NOAA TECHNICAL MEMORANDUM NWS NMC 68

COMPENDIUM OF MARINE METEOROLOGICAL AND OCEANOGRAPHIC PRODUCTS OF THE OCEAN PRODUCTS CENTER (REVISION 1)

NATIONAL METEOROLOGICAL CENTER
WASHINGTON, D.C.
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U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

NOAA TECHNICAL MEMORANDUMS

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National Weather Service, National Meteorological Center Series

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NWS NMC 49 A Study of Non-Linear Computational Instability for a Two-Dimensional Model. Paul D. Polger, February 1971, 22 pp. (COM-71-00246)

NWS NMC 50 Recent Research in Numerical Methods at the National Meteorological Center. Ronald D. McPherson, April 1971, 35 pp. (COM-71-00595)

NWS NMC 51 Updating Asynoptic Data for Use in Objective Analysis. Armand J. Desmarais, December 1972, 19 pp. (COM-73-10078)

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NOAA Technical Memorandum NWS NMC 68

COMPENDIUM OF MARINE METEOROLOGICAL AND OCEANOGRAPHIC PRODUCTS OF THE OCEAN PRODUCTS CENTER (REVISION 1)*

David M. Feit

National Meteorological Center
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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
GEOS	Geostationary Operational Environmental Satellite
GOES	Geostationary Operational Environmental Satellite
GS	Gulf Stream
GSOWM	Global Spectral Ocean Wave Model
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
NCDC	National Climate Data Center
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
OMS	Oceanographic Monthly Summary
OLS	Optical Line Scanner
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
SSM/I	Special Sensor Microwave Imager
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
UTC	Universal Time Coordinates
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
(Revision 1)

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ABSTRACT

The Compendium is the first revision of NOAA Technical Memorandum NWS NMC 68. In this Technical Memorandum brief descriptions of the current operational and experimental marine meteorological and oceanographic products of the Ocean Products Center (OPC) are presented. Included is information on 1) marine meteorology, 2) ocean waves, 3) ocean thermal structure, 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 with 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.

This compendium was first published in 1986 (Feit,1986) to provide a comprehensive information source, for the marine community at large, on the many products distribtrib]uted under the aegis of the OPC. It contains technical background information, descriptions of the existing product portfolio, and information on the frequency and method of product dissemination. Since its original publication a sufficient number of new products have been introduced, existing products modified, and methods of product generation altered, to warrant an up to date version of the compendium at this time. In addition to these new and modified products, some validation statistics resulting from OPC's internal monitoring are also presented.

II. PRODUCT DESCRIPTIONS

A. Marine meteorology

The systems of global and regional numerical forecast models run at NMC are rather coarse in both horizontal and and vertical resolution and only provide large scale forecasts of atmospheric variables. As a consequence, the boundary layer structure of the atmosphere overlying the ocean is not directly available for use by marine forecasters. By applying additional physical and statistical relationships to the output of these numerical models it is possible to derive useful forecasts of variables important to marine interests.

1. Ocean surface winds

The wind is one of the most important variables at the sea surface. Until May 1988 the operational ocean surface (10 meter) wind forecast disseminated from the OPC was produced using the Cardone model (Cardone, 1969). Some time prior to this period the thickness of lowest level of the NMC global scale operational aviation model (AVN) was reduced to 10 mb resulting in winds being available at around 50 m above the ocean. This allowed the possibility of using a direct log profile to reduce the winds to 10 m above the ocean surface. These adjusted winds have been compared, using wind speed measurements from the U.S. fixed buoy network as surface truth, with winds derived from Cardone's two layer scheme as well as 1000 mb and lowest sigma layer winds taken directly from the AVN model. Figure 1 shows the results of this comparison in terms of RMS error for 24 hour forecasts. As can be seen, the 10 m winds obtained through the use of the log profile appear to provide the most accurate large-scale surface wind speeds and hence this procedure was implemented to produce ocean surface winds in May 1988. The wind forecasts are projected to 72 hours in 24 hour increments and are distributed on AFOS (Figs. 8a and b, section III), and on HFAX, and AKFAX (Figs. 15a and 15b, section III).

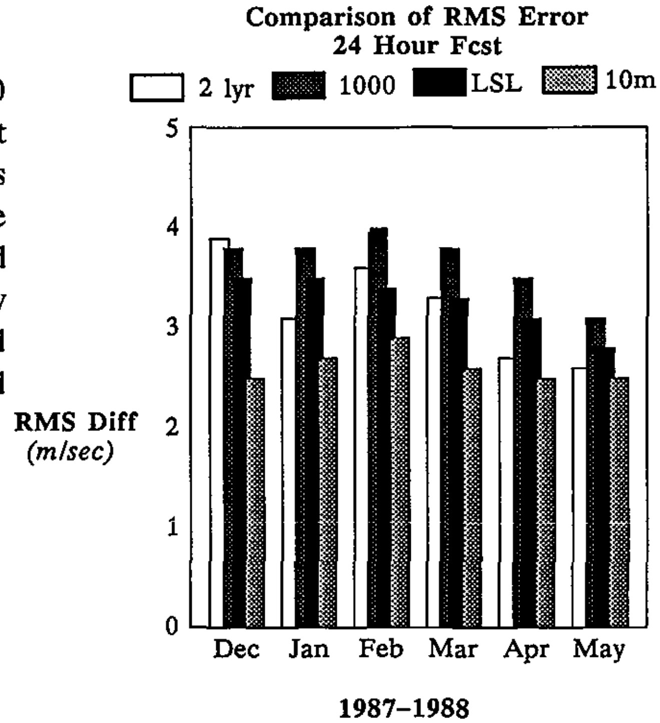


Figure 1. Ocean surface winds at 10 m by using a log reduction of the lowest sigma layer winds compared with winds computed from Cardone's 2–layer scheme (Cardone, 1969) and with 1000 mb and lowest sigma level winds taken directly from the AVN forecast model. Wind speed measurements from the U.S. fixed buoy network are used as a control.

2. 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 UTC), 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 2 and 3 show the locations of the stations and the Great Lakes sectors, respectively.

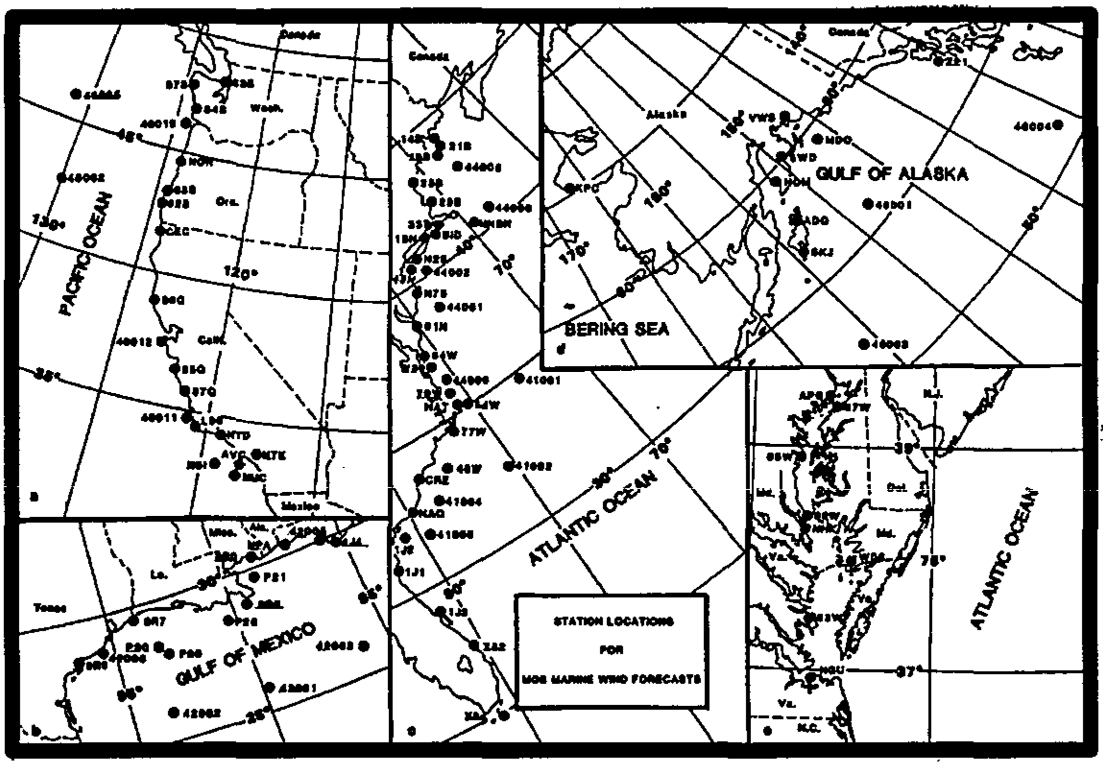


Figure 2. Coastal and offshore locations for MOS marine wind forecasts.

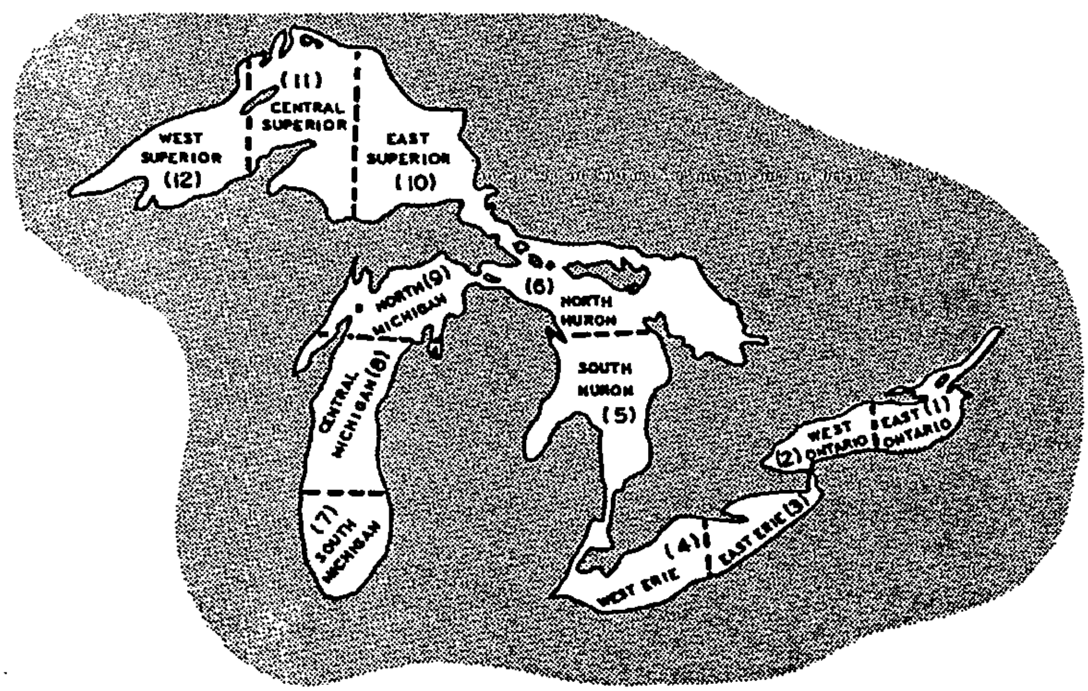


Figure 3. Location of the 12 sectors for Great Lakes wind forecasts.

The forecasts are disseminated twice daily over AFOS, FOS, and several teletype circuits. Figure 9 in section III shows a sample bulletin for the coastal winds along the Chesapeake Bay. 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 (see Fig. 10, section III) 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).

3. 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,1987). 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 grid point 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. See Figure 11 in section III.

4. Superstructure Icing

Among the hazards to ships operating at high latitude is the accumulation of ice formed on exposed structural components of ships. This phenomena, called superstructure icing, is created by the conditions of sub–freezing air temperatures combined with strong winds and sea temperature near freezing.

Over the years a number of efforts have been made to establish relationships between ice accretion on ships and meteorological and oceanographic parameters. Overland et al (1987) used a robust statistical procedure to develop an algorithm which relates wind speeds, air temperature, sea temperature, and salinity to icing rates. This model has been adapted at NMC in 1988 using the MRF model to supply the required fields of air temperatures and wind speeds (Feit, 1987). The sea surface temperature used is obtained from the NMC blended ship/satellite analysis.

Calculation of the fields of ice accretion have been extended to the entire Northern Hemisphere in the winter of 1988 and are displayed on the significant weather chart (see below), available on AFOS. Facsimile charts for the Alaskan waters continue to be produced as before but now uses the new algorithm mentioned above. It is distributed on AKFAX, see Figure 12 in section III.

5. Open Ocean Sea Fog

Another weather element that is a hazard at sea, but not a parameter of a numerical prediction model, is fog. It has been reported that 80 percent of accidents at sea occur with visibilities under one kilometer. WMO requirements specify that fog must be reported when visibility is less than 1 km. In view of this a new guidance product to aid in forecasting open ocean fog has been developed.

The so called "perfect prognosis" statistical technique was used to develop fog and visibility forecast equations, in the Northern Hemisphere, for the period April through October. Predictand data were obtained from ship observations and the predictor data were obtained from NMC's Global Data Assimilation System. Discriminant Analysis techniques were used to derive the prediction equations.

These forecasts apply only to the high seas and not to coastal or in-shore areas.A set of observations was taken from ship data for 1980–1984 at 12 hour intervals. Fog was designated when fog of any kind was observed or drizzle was observed and the past weather indicated fog and the visibility was reported to be less than 1 km. The visibility data were corrected to be consistent with observed weather and the WMO code and include poor visibility due to fog. Visibility is separated into 2 categories: less than or equal to 3 nm and greater than 3 nm. Fog and visibility forecasts are produced twice daily (0000 and 1200 UTC) out to 72 hours during April through October. The forecasts are incorporated on the Marine Significant Weather Chart (see below), and depicts areas of visibility to less than 3 miles and areas of fog.

6. Marine Significant Weather Chart

The Marine Significant Weather Chart (see Fig. 13, section III) is a new product, distributed via AFOS, which depicts areas of weather hazards at sea. The chart incorporates areas of high wind (greater than 25 knots), high seas (greater than 8 feet), ice accretion, fog and restricted visibility (less than 3 miles), and ice edge. This chart combines information from the appropriate OPC numerical forecast models and analyses, by a forecaster using a manual intervention device. At present this chart is produced once a daily at 0000 UTC with forecasts to 24, 48 and 72 hours.

B. Waves

For some time prior to the establishment of the OPC empirical methods based on the work by Munk and Sverdrup were used to generate global and regional wave forecasts. While effective for specifying significant wave heights, these techniques cannot provide information on the wave spectrum. In view of this, as well as to take advantage of the most recent advances in the state of wave forecasting, OPC has initiated a systematic effort to employ models based on spectral wave dynamics. Currently a deep water global spectral model and a shallow water spectral model for the Gulf of Mexico are operational. Both these models are second generation spectral models in which non-linear effects are treated in a parametarized form. TDL forecasts continue to be issued for the Great Lakes and Chesapeake Bay but are not discussed here.

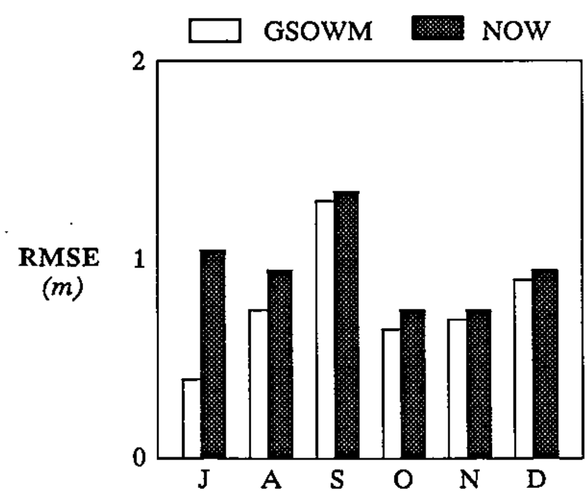
1. NOAA Ocean Wave (NOW) model

Ocean wave forecasts are operationally generated at the National Meteorological Center (NMC) using a second generation spectral wave model (Greenwood, et al, 1985). Fields of directional frequency spectra in 24 directions and 15 frequencies are generated in three hour intervals out to 72 hours.

The spatial resolution in the model is 2. 5 degree latitude by 2. 5 degree longitude. The grid is defined from 70S to 75N with an auxiliary land/sea table to preclude calculation over land. Lowest sigma layer winds corrected for stability to 10m height using a logarithmic profile are used to drive the ocean surface. Input to the model are the wind forecast fields to 72 hours at 6 hour intervals.

Significant wave heights computed by this model compare favorably with waves calculated by the Navy's GSOWM. Figure 4 shows the RMS error, of each model, for 24 hour forecasts, using wave measurements from the U.S. network of fixed buoys.

Figure 4. Average RMS error of 24 hour forecast of significant wave height from the NOW model compared with RMS errors of waves calculated by the Navy's GSOWM. The errors were computed during 1988 from 14 deep water buoys.



The wave forecasts from the global model are made available to the field forecast offices and other users in the following manner.

a) 12, 24, 48, and 72 hour projections of significant wave heights are individually displayed at the grid points on AFOS (see Fig. 14a, section III).

b) Similarly, for each forecast period the direction of propagation of the primary (most energetic) wave at grid points are displayed (see Fig. 14b, section III) as well as primary period (eastern Pacific only), Fig. 14c, section III.

c) At selected points on the east and west coasts a condensed matrix listing the forecast values of spectral energy densities as a function of frequency and direction are provided on AFOS. These values are presented for 12, 24, 48, and 72 hour projections for the following locations (lat,lon):

(47.5,125.0) (45.0,125.0) (42.5,130.0) (35.0,122.5) (32.5,120.0) (27.5,122.5)
(40.0,67.5) (37.5,70.0) (35.0,72.5) (25.0,92.5) (25.0,85.0) (25.0,65.0)

d) Hawaii and Alaska regions receive the forecast products over facsimile circuit on two charts for each forecast period. One chart displays the wave height values and winds at grid points (see Figs. 15a and 15b, section III). The second presents the primary wave direction and period (see Figs. 15c and 15d, section III).

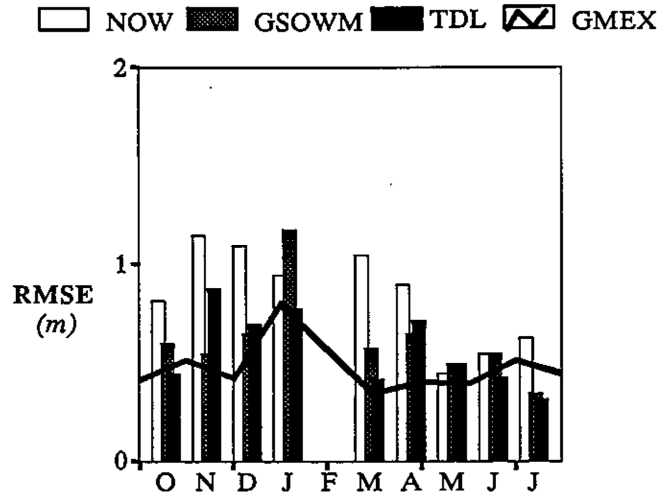
e) Significant wave heights, primary wave period and direction at all global grid points are provided in GRIB code to FOS.

2. Gulf of Mexico (GMEX) Spectral Wave Model

Winds used to drive the model are at 10m height derived from the 1000 mb winds of the NMC Regional Analysis and Forecasting System using the modified two layer boundary layer model of Cardone (loc. cit.).

Using wave measurements from fixed buoys in the Gulf as a control, significant wave heights computed by this model have been compared with similar waves calculated by the Navy's GSOWM, the previously operational TDL model, and the NOW model. Figure 5 shows the results of this comparison in terms of RMS error for 24 hour forecasts. The GMEX model compares favorably with these models in the deep water and even better in shallow water. Hence, the new model became the operational model in September 1988. Forecasts from this model are produced twice per day (00Z and 12Z) in 12 hour intervals out to 48 hours and distributed on AFOS (Fig 16a, section III) and FAX (Fig 16b, section III).

Figure 5. Wave height RMS error from the Gulf of Mexico wave model, the Navy's GSOWM, the TDL model, and the NOW model. Errors are computed using measurements from buoy 42001.



C. 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. Details may be found in Reynolds (1982) and Reynolds and Gemmill (1984).

An example of the resulting mean fields and anomaly fields, based on Reynolds climatology, for the 15 day running mean are shown in Figs. 17 and 18, section III. In addition subsets of the global analysis (Atlantic region and Pacific region) are distributed via FAX, see Figs. 19a and 19b, section III. The stippling indicates regions where the SST field was fixed by the *in situ* data. The monthly TOGA analysis includes carefully screened drifting buoy data as well. The daily SST analysis is disseminated by a number of standard methods including the GTS, FAX and FOS.

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 6 identifies these regions. Examples of each of these charts are shown in Figs. 20 through 23, section III.

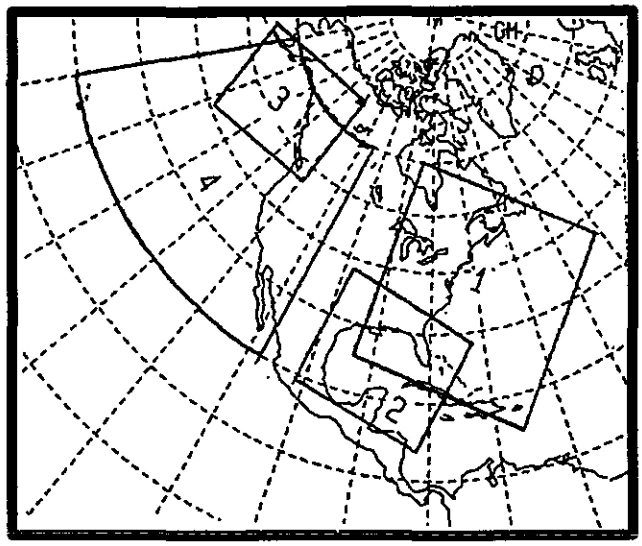


Figure 6. Location of regional SST analyses and associated map projections: 1) Northwest Atlantic, polar stereographic, 2) Gulf of Mexico, polar stereographic, 3) Gulf of Alaska, polar stereographic, 4) Eastern Pacific, mercator.

In addition, a special 15 day regional blend for the Eastern Pacific is distributed by mail. The area of coverage and map projection is identical to Fig. 23, section III.

2. MCSST analyses

a. Global, regional, and coastal

MCSST techniques do not include *in situ* data but rather make use of measurements from thermal infrared (IR), near IR and visible bands (Cornillon, 1982) on the AVHRR sensors aboard the TIROS 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). Several different equations are used to process MCSST calculations depending on such variables as day/night, cloud cover, atmospheric moisture, etc. Different night and day time equations are applied to the sensors in order to derive SST's.

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. 7). 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 daily in an alphanumeric bulletin on the GTS.

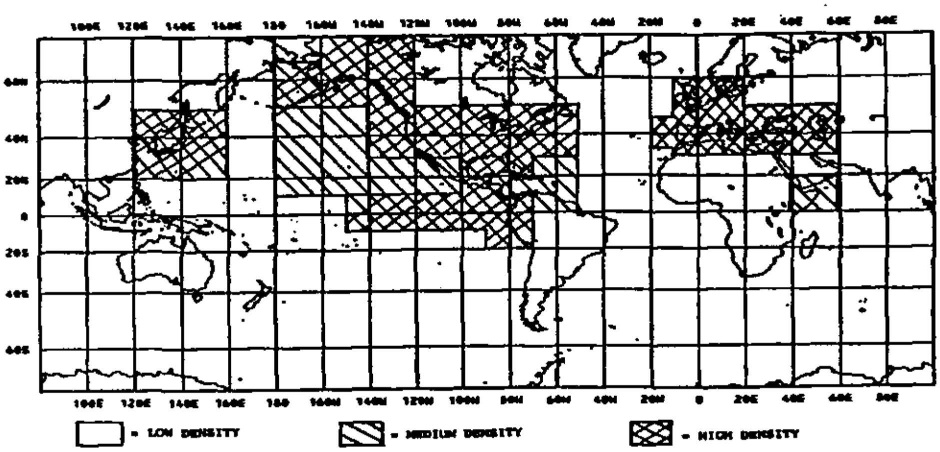


Figure 7. Geographical regions with associated
SST observation sample densities.

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. 24, section III). Regional analyses for the waters adjacent to the U. S. are currently produced weekly at 50 km grid spacing (see Fig. 25 through 29, section III) and local analyses in the coastal areas of the contiguous U. S. are produced twice weekly at 14 km grid spacing (see Figs. 30 through 36, section III).

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, see Fig. 37 in section III. Manual analyses are produced twice a week in the following way. 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, using temperatures from the nearest buoy as an anchor point, for each of the lakes. Analyses are manually transferred to a separate base map for preparation of the final product and *in situ* temperatures from fixed buoys in the lakes are annotated on the analyses where appropriate.

3. Gulf Stream and Loop Current analysis

An analysis of the Gulf Stream and Loop current system is produced five days per week by subjective methods. This 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, Fig. 38, section III) 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. 39, section III). The charts are updated twice each week and three times each week respectively.

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 SST (when available) 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.

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, 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.

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. Sub-surface 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 quality controlled, assembled and re–transmitted as collective bulletins on the GTS.

All real time BATHY messages received at NMC are routinely processed, quality controlled, and archived and sent to NODC. Real time depth–temperature salinity messages are processed in a "raw" form, quality controlled and also sent to NODC to be archived.

Quality control of data is accomplished by 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. Monthly data statistics are provided to IGOSS.

5. Sub–surface 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 (Fig. 40, section III). 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 sub–surface temperature, i.e., at any given location the sub–surface analysis value is not permitted to exceed the Bathy surface temperature. The 100 meter sub–surface 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 sub–surface analysis.

6. Oceanographic Monthly Summary

The Oceanographic Monthly Summary (OMS) is a periodical whose prime purpose is to disseminate 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. The table of contents, which remains unchanged from month to month, is shown in Fig. 41, section III.

D. 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 formidable 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. A scheme of collecting information from several sources must be used to construct sea ice analyses on various scales. Table 1 lists the most commonly used data sources.

Table 1. Data sources used in sea ice analysis.

DATA SOURCE	RESOLUTION	COVERAGE	ROUTINE	SPECIAL
SATELLITE:				
NOAA polar orbiter AVHRR				
LAC/HRPT (VIS/IR)	1 km	Regional	X	
GAC (VIS)	4 km	Global	X	
DMSP polar orbiter				
OLS (VIS)	.6 km	Regional	X	
OLS (VIS, MOSAIC)	5 km	Global	X	
SSM/I	36 km	Global	X	
GEOSAT				
Altimeter	7 km	Global	X	
DATA SOURCE	RESOLUTION	COVERAGE	ROUTINE	SPECIAL
AERIAL RECONNAISSANCE:				
U.S. Navy	1 km	Local	X	
Canadian (AES)	1 km	Regional	X	
Danish	1 km	Local	X	
Private industry	1 km	Local		X

Table 1 cont.

SHIP AND DRIFTING BUOY REPORTS:

Ship	N/A	Point		X
Buoys	N/A	Point	X	
Shore station 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 are plotted. 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 the DMSP's SSM/I sensor where ever possible. Table 2 below shows the current Joint Ice Center analysis capabilities under cloud covered and cloud free conditions.

Table 2. Analysis capabilities.

PARAMETER	CLOUD FREE	CLOUD LIMITED (SSM/I) *	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 sq km	none	20 sq 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 ICE THICKNESS INFERRED FROM ESTIMATED AGE		
RIDGING/KEELING FREQUENCY/SIZE	NO PRESENT CAPABILITY		

* 24 HOUR COMPOSITE RECEIVED EACH DAY

Sea ice analysis products are produced at the Navy/NOAA Joint Ice Center on three scales: global, regional and local (Figs. 42–47, section III). Global scale products make up the bulk of the products and are disseminated by mail and facsimile. Primarily 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 via INMARSAT 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 sources available and are almost always disseminated by message, or INMARSAT TELEFAX.

Ice on the Great Lakes is analyzed from AVHRR satellite data and Canadian AES reconnaissance by the JIC in cooperation with the NWS forecast office at Cleveland, Ohio. 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 (Figs. 48-51, section III) 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 modeling 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.

A numerical model based upon Hibler's (1979) dynamic/thermodynamic model of Arctic sea ice is now being run operationally by FNOC. Called FIPS (Polar Ice Prediction System), this model is suitable for the ice covered waters of the Arctic Ocean and incorporates ice rheology in its dynamics to more accurately determine the ice thickness distribution. 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 developing finer mesh, regional models for the marginal seas.

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.

III. EXAMPLES OF PRODUCTS

An example of each of the guidance products produced by the OPC is shown below in Figures 8 through 51.

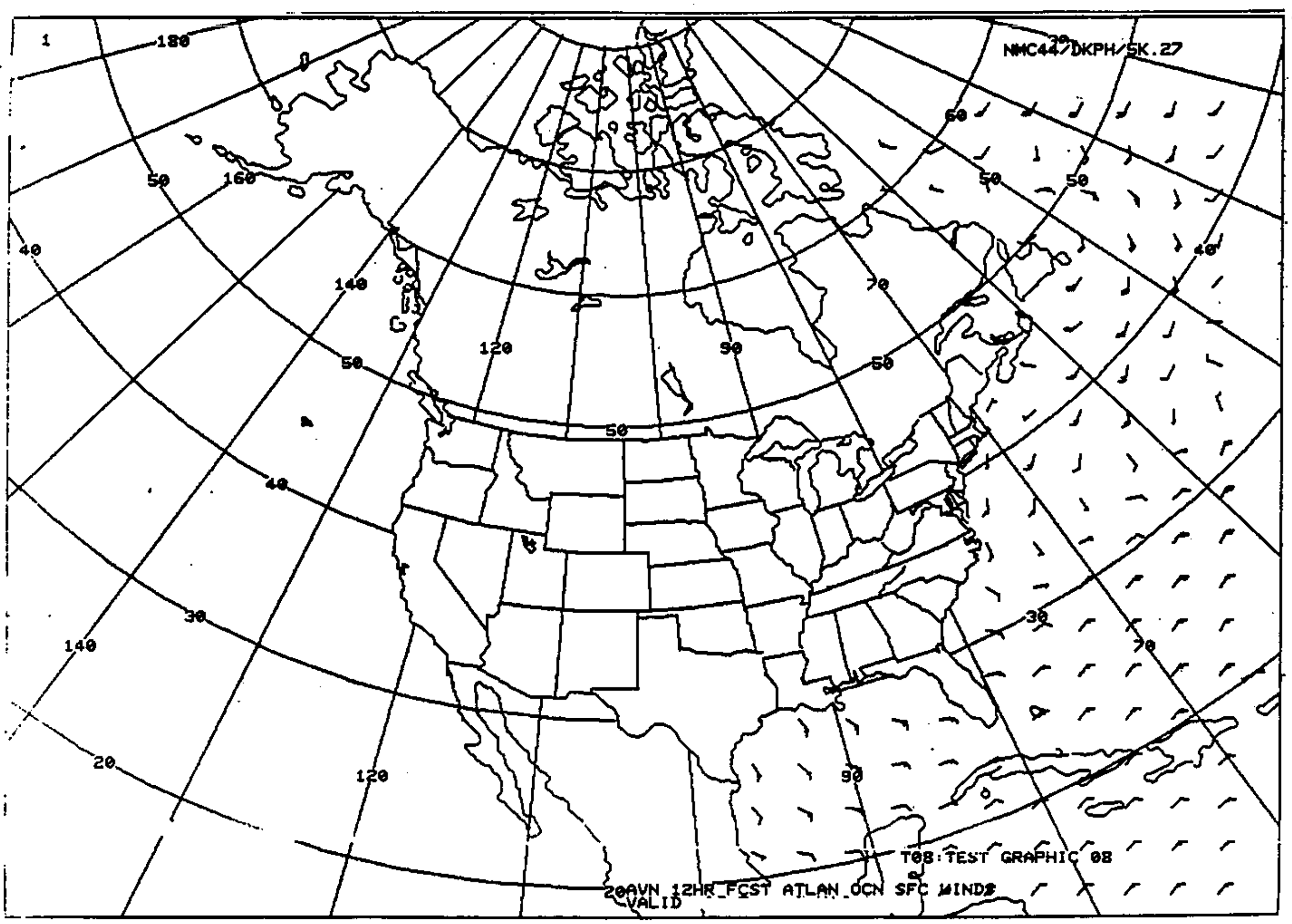


Figure 8a. Global ocean surface wind forecasts derived from MRF lowest sigma layer winds as presented on AFOS (Atlantic section),

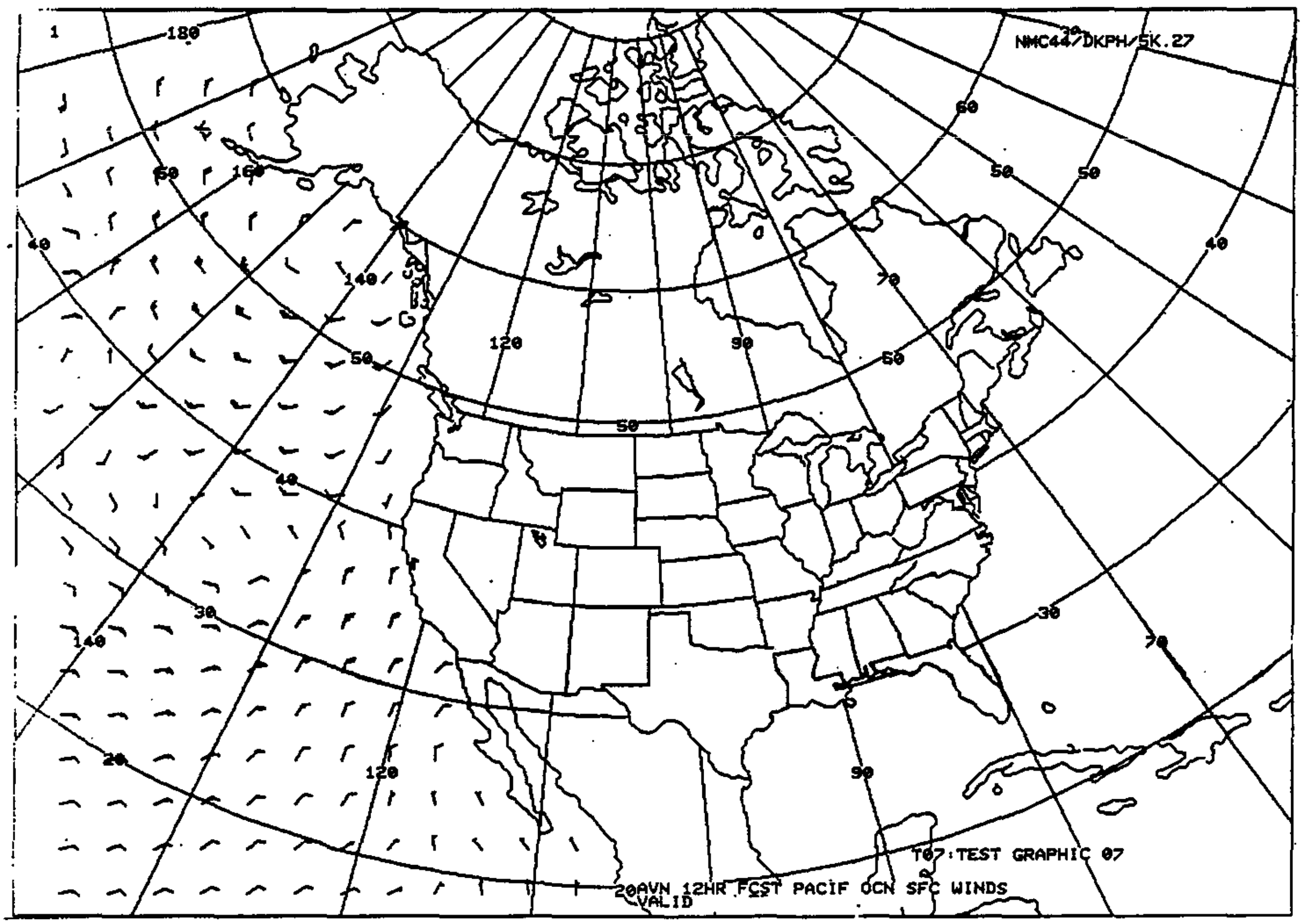


Figure 8b. Global ocean surface wind forecasts derived from MRF lowest sigma layer winds as presented on AFOS (Pacific section).

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 9. Coastal wind forecasts for Chesapeake Bay. The first lines indicate the date/time. The wind forecast for each of the directions 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).

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 10. 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).

```
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
```

Figure 11. 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).

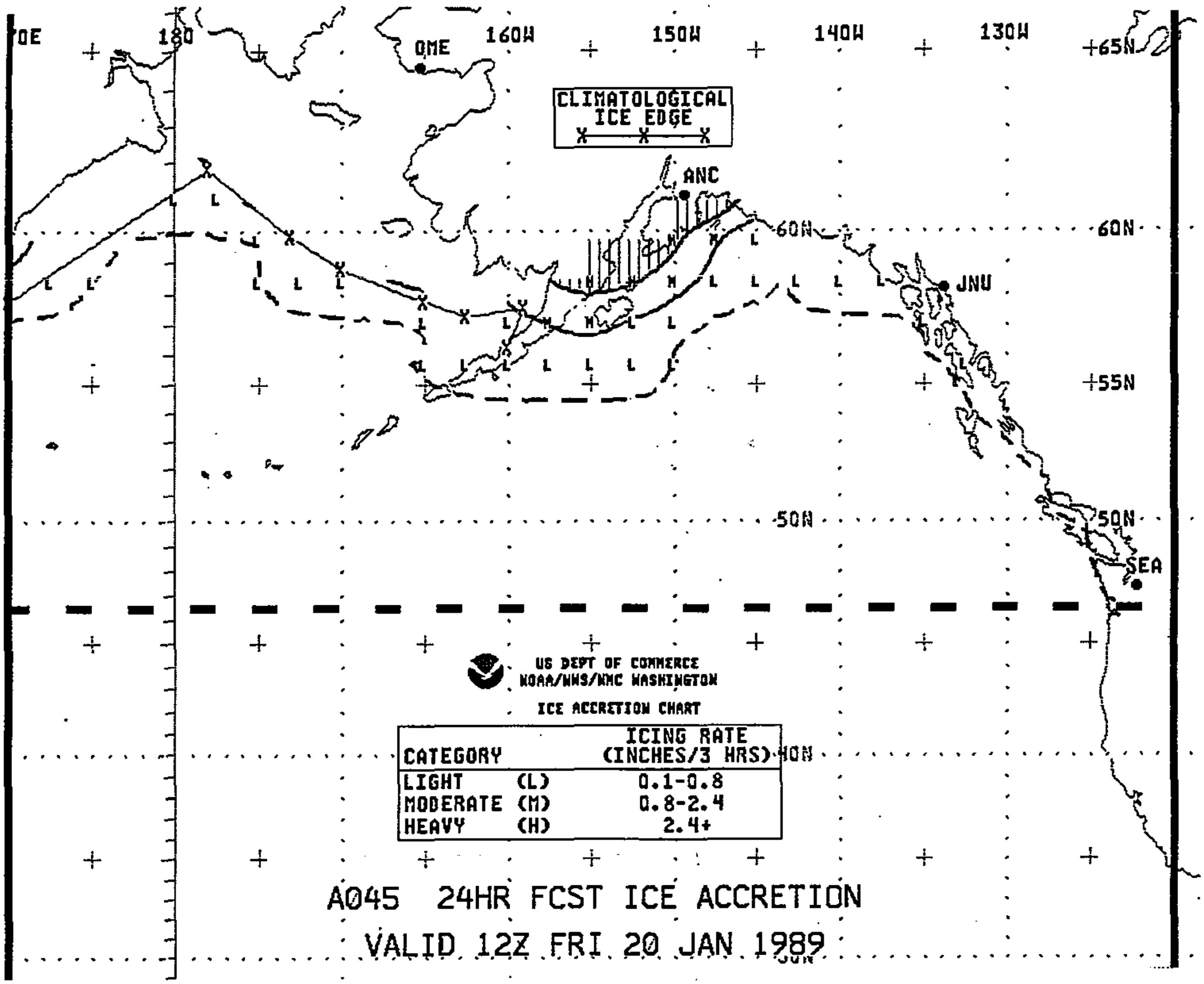


Figure 12. Superstructure ice accretion 24 hour forecast.

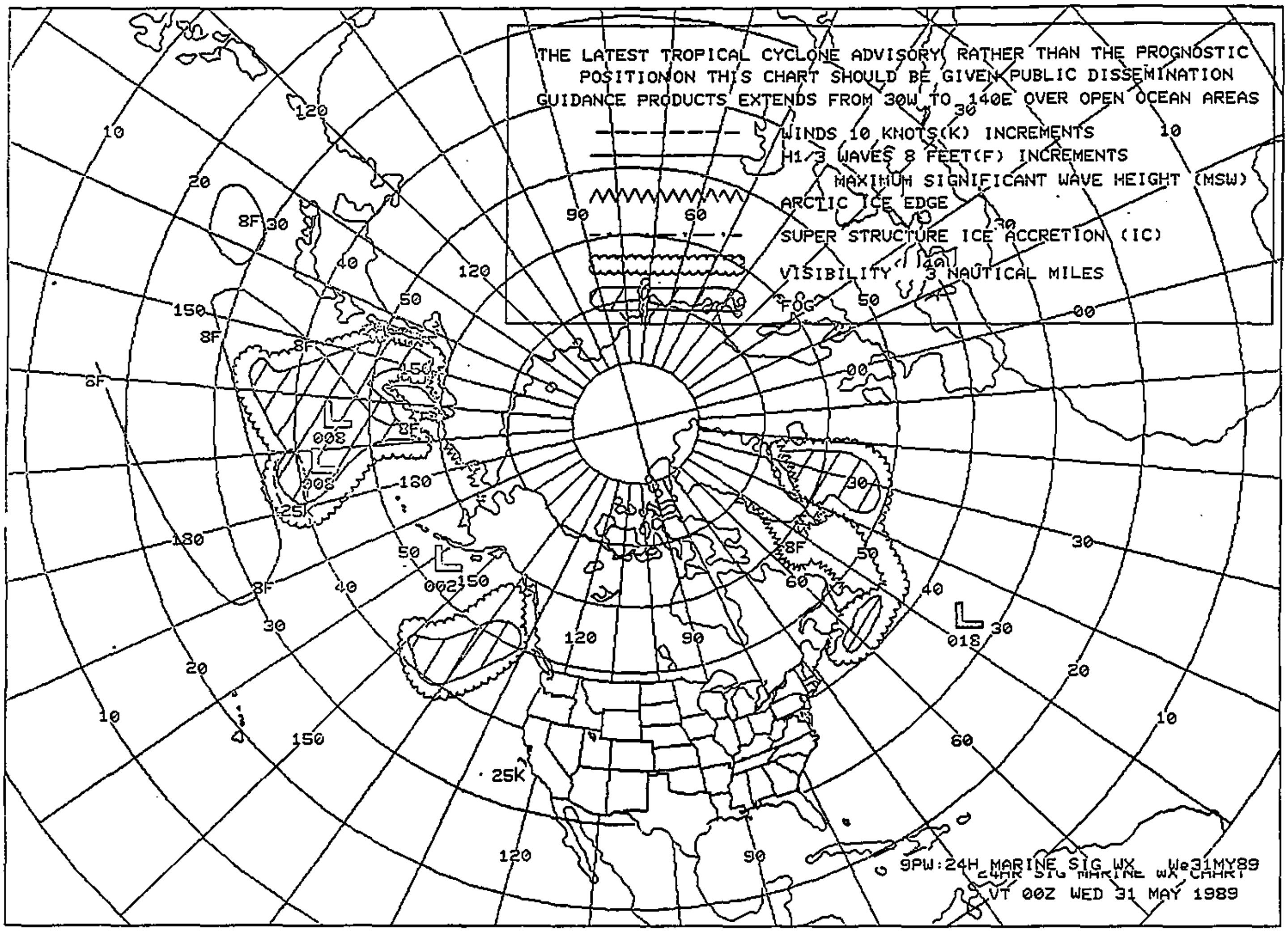


Figure 13. Marine significant weather chart.

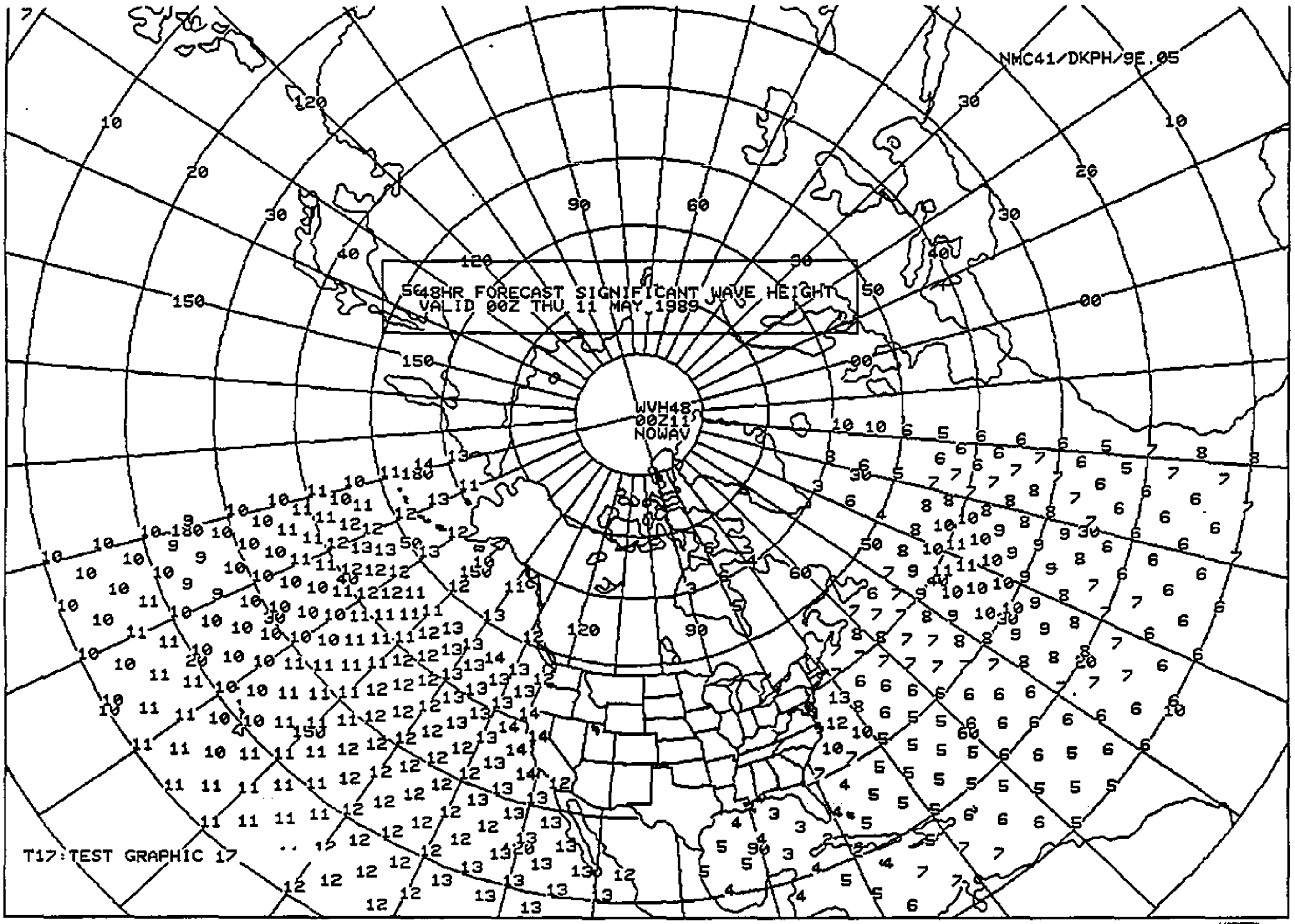


Figure 14a. Global significant wave height (ft) forecasts at grid points on AFOS.

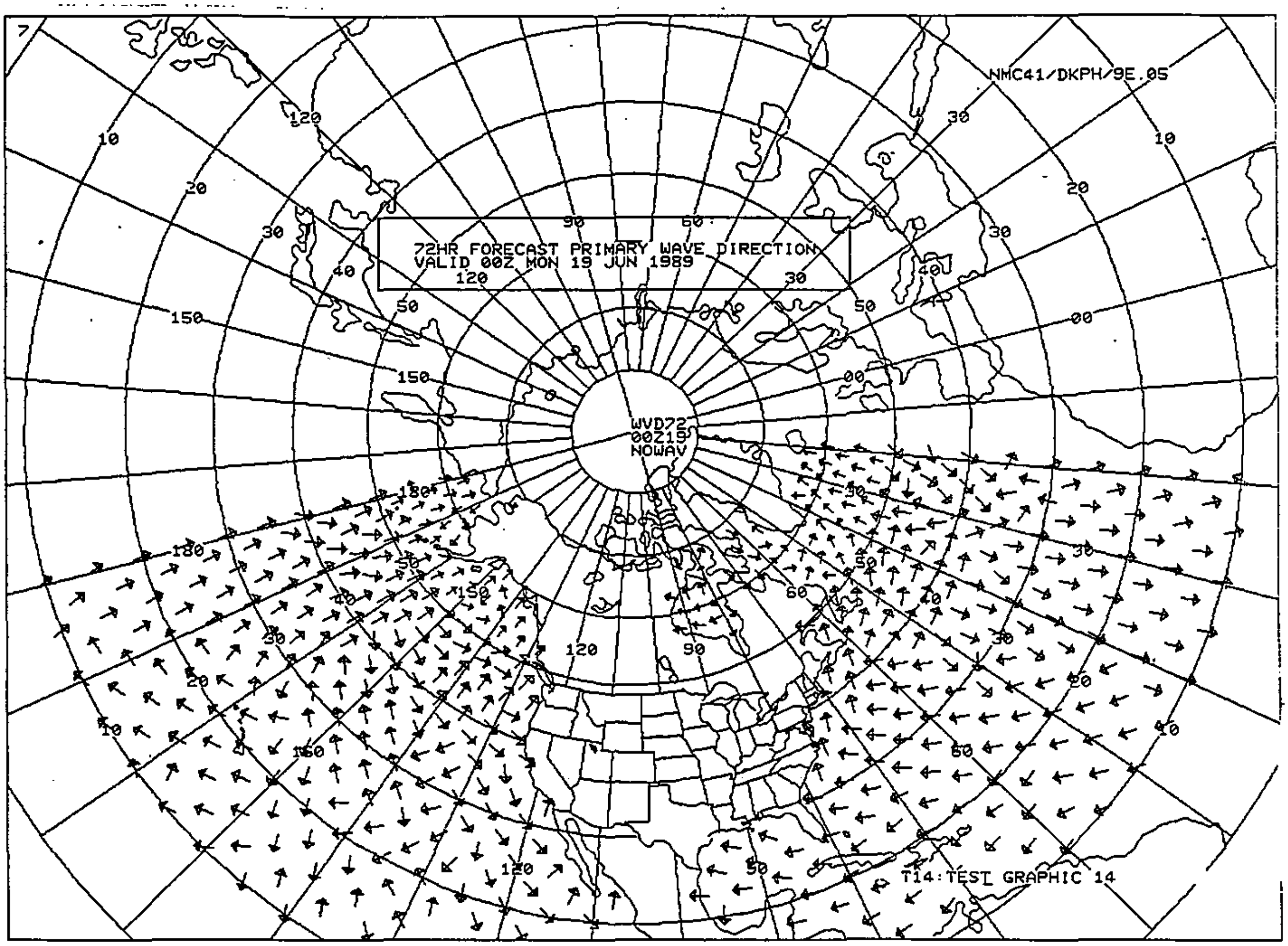


Figure 14b. Global 24 hour forecasts, on AFOS, of direction of the primary wave at grid points.

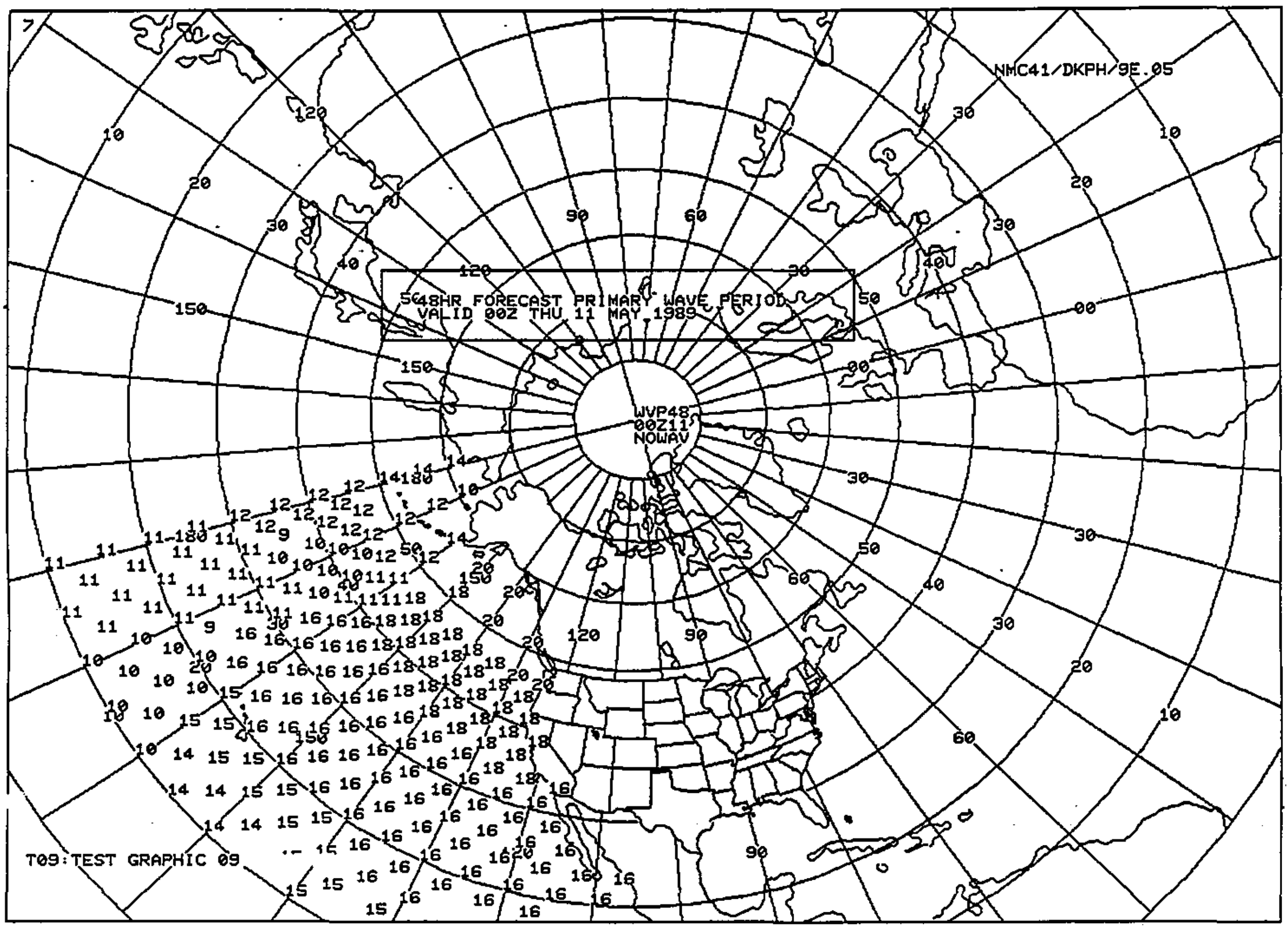


Figure 14c. Global wave forecasts, on AFOS, of primary period (eastern Pacific only).

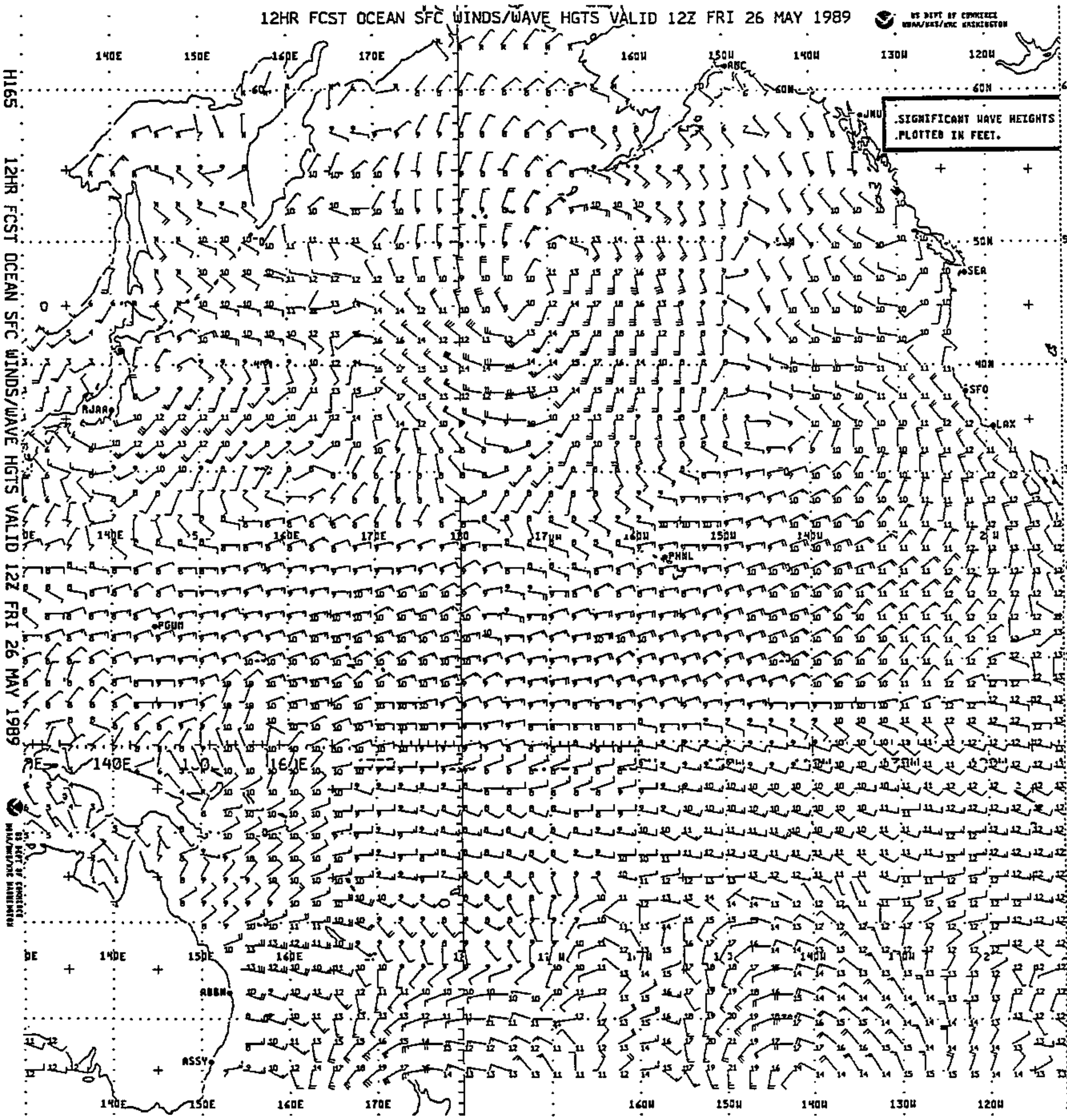


Figure 15a. Wave height values (ft) and winds (kts) at grid points as presented on HFAX.

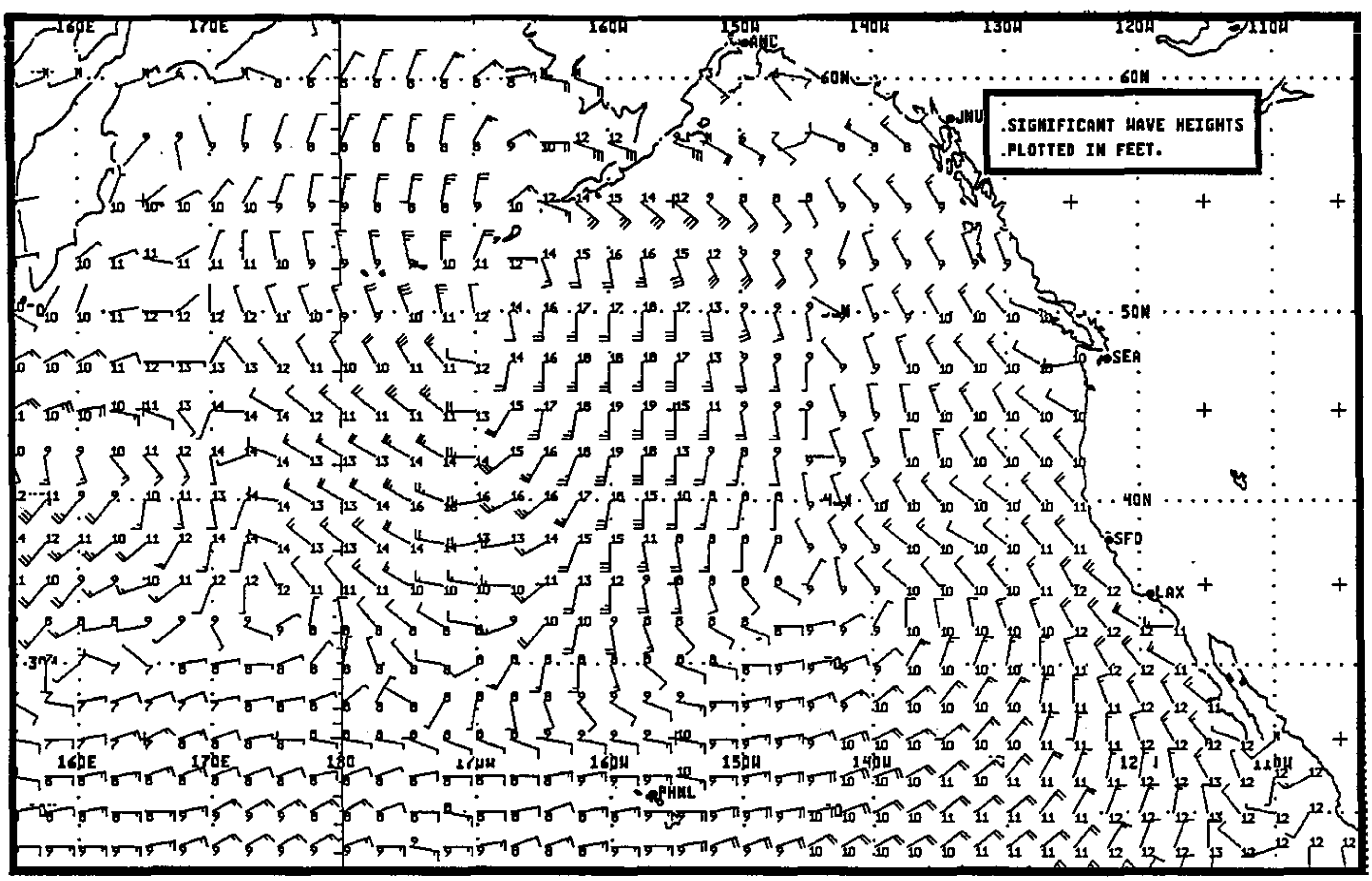


Figure 15b. Wave height values (ft) and winds (kts) at grid points as presented on AK-FAX.

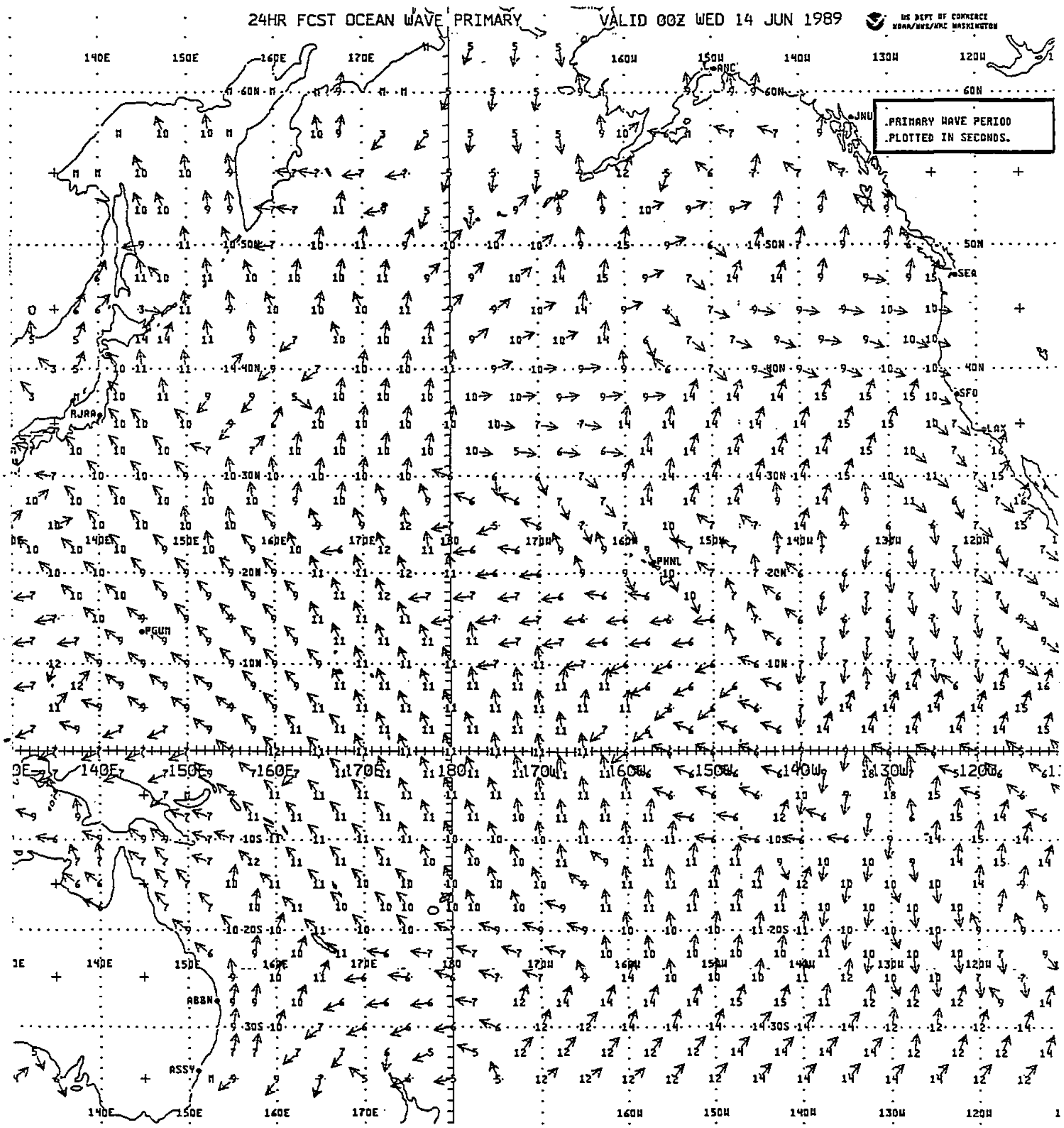


Figure 15c. Primary wave direction and period as presented on HFAX.

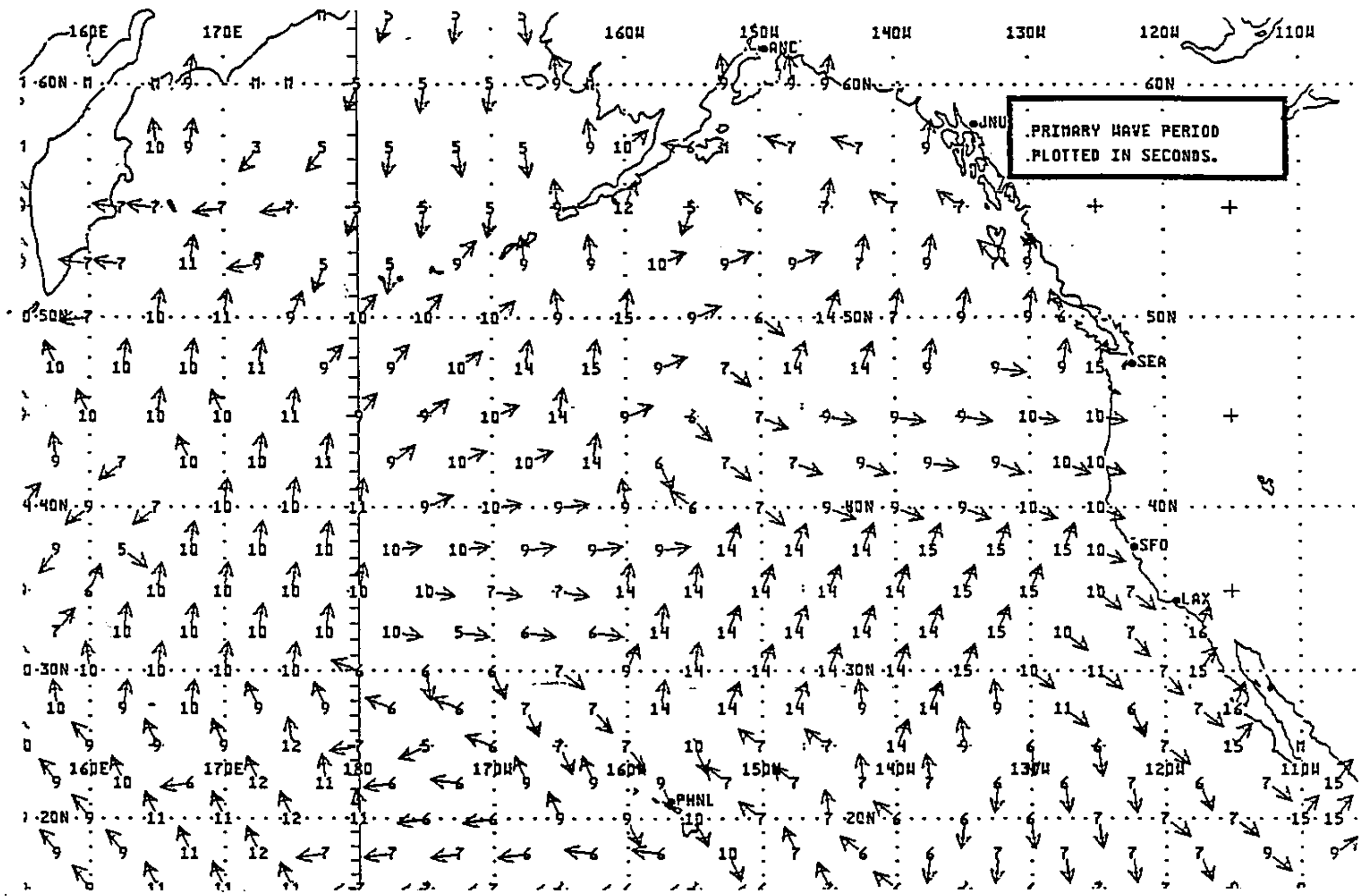


Figure 15d. Primary wave direction and period as presented on AKFAX.

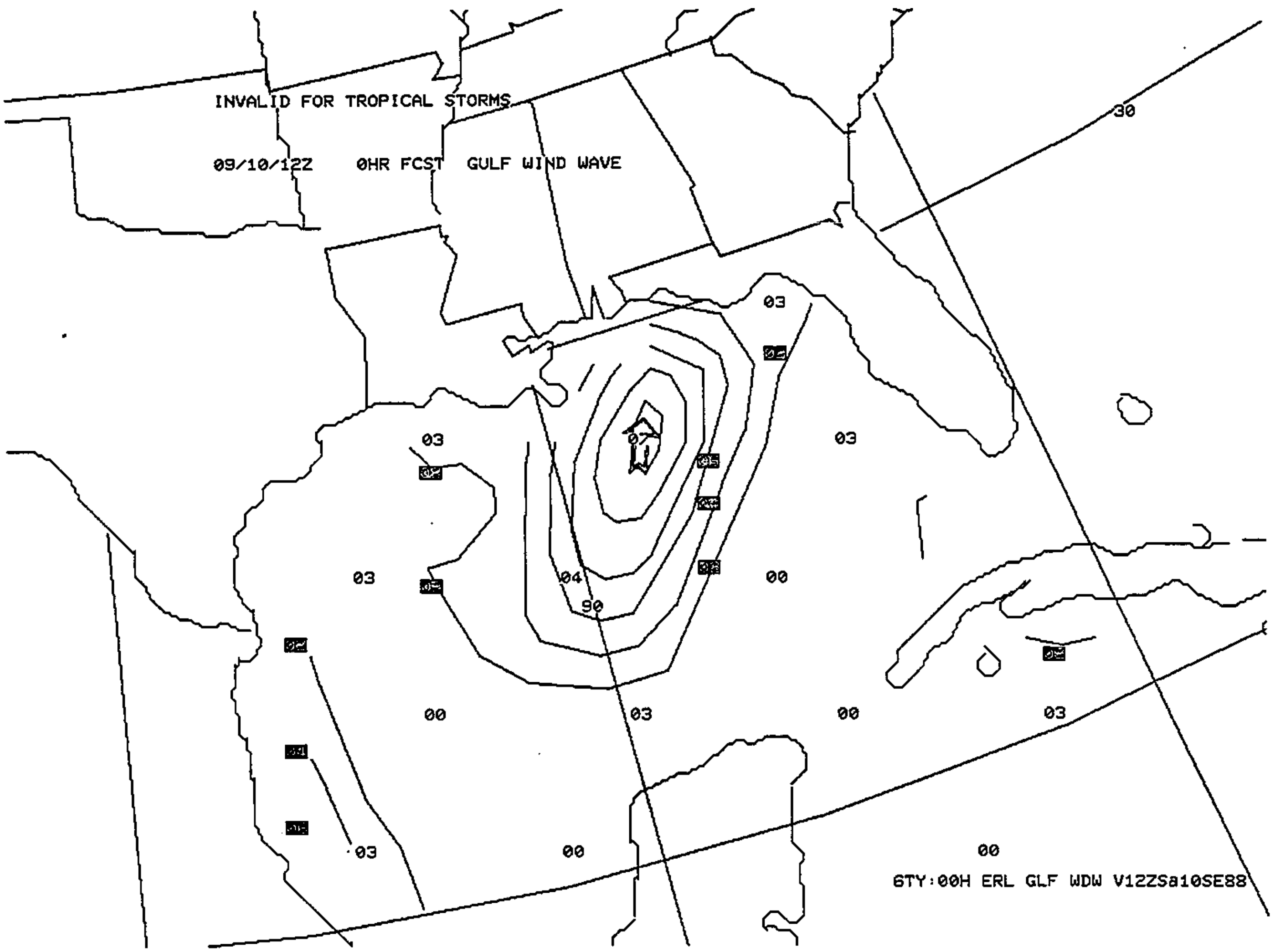


Figure 16a. Gulf of Mexico regional ocean wave forecast (ft) as presented on AFOS.

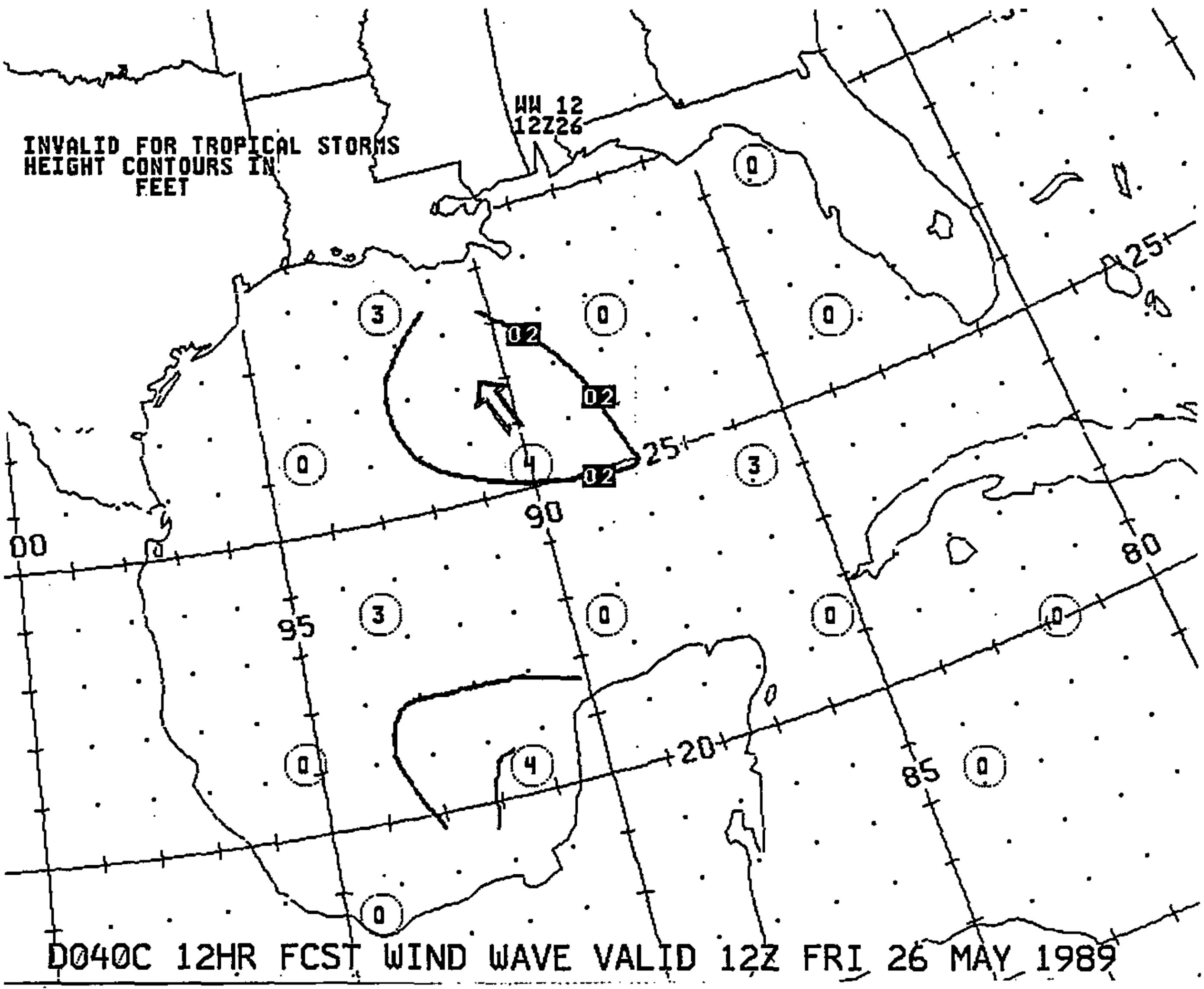


Figure 16b. Gulf of Mexico regional ocean wave forecast (ft) as presented on FAX.

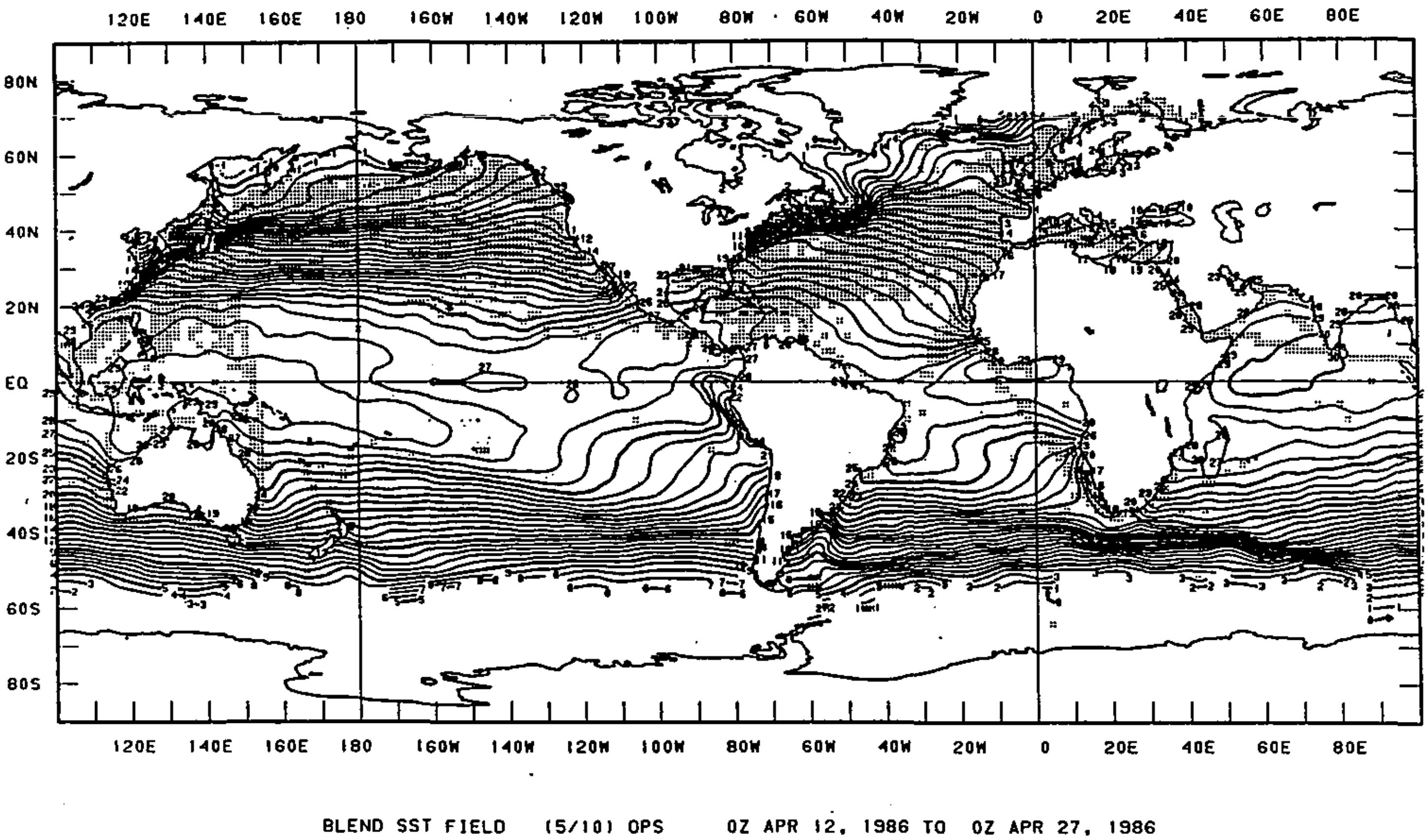


Figure 17. Global satellite, ships and buoy blended SST (deg C) analysis. This product is based on a 15 day running mean with 2 degree resolution.

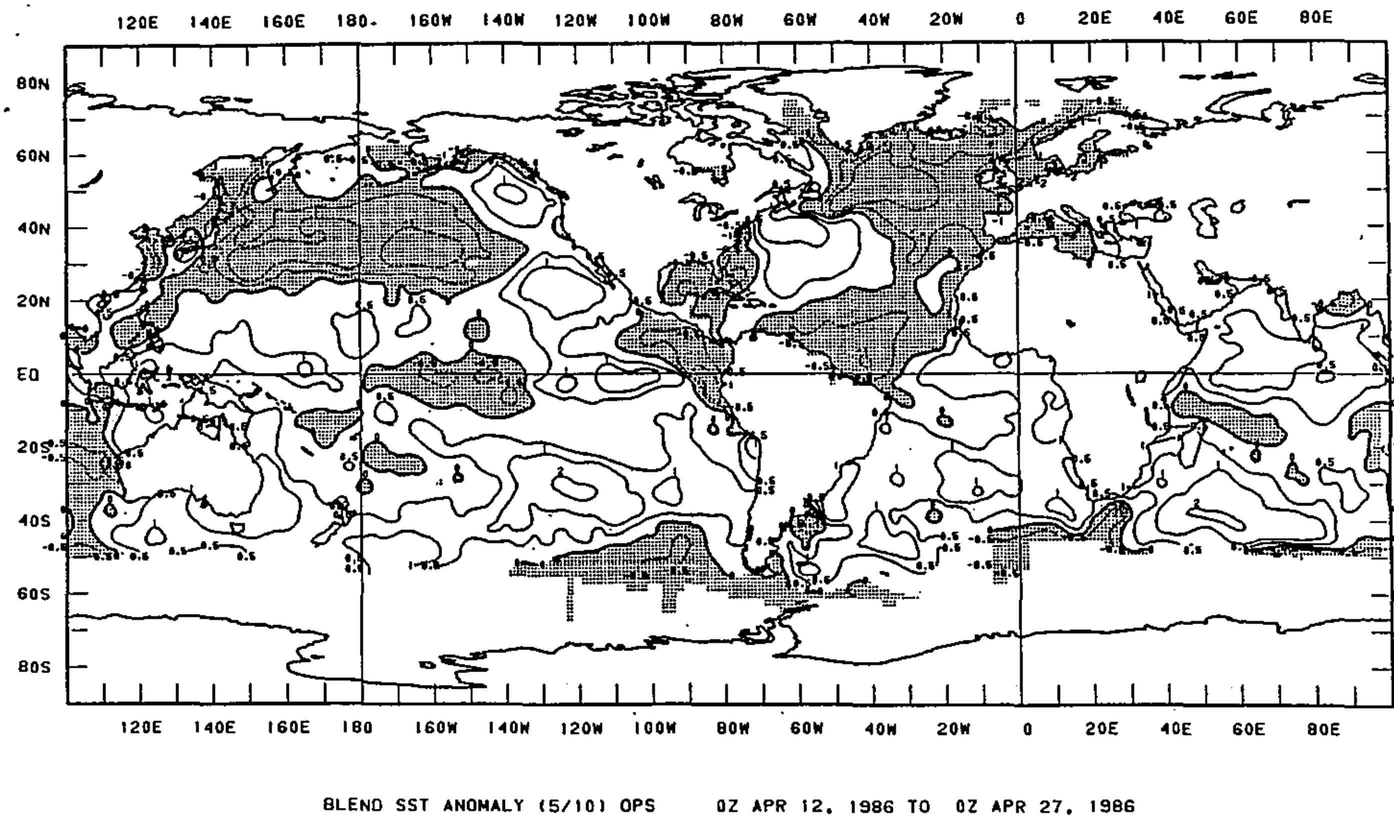


Figure 18. Global satellite, ships and buoy blended anomaly (deg C). This product is based on a 15 day running mean with 2 degree resolution.

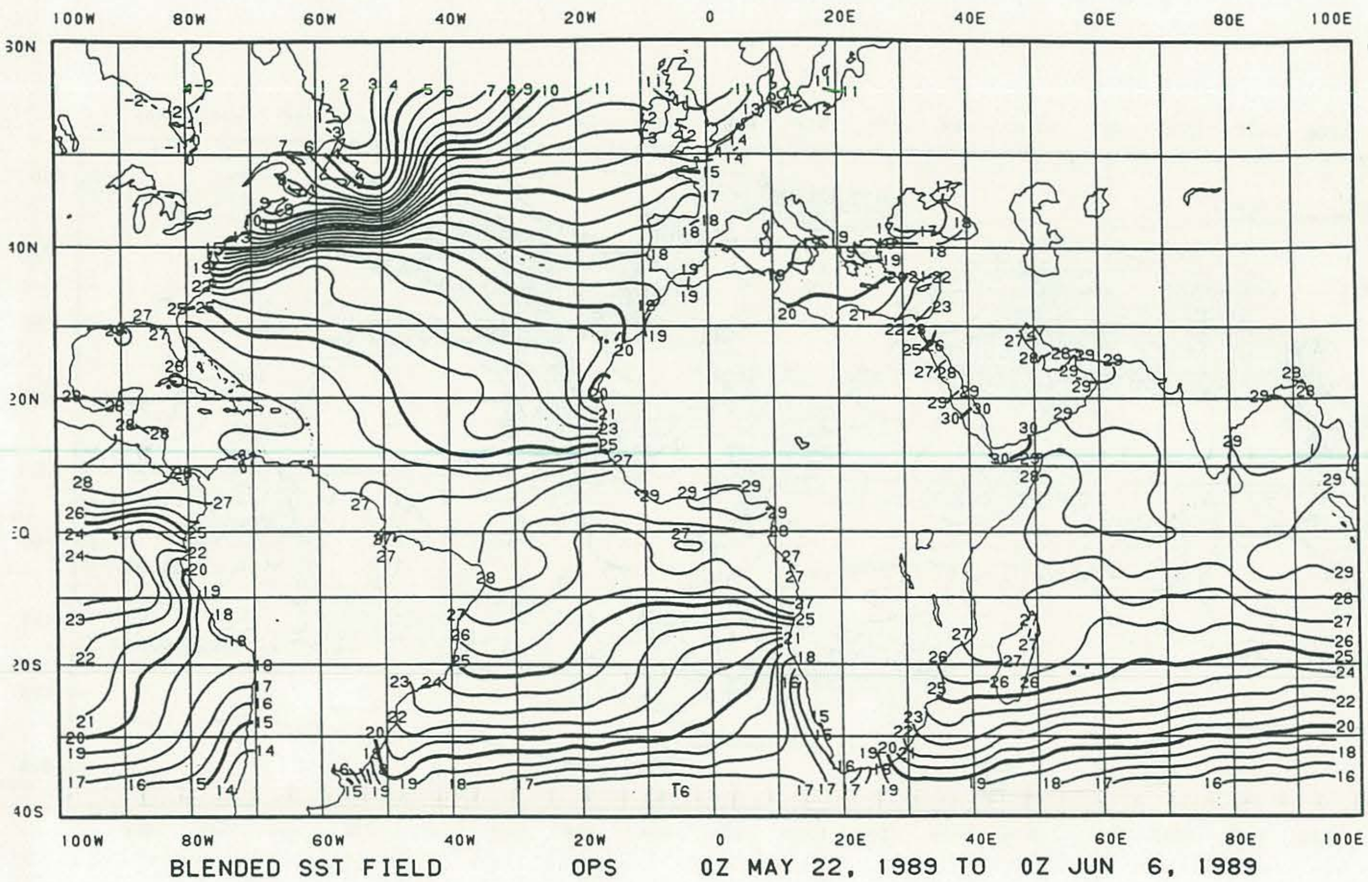


Figure 19a. Global satellite, ship and buoy blended SST (deg C) for Atlantic.

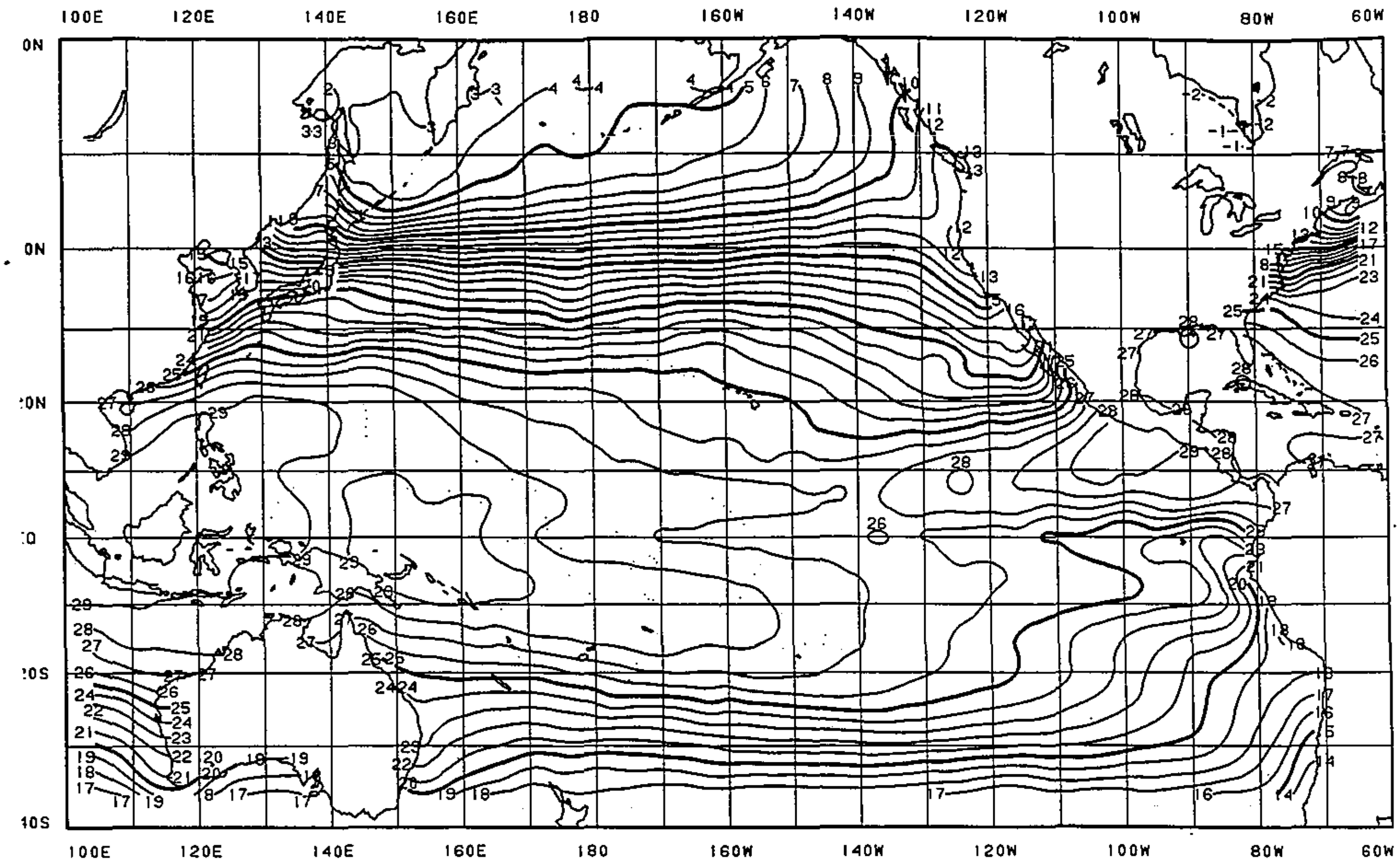


Figure 19b. Global satellite, ship and buoy blended SST (deg C) for Pacific.

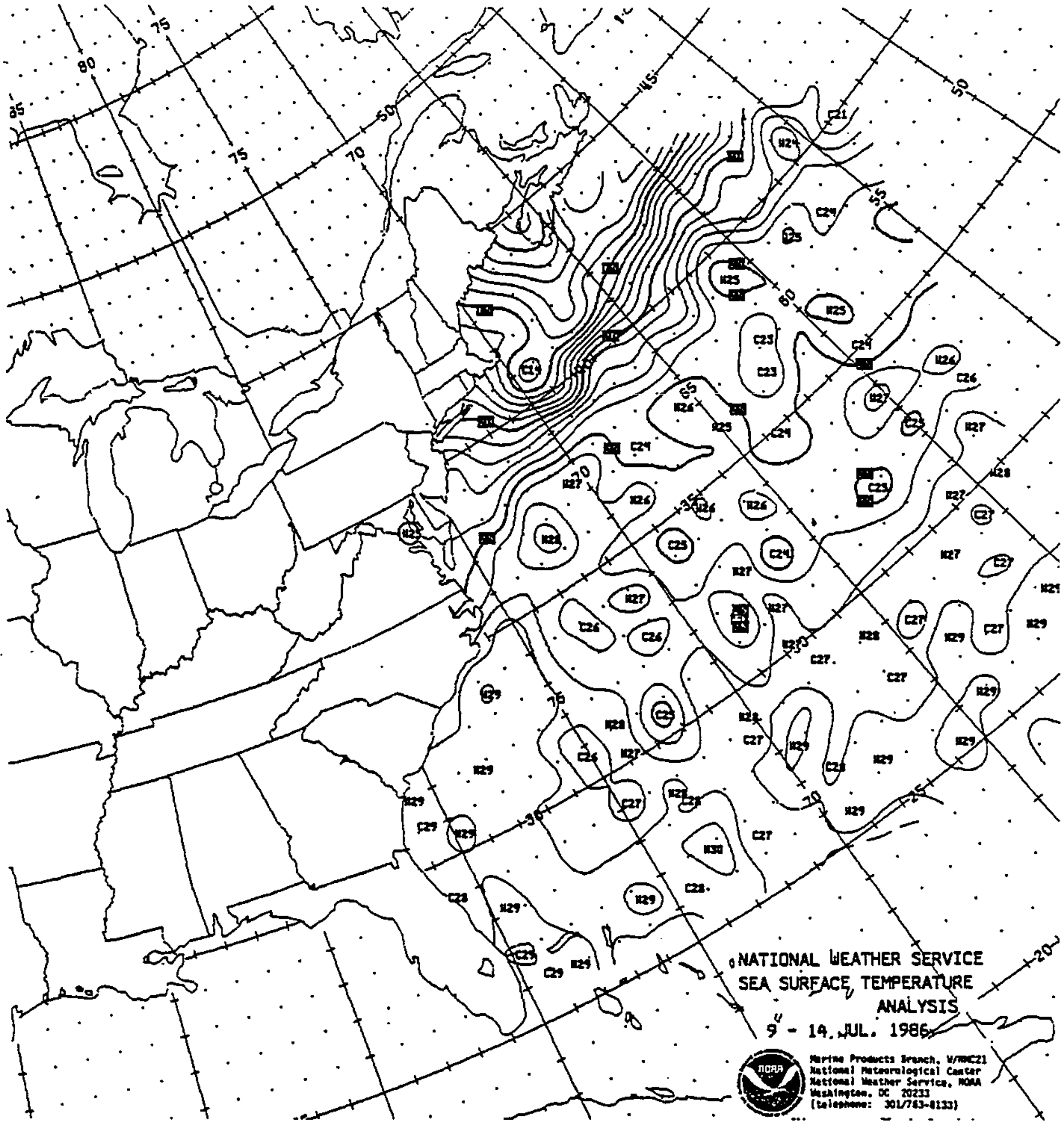


Figure 20. Northwest Atlantic satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

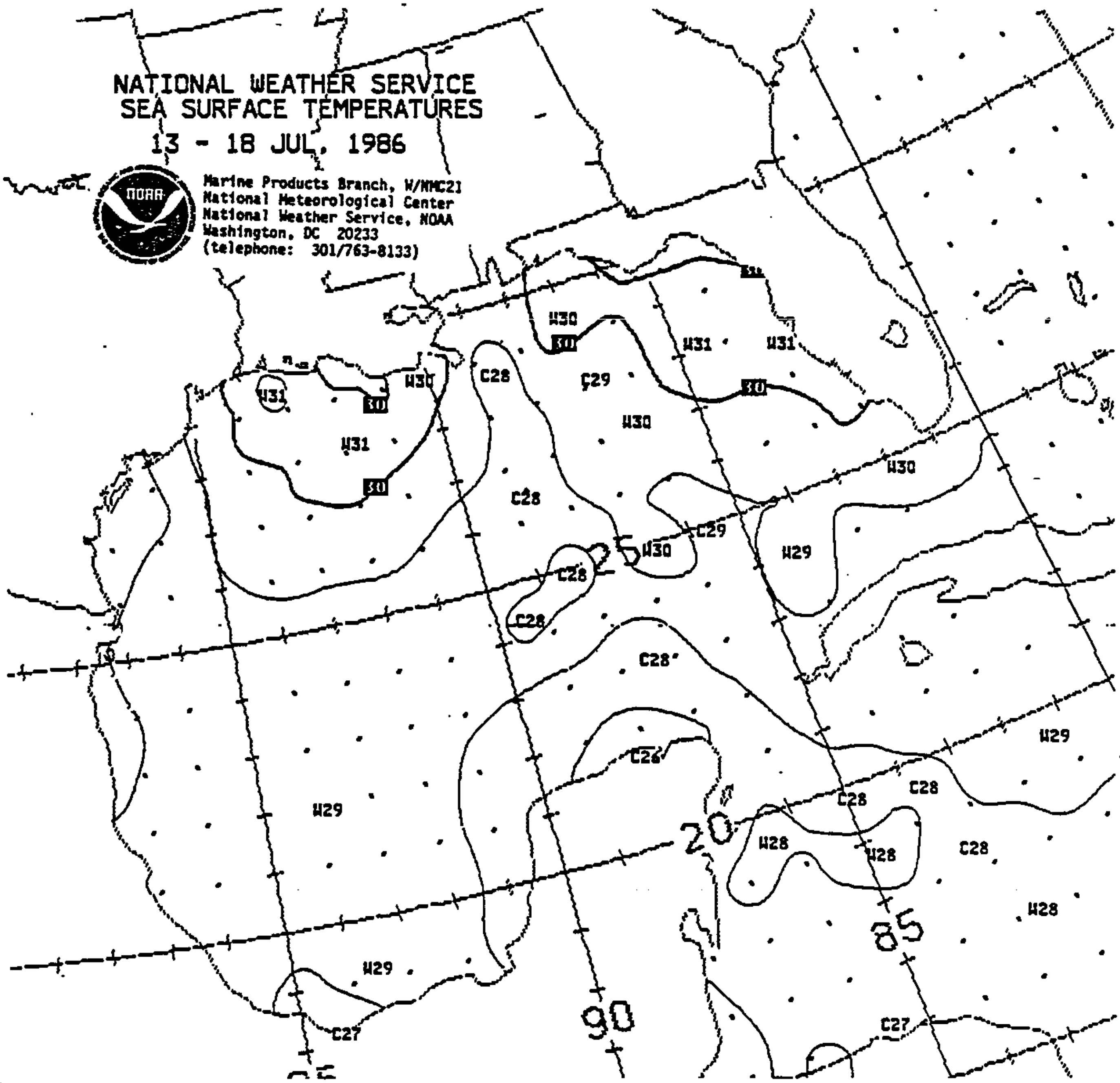


Figure 21. Gulf of Mexico satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

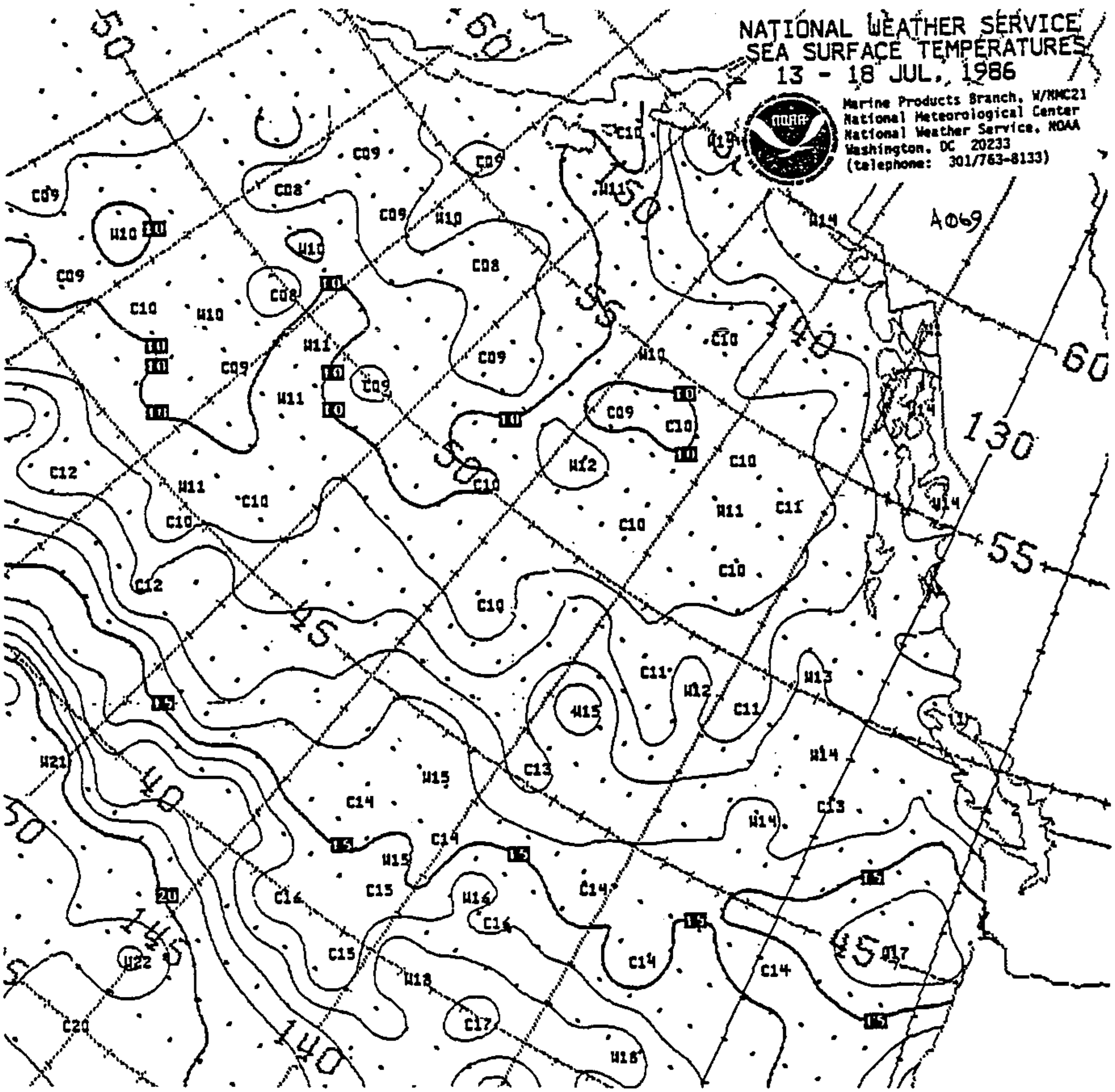


Figure 22. Gulf of Alaska satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

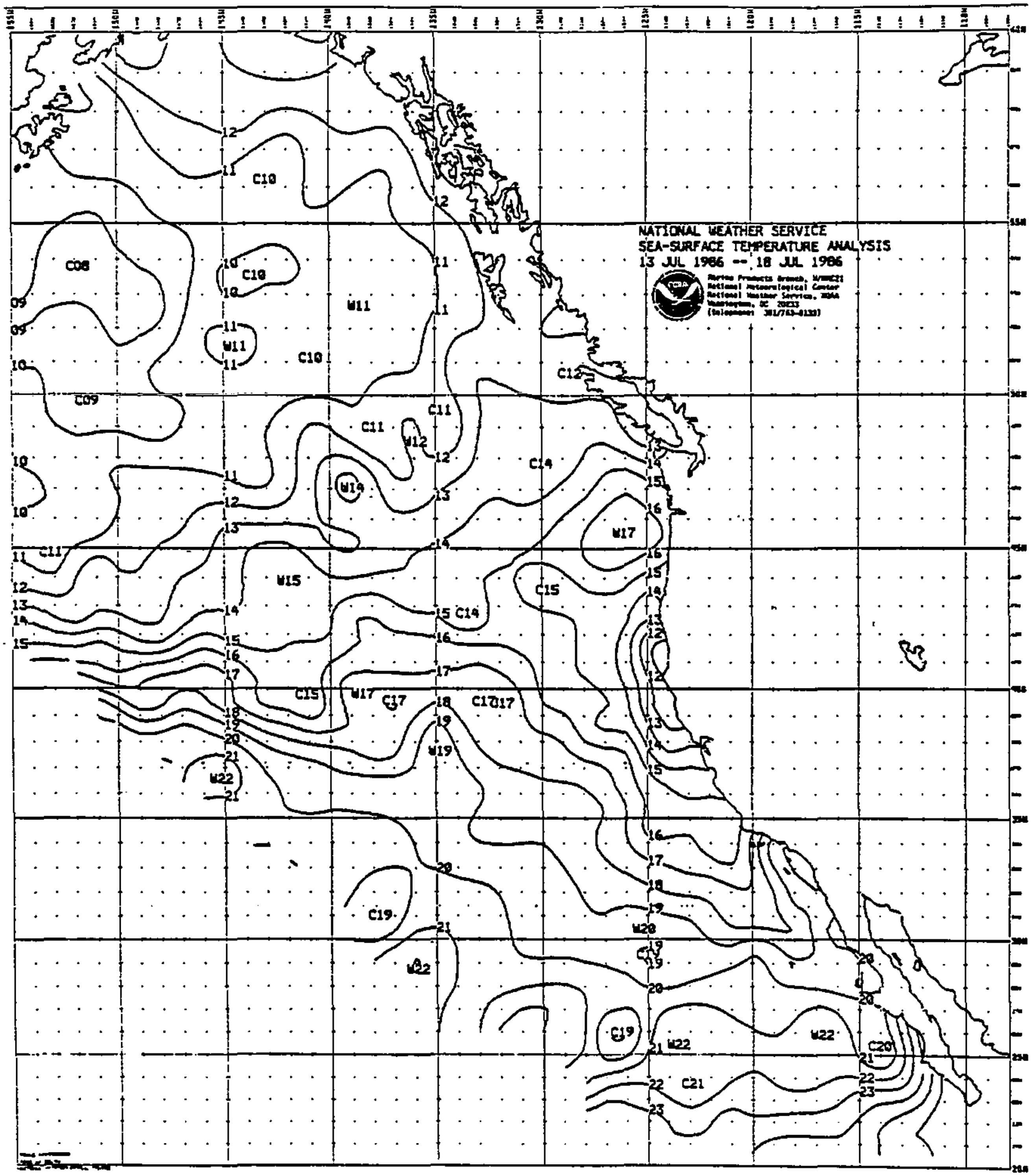


Figure 23. East Pacific satellite ship, and buoy blended SST (deg C) analysis based on 5 day running mean.

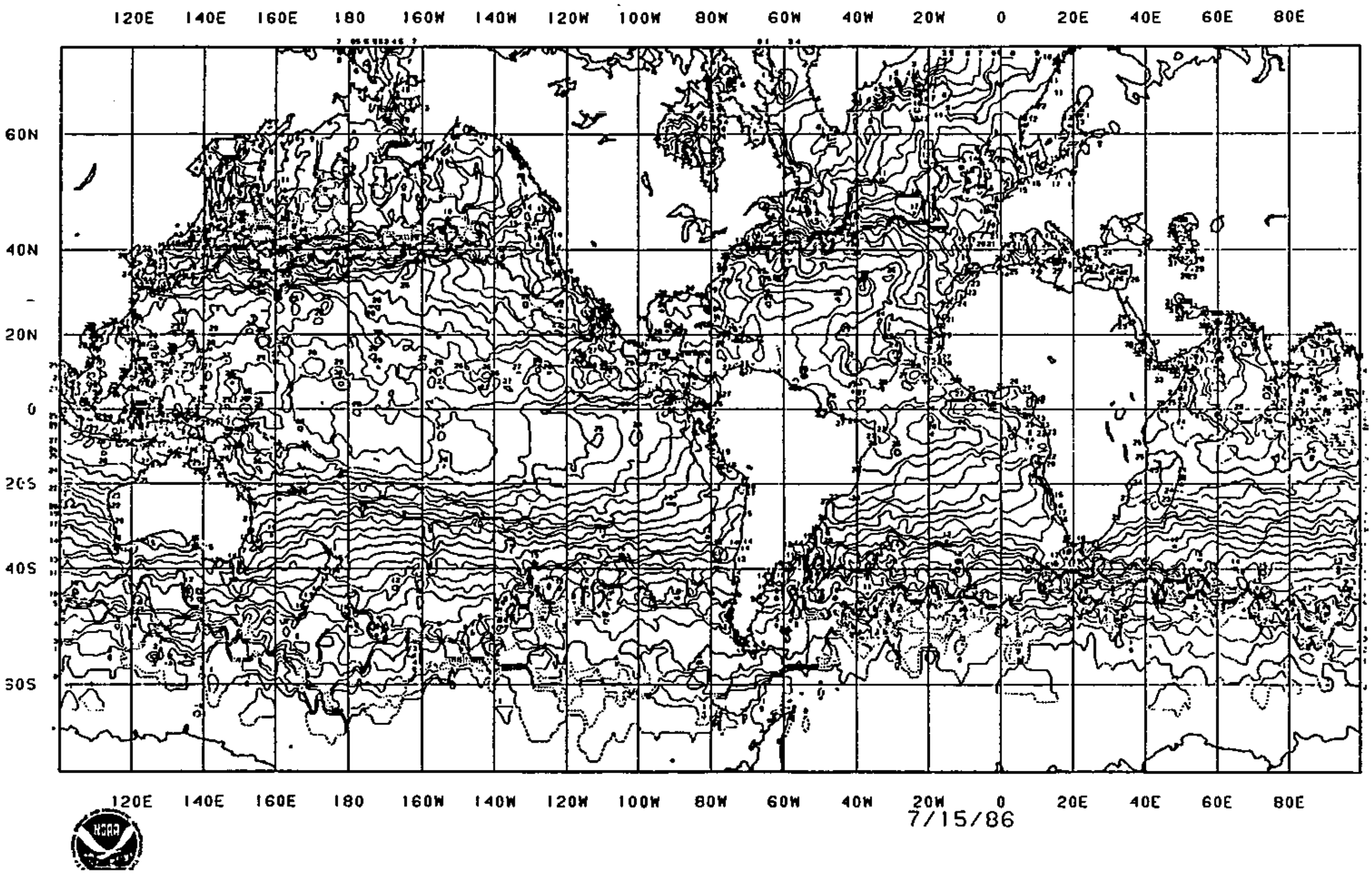


Figure 24. Global 100 km resolution satellite only SST (deg C) analysis.

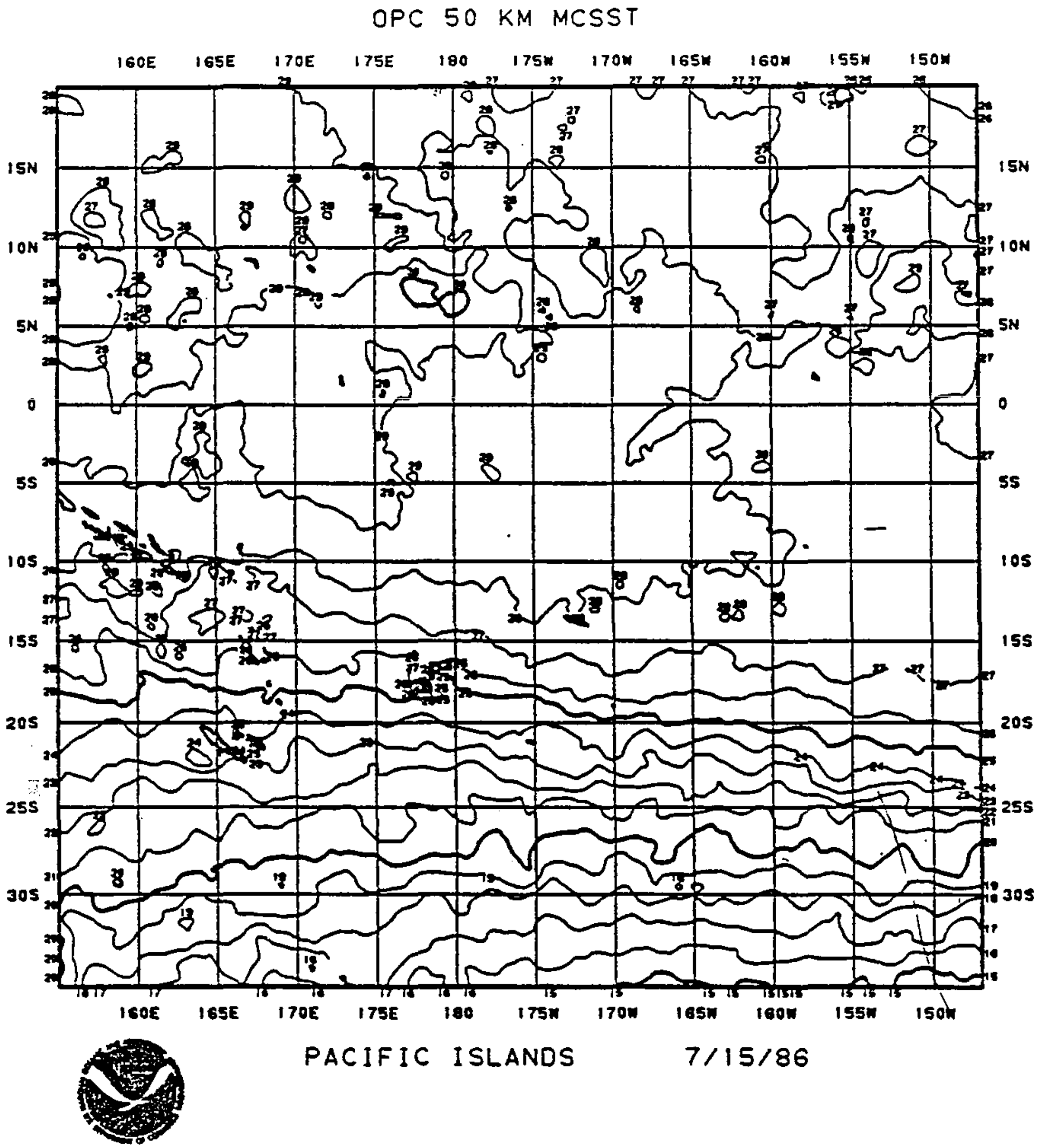


Figure 25. Pacific Islands 50 km resolution satellite only SST (deg C).

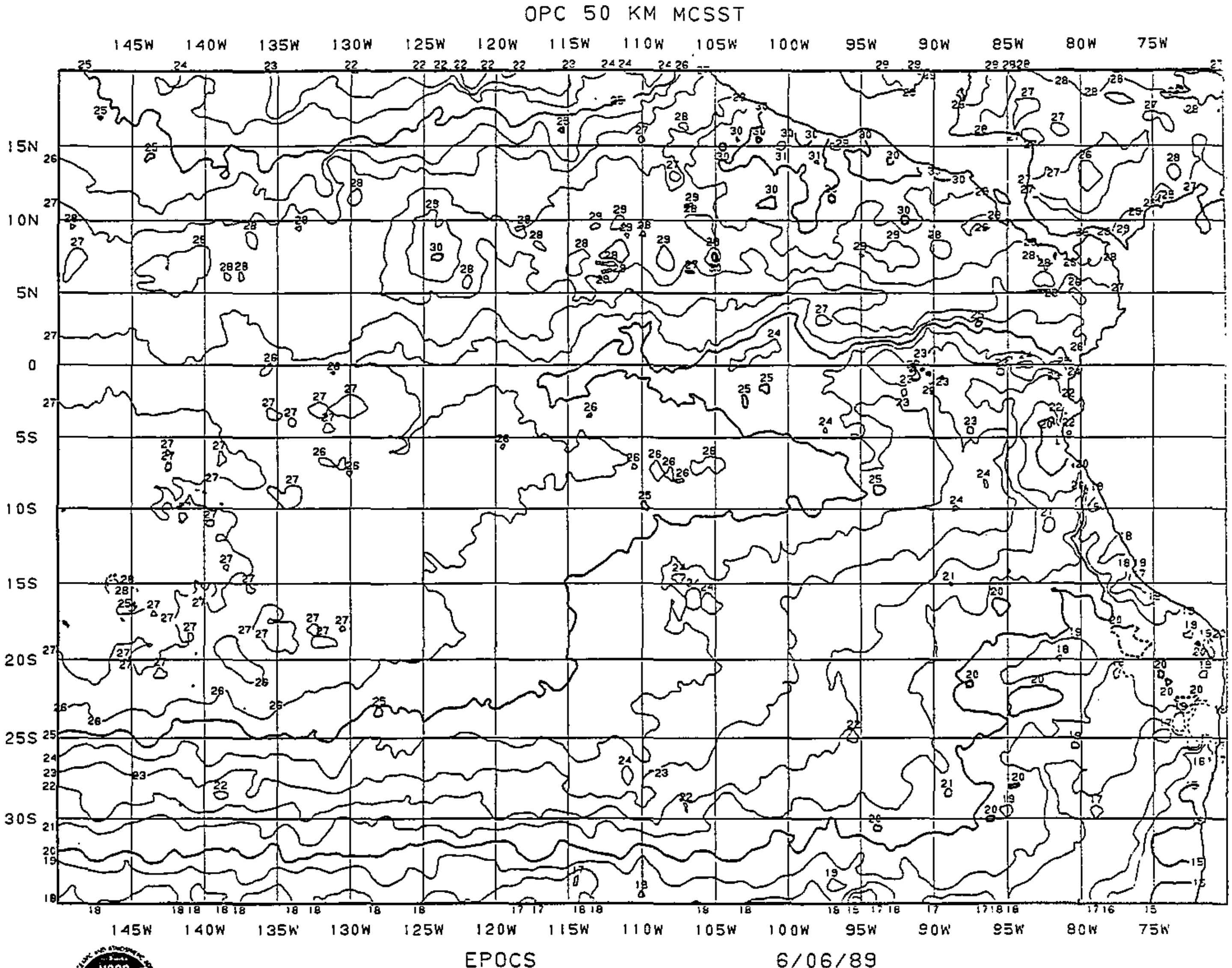


Figure 26. EPOCS 50 km resolution satellite only SST (deg C) analysis.

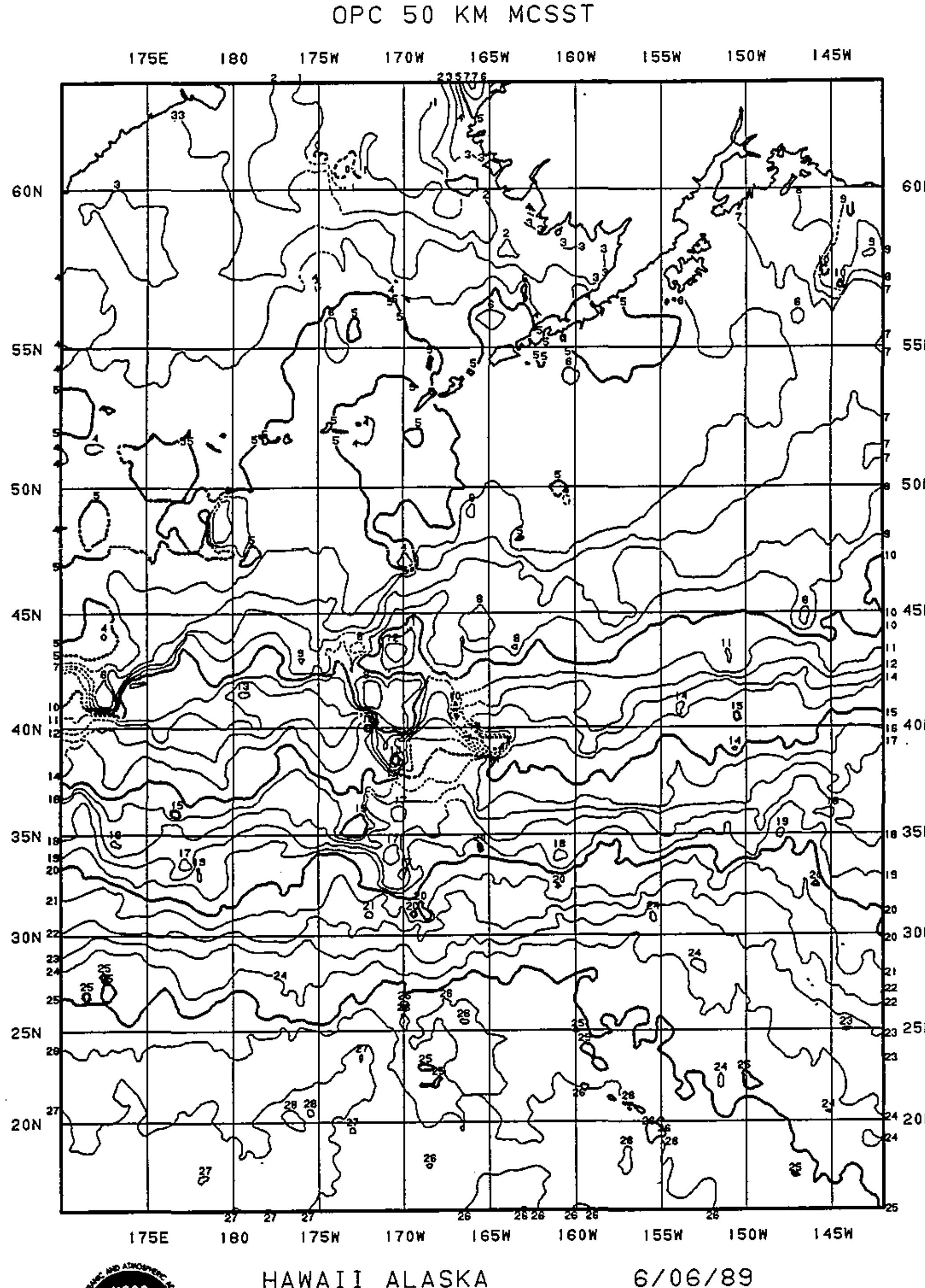


Figure 27. Hawaii/Alaska 50 km resolution satellite only SST (deg C) analysis.

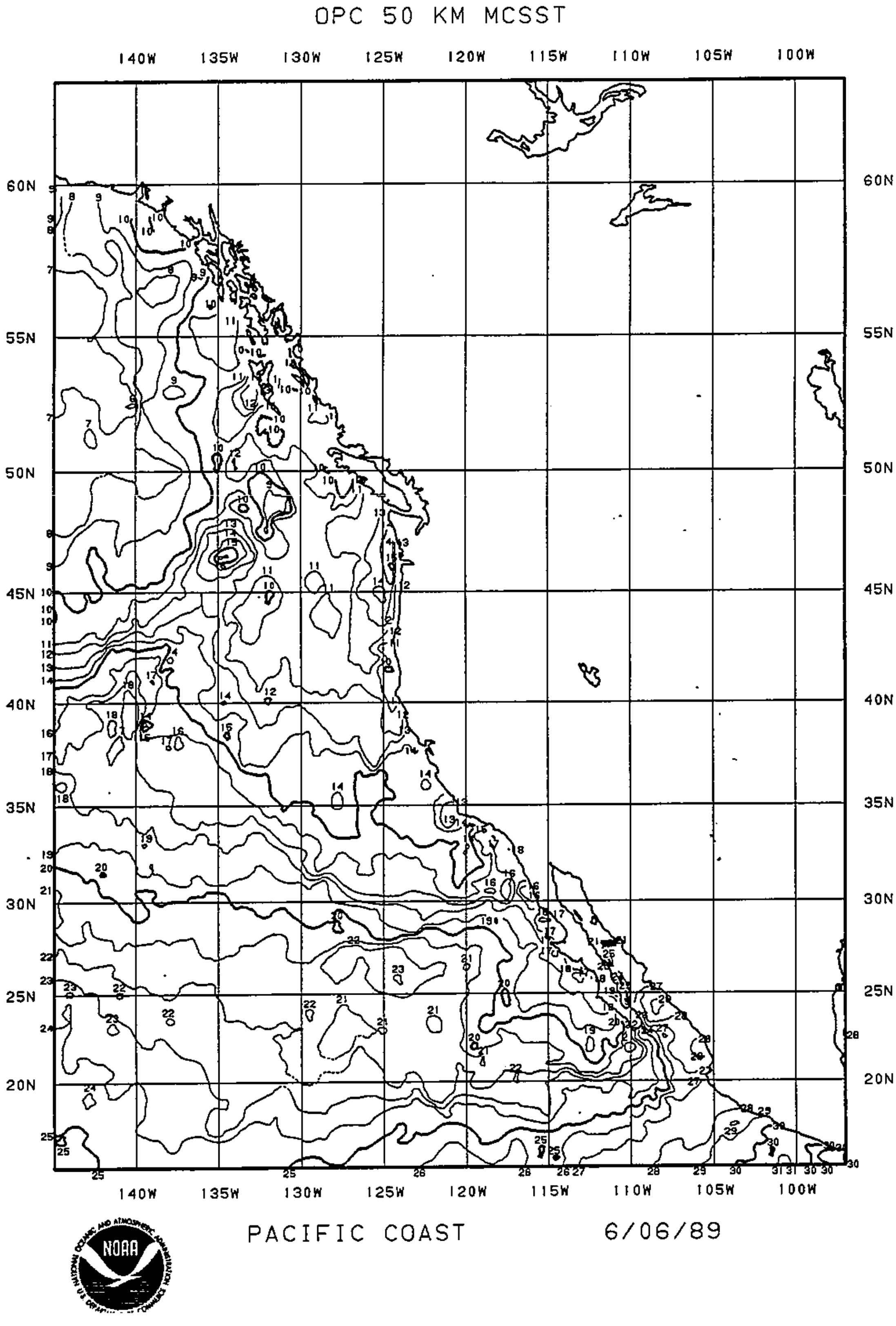


Figure 28. Pacific Coast 50 km resolution satellite only SST (deg C) analysis.

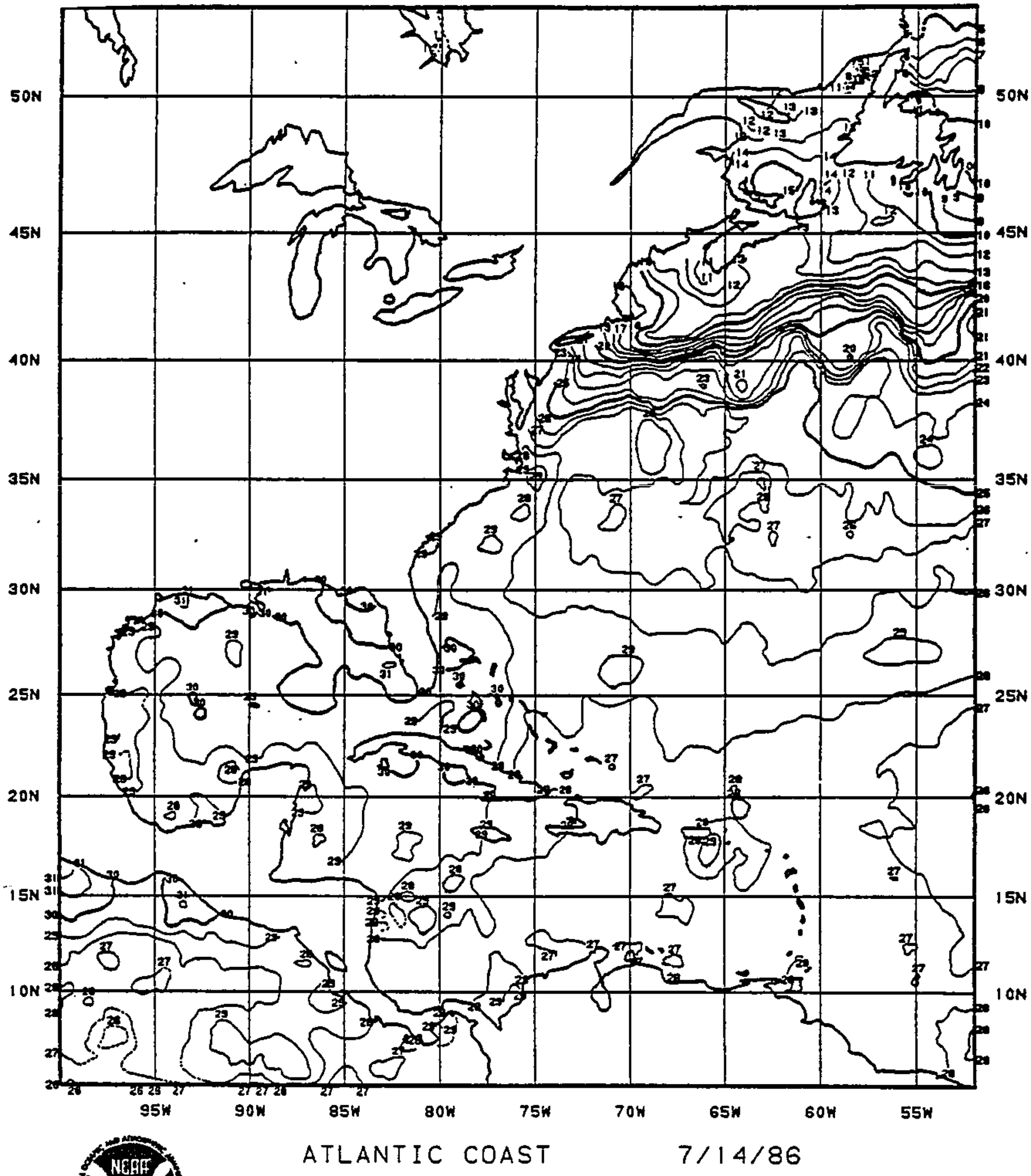


Figure 29. Atlantic Coast 50 km resolution satellite only SST (deg C) analysis.

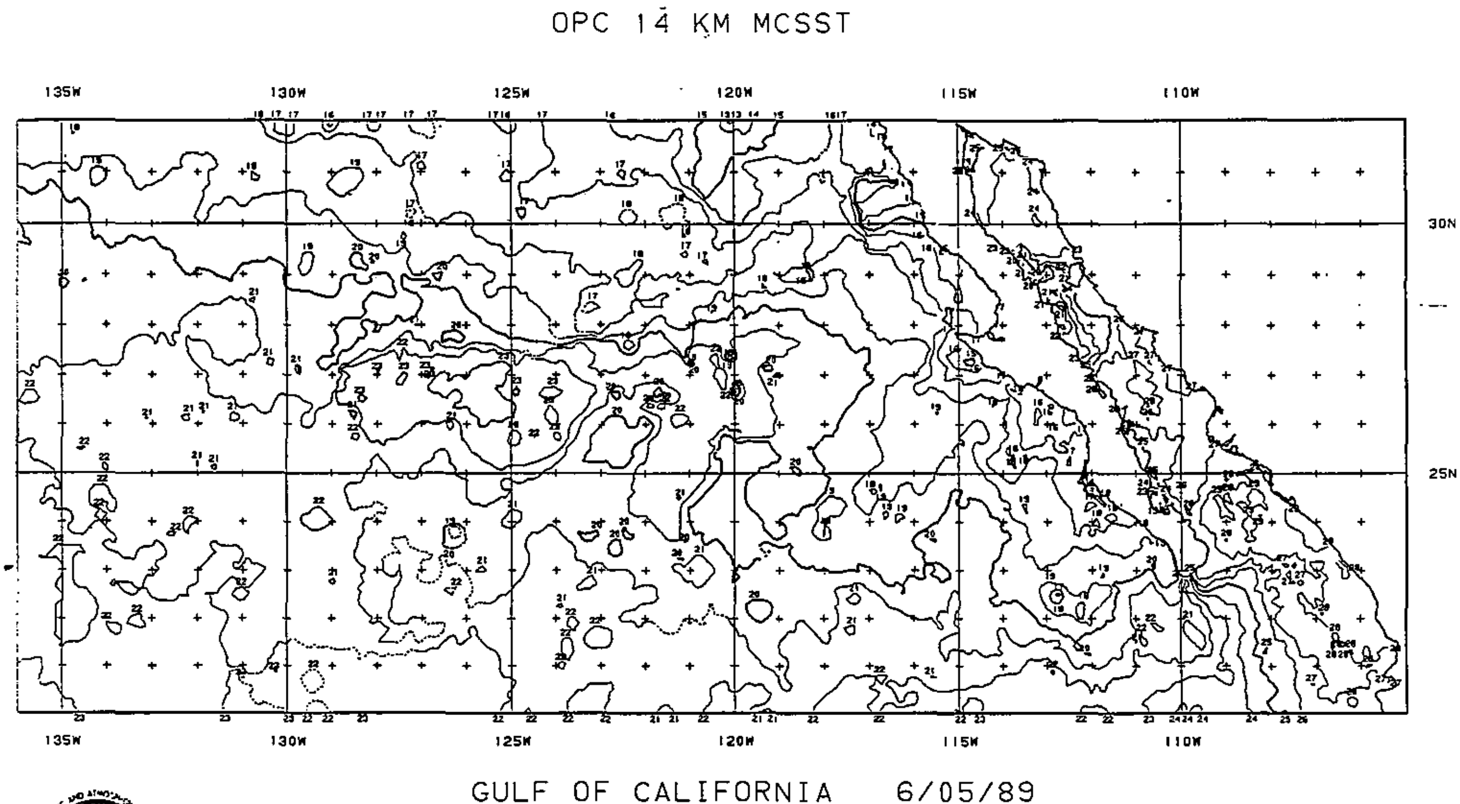


Figure 30. Gulf of California 14 km resolution satellite only SST (deg C) analysis.

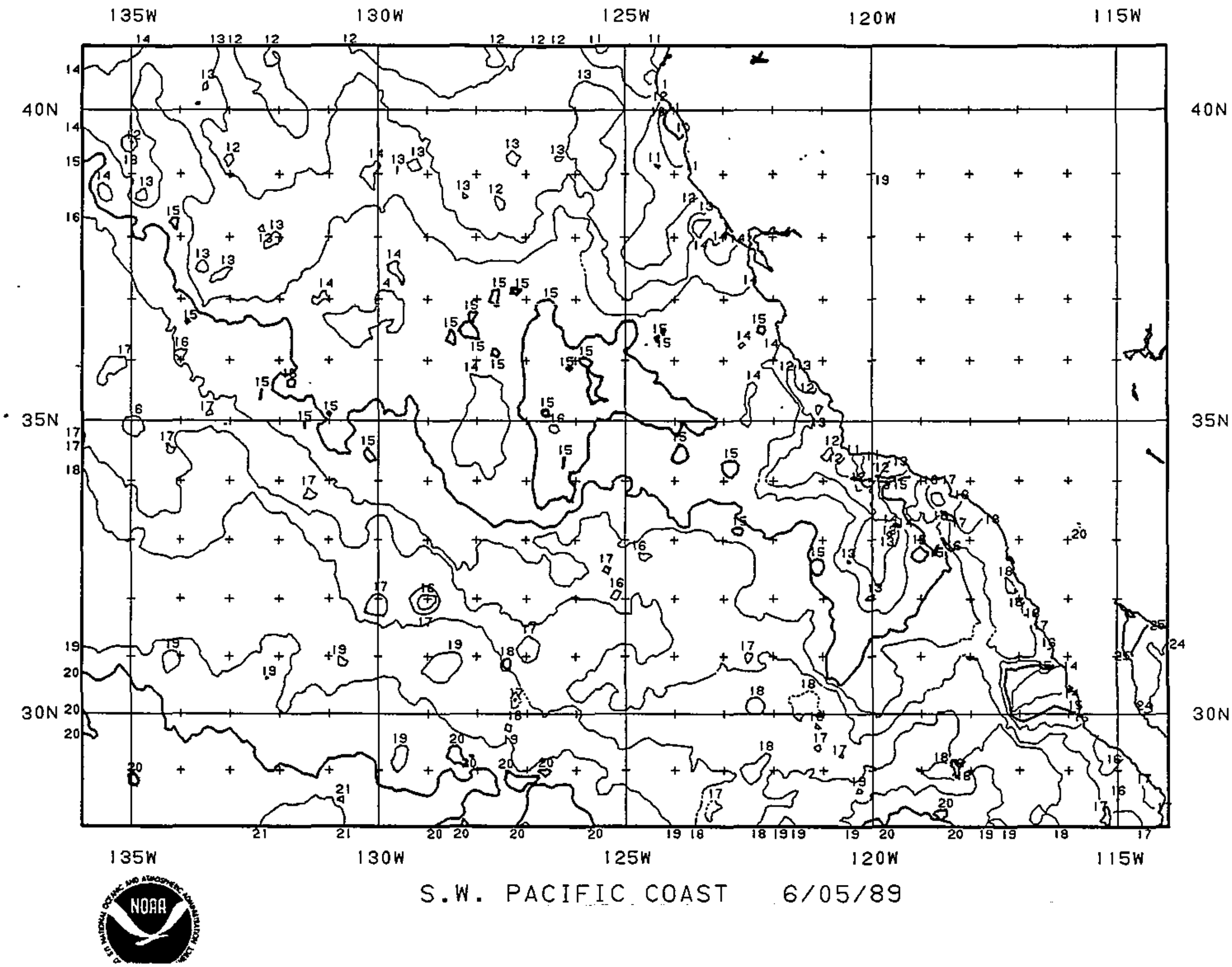


Figure 31. Southwest Pacific Coast 14 km resolution satellite only SST (deg C) analysis.

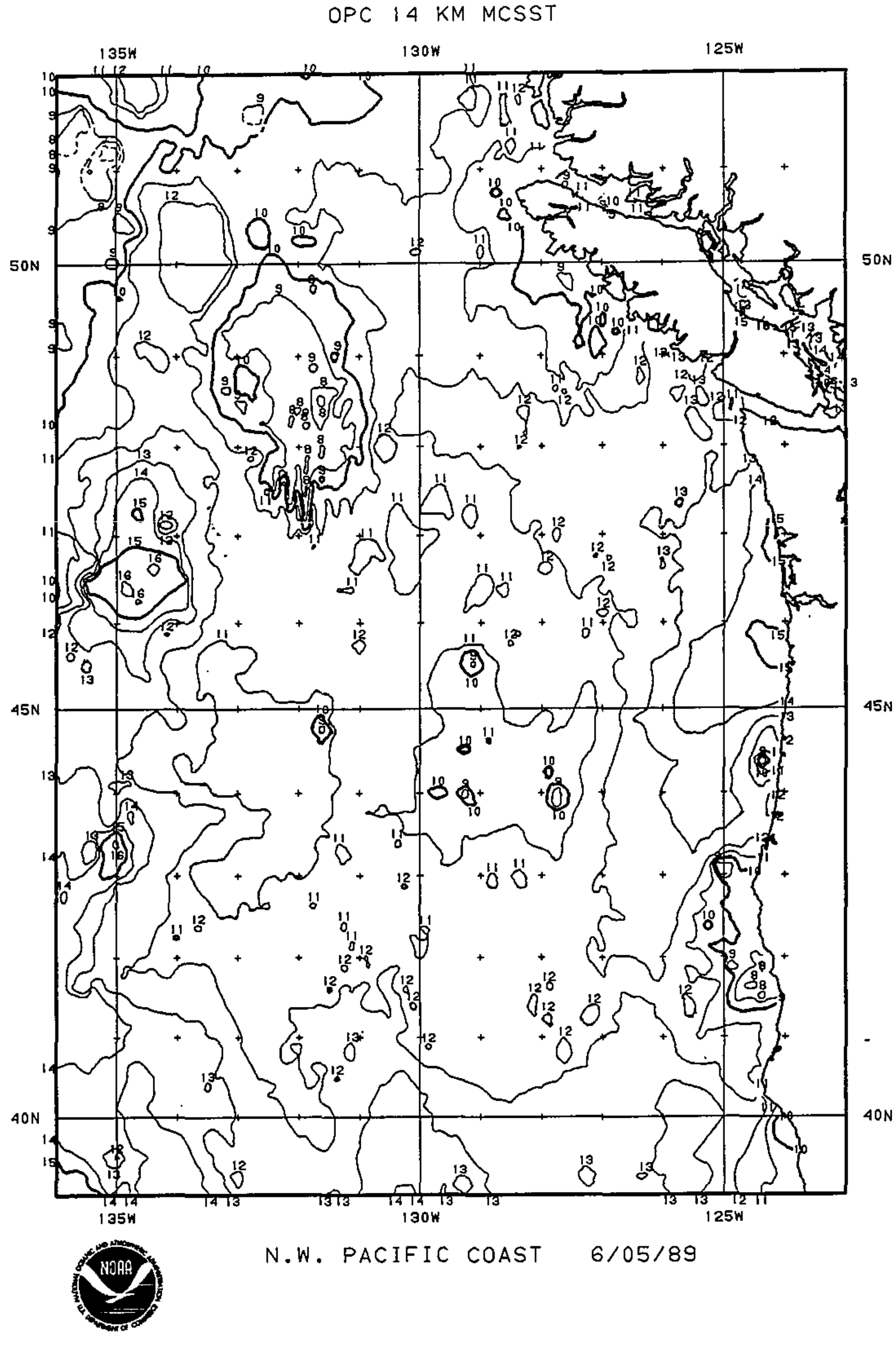


Figure 32. Northwest Pacific Coast 14 km resolution satellite only SST (deg C) analysis.

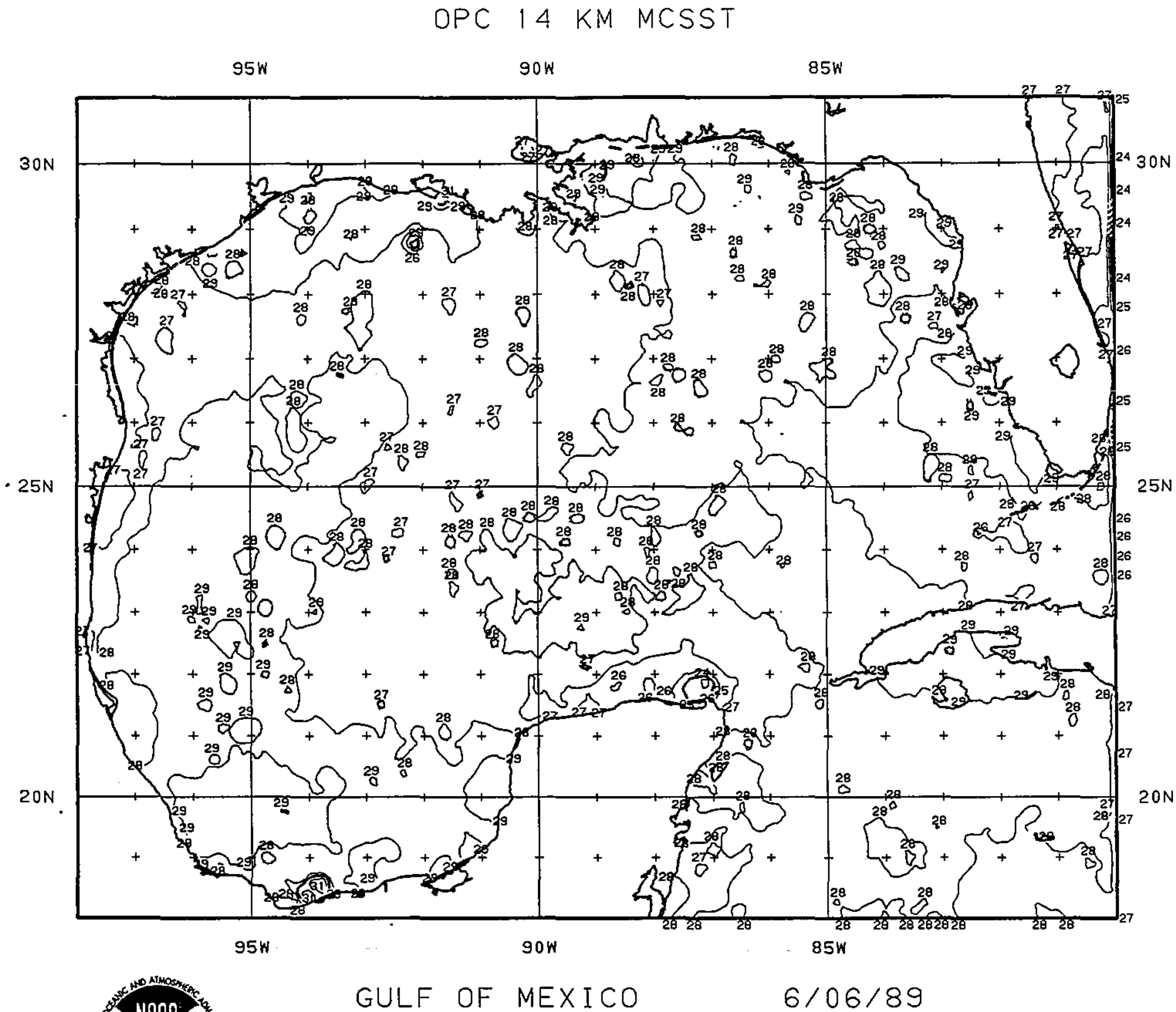


Figure 33. Gulf of Mexico 14 km resolution satellite only SST (deg C) analysis.

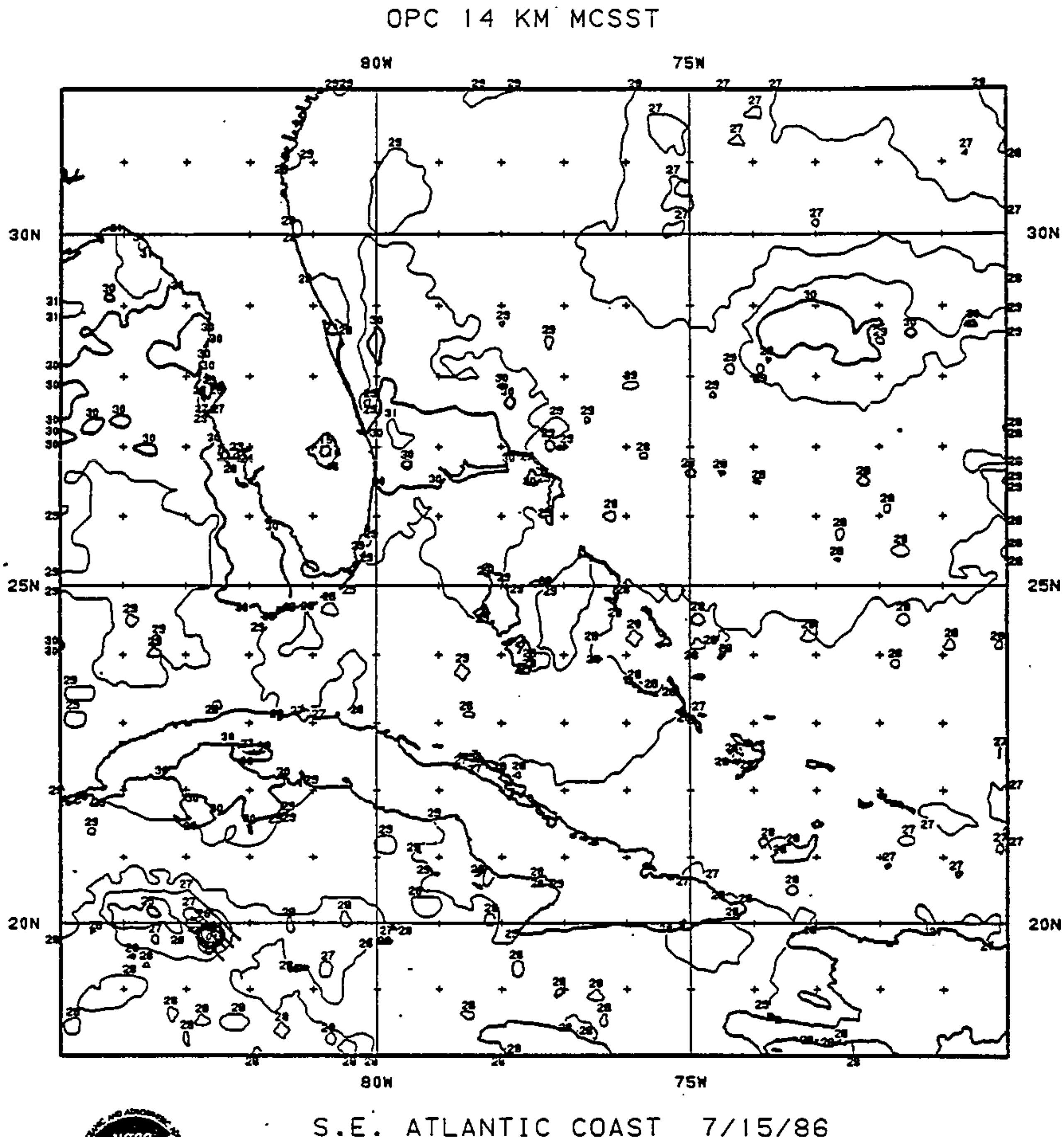


Figure 34. Southeast Atlantic coast 14 km resolution satellite only SST (deg C) analysis.

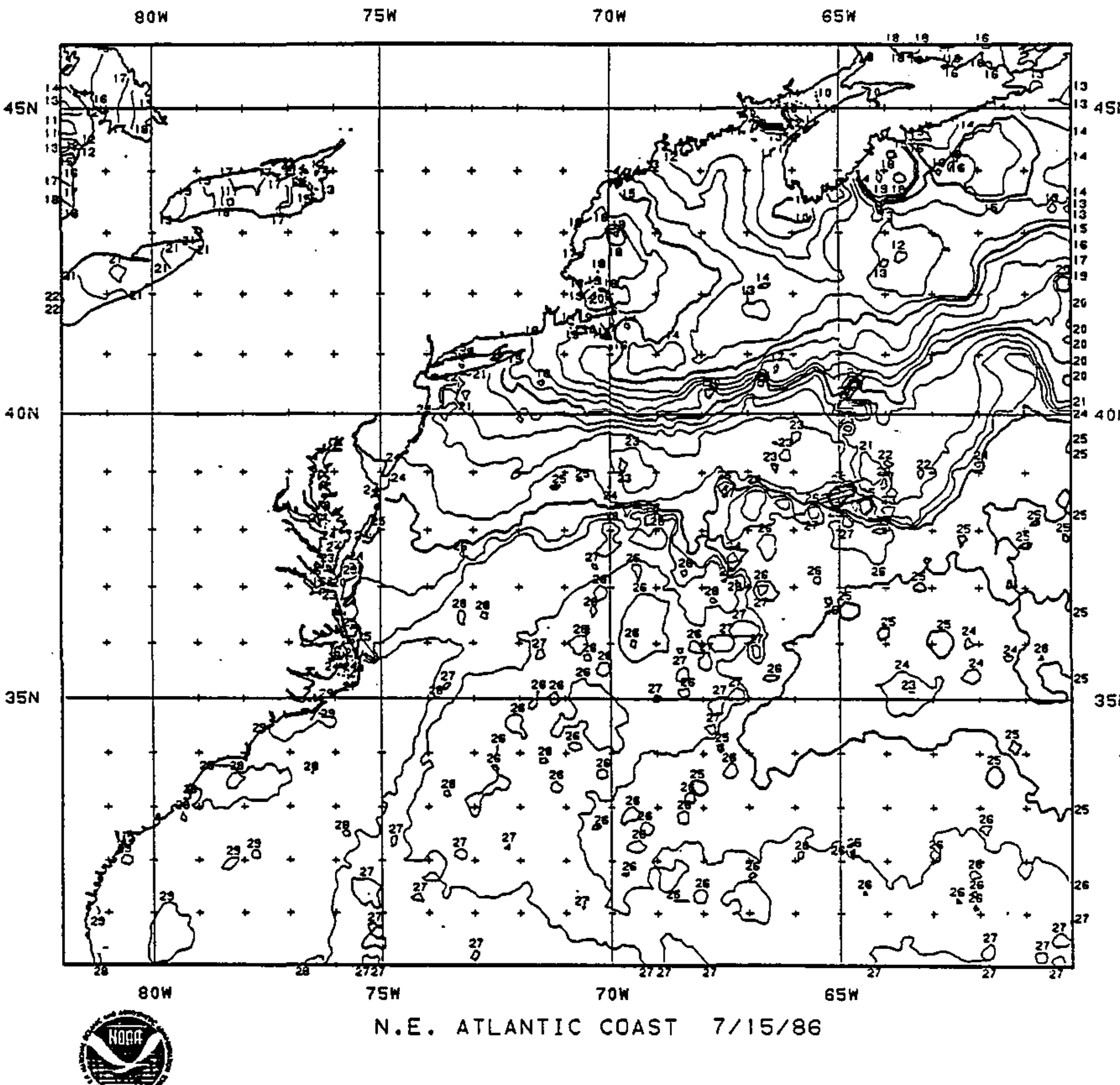


Figure 35. Northeast Atlantic Coast 14 km resolution satellite only SST (deg C) analysis.

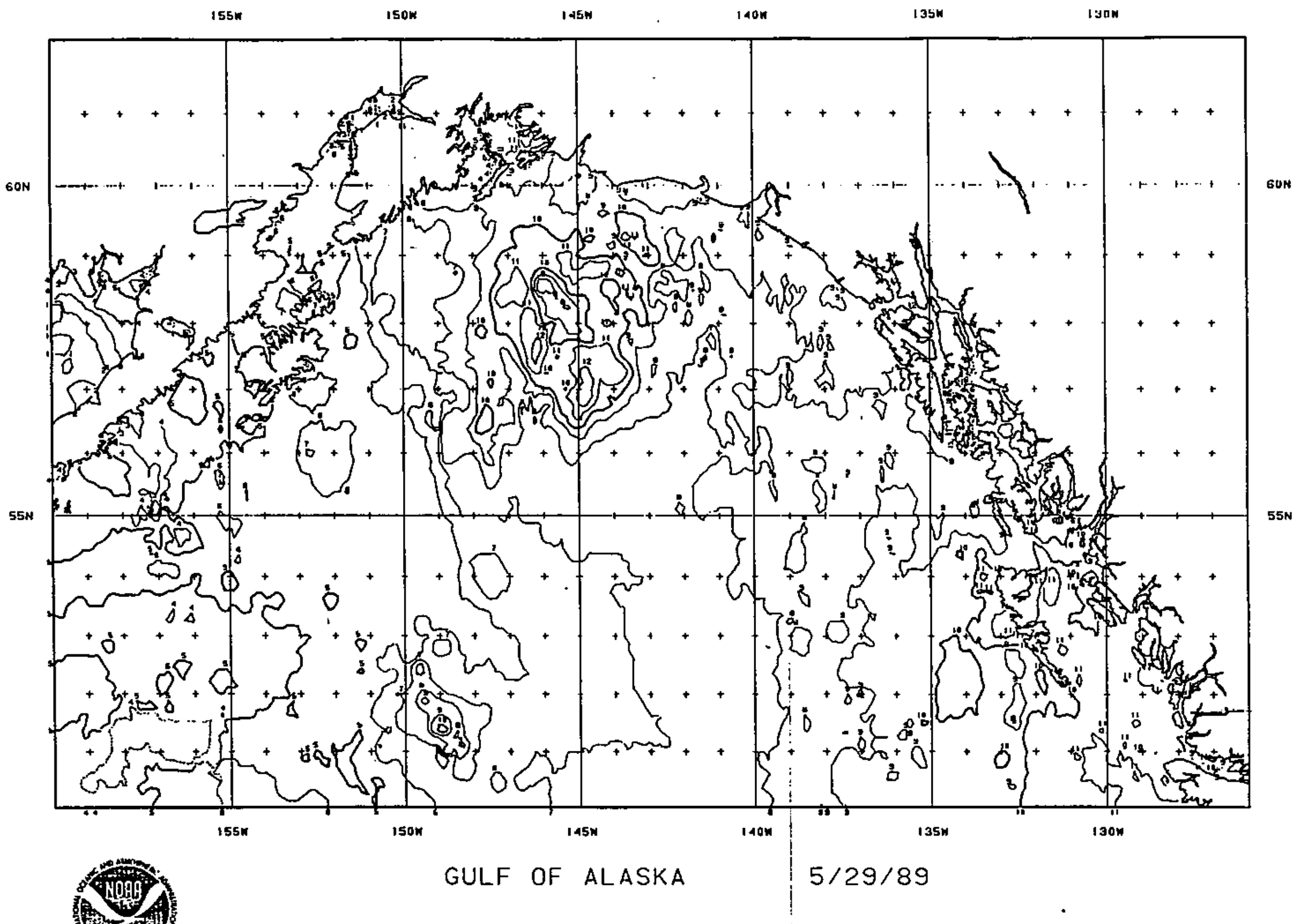


Figure 36. Gulf of Alaska 14 km resolution satellite only SST (deg c) analysis.

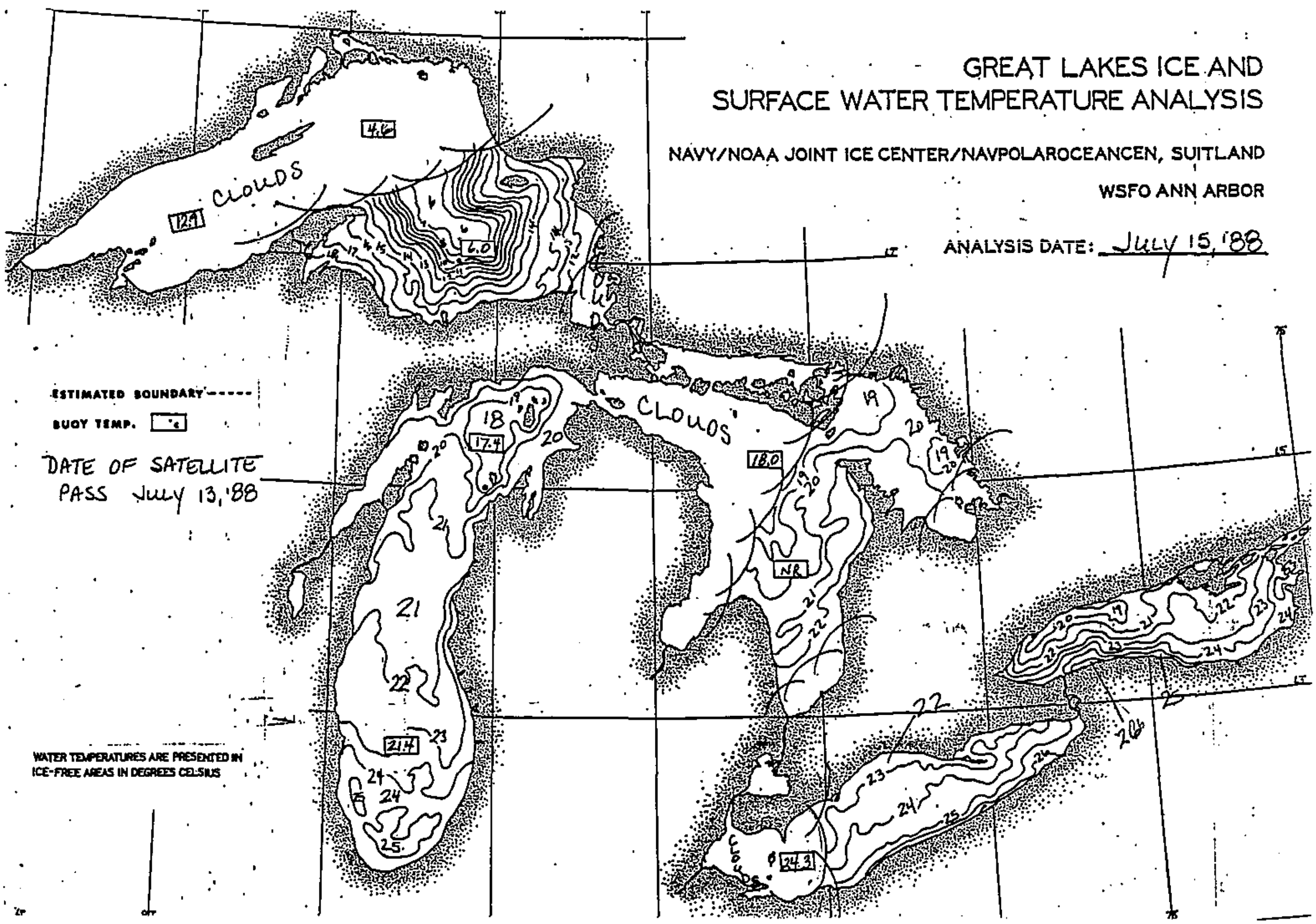


Figure 37. Great Lakes surface temperature (SST).

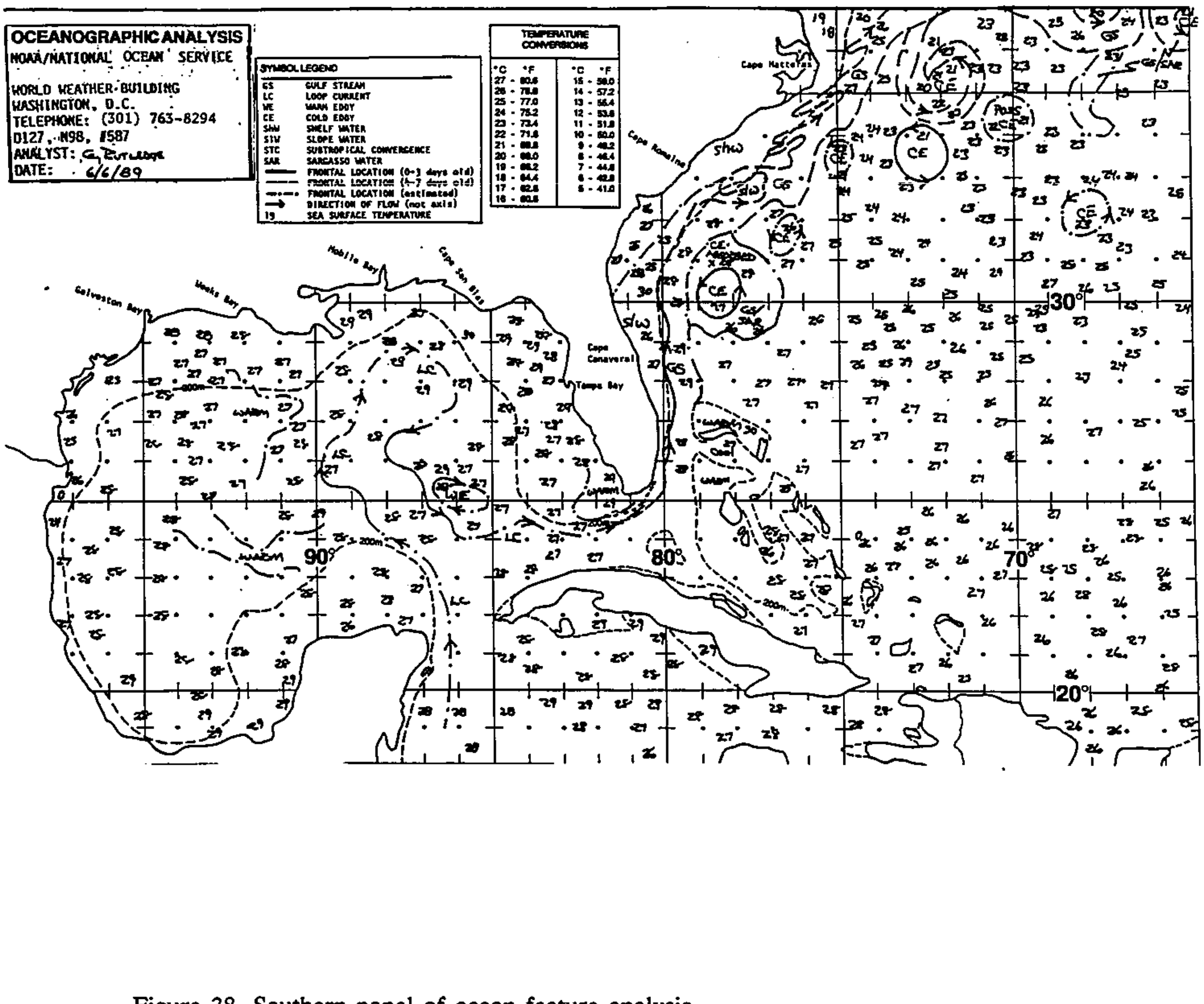


Figure 38. Southern panel of ocean feature analysis.

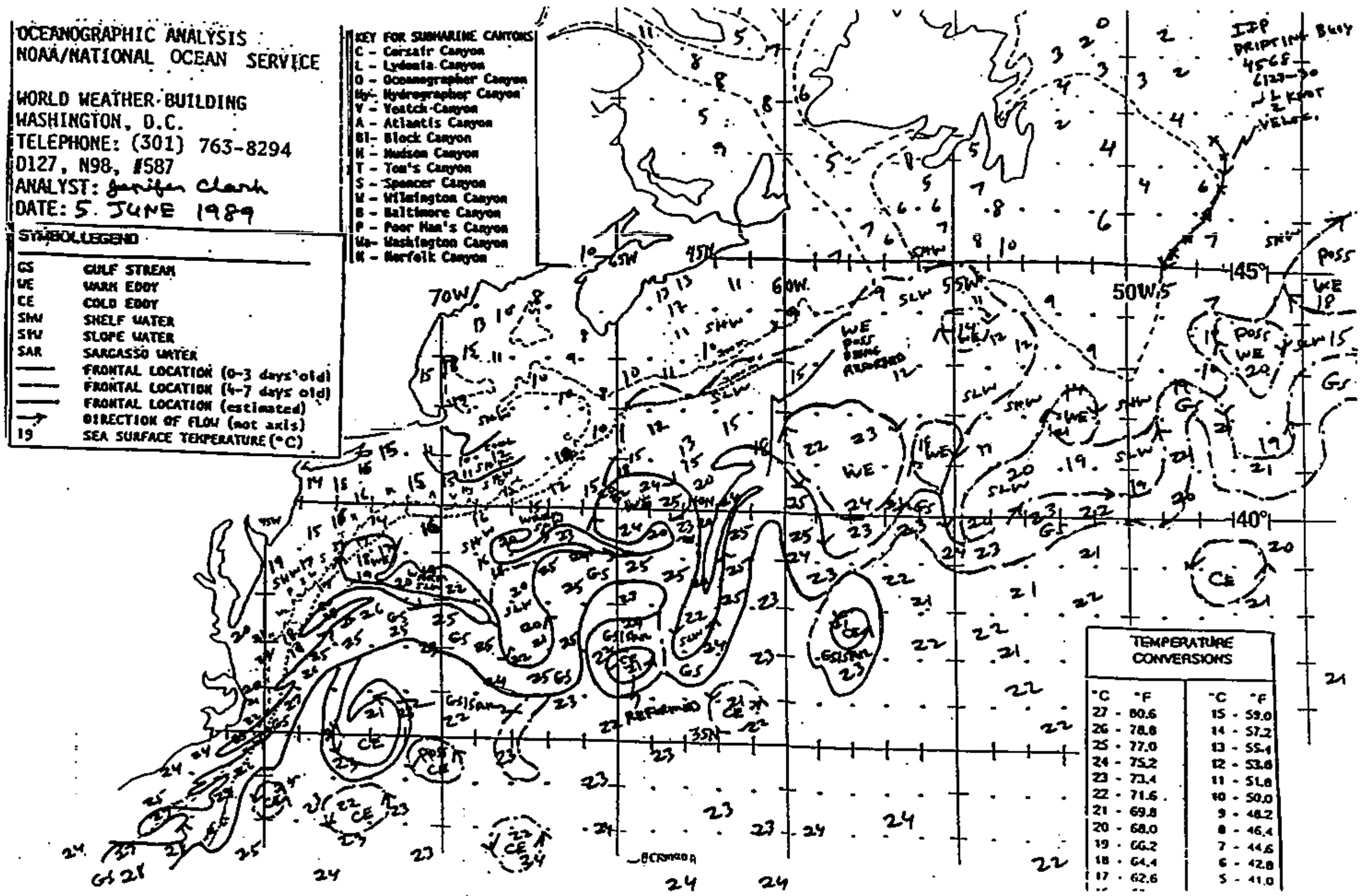


Figure 39. Northern panel of ocean feature analysis.

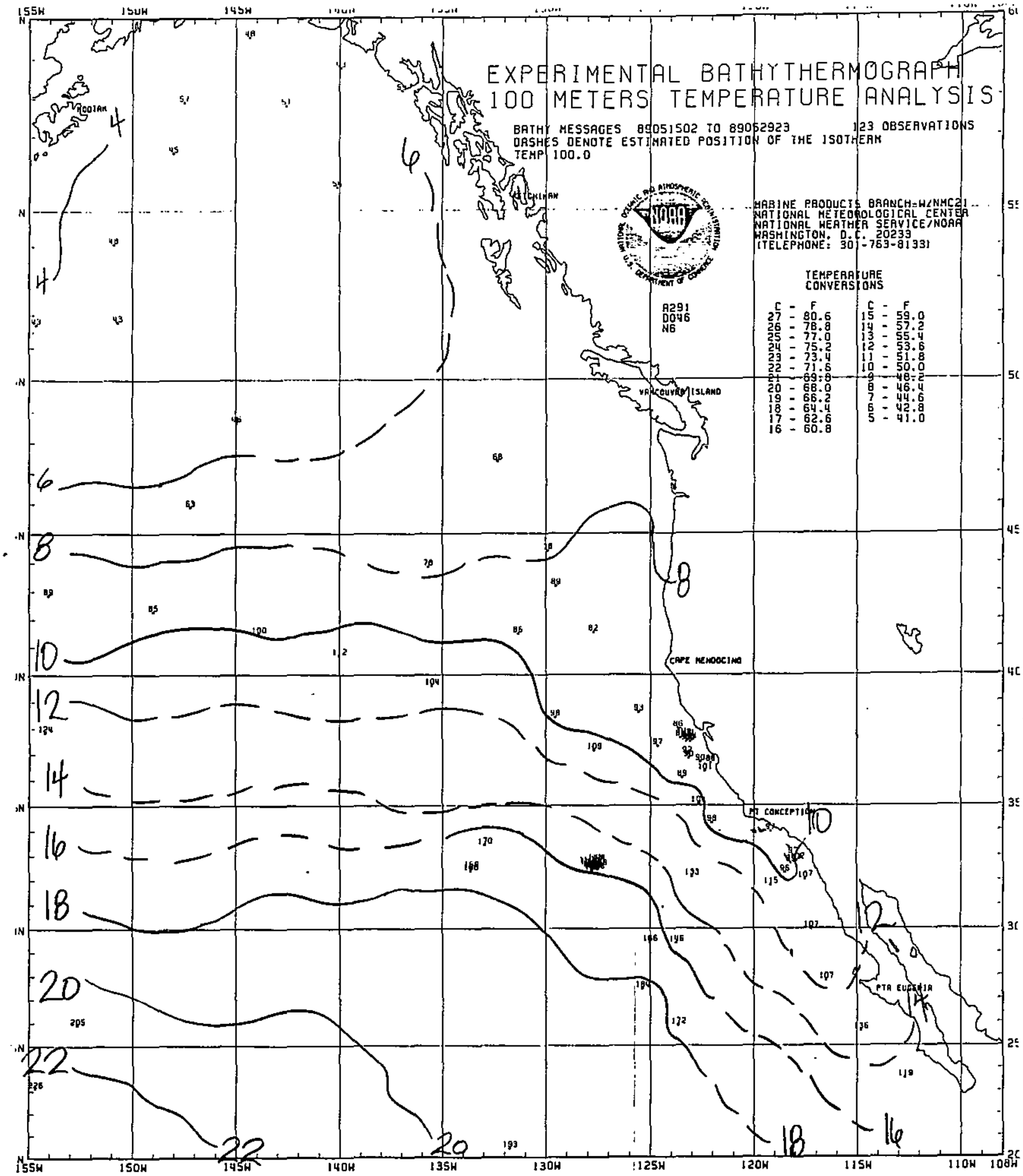


Figure 40. Northeast Pacific 100 meter sub-surface temperature (deg C) analysis.

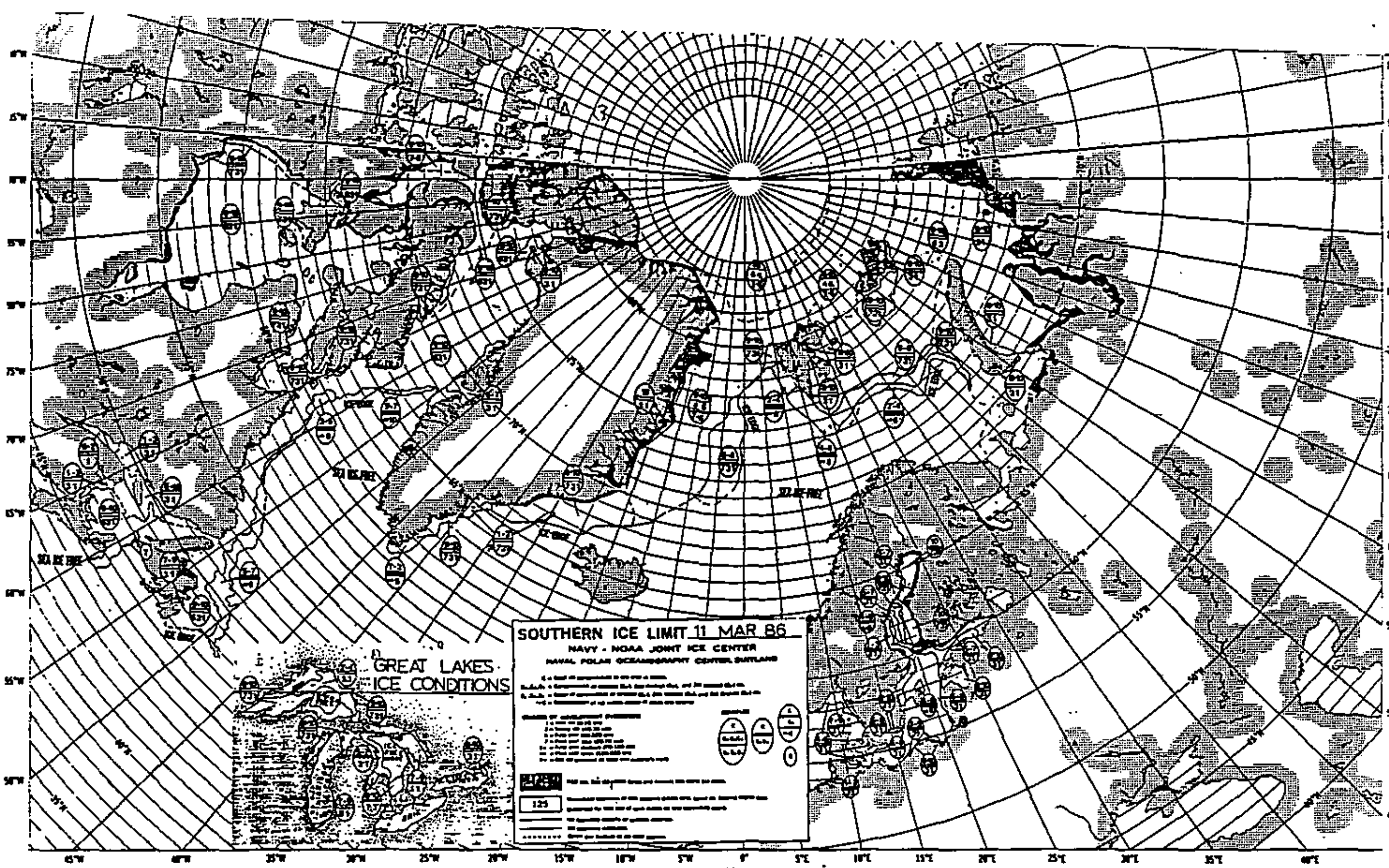
OCEANOGRAPHIC Monthly Summary

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 41. Sample table of contents of Oceanographic Summary.



118041-D

Figure 42. Eastern Arctic ice analysis.

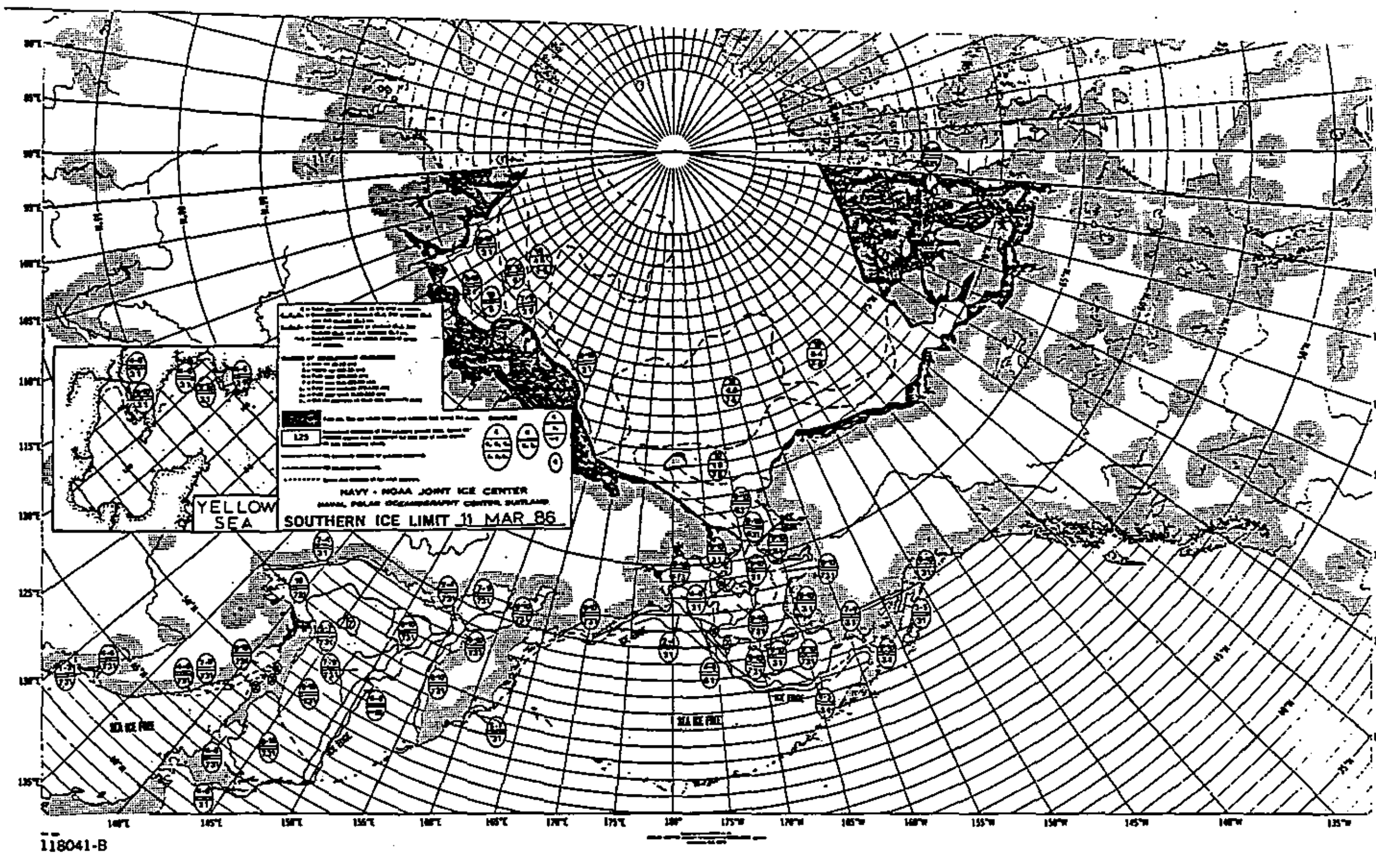


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Figure 43. Western Arctic ice analysis.

118041-F

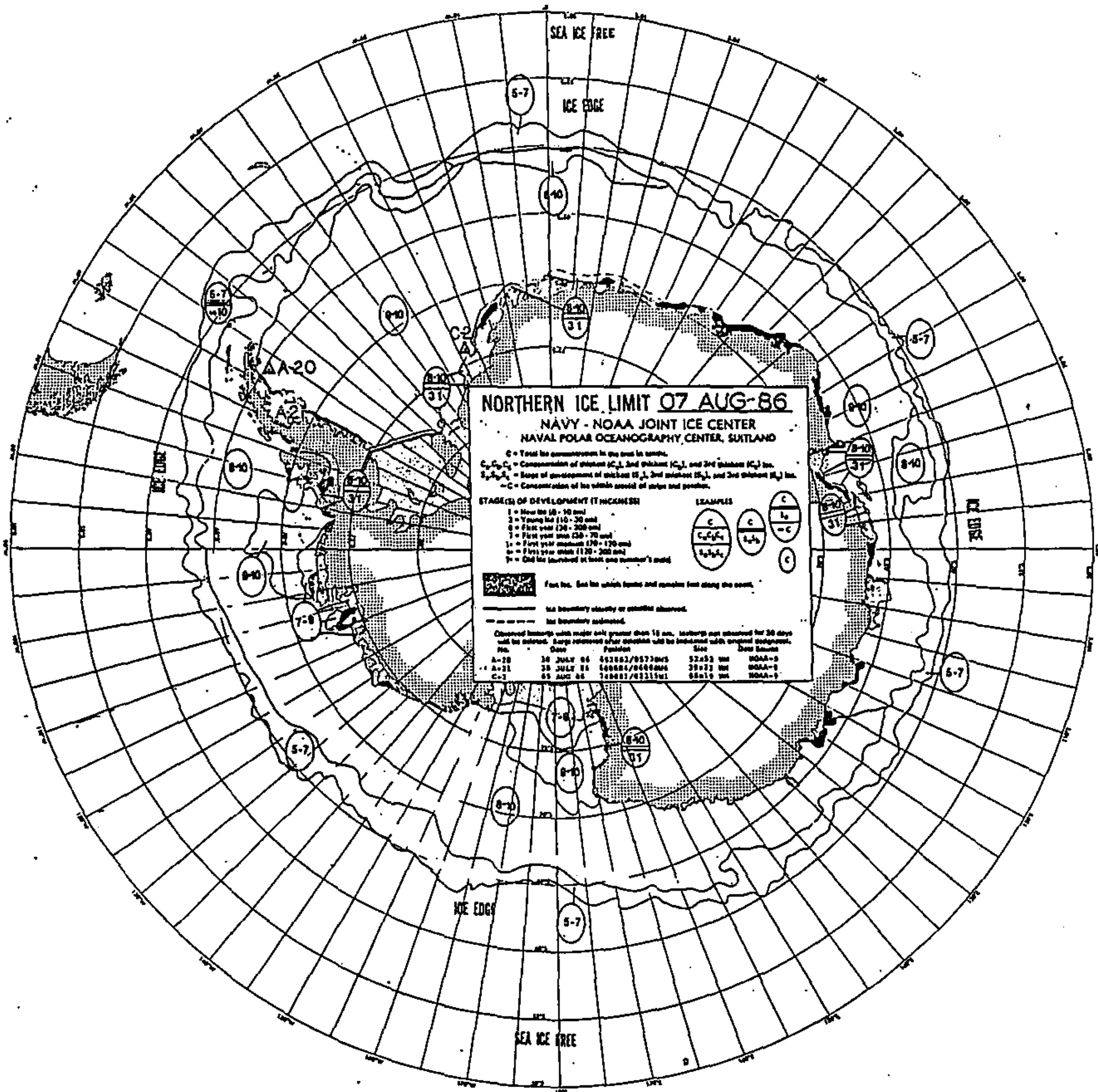

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Figure 44. Antarctic ice analysis.

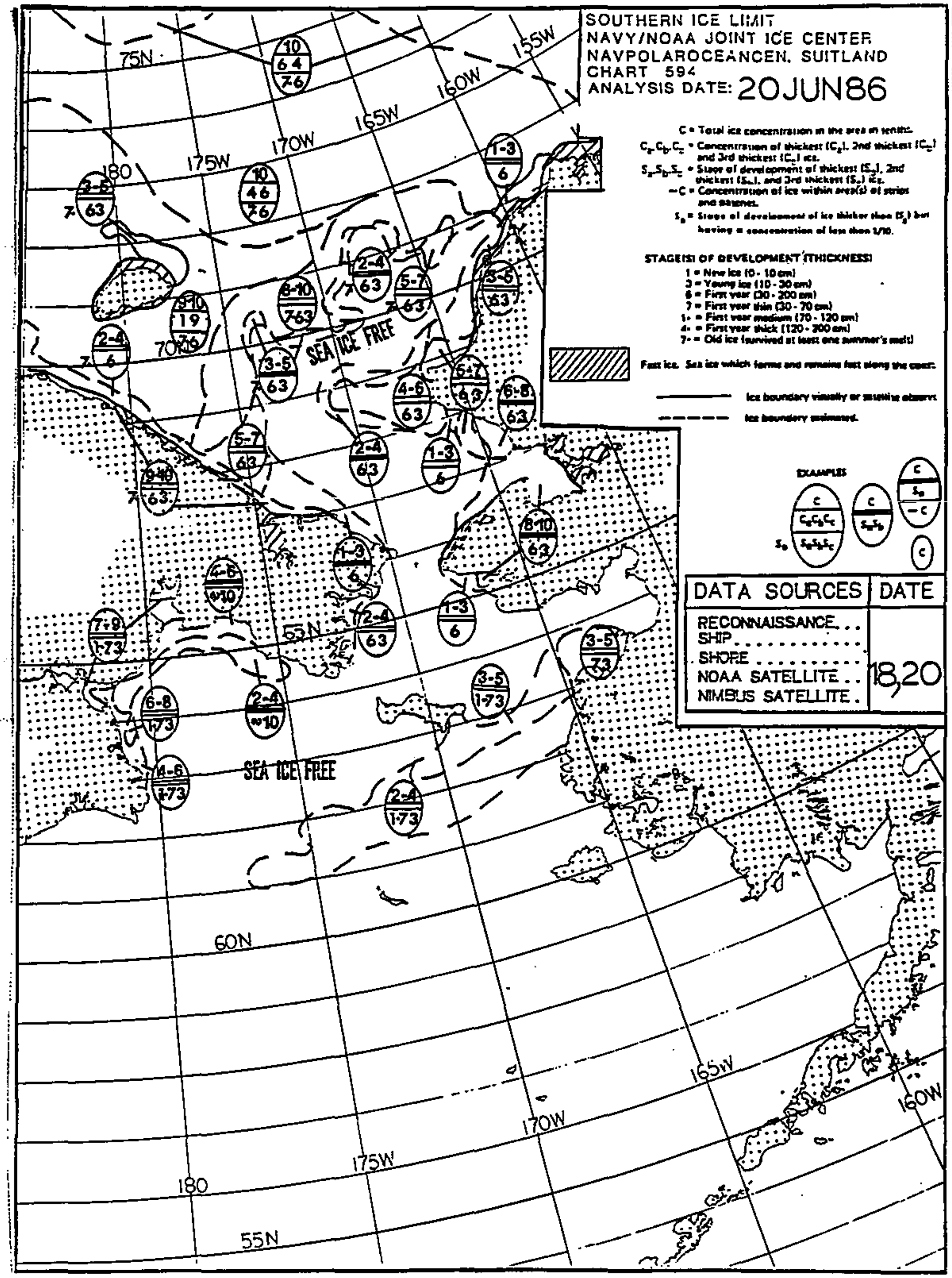

Figure 45. Bering/Chukchi seas ice analysis.

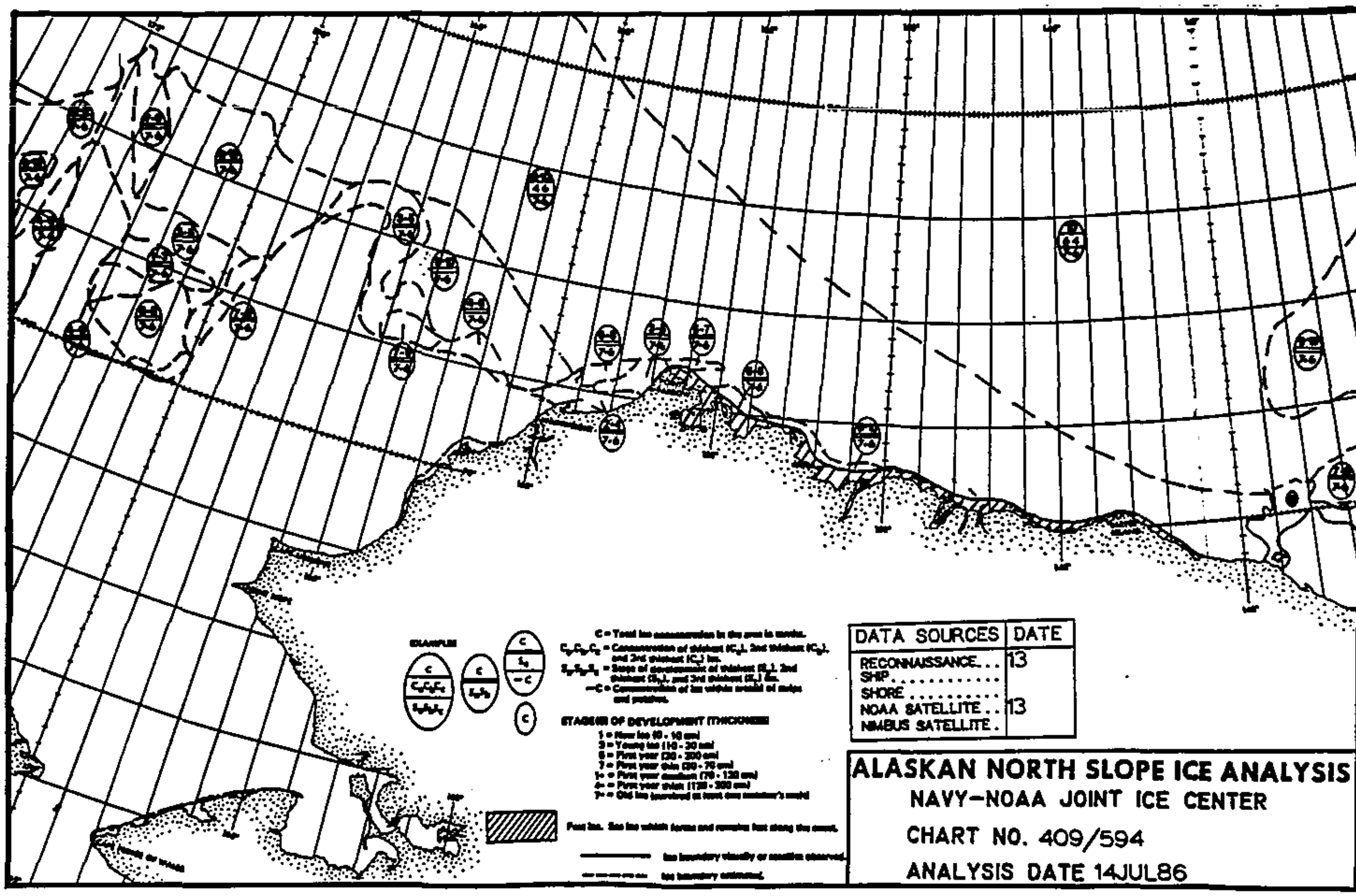

Figure 46. Alaskan North slope ice analysis.

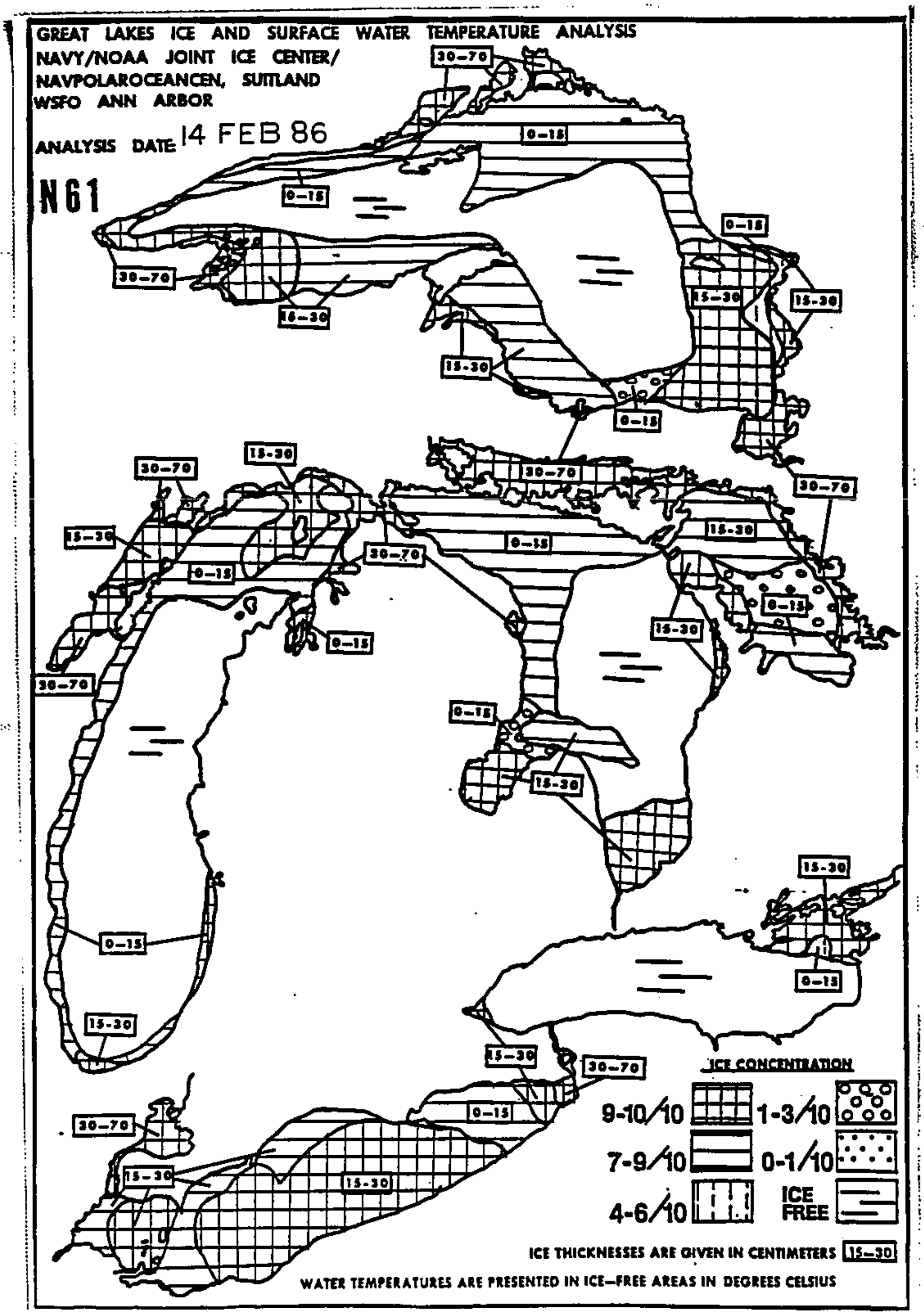

Figure 47. Great Lakes ice analysis.

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P [illegible] MAY 86
FM [illegible]POLAROCEANCEN 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
 [illegible]S5/08110W0 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 6550S6/04950W8 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 48. 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 49. Eastern Arctic 7 day forecast. Decoding information is able from the JIC.

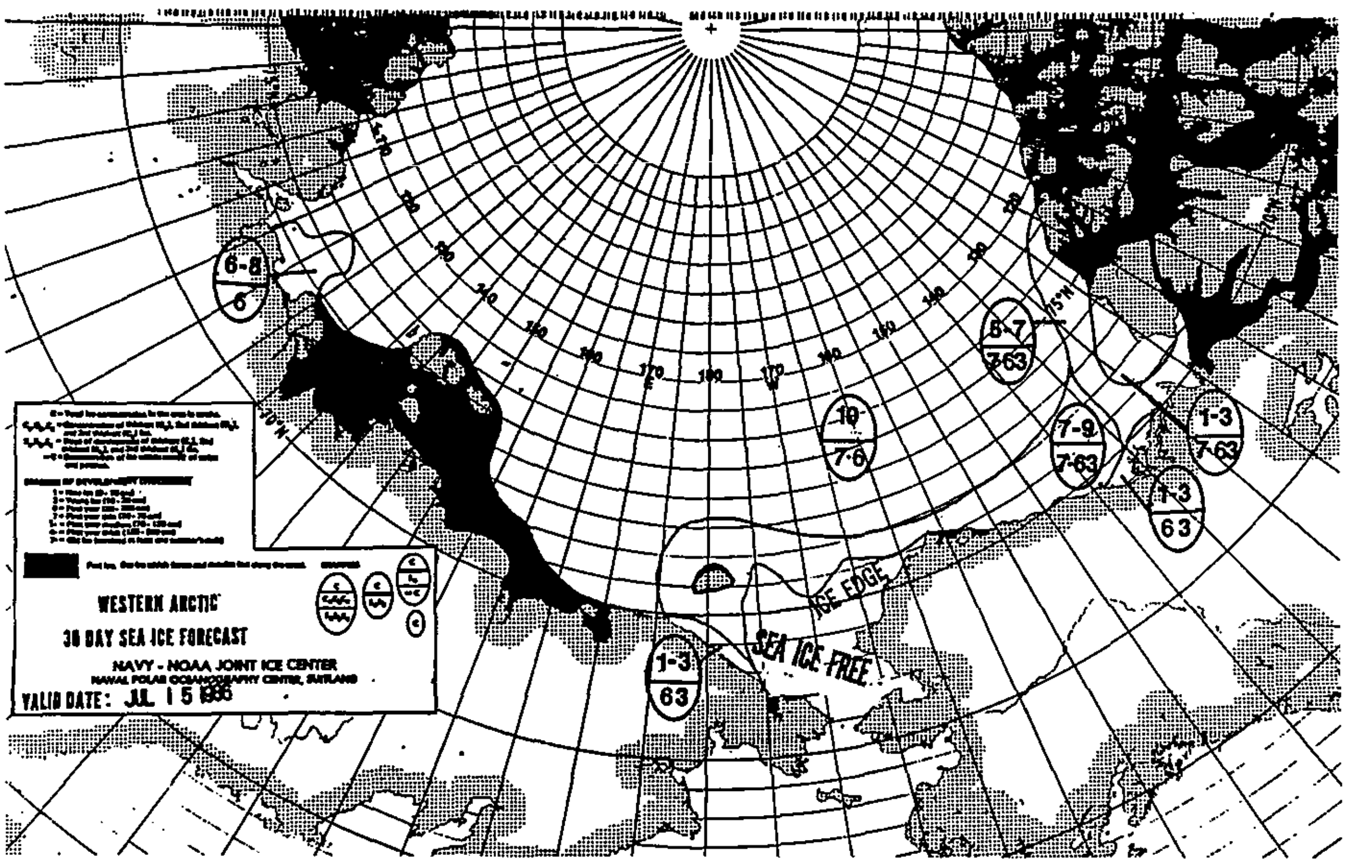

Figure 50. Western Arctic 30 day forecast.

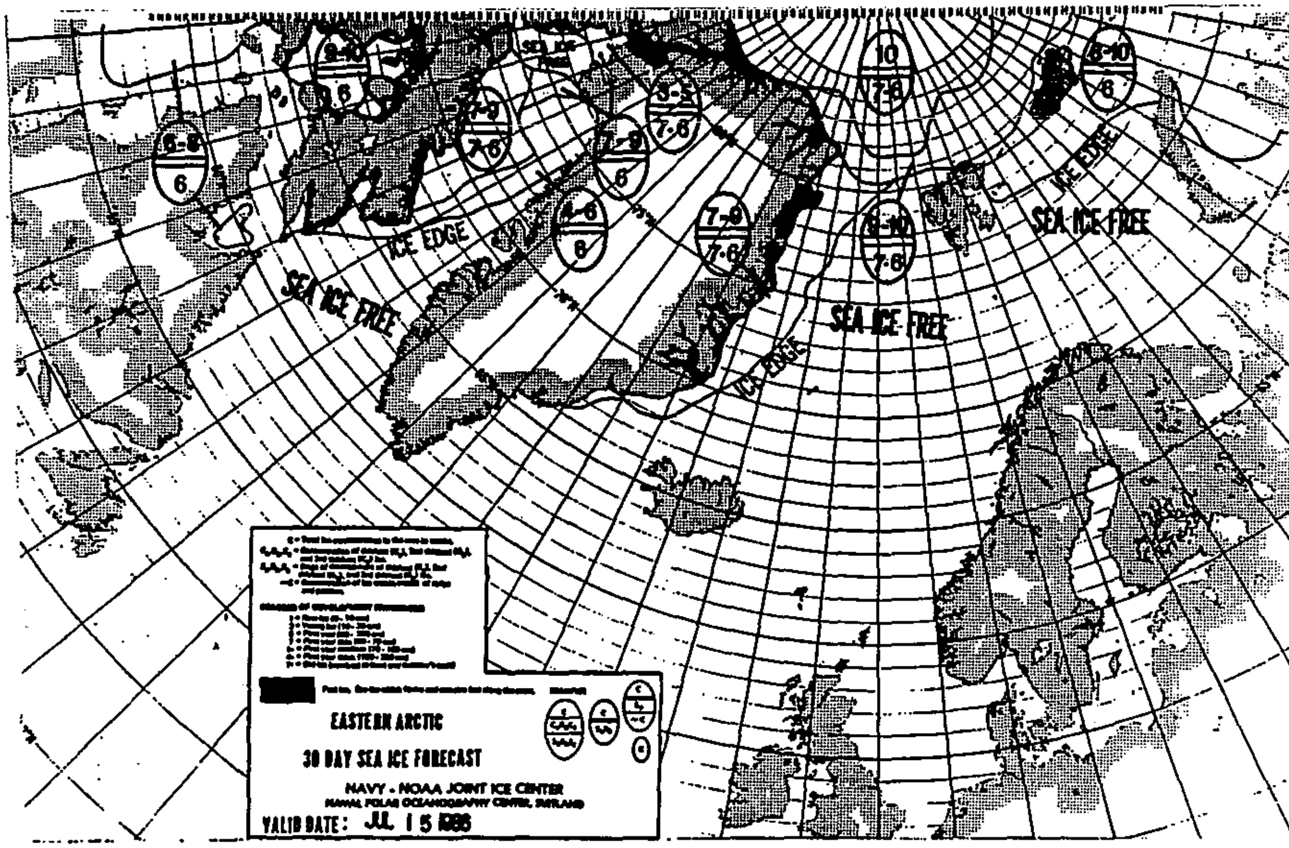

Figure 51. Eastern Arctic 30 day forecast.

IV. PRODUCT DISSEMINATION

OPC products are disseminated by a number of different modes ranging from electronic means to postal delivery. Table 3 below lists the available products and summarizes the production frequency, times available, and dissemination method. Further details concerning availability, status and procedures for accessing these products may be obtained by contacting the OPC directly.

Table 3. Summary of guidance products available through the OPC.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
A. MARINE METEOROLOGY				
Global ocean surface wind	1/day	1000Z	AFOS, FOS, FAX	
Coastal US wind forecasts	2/day	0330Z,1600Z	AFOS	
Great Lakes wind forecasts	2/day	0330Z,1600Z	AFOS	
Santa Ana wind forecasts	2/day	0330Z,1600Z	AFOS	
Marine signif-icant wea chart	1/day	1000Z	AFOS	
Alaska supers-structure icing	1/day	1200Z	AKFAX	
Global super-structure icing	1/day	1000Z	AFOS	displayed on marine significant wea chart
Open ocean fog	1/day	1000Z	AFOS	displayed on marine significant wea chart
B. OCEAN WAVES				
Global ocean wave forecasts	1/day	1000z	AFOS,FAX	
Alpha-numeric ocean wave msg	1/day	1000z	AFOS	

Table 3 cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
C. OCEAN THERMAL STRUCTURE				
Satellite, ship and buoy blended analyses:				
Global SST:				
analysis	1/day	1600Z	NCDC	
anomaly	1/day	1600Z	NCDC	
Atlantic	1/day	S	FAX	subset of global SST
Pacific	1/day	M,T,Th,F	FAX	subset of global SST
TOGA:		3rd day of		
analysis	1/month	month	mail	
anomaly	1/month		mail	
Regional SST:				
15 day composite	2/month	3rd and 17th	NCDC	same areas as E pacific
NW Atlantic	1/week	S	NCDC, FAX	
E Pacific	5/week	T,W,Th, S,Su	NCDC, FAX	
Gulf of Mexico	1/week	S	NCDC, FAX	
Gulf of Alaska	4/week	M,W,F,Su	NCDC, FAX	
100 m subsurface	1/week	F	NCDC	
Satellite only SST analyses:				
Global	1/week	T	NCDC	100 km resolution
Pacific Islands	1/week	T	NCDC	50 km resolution
Alaska/ Hawaii	1/week	T	NCDC	50 km resolution

Table 3 cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
EPOCS	1/week	T	NCDC	50 km resolution
Pacific coast	1/week	T	NCDC	50 km resolution
Atlantic coast	1/week	T	NCDC	50 km resolution
G of California	2/week	T, S	NCDC	14 km Resolution
S Pacific coast	2/week	T, S	NCDC	14 km Resolution
N Pacific coast	2/week	T, S	NCDC	14 km Resolution
G of Alaska	2/week	T, S	NCDC	14 km Resolution
G of Mexico	2/week	W, Su	NCDC	14 km Resolution
S Atl coast	2/week	W, Su	NCDC	14 km Resolution
N Atl coast	2/week	W, Su	NCDC,	14 km Resolution
Great Lakes sfc temp	2/week	W,S	NCDC, FAX	during ice free season
Ocean feature analysis	1/day	1400Z	NCDC, FAX	GS/Loop alternate days
Oceanographic Monthly Summary	1/month		NCDC	

D. POLAR SEAS AND GREAT LAKES ICE

ANALYSES:

Eastern/Western Arctic	1/week	W/Th	Mail, FAX, AUTODIN	
Antarctic	1/week	F	Mail, FAX, AUTODIN	
Alaskan region	3/week	M,W,F	Mail, FAX	
Great Lakes	3/week	M,W,F	Mail, FAX	
ship support	As req.		INMARSAT AUTODIN	

Table 3 cont.

PRODUCT	PRODUCTION FREQUENCY	TIMES AVAILABLE	DISSEMINATION METHOD	REMARKS
FORECASTS:				
Eastern/Western Arctic (7 day)	1/week	Th	FAX, AUTODIN	
7 day Ross Sea	1/week	F	AUTODIN, FAX	Nov–Feb
Western/Eastern Arctic 30 day	2/month	15th/30th	Mail, FAX	
Eastern Arctic 30 day forecast	2/month	15th/30th	Mail, FAX	
Seasonal outlook:				
Western Arctic/ Alaskan	1/year	May	Mail, FAX	
Eastern Arctic/ Baffin Bay	1/year	May	Mail, FAX	
Western Ross Sea/ McMurdo Sd	1/year	Oct	Mail FAX	
ship support	as req.		INMARSAT, AUTODIN	

V. SUMMARY AND FUTURE PLANS

A brief review of the methods involved in the generation of various OPC operational analyses and forecasts is presented. Each type of chart and message generated at the center is Illustrated along with information concerning availability and methods of dissemination. 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 will undergo periodic re-examination, in view of the latest technical advances, to determine their value to users and their validity. Plans for improving the existing material and developing new products are continually evolving and parallel the progress in the art of numerical weather and ocean prediction, improved analysis techniques, increased availability of data from future satellites, and the advent of advanced dissemination systems.

Future plans include:

an examination of the feasibility of using a numerical fog model to forecast fog in coastal and offshore areas;

developing a system to forecast rapidly developing cyclones, particularly in the Pacific Ocean;

further improving wave forecasts generated by the NOW model;

assessing the impact of data assimilation from satellite altimeters and scatterometers on numerical weather and wave forecast models;

continuing the development of regional scale wave models;

developing models, for use on micro-computers, which forecast wave conditions over bars and at river entrances;

re-examining the technique for blending *in situ* and satellite data for regional SST analysis;

applying objective techniques to sub-surface thermal structure analyses.

ACKNOWLEDGMENTS

The author wishes to acknowledge L. Burroughs, W.B. Campbell, J. Clark, Y.Y. Chao, D. Esteva, W. H. Gemmill, J. Kundrat, G. Wohl, and T.W. Yu for providing much of the basic information for this revised 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 Susan Hubbard for helping to assemble this document, and to the OPC staff whose efforts made this publication possible.

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(continued from inside front cover)

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NWS NMC 53 A Semi-Implicit Version of the Shuman-Hovermale Model. Joseph P. Gerrity, Jr., Ronald D. McPherson, and Stephen Scolnik, July 1973, 44 pp. (COM-73-11323)

NWS NMC 54 Status Report on a Semi-Implicit Version of the Shuman-Hovermale Model. Kenneth Campana, March 1974, 22 pp. (COM-74-11096/AS)

NWS NMC 55 An Evaluation of the National Meteorological Center's Experimental Boundary Layer Model. Paul D. Polger, December 1974, 16 pp. (COM-75-10267/AS)

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NWS NMC 58 Operational-Type Analyses Derived Without Radiosonde Data from NIMBUS 5 and NOAA 2 Temperature Soundings. William D. Bonner, Robert Van Haaren, and Christopher M. Hayden, March 1976, 17 pp. (PB-256-099)

NWS NMC 59 Decomposition of a Wind Field on the Sphere. Clifford H. Dey and John A. Brown, Jr. April 1976, 13 pp. (PB-265-422)

NWS NMC 60 The LFM Model 1976: A Documentation. Joseph P. Gerrity, Jr., December 1977, 68 pp. (PB-279-419)

NWS NMC 61 Semi-Implicit Higher Order Version of the Shuman-Hovermale Model. Kenneth A. Campana, April 1978, 55 pp. (PB-286-012)

NWS NMC 62 Addition of Orography to the Semi-Implicit Version of the Shuman-Hovermale Model. Kenneth A. Campana, April 1978, 17 pp. (PB-286-009)

NWS NMC 63 Day-Night Differences in Radiosonde Observations in the Stratosphere and Troposhere. Raymond M. McInturff, Frederick G. Finger, Keith W. Johnson, and James D. Laver, September 1979, 54 pp. (PB80 117989)

NWS NMC 64 The Use of Drifting Buoy Data at NMC. David Wright, June 1980, 23 pp. (PB80 220791)

NWS NMC 65 Evaluation of TIROS-N Data, January-June 1979. David Wright, June 1980, 21 pp. (PB80 220494)

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NWS NMC 67 Gulf Stream System Landward Surface Edge Statistics. Stephen J. Auer, October 1983, 20 pp. (PB84 104314)

NWS NMC 68 Compendium of Marine Meteorological and Oceanographic Products of the Ocean Products Center. David M. Feit, September 1986, 93 pp. (PB87 101812/AS)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

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