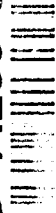


AD-A236 540



**EASTERN—WESTERN
ARCTIC SEA ICE ANALYSES
1989**

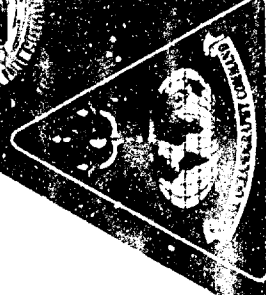
**PREPARED BY
NAVAL POLAR OCEANOGRAPHY CENTER
SUITLAND, MD**

**PREPARED UNDER AUTHORITY OF
COMMANDER, NAVAL OCEANOGRAPHY COMMAND
STENNIS SPACE CENTER, MS 39529-5000**

91-01433



A-1



FOREWORD

The U.S. Navy has a long and eventful history of polar exploration from Robert E. Peary in the Arctic to Richard E. Byrd in the Antarctic. In recent years the strategic importance and expanded research pursuits in these areas have resulted in greater national and international requirements for environmental information. Since 1976, the National Oceanic and Atmospheric Administration (NOAA) and the Navy have worked together at the Joint Ice Center (JIC) in Suitland, Maryland. By combining the Navy's experience in observing and recording sea ice data, and NOAA's expertise in satellite data collection and interpretation, the JIC has been able to keep pace with that demand in both polar regions.

This publication is the 16th edition of the Arctic sea ice atlases prepared by the JIC. The atlas contains weekly charts depicting Northern Hemisphere and Great Lakes ice conditions and extent. The significant use of high resolution satellite imagery, combined with valuable ice reconnaissance data from various sources, has greatly improved the accuracy of these analyses.

The purpose of this atlas is to provide the user with reliable weekly hemispheric ice analyses. Both Navy and NOAA personnel with considerable experience in sea ice analysis prepare the analyses. The following procedures have been developed to ensure the quality of the final products:

- a. Conventional shore station, ship and aerial ice reconnaissance observations are plotted and evaluated.
- b. Satellite data from different sensors is compared and analyzed for ice information content. Table I, located on the inside back cover, summarizes satellite data availability for 1989.
- c. A final product results from a and b. However, where insufficient data is available, an estimated boundary will be depicted. Meteorological data and computer generated ice drift vectors are utilized to determine the estimated ice edge position.

NAVY / NOAA Joint Ice Center
Naval Polar Oceanography Center
4301 Suitland Road
Washington, DC 20395-5180

1989

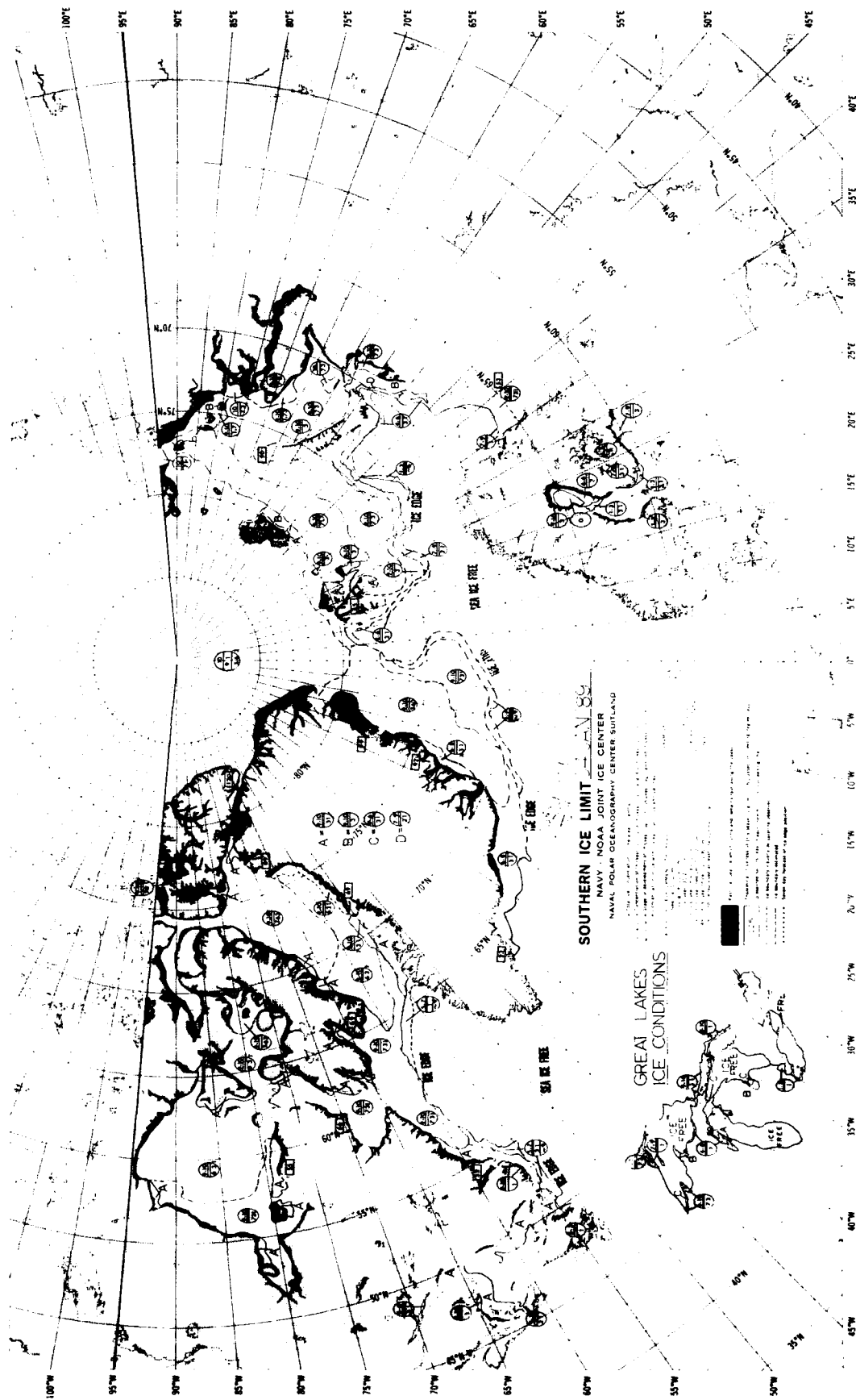
Annual Ice Analysis Atlas Jan-Dec 1989

Eastern-Western Arctic Sea Ice Analysis 1989

Joint Ice Center, Naval Polar Oceanography Center
FOB No. 4, 4301 Suitland Rd
Washington, D.C. 20395-5180

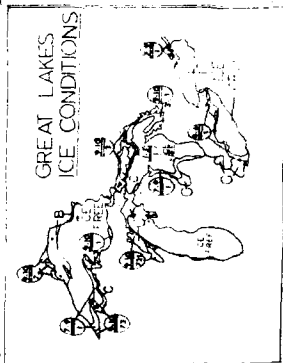
No restriction on distribution
Non DoD users, Available from NTIS Springfield, Va 22161

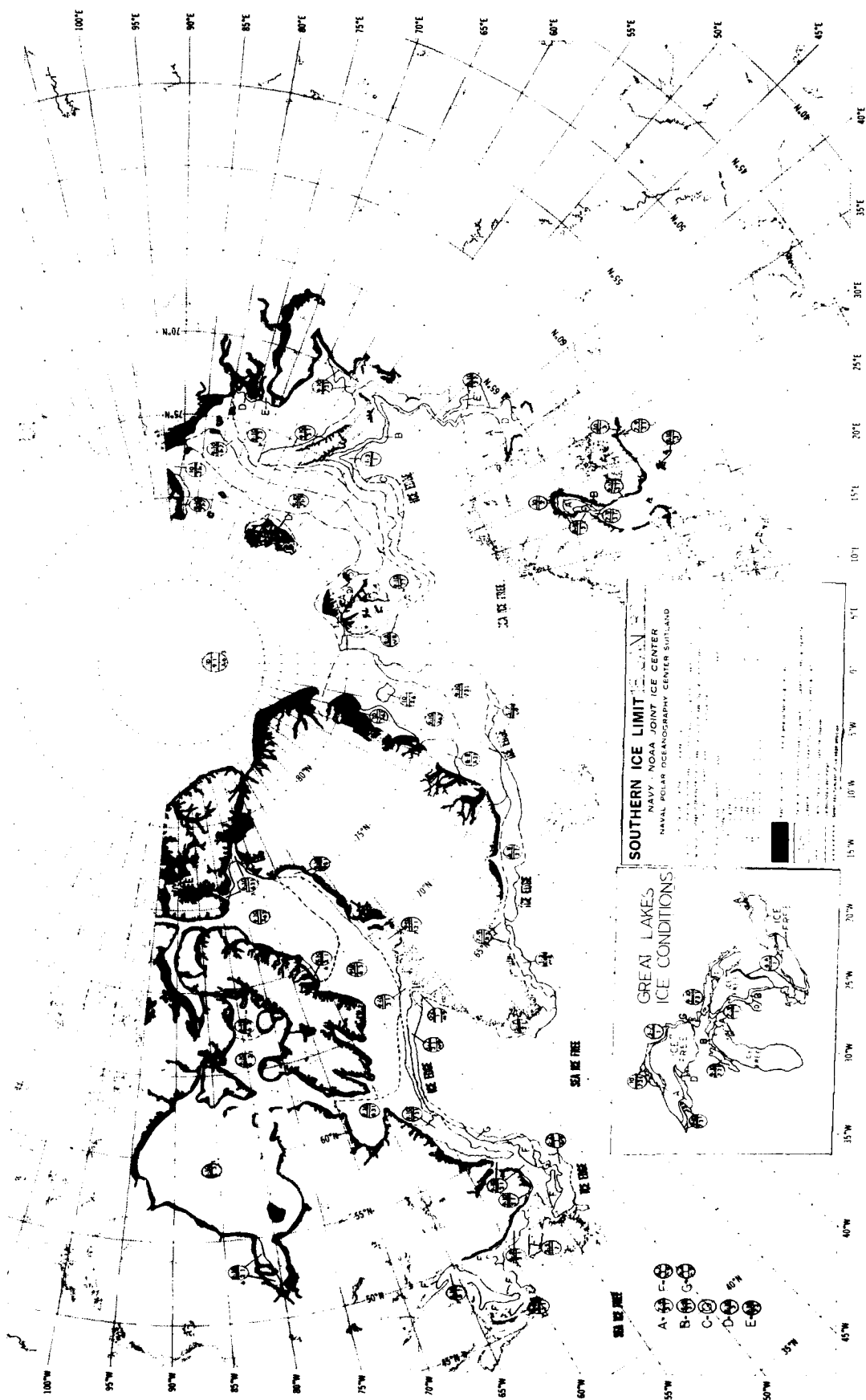
Compilation of the weekly sea ice analyses produced by the Navy/NOAA Joint Ice Center. The Eastern-Western Sea Ice Analysis is produced every year by June or July.

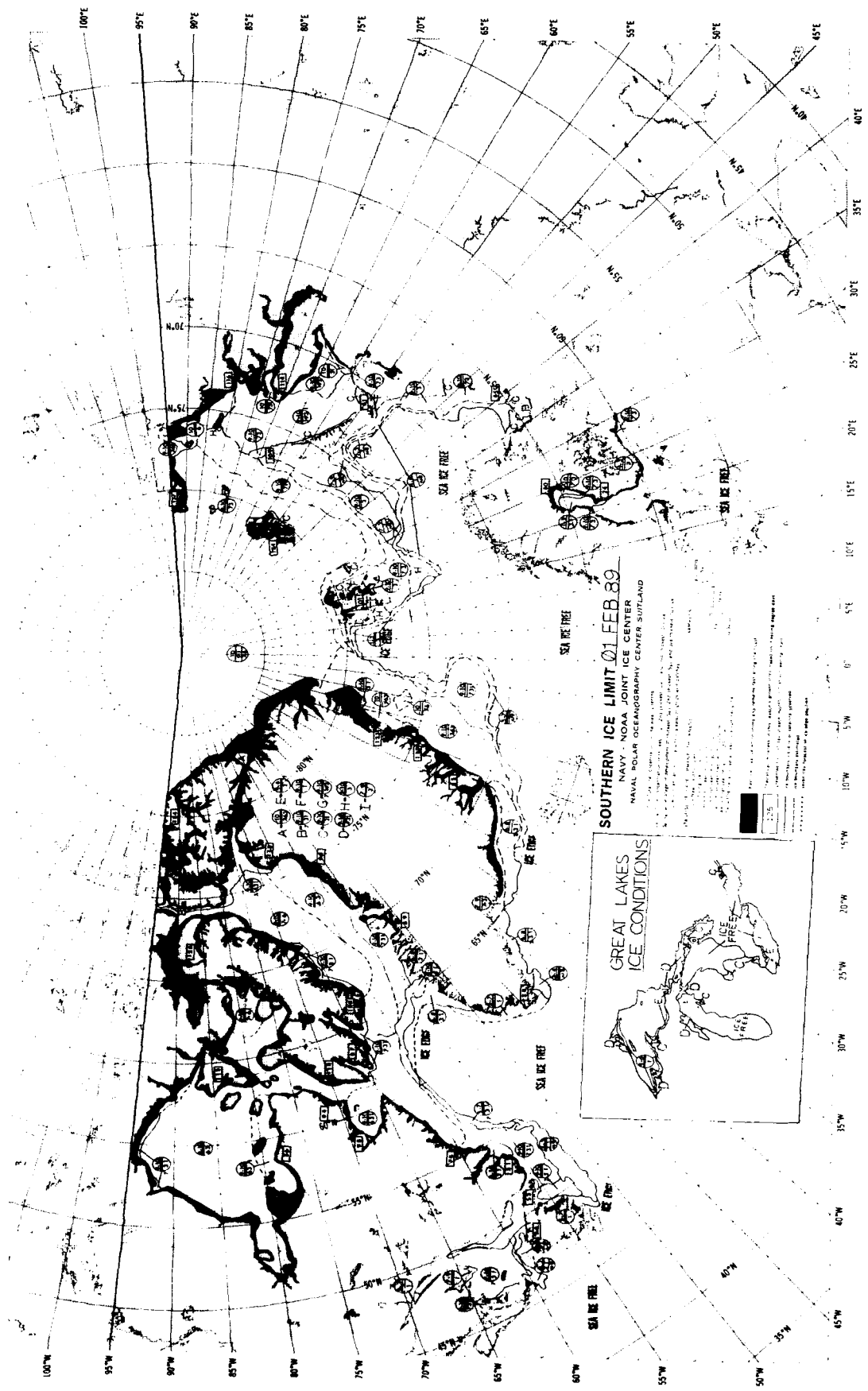




SOUTHERN ICE LIMIT
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER OUTLAND



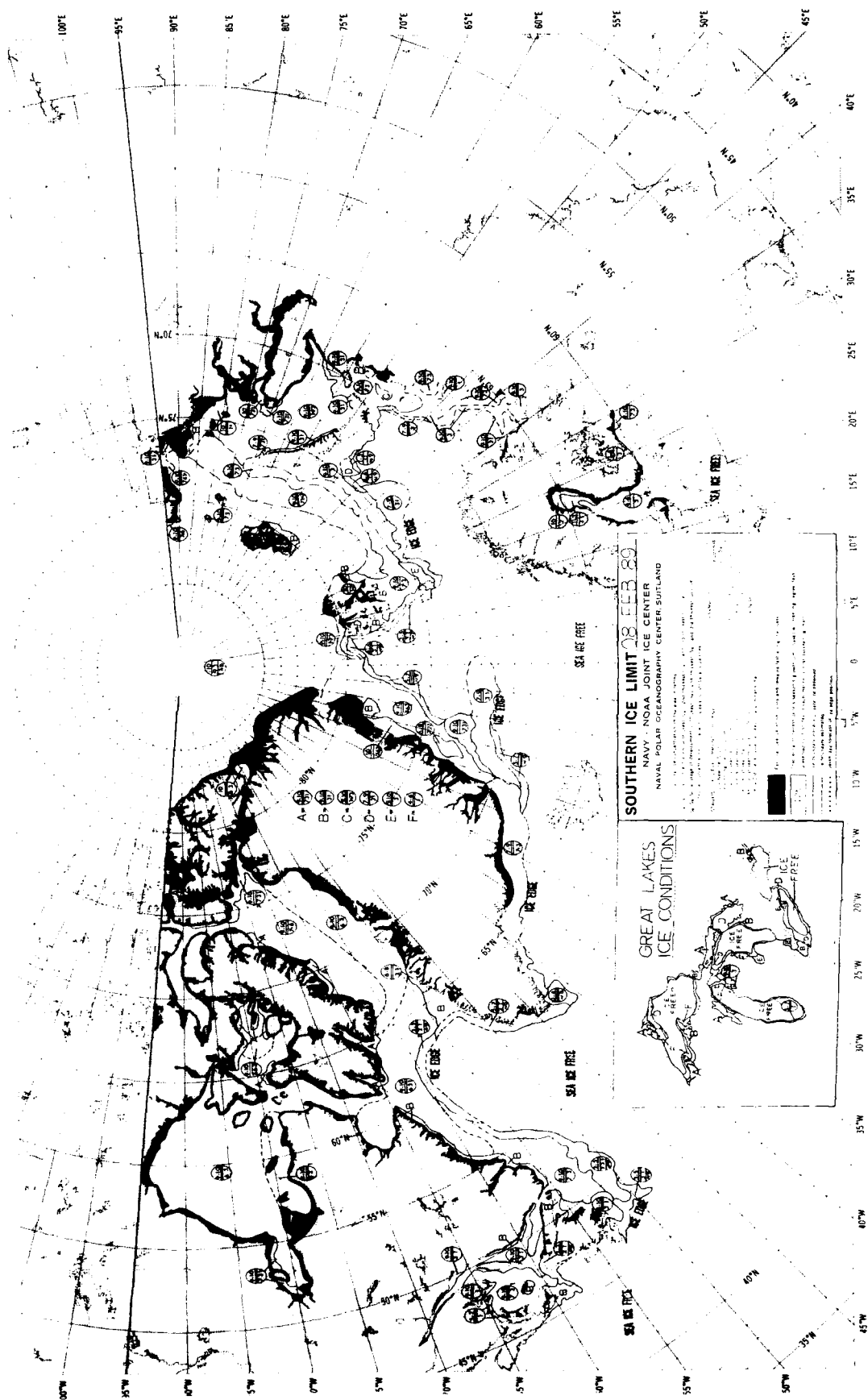


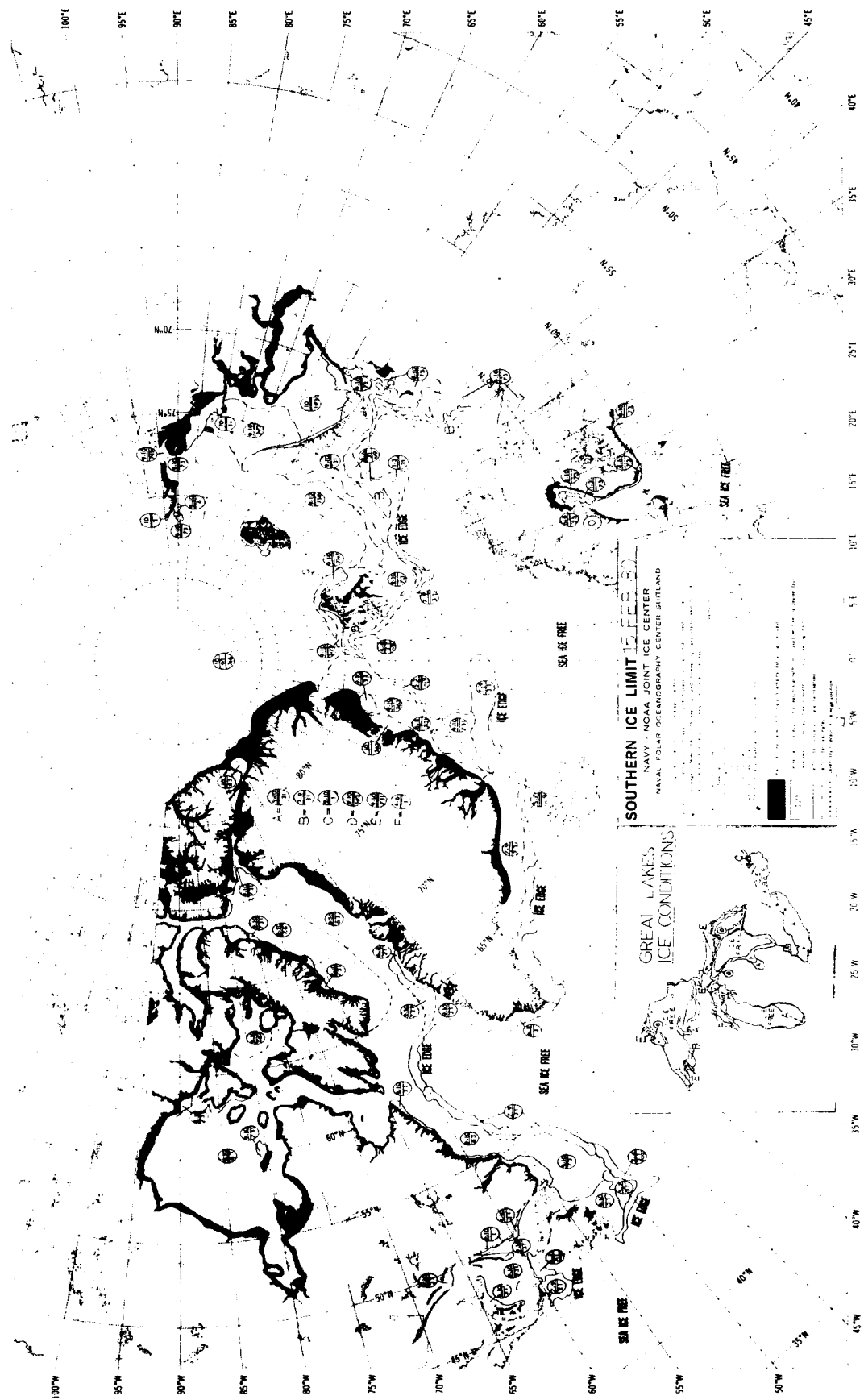


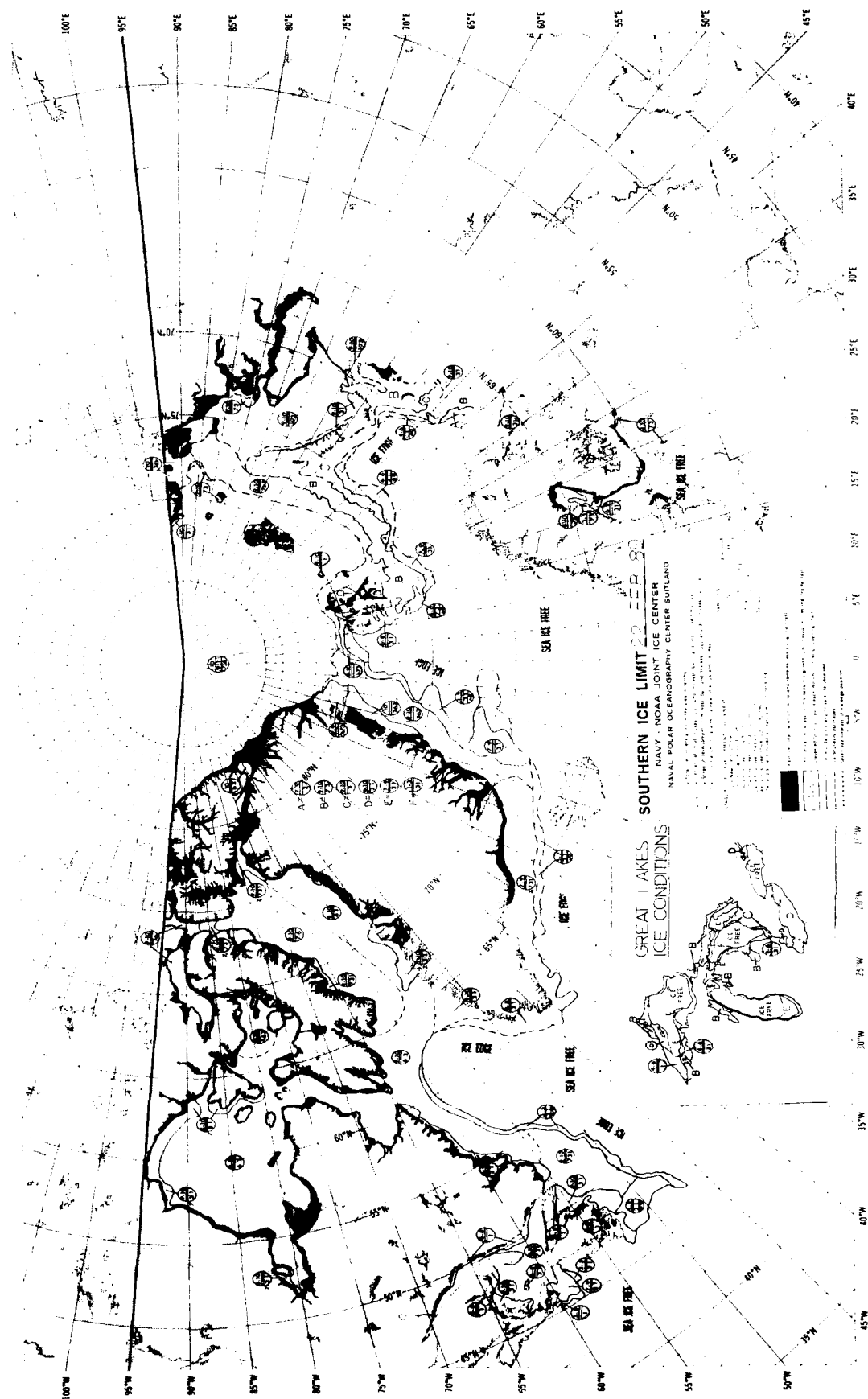
SOUTHERN ICE LIMIT 01 FEB 89
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND

GREAT LAKES
ICE CONDITIONS

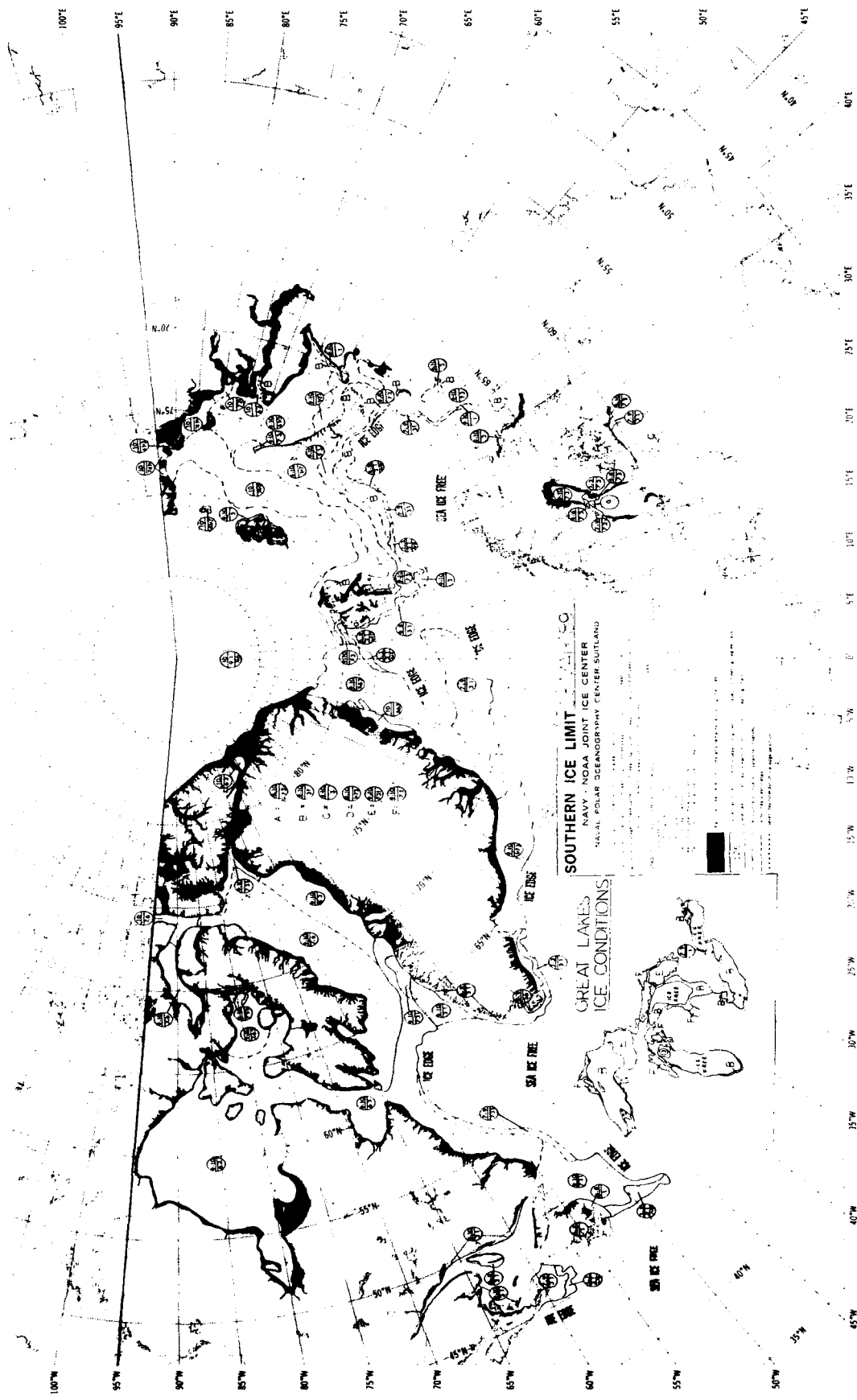
1. This map shows the southern ice limit for the Great Lakes region on 01 Feb 89. The data was collected by the Navy - NOAA Joint Ice Center and the Naval Polar Oceanography Center, SUTLAND. The map is based on a combination of satellite data and ship reports. The ice limit is defined as the southernmost edge of the ice field. The map is intended for use by the Navy and NOAA for operational planning and research. The map is not to be used for navigation purposes. The map is a product of the Navy - NOAA Joint Ice Center and the Naval Polar Oceanography Center, SUTLAND. The map is a product of the Navy - NOAA Joint Ice Center and the Naval Polar Oceanography Center, SUTLAND. The map is a product of the Navy - NOAA Joint Ice Center and the Naval Polar Oceanography Center, SUTLAND.

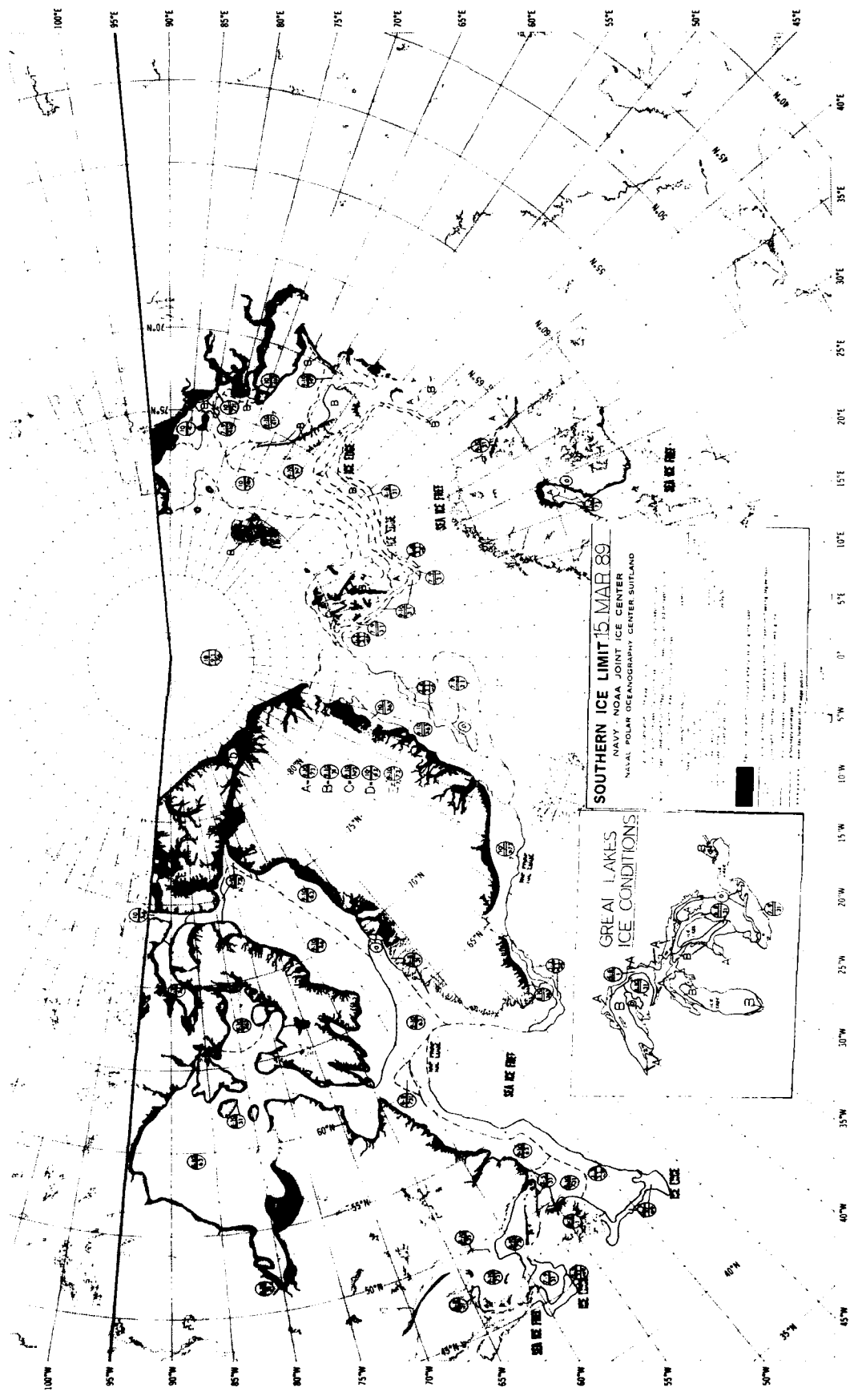






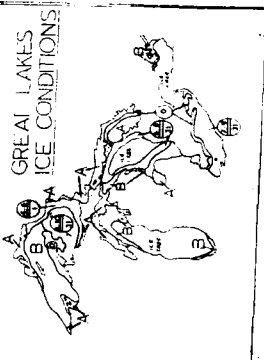


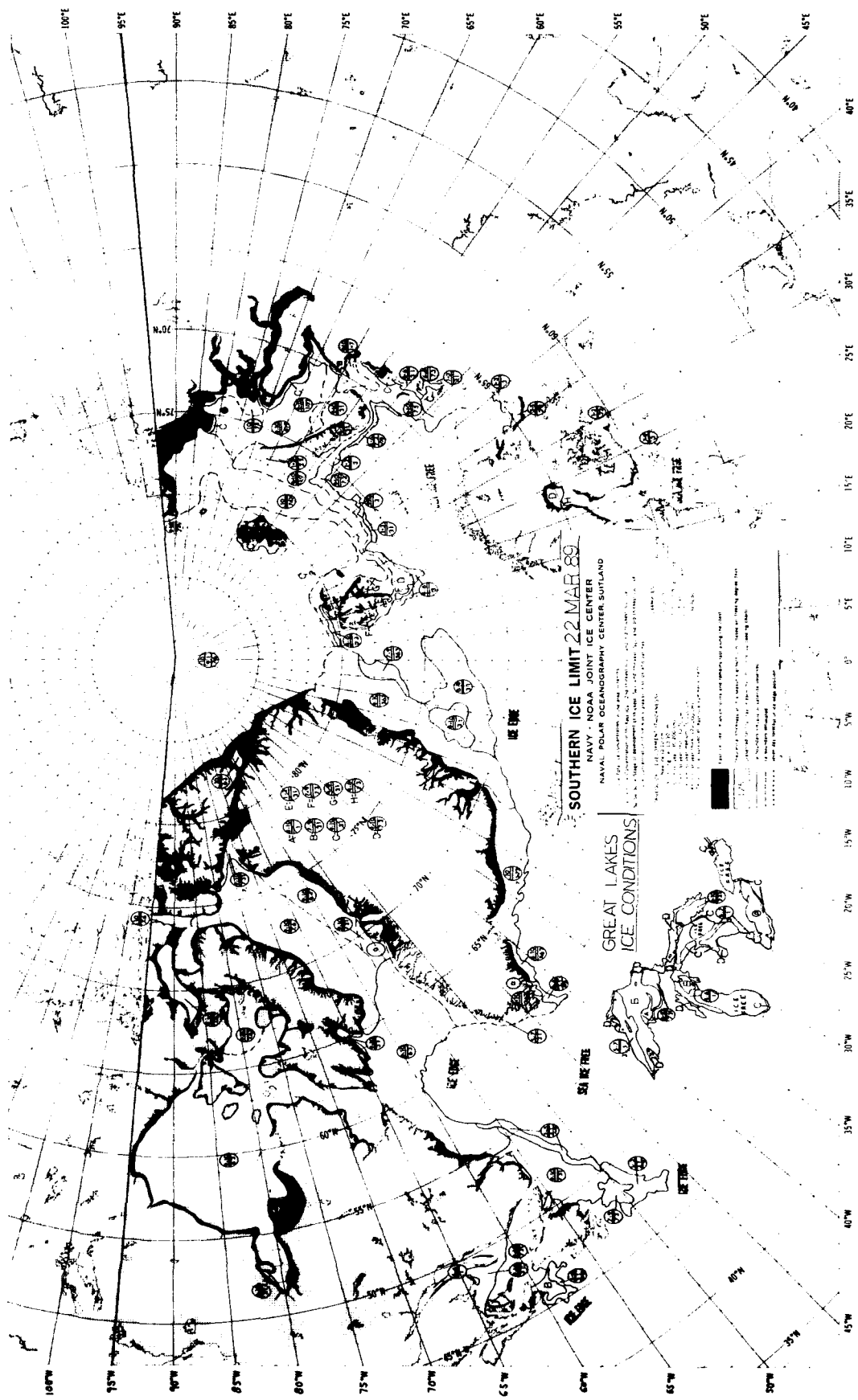


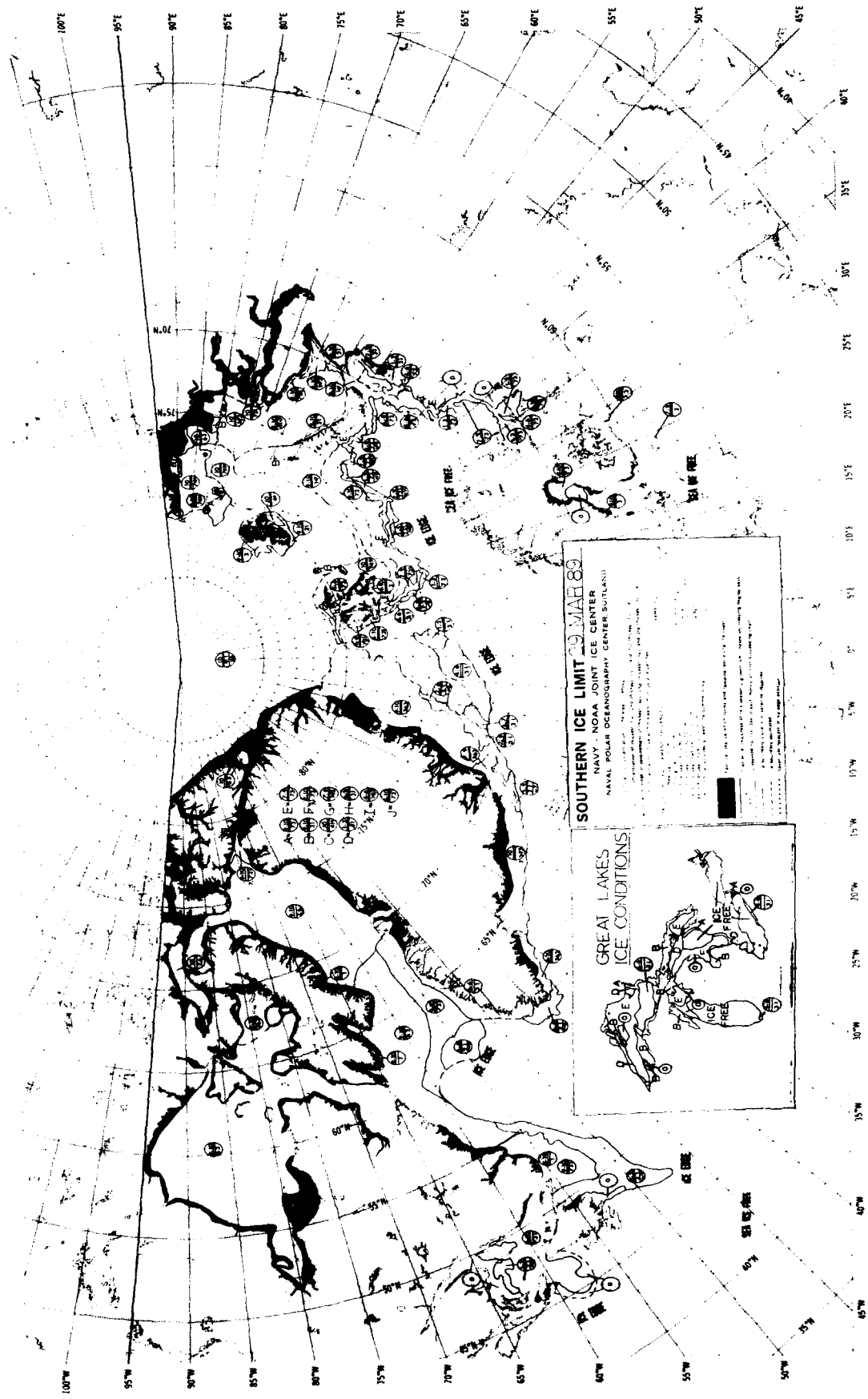


SOUTHERN ICE LIMIT 15 MAR 89
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND

GREAT LAKES
ICE CONDITIONS

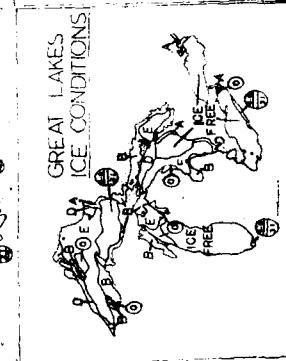


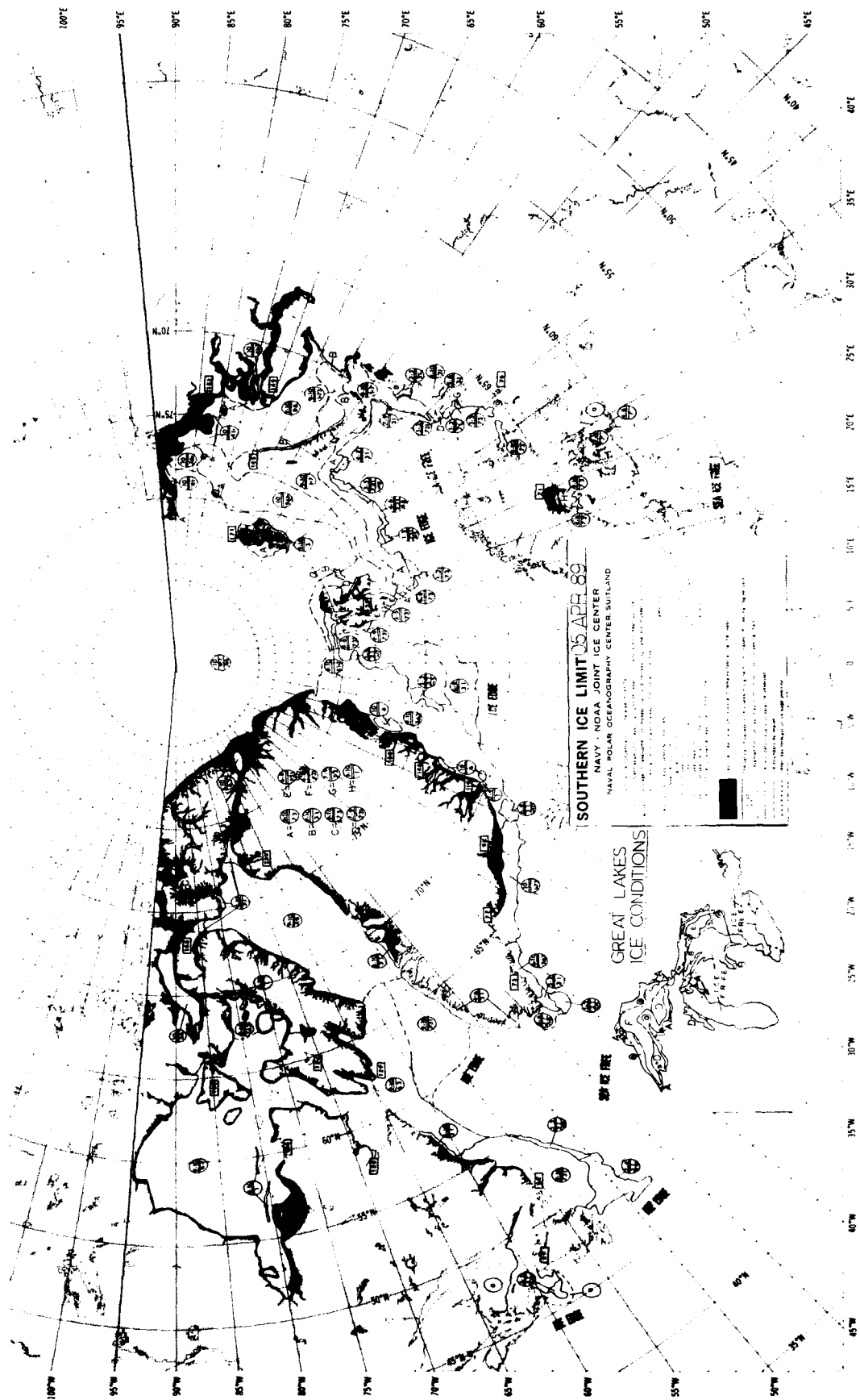




SOUTHERN ICE LIMIT 29 MAR 89
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER (SUTLAND)

1. This chart is a composite of data from the Navy's Antarctic Oceanographic Center (SUTLAND) and the NOAA's Joint Ice Center. It shows the southern ice limit for the date 29 March 1989. The data is derived from satellite observations and ship reports. The chart is intended for use in the Southern Ocean, south of 50°S, and west of 160°W. The ice limit is shown as a solid line, and the area to the south of the line is shaded. The chart is a composite of data from the Navy's Antarctic Oceanographic Center (SUTLAND) and the NOAA's Joint Ice Center. It shows the southern ice limit for the date 29 March 1989. The data is derived from satellite observations and ship reports. The chart is intended for use in the Southern Ocean, south of 50°S, and west of 160°W. The ice limit is shown as a solid line, and the area to the south of the line is shaded. The chart is a composite of data from the Navy's Antarctic Oceanographic Center (SUTLAND) and the NOAA's Joint Ice Center. It shows the southern ice limit for the date 29 March 1989. The data is derived from satellite observations and ship reports. The chart is intended for use in the Southern Ocean, south of 50°S, and west of 160°W. The ice limit is shown as a solid line, and the area to the south of the line is shaded.

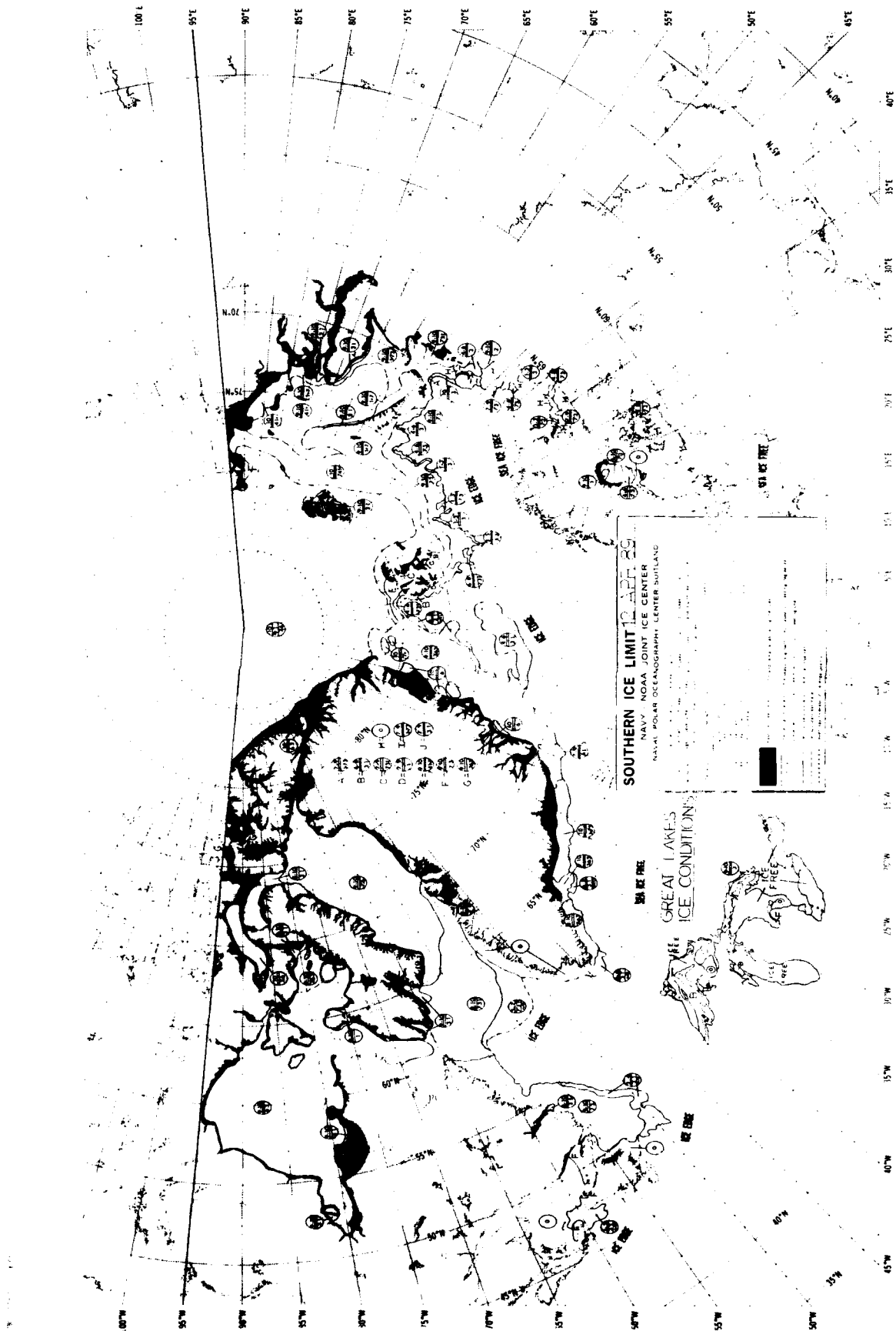




SOUTHERN ICE LIMIT 25 APR 89
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND

GREAT LAKES
ICE CONDITIONS

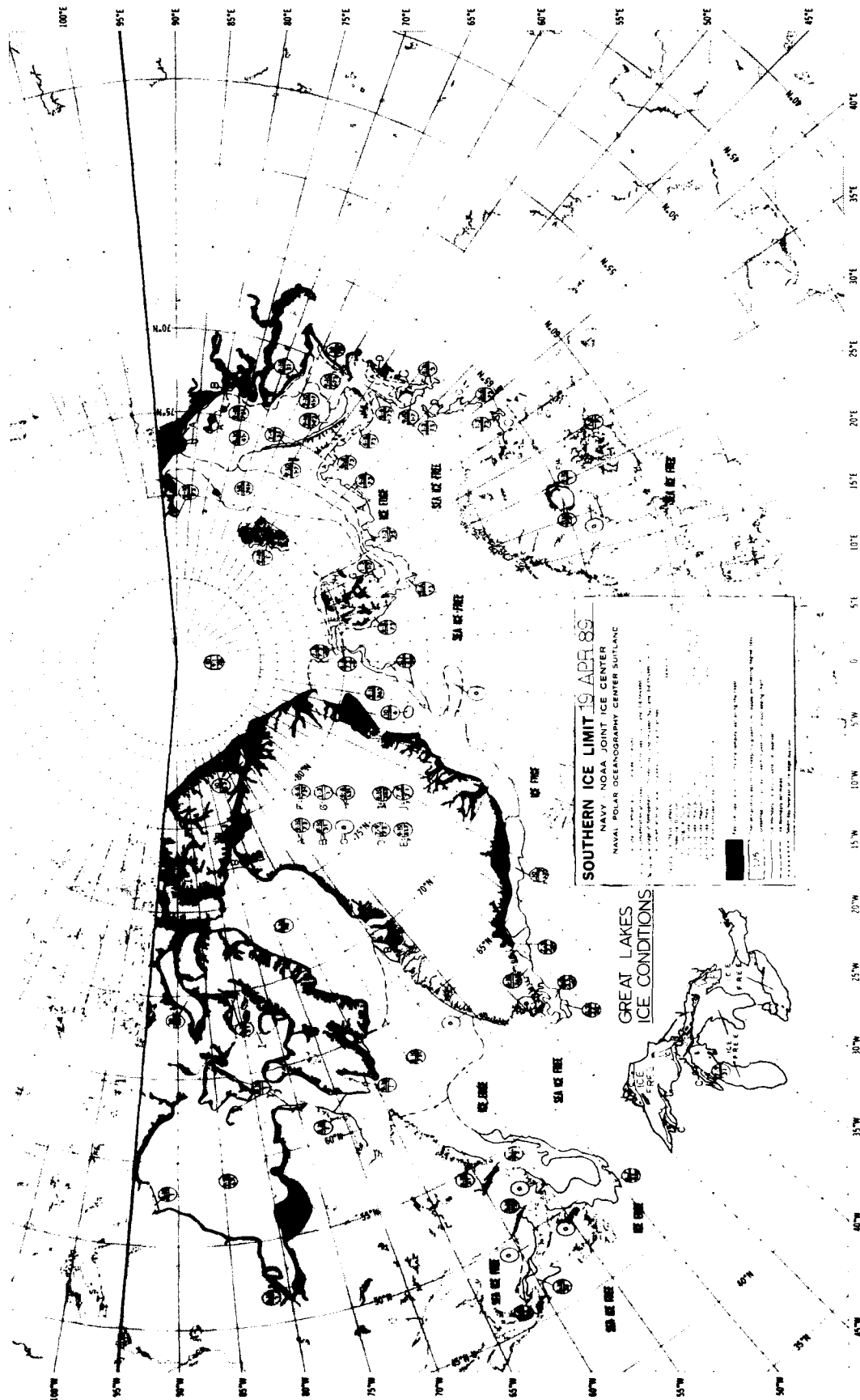
Legend:
A - Ice Limit
B - Ice Edge
C - Ice Concentration
D - Ice Type
E - Ice Thickness
F - Ice Strength
G - Ice Movement
H - Ice Duration



SOUTHERN ICE LIMIT 12 APR 89

NAVY NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER OUTLAND

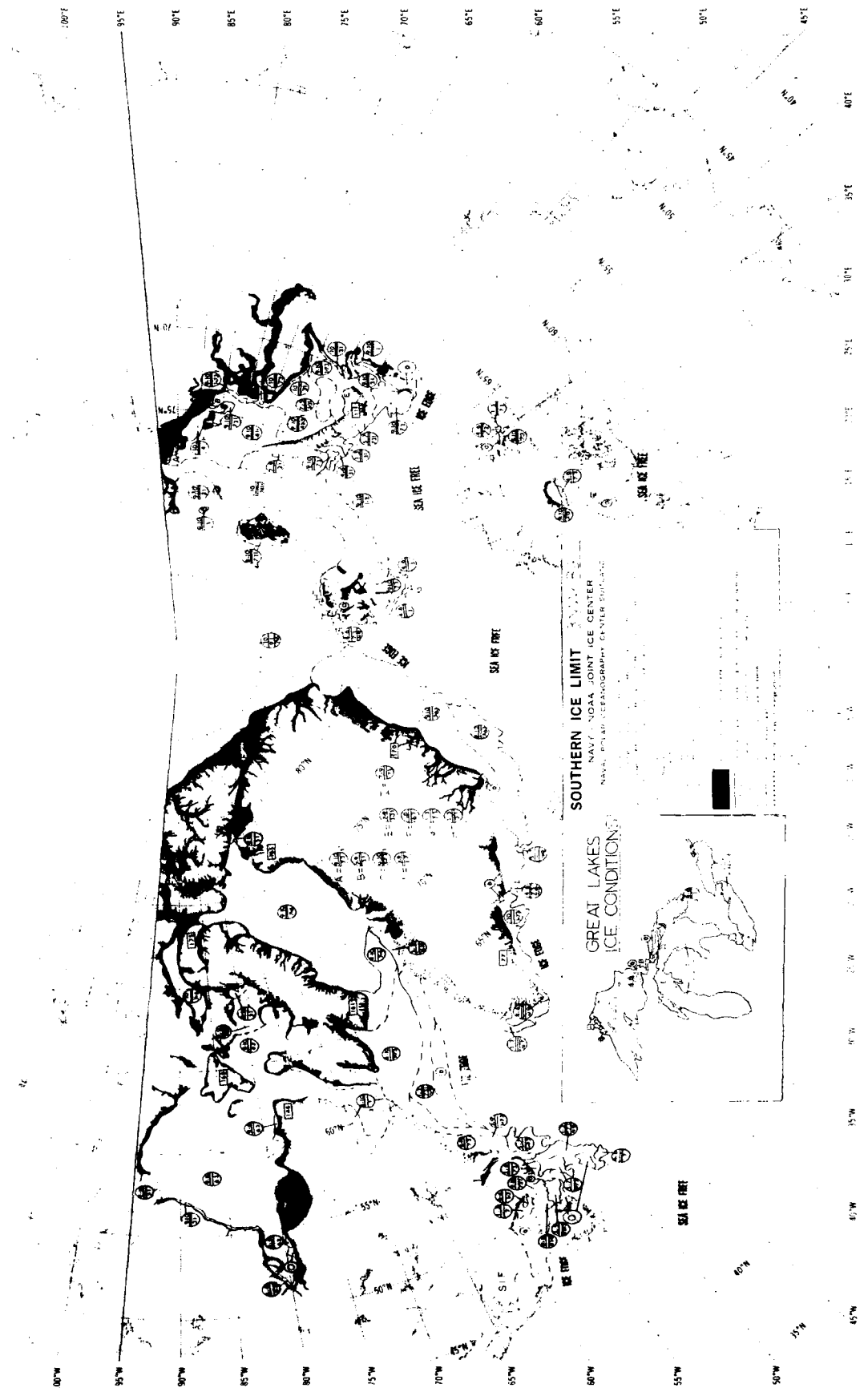
GREAT LAKES
ICE CONDITIONS





SOUTHERN ICE LIMIT 26 APR 80
NAVY NOAA JOINT ICE CENTER
NAVAL POLAR RECONNAISSANCE CENTER SUTCLIFF

GREAT LAKES
ICE CONDITIONS



SOUTHERN ICE LIMIT
NAVY / NOAA JOINT ICE CENTER
NAVAL ROTARY CELESTIAL CENTER SOUTHERN

GREAT LAKES
ICE CONDITIONS



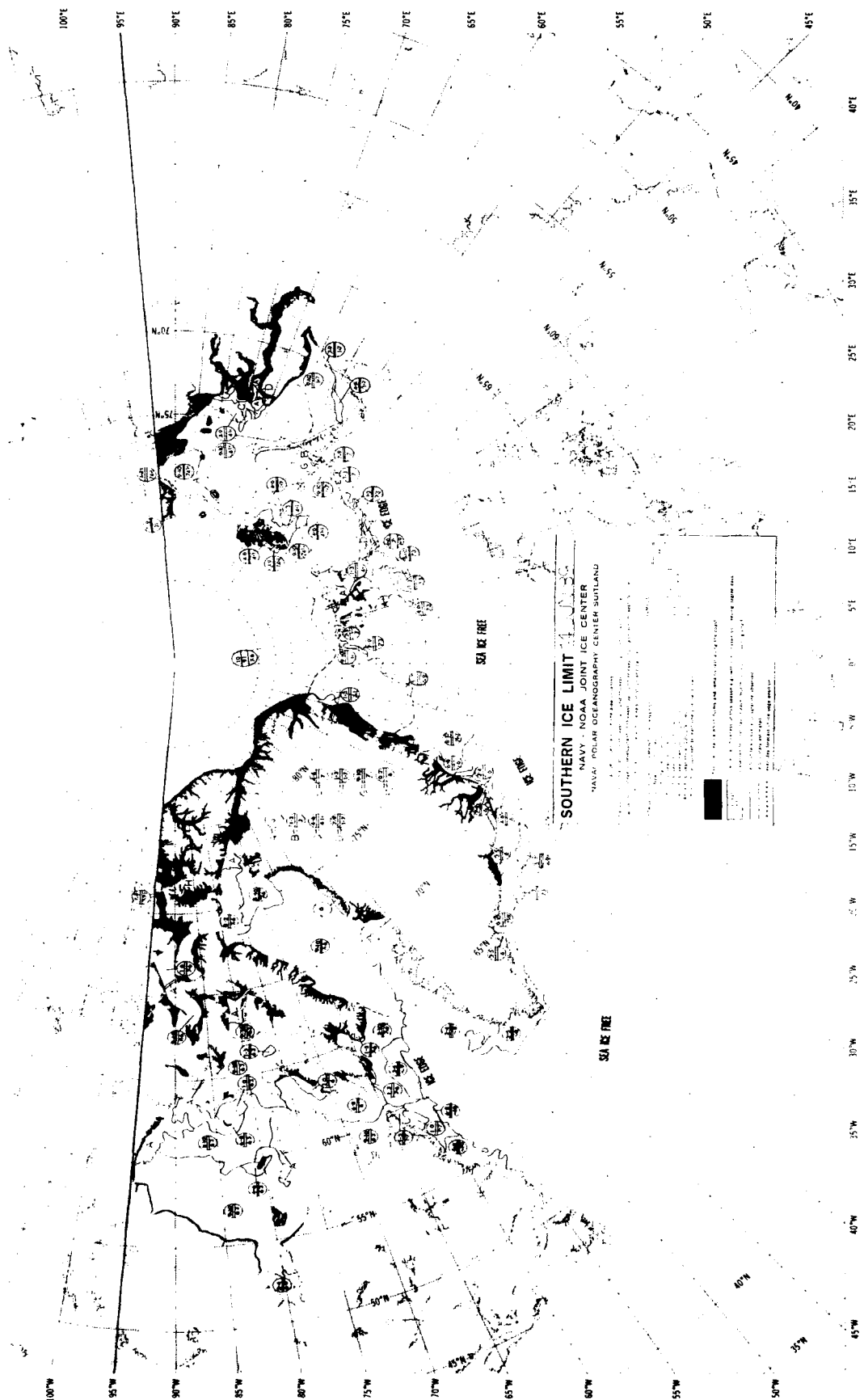
SOUTHERN ICE LIMIT IN WINTER
NAVY, NOAA JOINT ICE CENTER
BASED ON AIR PHOTOGRAPHIC CENTER SURVEY

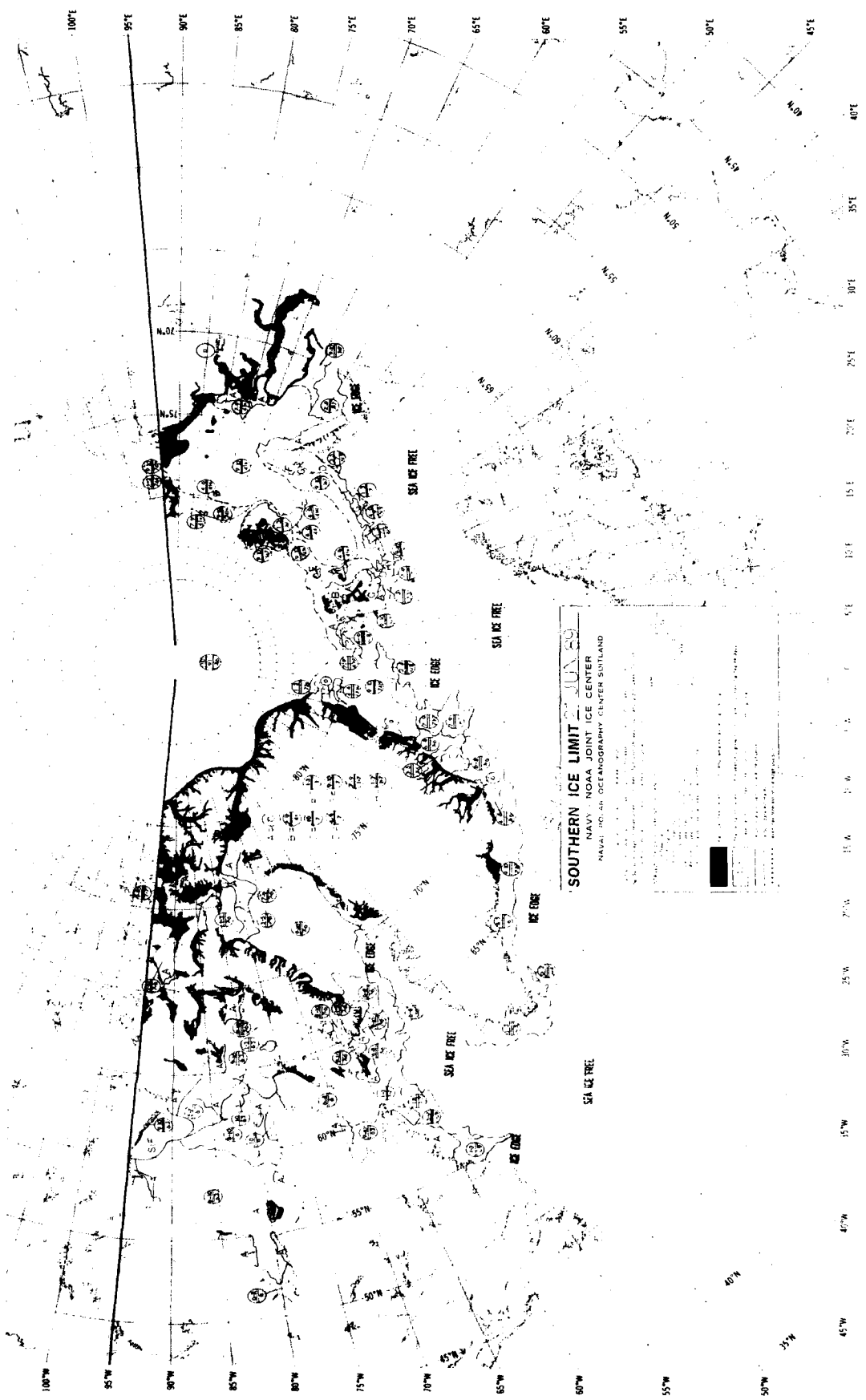




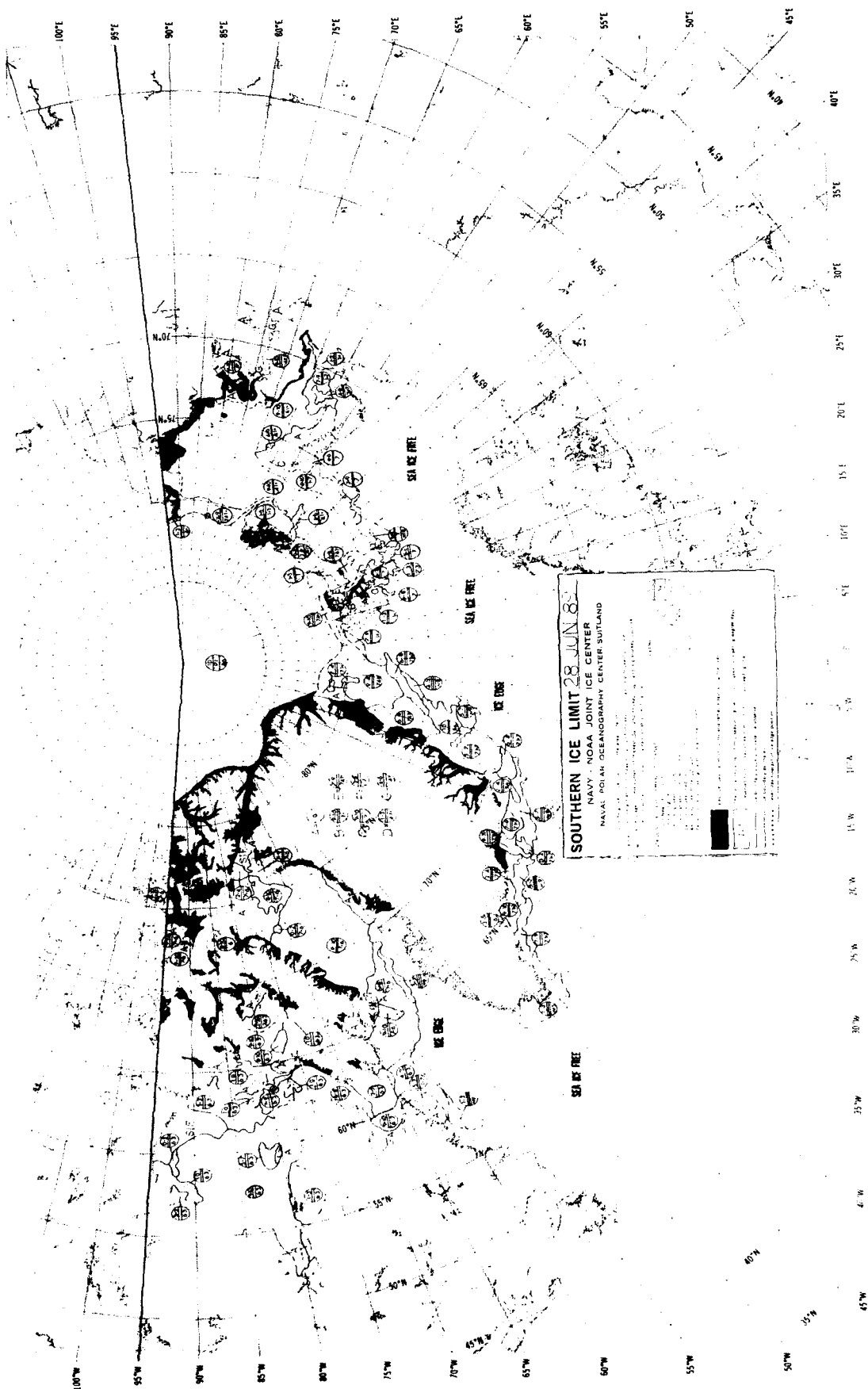


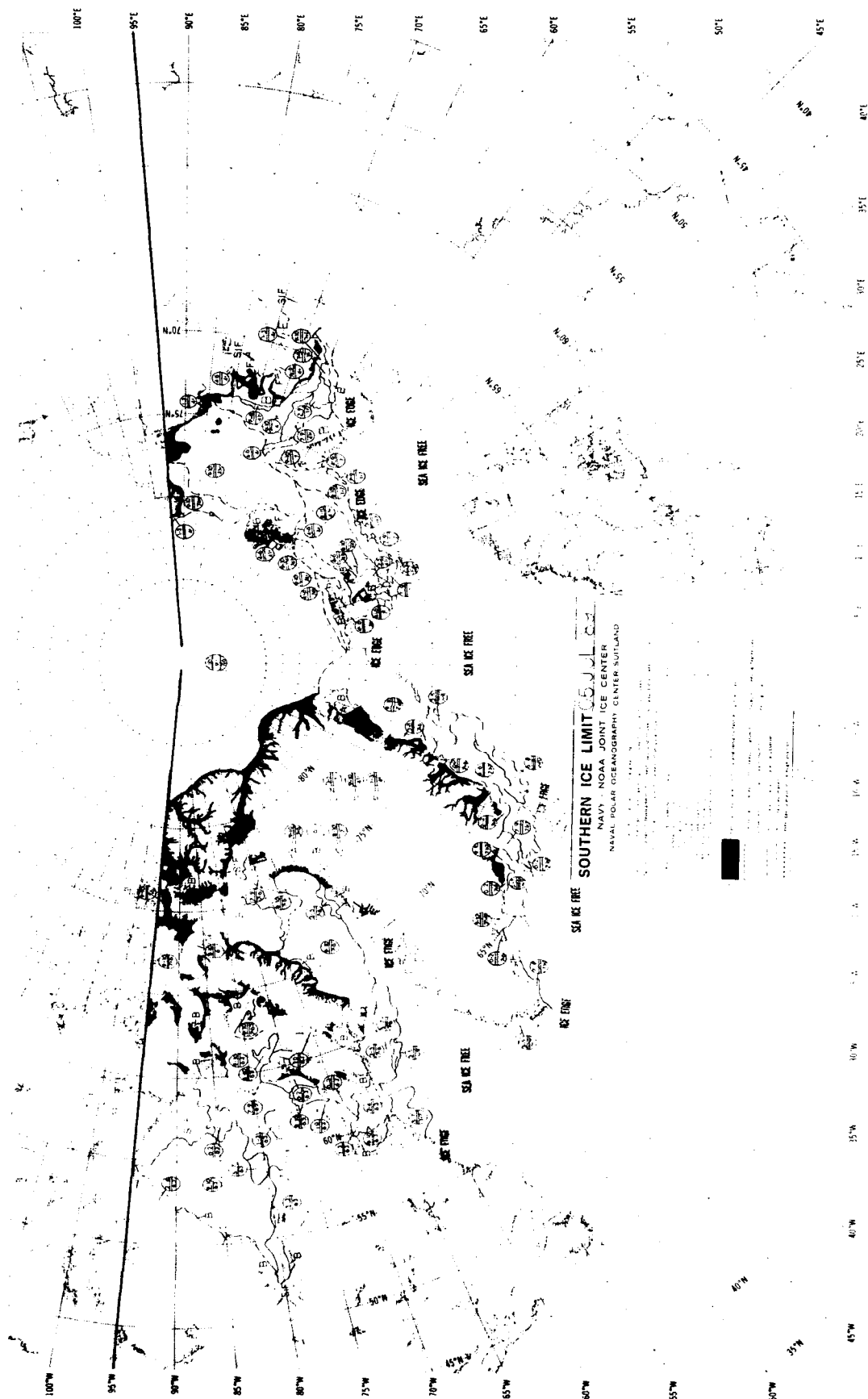




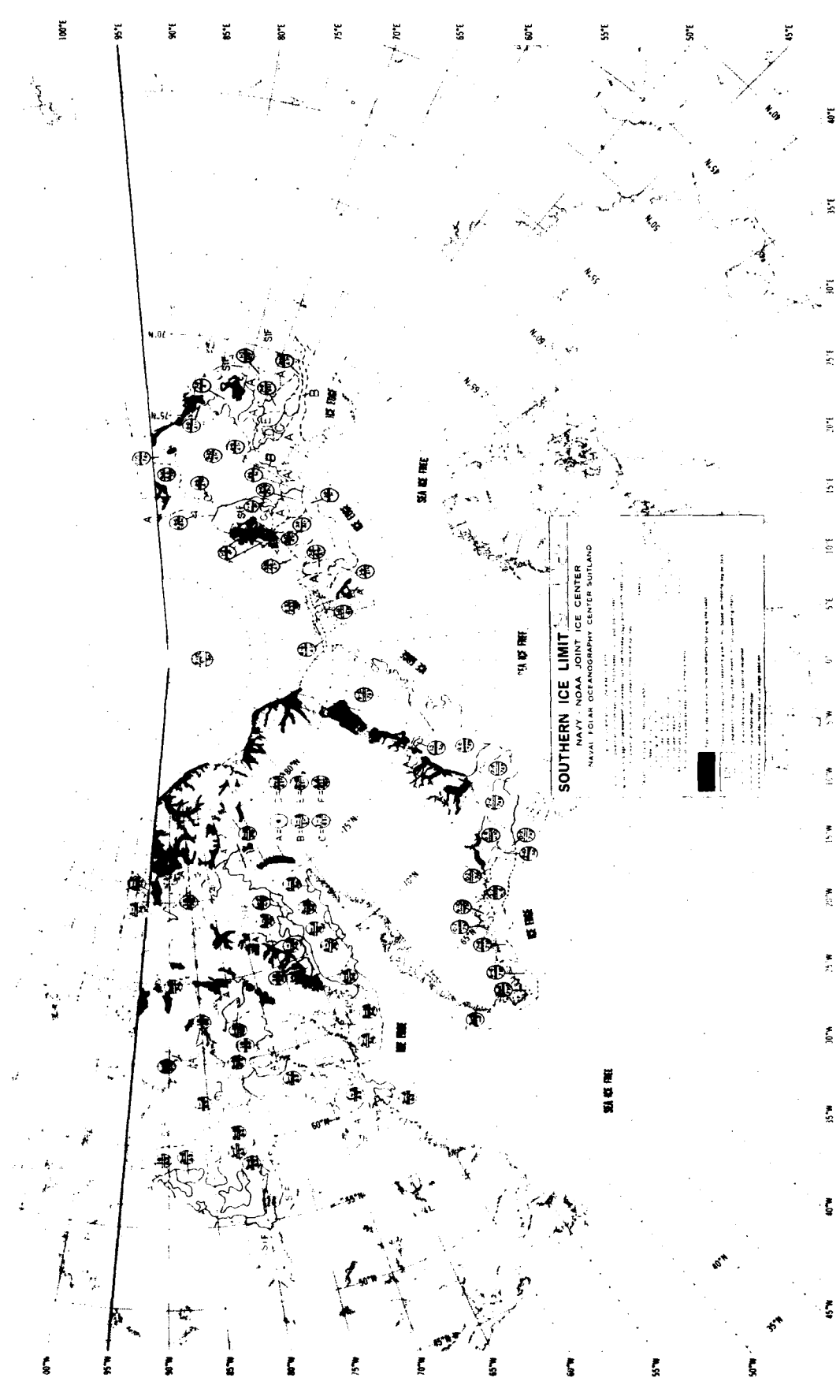


SOUTHERN ICE LIMIT 2 JUN 59
NAVY - NOAA JOINT ICE CENTER
NAVAL - NO-40 OCEANOGRAPHY CENTER SUTLAND









SOUTHERN ICE LIMIT
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SOUTLAND

1. This map shows the Southern Ice Limit, which is the limit of the ice field in the Southern Ocean. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line.

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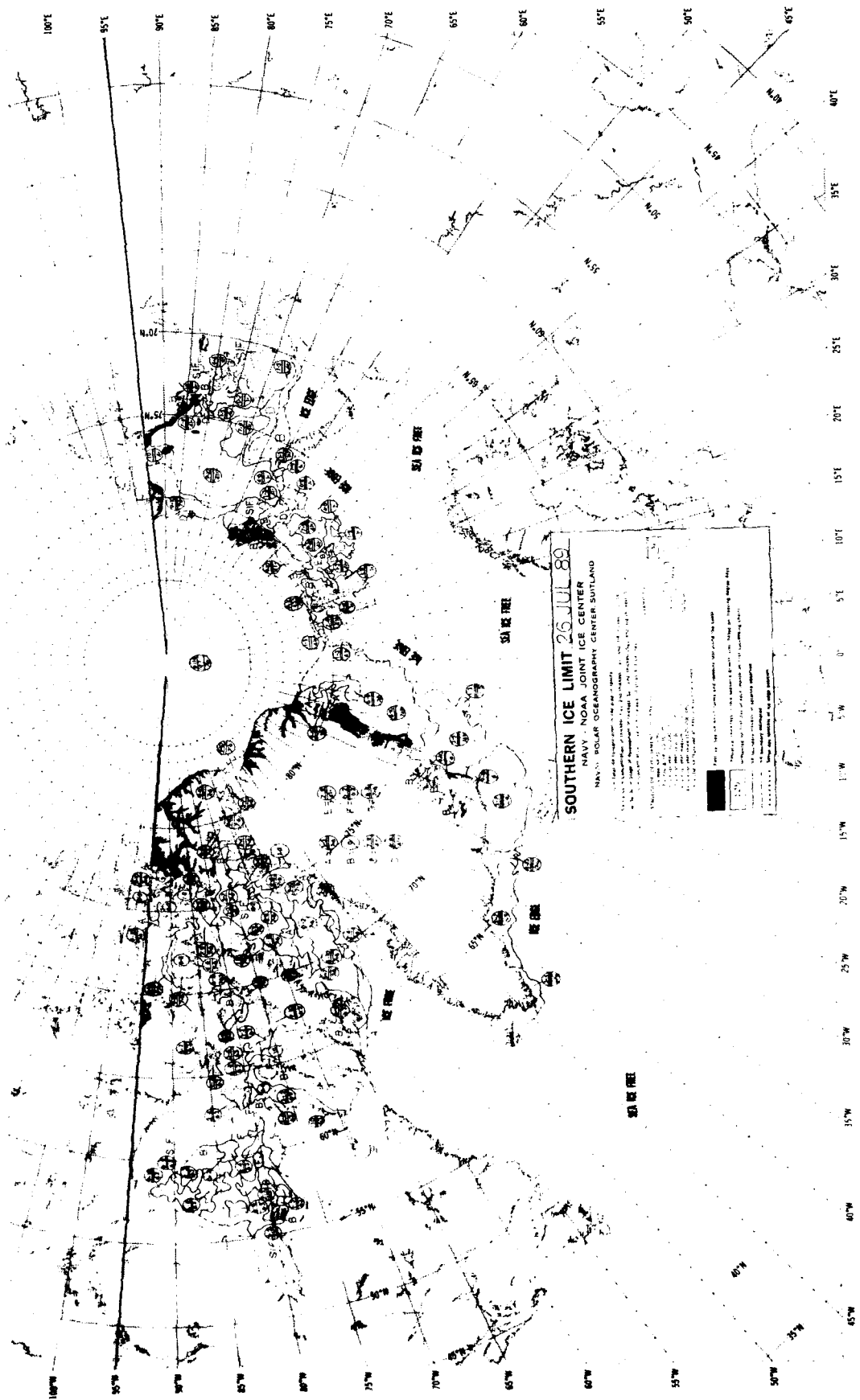
6. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line.

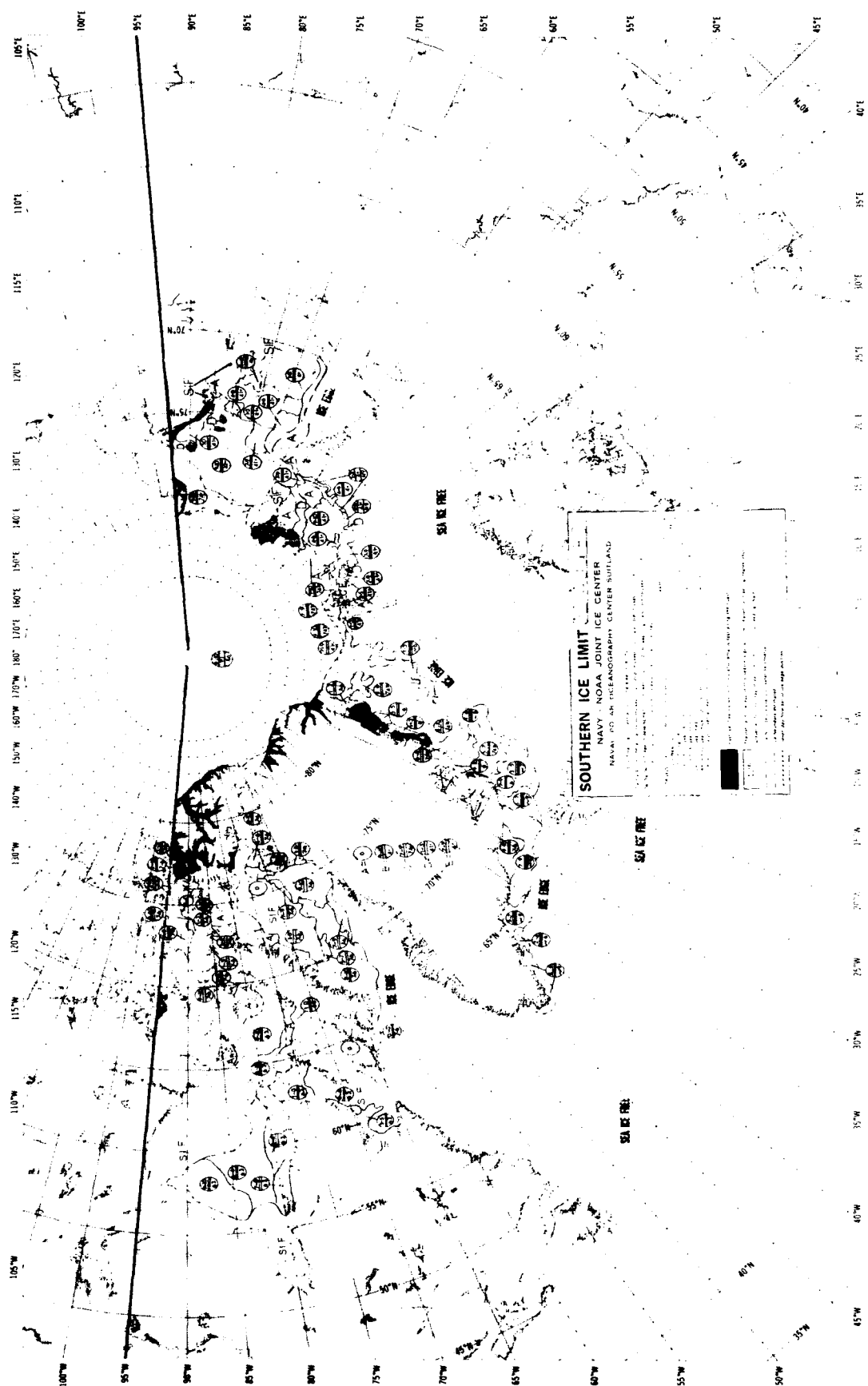
7. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line. The ice field is defined by the ice limit, which is the boundary between the ice field and the open ocean. The ice limit is shown as a dashed line. The ice field is shown as a solid line.

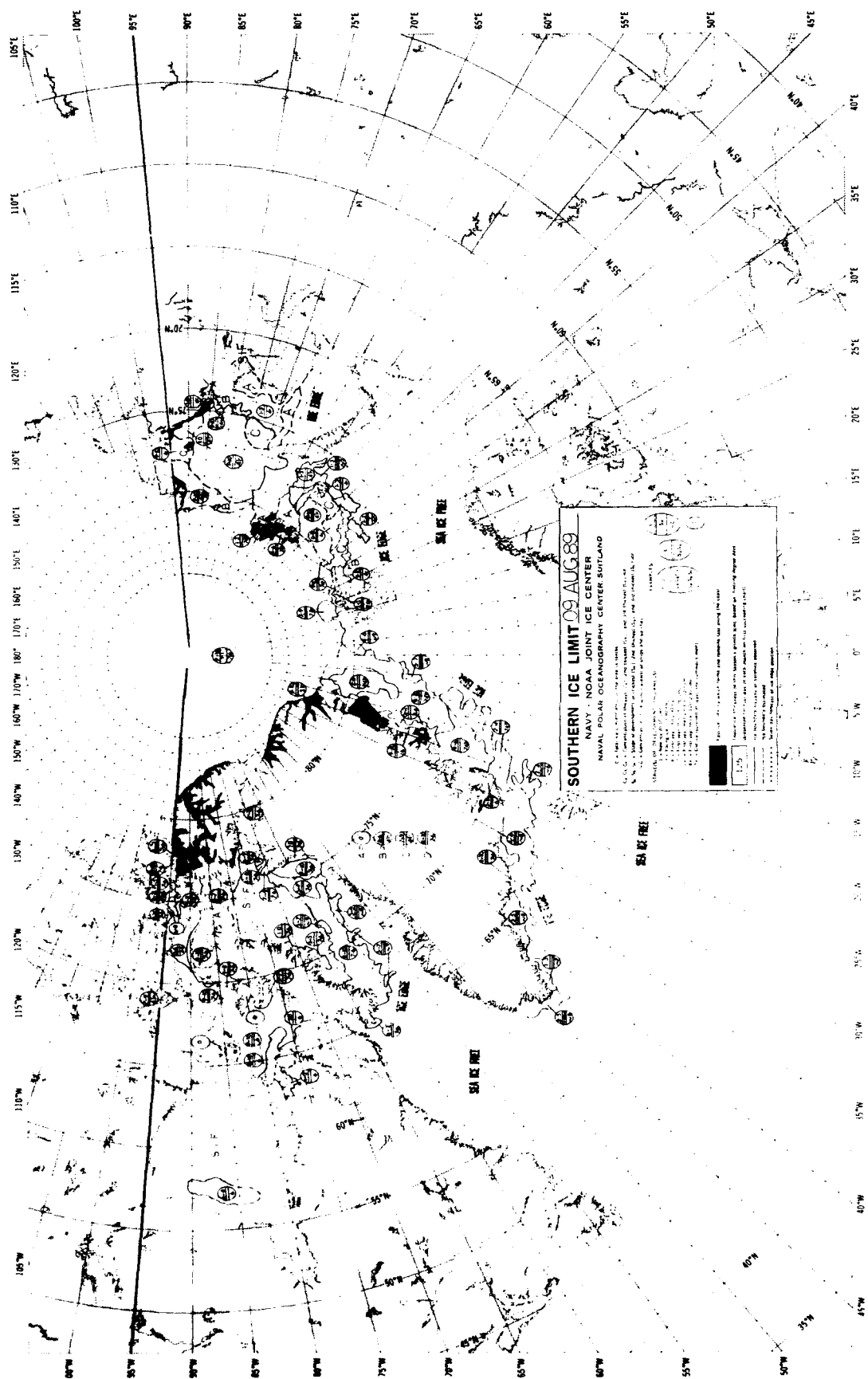
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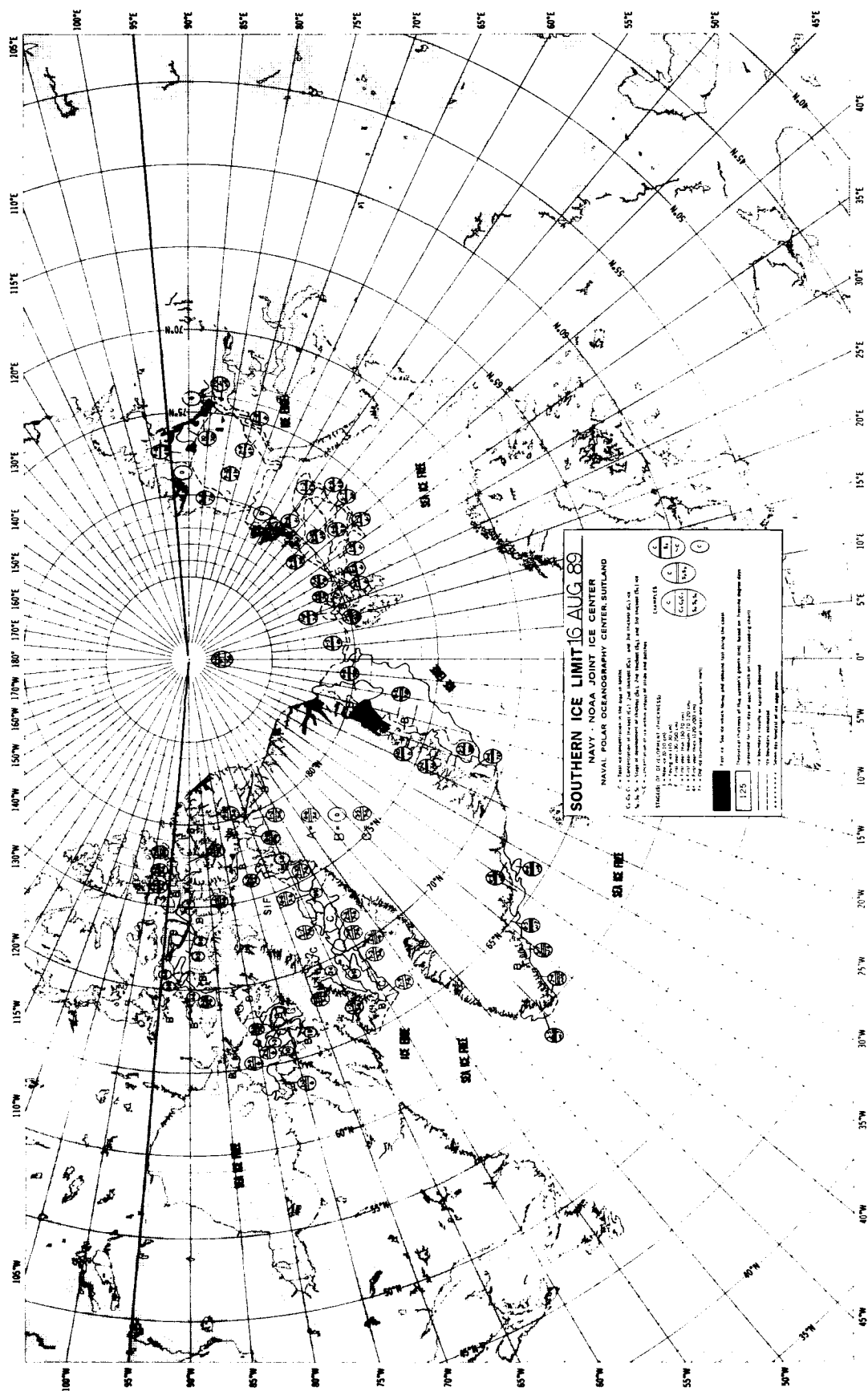
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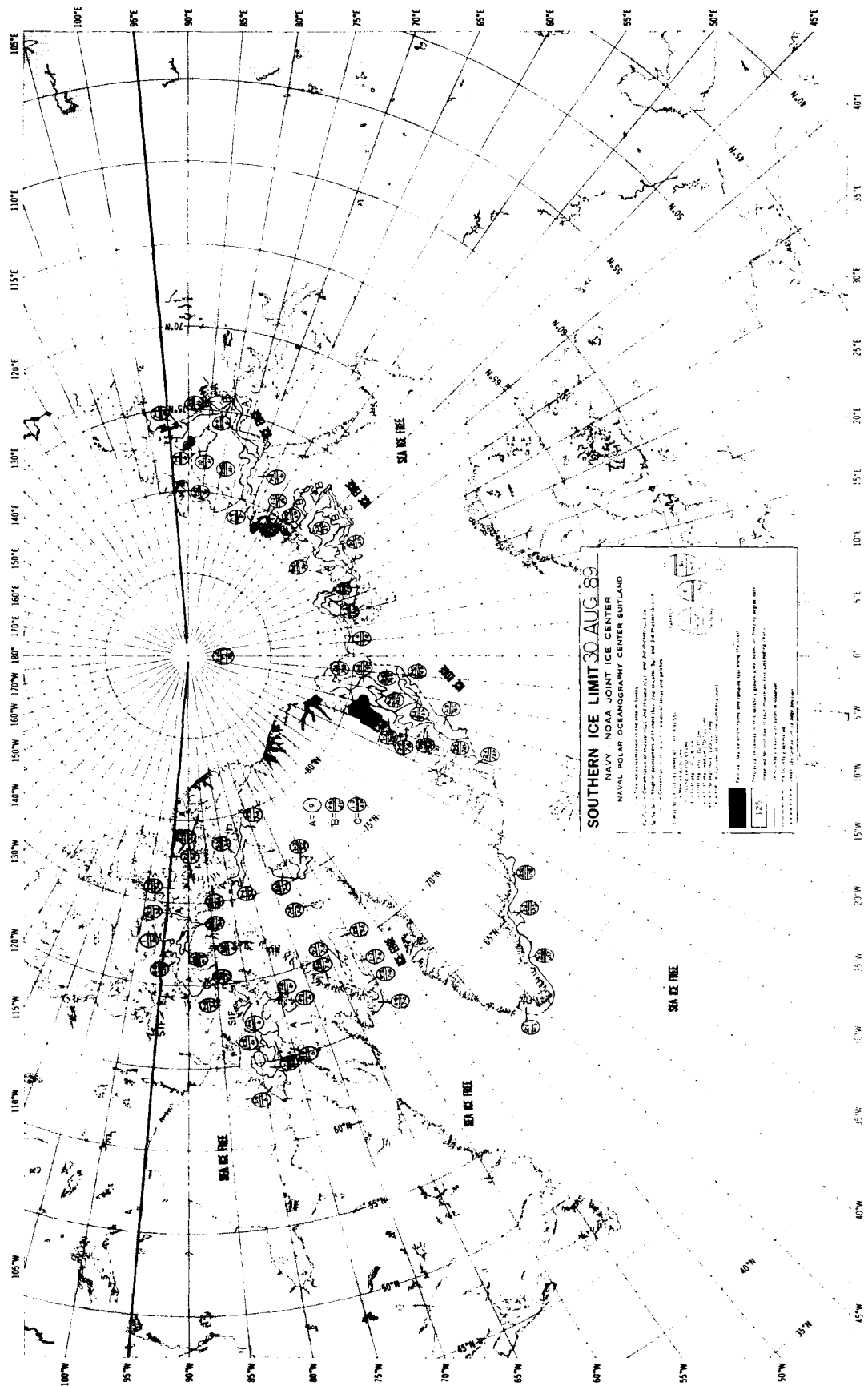
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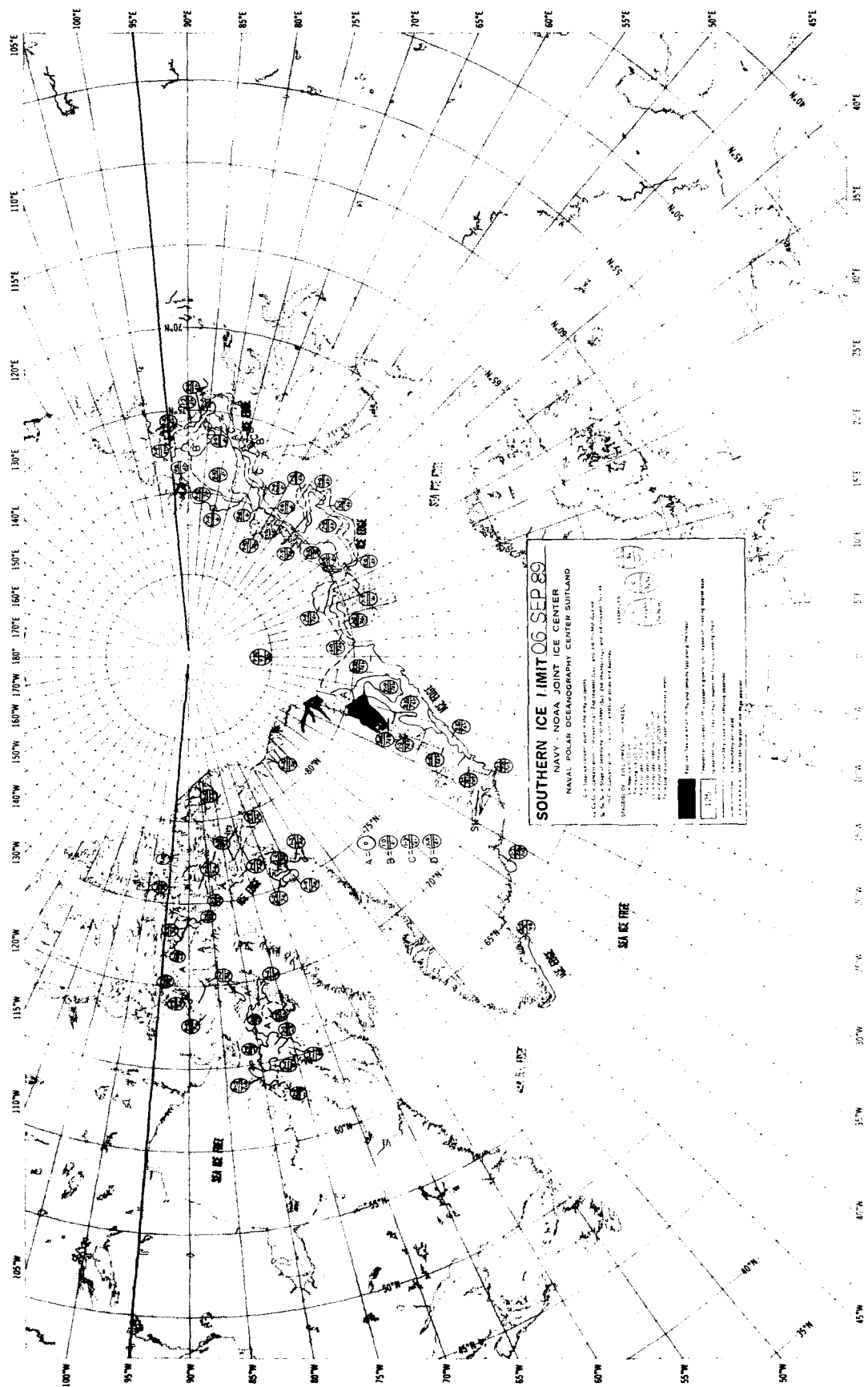


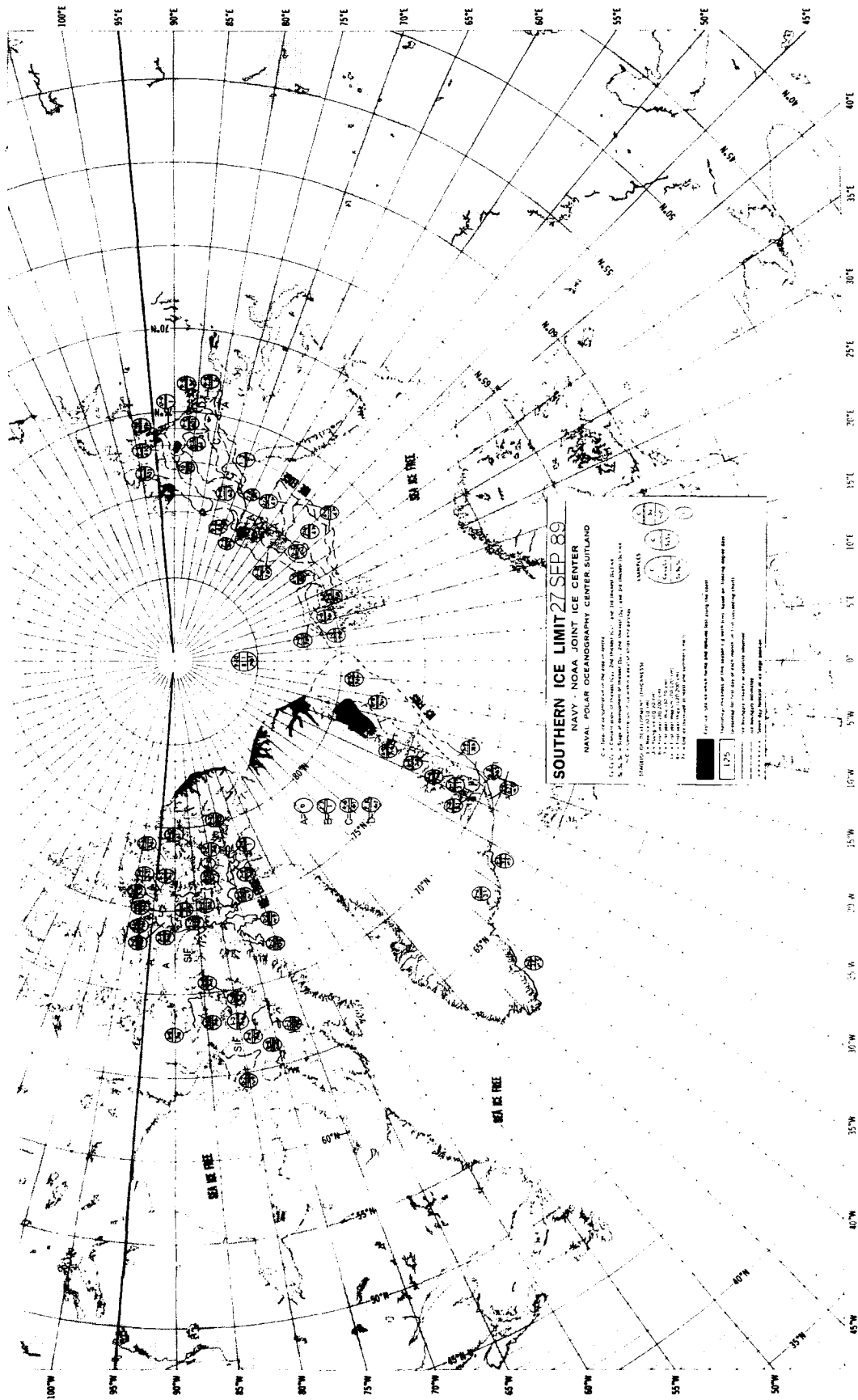


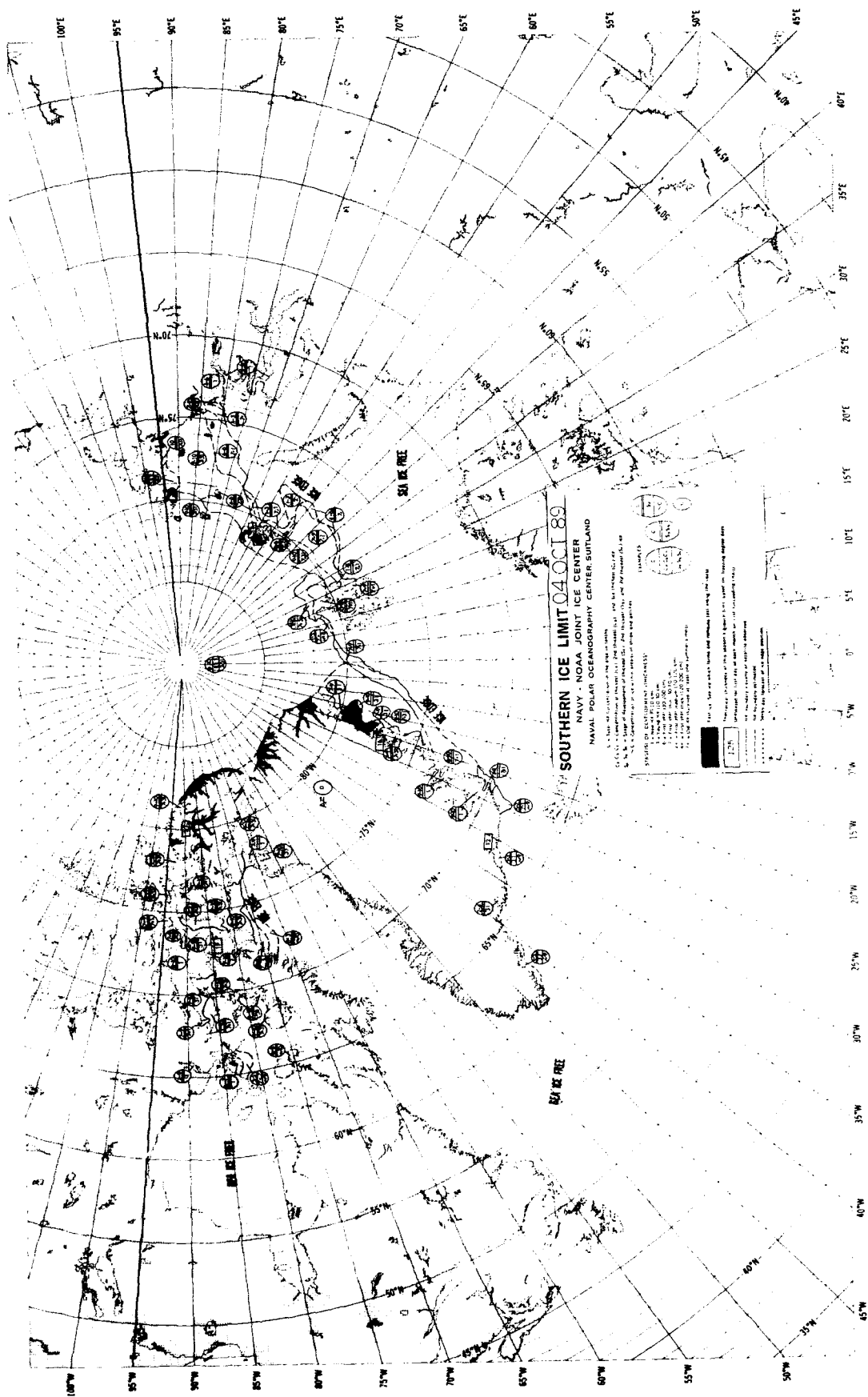


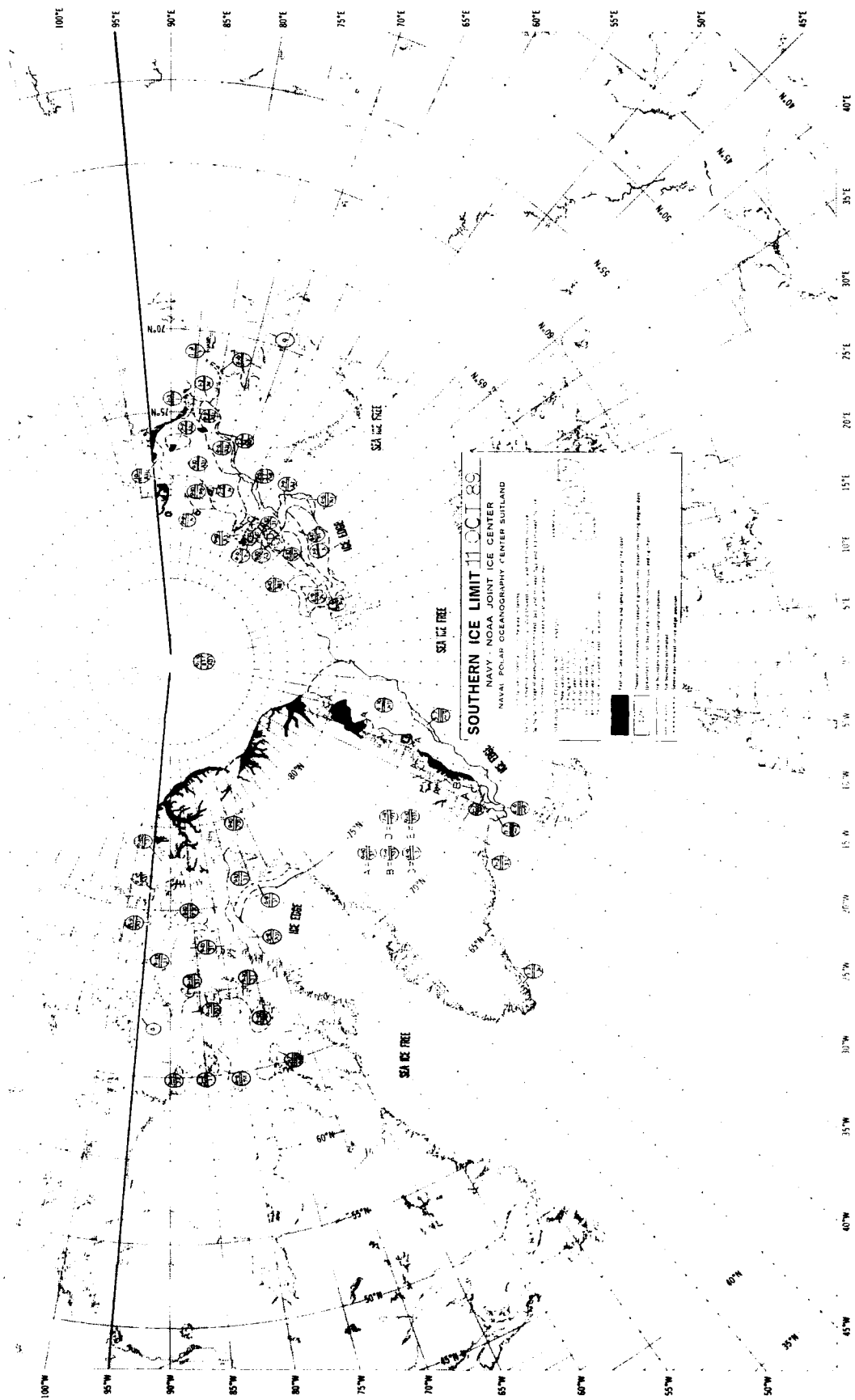


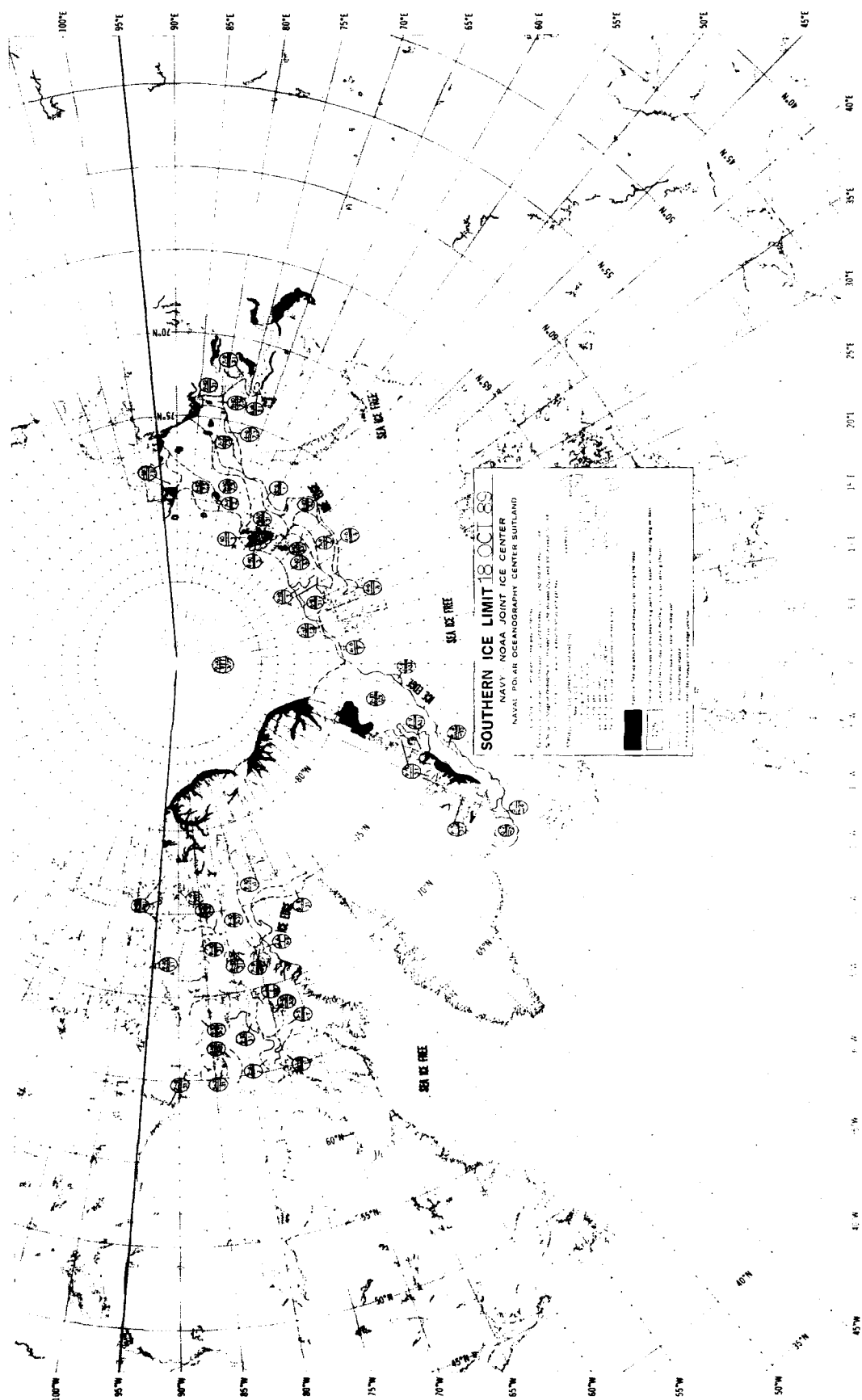


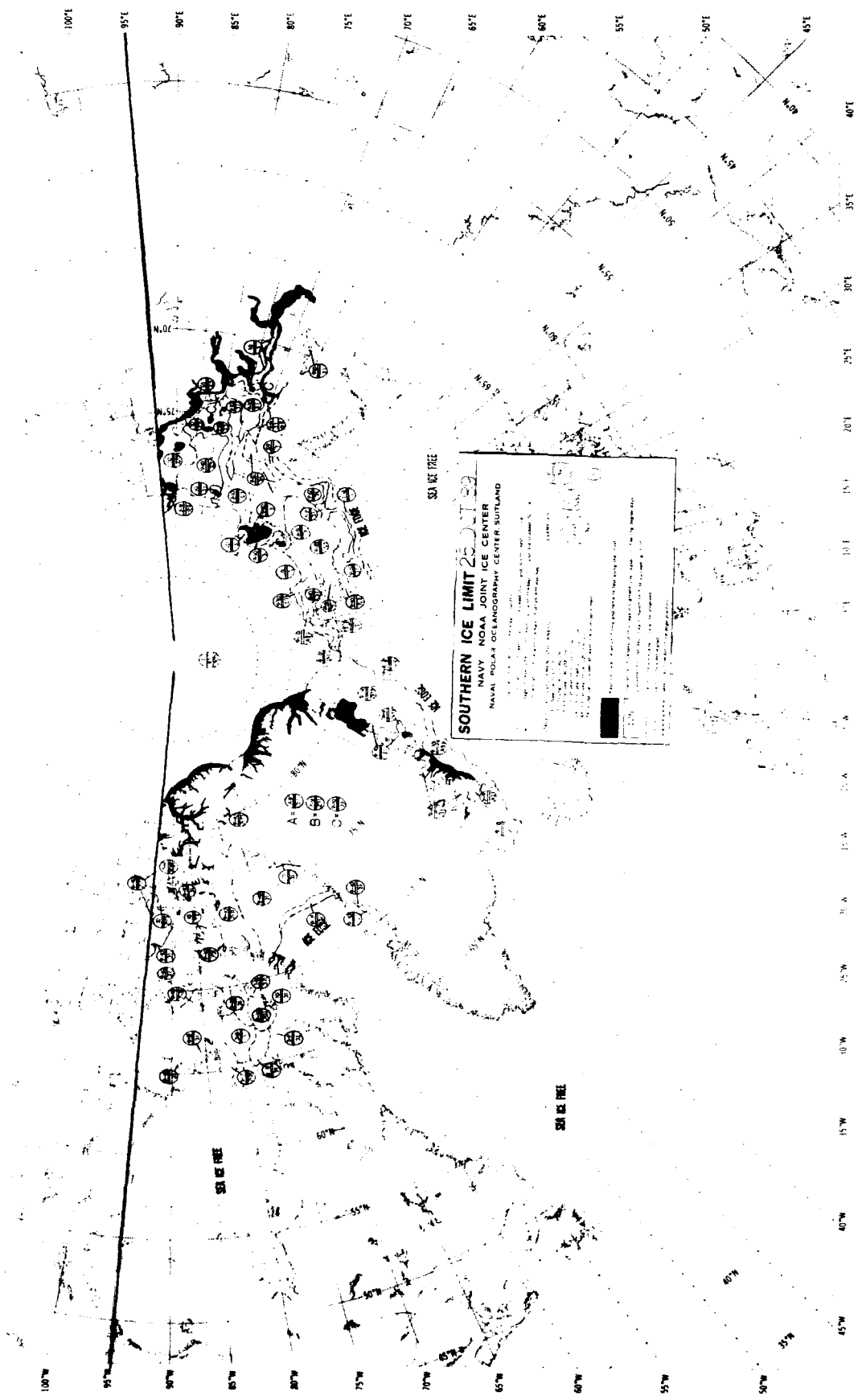




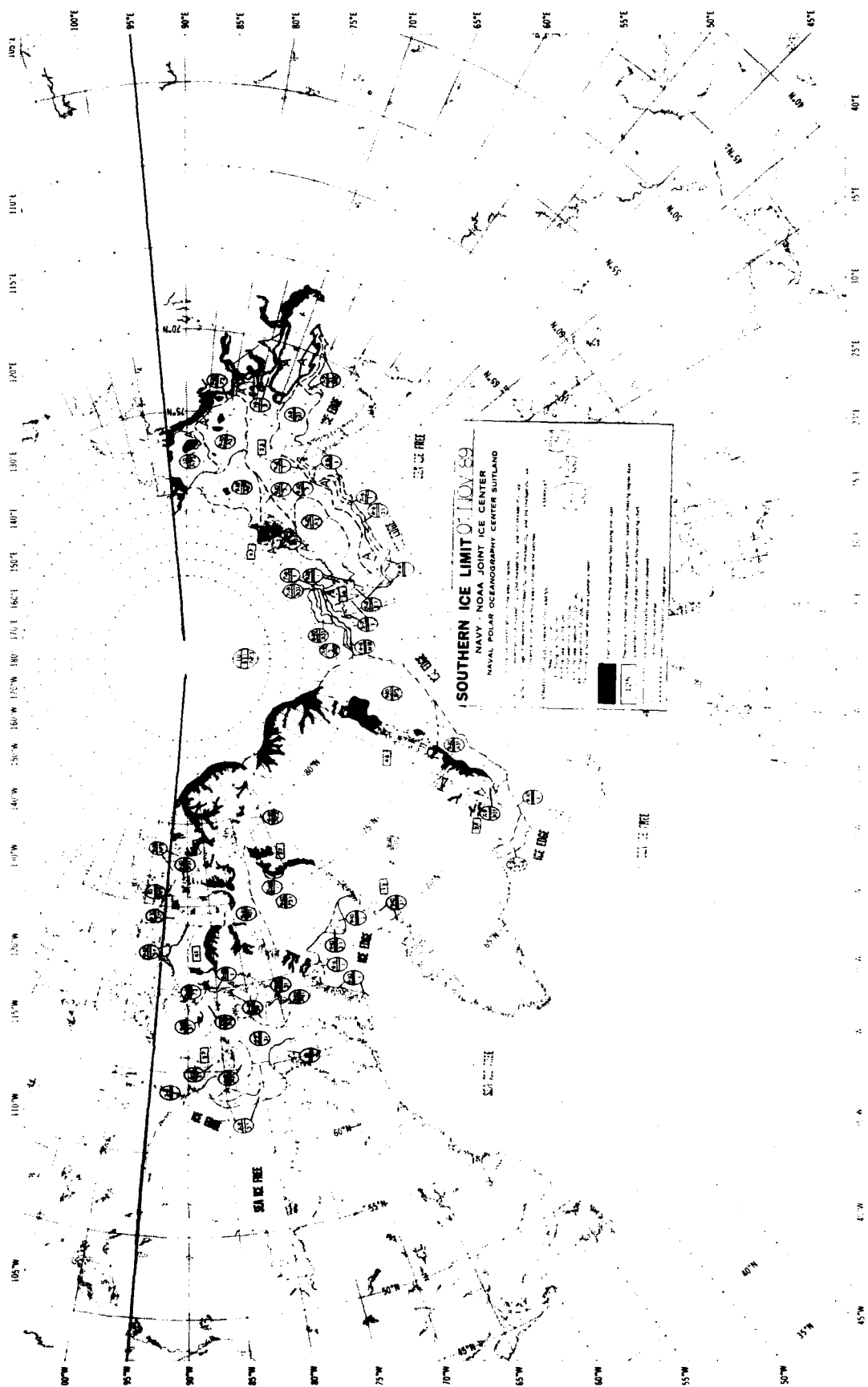


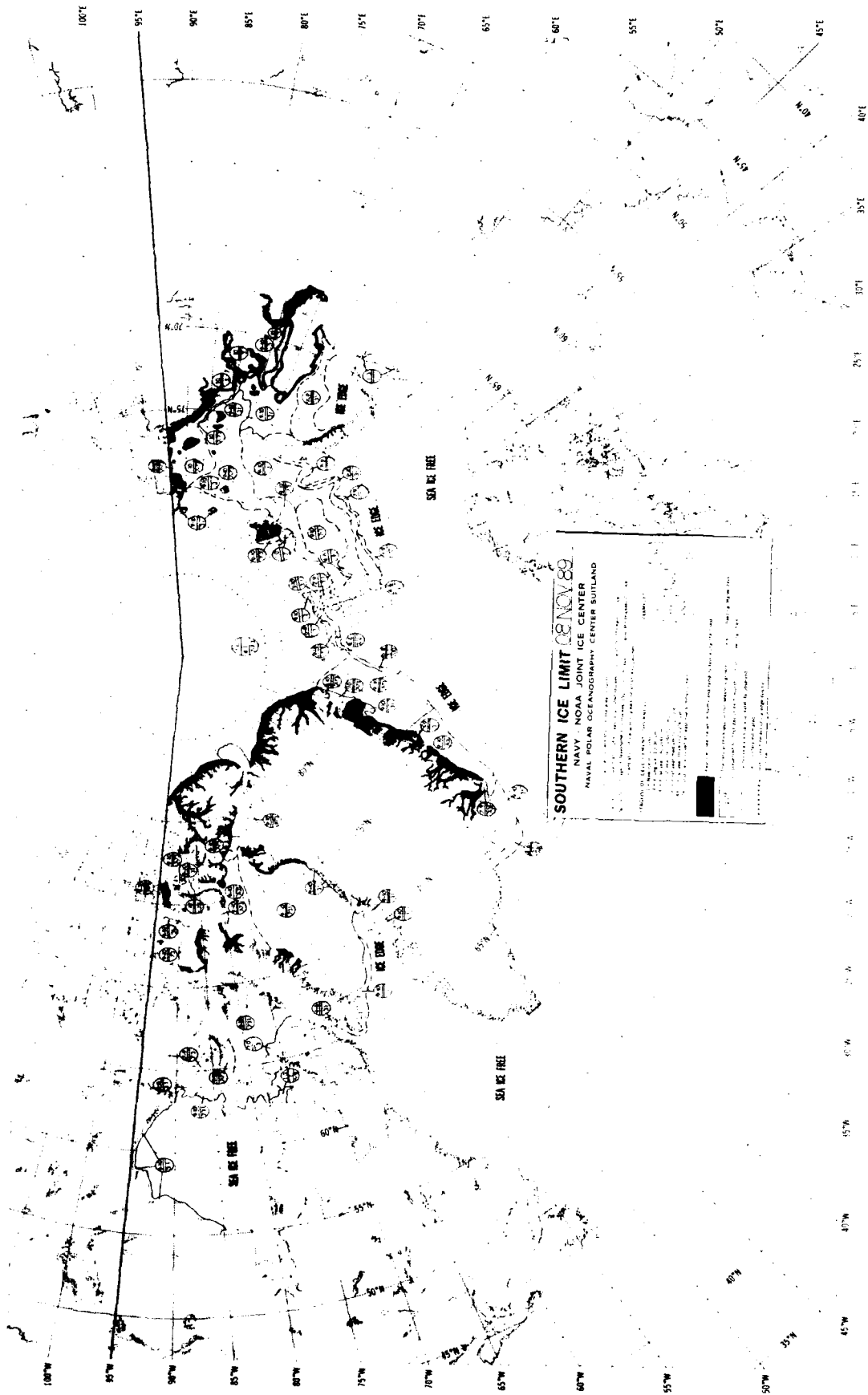


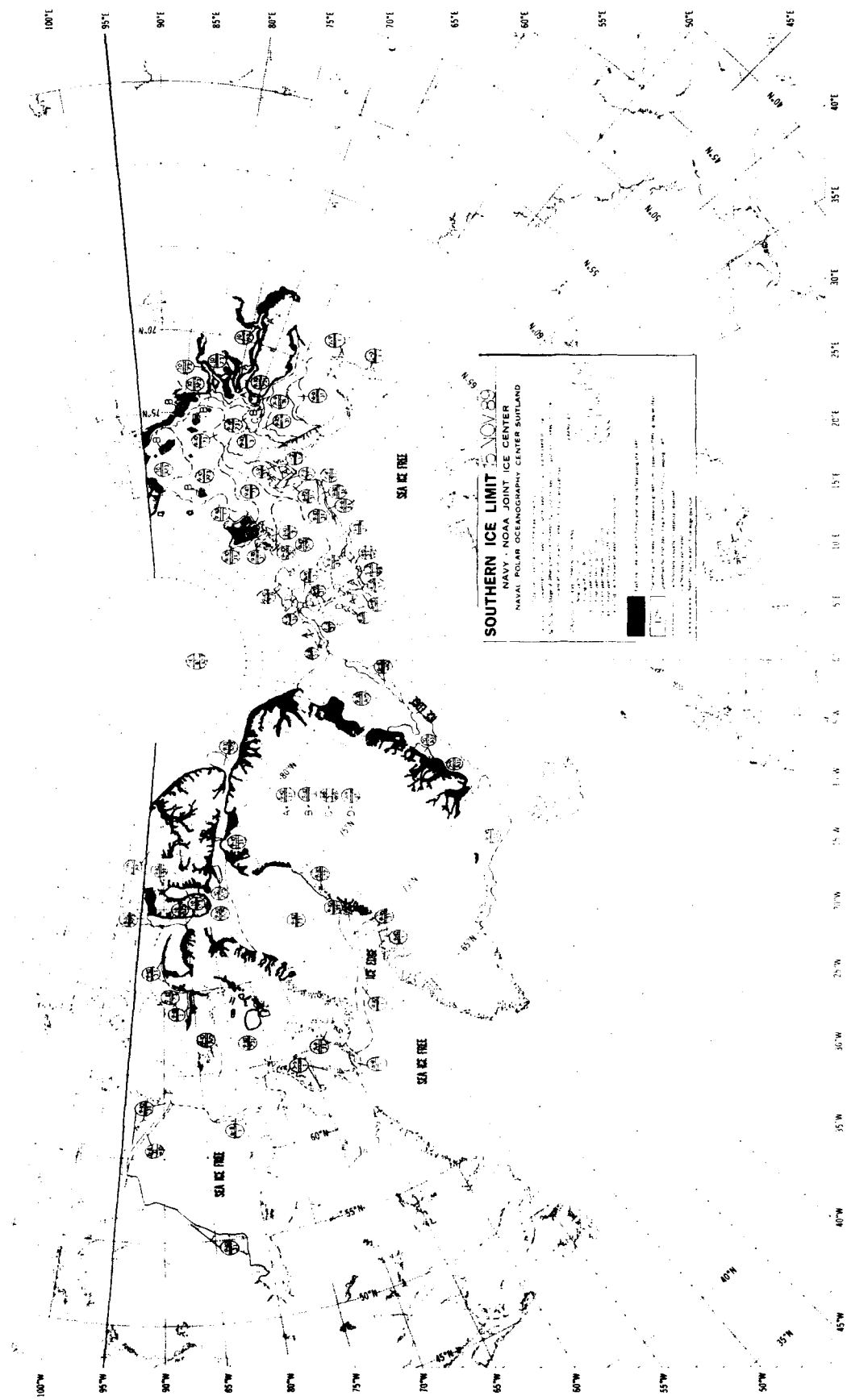


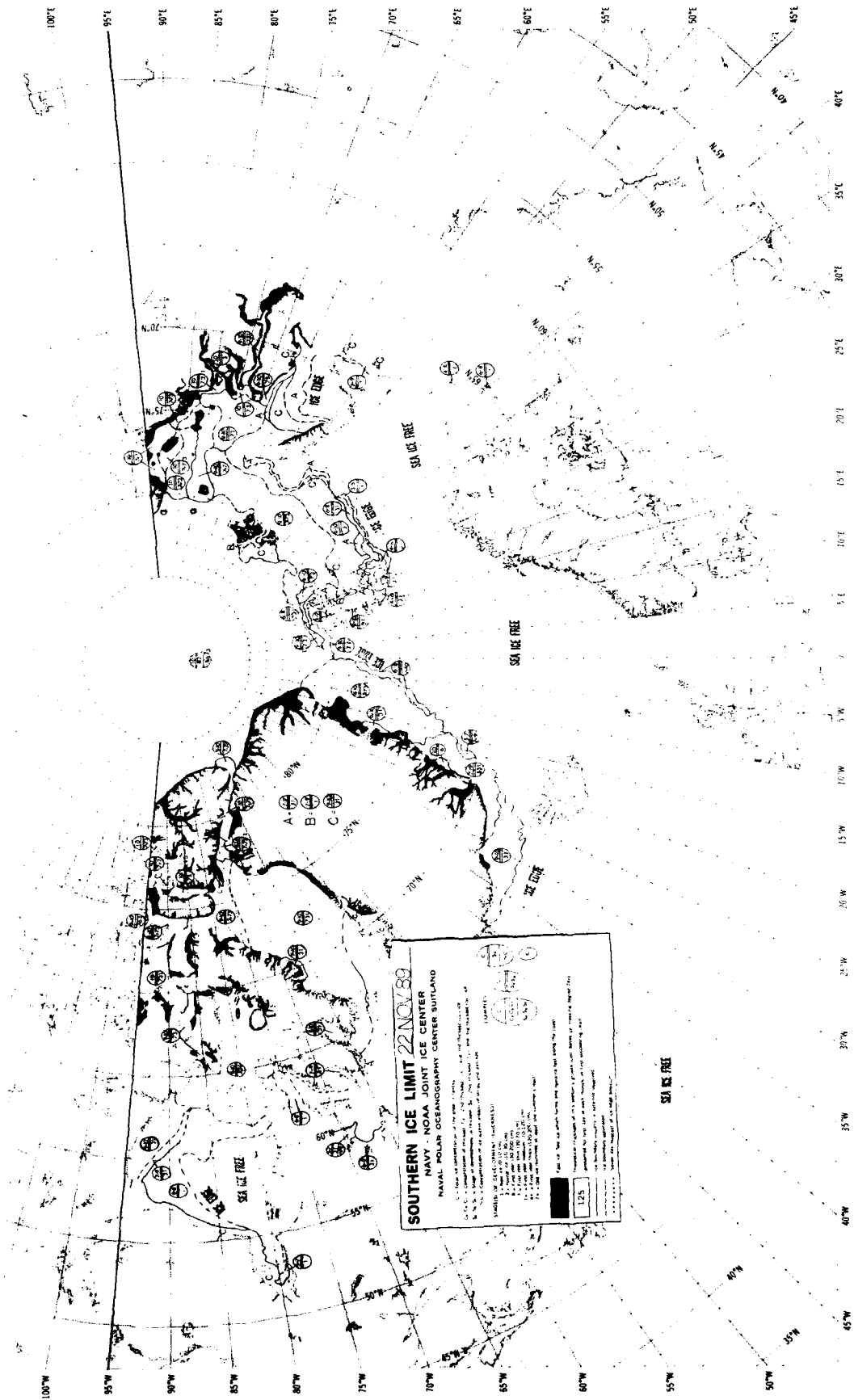


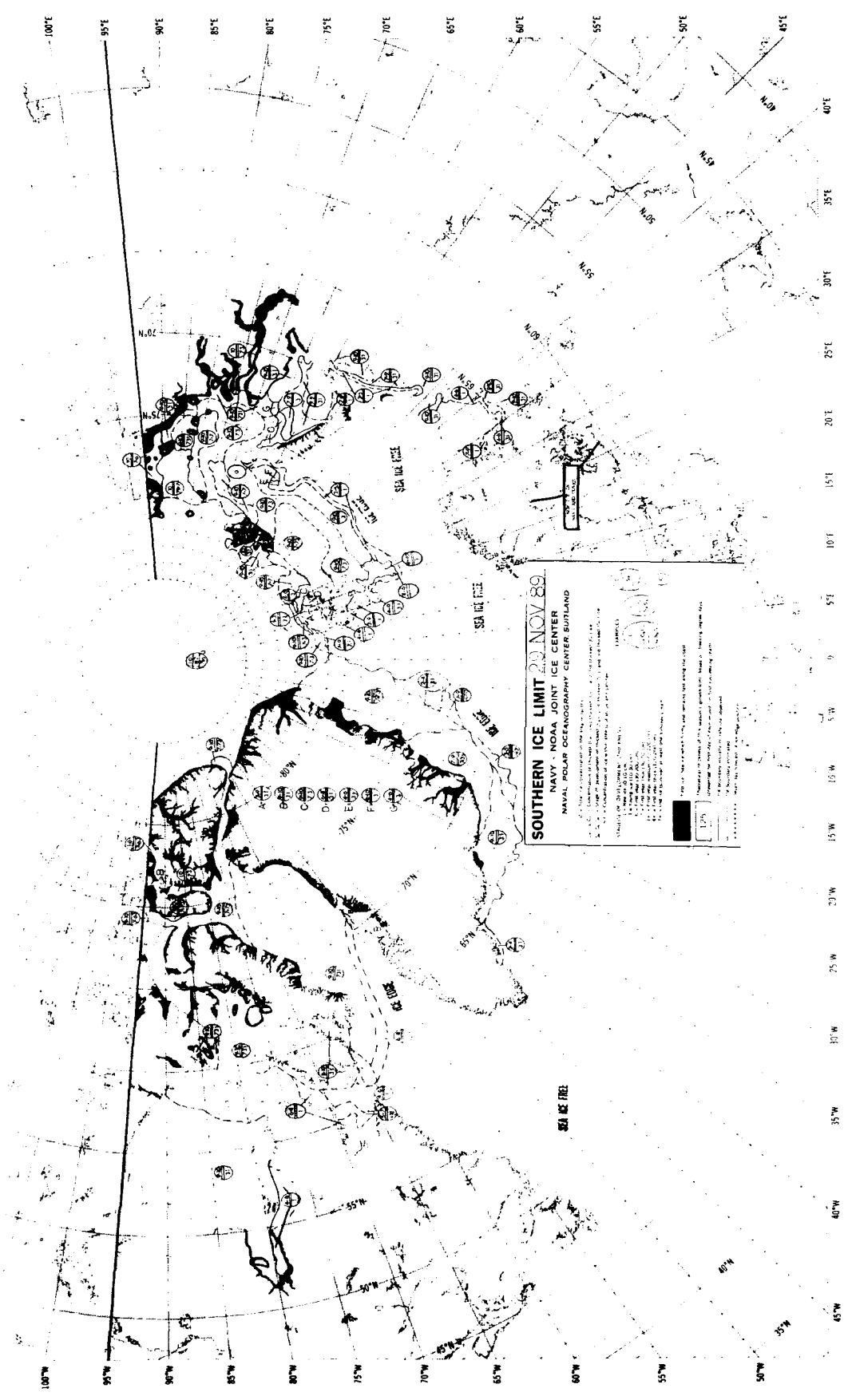
SOUTHERN ICE LIMIT 25 JUL 59
NAVY NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND











SOUTHERN ICE LIMIT 20 NOV 89
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND

1. This map is a representation of the ice limit as of 20 NOV 89. It is based on the data received from the Navy and NOAA. The data is subject to change and the map is not to be used for navigation purposes.

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SOUTHERN ICE LIMIT
NAVY, NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND

SEA ICE FREE

WEST LAKES OF ANTARCTICA

SEA ICE FREE

SEA ICE FREE

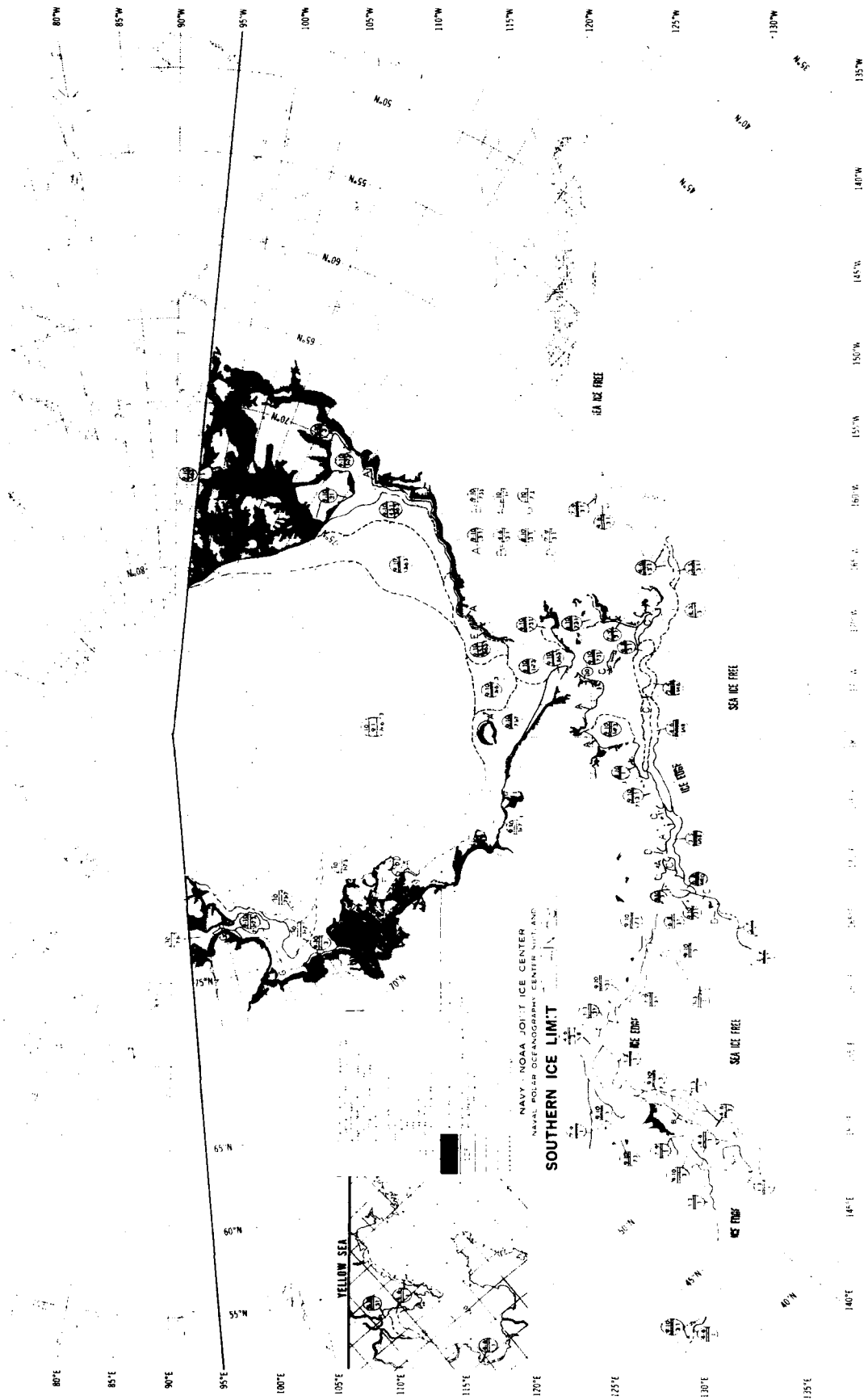
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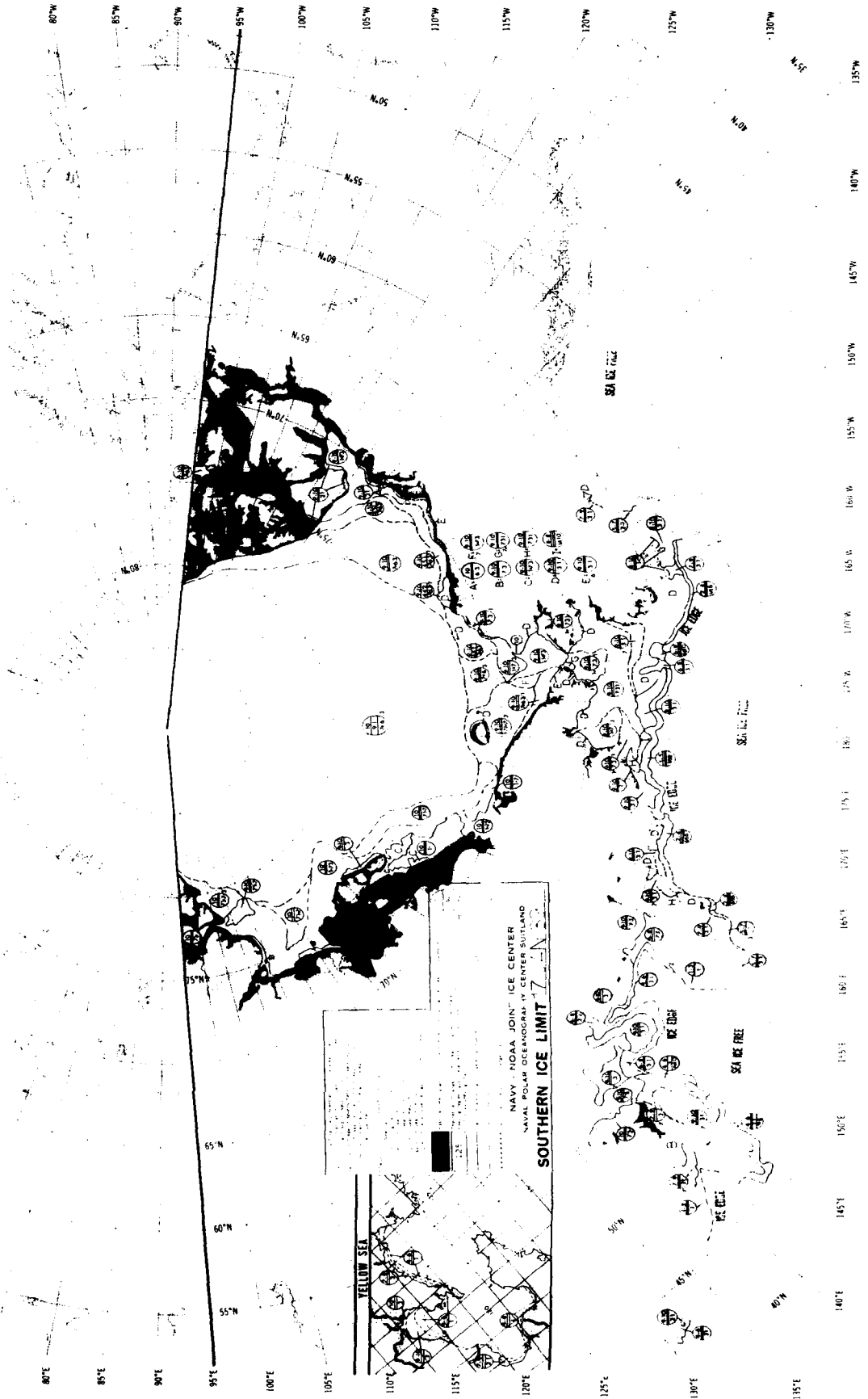
SEA ICE FREE

SEA ICE FREE

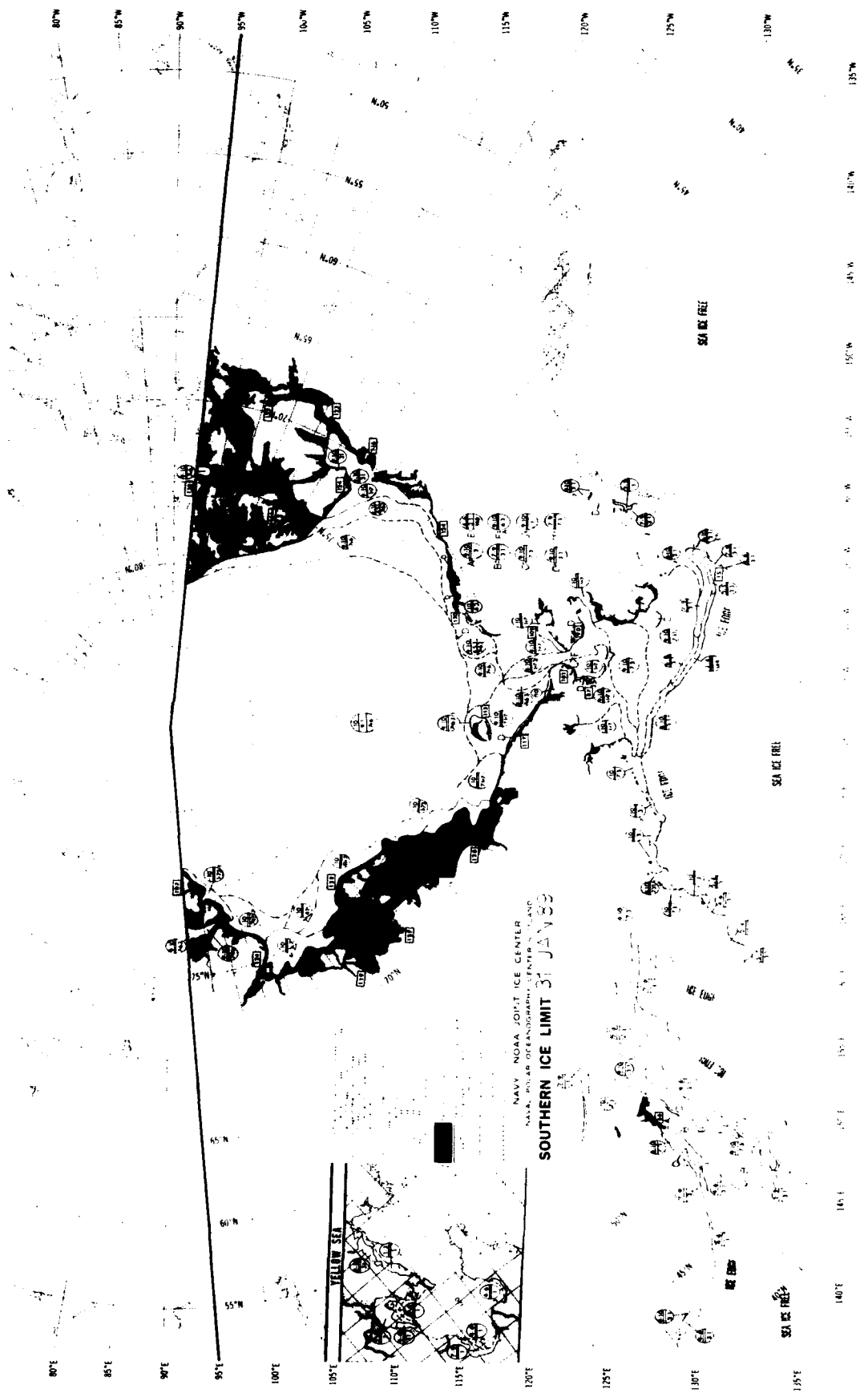
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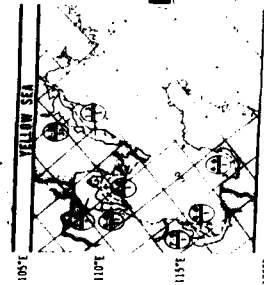








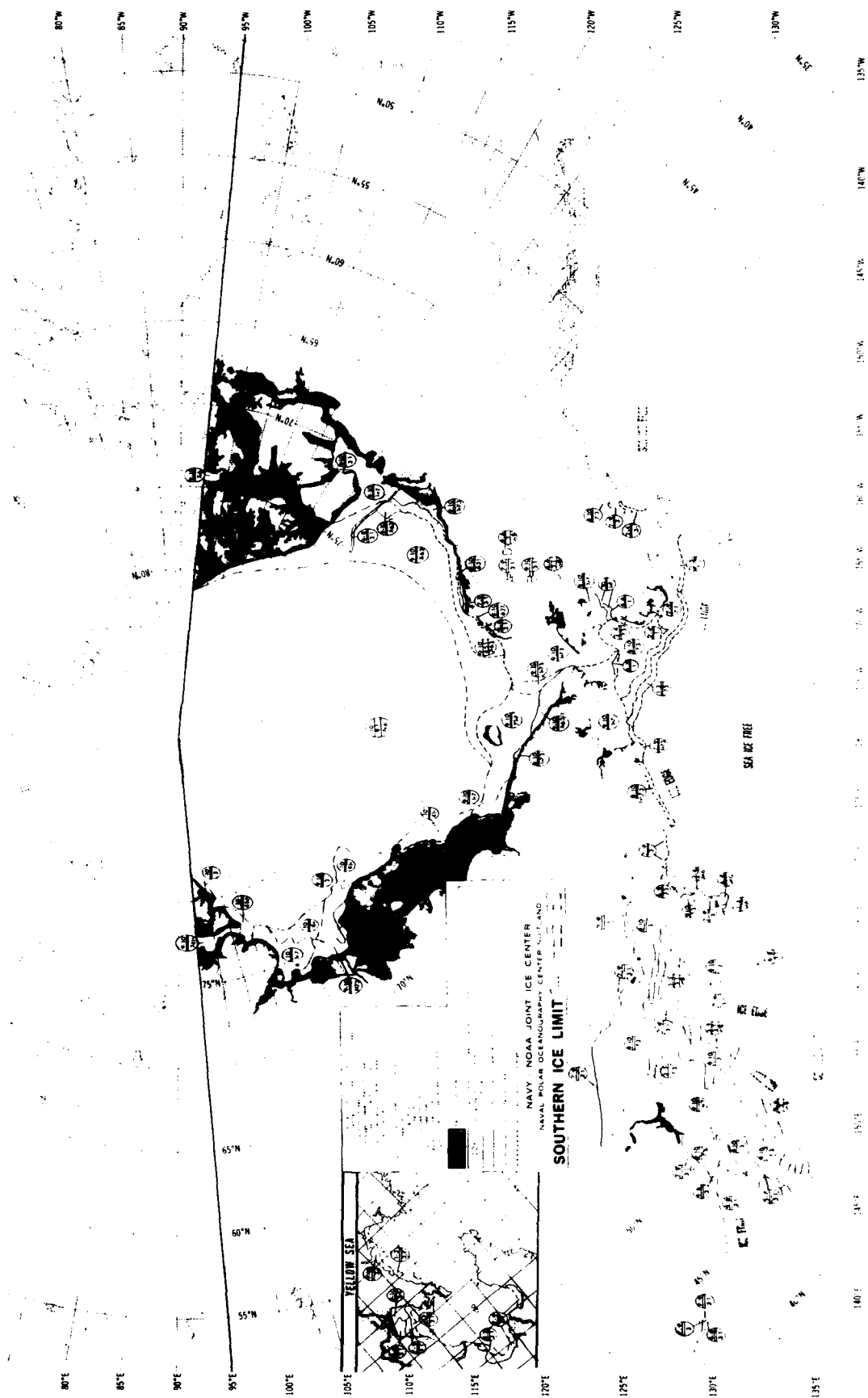
NAVY NOAA JOINT ICE CENTER
NAVY POLAR OCEANOGRAPHY CENTER
SOUTHERN ICE LIMIT 31 JAN 89

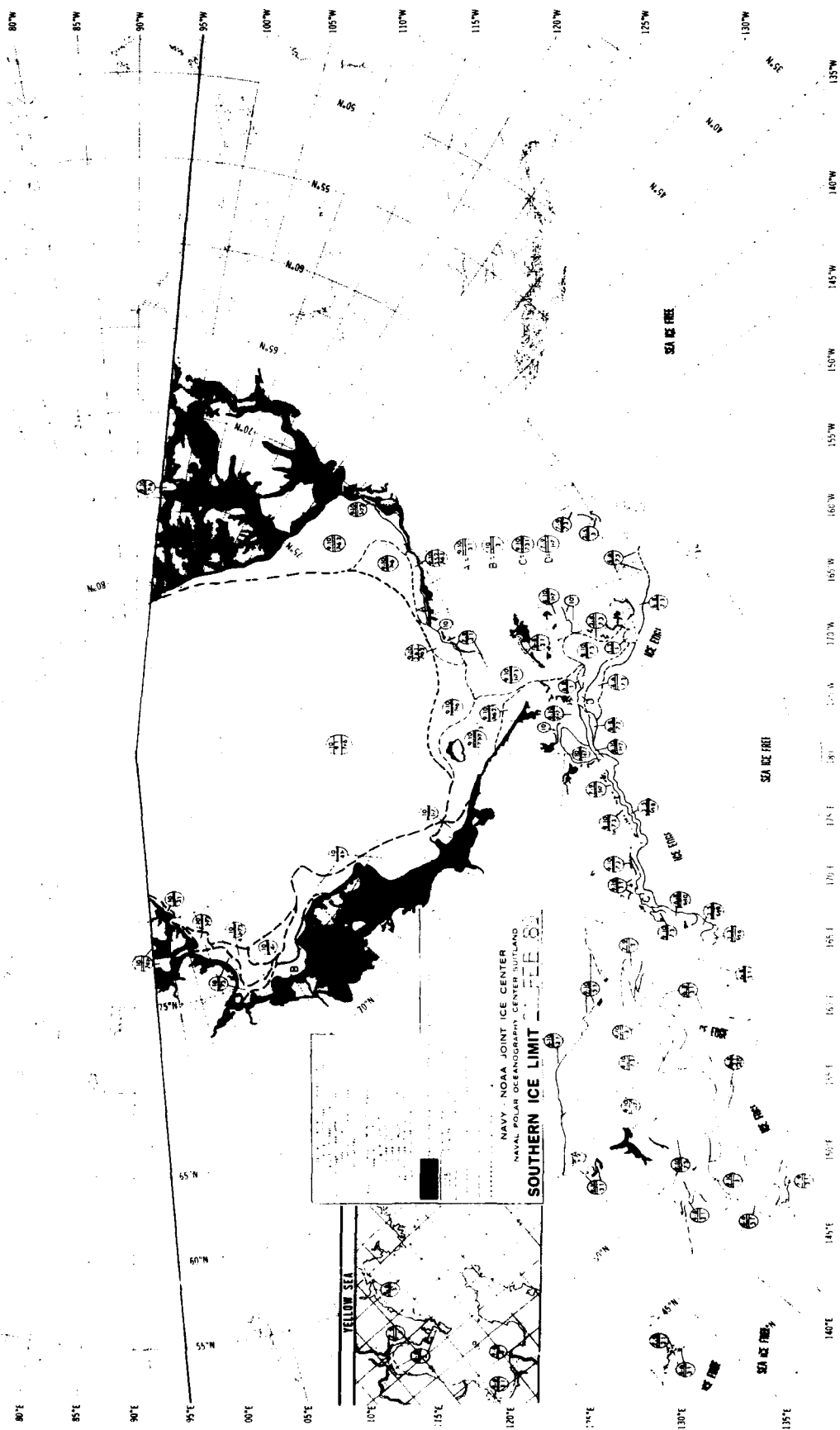


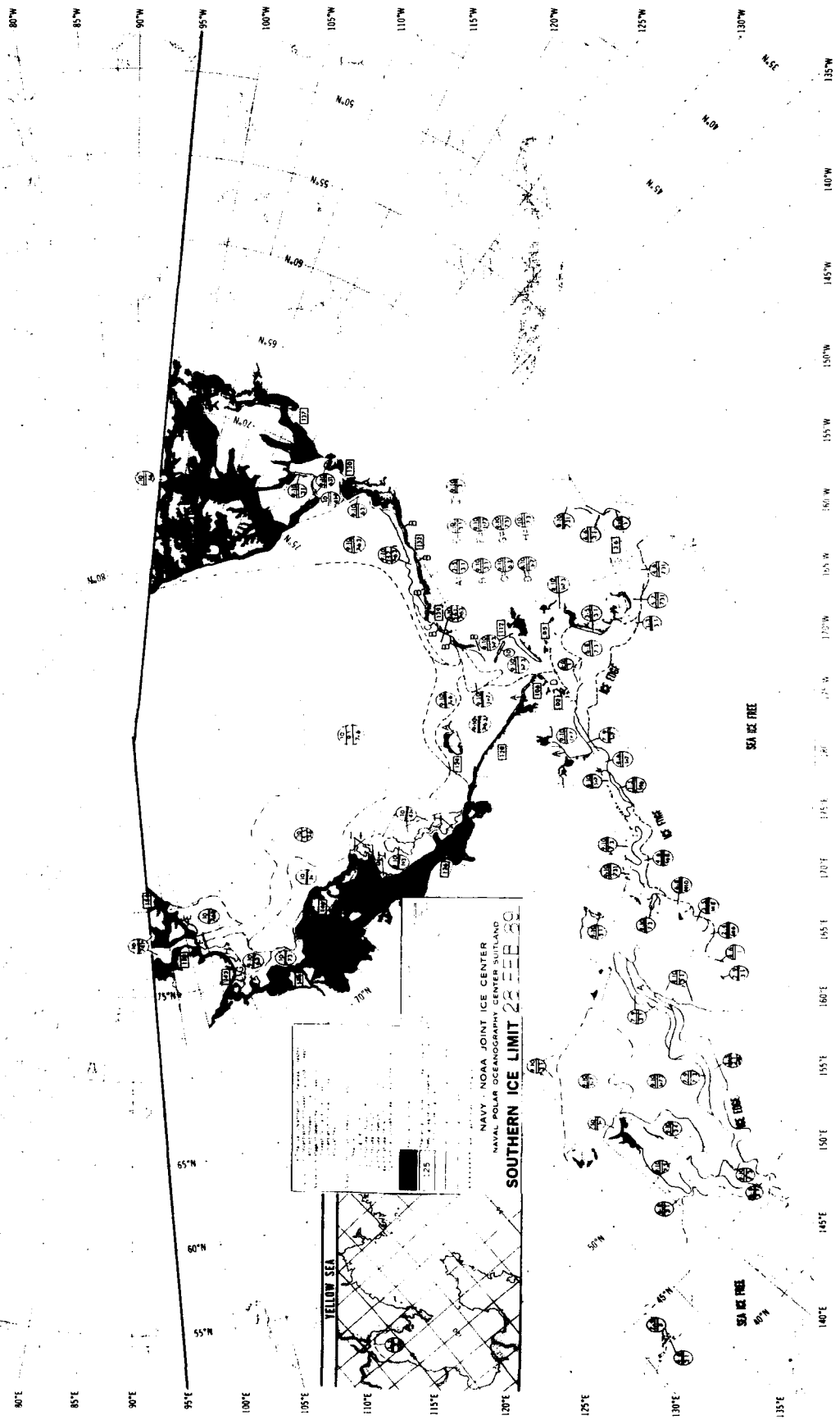


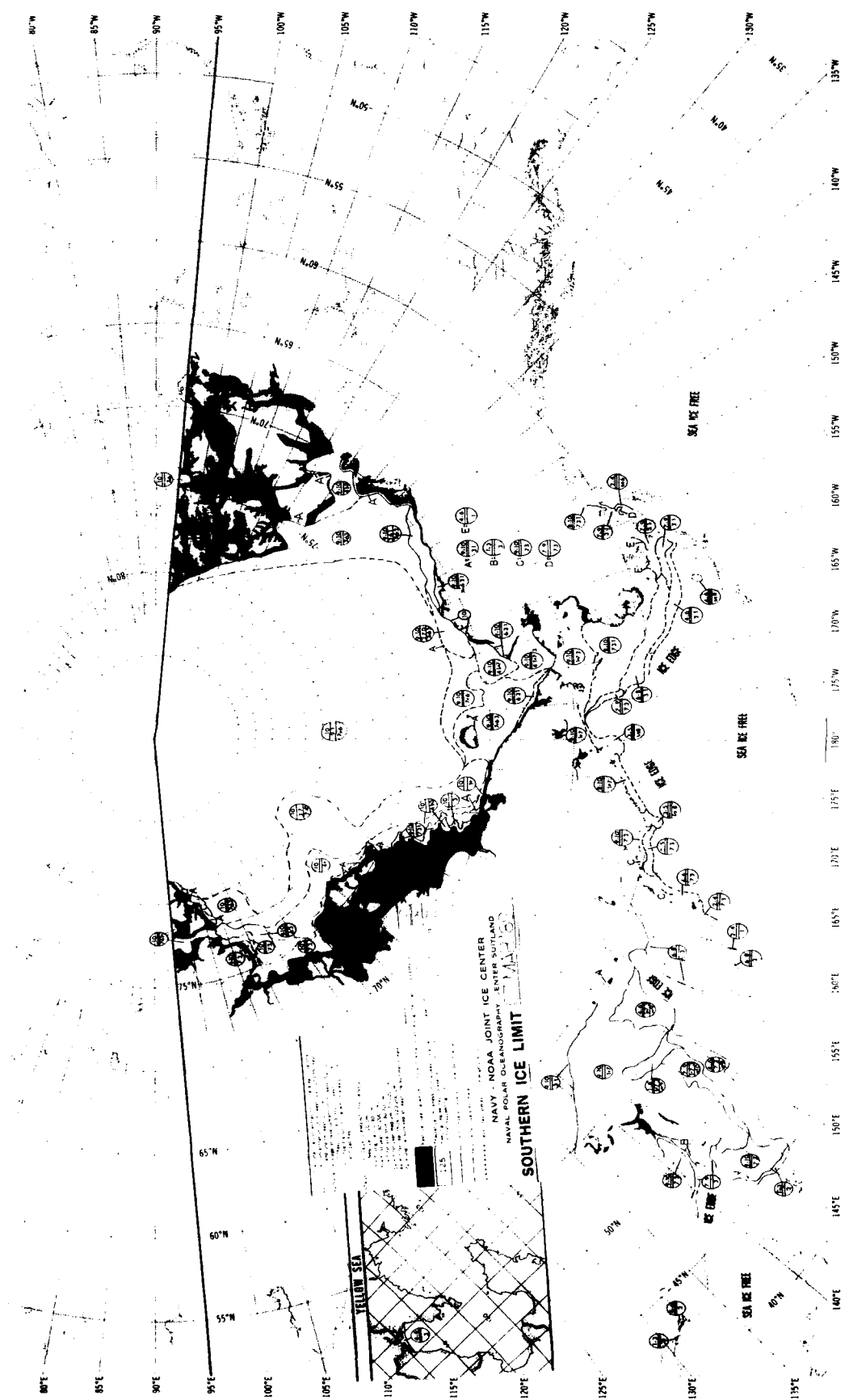
NAVY, NOAA JOINT ICE CENTER
N.A.S. POLAR OCEANOGRAPHY CENTER, LAND
SOUTHERN ICE LIMIT





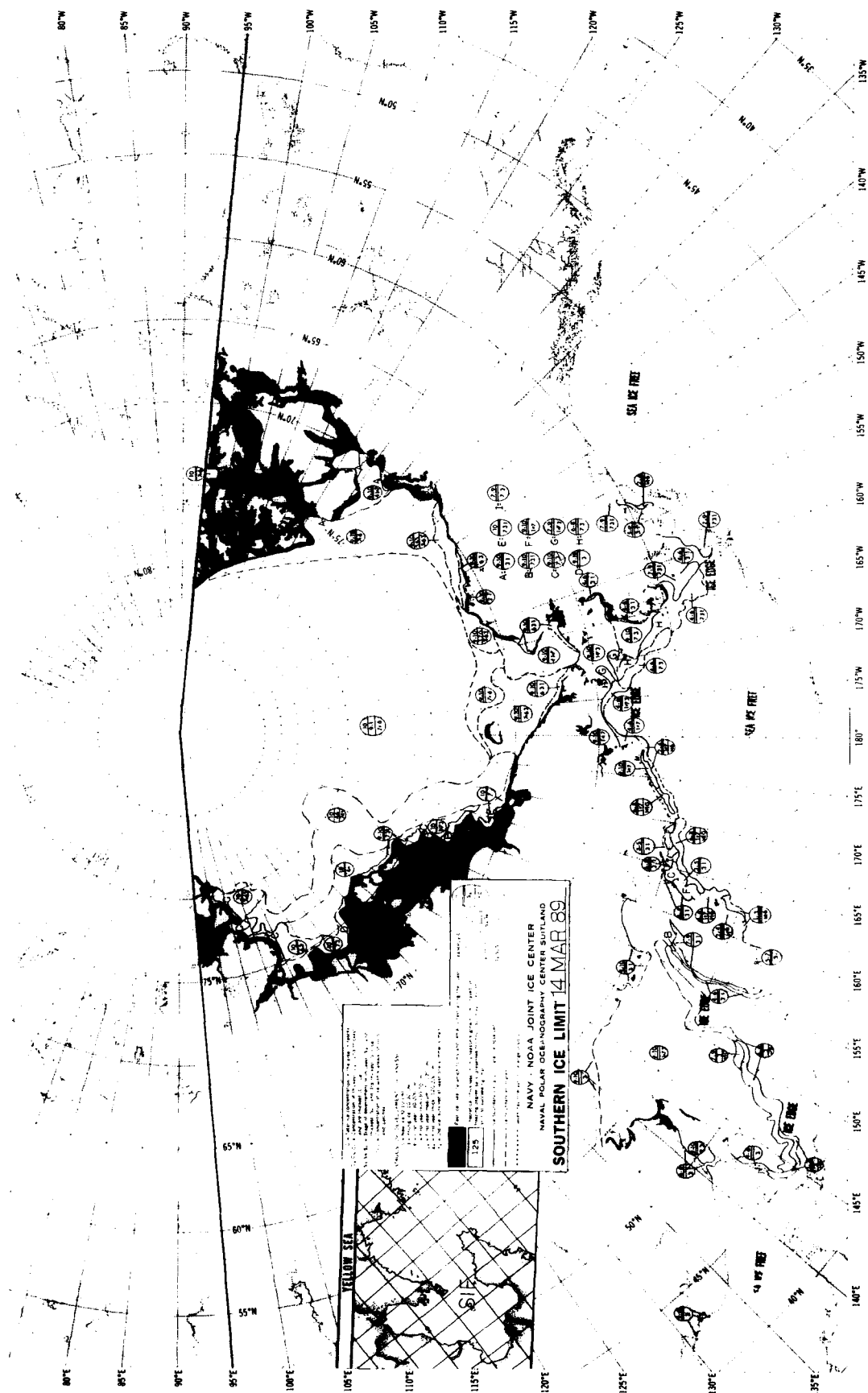


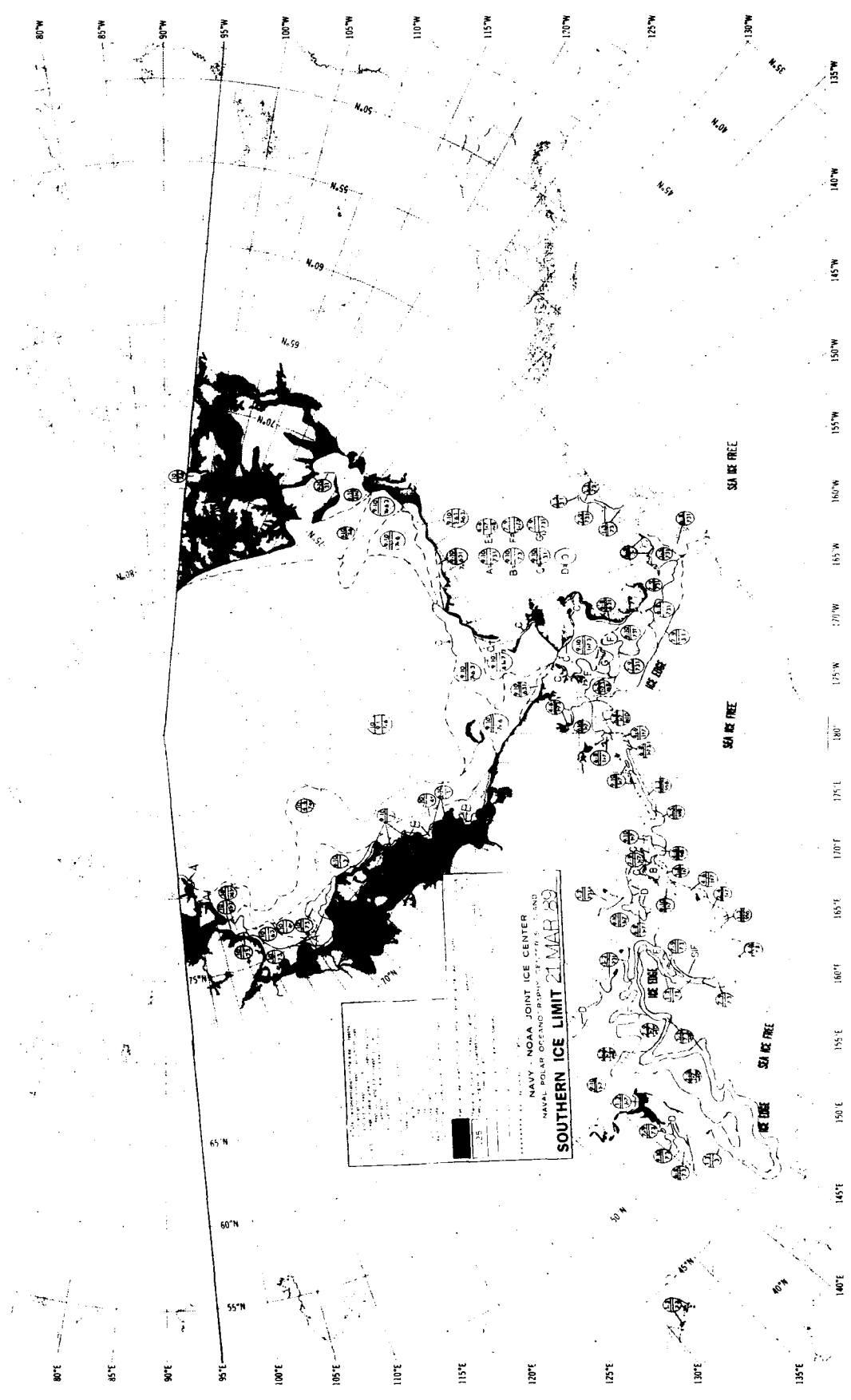


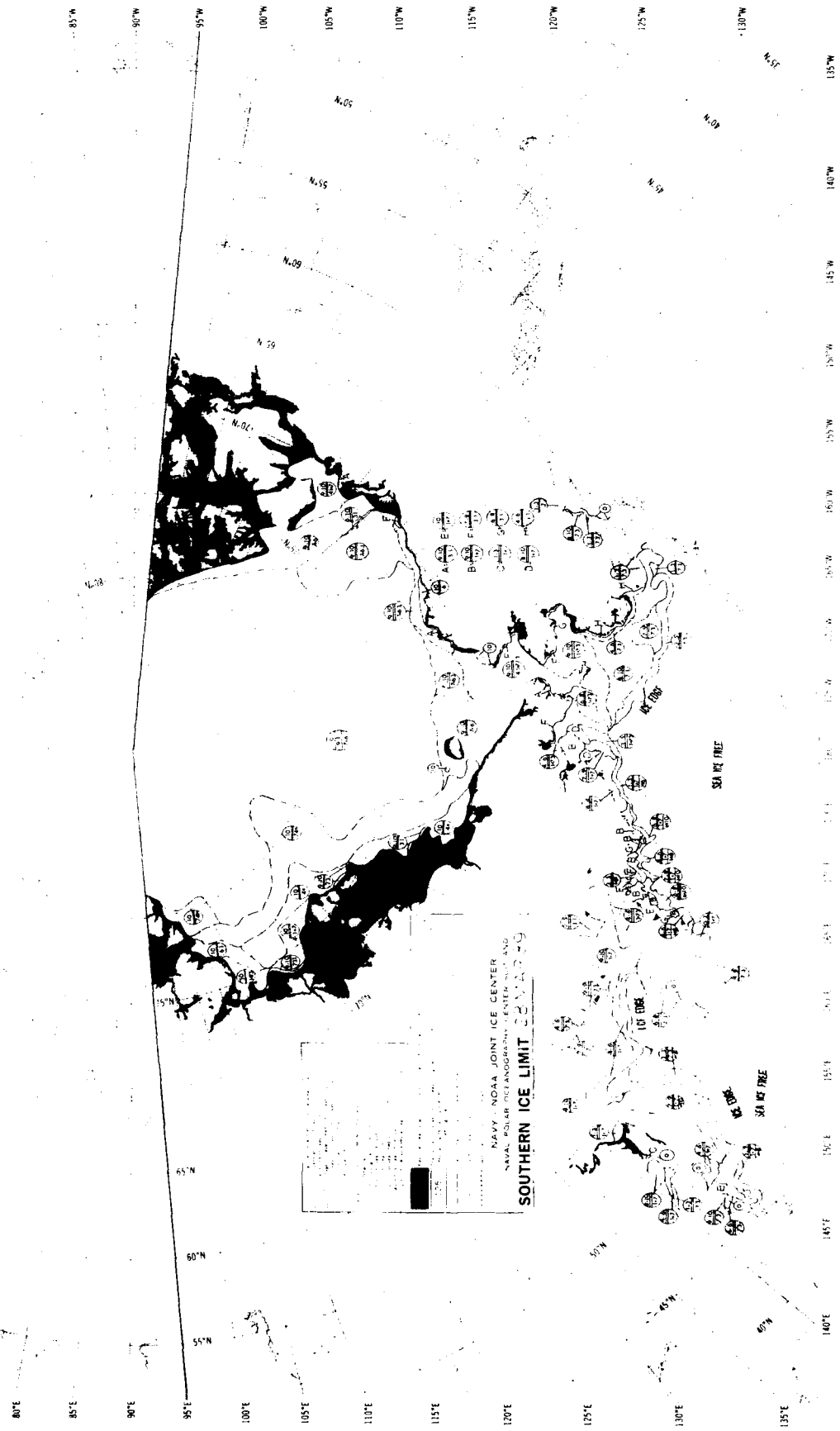


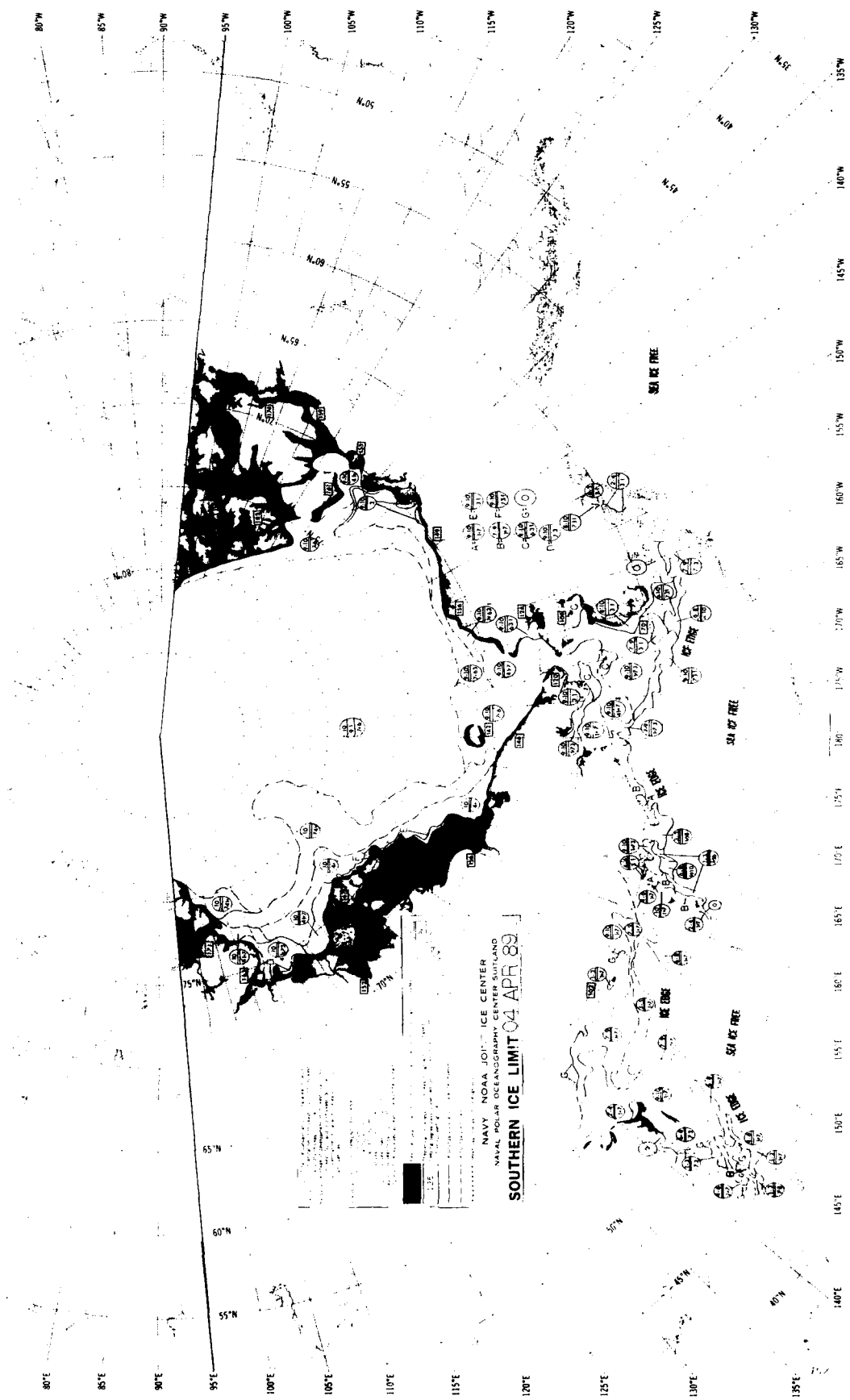
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY ENTER SUITLAND
SOUTHERN ICE LIMIT

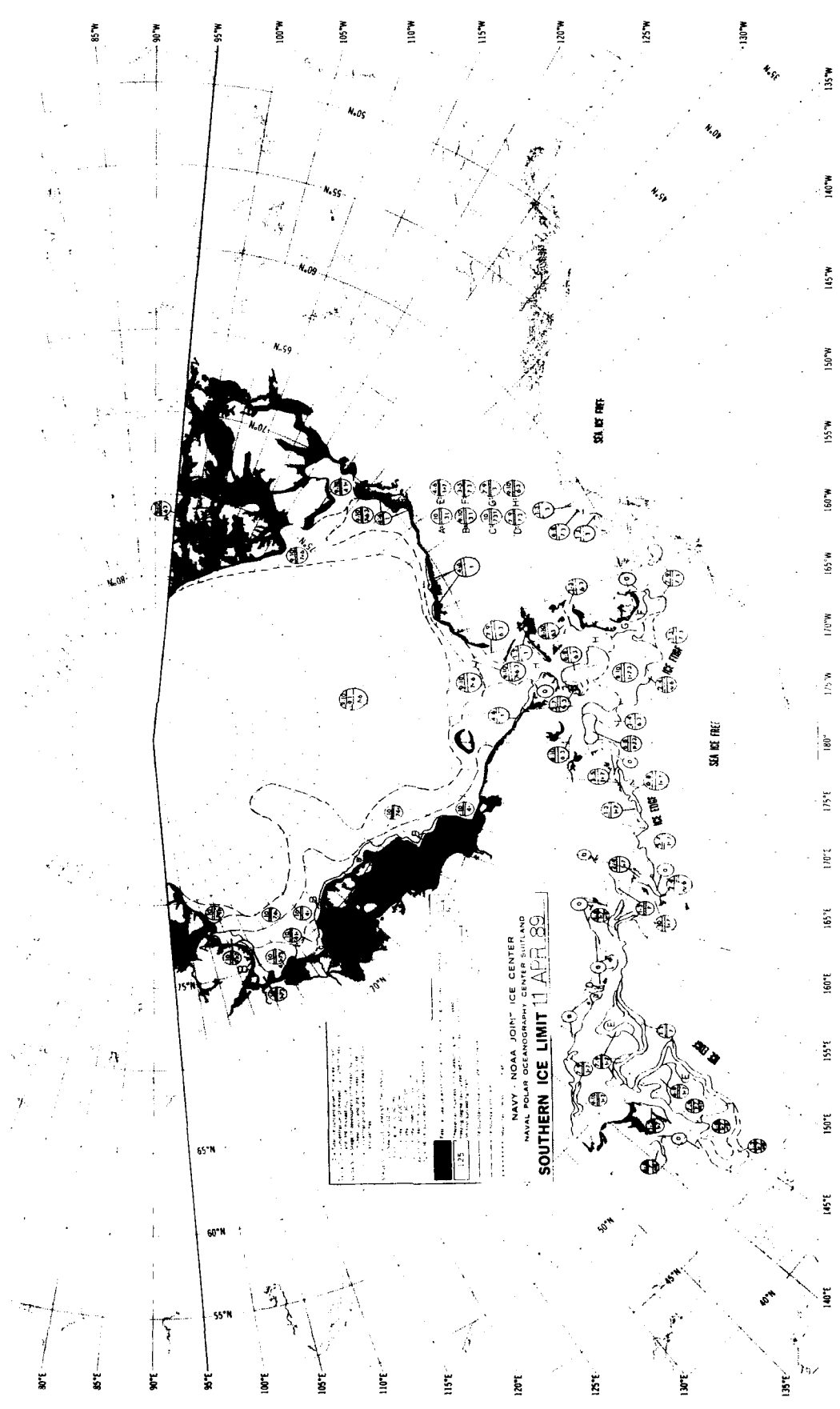
YELLOW SEA





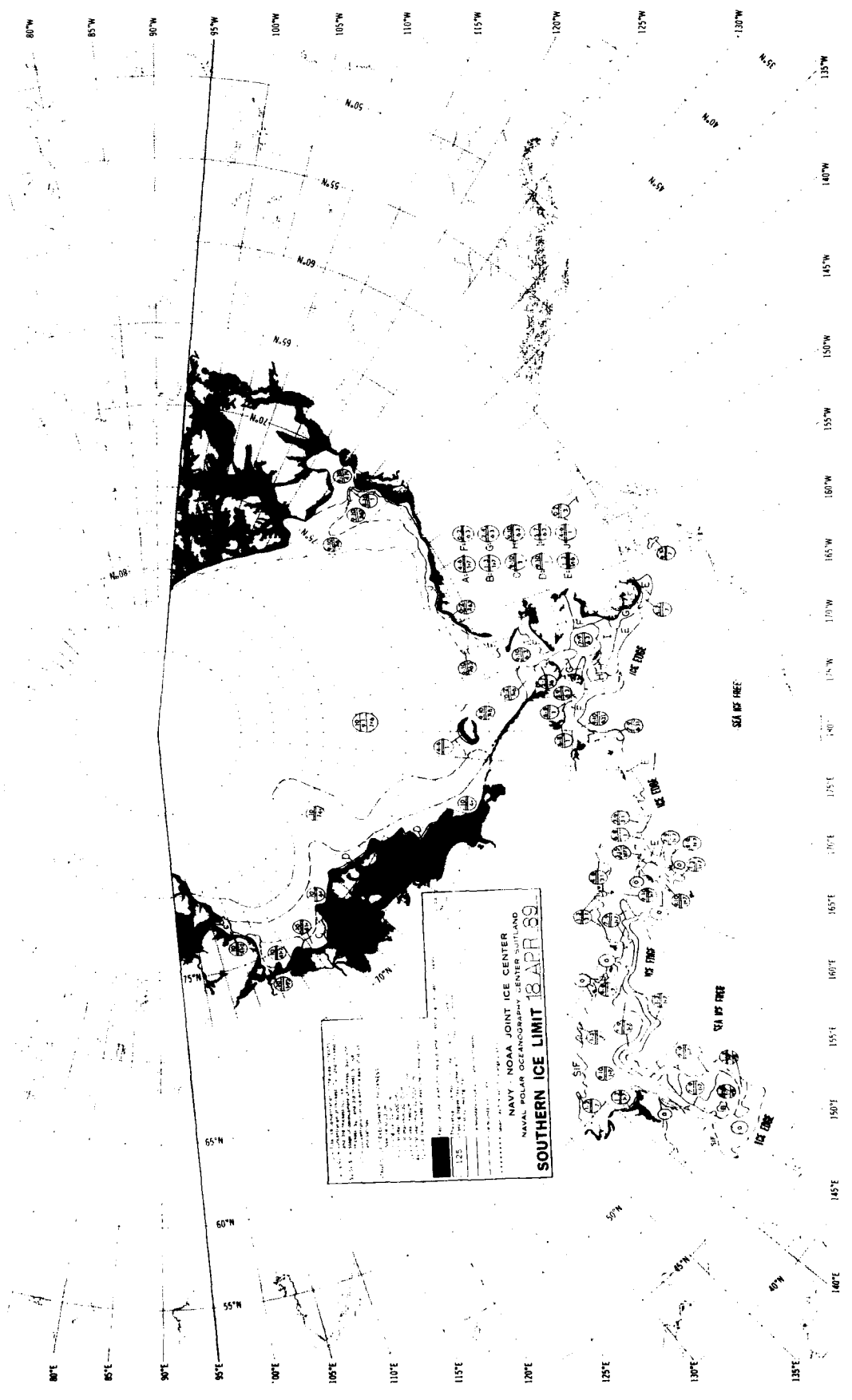






NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER BUILDING
SOUTHERN ICE LIMIT 11 APR 89

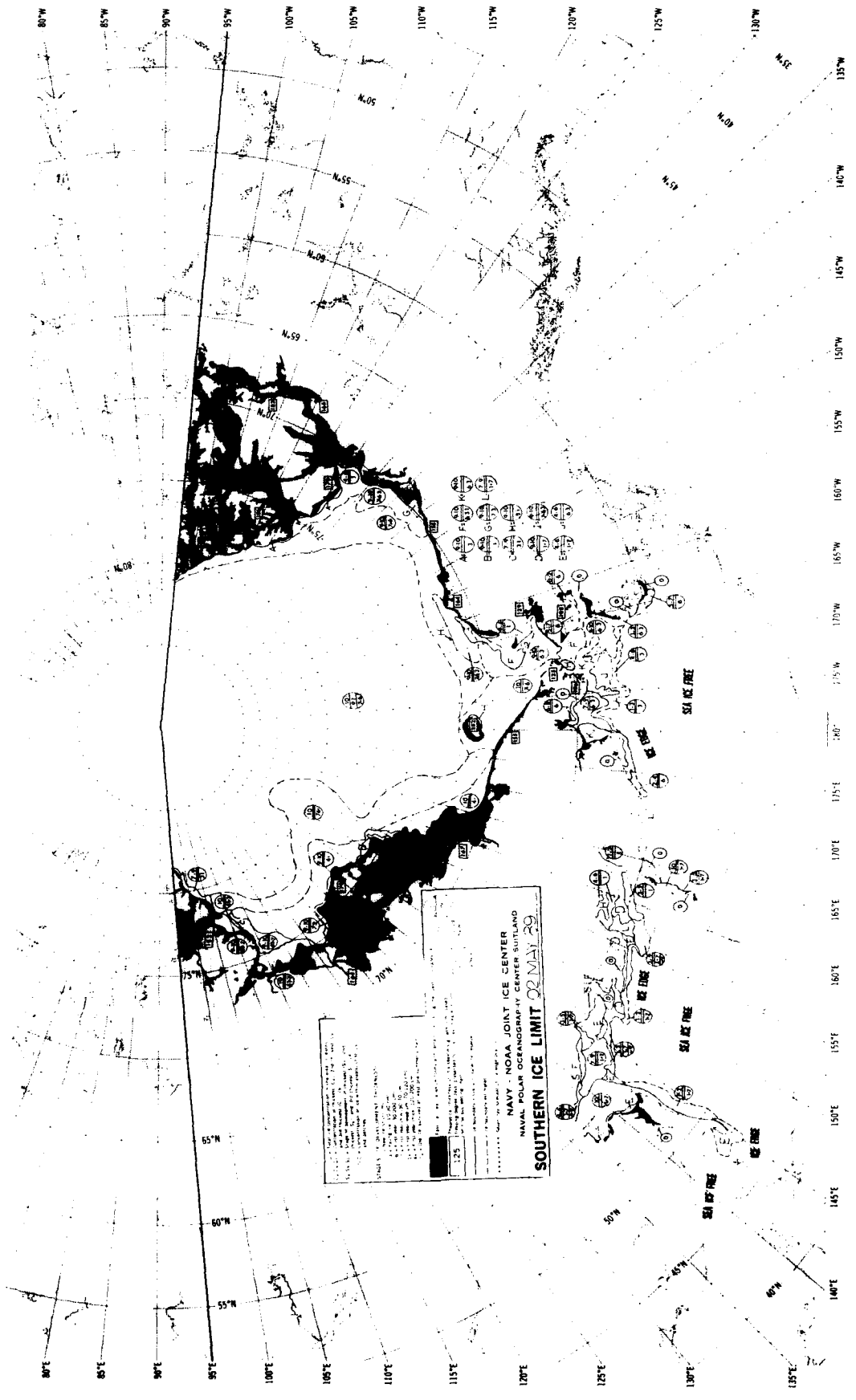
Legend:
1. Ice Limit
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100. Ice Limit



NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUITLAND
SOUTHERN ICE LIMIT 18 APR 89

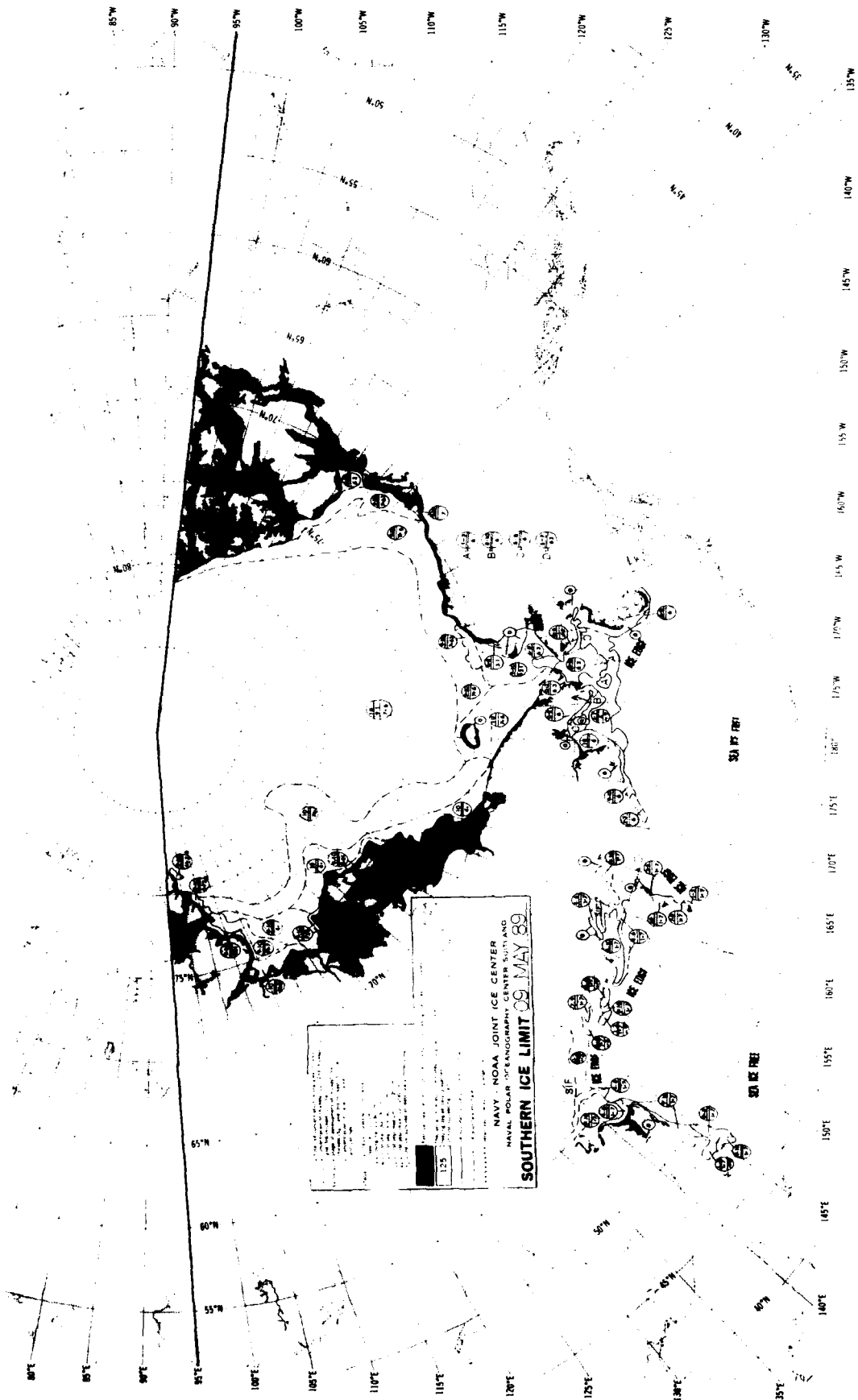
1. This map shows the Southern Ice Limit as of 18 APR 89. The data was collected by the Navy - NOAA Joint Ice Center and the Naval Polar Oceanography Center, Suitland. The map is based on a combination of satellite data and ship reports. The data points are represented by circles with numbers inside. The numbers represent the ice concentration in percent. The map is a composite of several maps, each covering a different area of the Southern Ocean. The map is a composite of several maps, each covering a different area of the Southern Ocean. The map is a composite of several maps, each covering a different area of the Southern Ocean.

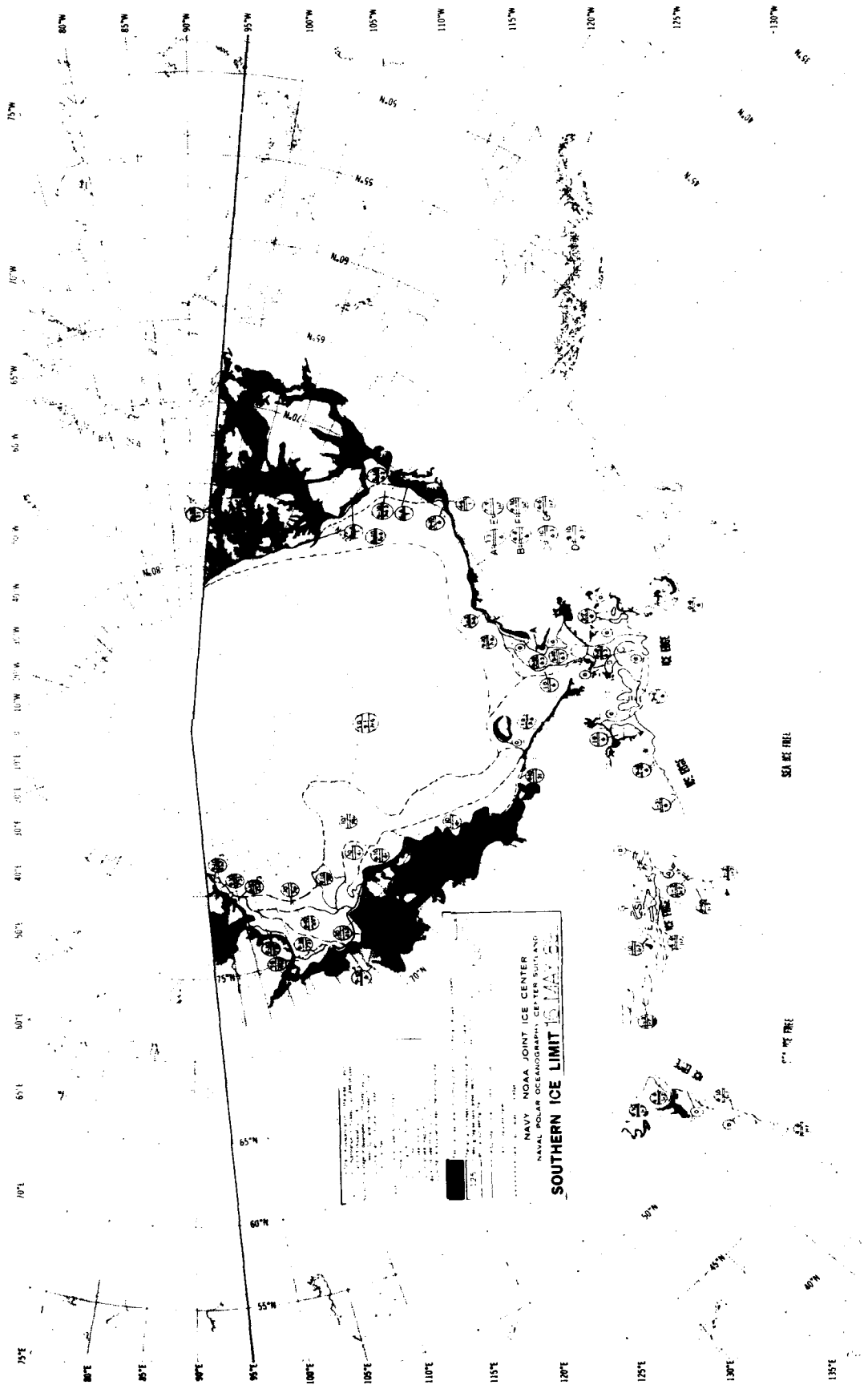




NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND
SOUTHERN ICE LIMIT 02 MAY 20

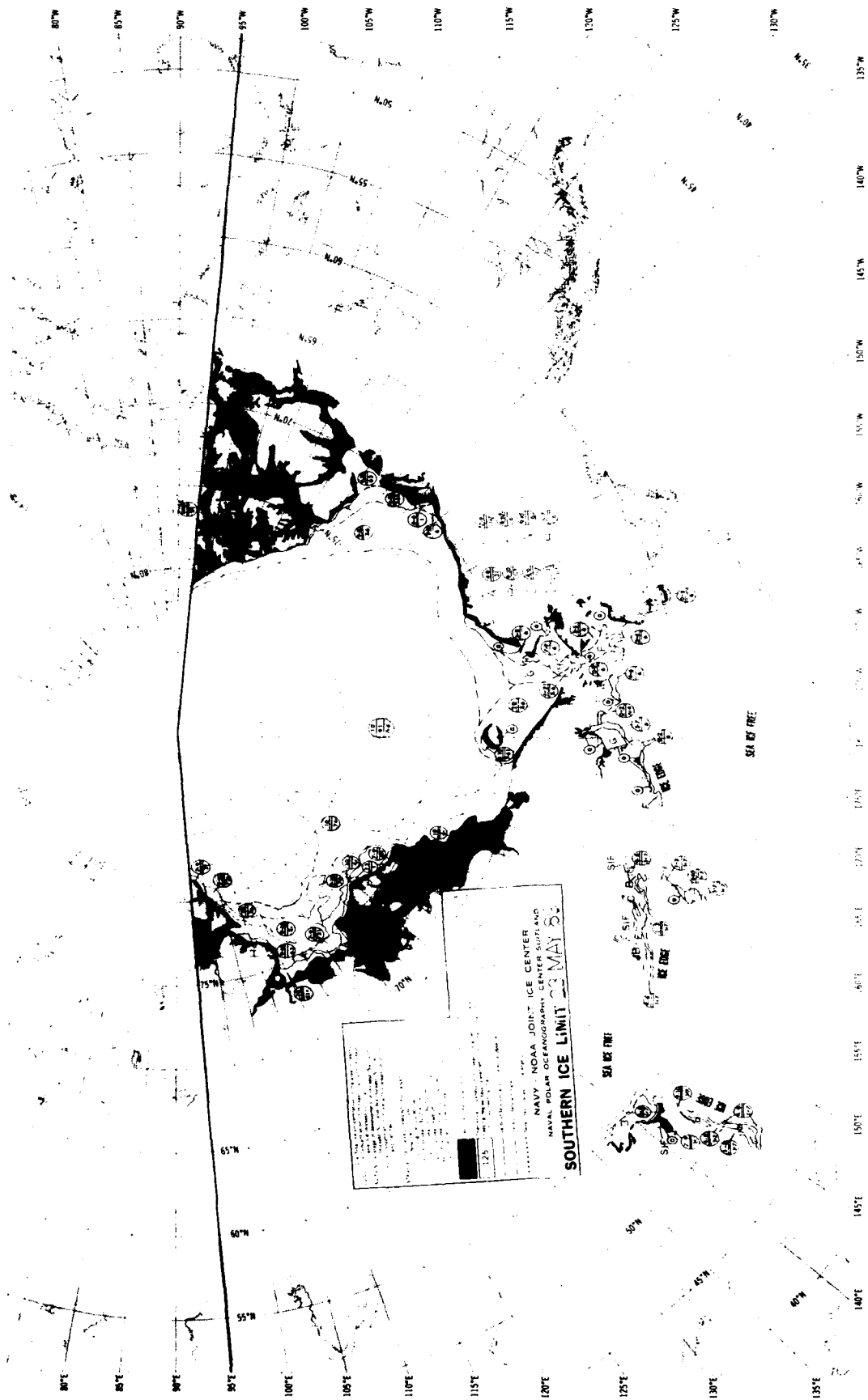
Legend:
1. Ice Thickness (meters)
2. Ice Concentration (%)
3. Ice Type (Sea Ice, Land Ice)
4. Ice Age (Years)
5. Ice Motion (Direction, Speed)
6. Ice Edge (Type)
7. Ice Breakup (Type)
8. Ice Melt (Type)
9. Ice Freeze (Type)
10. Ice Accumulation (Type)

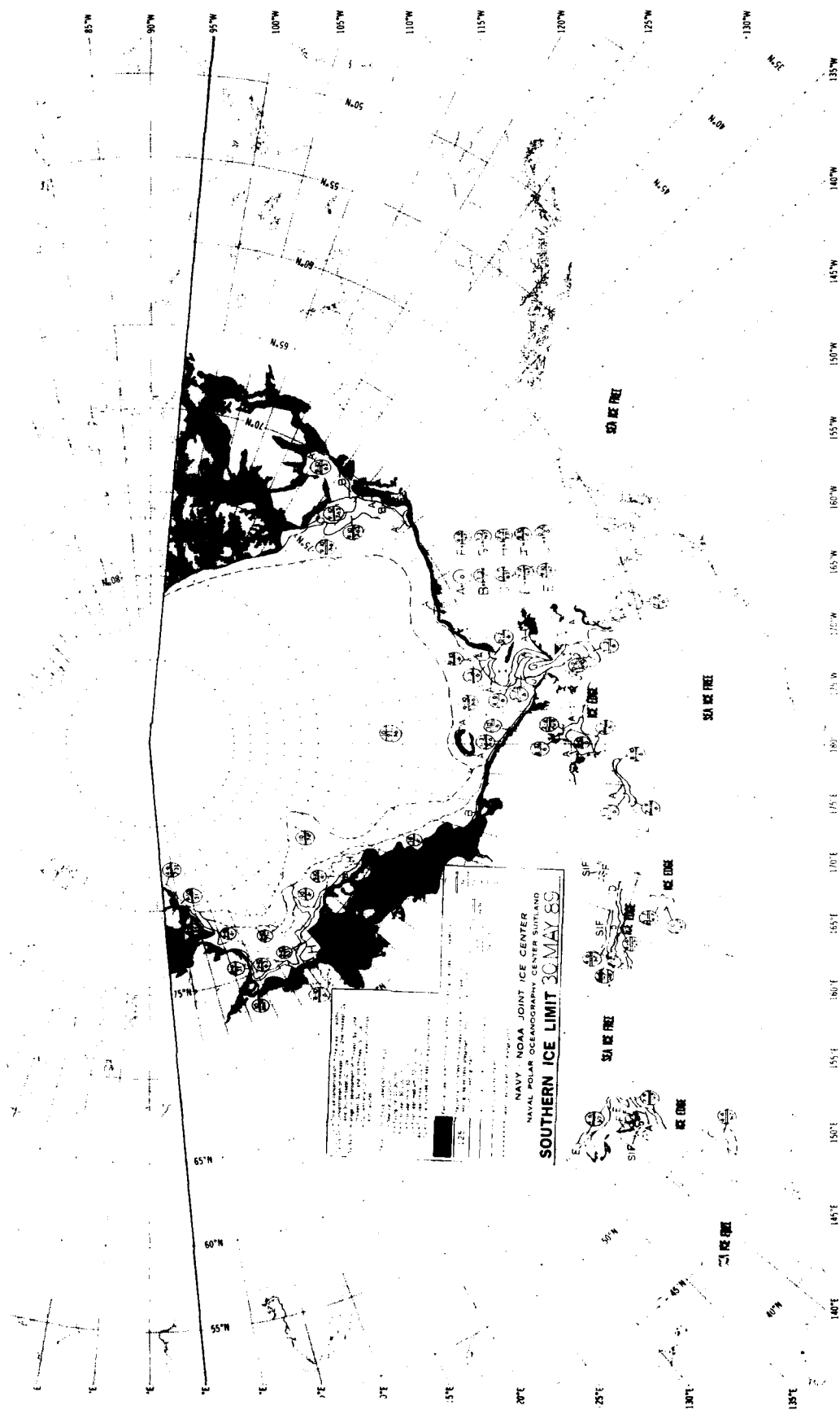


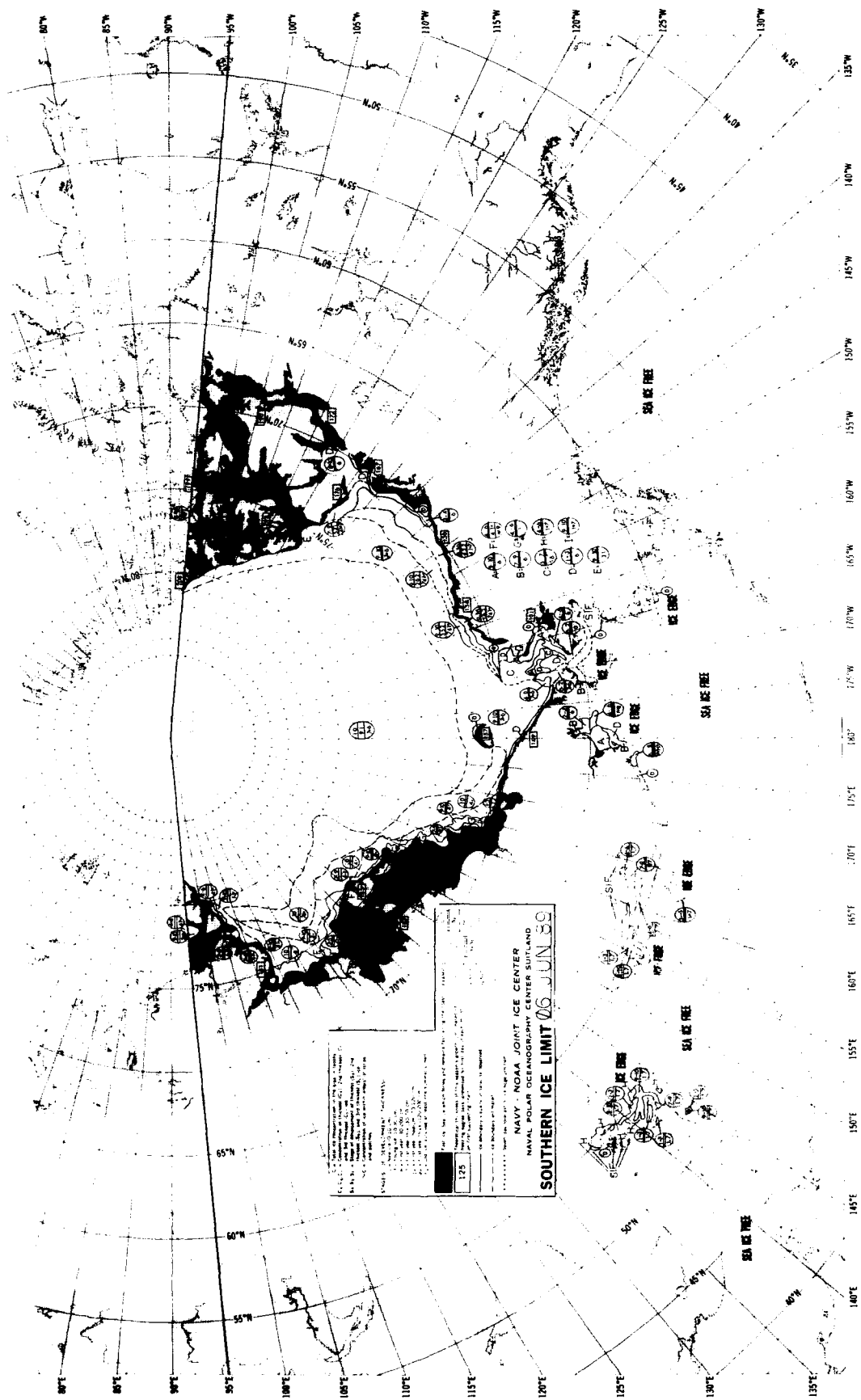


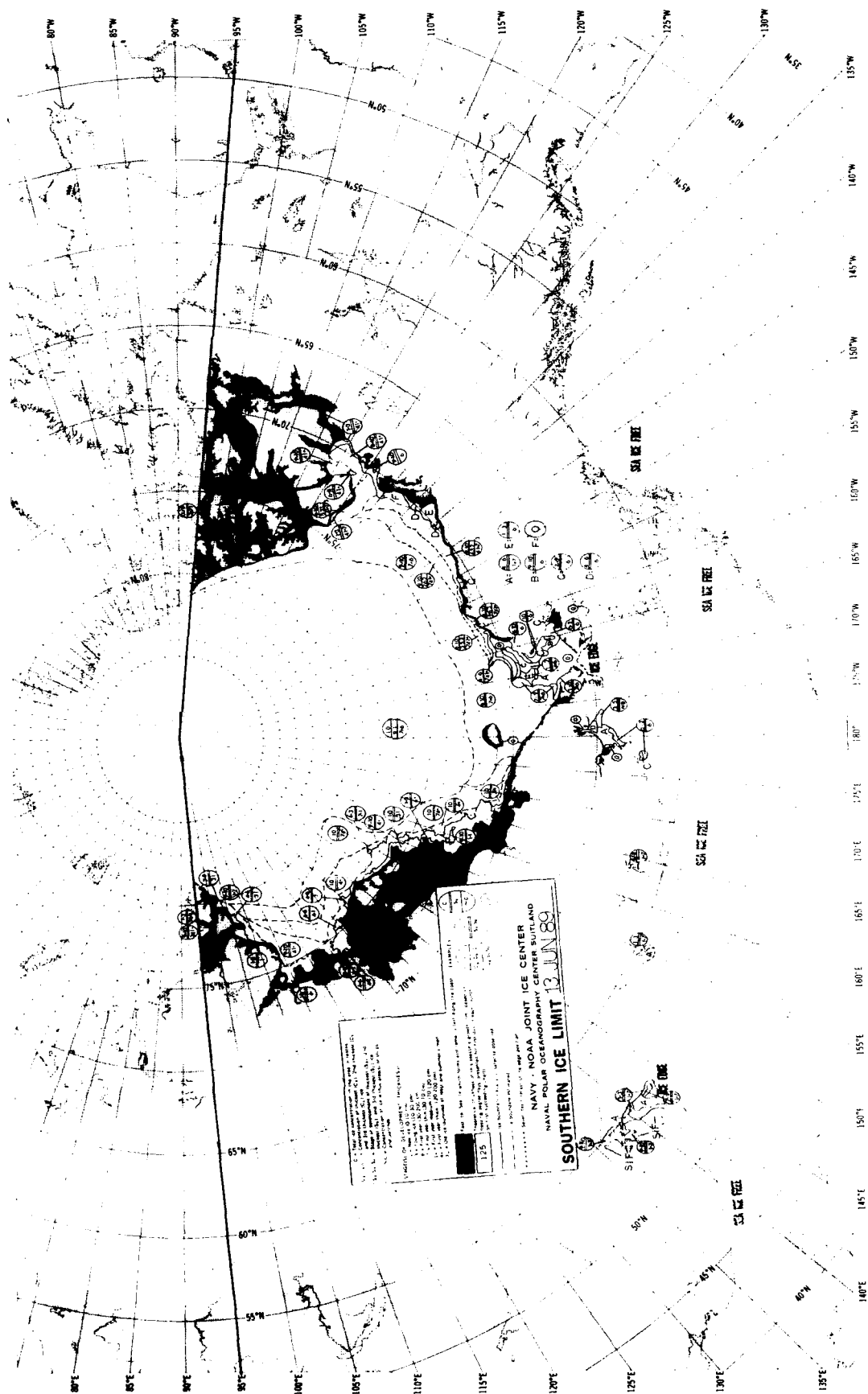
NAVY NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER BULFORD
SOUTHERN ICE LIMIT 15 MAY 55

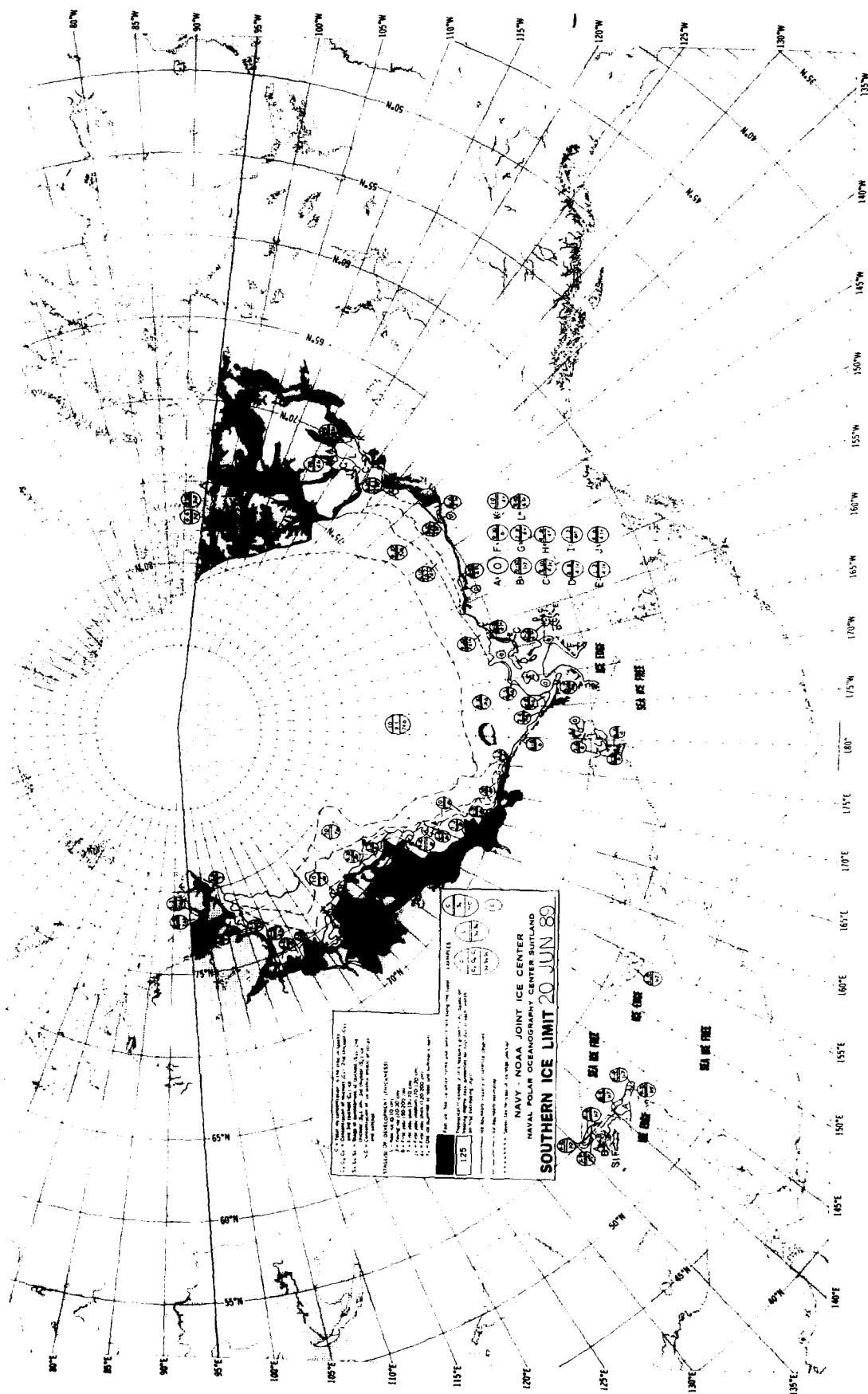
Symbol	Description
(Symbol)	Ice Extent
(Symbol)	Ice Thickness
(Symbol)	Ice Type
(Symbol)	Ice Age
(Symbol)	Ice Motion
(Symbol)	Ice Edge
(Symbol)	Ice Lead
(Symbol)	Ice Break
(Symbol)	Ice Drift
(Symbol)	Ice Current
(Symbol)	Ice Pressure
(Symbol)	Ice Temperature
(Symbol)	Ice Salinity
(Symbol)	Ice Density
(Symbol)	Ice Viscosity
(Symbol)	Ice Elasticity
(Symbol)	Ice Compressibility
(Symbol)	Ice Thermal Conductivity
(Symbol)	Ice Specific Heat
(Symbol)	Ice Latent Heat
(Symbol)	Ice Melting Point
(Symbol)	Ice Freezing Point
(Symbol)	Ice Boiling Point
(Symbol)	Ice Sublimation Point
(Symbol)	Ice Condensation Point
(Symbol)	Ice Evaporation Point
(Symbol)	Ice Precipitation Point
(Symbol)	Ice Accumulation Point
(Symbol)	Ice Depletion Point
(Symbol)	Ice Distribution Point
(Symbol)	Ice Concentration Point
(Symbol)	Ice Dispersion Point
(Symbol)	Ice Migration Point
(Symbol)	Ice Transformation Point
(Symbol)	Ice Conversion Point
(Symbol)	Ice Transmutation Point
(Symbol)	Ice Transference Point
(Symbol)	Ice Translocation Point
(Symbol)	Ice Translocation Point

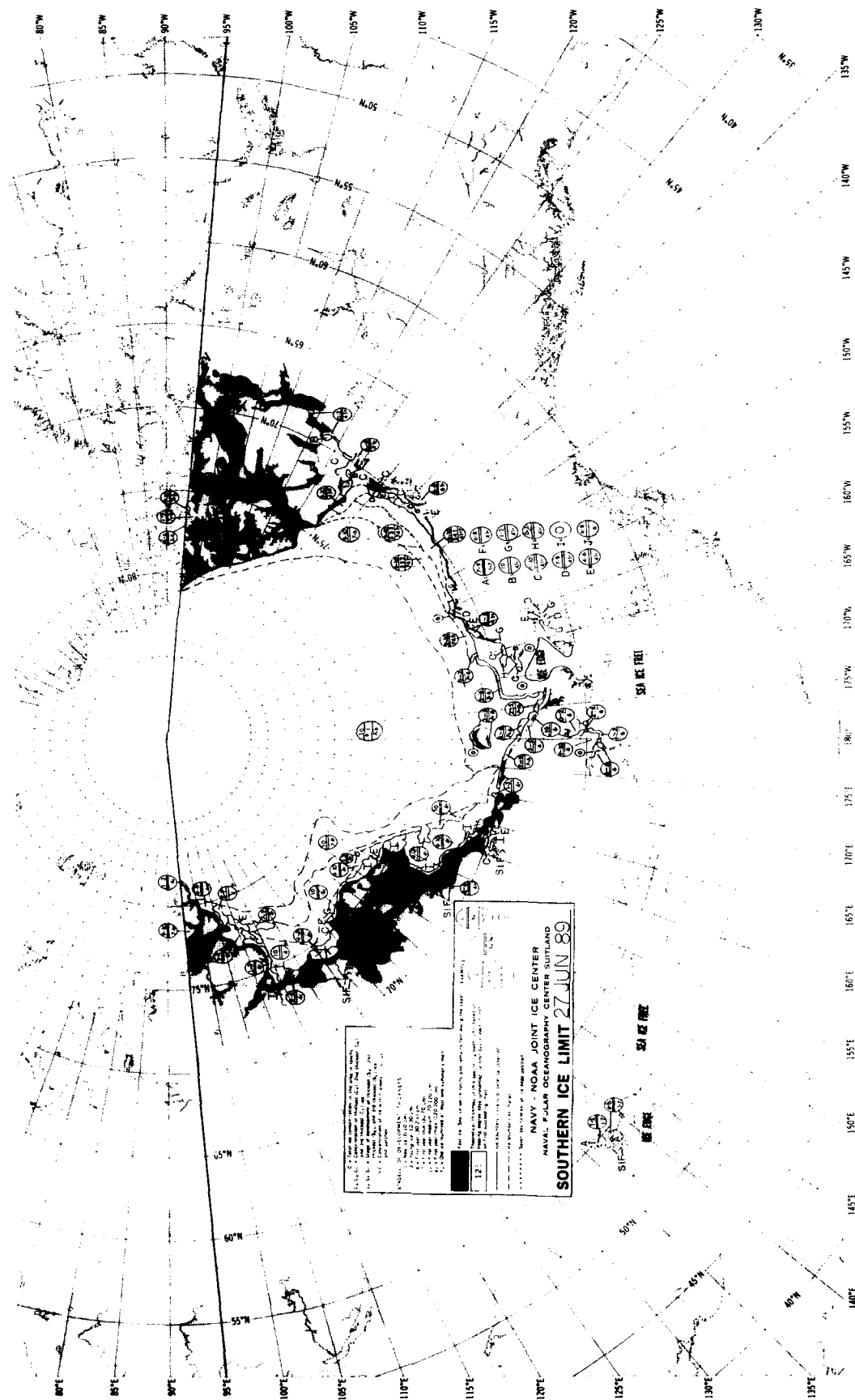


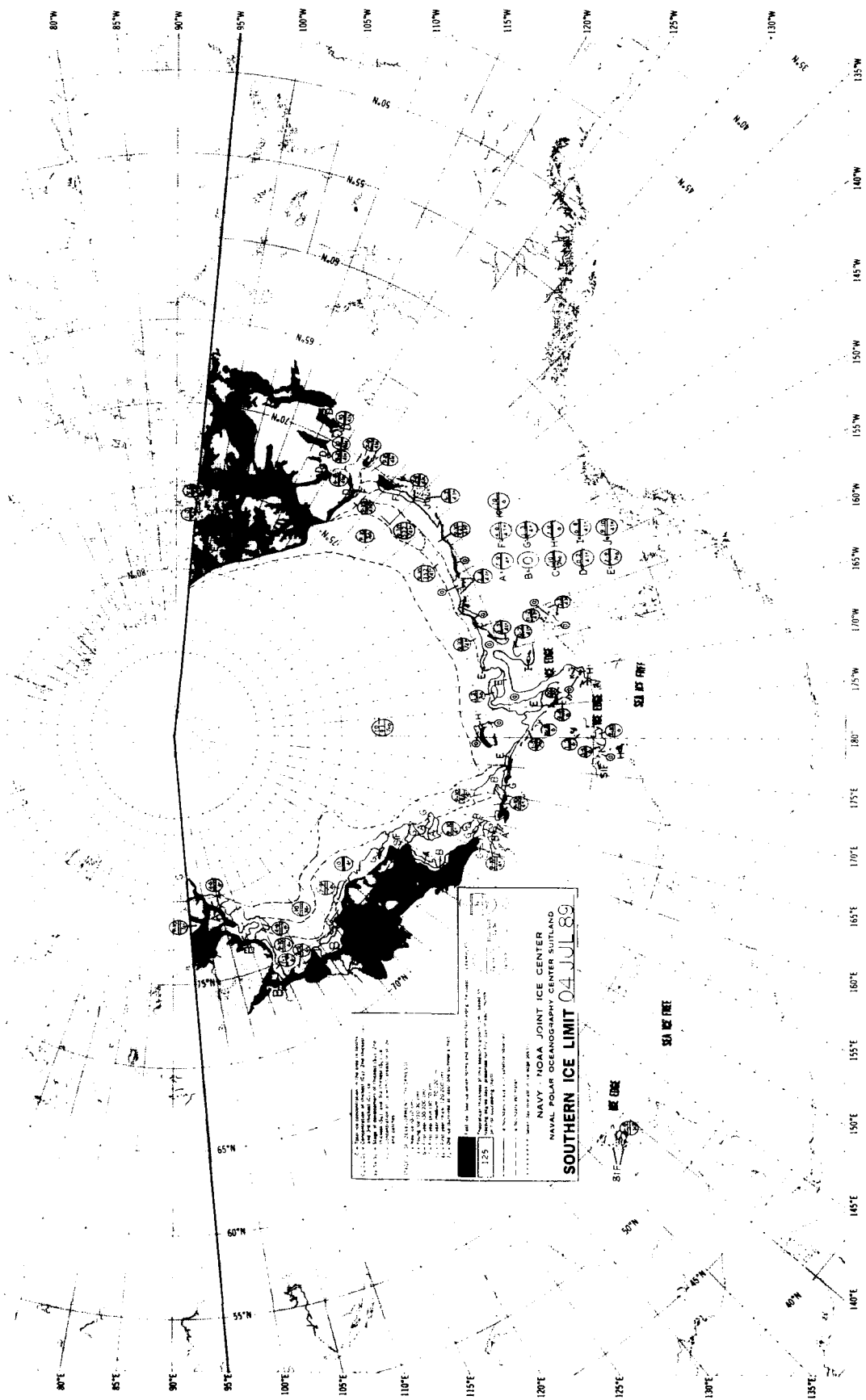


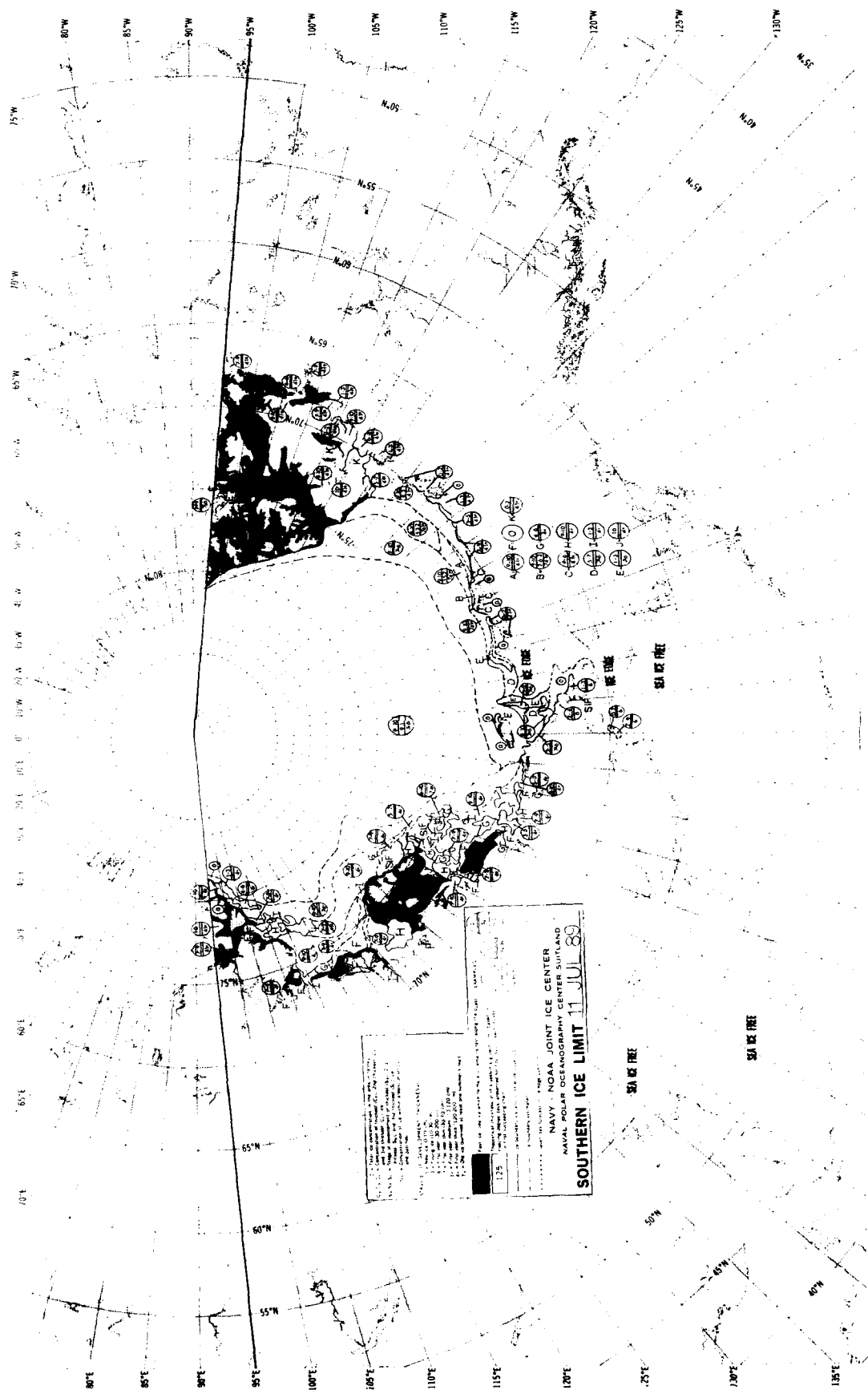






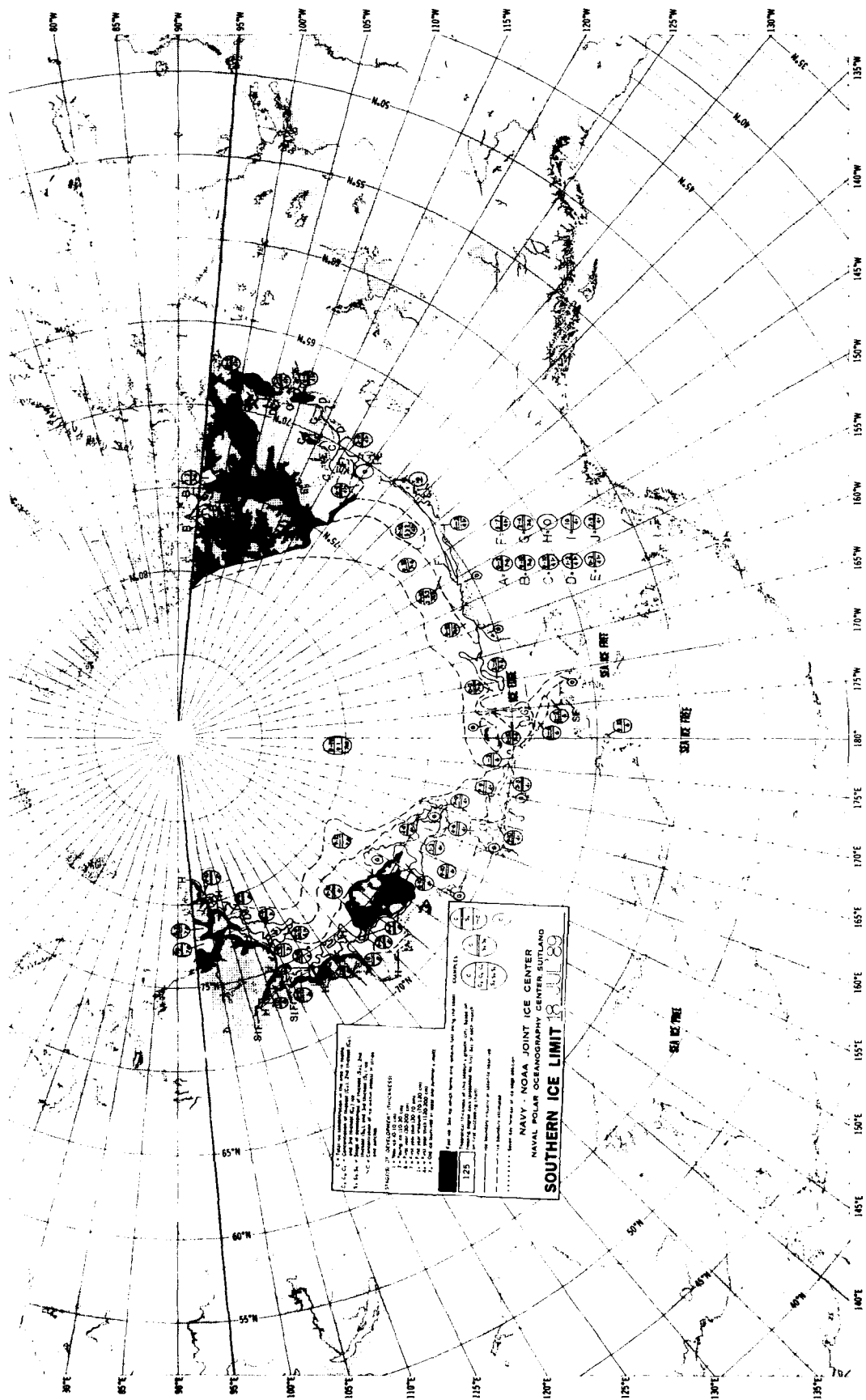


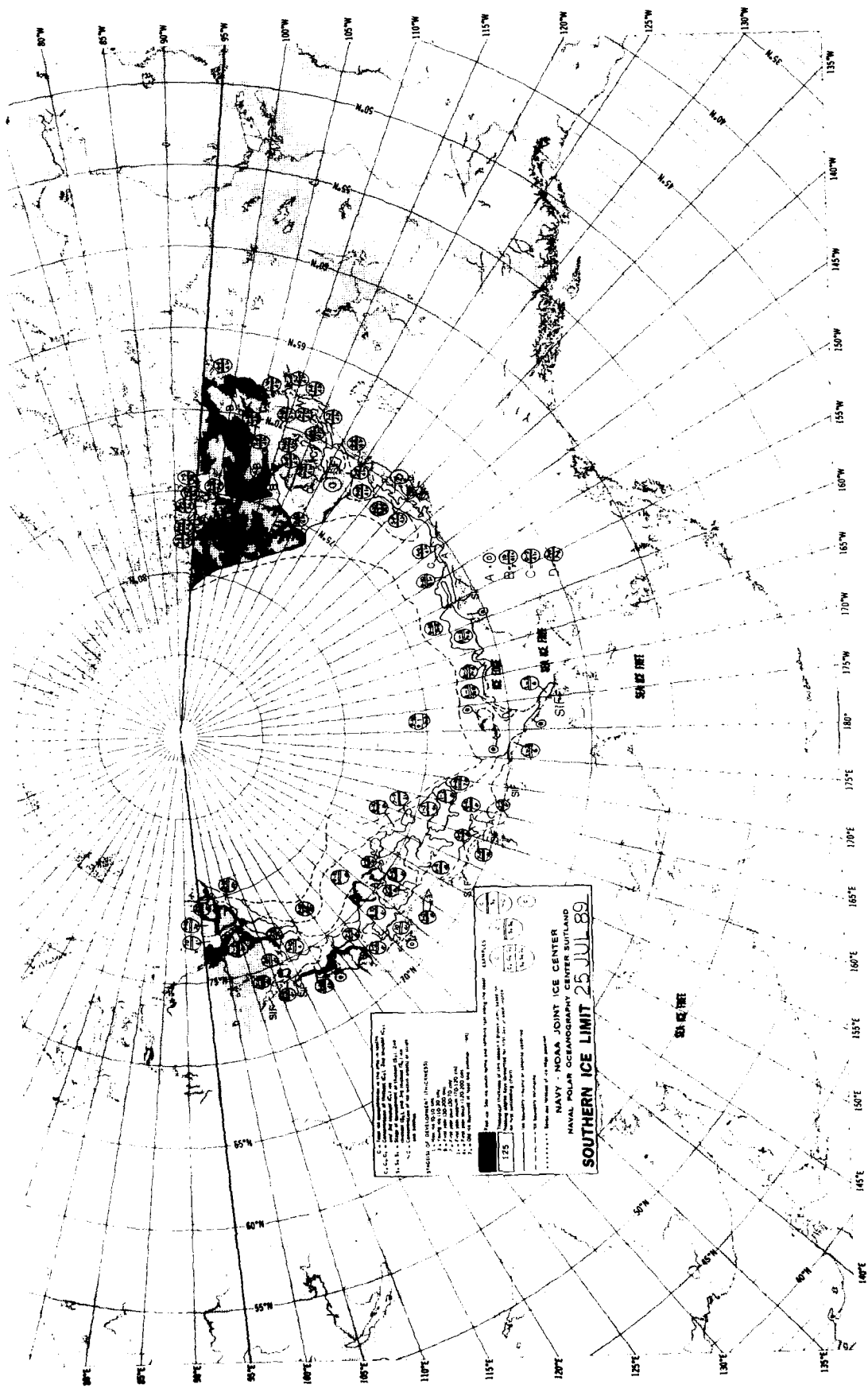


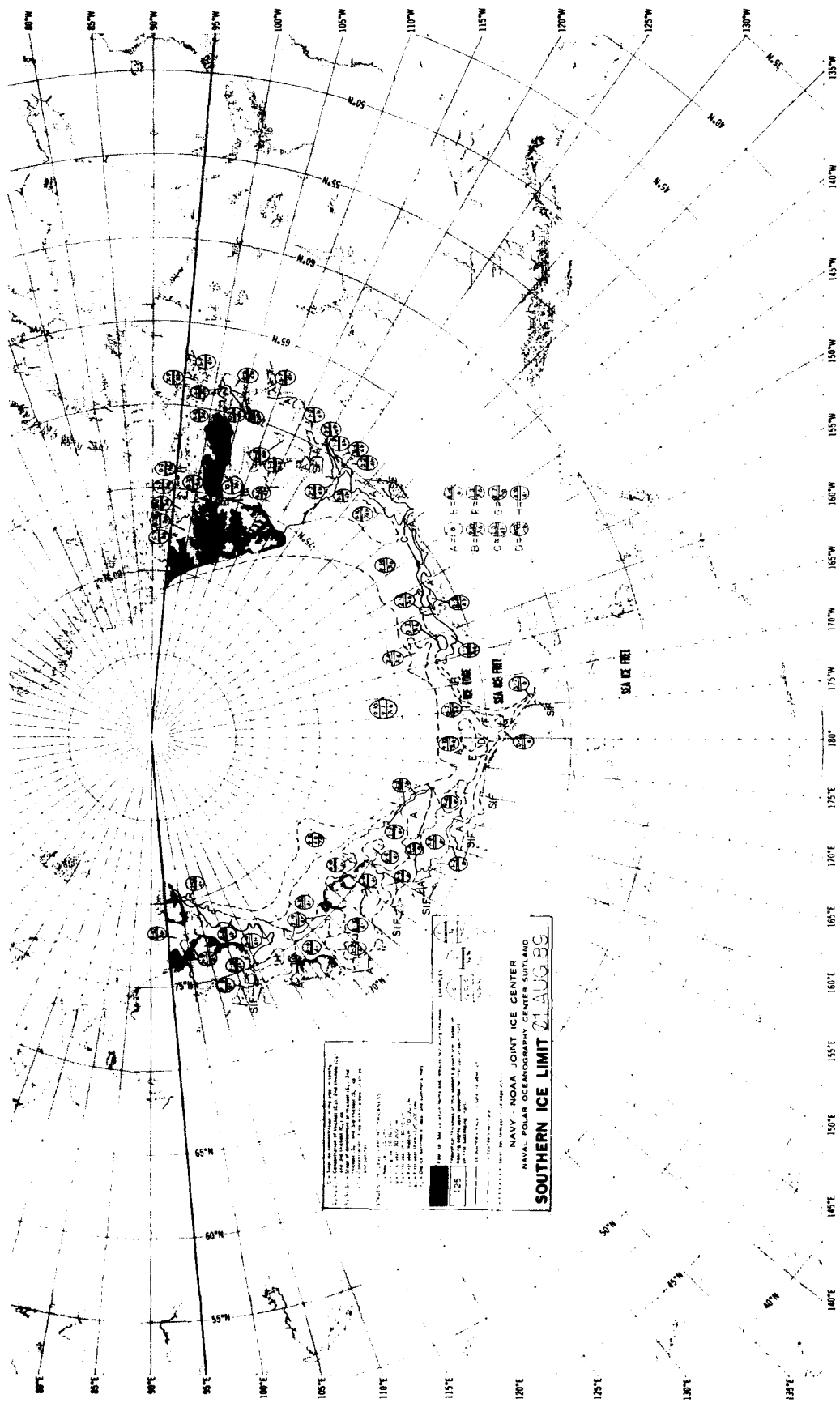


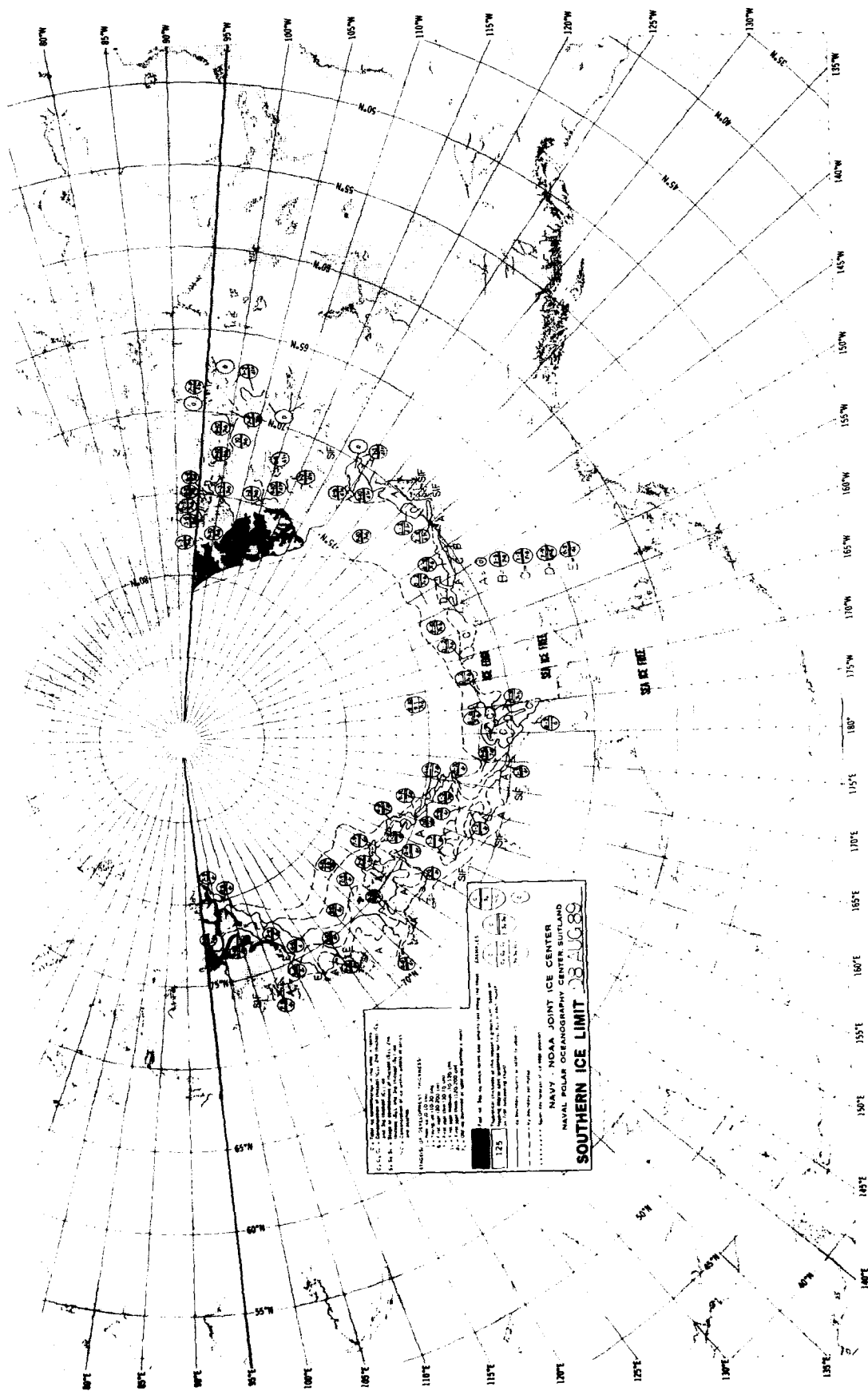
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUITLAND
SOUTHERN ICE LIMIT 11 JUL 89

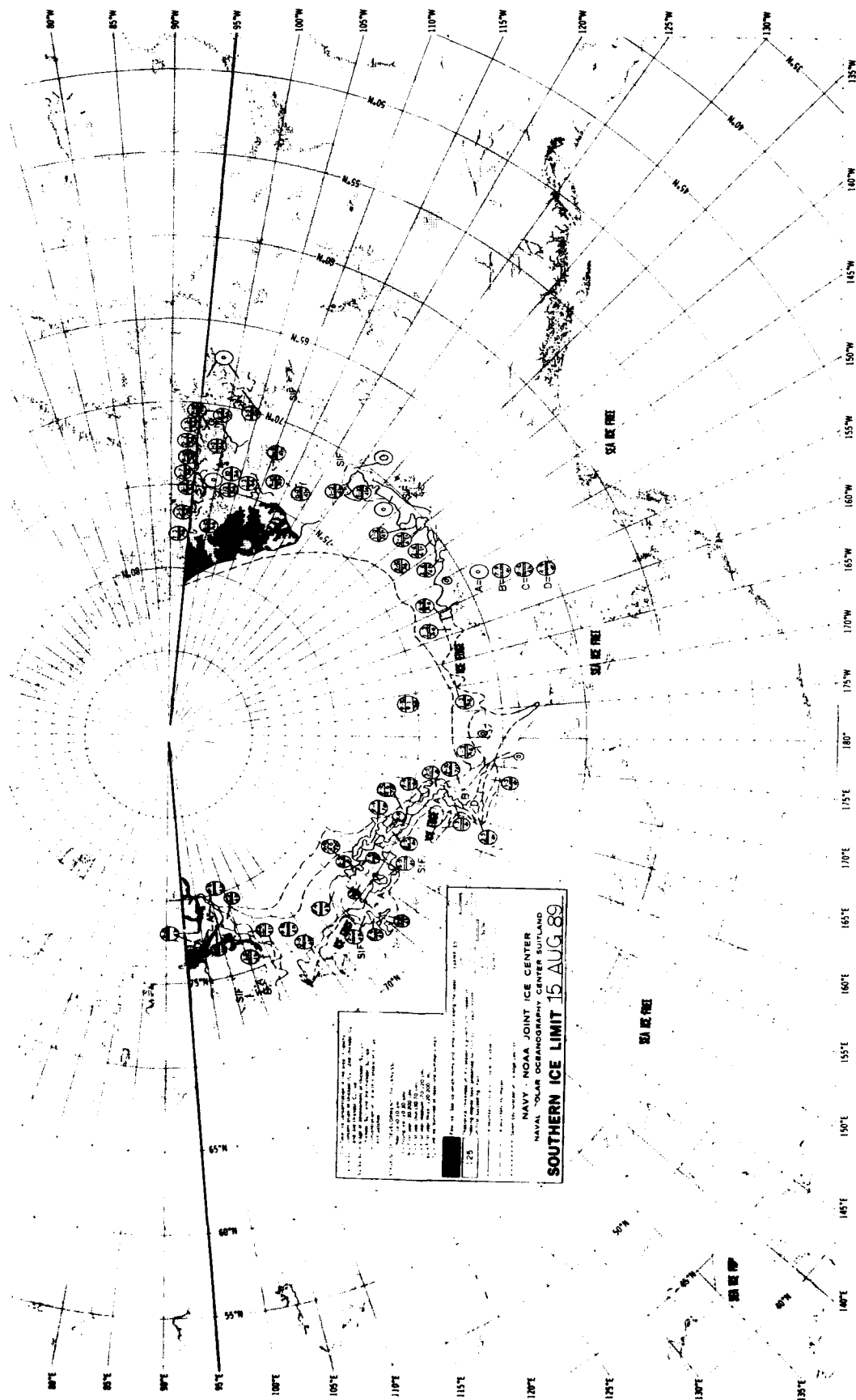
1. This map is a representation of the ice limit as of 11 JUL 89. It is based on data from the Navy's Joint Ice Center and the NOAA's Joint Ice Center. The map is a black and white line drawing.

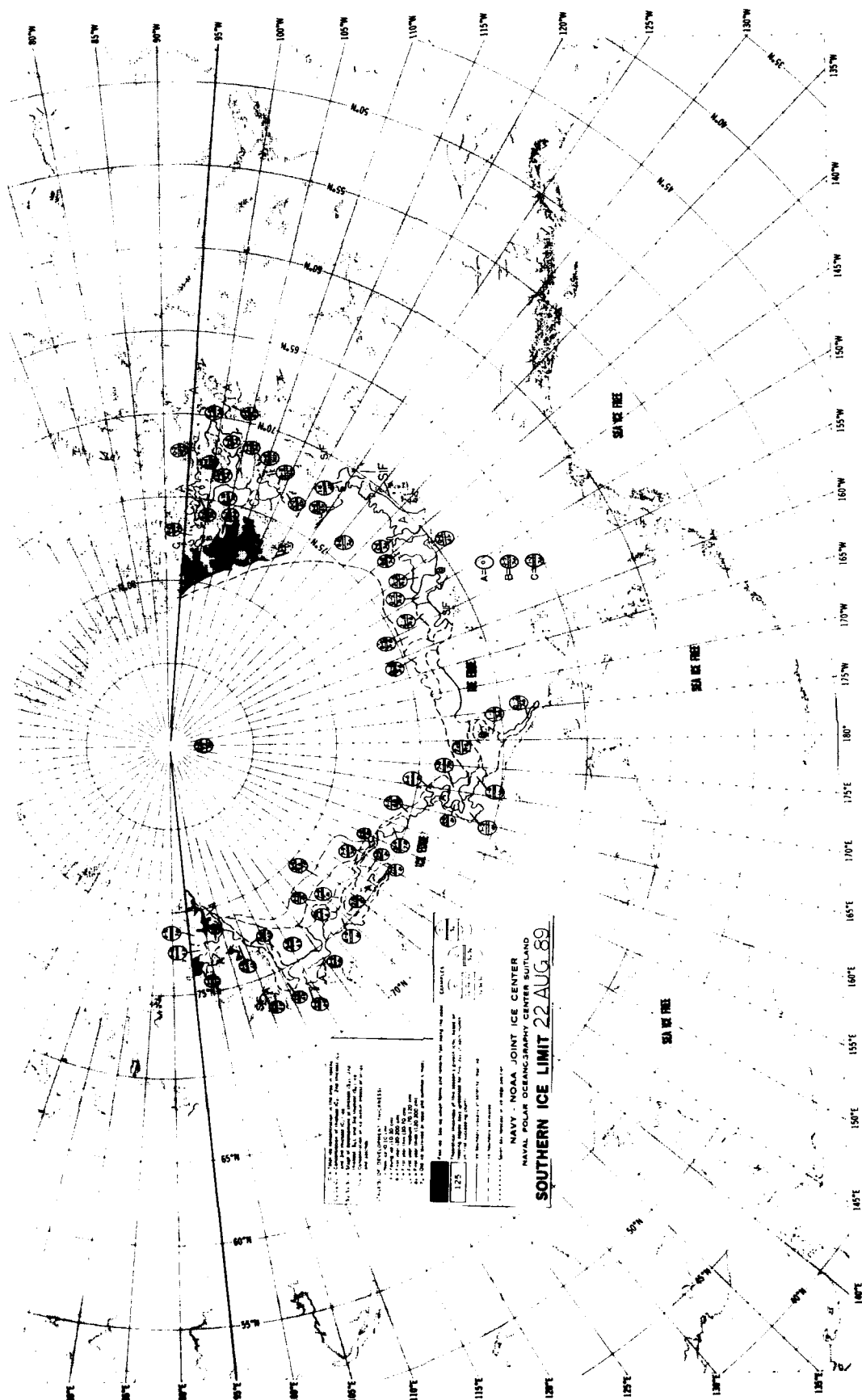


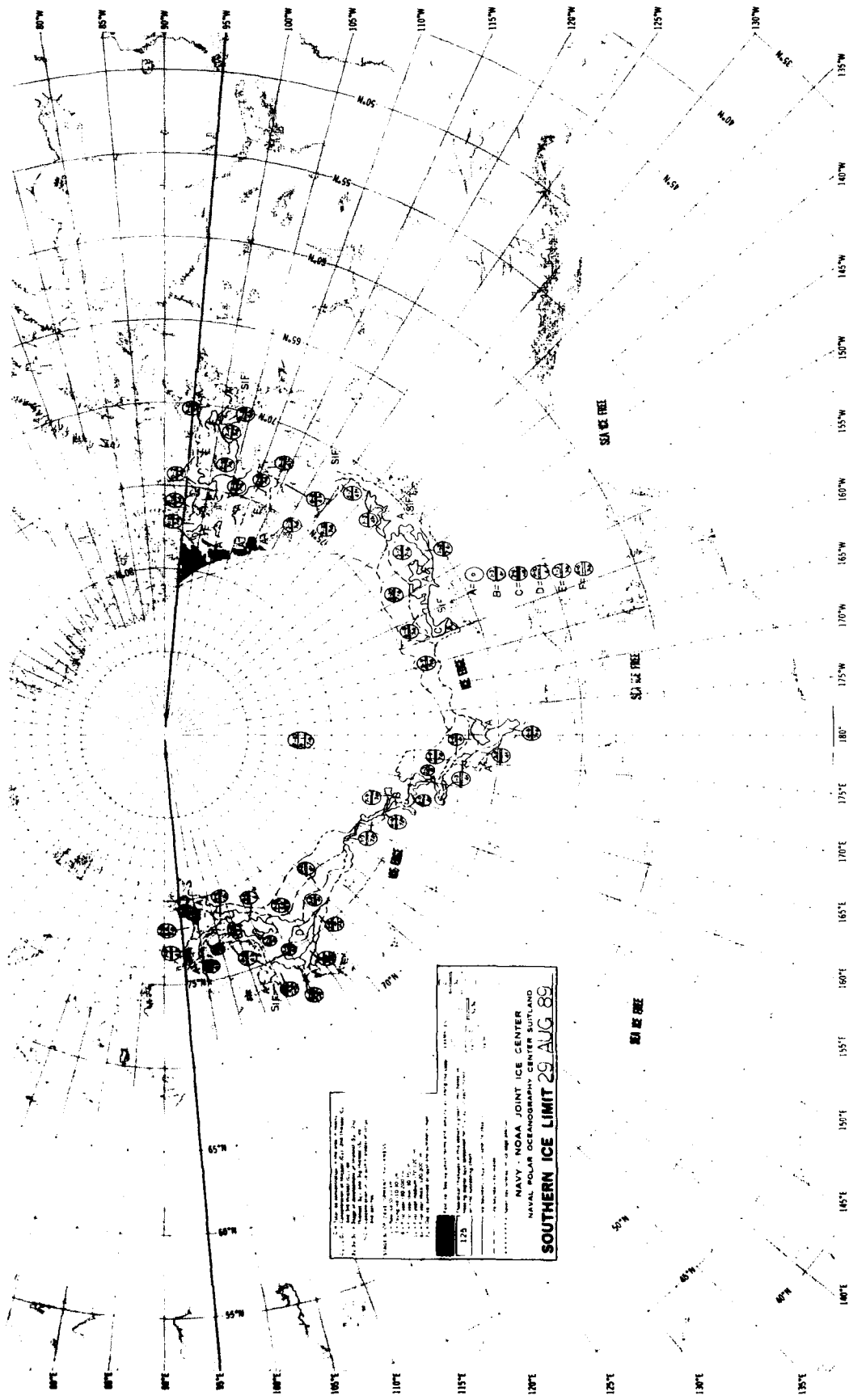












NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER SUTLAND
SOUTHERN ICE LIMIT 29 AUG 89

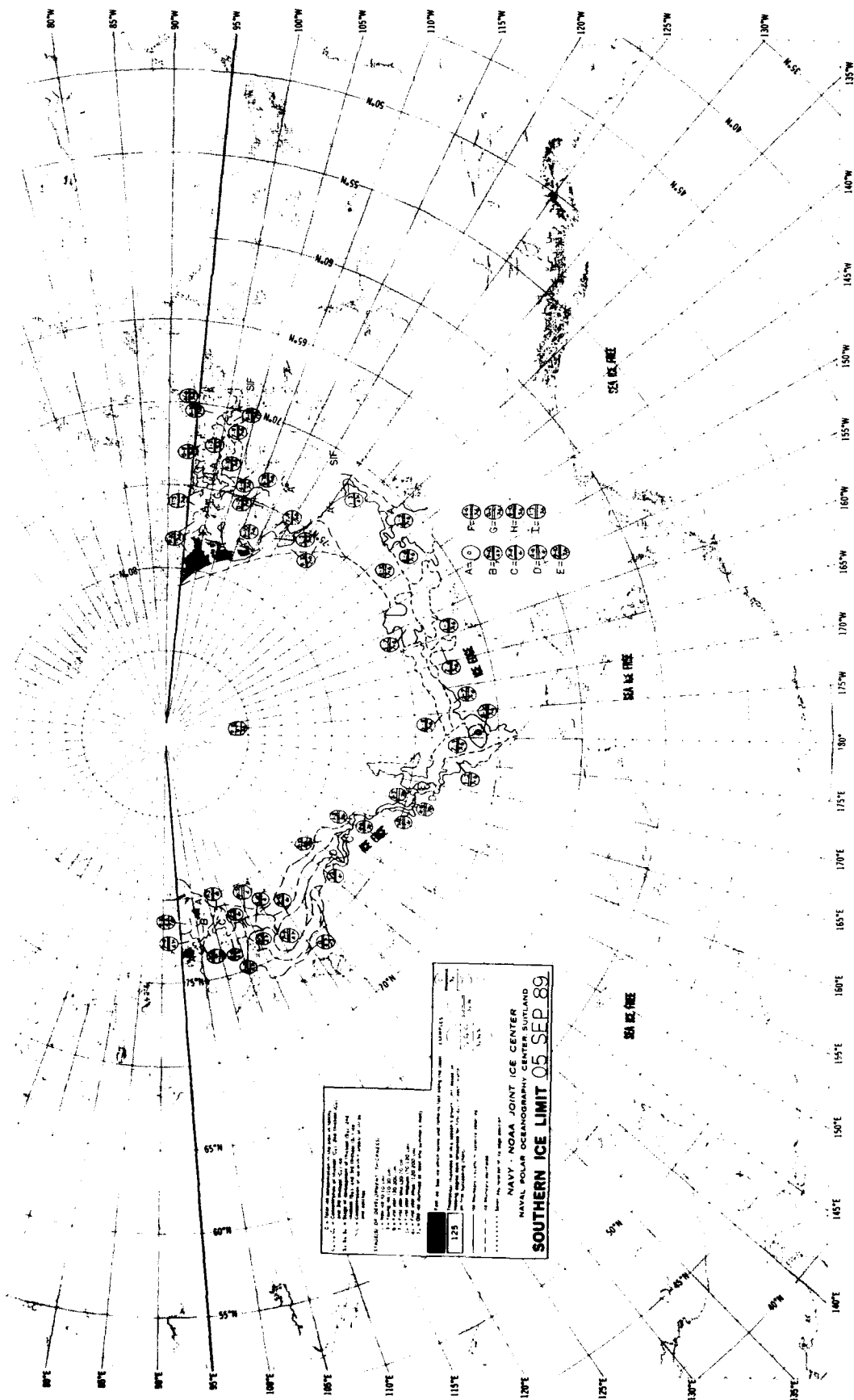
1. This map shows the ice limit for the Southern Ocean as of 29 August 1989. The ice limit is defined as the outermost edge of the ice field. The ice limit is shown as a solid line. The area inside the solid line is shaded. The area outside the solid line is unshaded. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean.

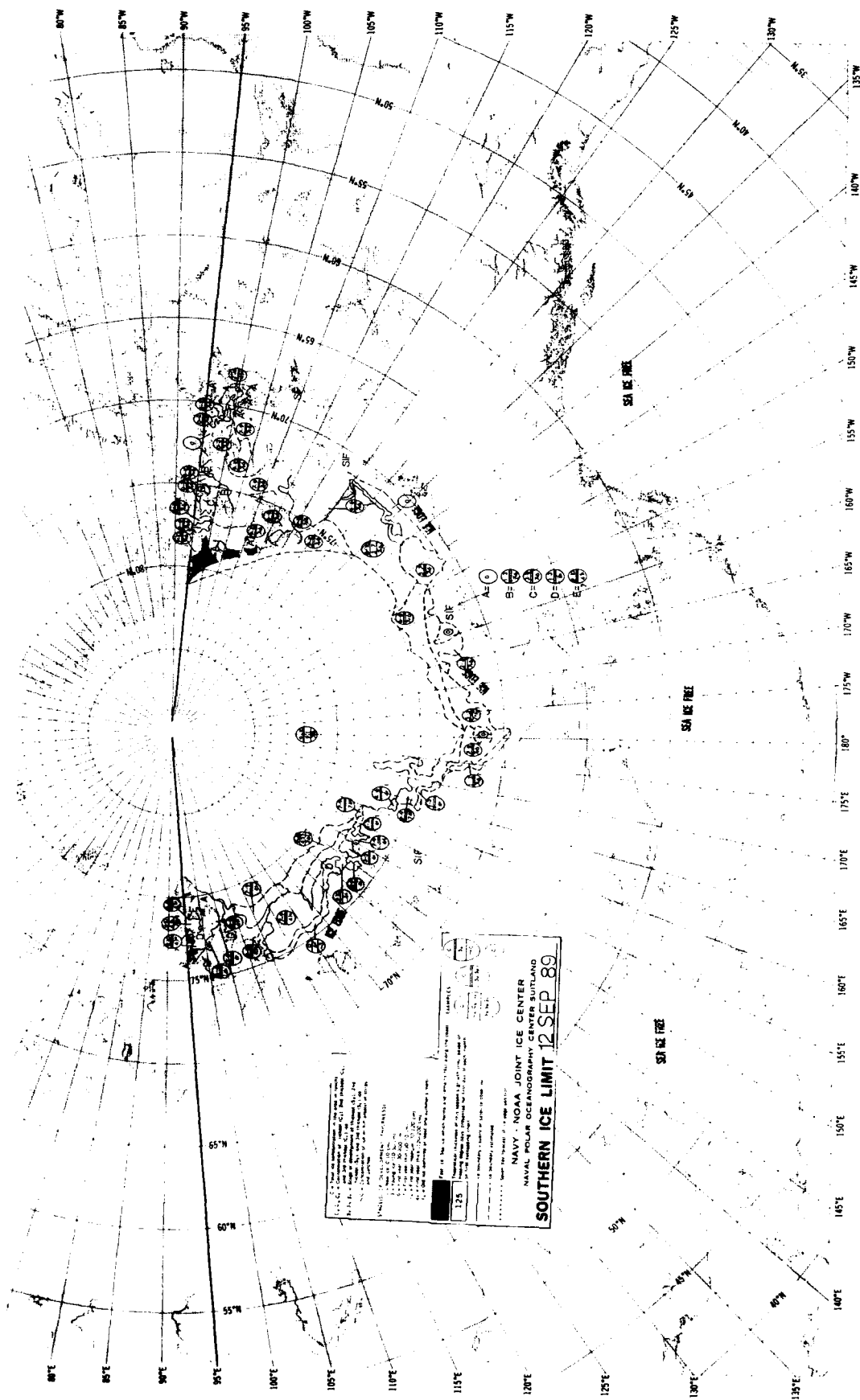
2. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean.

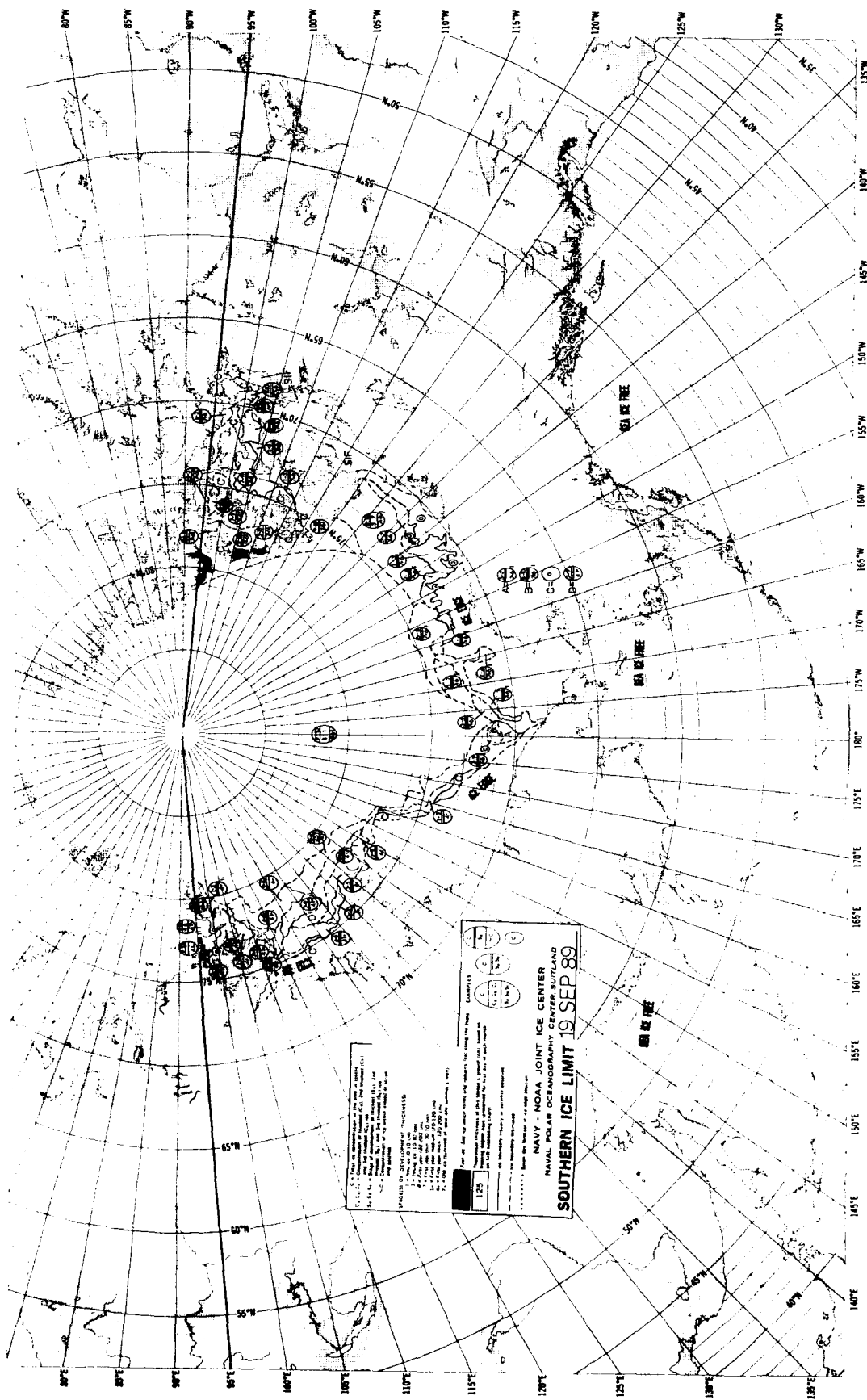
3. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean.

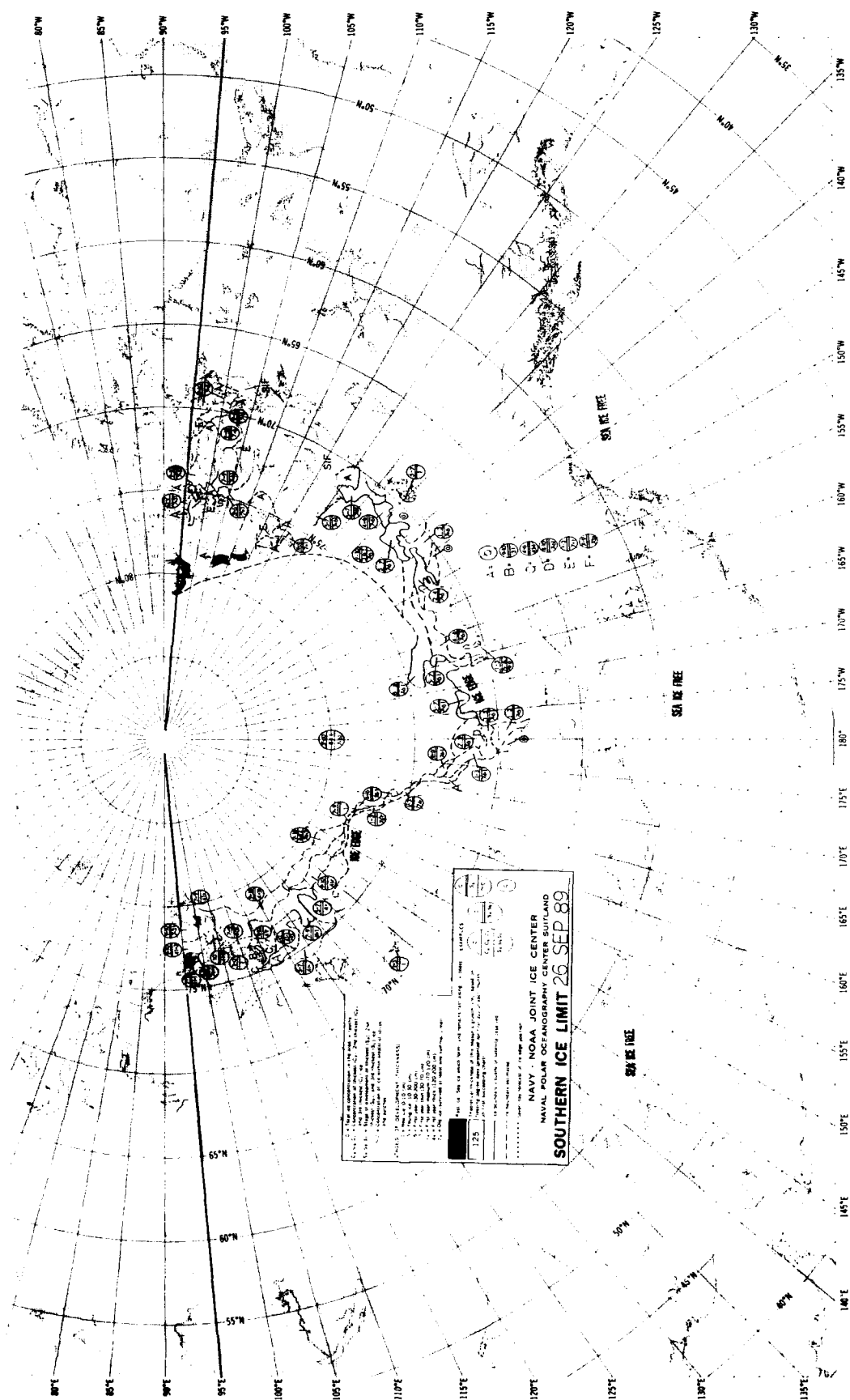
4. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean.

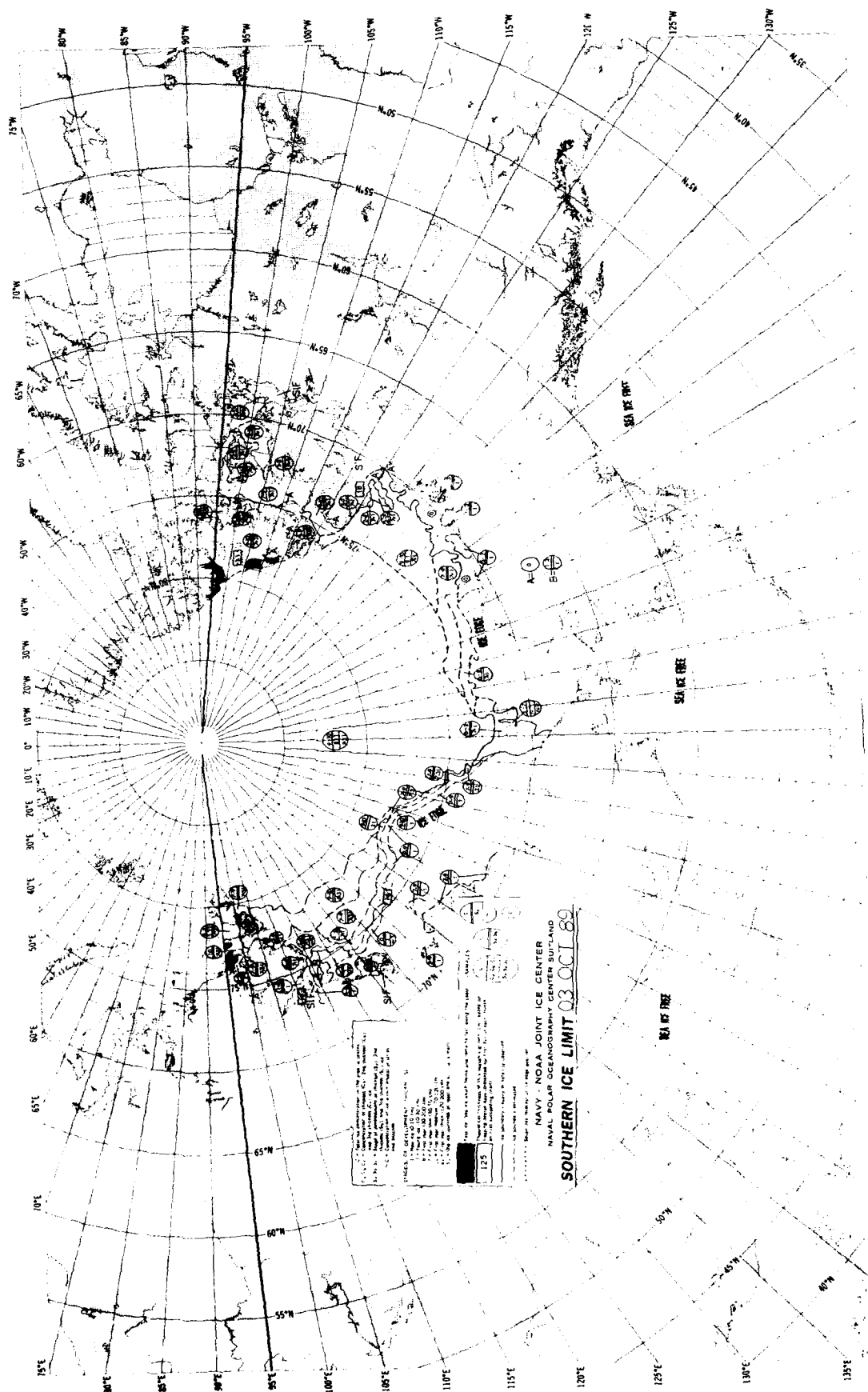
5. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean. The ice limit is shown for the entire Southern Ocean.

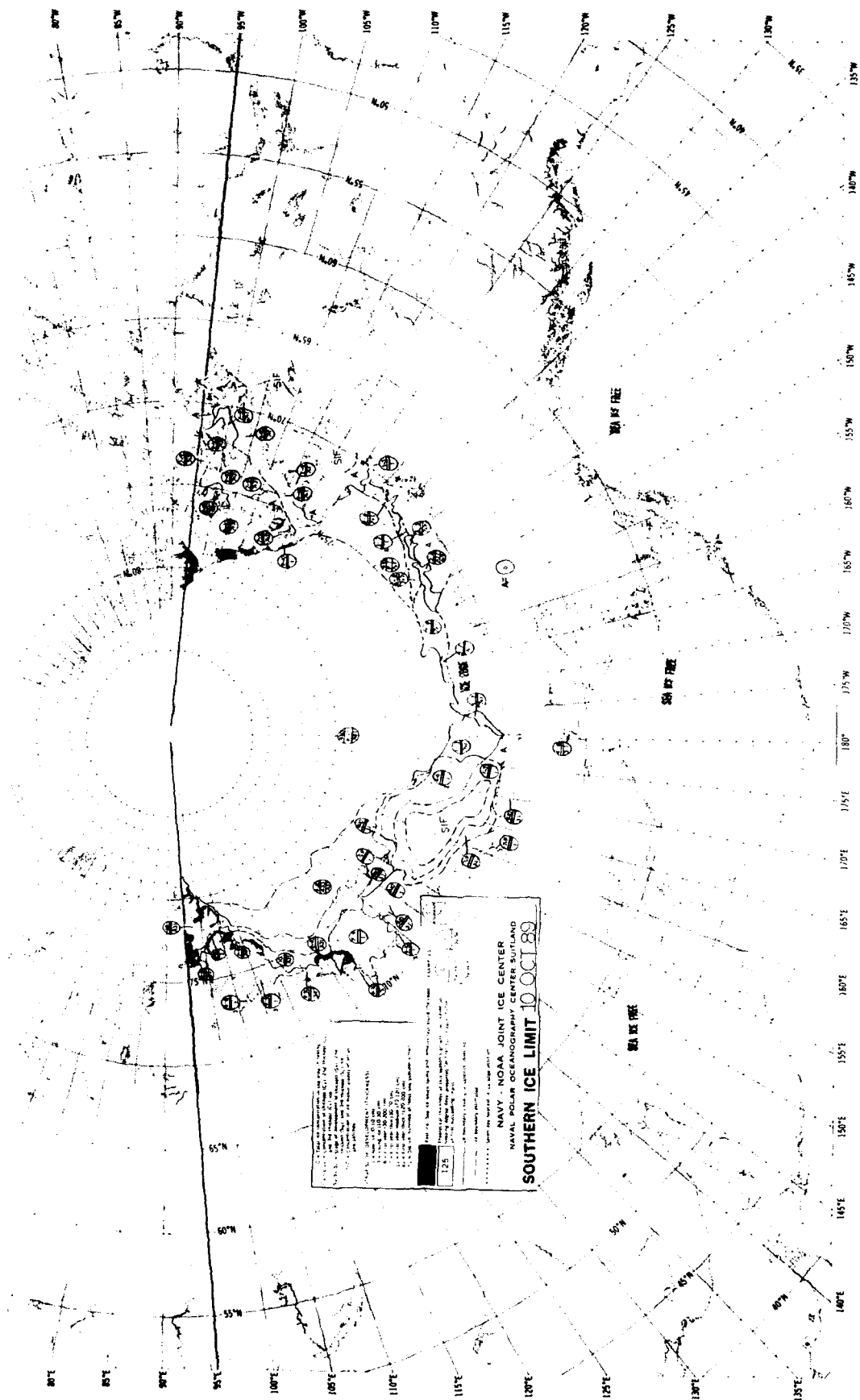


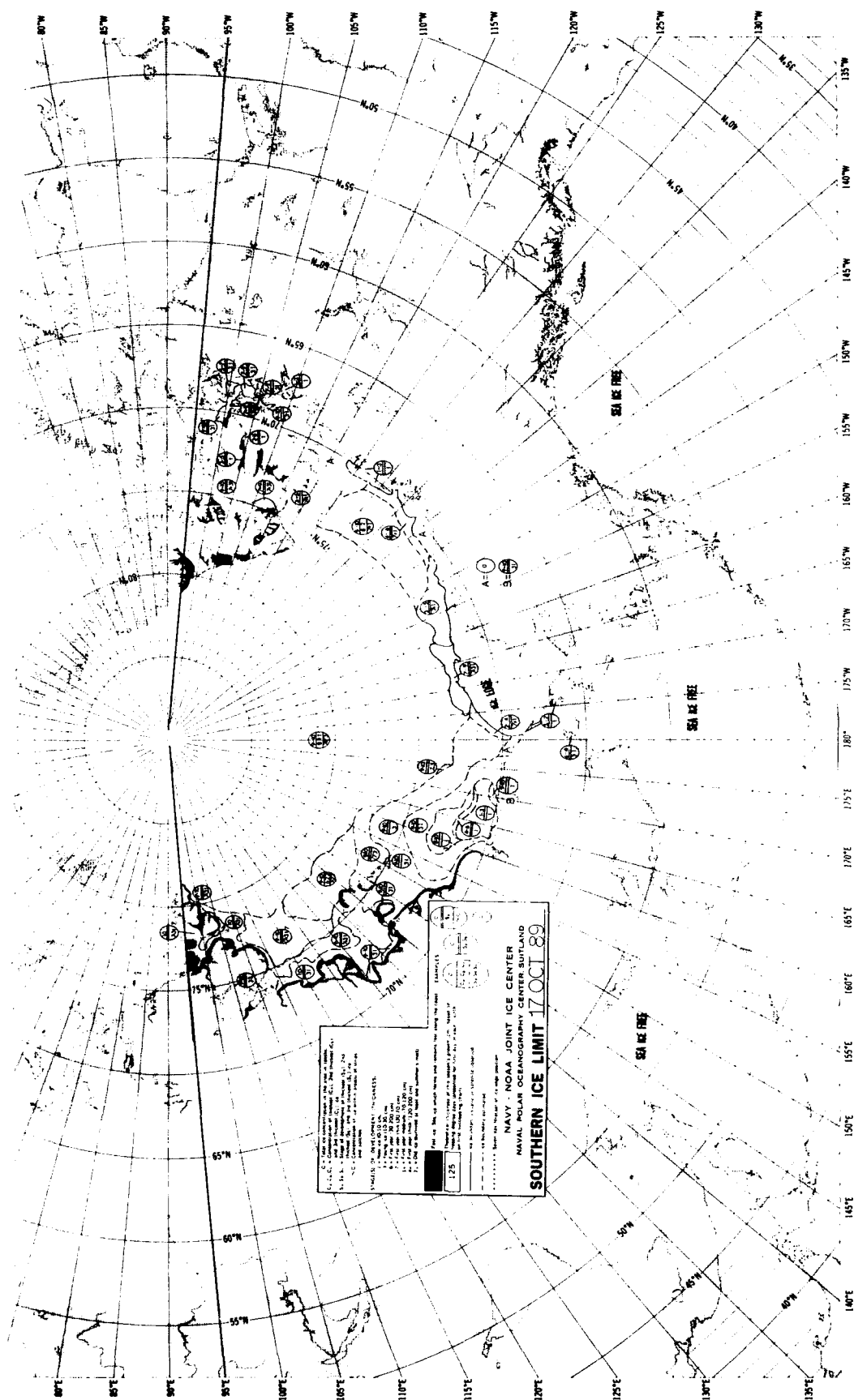


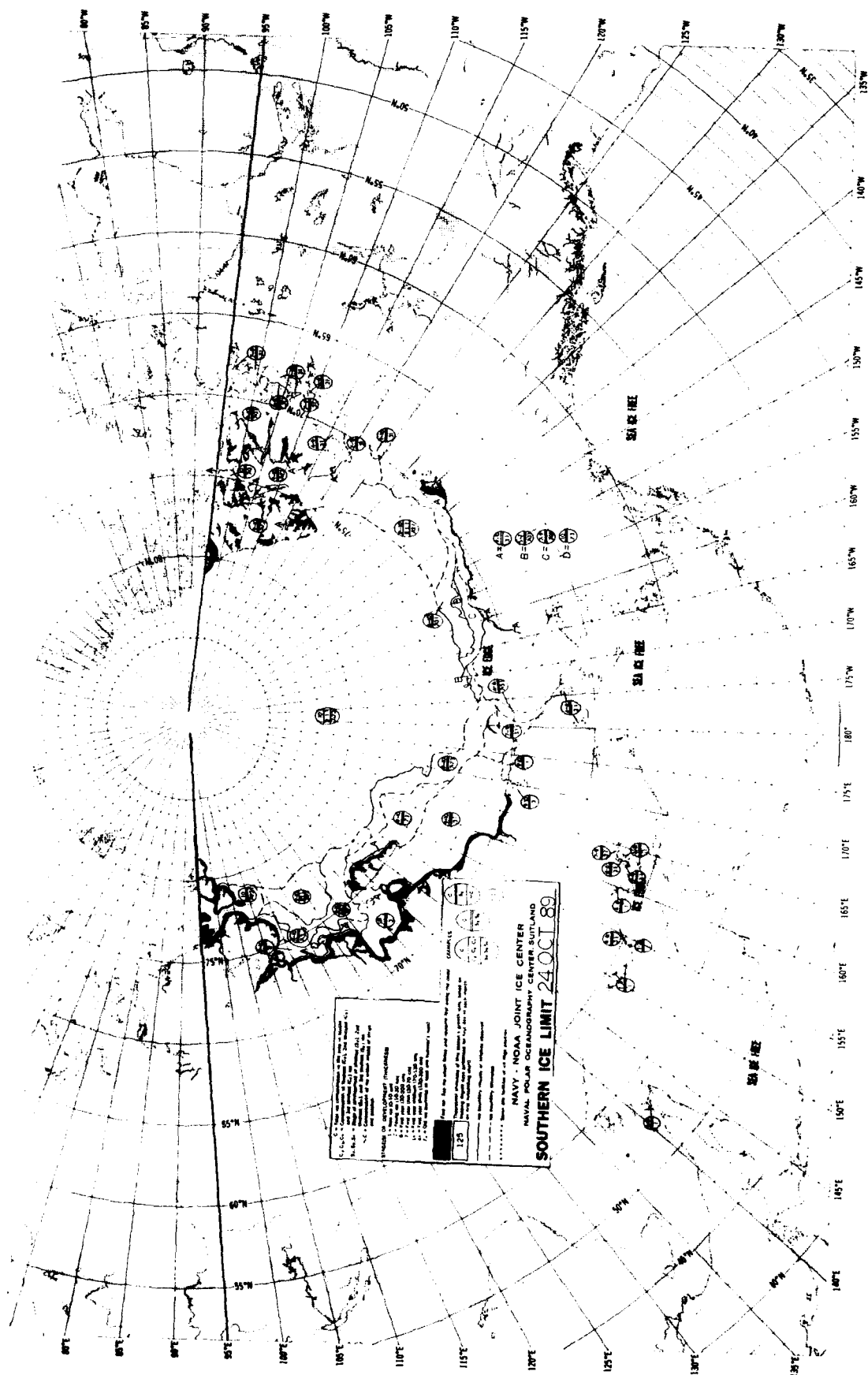


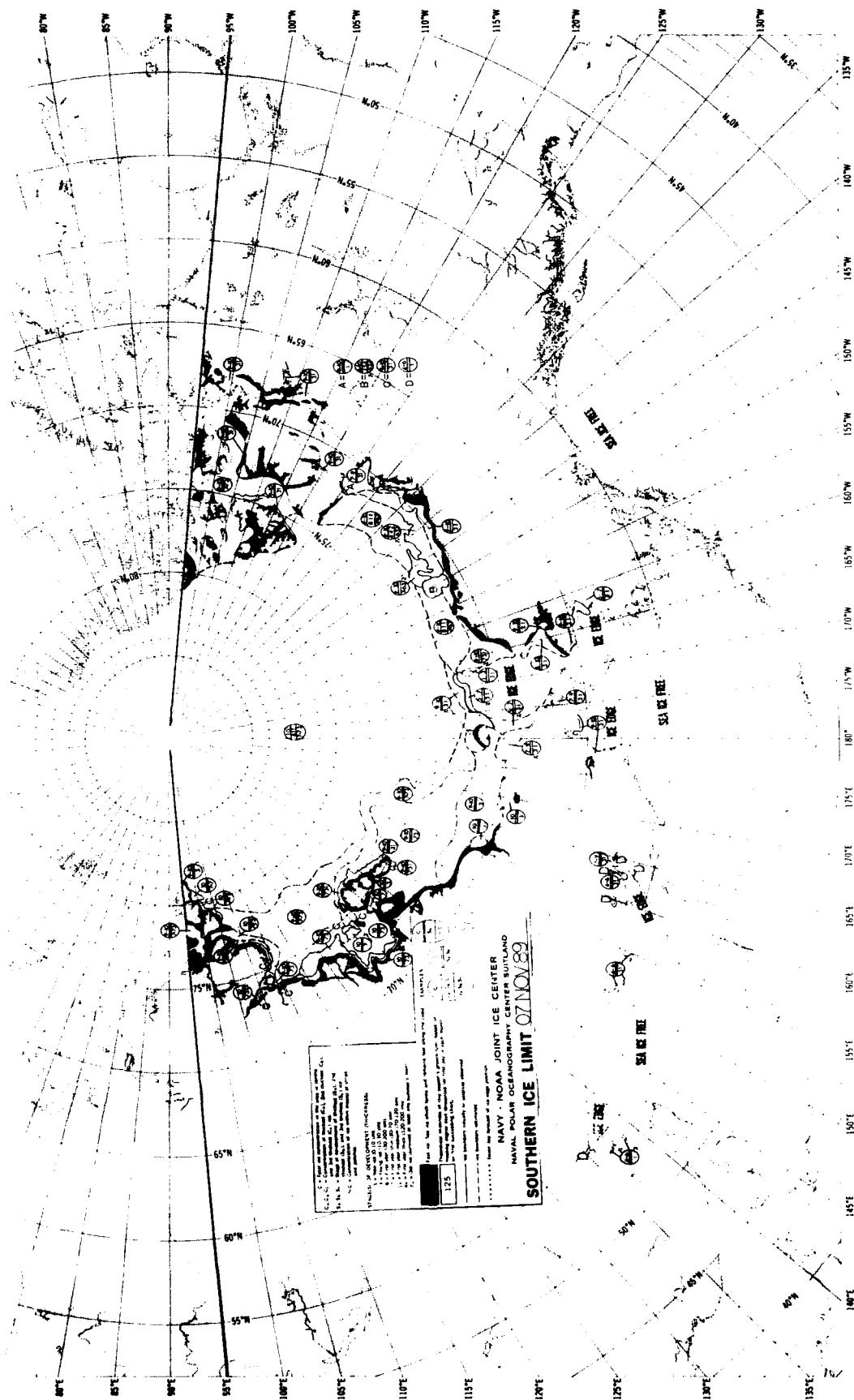


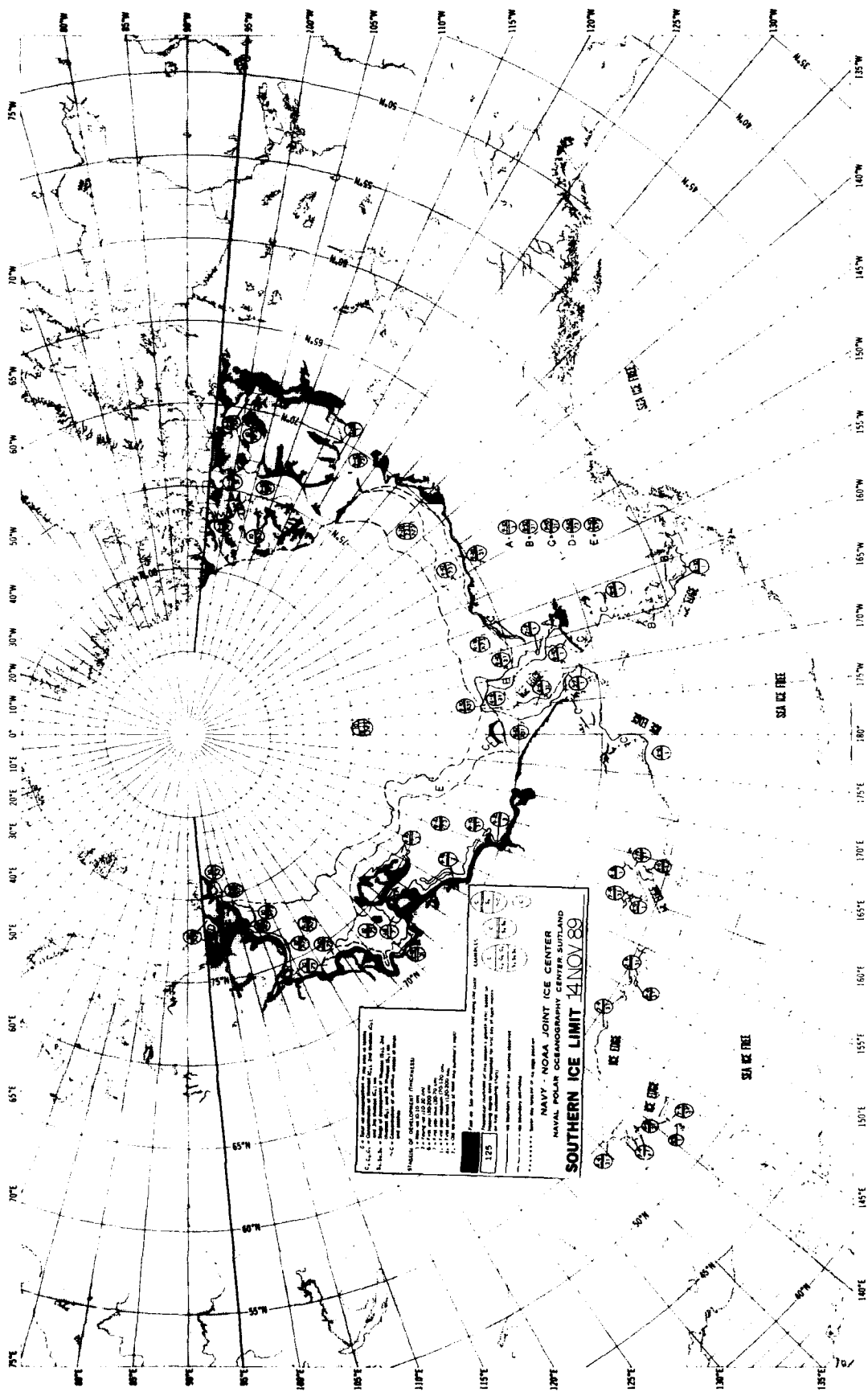


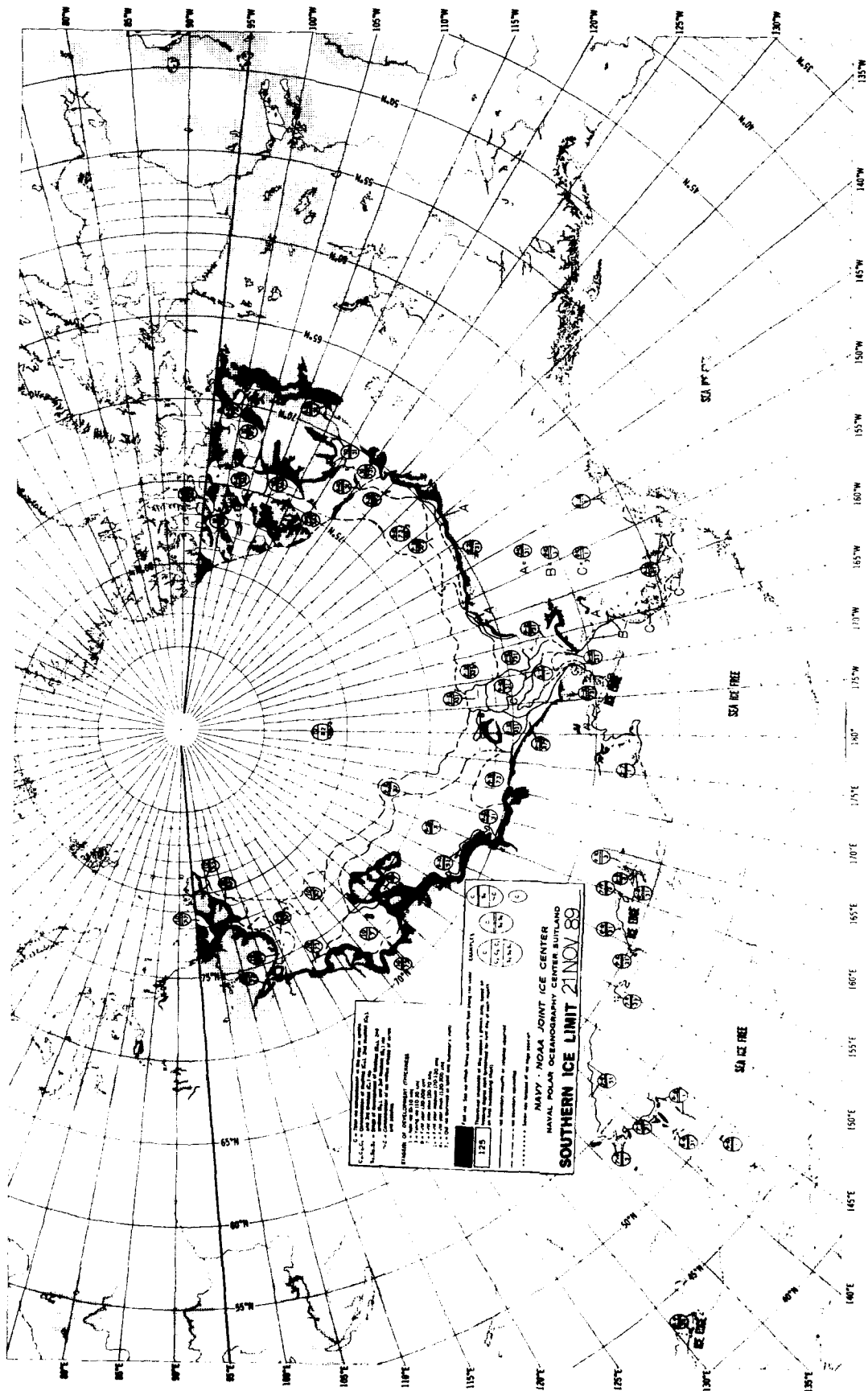


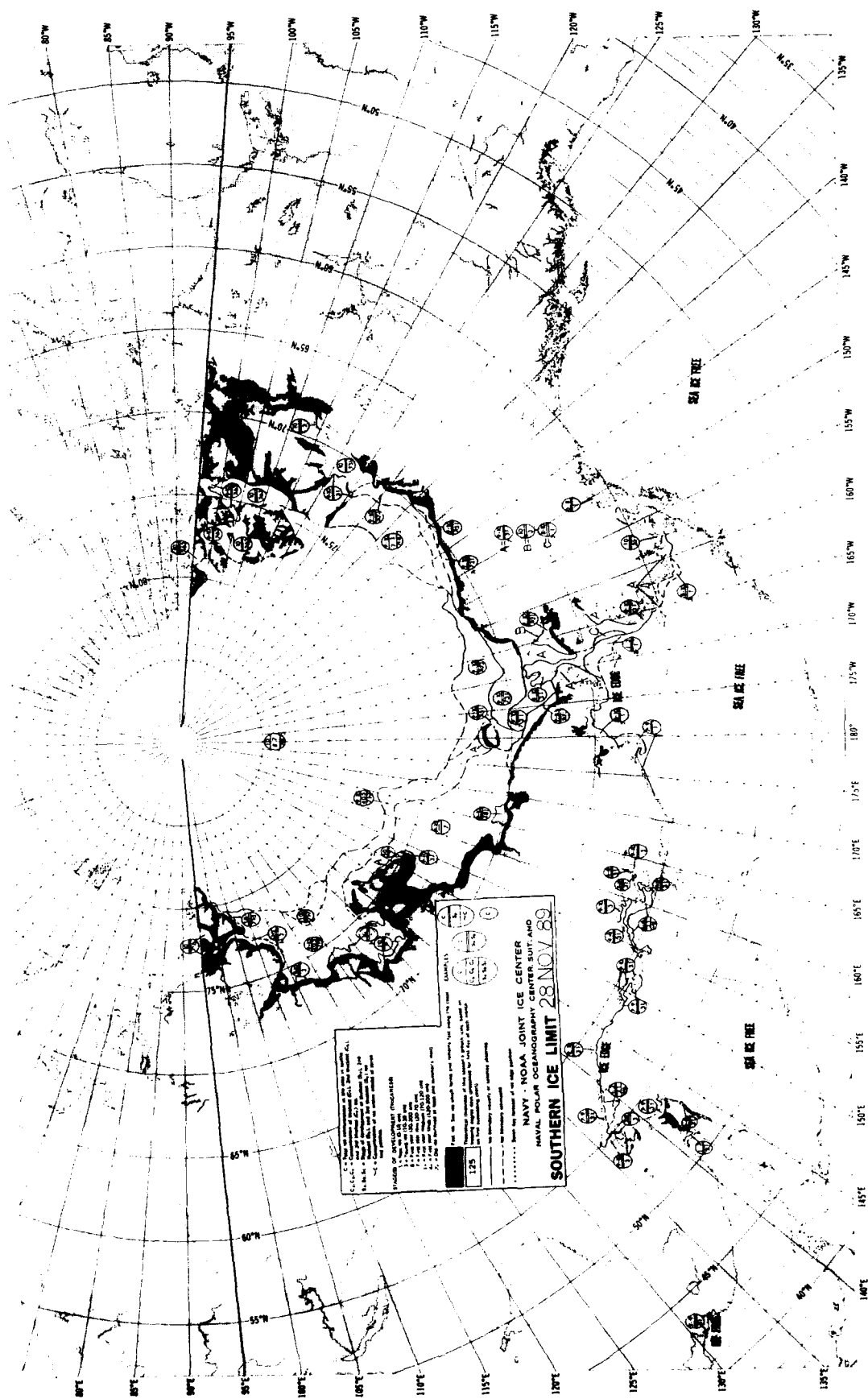


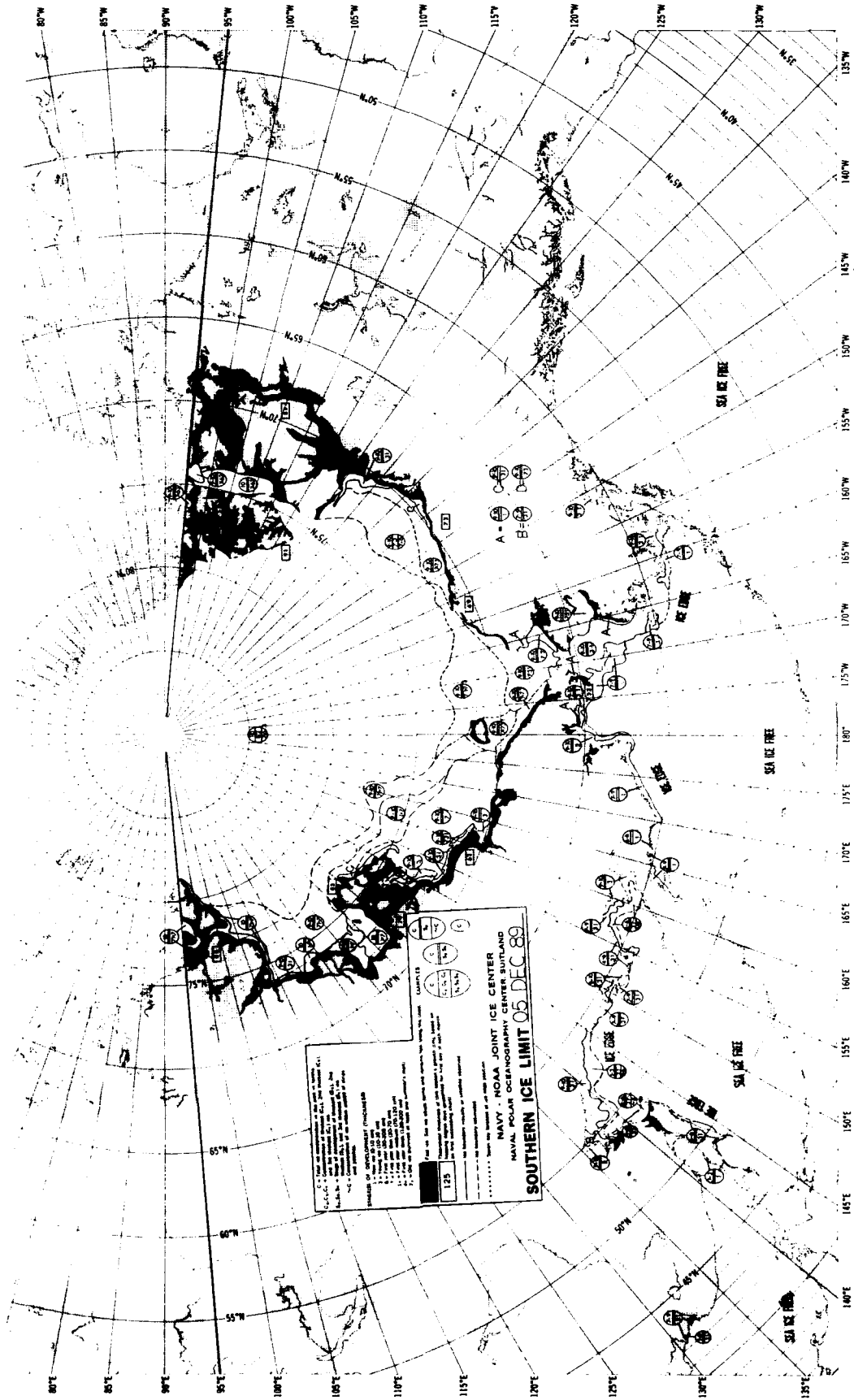


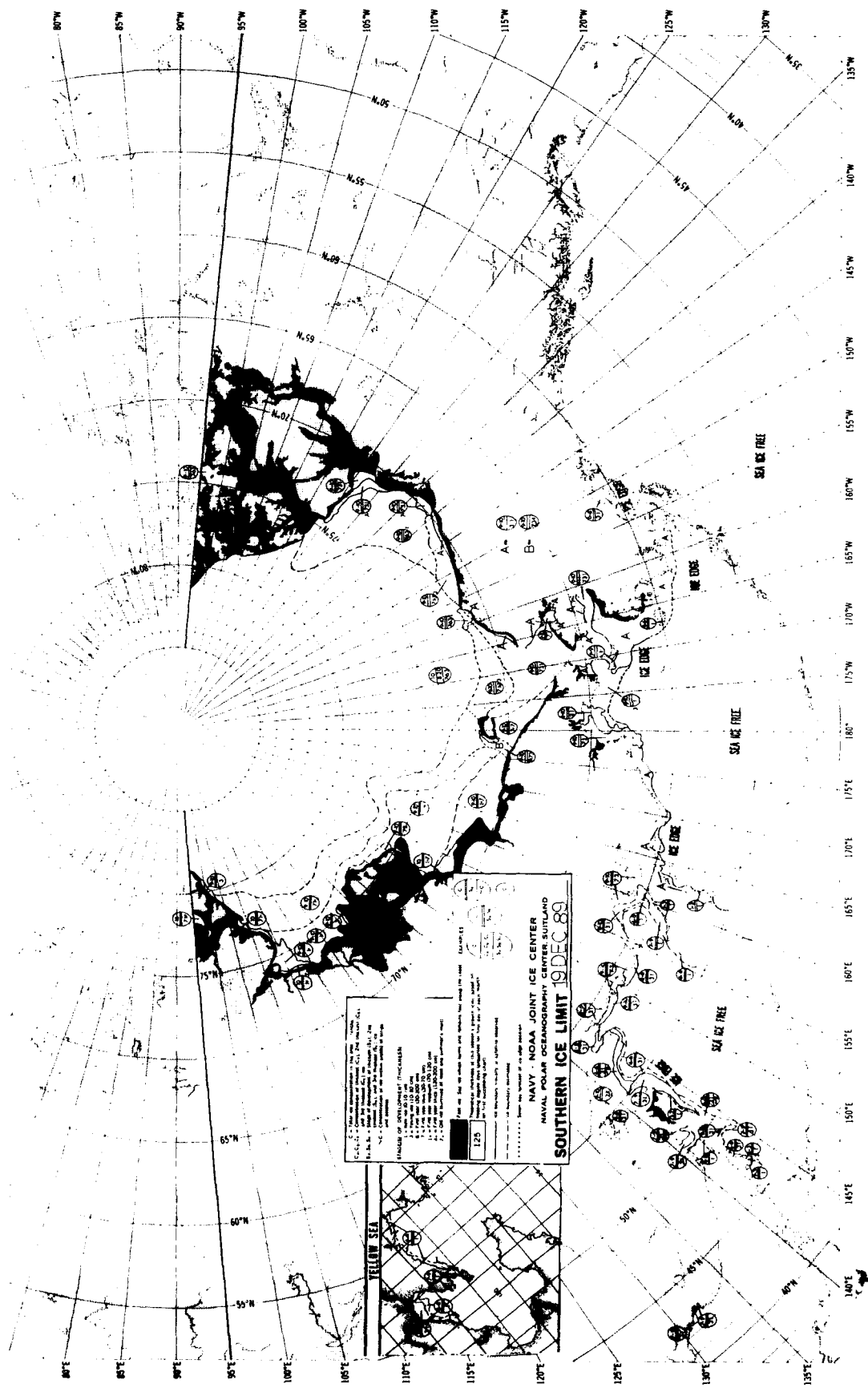












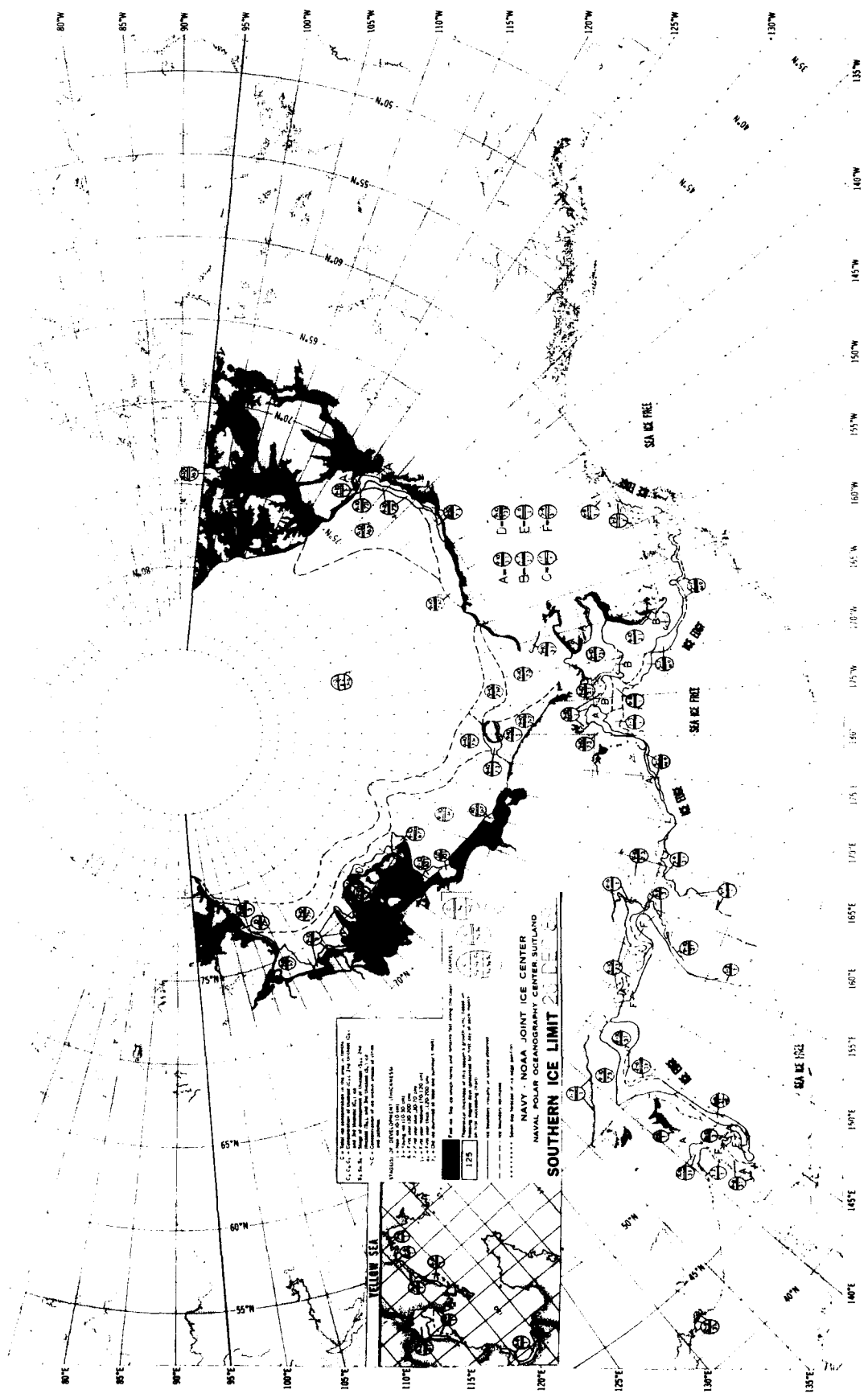


TABLE 1. SATELLITE DATA UTILIZED DURING 1989 (ARCTIC)

Time period		Satellite Remote Sensor					
From	To	Sensor Platform	Sensor Type	Spectral region	Resolution	Coverage	
1-89	12-89	NOAA-A-10	AVHRR				
			HRPT/LAC				
			VIS	0.58-0.68 um	1 km	Regional	
			NIR	0.725-1.10 um			
			IR	10.5-11.5 um			
			LAC				
1-89	1-89	NOAA-11	AVHRR				
			HRPT/LAC				
			VIS	0.58-0.68 um	1 km	Regional	
			NIR	0.725-1.10 um			
			IR	10.5-11.5 um			
			GAC				
1-89	11-89	DMSP-F(8)	VIS	0.58-0.68 um	4 km	Regional	
			IR	10.5-11.5 um			
1-89	11-89	DMSP-F(8)	VIS	0.4-1.1 um	3.7 km	Global	
			IR	10.2-12.8 um	4.4 km		
1-89	12-89	DMSP-F(9)	VIS	0.4-1.1 um	3.7 km	Global	
			IR	10.2-12.8 um	4.4 km		
			SSM/I	1.55 cm	50 km	Global	
				(19-35 GHz)			
1-89	9-89	GEOSAT		0.81 cm	35 km	Global	
				(7.0 GHz)			
1-89	9-89	GEOSAT	Radar	N/A	7 km	Regional	
			Altimeter				

Abbreviations and Acronyms

AVHRR	-	Advanced Very High Resolution Radiometer
cm	-	Centimeter
GAC	-	Global Area Coverage
HRPT	-	High Resolution Picture Transmission
IR	-	Infrared
km	-	Kilometer
LAC	-	Local Area Coverage
NIR	-	Near Infrared
SSM/I	-	Special Sensor Microwave Imager
VIS	-	Visible
um	-	micrometer
GHz	-	Giga hertz