition to momentum,

developing statistical forecast equations for marine fog,

examining the feasibility of using a numerical model to forecast fog at sea,

implementing a significant marine weather chart with delineation of regions of high winds and waves, ship icing, sea ice edge, marine fog, pressure system centers and their movement, ocean fronts, etc.

Polar seas and Great Lakes ice-

Validation of and improvements in the Bering Sea ice edge move ment forecasts.

Development of two dimensional forecast models of ice edge, ice concentration, thickness, etc.

Upgrading the computer facilities at the Joint Ice Center to include digital image processing to aid sea ice analysis and forecasting.

Developing plans for incorporating data from future satellites into ice analyses.

Waves-

Validation and further improvements in wave forecasts generated by the NOW model will be carried out on a continuing basis.

The imact of satellite date assimilation from satellite altimeters on wave forecasts will be examined.

Regional mesoscale ocean wave forecast models will be developed for the Gulf of Mexico and the Gulf of Alaska which take into account shallow water effects.

Models which forecast wave conditions over bars and at river entrances for critical shipping lanes of the U.S. coast will be developed.

Acknowledgements

The author wishes to acknowledge S. Auer, A. Bell, L. Burroughs, W.B. Campbell, H. Chin, J. Clark, D. Esteva, W. H. Gemmill, J. Kundrat, G. Rutledge, G. Wohl, and T.W. Yu for providing much of the basic information for this publication. Special thanks are extended to D. B. Rao for his suggestions and guidance. Thanks also go to W. Newell for assistance in locating the many illustrations necessary for this compendium, to D. Johnson for typing the manuscript and to the OPC staff whose efforts made this publication possible.

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