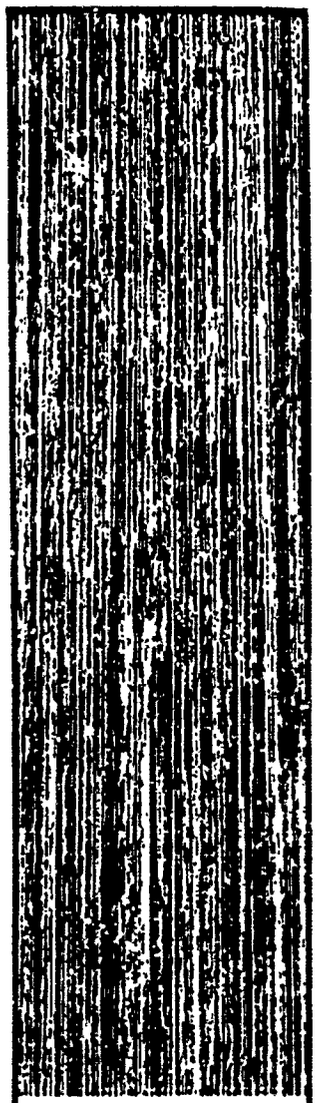
THE MITRE
Bedford, Massachusetts

MTR-145

A CLIMATIC ISOVISIC AND NEPHANALYSIS ATLAS OF THE NORTH ATLANTIC, NORTH PACIFIC AND INDIAN OCEANS

J. H. Keating

APRIL 1966



THE MITRE CORPORATION

BEDFORD, MASSACHUSETTS

MITRE Technical Report

MTR- 145 - ____ - ____ - ____ - ____ - ____
No. Vol. Series Rev. Supp. Corr.

CONTROLLED DISTRIBUTION

Subject: A Climatic Isovisic and Nephanalysis Atlas of the North Atlantic, North Pacific and Indian Oceans

Author: J. H. Keating

Dept.: D-50

Date: 7 April 1966

Contract No.: N228-(62479)69887

Contract Sponsor: USNRDL

Project: 8260

Issued at:

Department Approval: R. S. Greeley
R. S. Greeley

MITRE Project Approval: J. R. Corf
J. R. Corf

Page 1 of 154 Pages

ABSTRACT

In support of the NRDL Optical Sensor Study climatological charts are provided for the mid-season months of January, April, July and October for the North Atlantic, North Pacific and Indian Oceans. The climatological charts provide:

a. Isovisic (visibility) maps of the percentage frequency of visibilities less than 25, 10, five, two and one nm.

b. Isovisic maps of visibility for 90 percent, 75 percent, 50 percent and 25 percent.

c. Nephanalysis maps of the percentage frequency of total cloud cover greater than or equal to seven eights ($\geq 7/8$).

d. Nephanalysis maps of percentage frequency of total cloud cover equal to or less than two tenths ($\leq 2/10$).

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONTINUED)

LIST OF ILLUSTRATIONS (CONTINUED)

LIST OF ILLUSTRATIONS (CONCLUDED)

SECTION I

INTRODUCTION

This atlas has been prepared in support of the Optical Environmental Study conducted by the MITRE Corporation for the Naval Research Devense Laboratory (NRDL). The climatological analysis presented in ths paper is intended to support the atmospheric transmission task of the study but is provided in a format that is generally applicable to a wide range of naval engineering and operational planning activities.

The study provides a climatological analysis of visibility and total cloud cover for each of the mid-season months of January, April, July, and October. The geographical areas of interest were selected based upon their significance to naval operations. They are the North Atlantic Ocean, the North Pacific Ocean, and the Indian Ocean.

SECTION II

METEOROLOGICAL VISIBILITY

Middleton (Reference 1) has summarized the meteorological visibility observation technique as follows: "Visibility is the greatest distance in a given direction at which it is just possible to see and identify with the unaided eye: in the daytime a prominent dark object against the sky at the horizon; and at night, a known preferably unfocused, moderately intense light source. After visibilities have been determined around the entire horizon circle, they are resolved into a single value of prevailing visibility for reporting purposes."

The directives for the observation and encoding of visibility are contained in the Manual of Surface Observations (WBAN), "Circular N," and are consistant with the international procedures coordinated through the World Meteorological Organization (WMO). "Circular N" defines the prevailing visibility as the greatest visibility which is attained or surpassed throughout half of the horizon circle, not necessarily continuous. Under non-uniform conditions, the sectors may be distributed in any order Under uniform conditions, the prevailing visibility is the same as the visibility in any direction. If the visibility is variable, i.e., the prevailing visibility rapidly increases and decreases one or more reportable value during the period of observation, the average is used.

The meteorological visibility observation is intended for visual range estimates over flat horizontal paths only and, because of the general lack of uniformity of the atmosphere in the lower levels, it is not a reliable indicator of the slant range visibility.

RELIABILITY OF VISIBILITY OBSERVATIONS

The observation of meteorological visibility is highly subjective. Inland and coastal stations have an advantage in having fixed objects and light sources at known distances to help determine visual range

Ships at sea have neither reference markers nor trained observors. Although no quantitative analysis has been made, it may be assumed that during daytime, ship visibility observations are probably overestimated for the short visual ranges (less than three miles), and underestimated for longer distances.

A major area of concern is night time observations at sea. Without moonlight, observation is practically impossible. The acceptable practice is to continue to record the last valid visibility observation until such time as there is sufficient light to observe a change. The diurnal variation of visibility over the ocean is probably negligible because diurnal variations in the thermal stratification are small and thus, little diurnal change in the wind or aerosol distribution is expected.

ISOVISIC ANALYSIS

The term "Isovisic" (adjective Isovisic) was coined by Eldridge (Reference 2) to describe the analysis of visibilities to provide lines of constant visibility.

An isovisic chart is based upon the assumption that visibility is a conservative parameter with respect to space or time. While it is very difficult to validate the conservation between observational points with "real-time," synoptic data, the statistical nature of climatological visibility data lends itself to such an analysis.

SECTION III

NEPHANALYSIS

A nephanalysis is a cloud cover analysis resulting in contours of equal cloudiness or percentage frequency of selected cloud cover intervals. The percentage frequency of cloud cover for amounts less than or equal to two tenths, and for amounts greater than or equal to seven eights, is provided to supplement the visibility data in the evaluation of transmissivity.

Cloud observation procedures are standarized in "Circular N." Observational bias can be expected due to the difficulty of distinguishing between cloud sides and cloud bottoms at low angles of view. The bias is generally one of overestimating the percentage of cloud cover.

SECTION IV

GEOGRAPHICAL AREAS STUDIED

Based upon the validity and reliability of the available climatological studies and upon a determination of areas of operational significance an analysis was made of three ocean areas. The areas and principle reference documents are as follows:

a. North Atlantic - U.S. Navy Marine Climatic Atlas of the World, Volume, I, North Atlantic Ocean, NAVAER 50-IC-528, 1 July 1956.

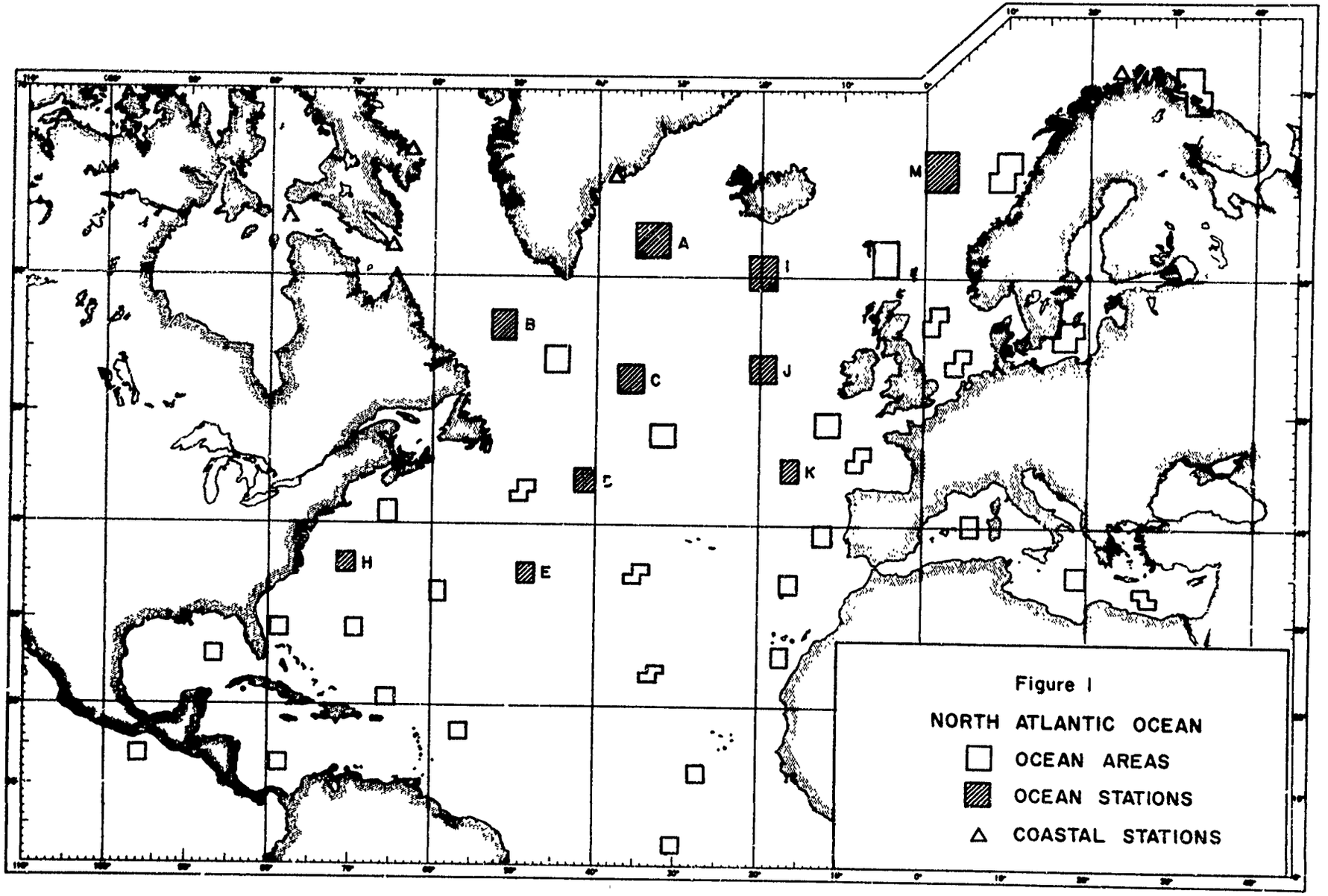
b. North Pacific - U.S. Navy Marine Climatic Atlas of the World, Volume II, North Pacific Ocean, NAVAER 50-IC-529, 1 July 1956.

c. Indian Ocean - U.S. Navy Marine Climatic Atlas of the World, Volume III, Indian Ocean, NAVAER 50-IC-530, 1 September 1957.

For each of the oceanic areas, the NAVAER Climatic Atlas provides cumulative percentage frequency distributions of horizontal visibility and total cloud cover for approximately 50 data points. Figures 1 through 3 illustrate the data points from coast and island stations, ocean stations (weather stations) and small ocean areas representative of a relatively homogeneous climatic region. Areas where the climatological data is scarce are identified as jagged boxes.

The number of observations used in the NAVAER series to provide the percentage frequency distributions is unknown but includes all the available data from the National Weather Records Center, Asheville, North Carolina.

Over the Indian Ocean dashed contours have been used to indicate areas requiring more subjective analysis due to the availability or reliability of the data.


A
B
C
D
E
H
I
J
K
M
Figure I
NORTH ATLANTIC OCEAN
OCEAN AREAS
OCEAN STATIONS
COASTAL STATIONS

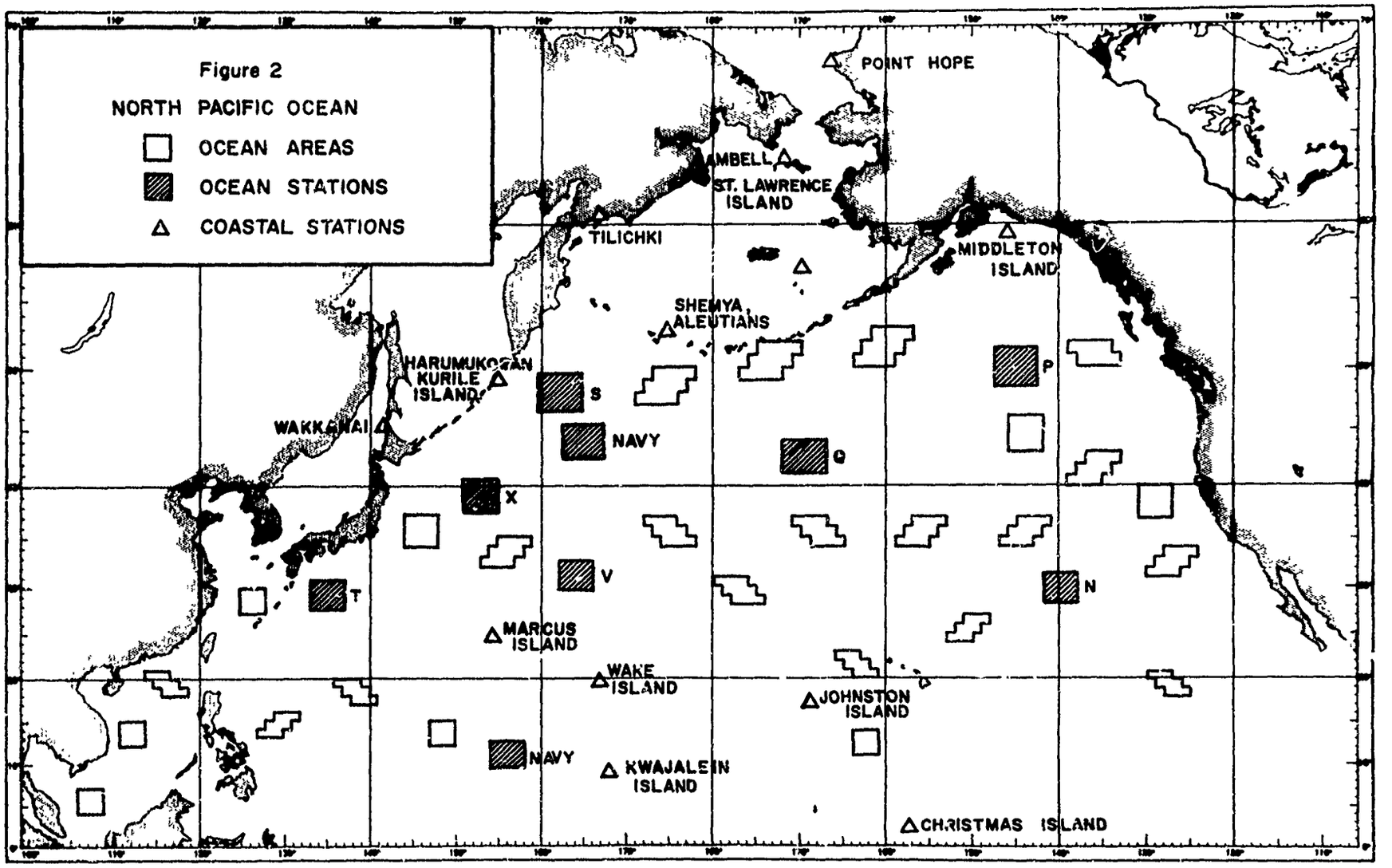


Figure 2
NORTH PACIFIC OCEAN
OCEAN AREAS
OCEAN STATIONS
COASTAL STATIONS
POINT HOPE
AMBELL
ST. LAWRENCE ISLAND
TILICHKI
MIDDLETON ISLAND
SHEMYA ALEUTIANS
HARUMUKOTAN KURILE ISLAND
WAKKANAI
S
NAVY
P
Q
X
V
T
N
MARCUS ISLAND
WAKE ISLAND
JOHNSTON ISLAND
NAVY
KWAJALEIN ISLAND
CHRISTMAS ISLAND

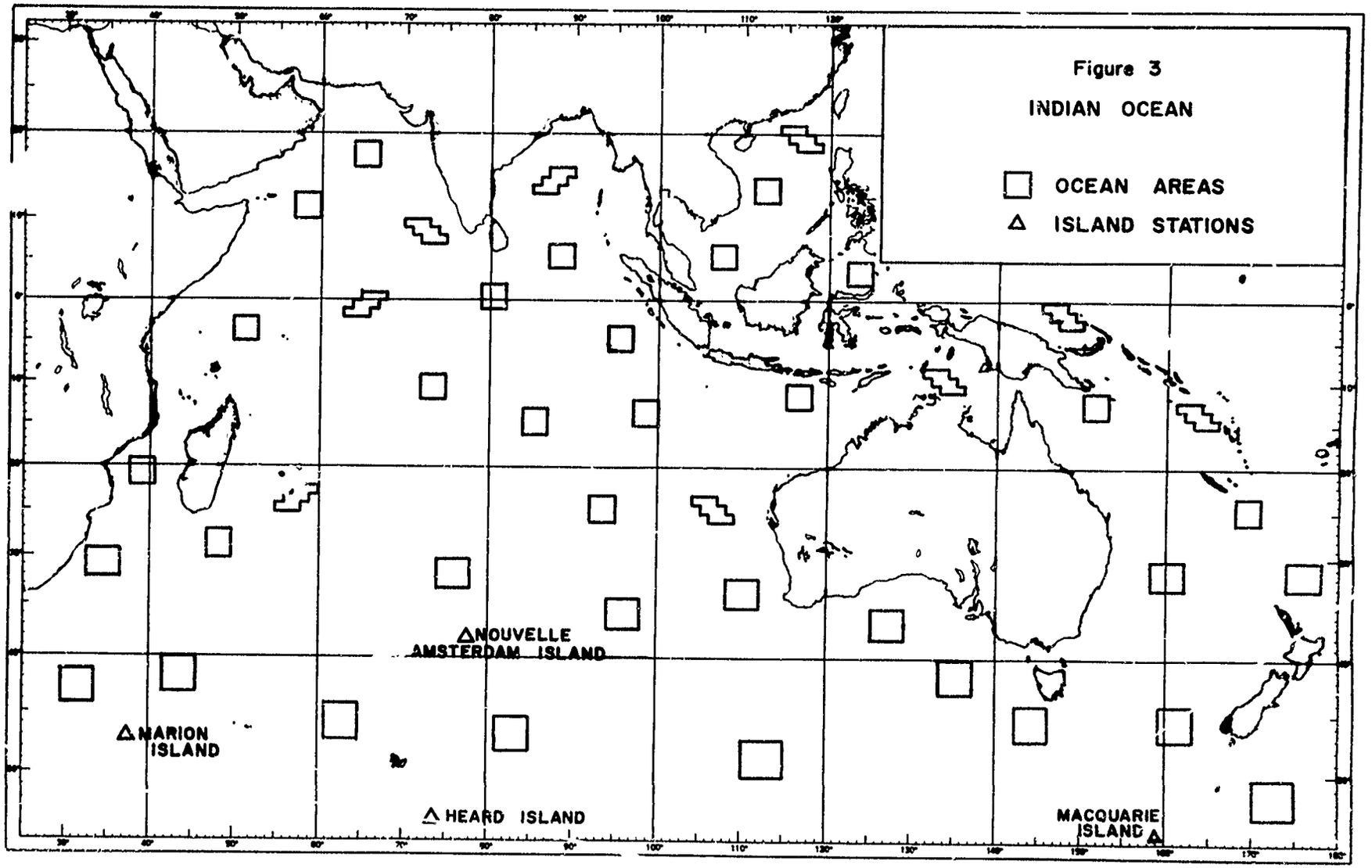


Figure 3
INDIAN OCEAN
OCEAN AREAS
ISLAND STATIONS
NOUVELLE AMSTERDAM ISLAND
MARION ISLAND
HEARD ISLAND
MACQUARIE ISLAND

SECTION V

DESCRIPTION OF THE ANALYSIS

For each of the three geographical areas and for the mid-season months of January, April, July, and October, the visibility and cloud cover analysis is present in four basic forms, each form in a separate Appendix as follows:

a. Appendix A - Isovisic maps providing contours of percentage frequency of the visibility falling into one of the following five categories: less than 25 nm, less than 10 nm, less than 5 nm, less than two nm, and less than one nm.

b. Appendix B - Isovisic maps providing contours of visibility for each of four categories of probability; 90 percent, 75 percent, 50 percent, and 25 percent.

c. Appendix C - Nephanalysis providing contours of percentage frequency of total cloud cover greater than or equal to seven eights ($\geq 7/8$).

d. Appendix D - Nephanalysis providing contours of percentage frequency of total cloud cover equal to or less than two tenths ($\leq 2/10$).

John H. Keating

J. H Keating
Strategic Systems

JHK:jg

APPENDIX A

ISOVISIC MAPS - PERCENTAGE FREQUENCY OF VISIBILITIES LESS THAN 25, 10, five, two and one Nautical Miles

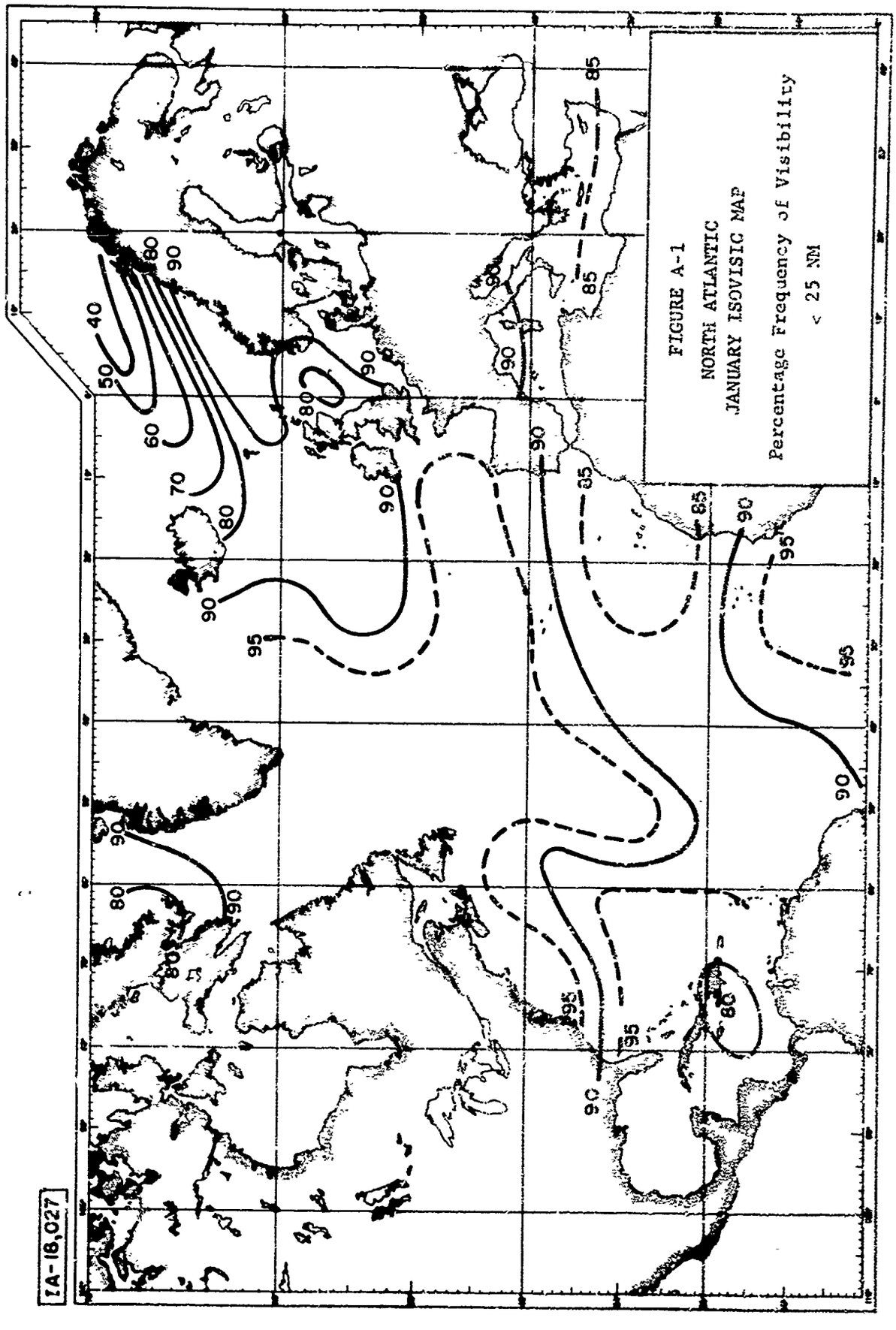


FIGURE A-1
NORTH ATLANTIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM
IA-18,027

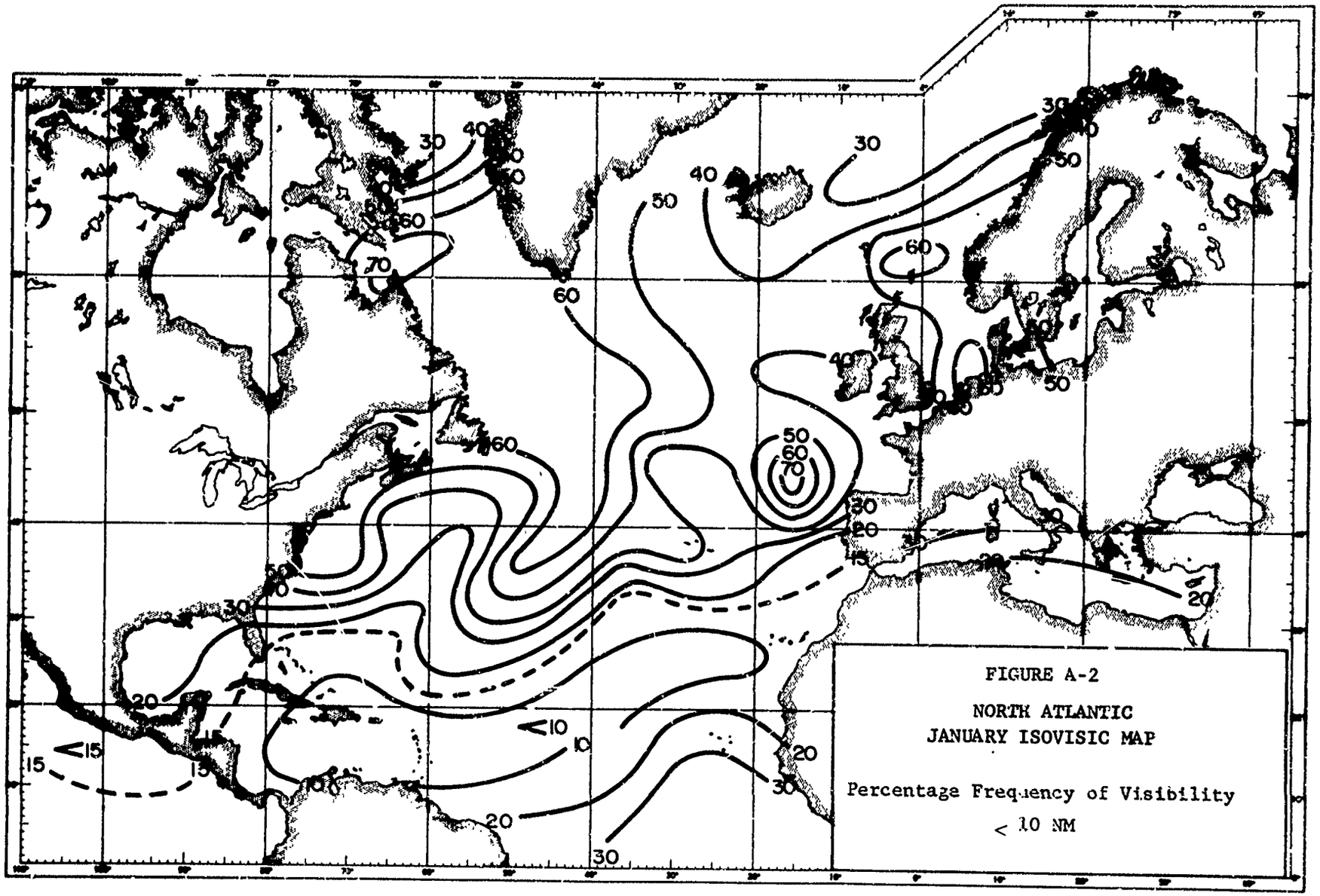


FIGURE A-2

NORTH ATLANTIC
JANUARY ISOVISIC MAP

Percentage Frequency of Visibility
< 10 NM

IA-18,025

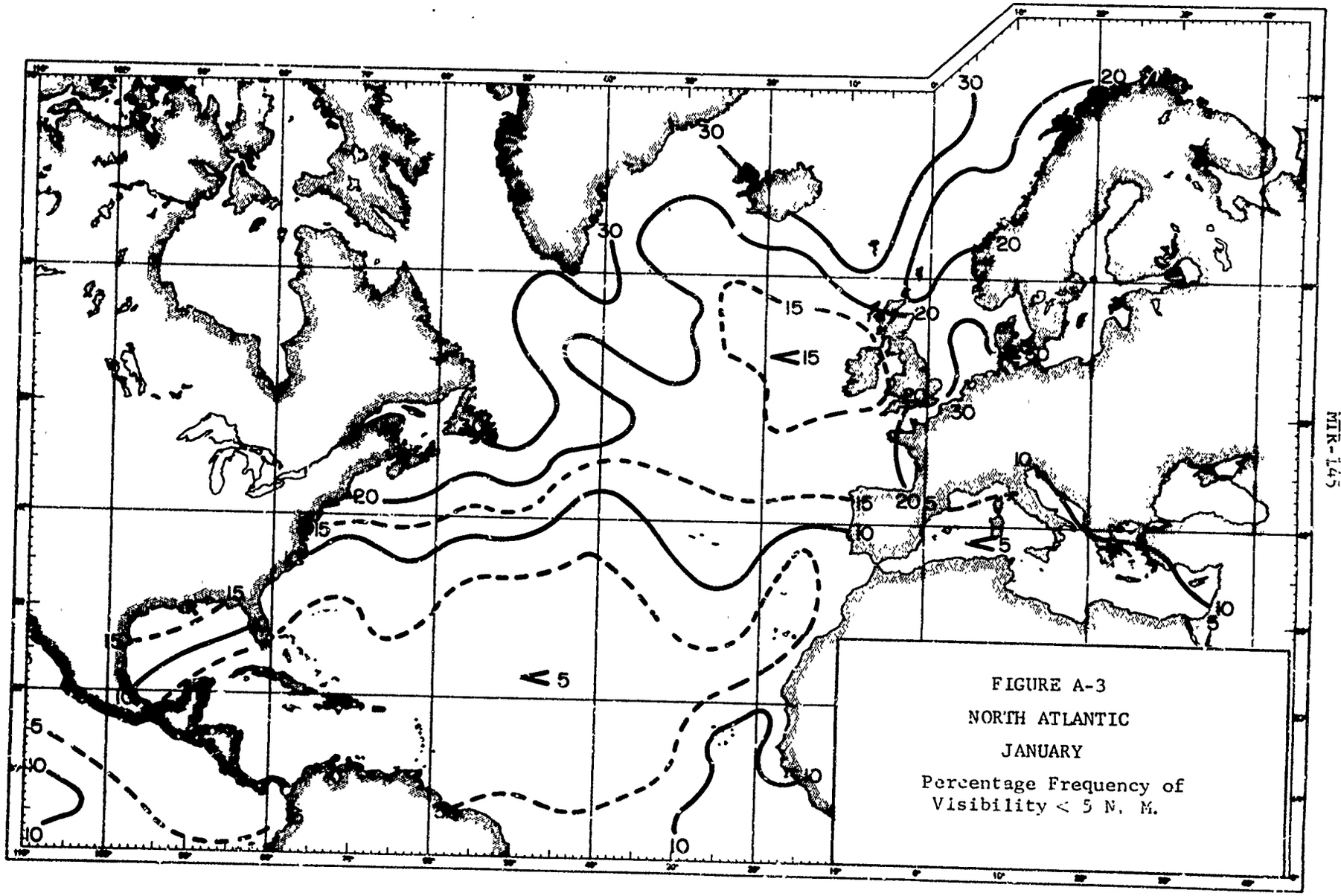


FIGURE A-3

NORTH ATLANTIC

JANUARY

Percentage Frequency of
Visibility < 5 N. M.

IA-18024

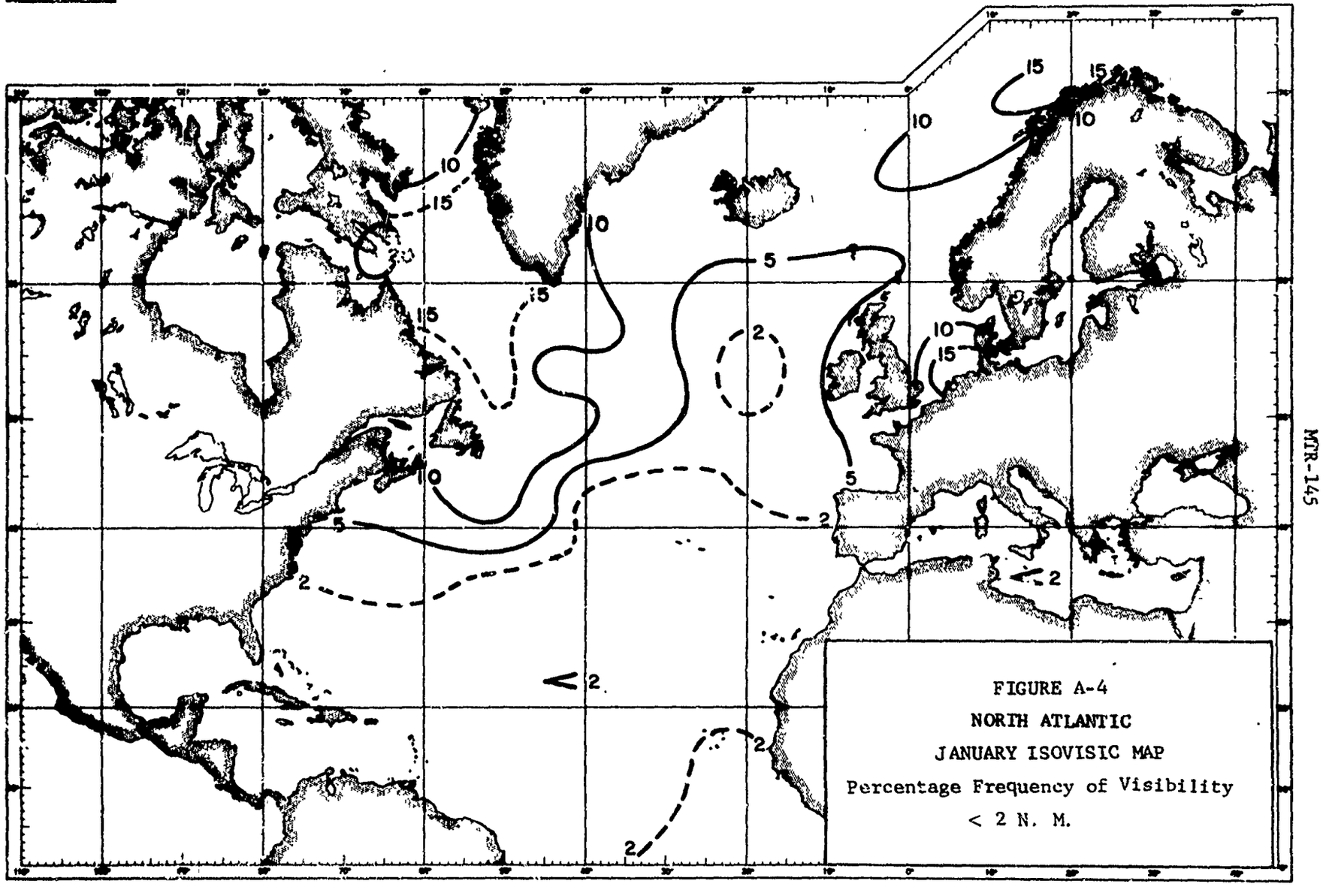


FIGURE A-4
NORTH ATLANTIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 2 N. M.

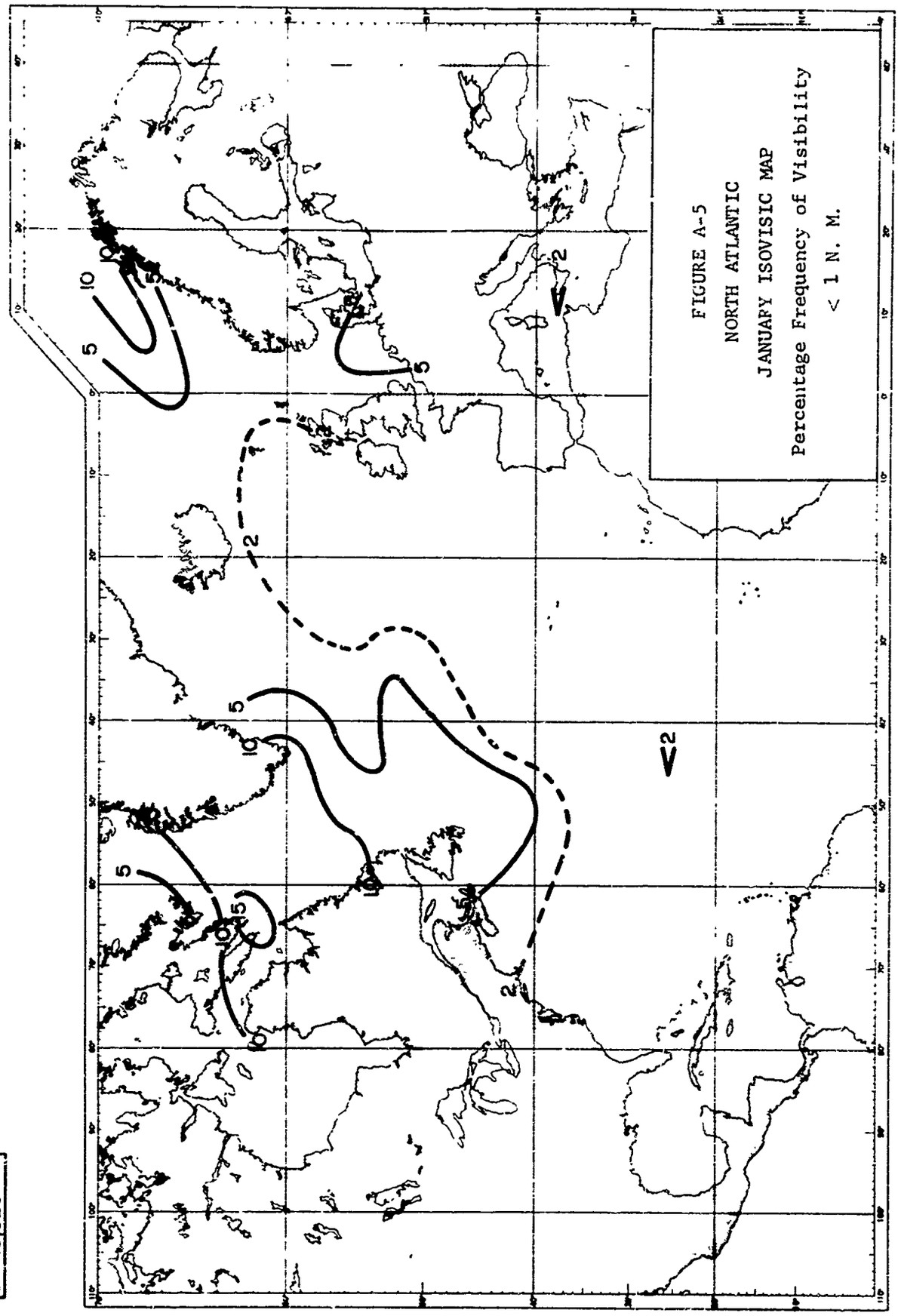


FIGURE A-5
NORTH ATLANTIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 1 N. M.

IA-18,023

IA-18022

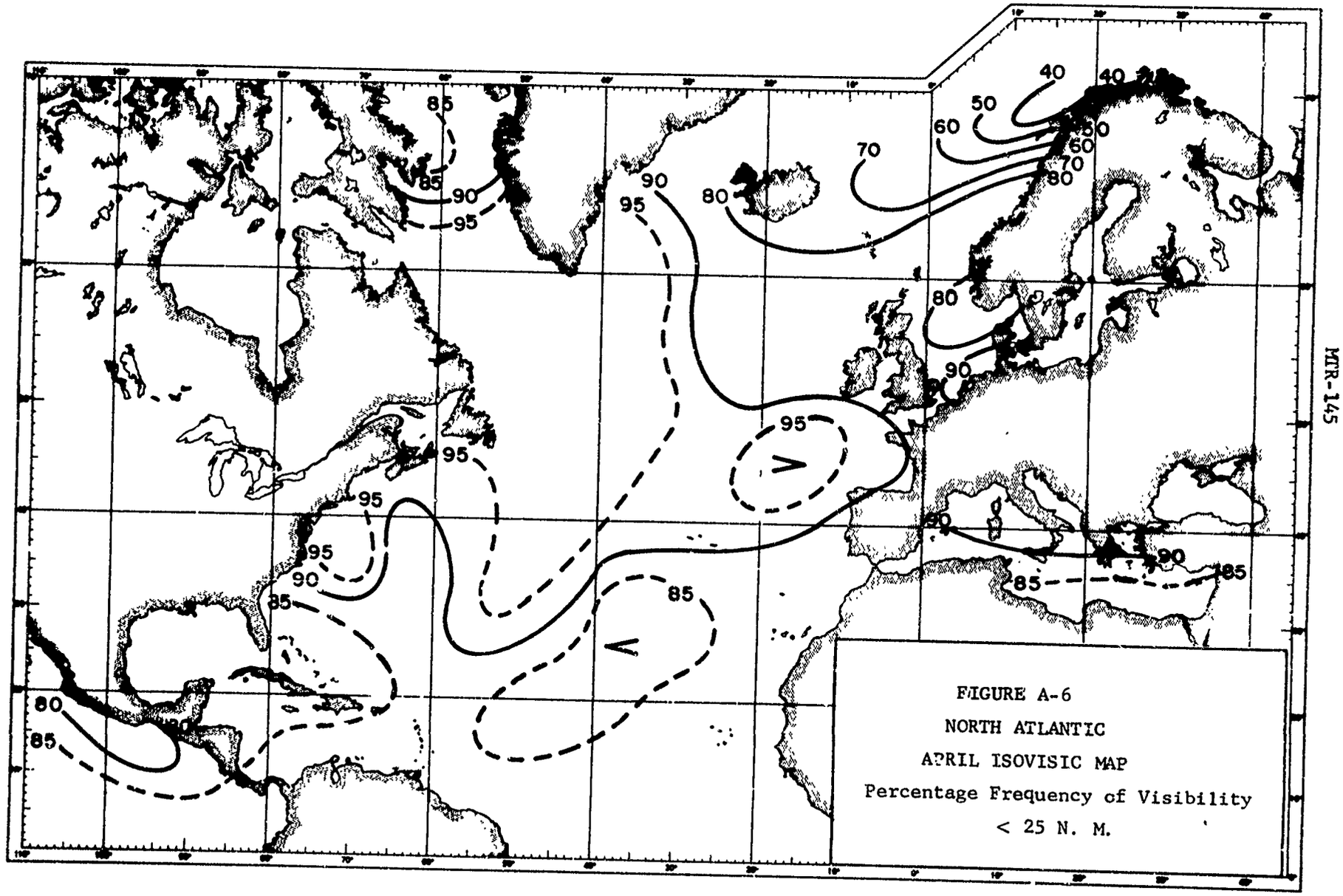


FIGURE A-6
NORTH ATLANTIC
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 25 N. M.

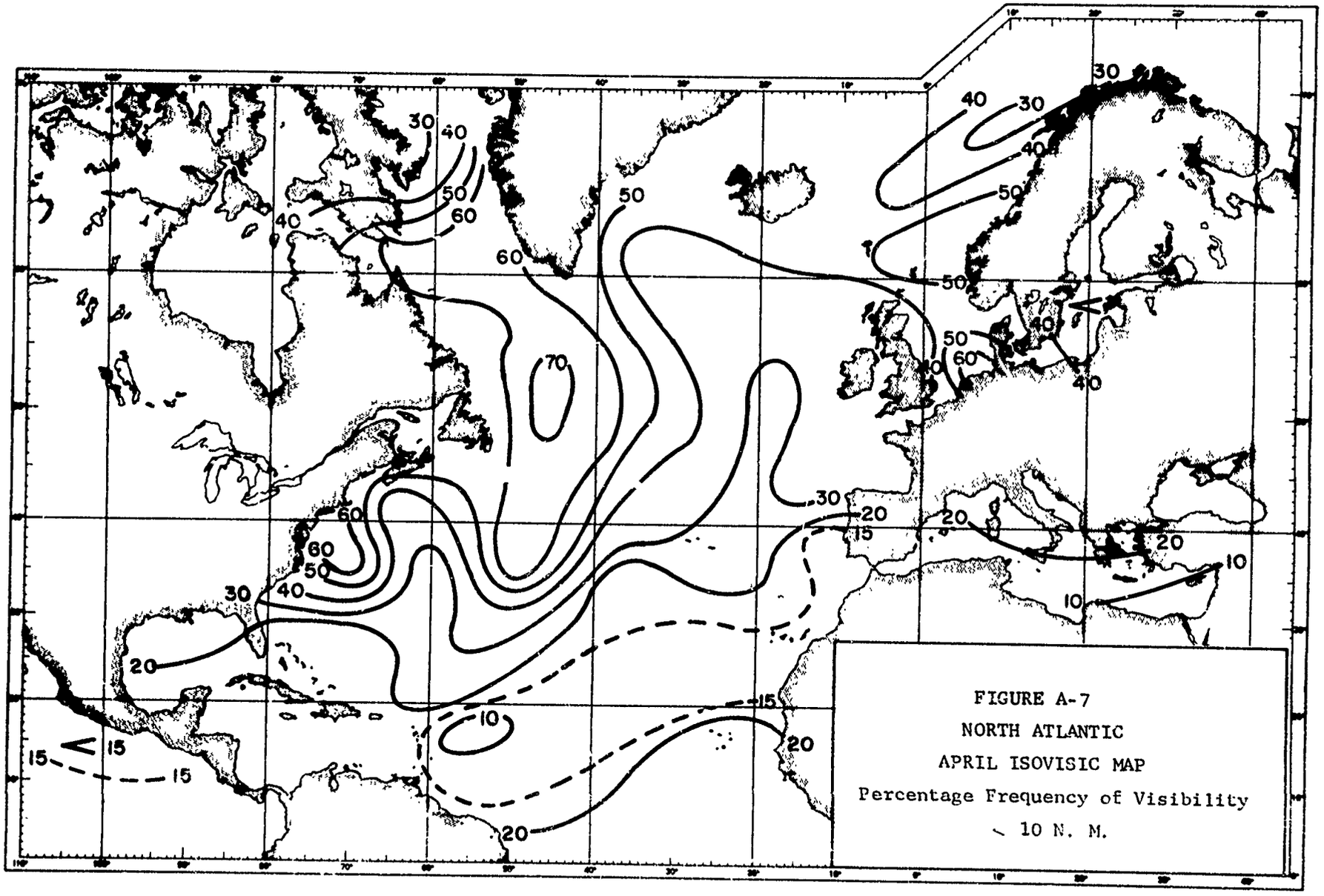


FIGURE A-7
NORTH ATLANTIC
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
~ 10 N. M.

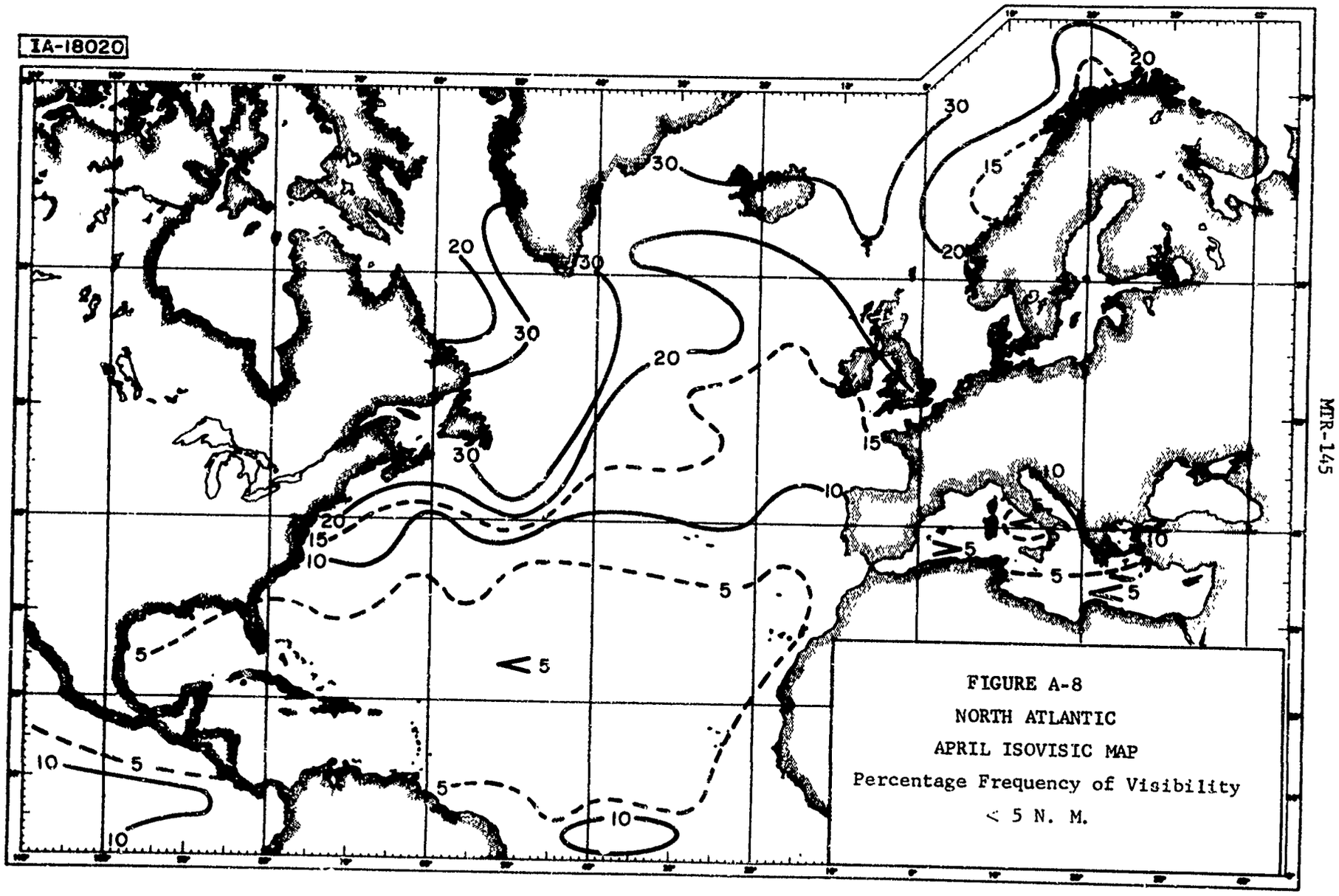


FIGURE A-8
NORTH ATLANTIC
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.

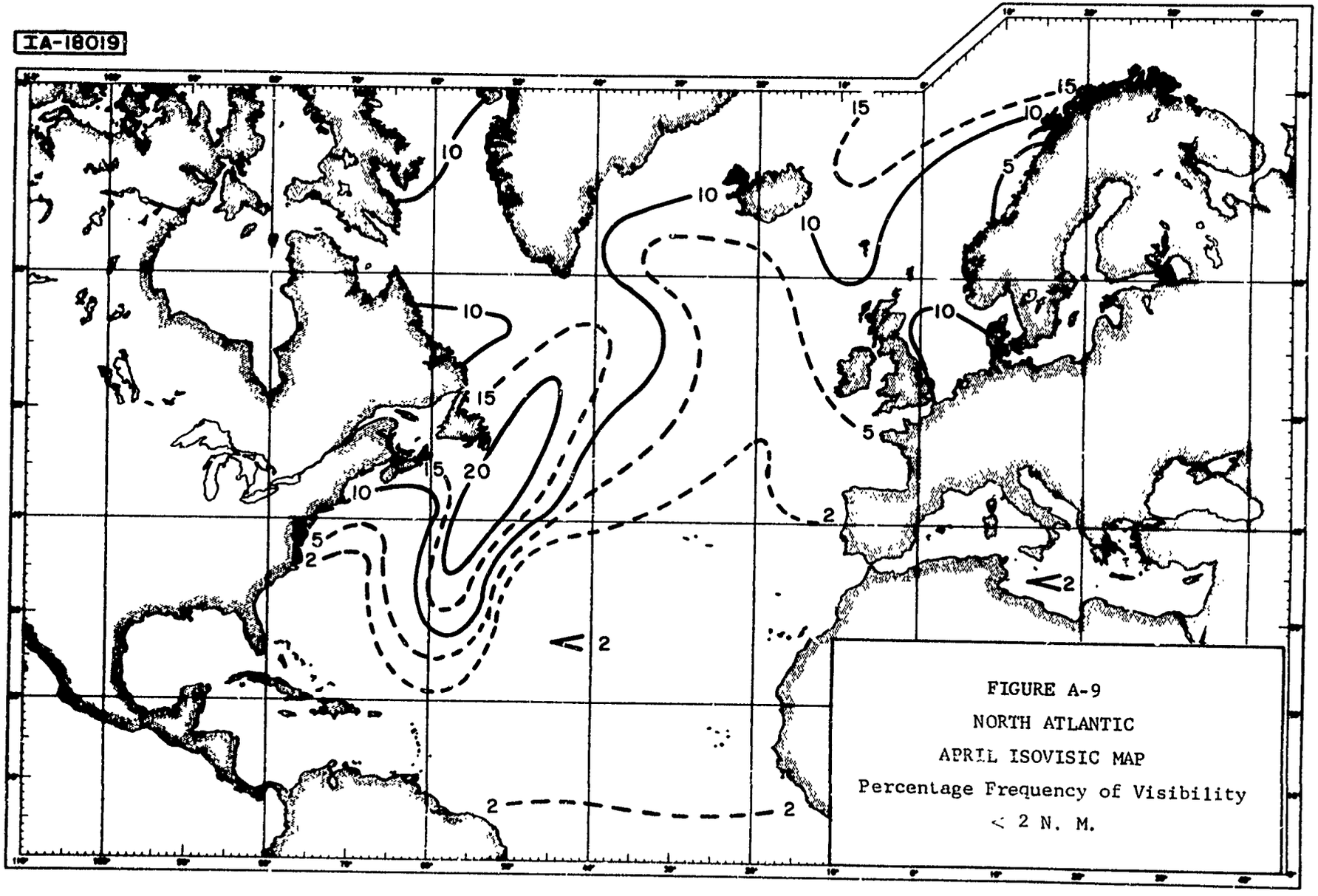


FIGURE A-9

NORTH ATLANTIC

APRIL ISOVISIC MAP

Percentage Frequency of Visibility

< 2 N. M.

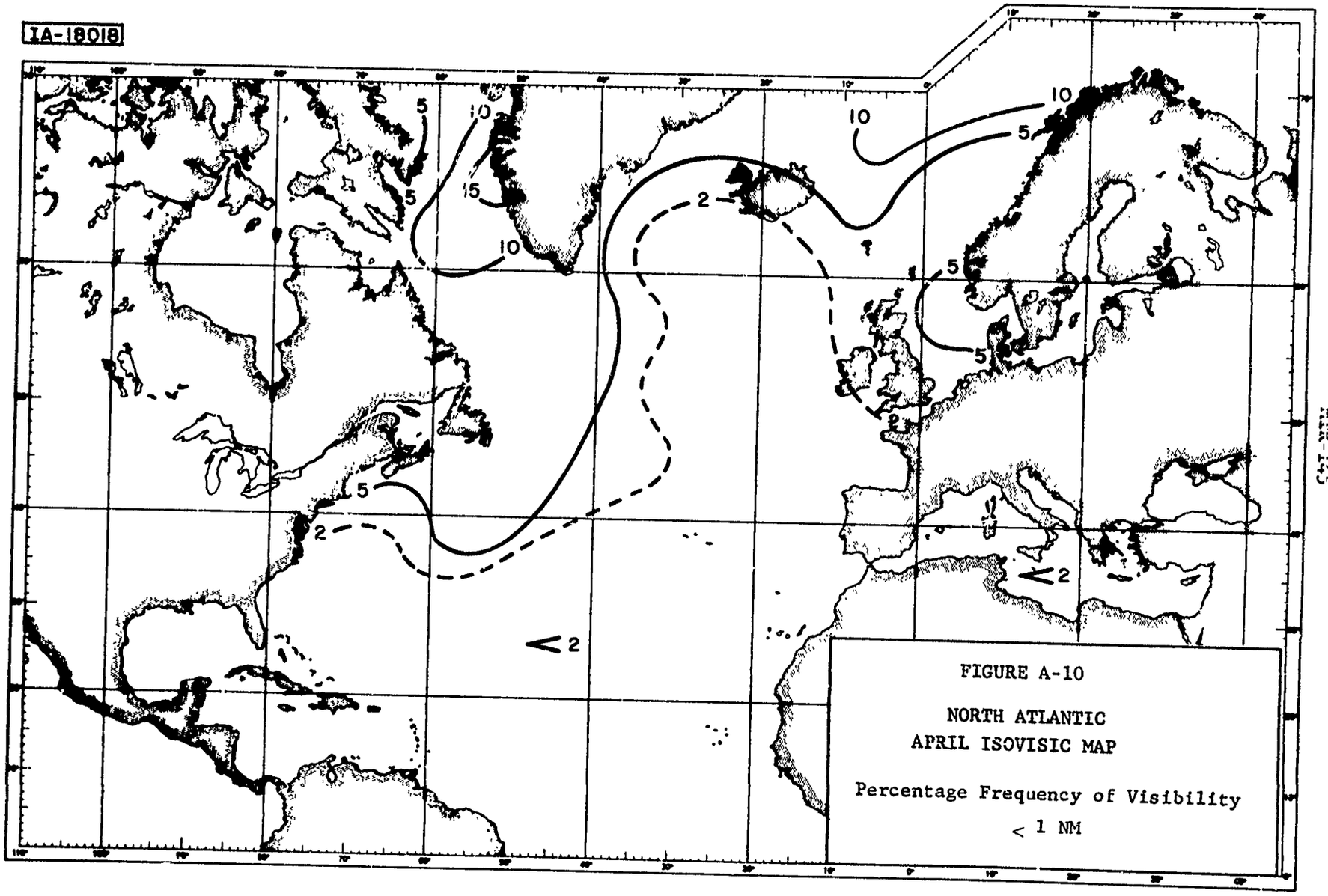


FIGURE A-10

NORTH ATLANTIC
APRIL ISOVISIC MAP

Percentage Frequency of Visibility
< 1 NM

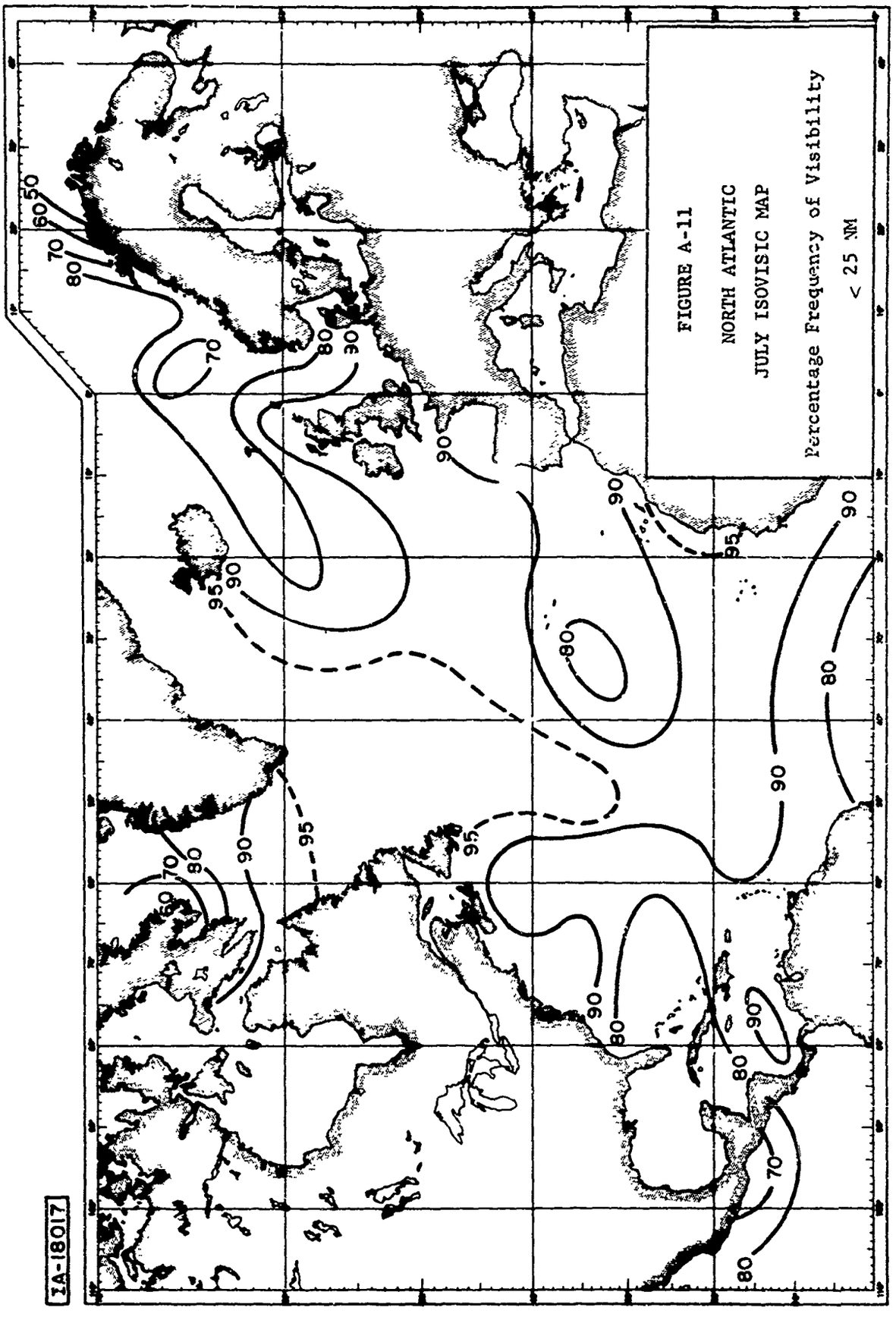


FIGURE A-11
NORTH ATLANTIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM
IA-18017

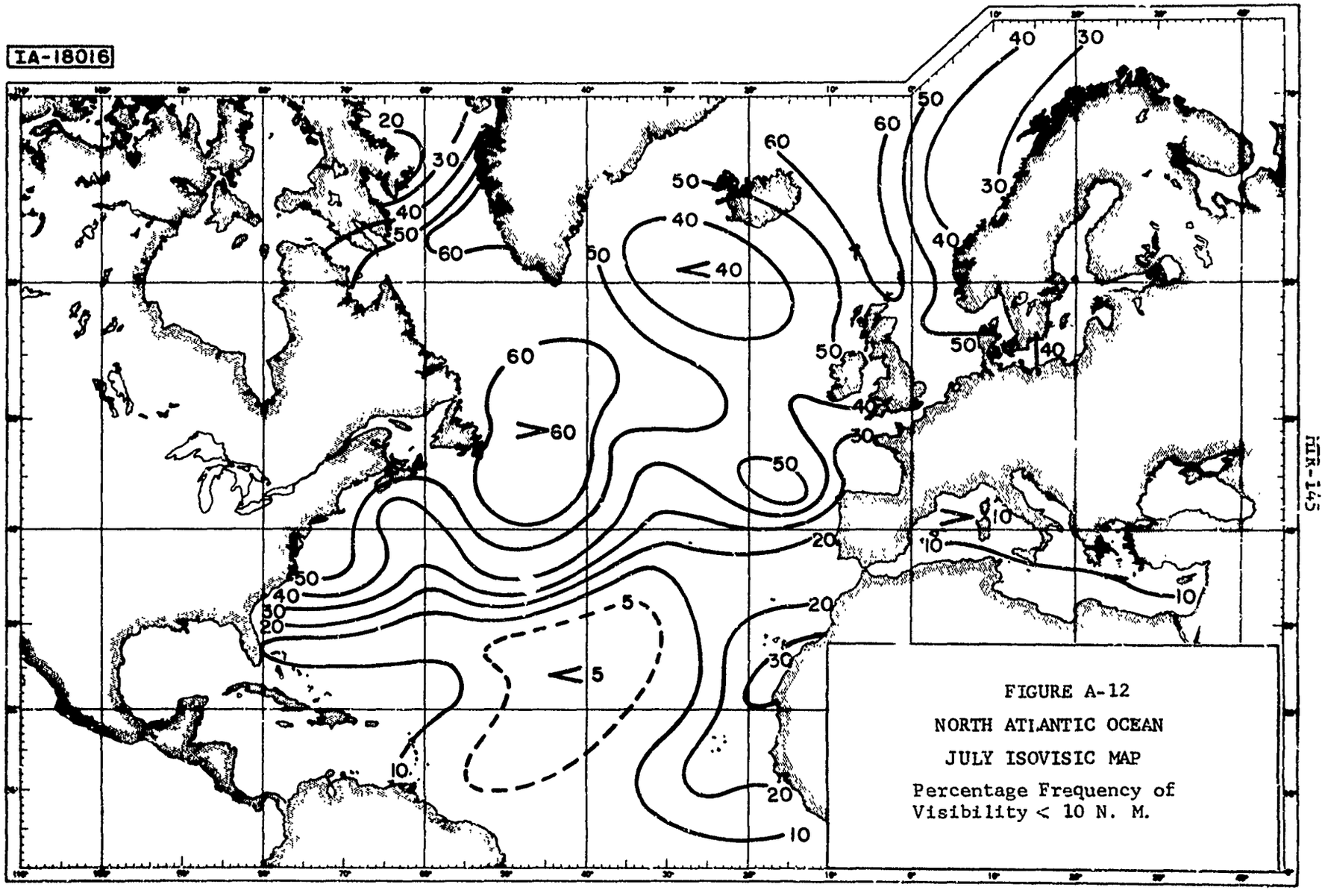


FIGURE A-12

NORTH ATLANTIC OCEAN

JULY ISOVISIC MAP

Percentage Frequency of
Visibility < 10 N. M.

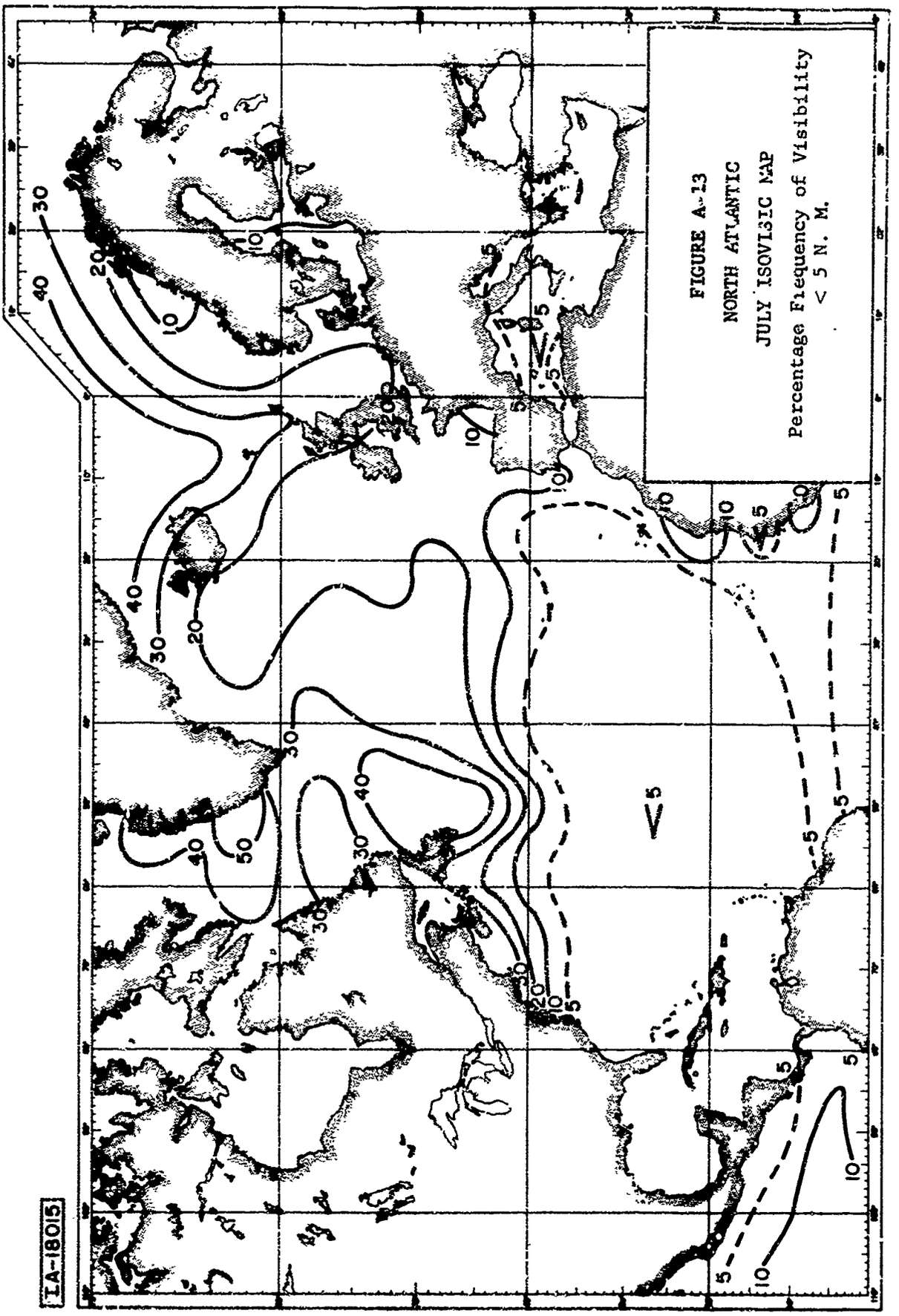


FIGURE A-13
NORTH ATLANTIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.
IA-18015

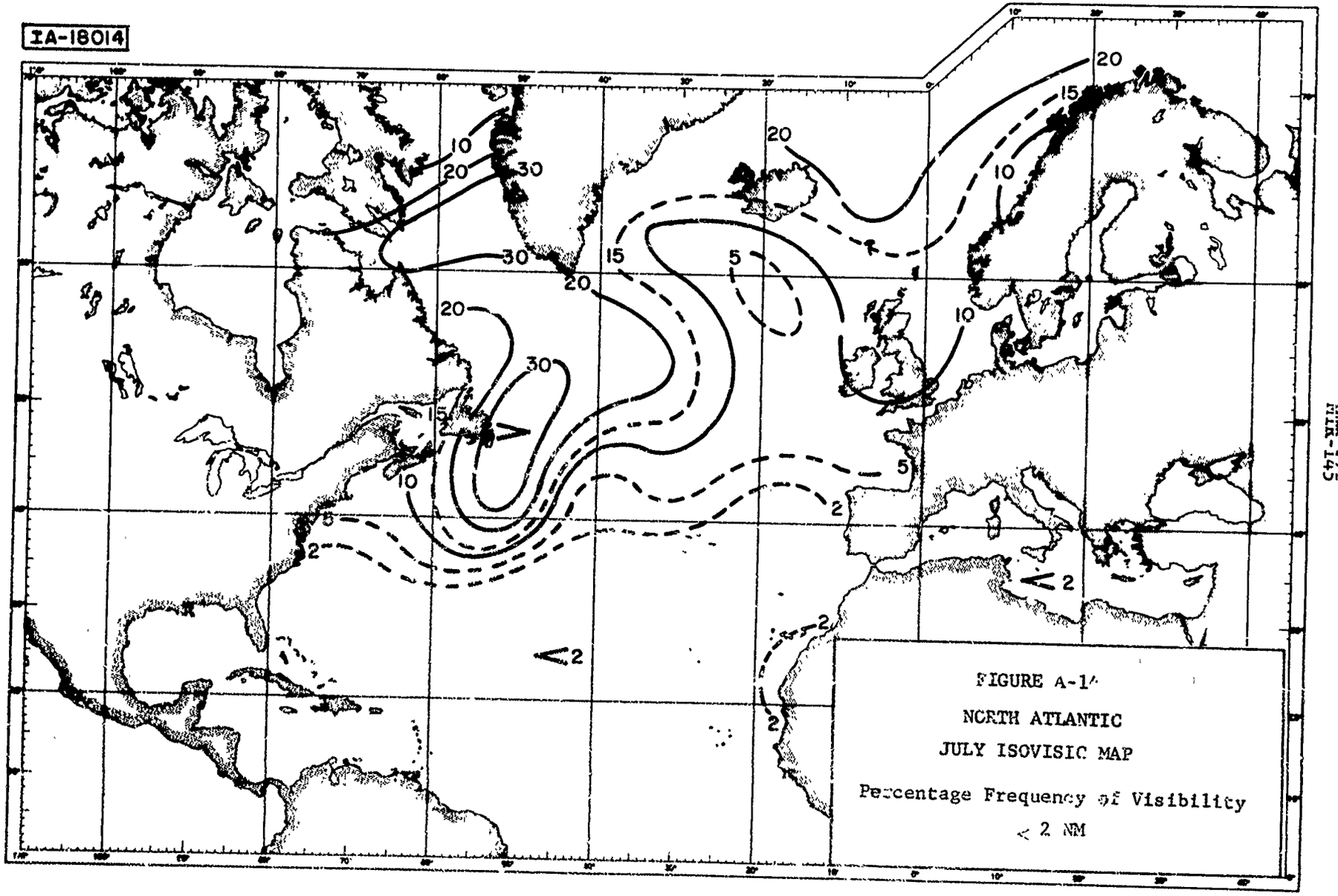


FIGURE A-14

NORTH ATLANTIC

JULY ISOVISIC MAP

Percentage Frequency of Visibility

< 2 NM

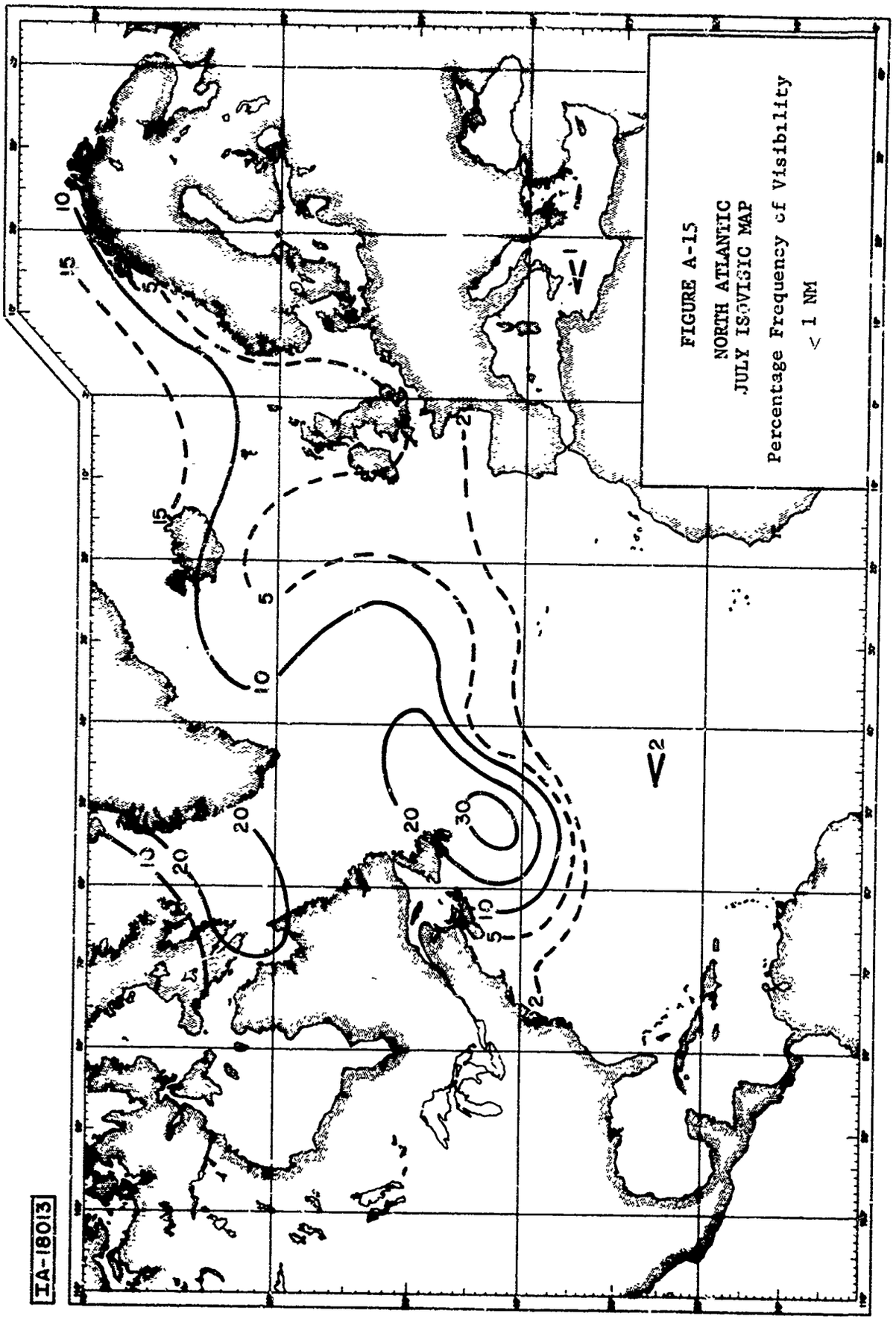


FIGURE A-15
NORTH ATLANTIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
≤ 1 NM
V1
V2
IA-18013

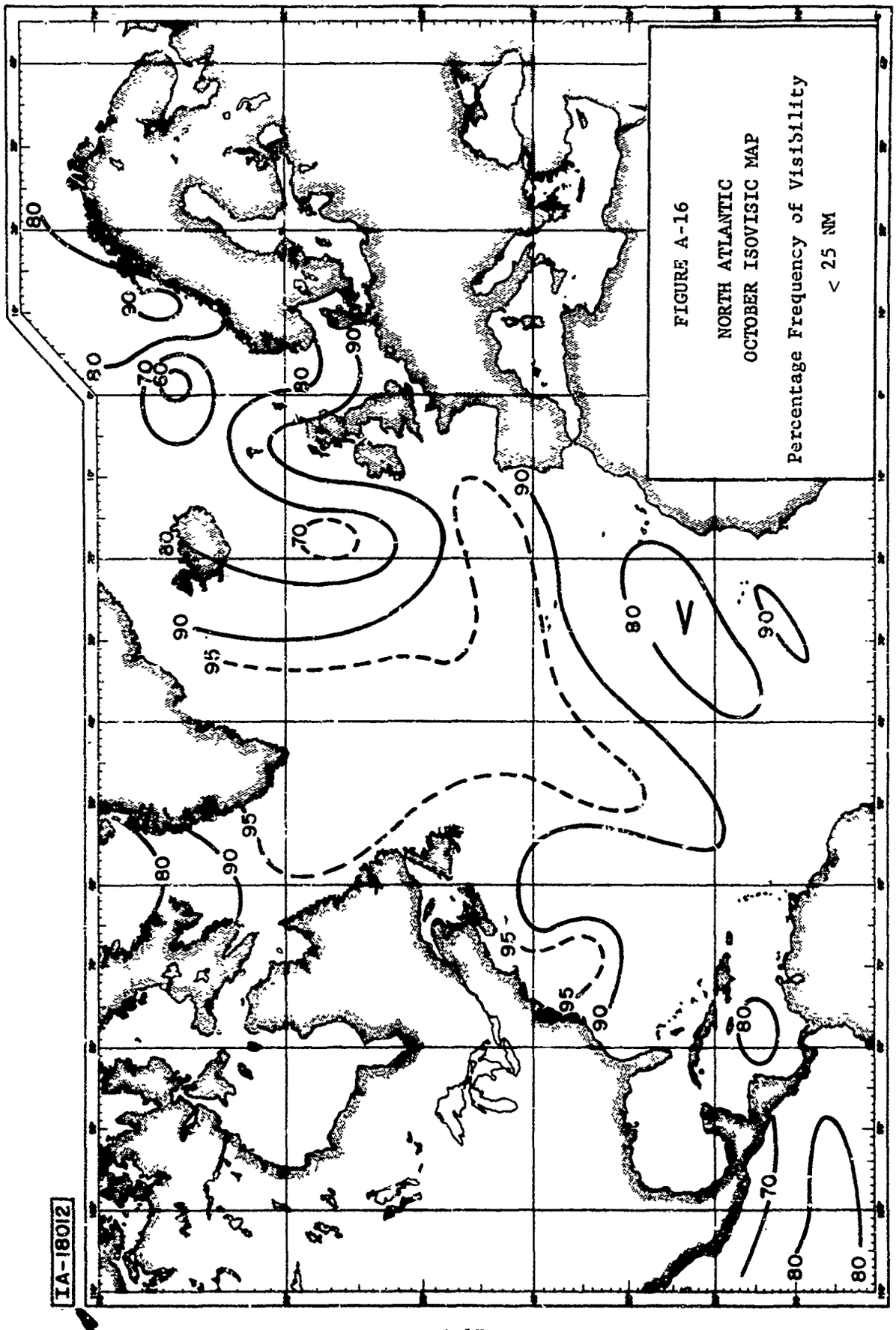


FIGURE A-16
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM
IA-18012

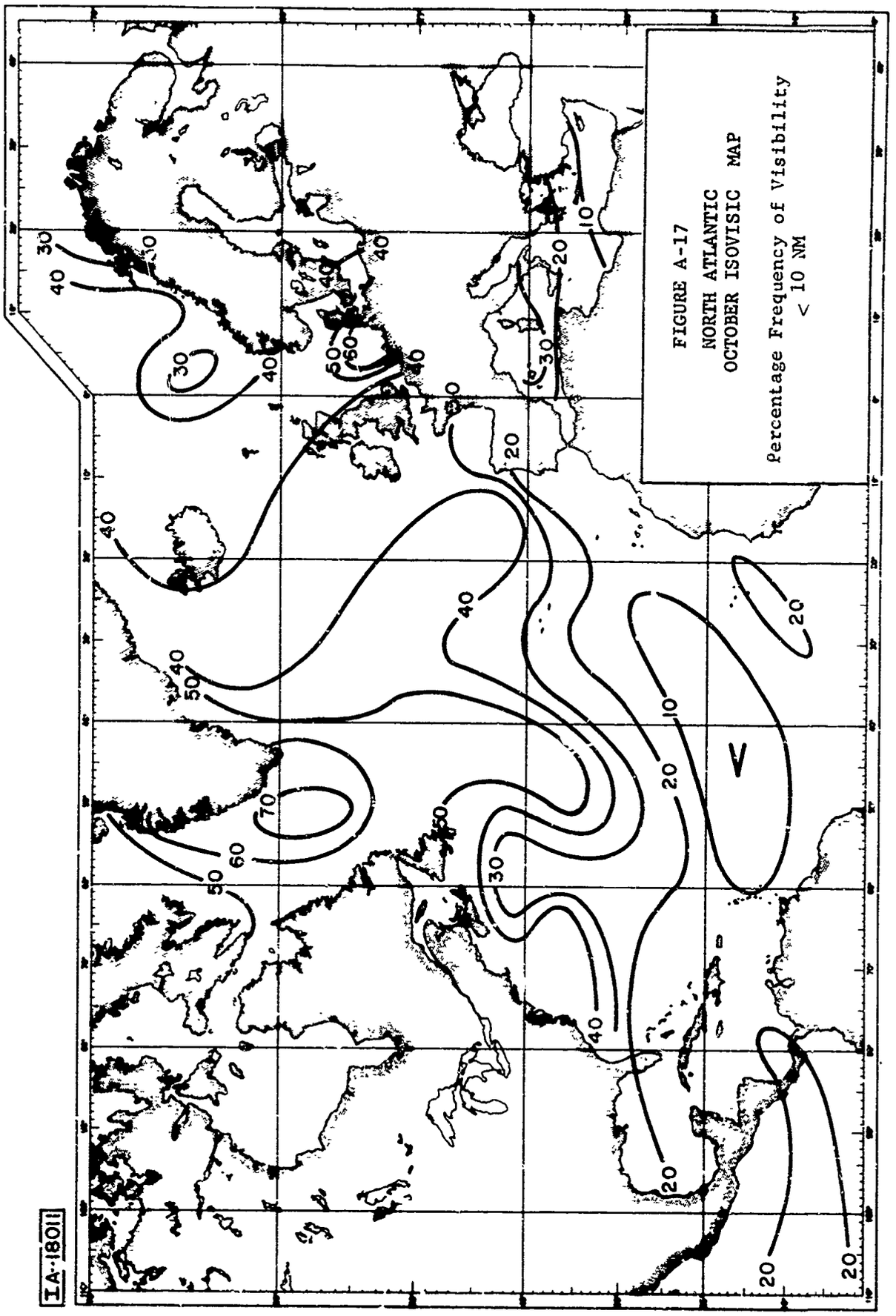


FIGURE A-17
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 10 NM
IA-18011

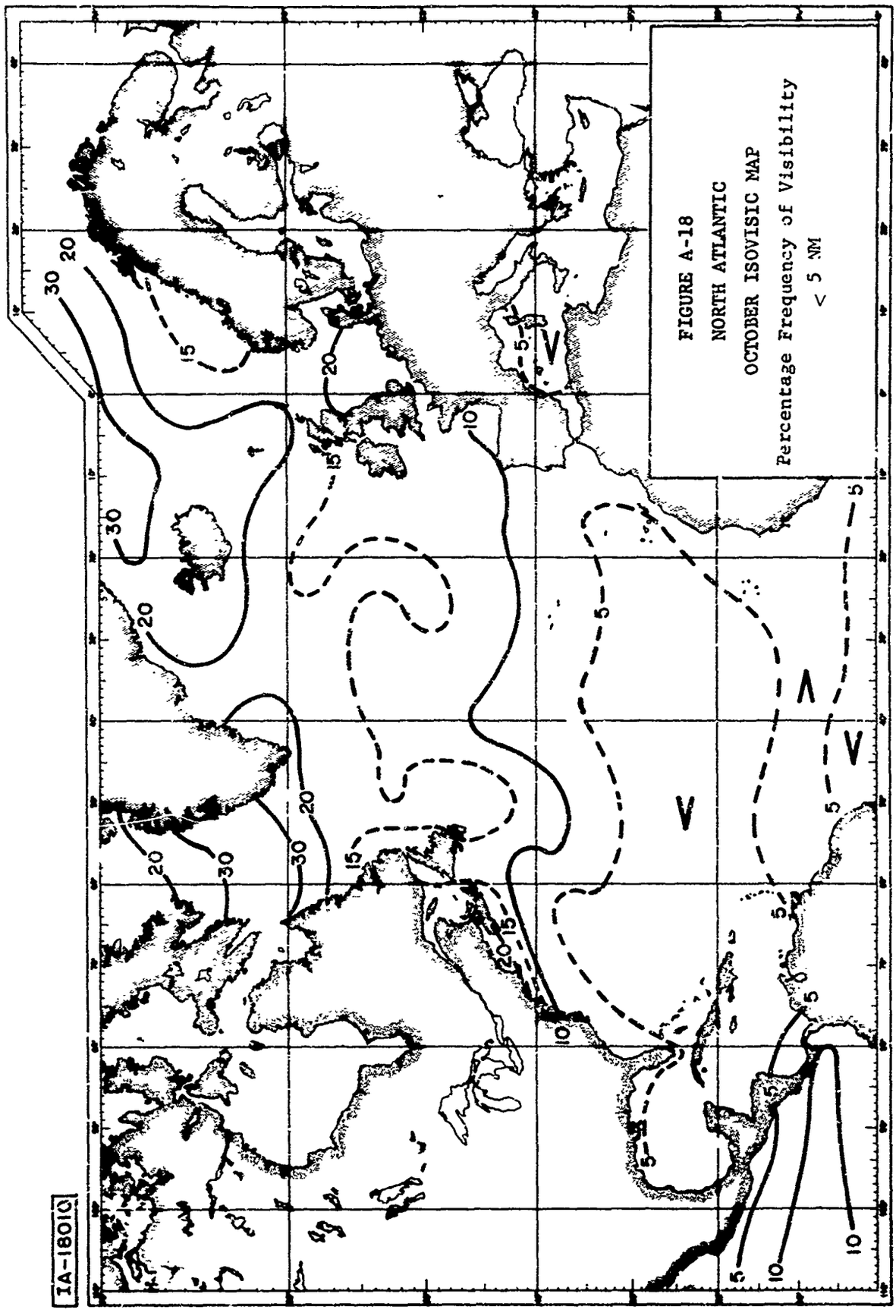


FIGURE A-18
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 5 NM
IA-18010

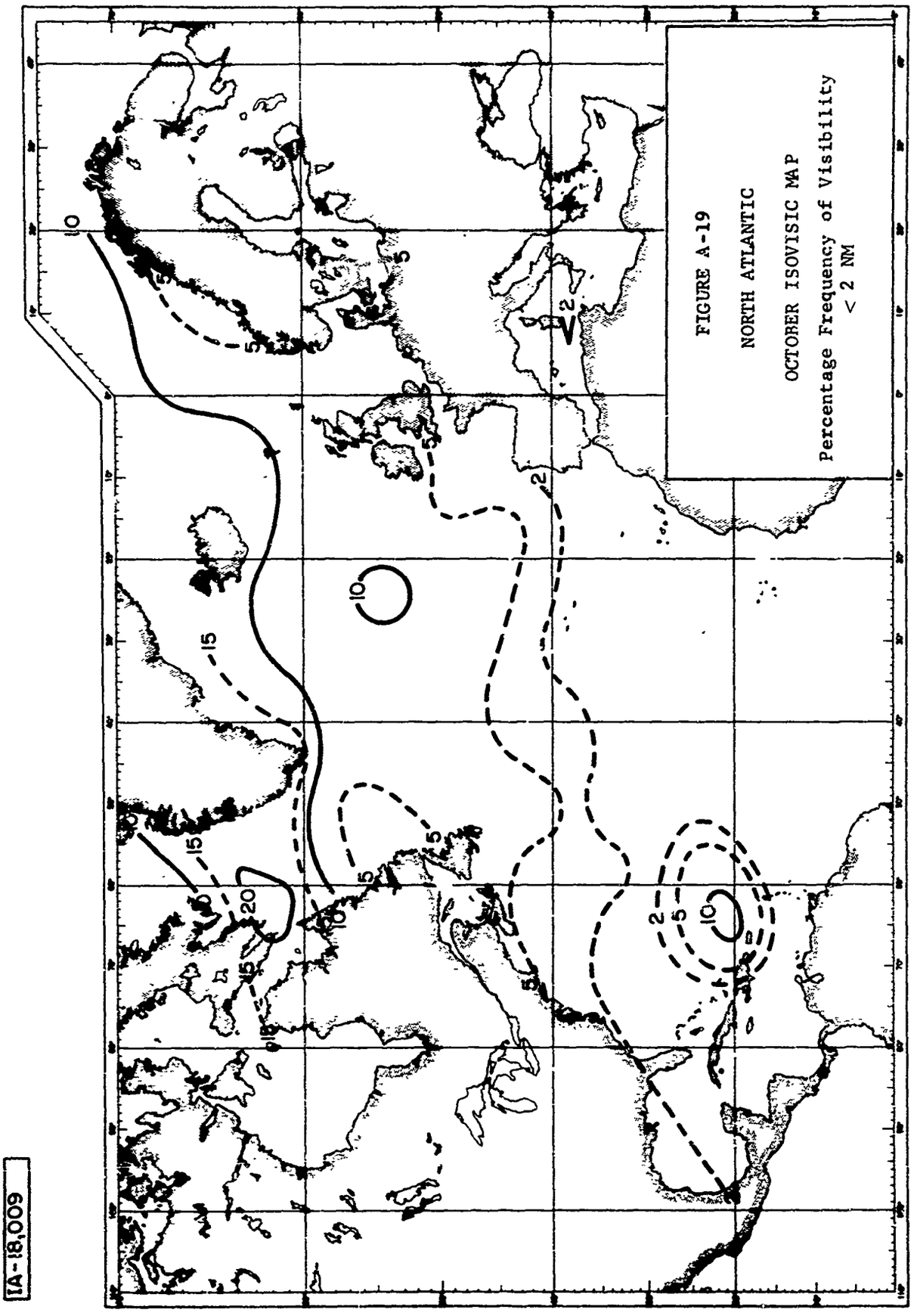


FIGURE A-19
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 2 NM
IA-18,009

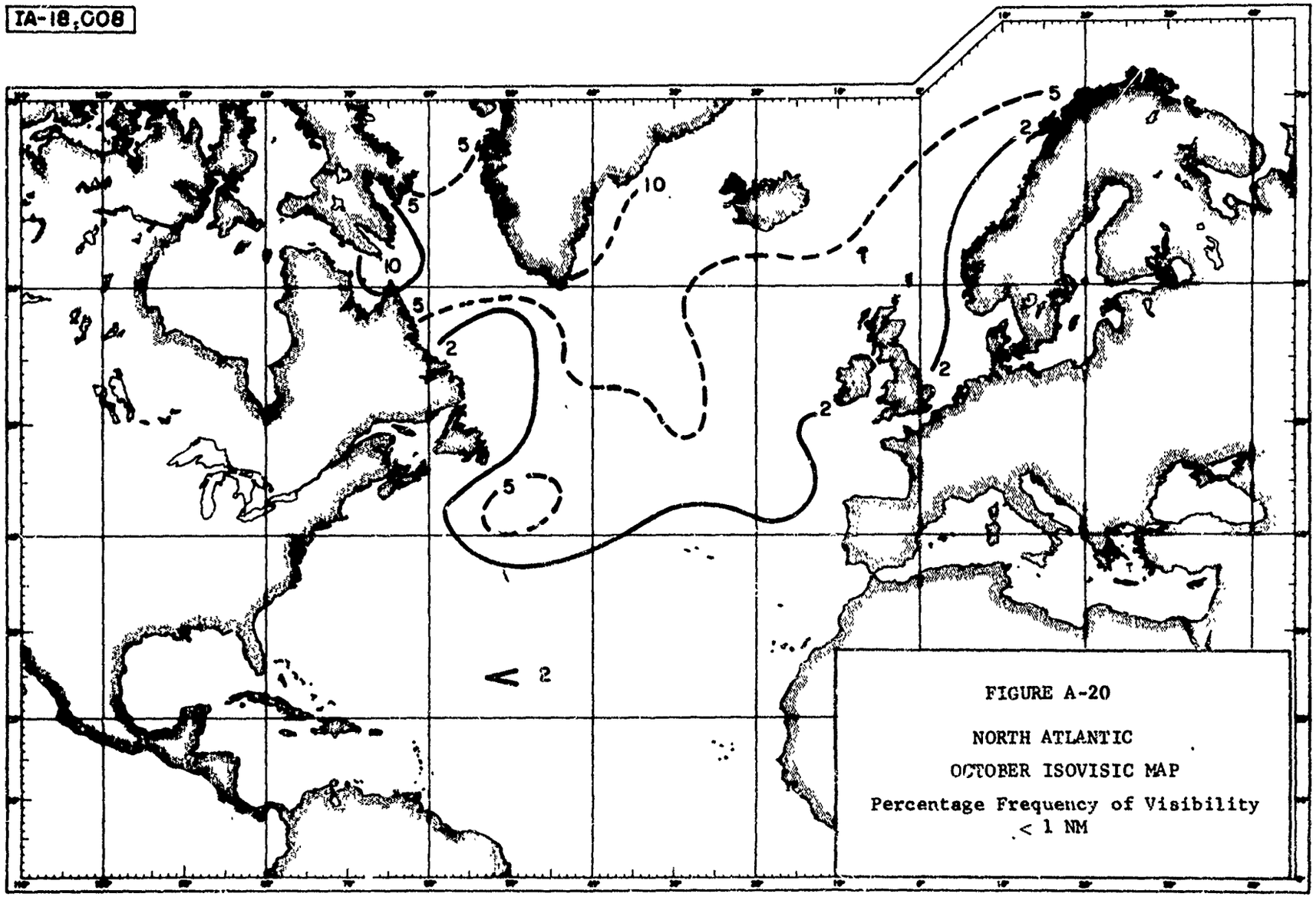


FIGURE A-20

NORTH ATLANTIC

OCTOBER ISOVISIC MAP

Percentage Frequency of Visibility
< 1 NM

IA-18,032

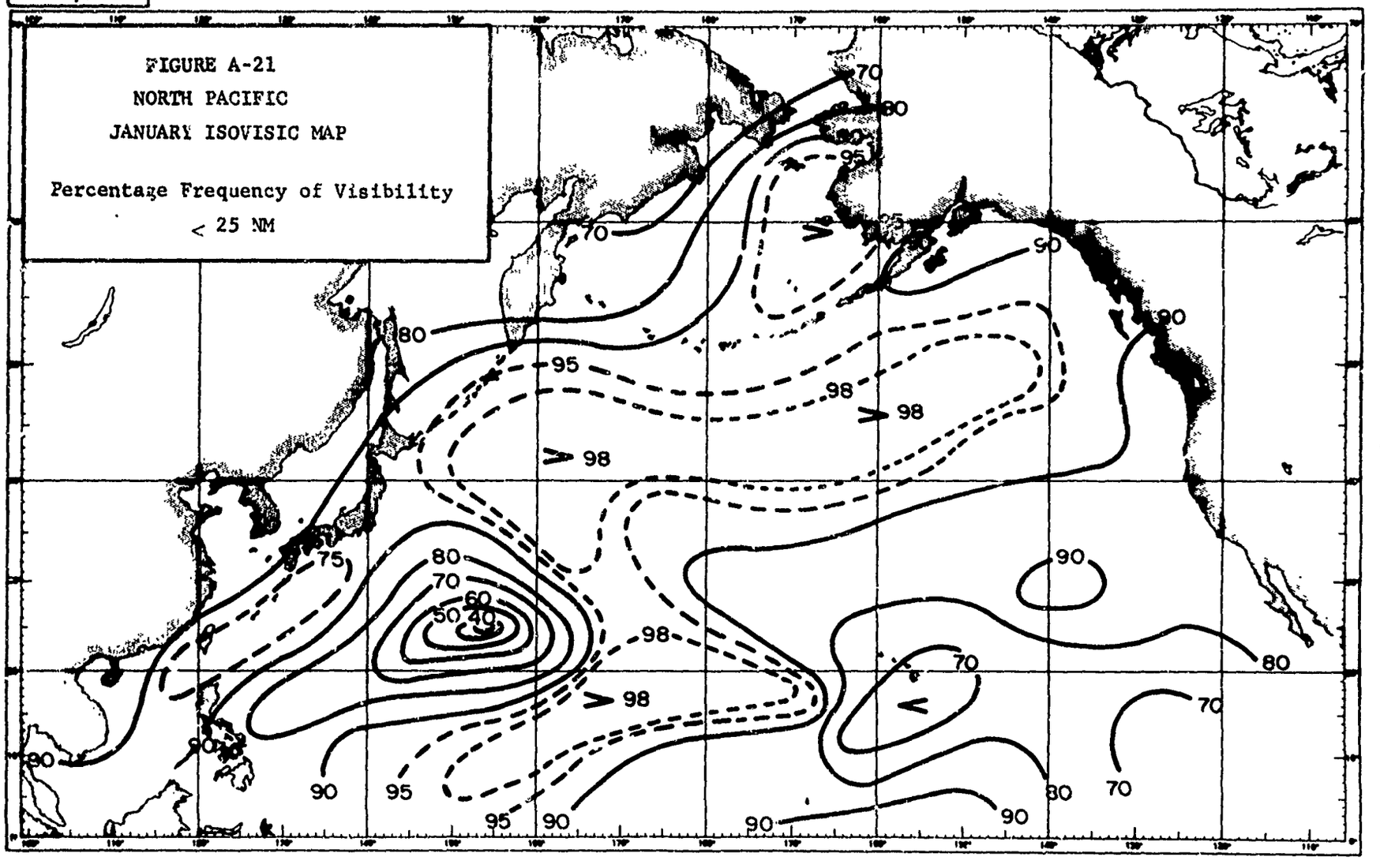


FIGURE A-21
NORTH PACIFIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM
70
80
95
90
98
75
60
50
40

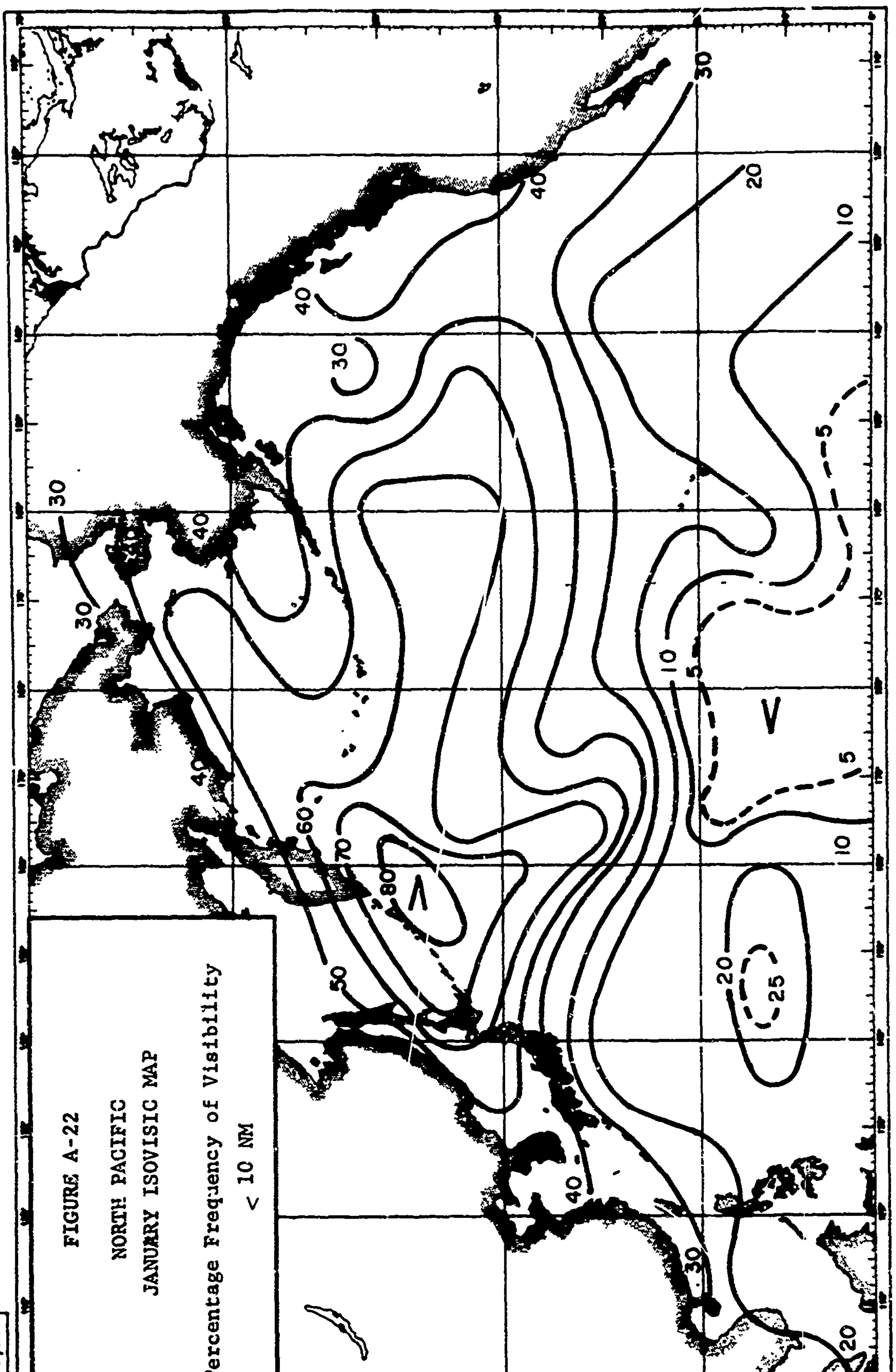


FIGURE A-22

NORTH PACIFIC

JANUARY ISOVISIC MAP

Percentage Frequency of Visibility

< 10 NM

IA-18,031

IA-18,030

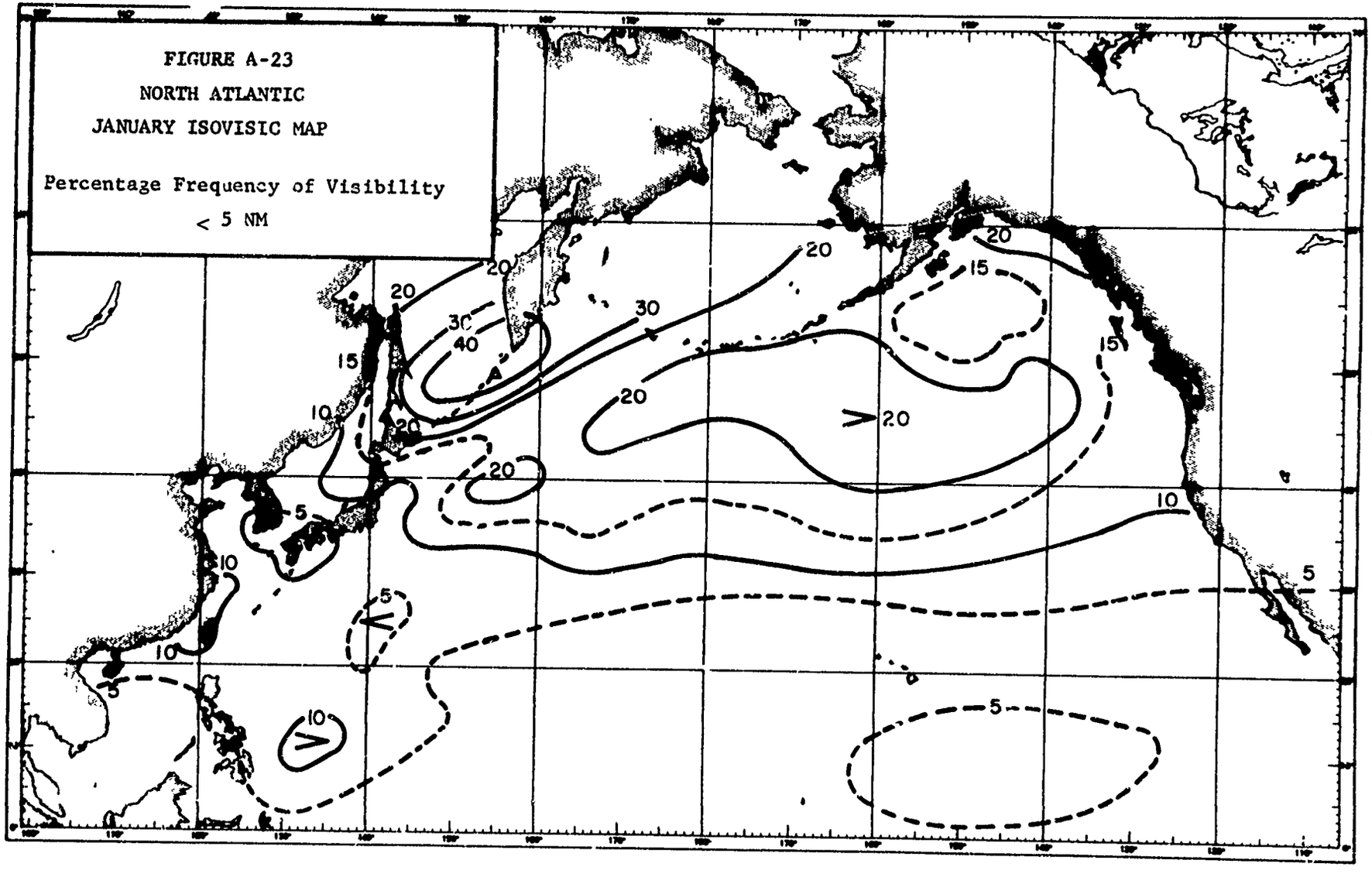


FIGURE A-23
NORTH ATLANTIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 5 NM
20
30
40
15
10
5
> 20

IA-18,029

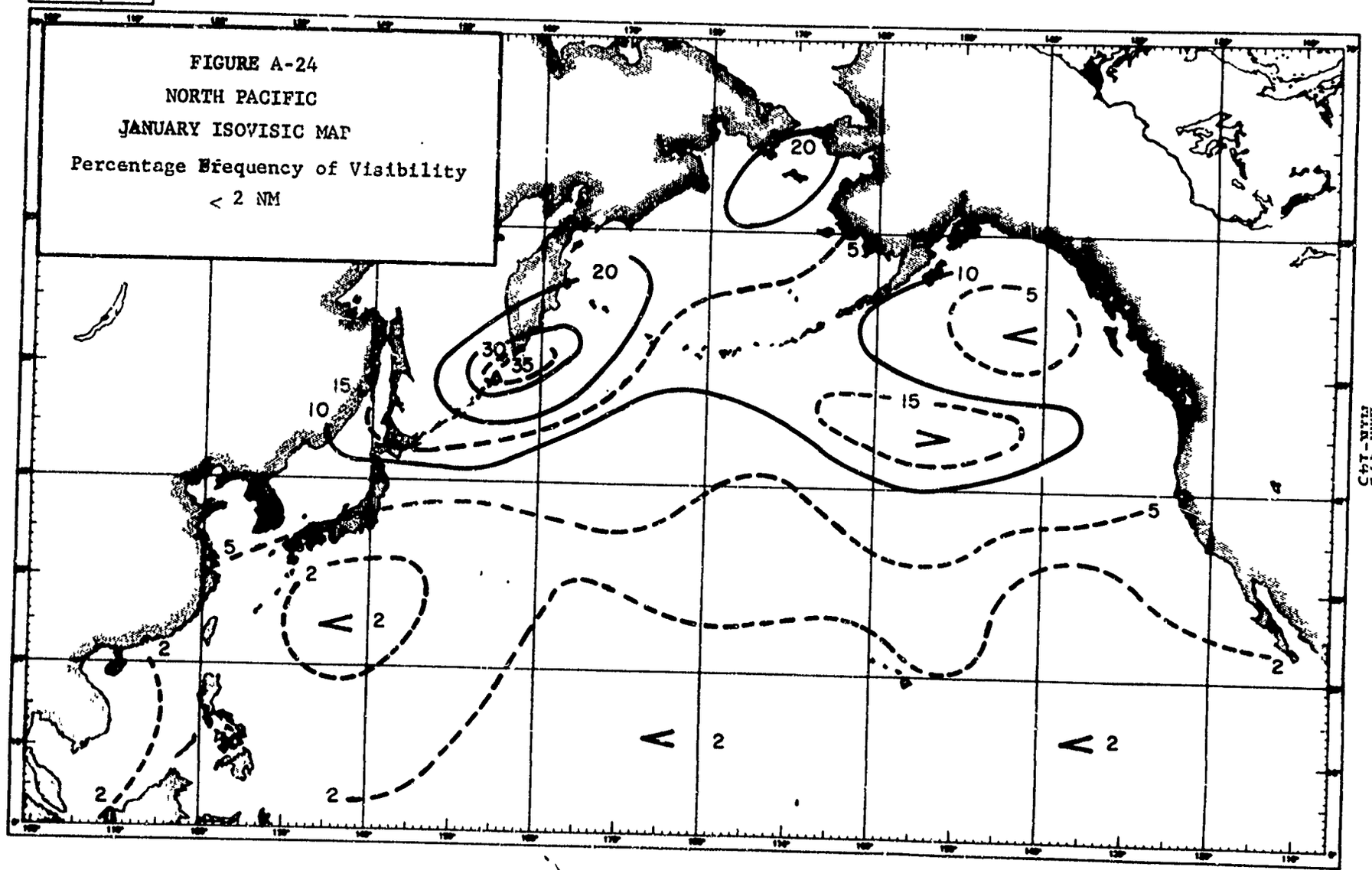


FIGURE A-24
NORTH PACIFIC
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 2 NM
20
20
5
10
5
30
35
15
10
15
5
5
2
2
2
2
2
2
2

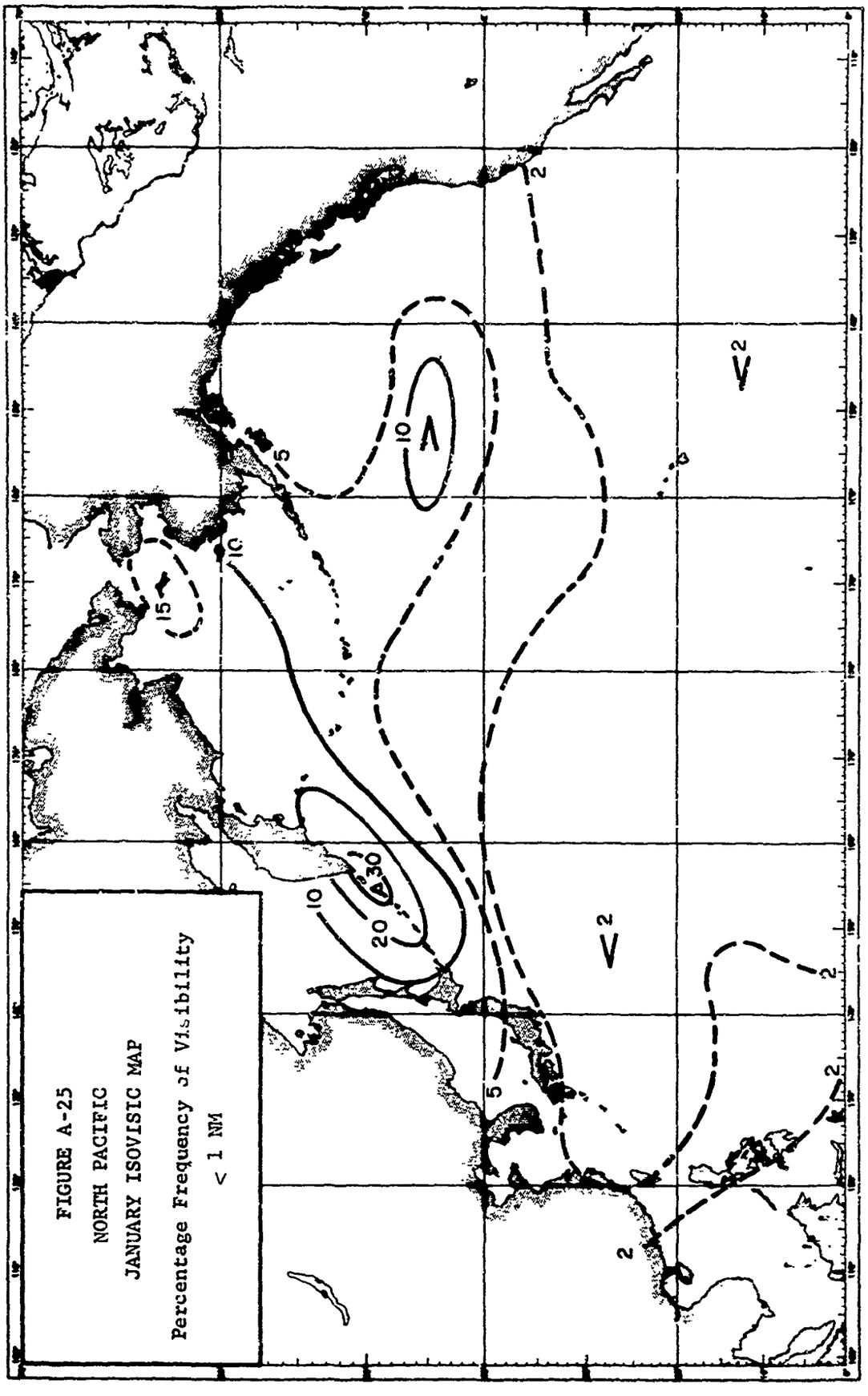
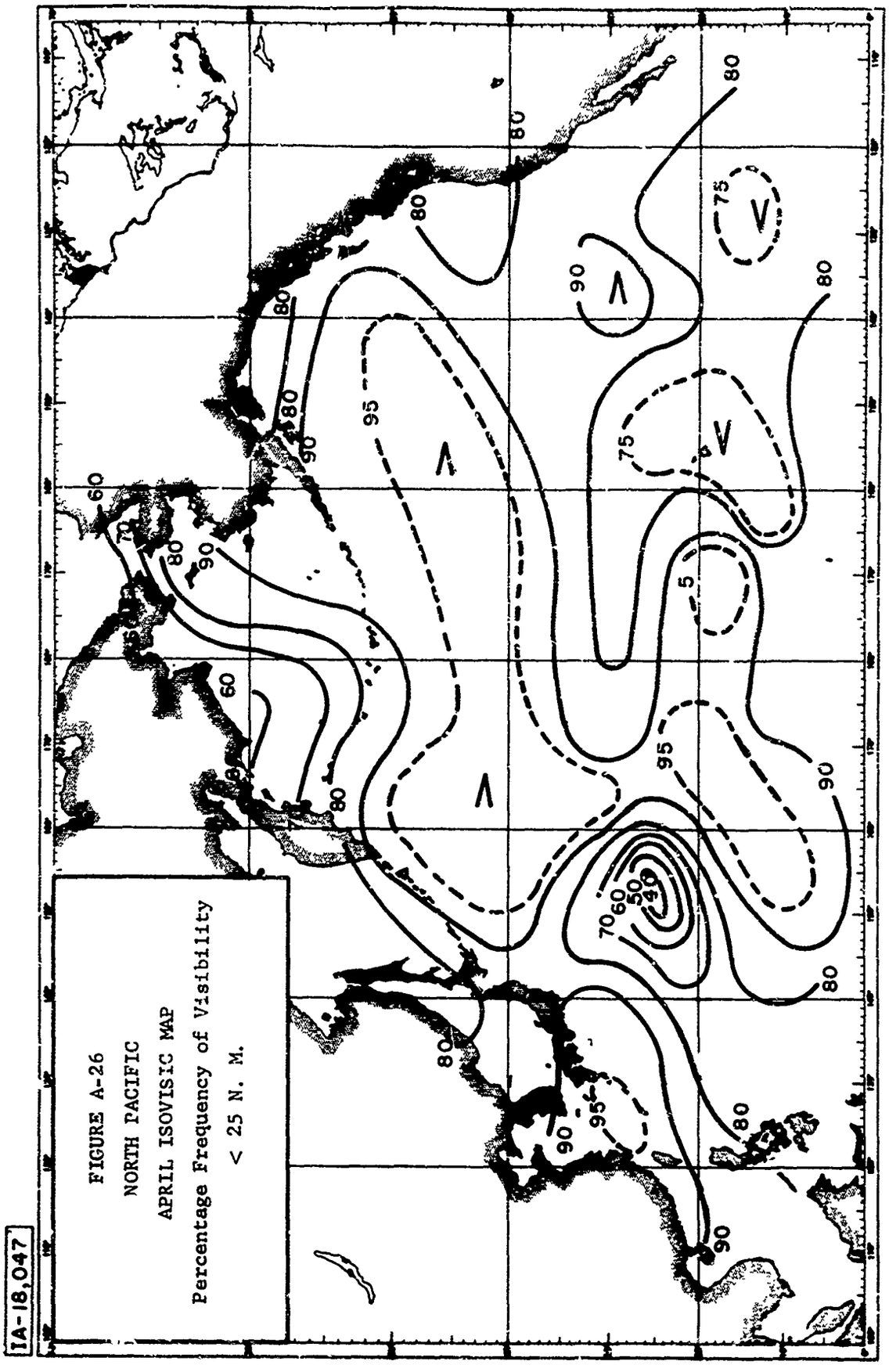


FIGURE A-25
NORTH PACIFIC
JANUARY ISOVISTIC MAP
Percentage Frequency of Visibility
< 1 NM
2
5
10
15
20
30
< 2


1A-18,047
FIGURE A-26
NORTH PACIFIC
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 25 N. M.

IA-18,046

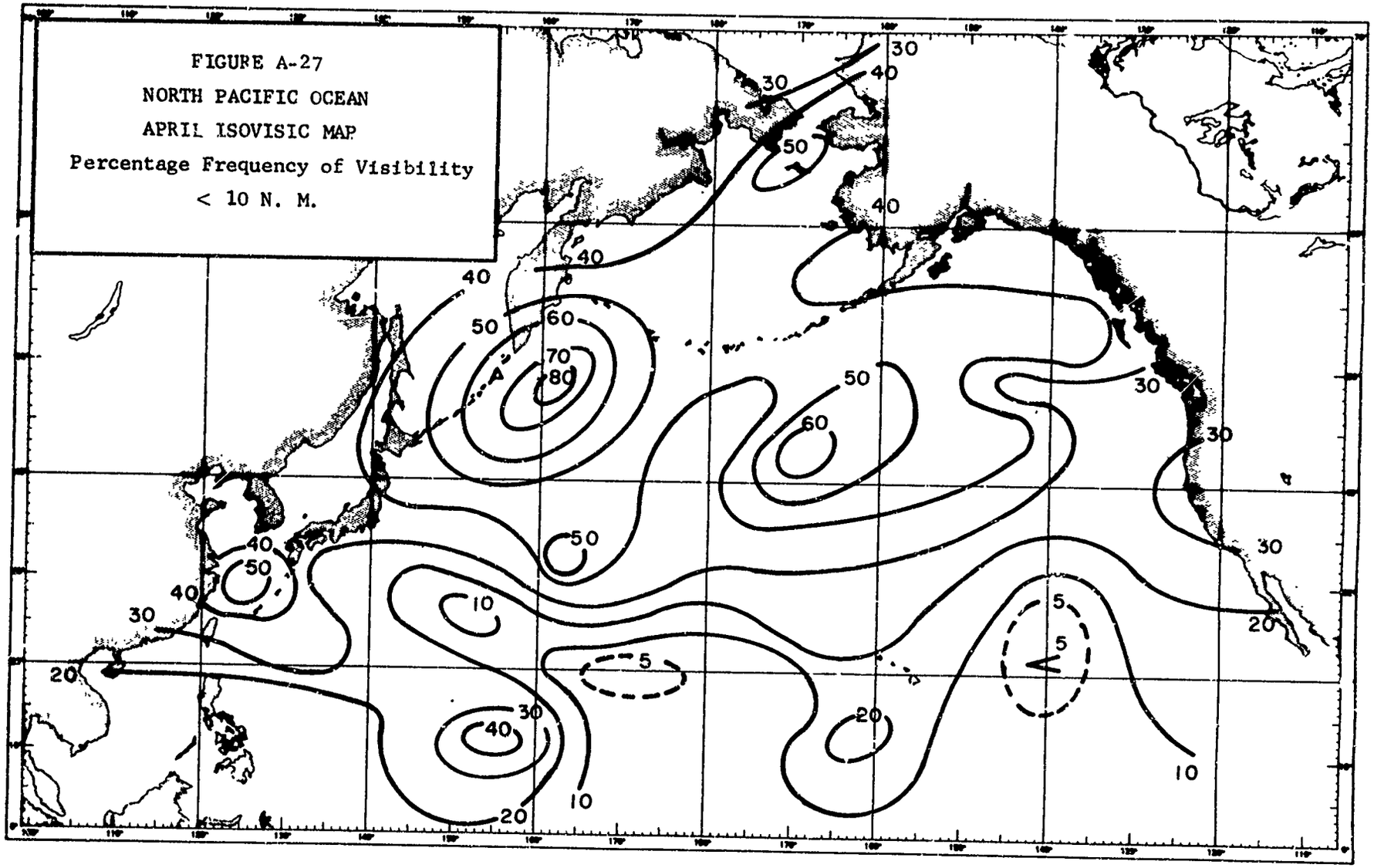
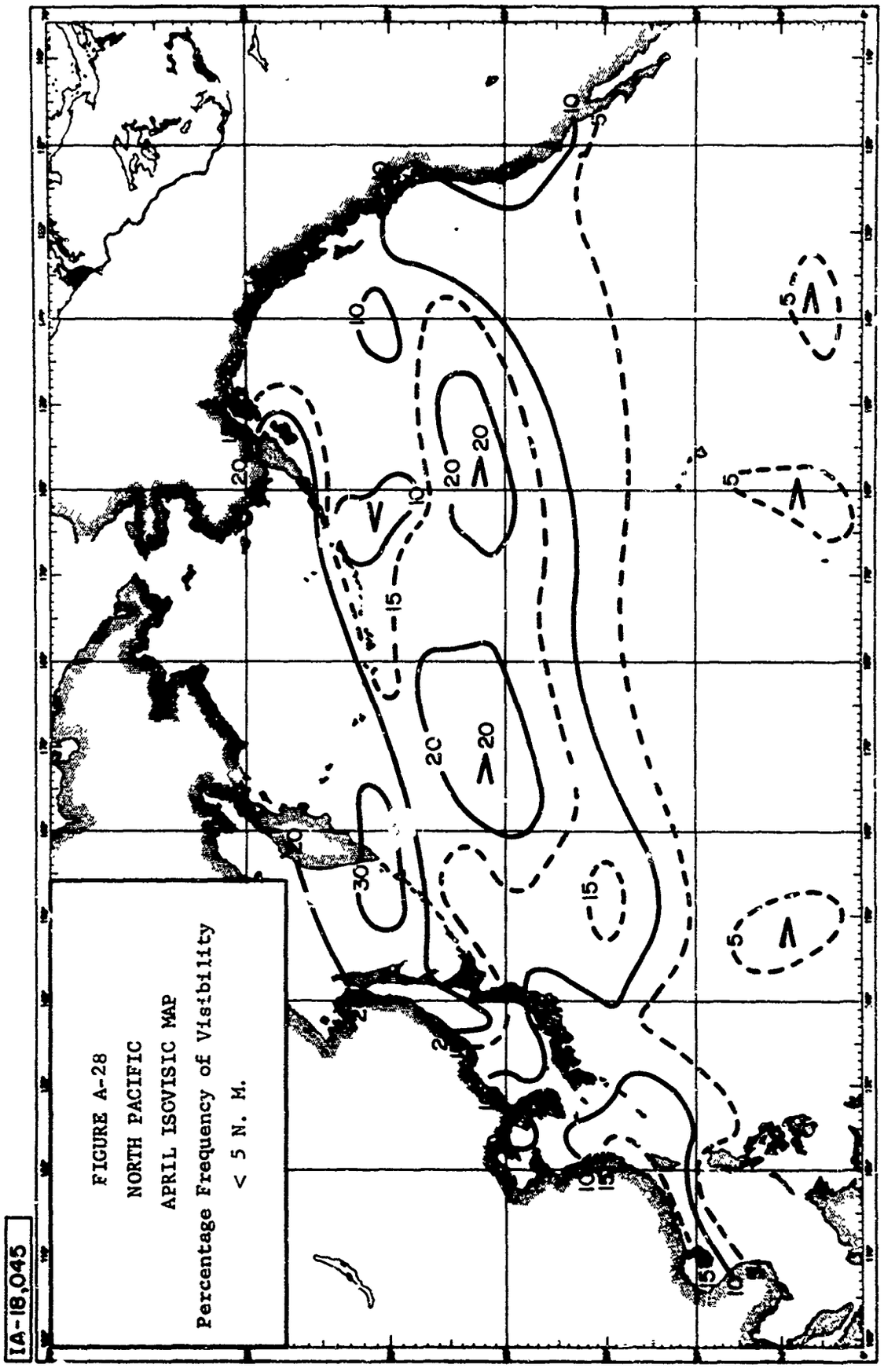
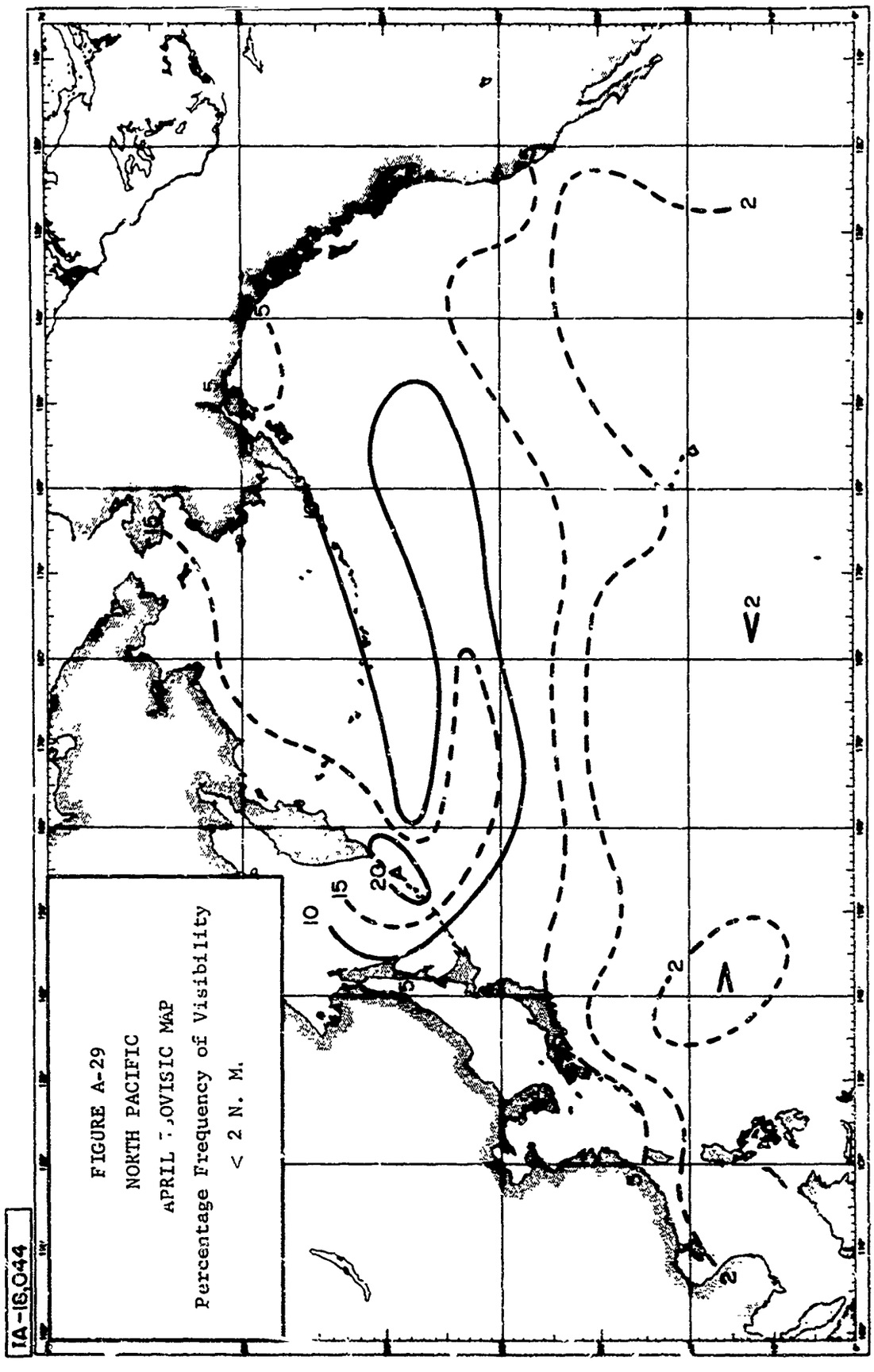


FIGURE A-27
NORTH PACIFIC OCEAN
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 10 N. M.
30
40
50
60
70
80
10
5
20
A


IA-18,045
FIGURE A-28
NORTH PACIFIC
APRIL ISCVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.
5
10
15
20
30
≥ 20


IA-16,044
FIGURE A-29
NORTH PACIFIC
APRIL METEOVISIC MAP
Percentage Frequency of Visibility
< 2 N. M.
2
5
10
15
20

IA-18,043

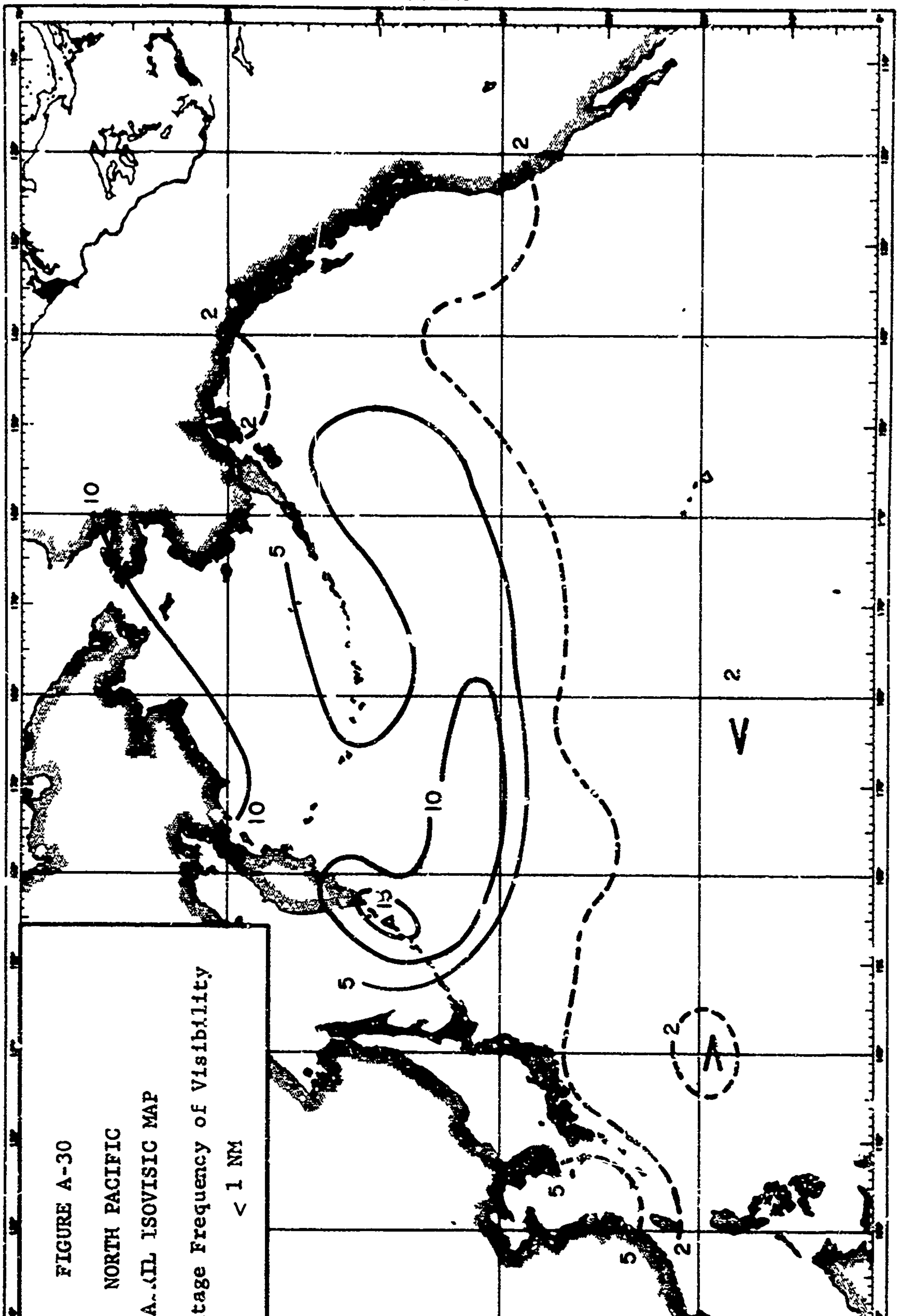
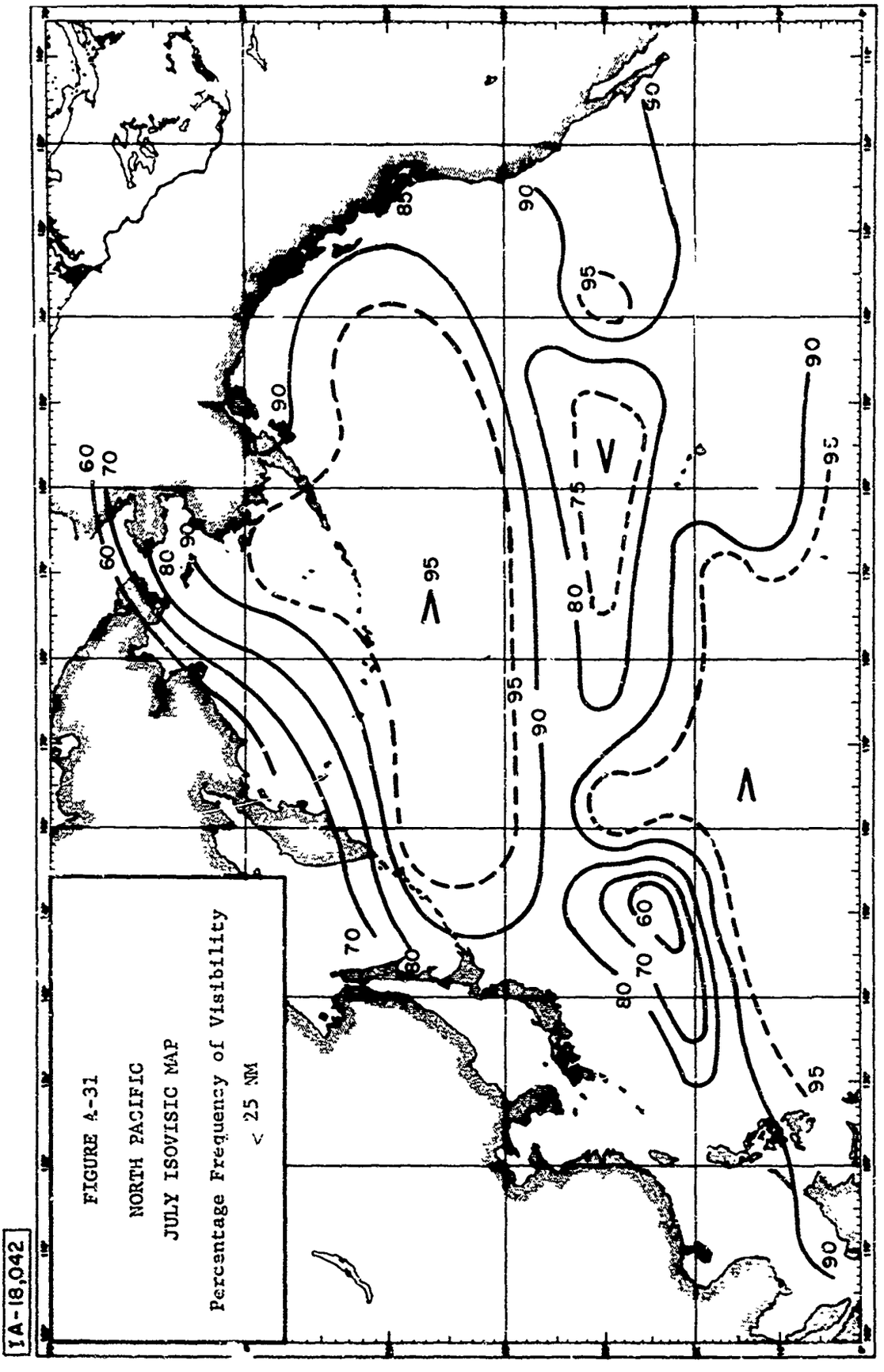
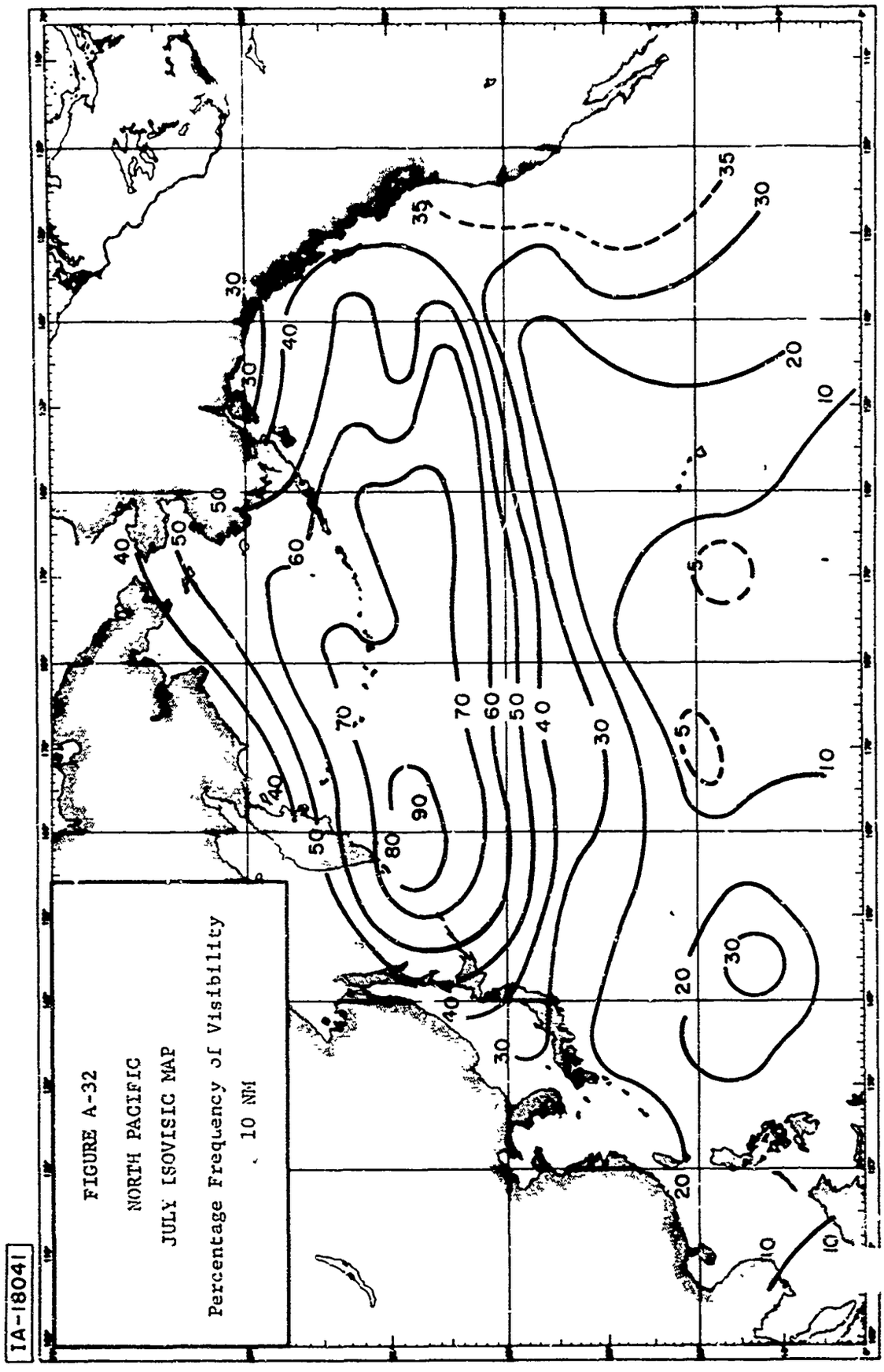
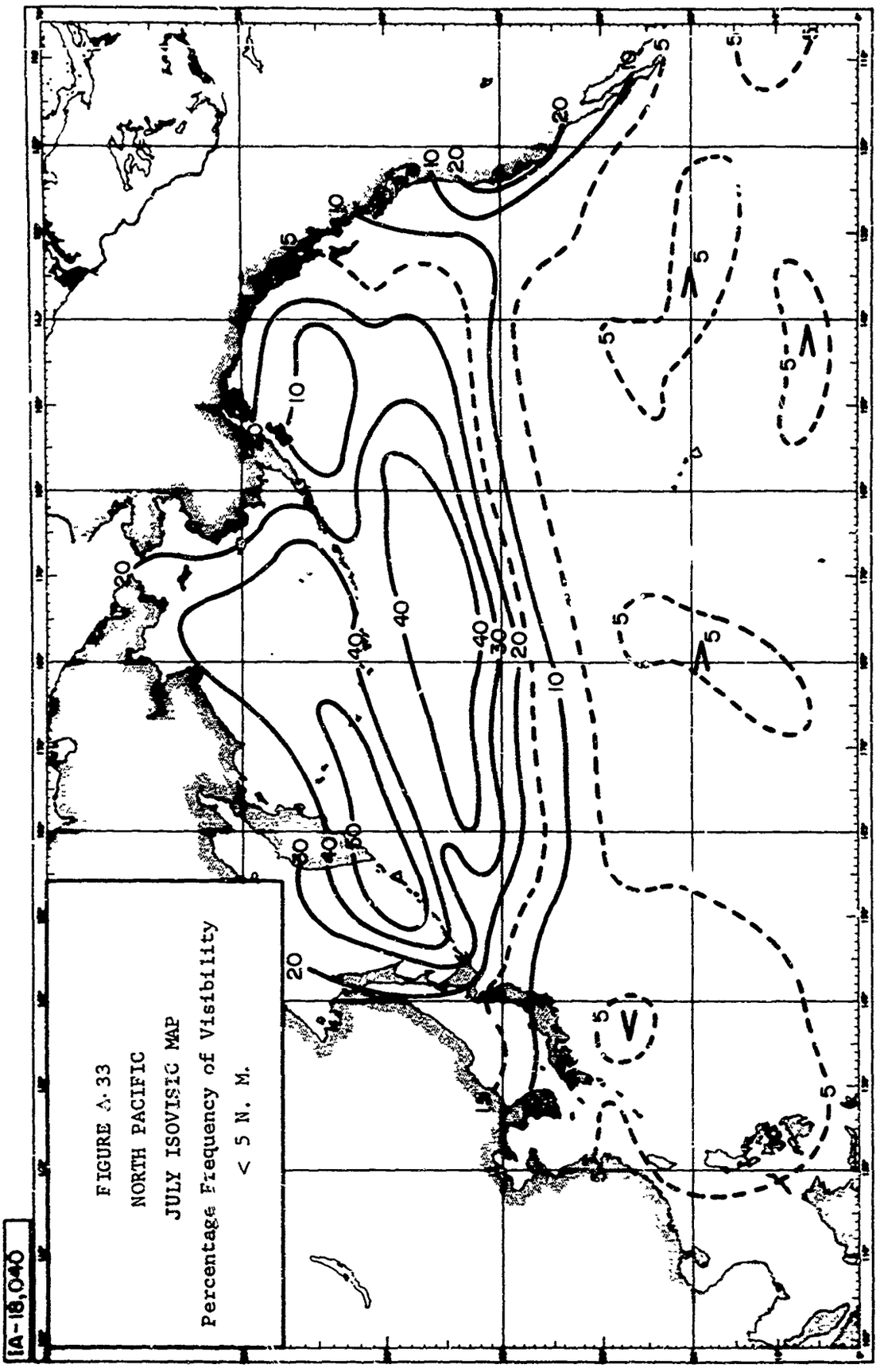
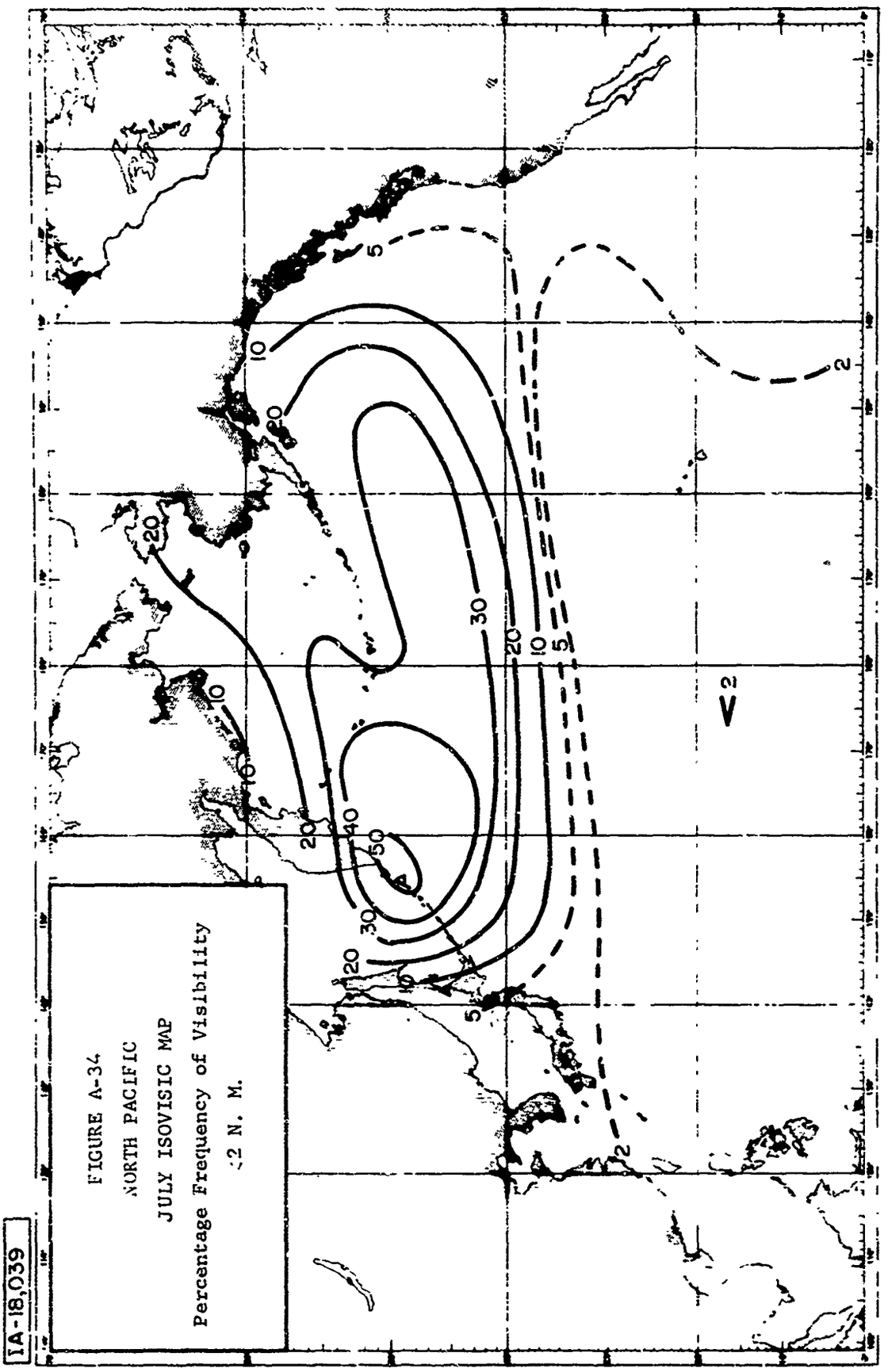


FIGURE A-30
NORTH PACIFIC
A..(IL ISOVISIC MAP
Percentage Frequency of Visibility
< 1 NM


IA-18,042
FIGURE A-31
NORTH PACIFIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM


IA-18041
FIGURE A-32
NORTH PACIFIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
10 NM


IA-18,040
FIGURE A-33
NORTH PACIFIC
JULY ISOVISTIC MAP
Percentage Frequency of Visibility
< 5 N. M.


IA-18,039
FIGURE A-34
NORTH PACIFIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
2 N. M.
V2

IA-18,038

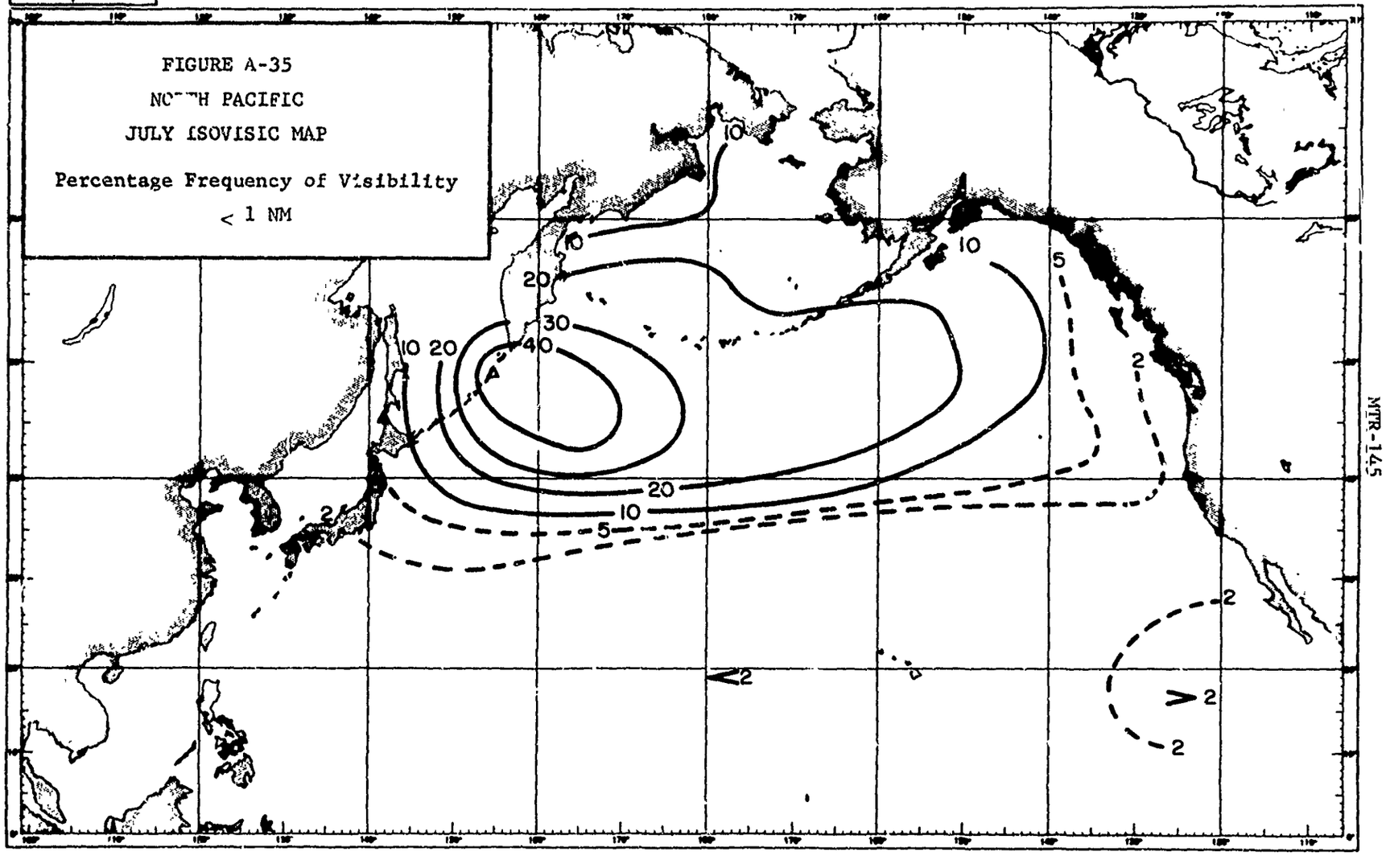
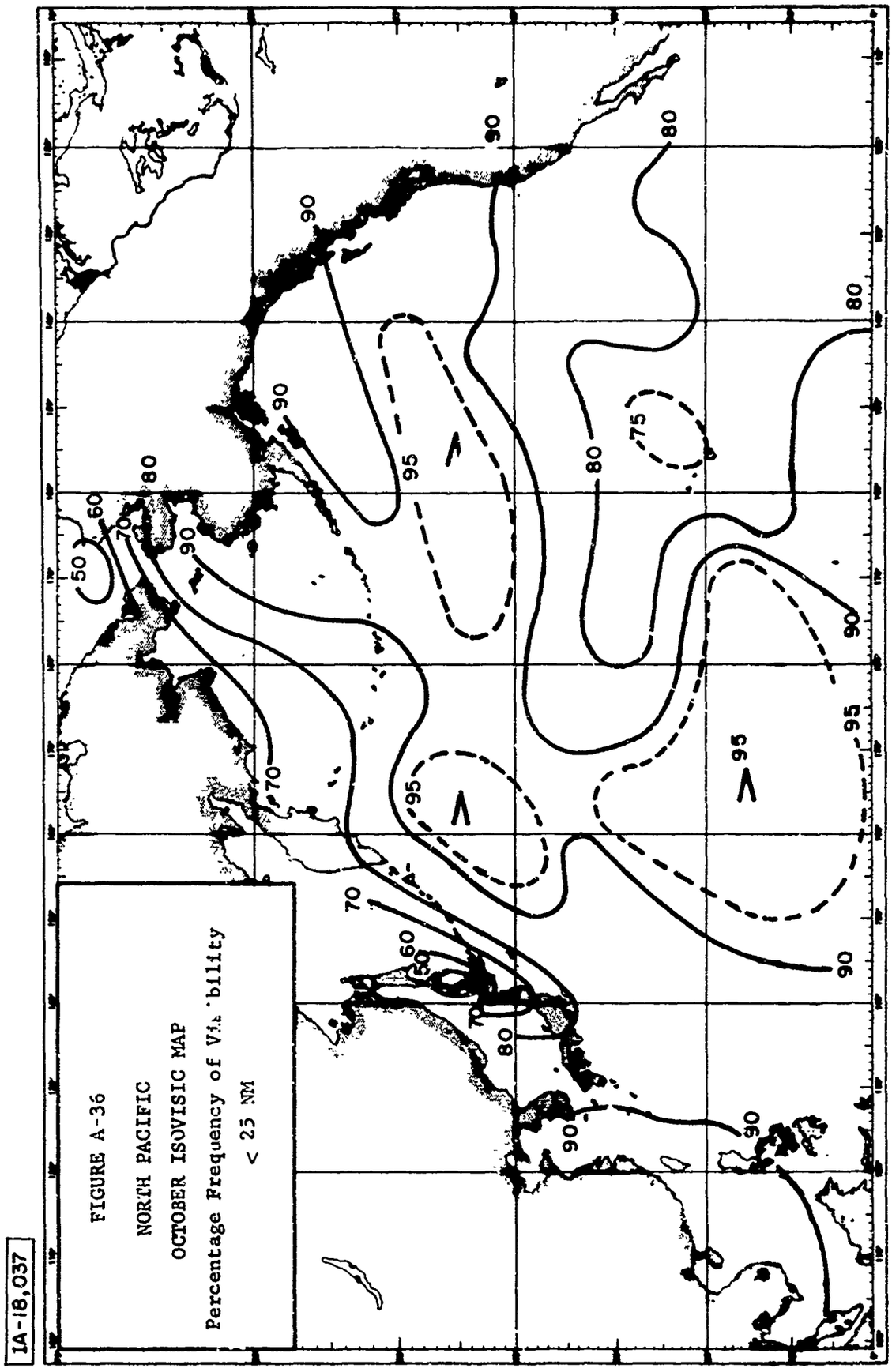


FIGURE A-35
NORTH PACIFIC
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 1 NM
10
10
20
30
40
10 20
10
5
2
20
10
5
2
2
<2
2
>2
2


IA-18,037
FIGURE A-36
NORTH PACIFIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM

IA-18,036

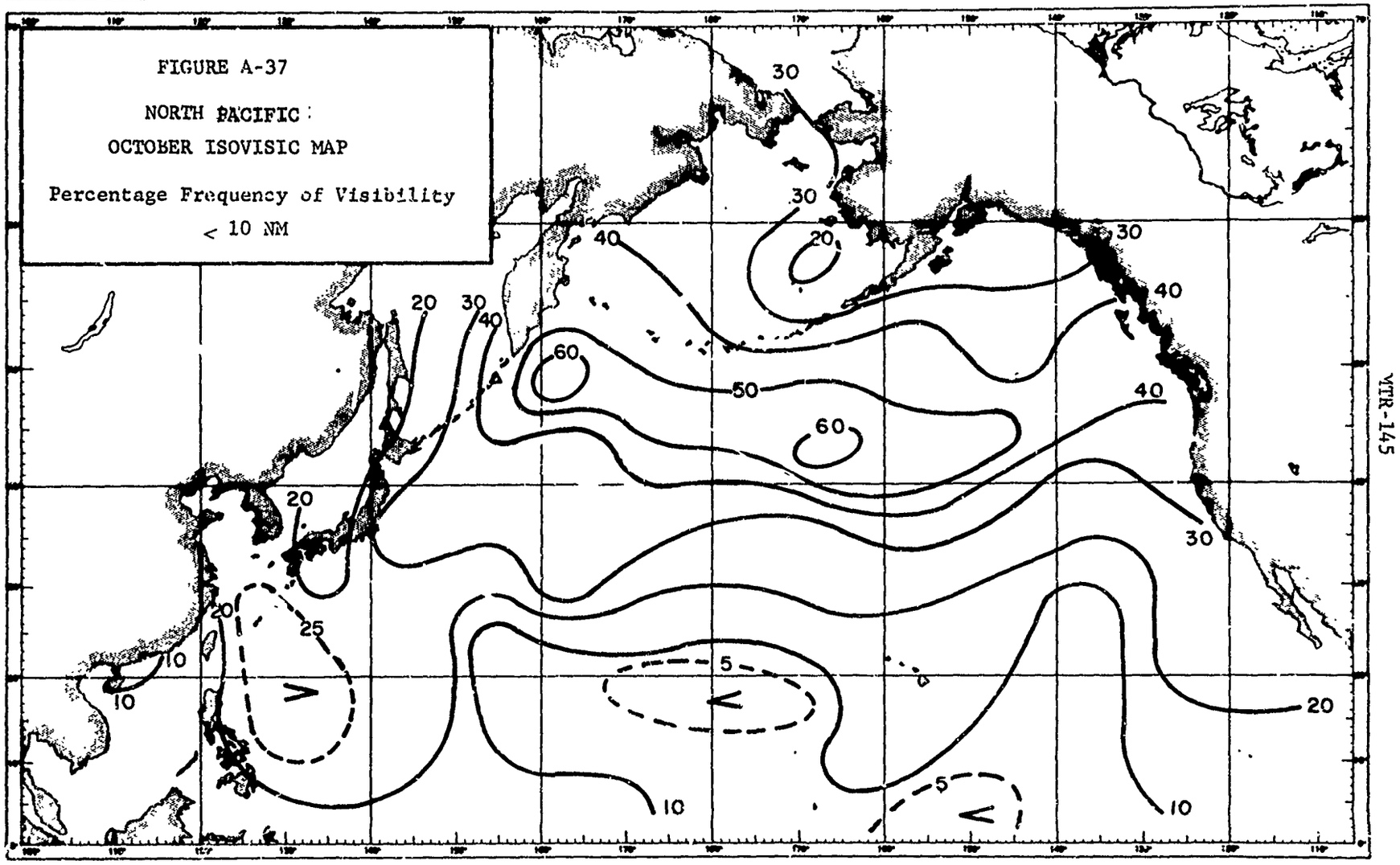


FIGURE A-37
NORTH PACIFIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 10 NM
30
30
40
20
30
40
60
50
40
60
20
30
20
25
10
10
5
5
20
10
10

IA-18,035

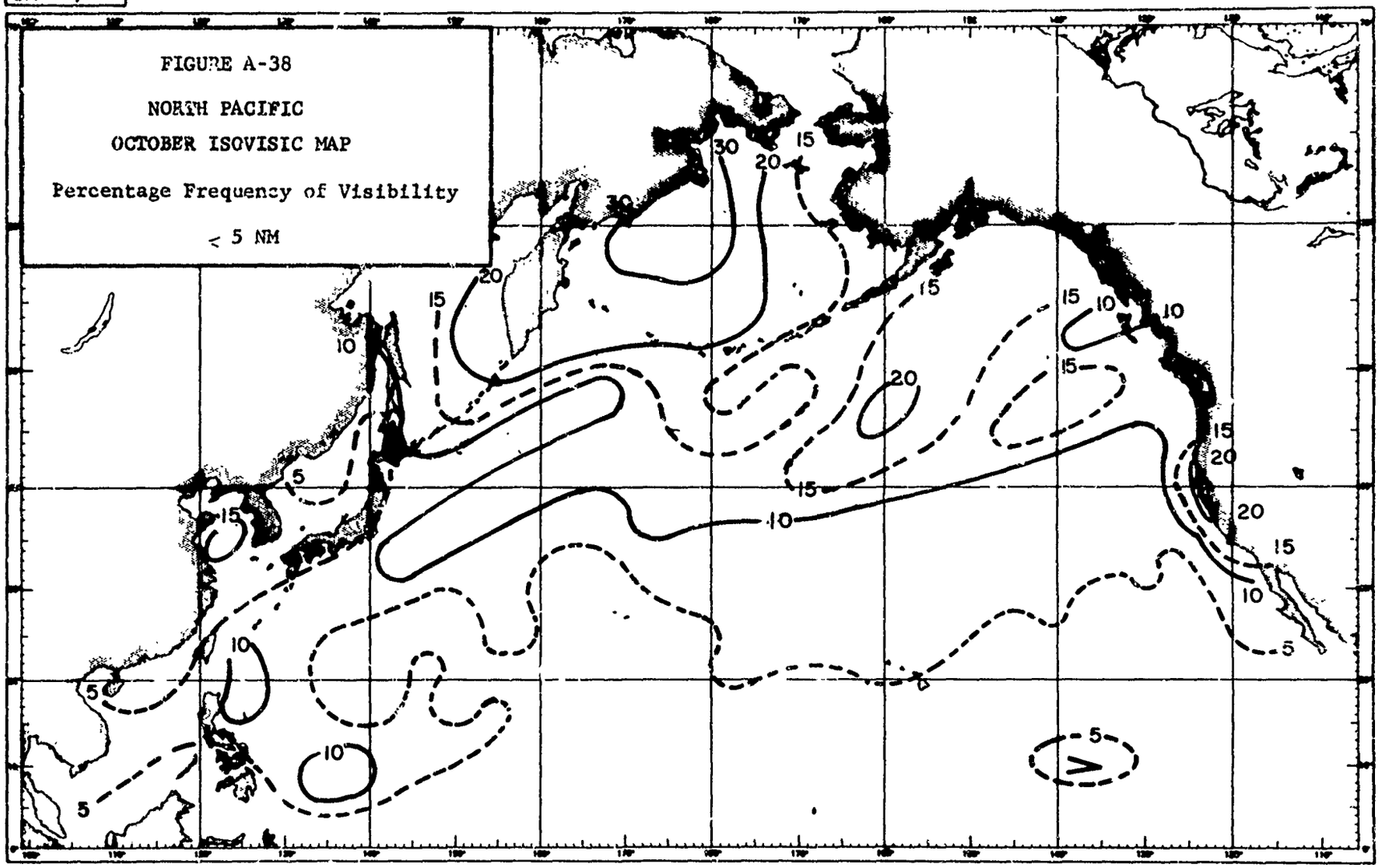


FIGURE A-38
NORTH PACIFIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 5 NM
30
20
15
10
5
<5

TA-18,034

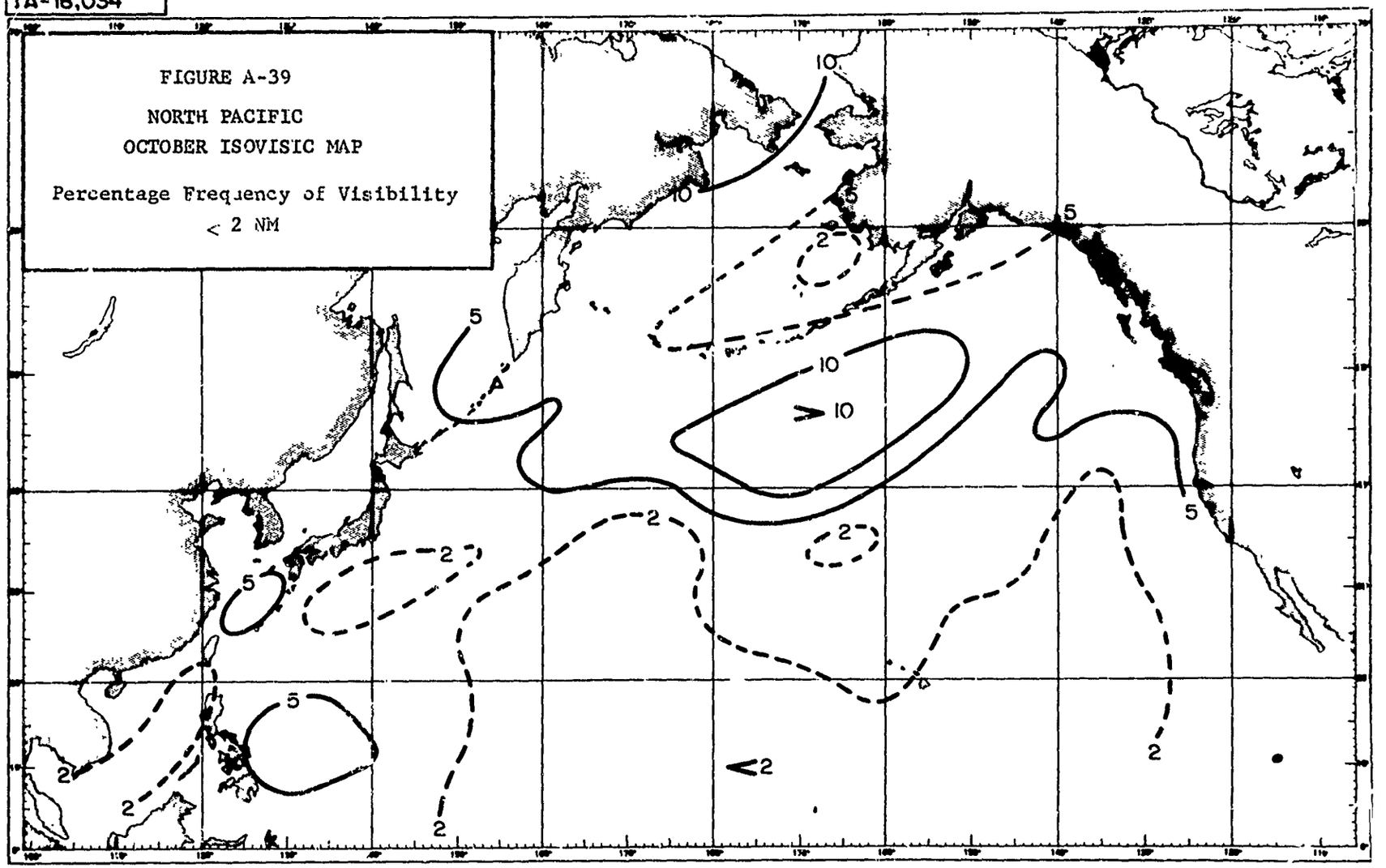


FIGURE A-39
NORTH PACIFIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 2 NM
10
10
5
5
2
5
10
> 10
5
2
2
5
2
2
5
2
2
<2

IA-18,033

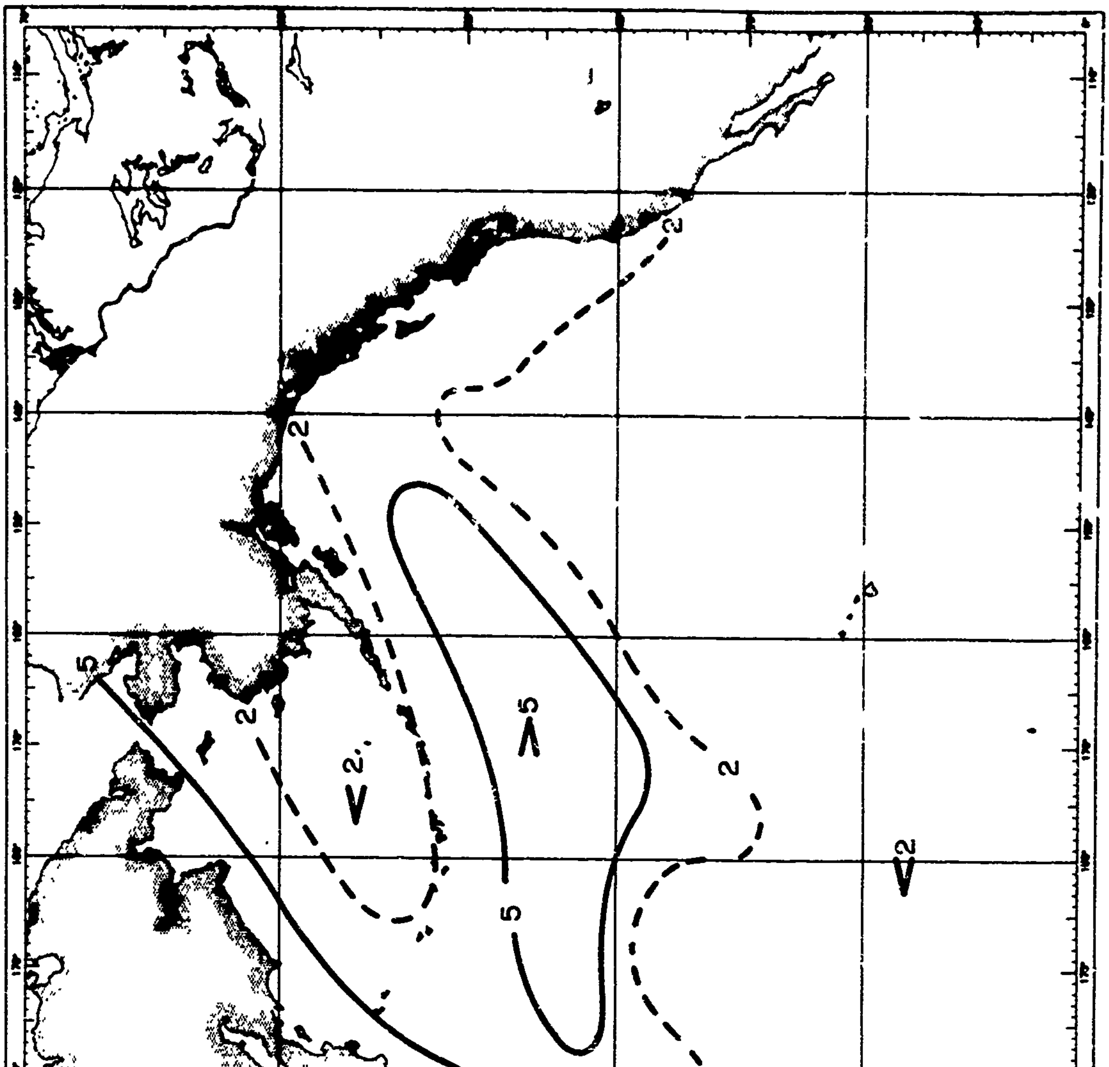


FIGURE A -40
NORTH PACIFIC
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 1 NM

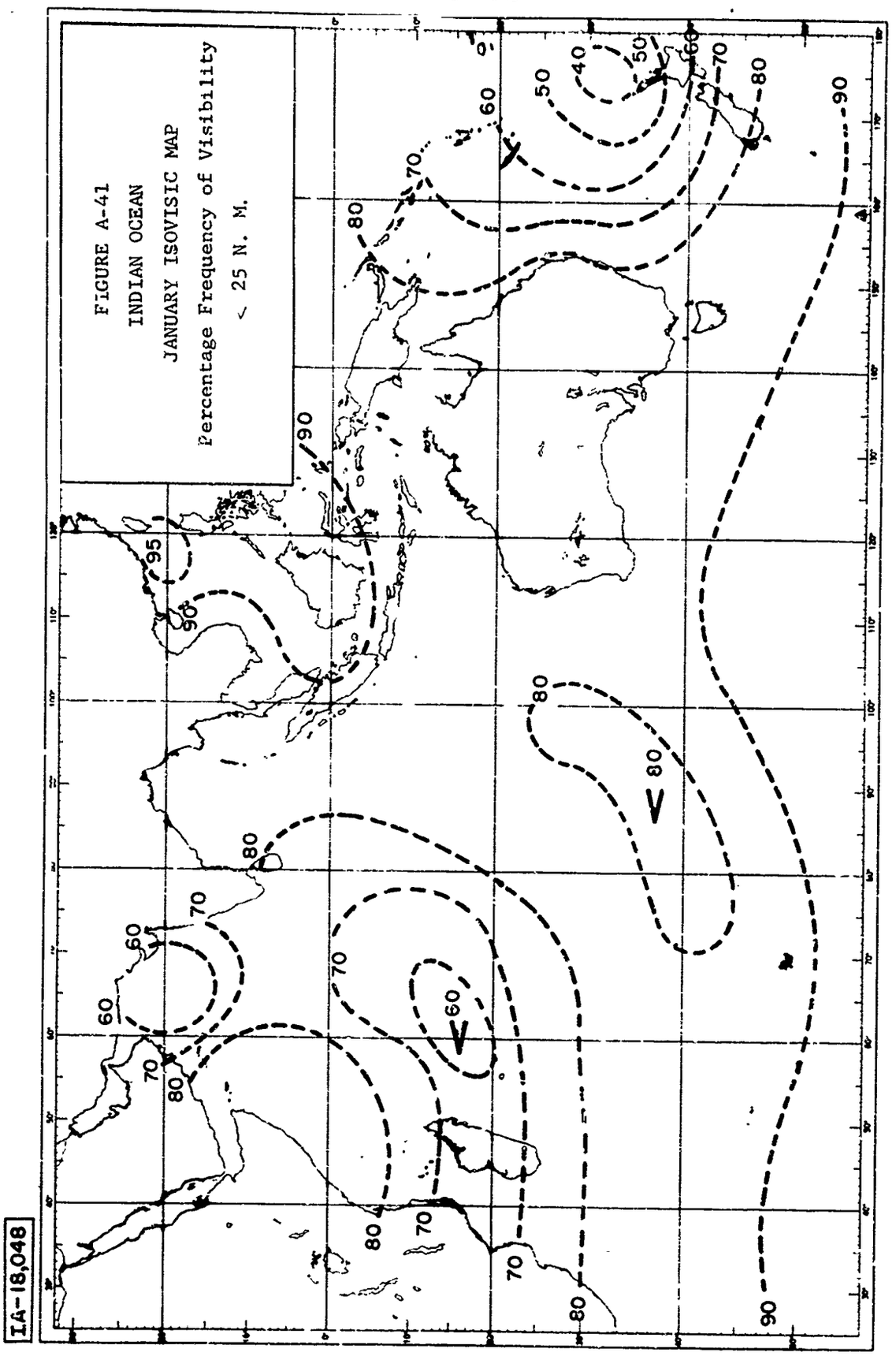


FIGURE A-41
INDIAN OCEAN
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 N. M.
IA-18,048

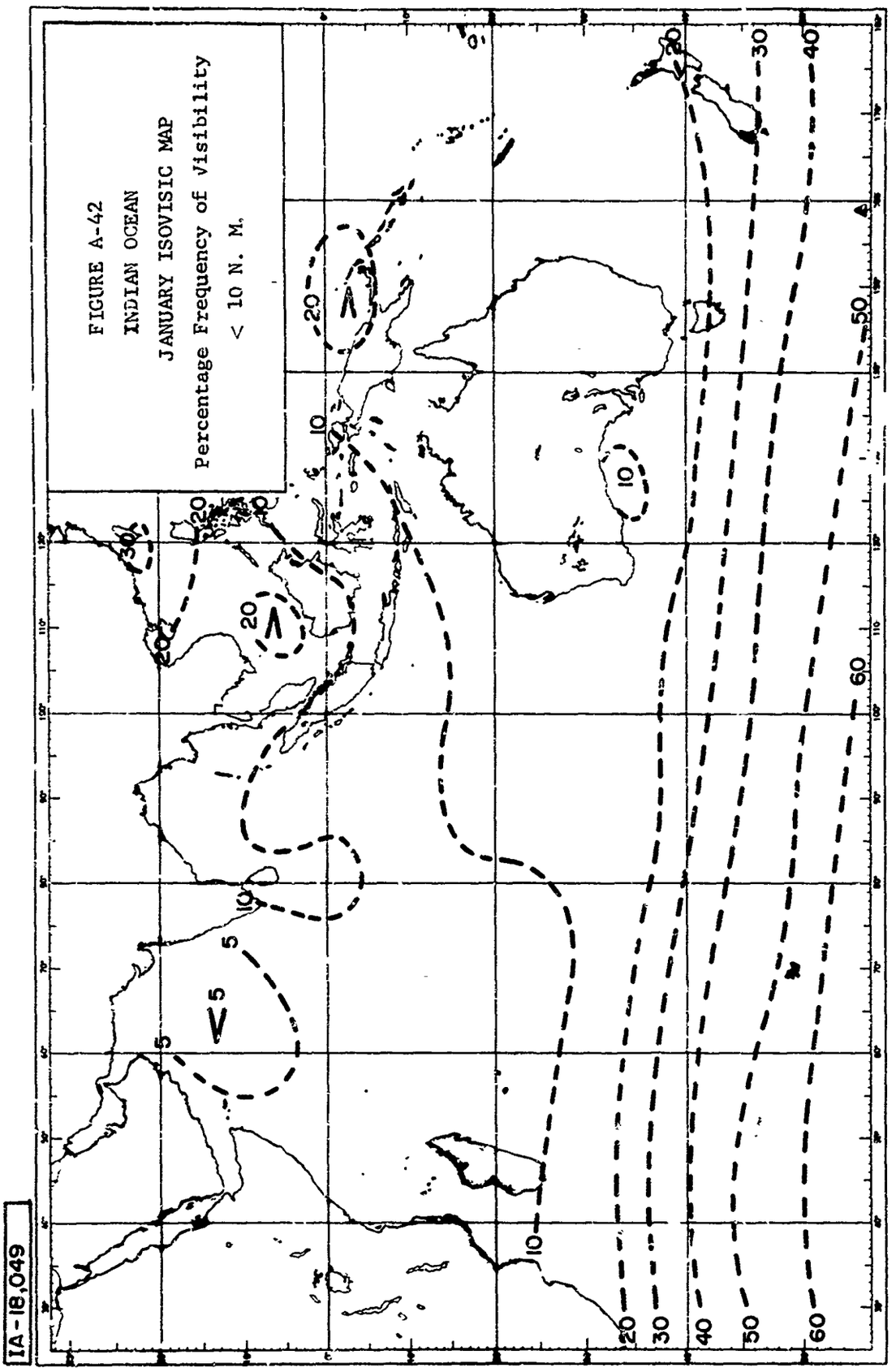


FIGURE A-42
INDIAN OCEAN
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 10 N. M.
IA-18,049

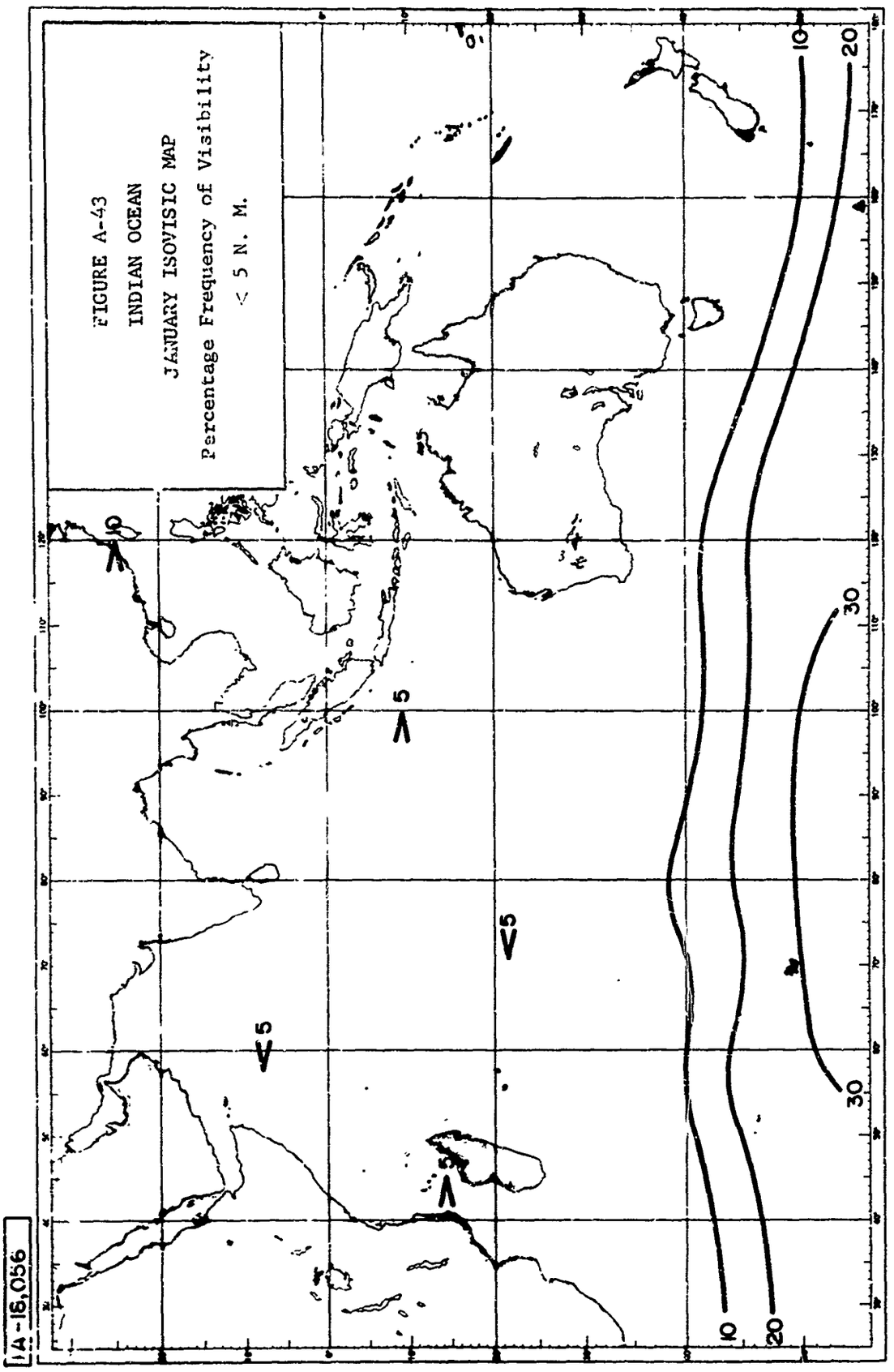


FIGURE A-43
INDIAN OCEAN
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.
10
20
30
5
14-16,056

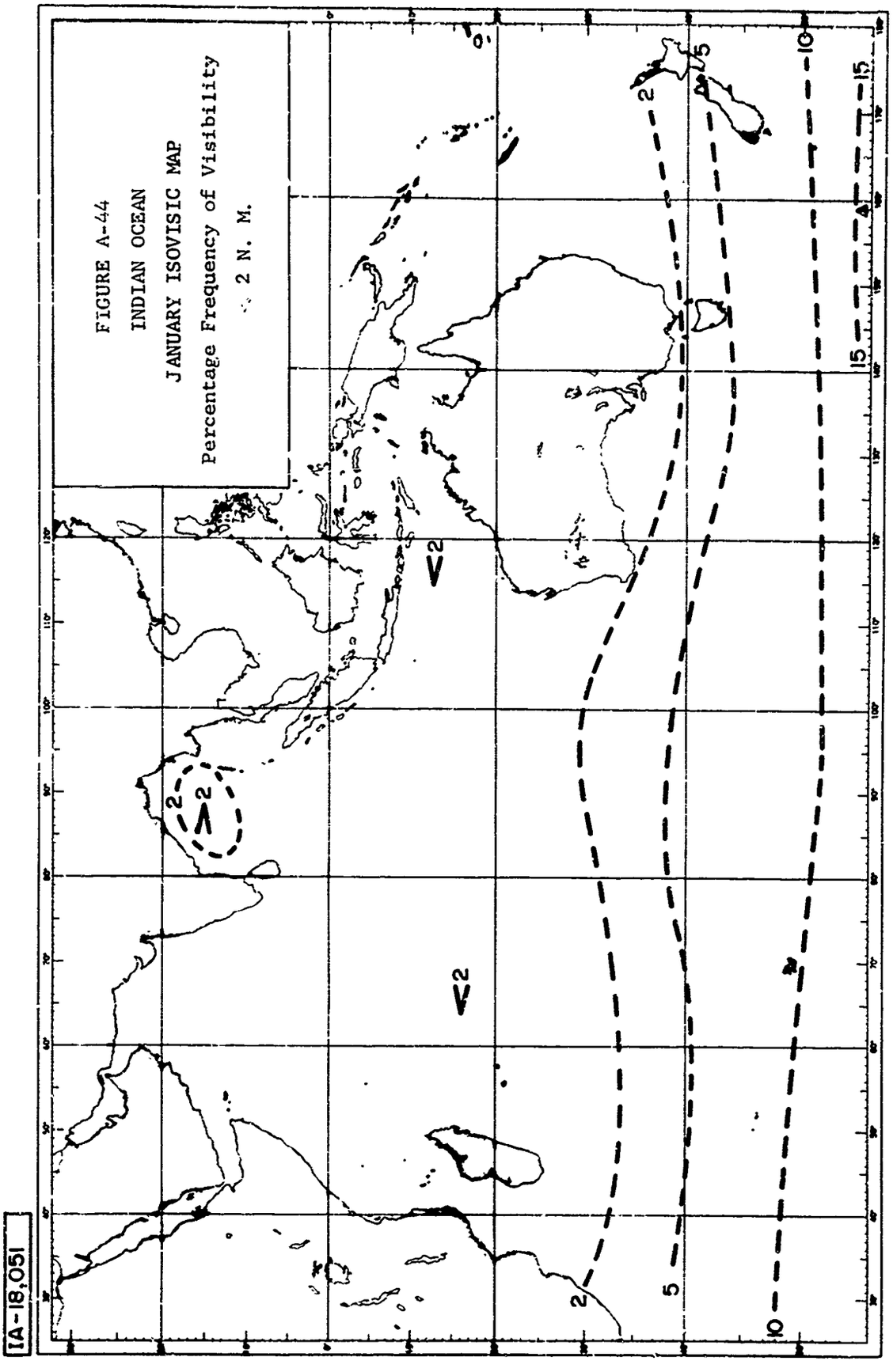


FIGURE A-44
INDIAN OCEAN
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
≥ 2 N. M.
IA-18,051
≥2
≥2
2
5
10
15

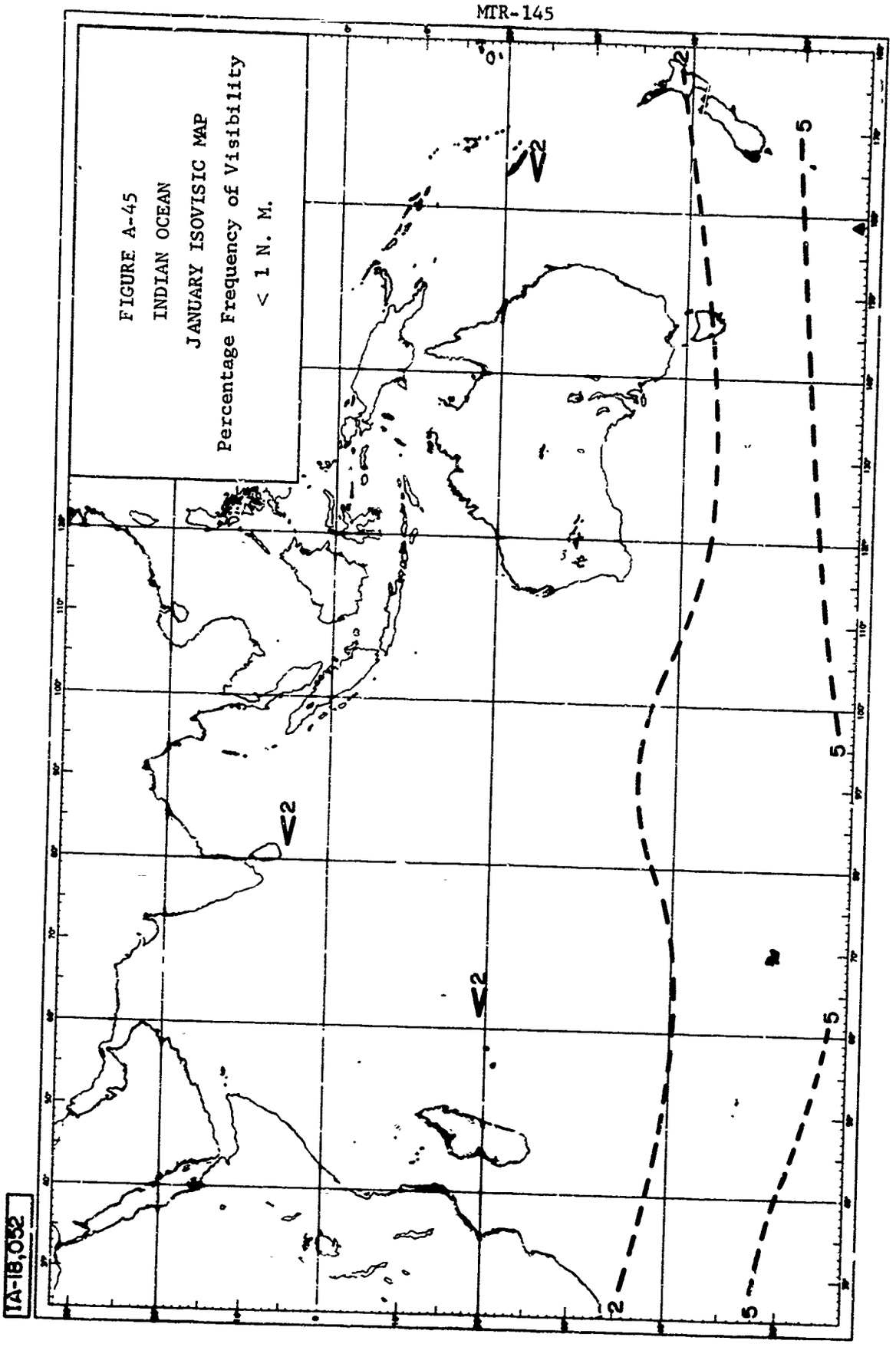


FIGURE A-45
INDIAN OCEAN
JANUARY ISOVISIC MAP
Percentage Frequency of Visibility
< 1 N. M.
2
5
ITA-18,052

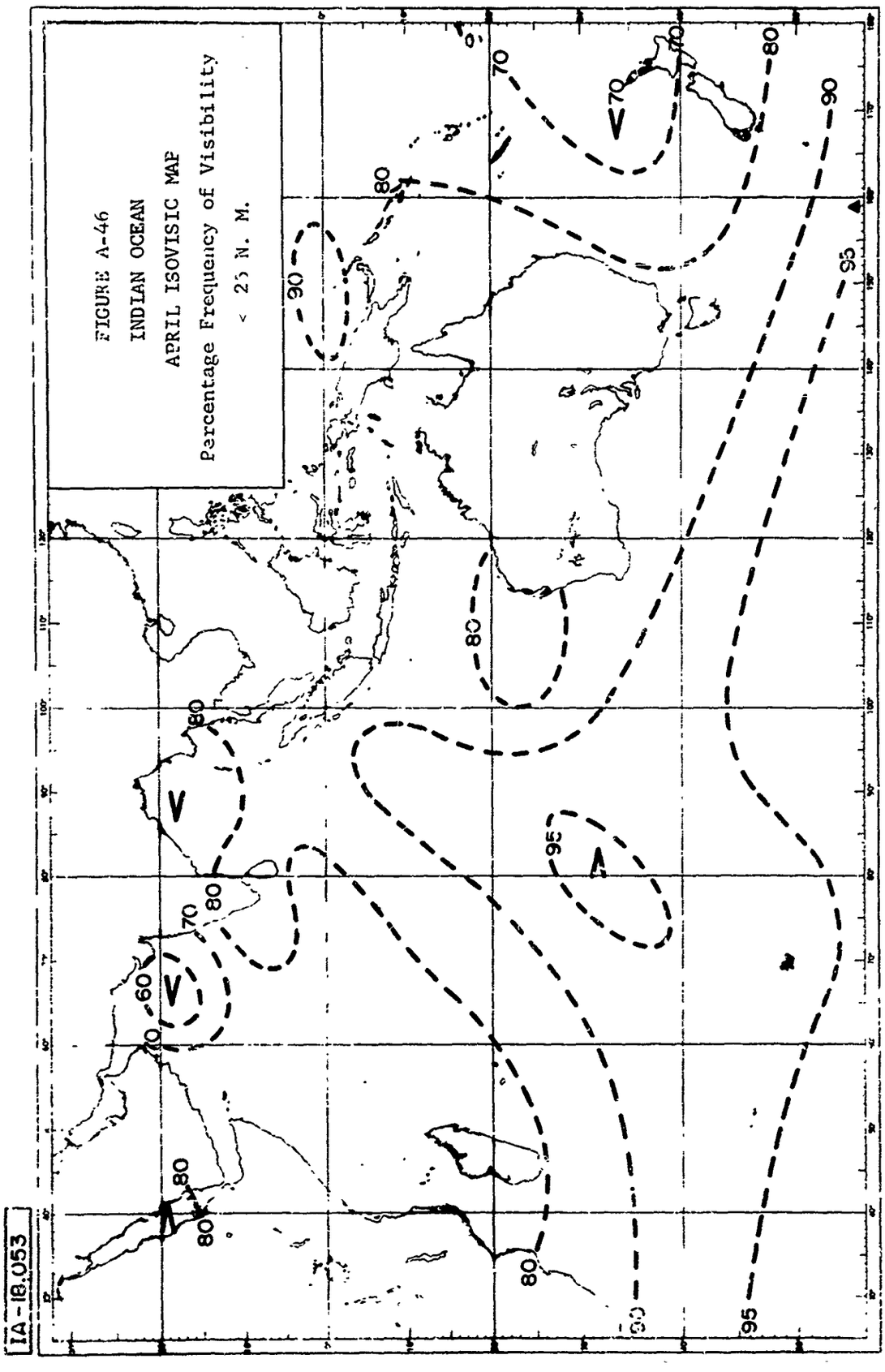


FIGURE A-46
INDIAN OCEAN
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 25 N. M.
IA-18,053
70
80
90
95
60

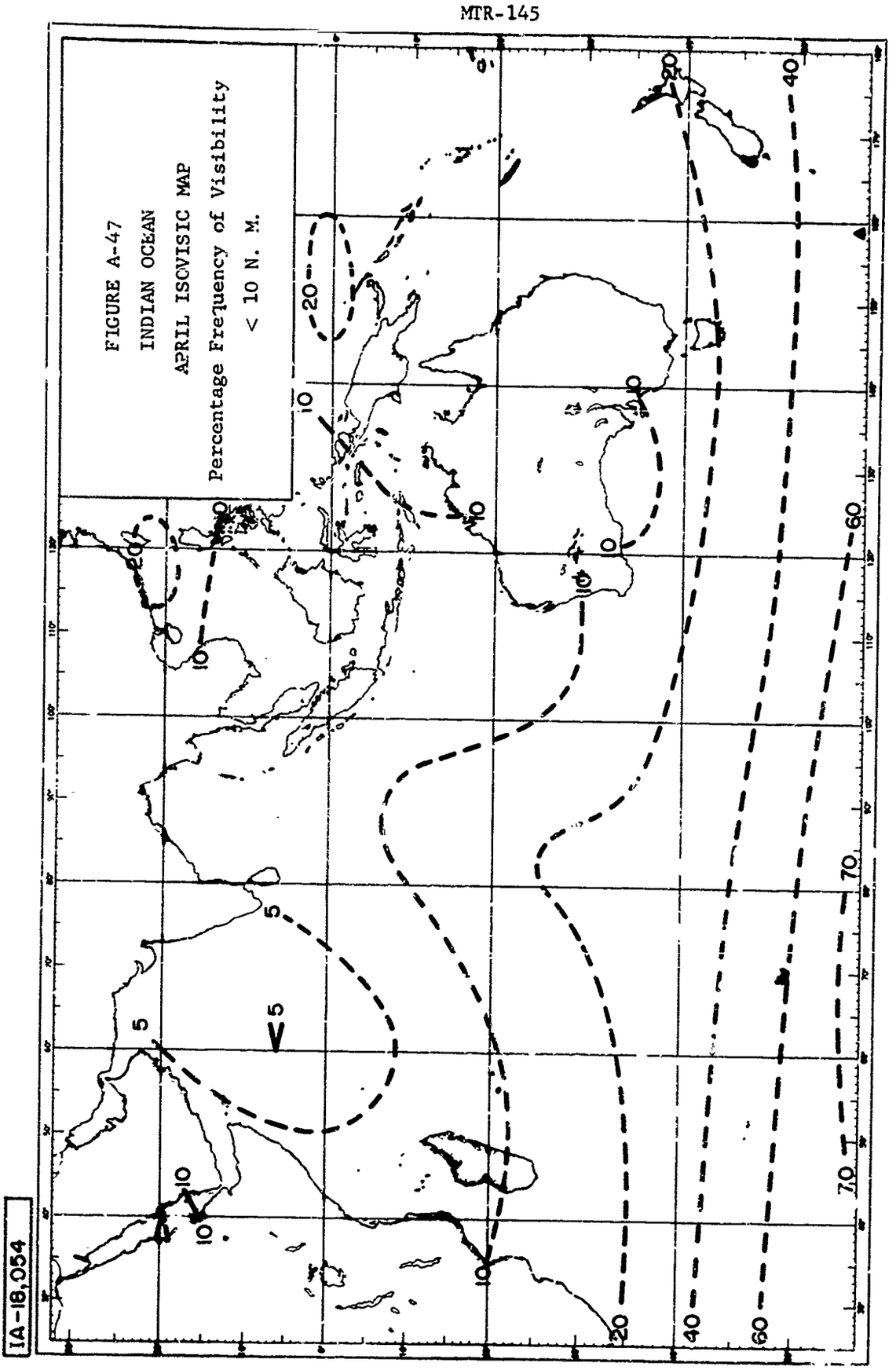


FIGURE A-47
INDIAN OCEAN
APRIL ISCVISIC MAP
Percentage Frequency of Visibility
< 10 N. M.
IA-18,054

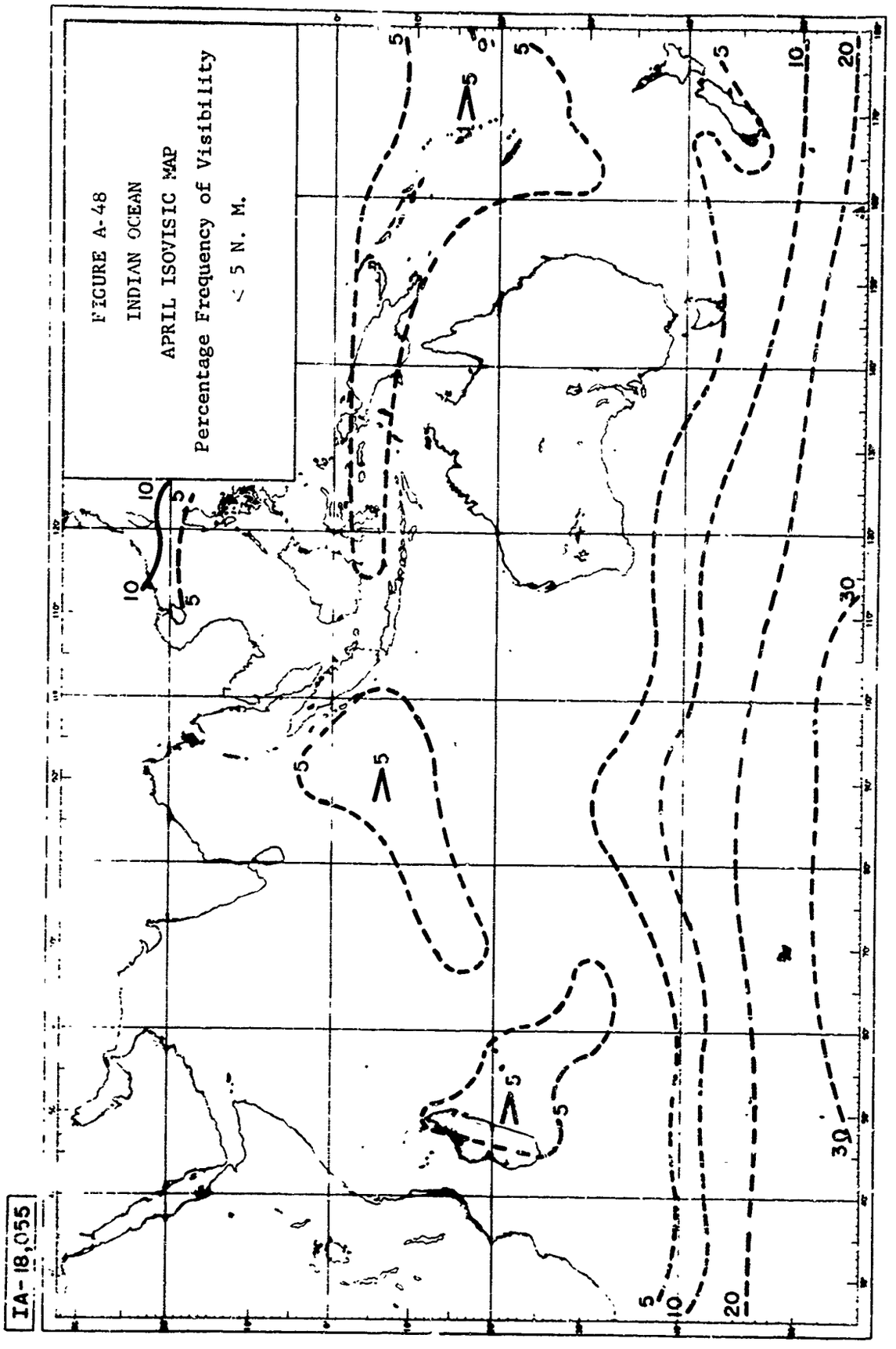


FIGURE A-48
INDIAN OCEAN
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.
IA-18,055

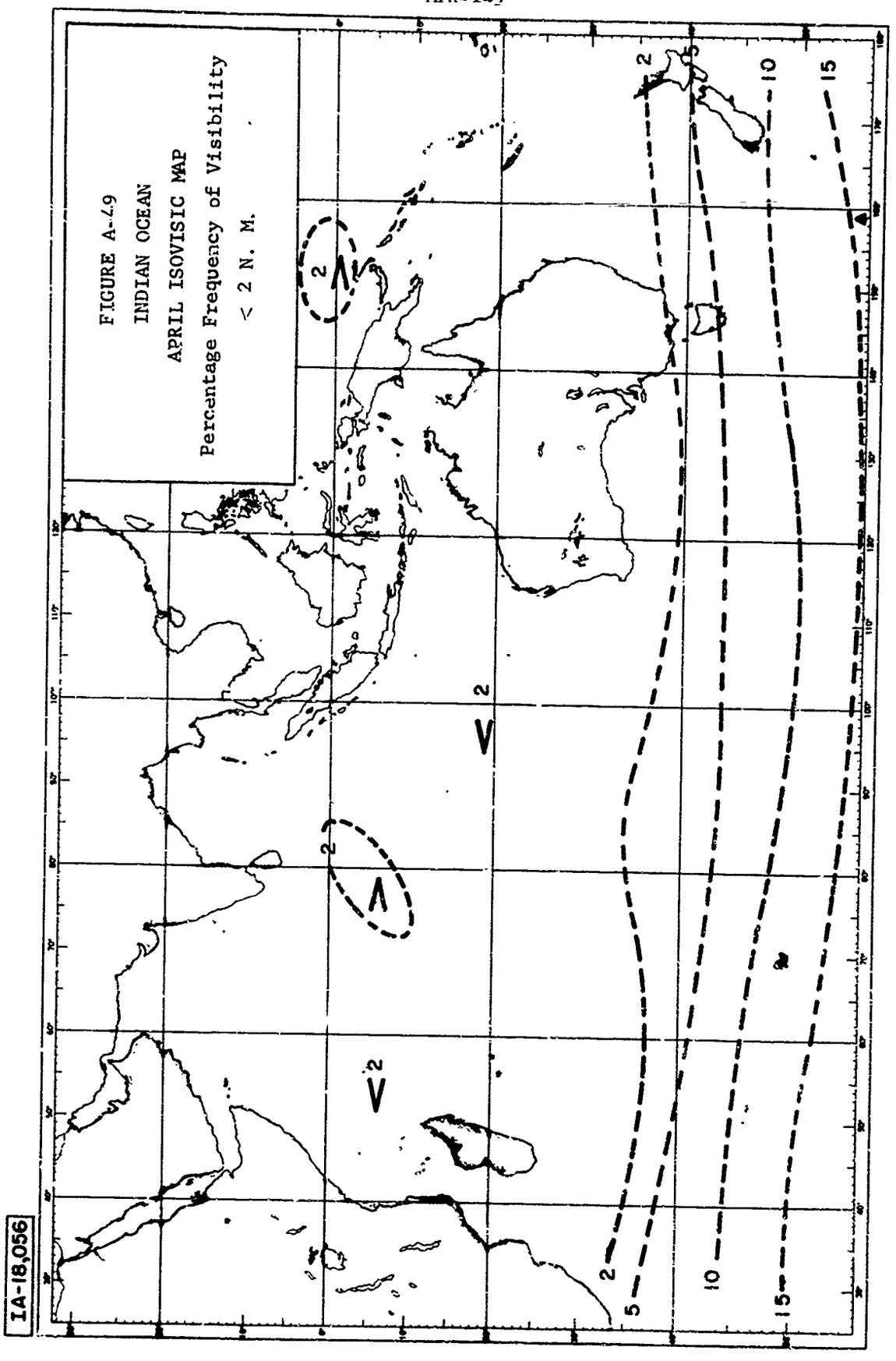


FIGURE A-49
INDIAN OCEAN
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 2 N. M.
IA-18,056
2
5
10
15

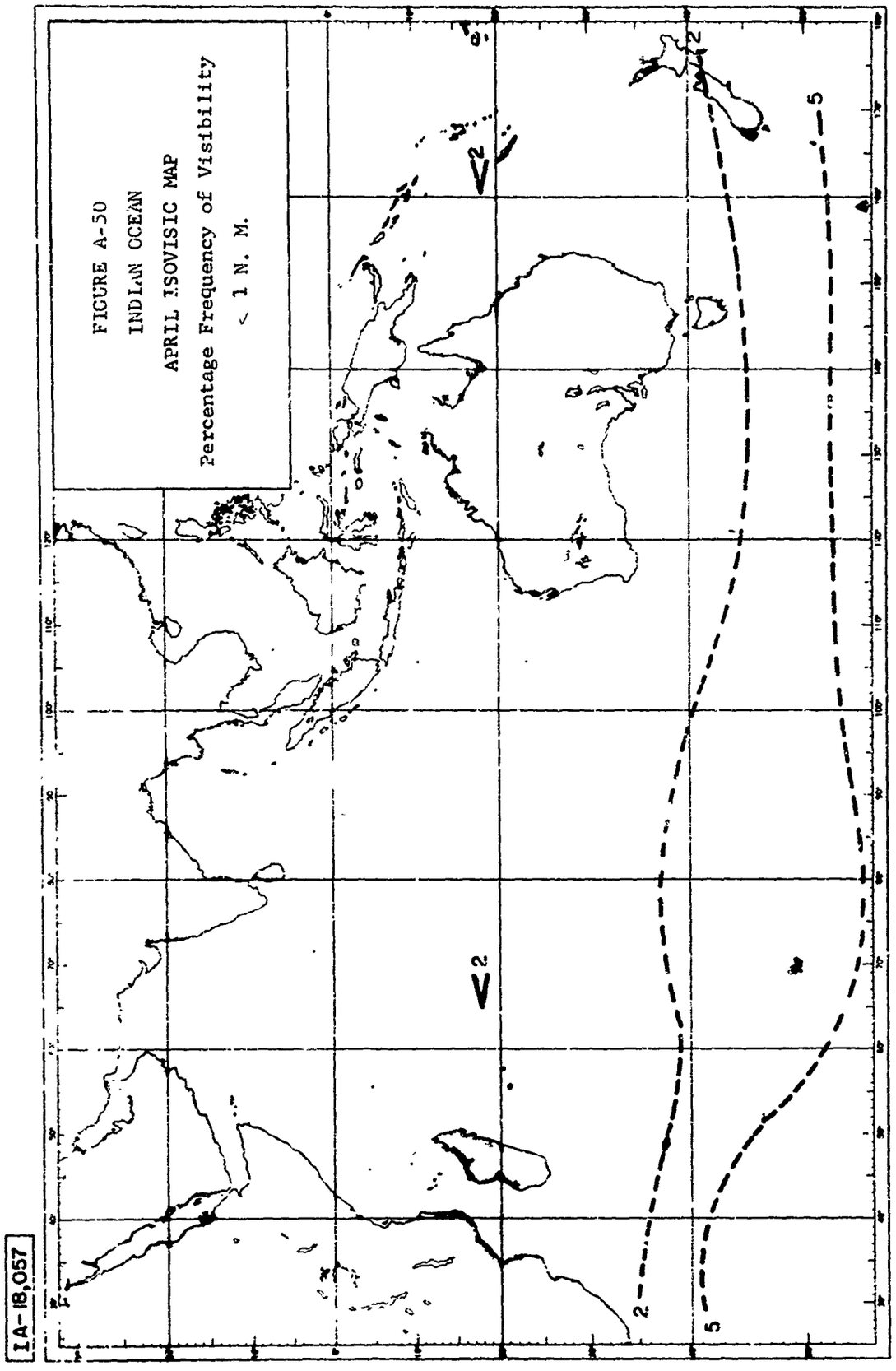
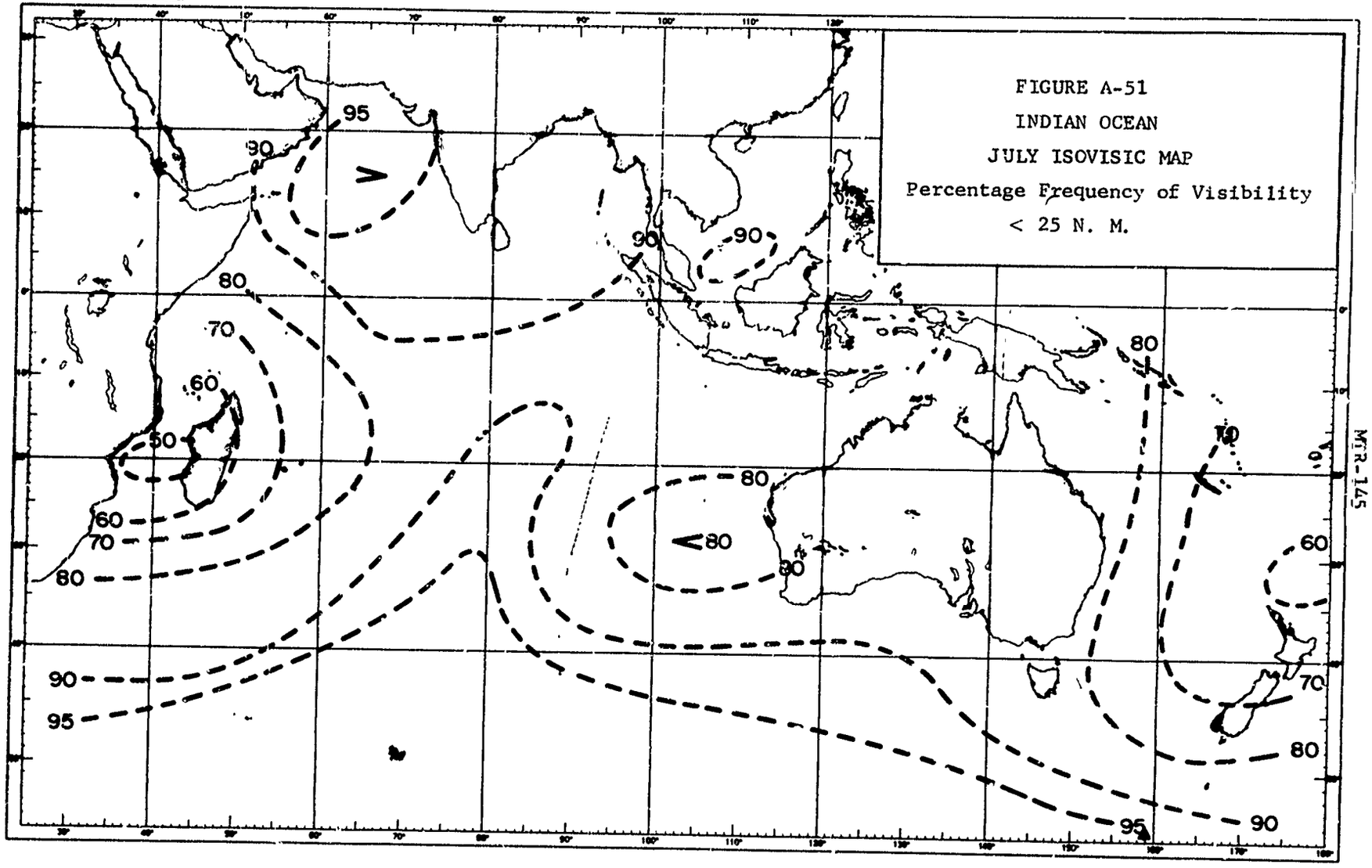


FIGURE A-50
INDIAN OCEAN
APRIL ISOVISIC MAP
Percentage Frequency of Visibility
< 1 N. M.
2
5
IA-18,057


IA-18,058
FIGURE A-51
INDIAN OCEAN
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 25 N. M.
95
90
80
70
60
50
MTR-145

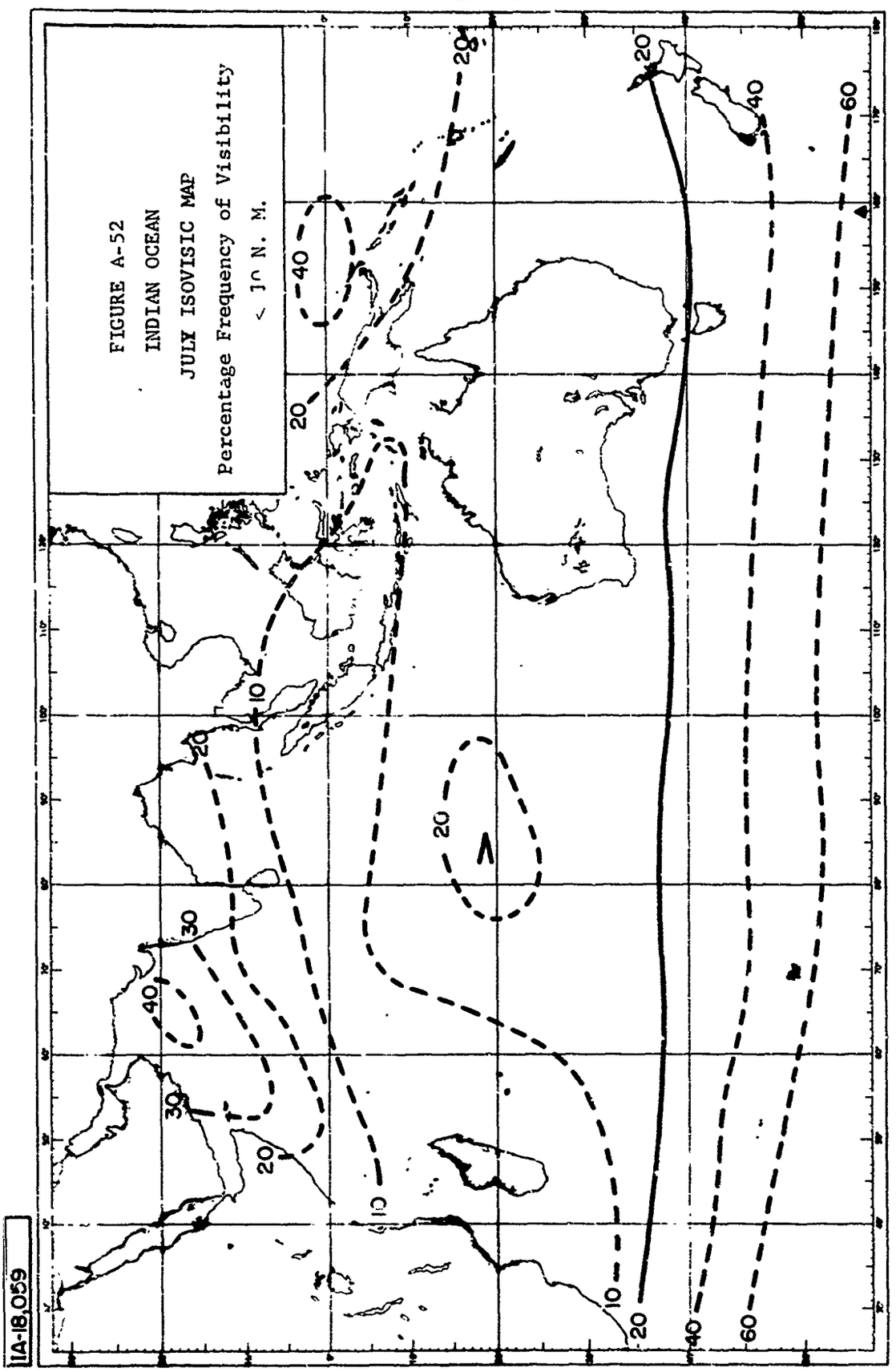


FIGURE A-52
INDIAN OCEAN
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 10 N. M.
IIA-18,059

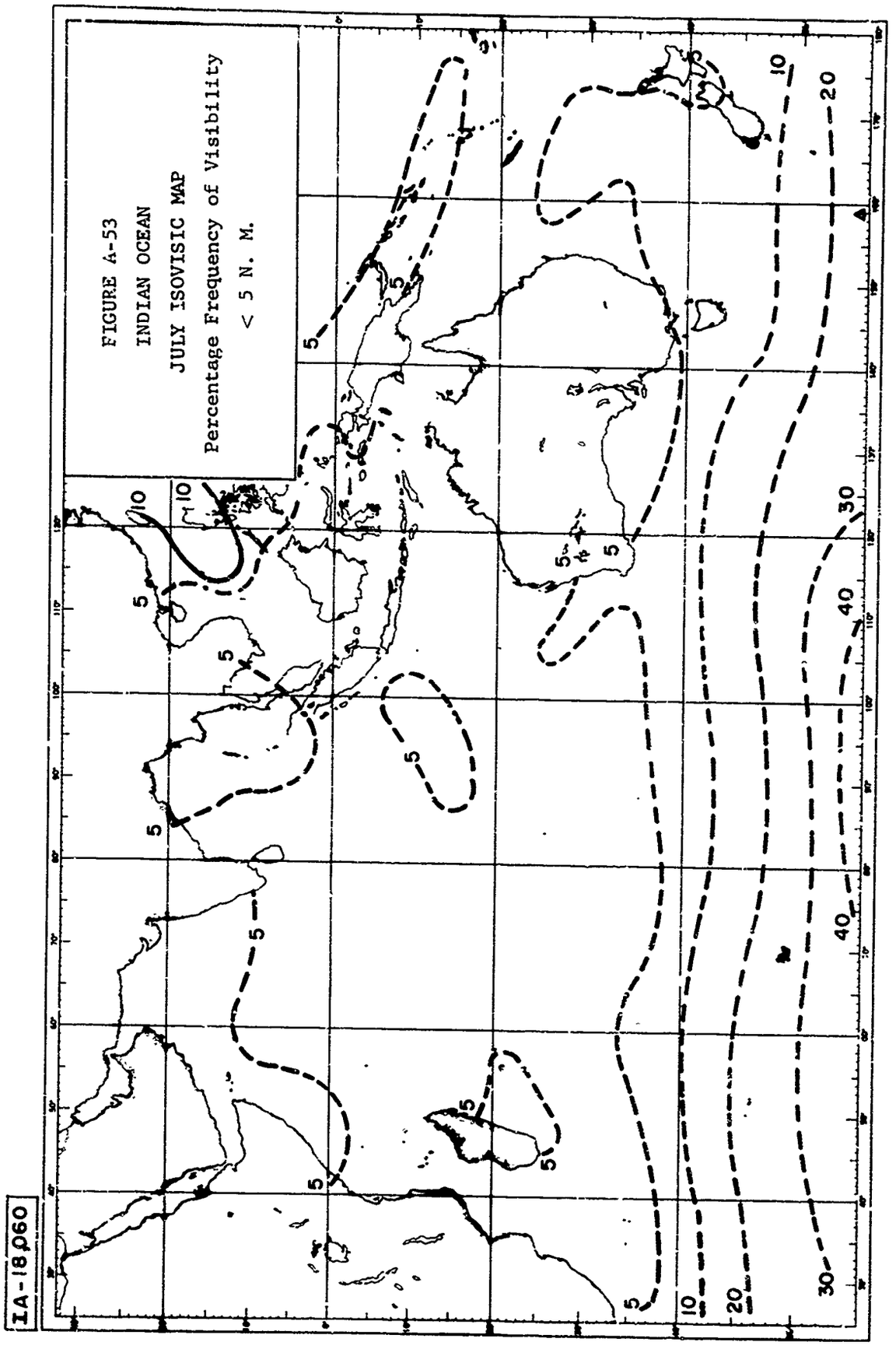


FIGURE 4-53
INDIAN OCEAN
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 5 N. M.
IA-18060

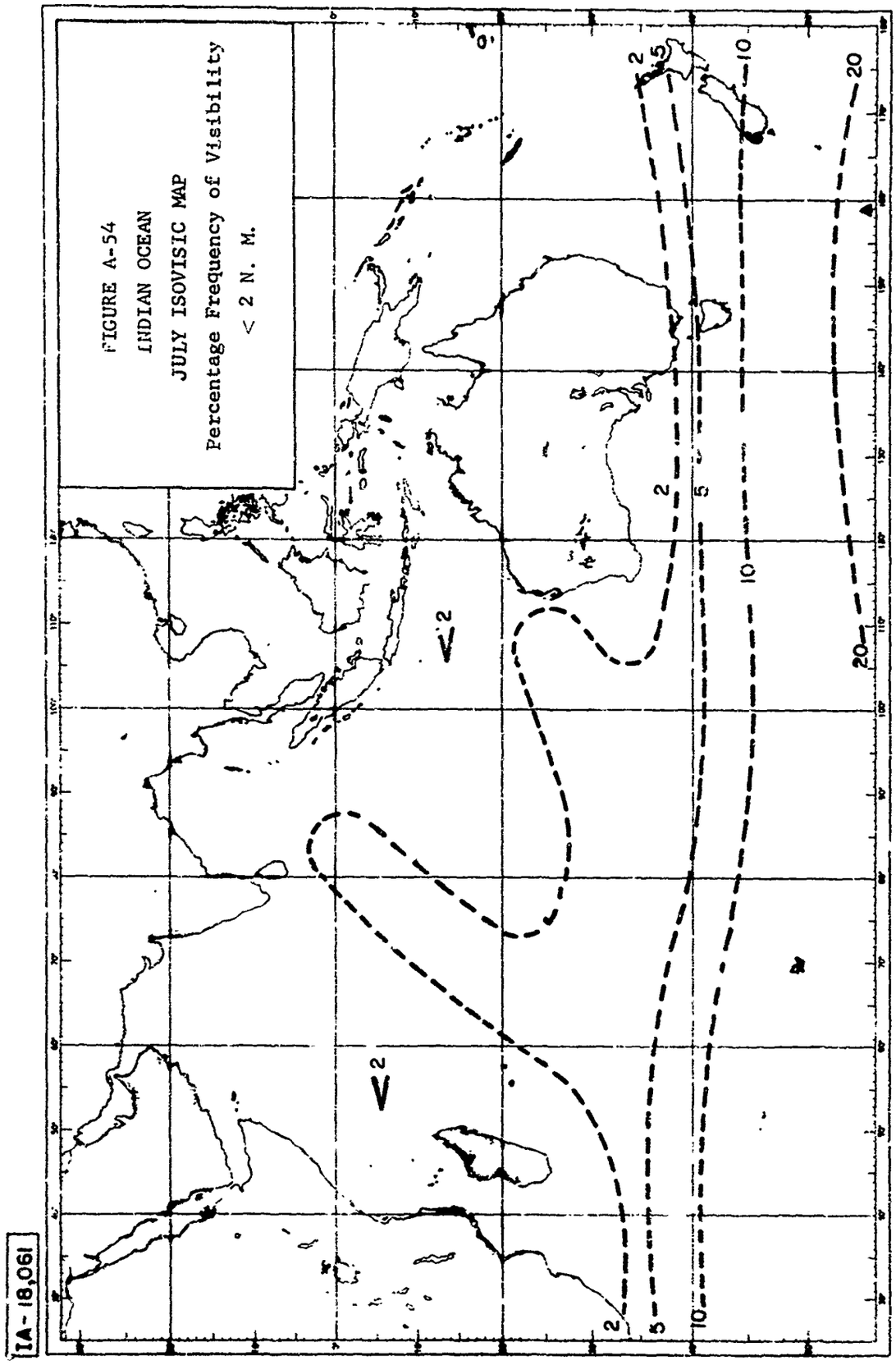


FIGURE A-54
INDIAN OCEAN
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 2 N. M.
IA-18,061
2
5
10
20

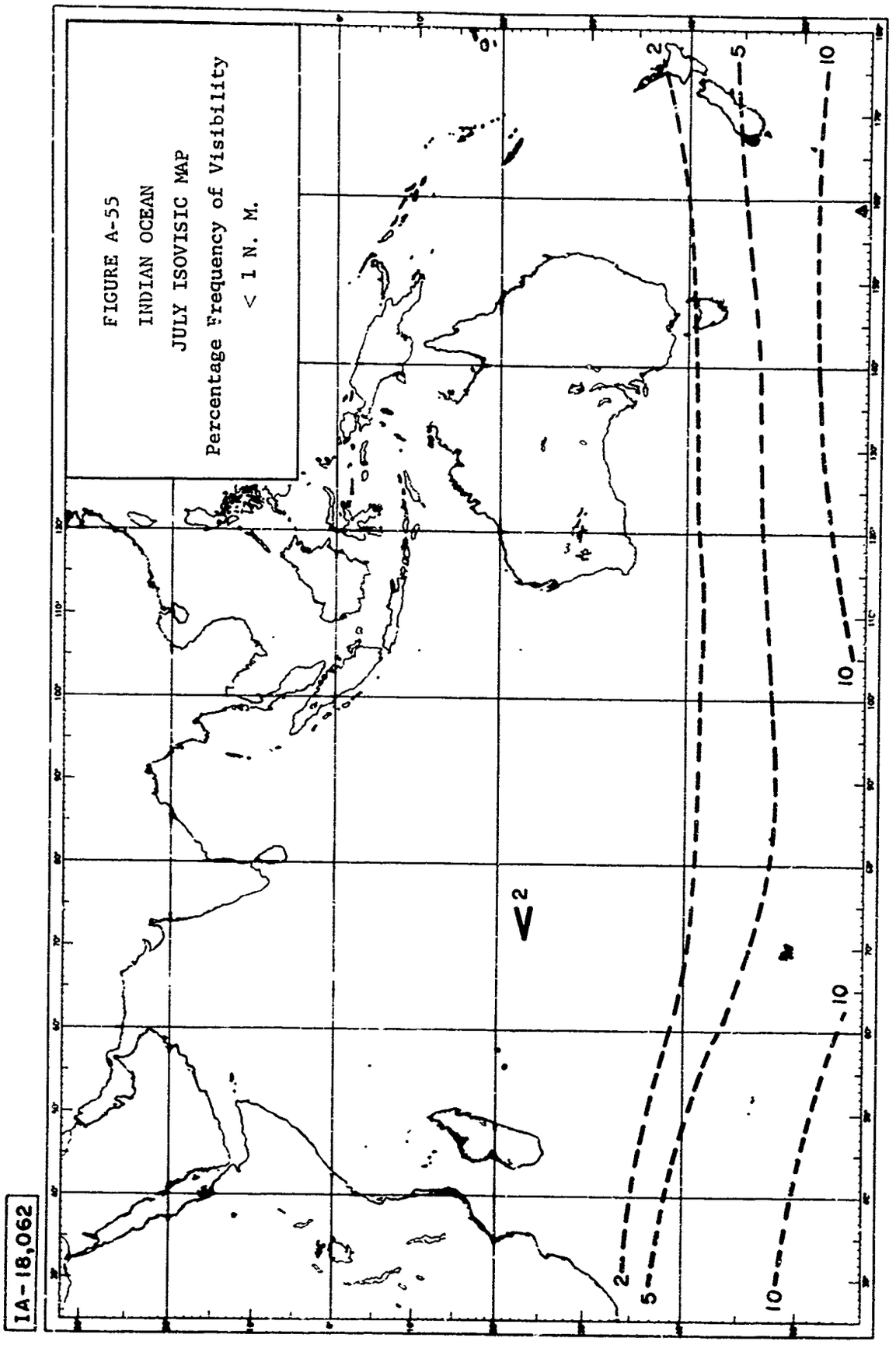


FIGURE A-55
INDIAN OCEAN
JULY ISOVISIC MAP
Percentage Frequency of Visibility
< 1 N. M.
2
5
10
10
2
5
10
V2
IA-18,062

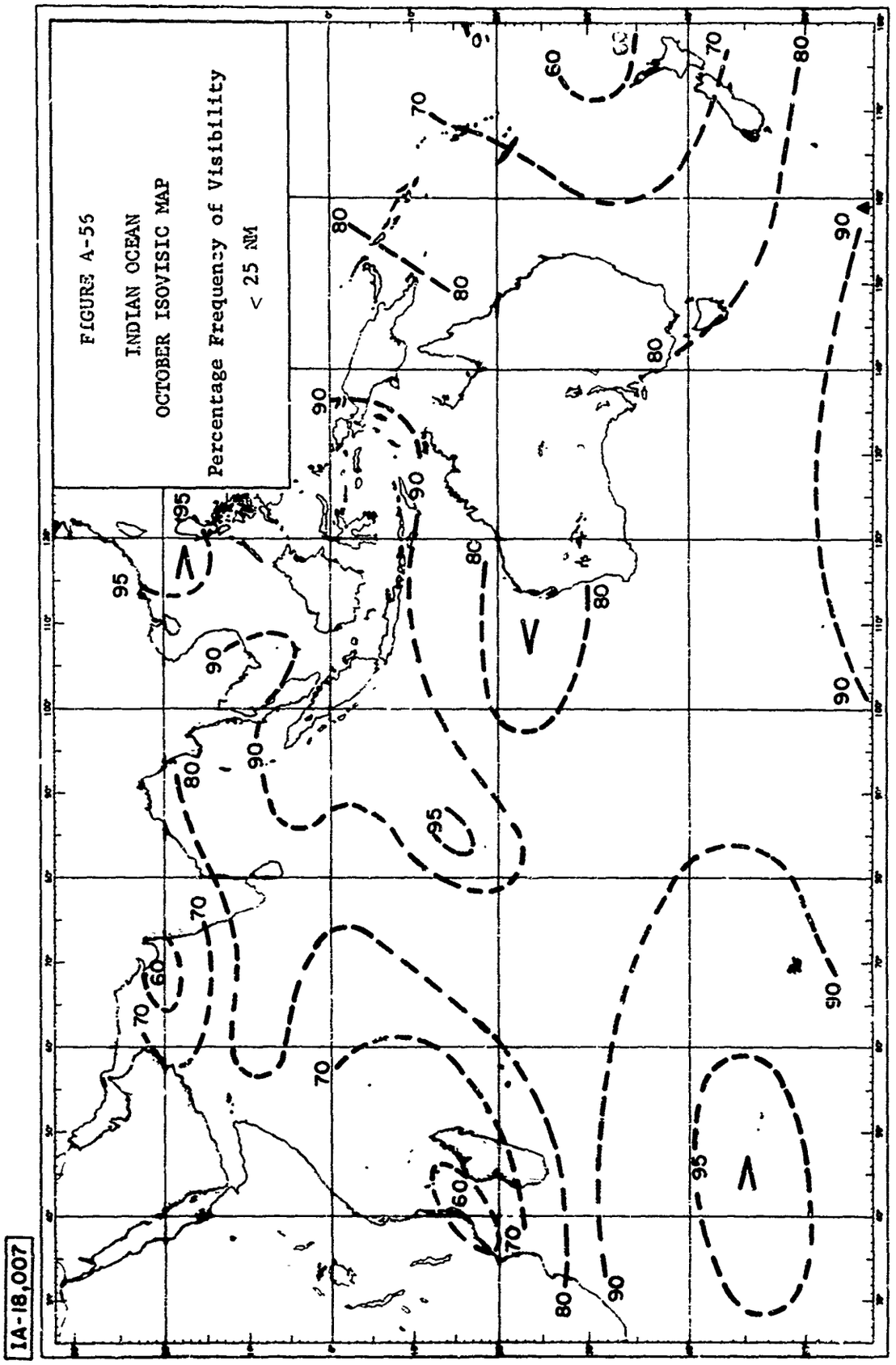


FIGURE A-55
INDIAN OCEAN
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 25 NM
IA-18,007

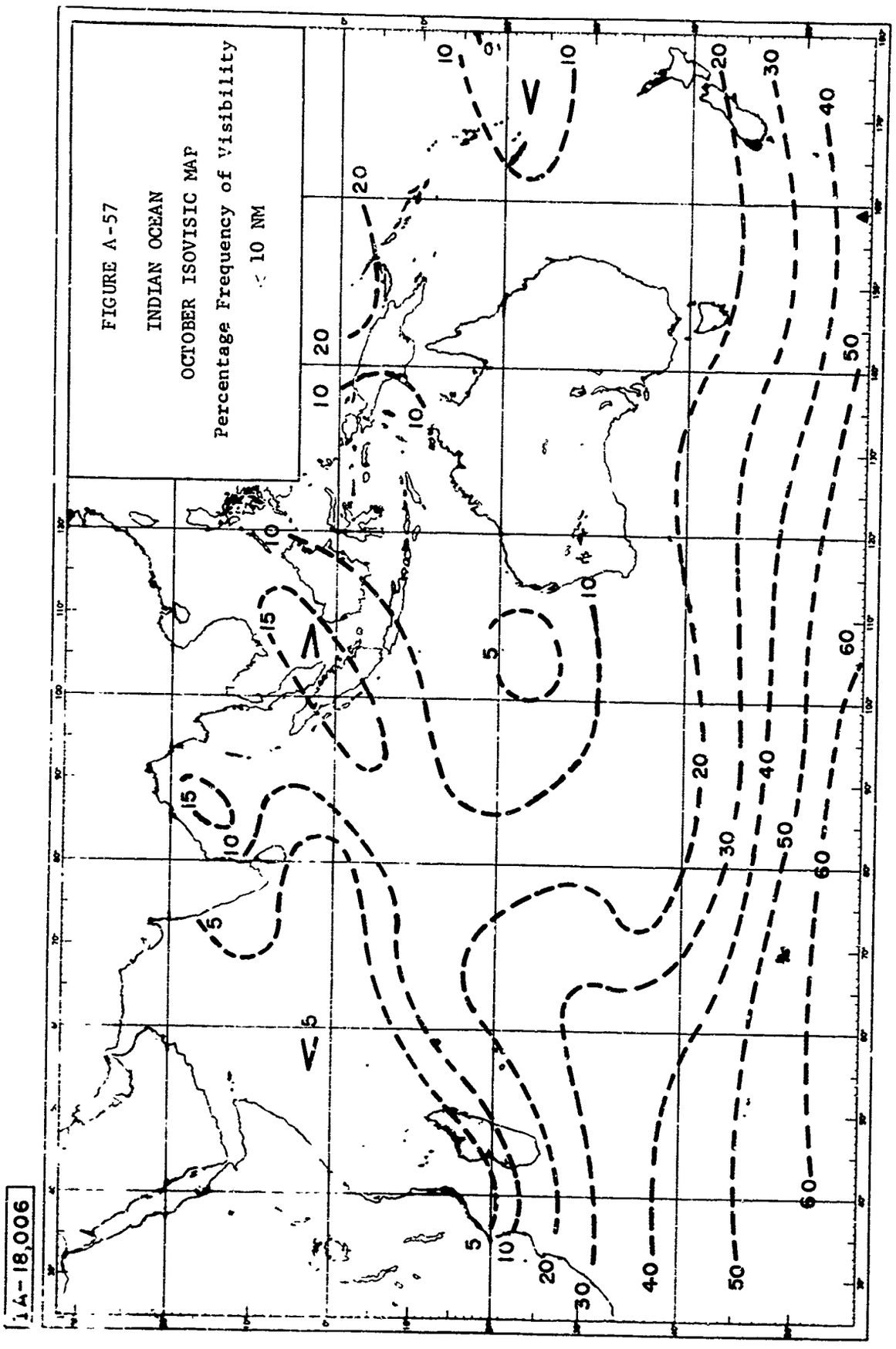


FIGURE A-57
INDIAN OCEAN
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
≤ 10 NM
14-18,006

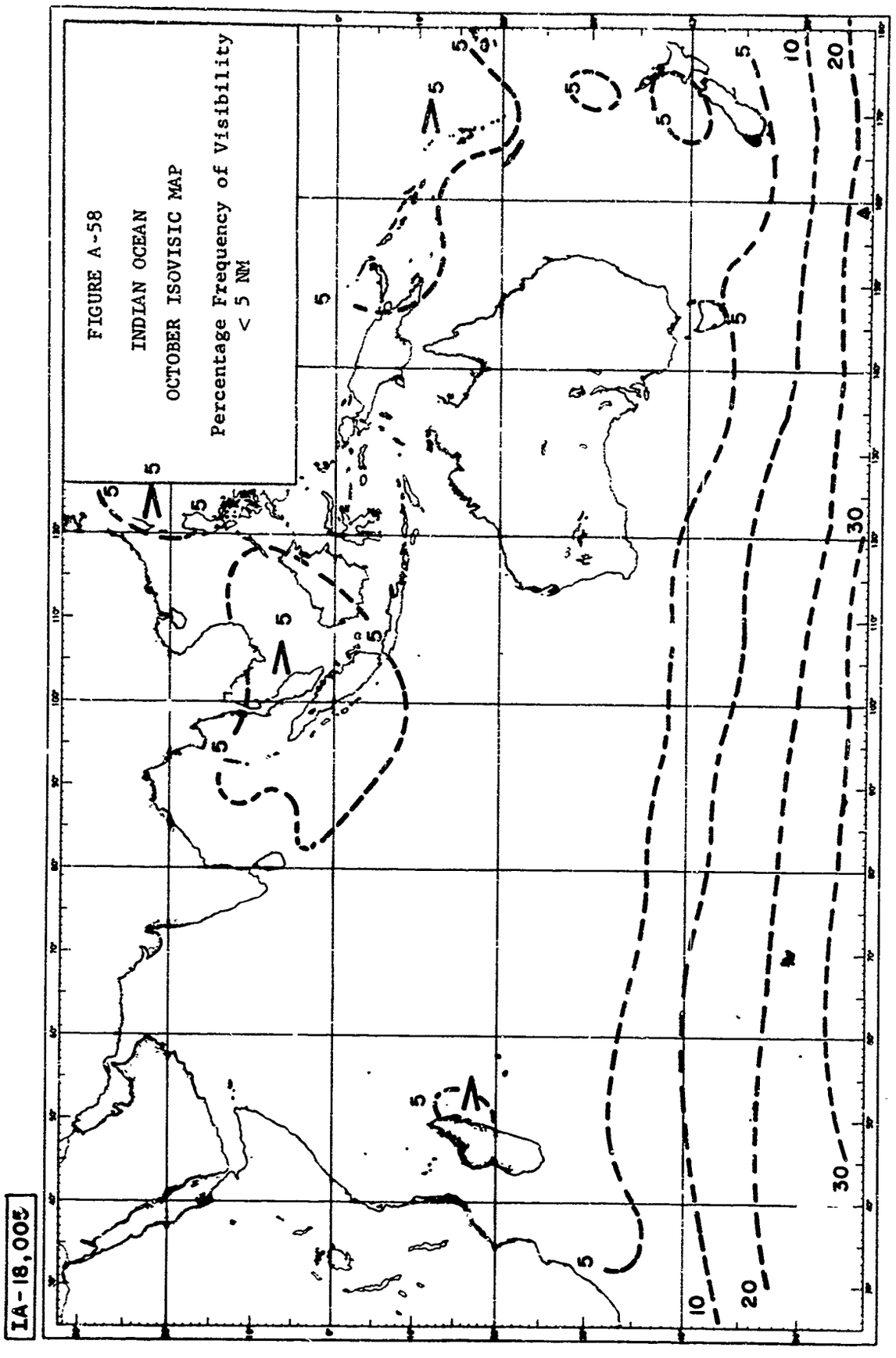


FIGURE A-58
INDIAN OCEAN
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 5 NM
5
10
20
30
IA-18,005

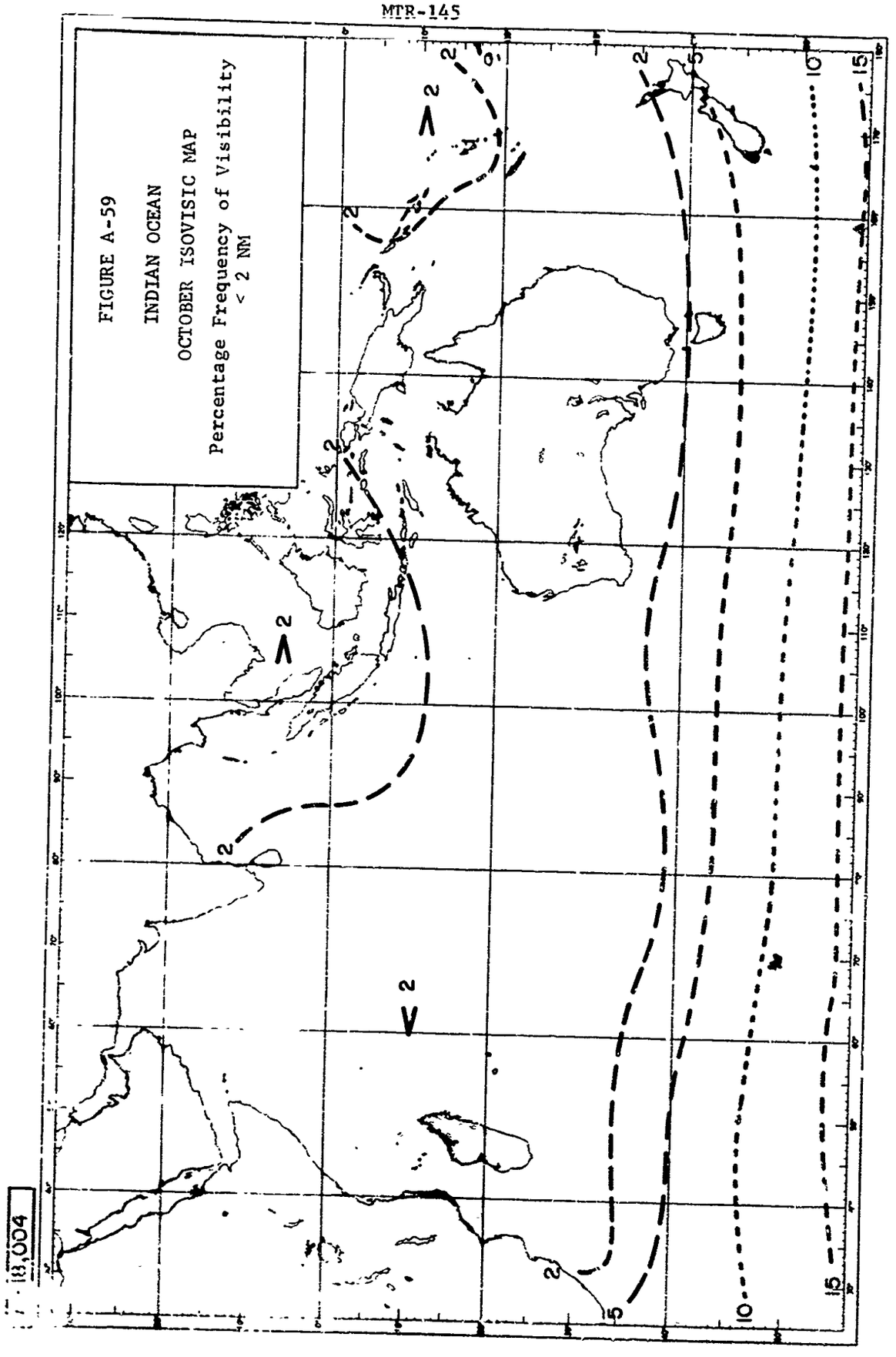


FIGURE A-59
INDIAN OCEAN
OCTOBER ISOVISIC MAP
Percentage Frequency of Visibility
< 2 NM
2
5
10
15
18,004

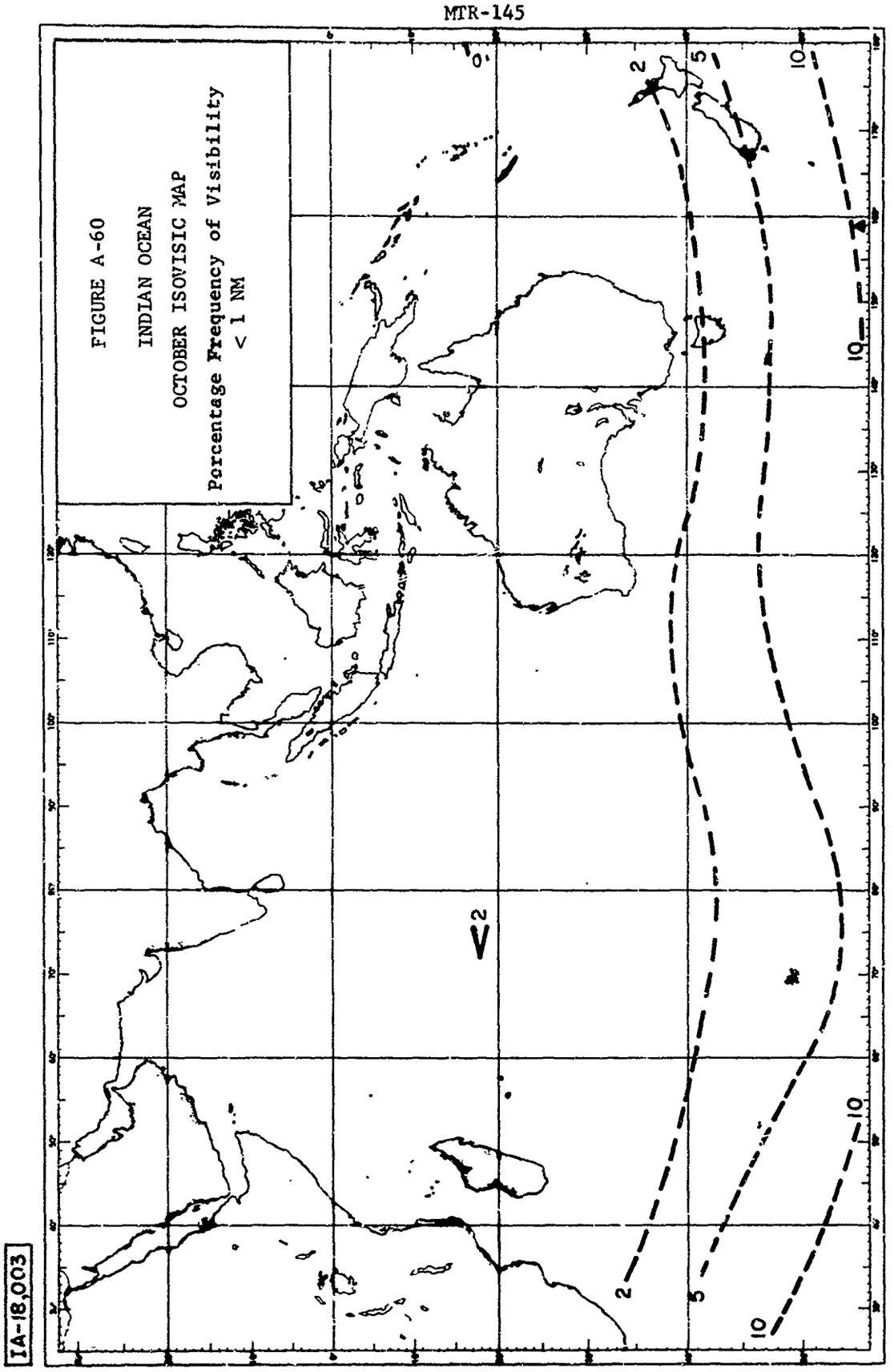


FIGURE A-60
INDIAN OCEAN
OCTOBER ISOVISIC MAP
Porcentage Frequency of Visibility
< 1 NM
IA-18,003
2
5
10
10
2
5
10

APPENDIX B

ISOVISIC MAPS - 90 PERCENT, 75 PERCENT, 50 PERCENT AND 25 PERCENT PROBABILITY OF VISIBILITY GREATER THAN INDICATED

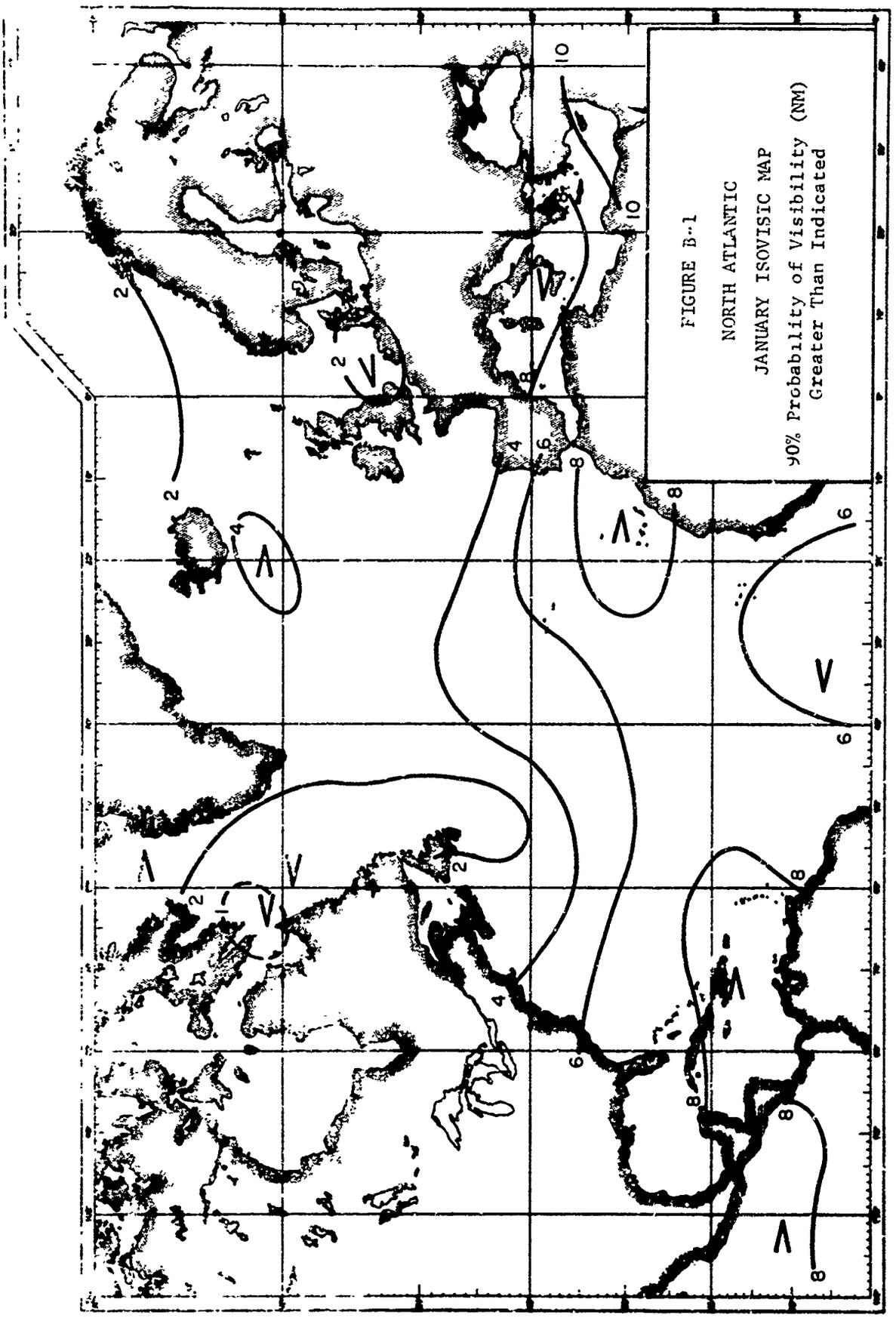


FIGURE B-1
NORTH ATLANTIC
JANUARY ISOVISTIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated

AD-A17,955

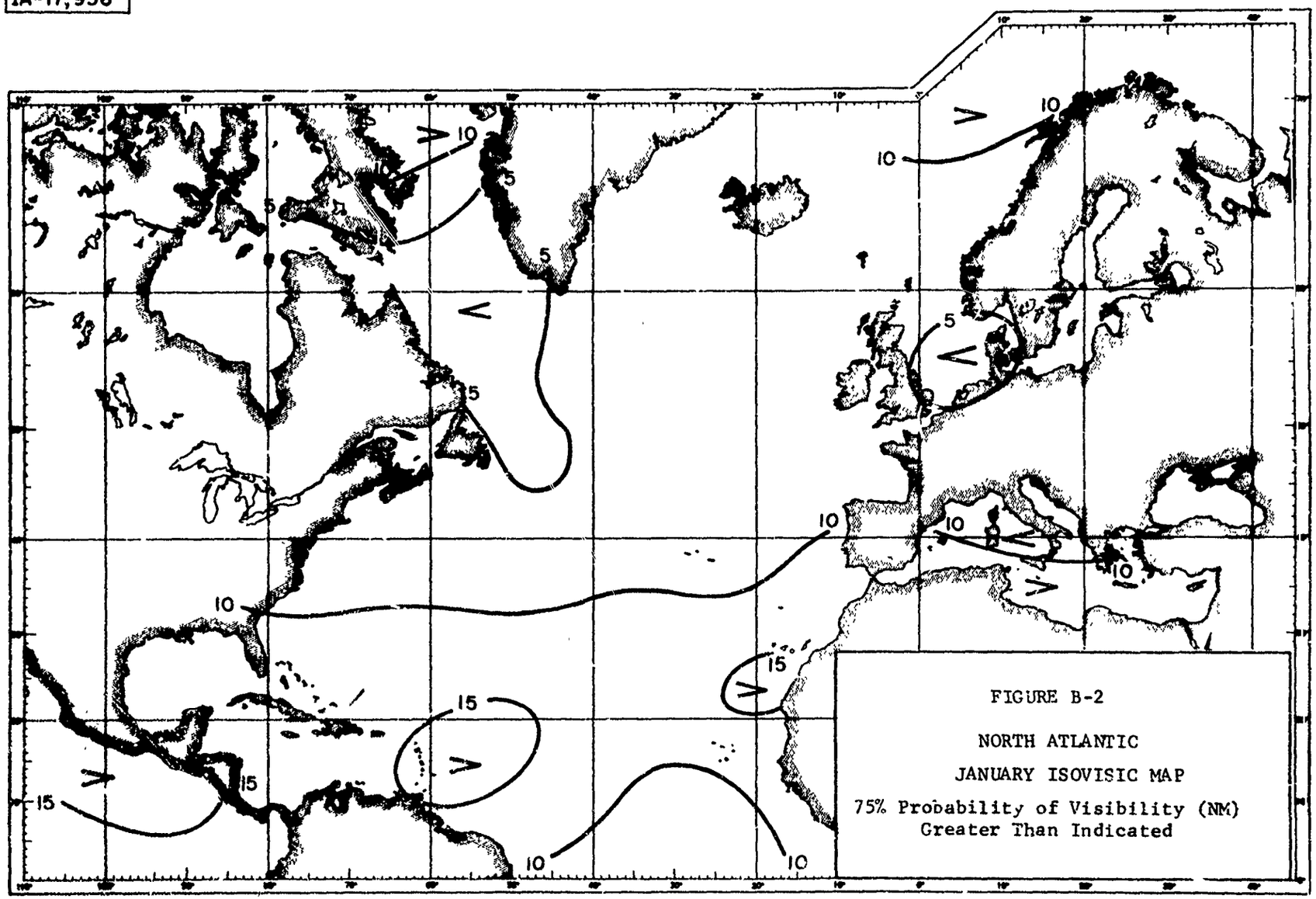


FIGURE B-2

NORTH ATLANTIC

JANUARY ISOVISIC MAP

75% Probability of Visibility (NM)
Greater Than Indicated

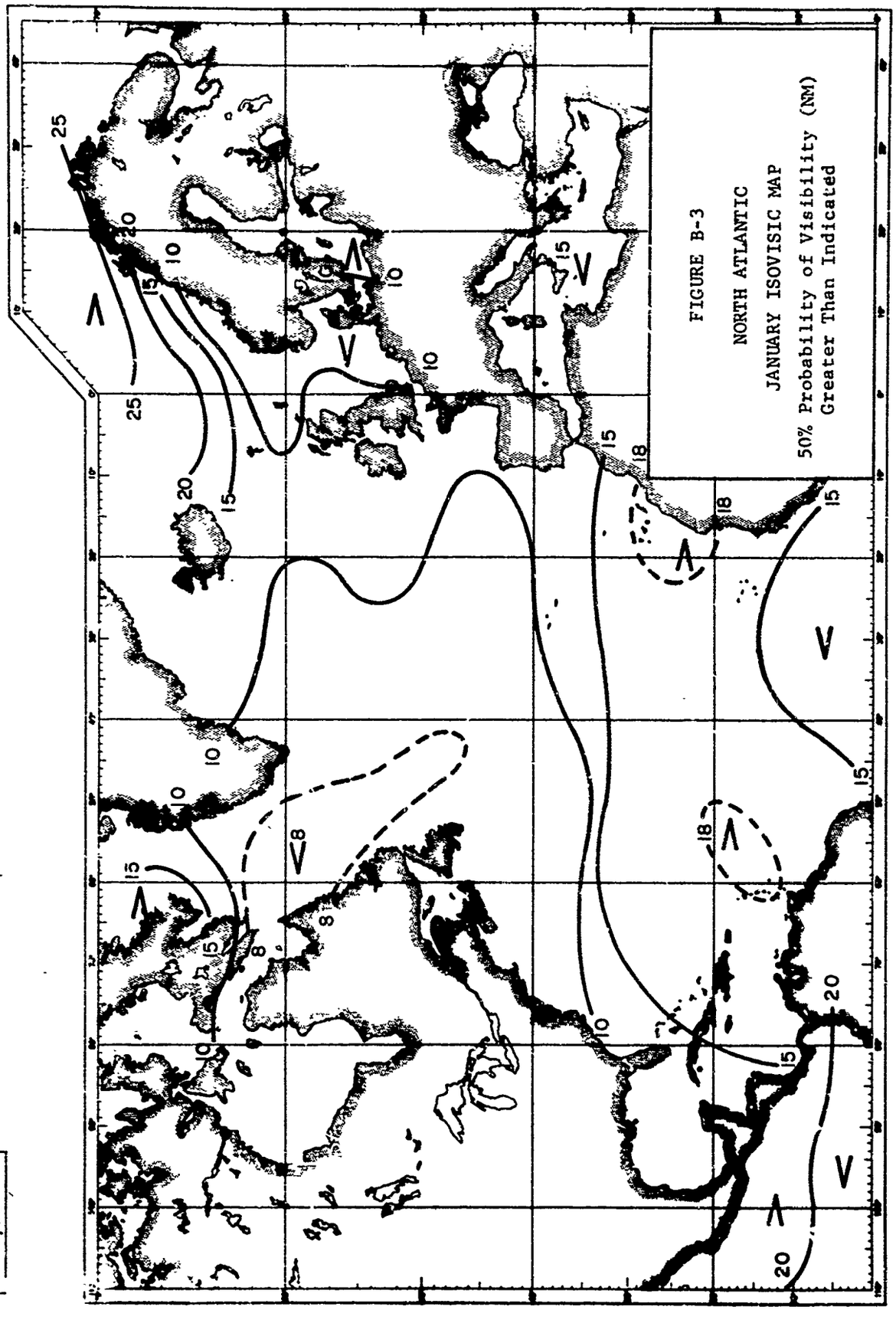


FIGURE B-3
NORTH ATLANTIC
JANUARY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
TA-17,957

IA-17,958

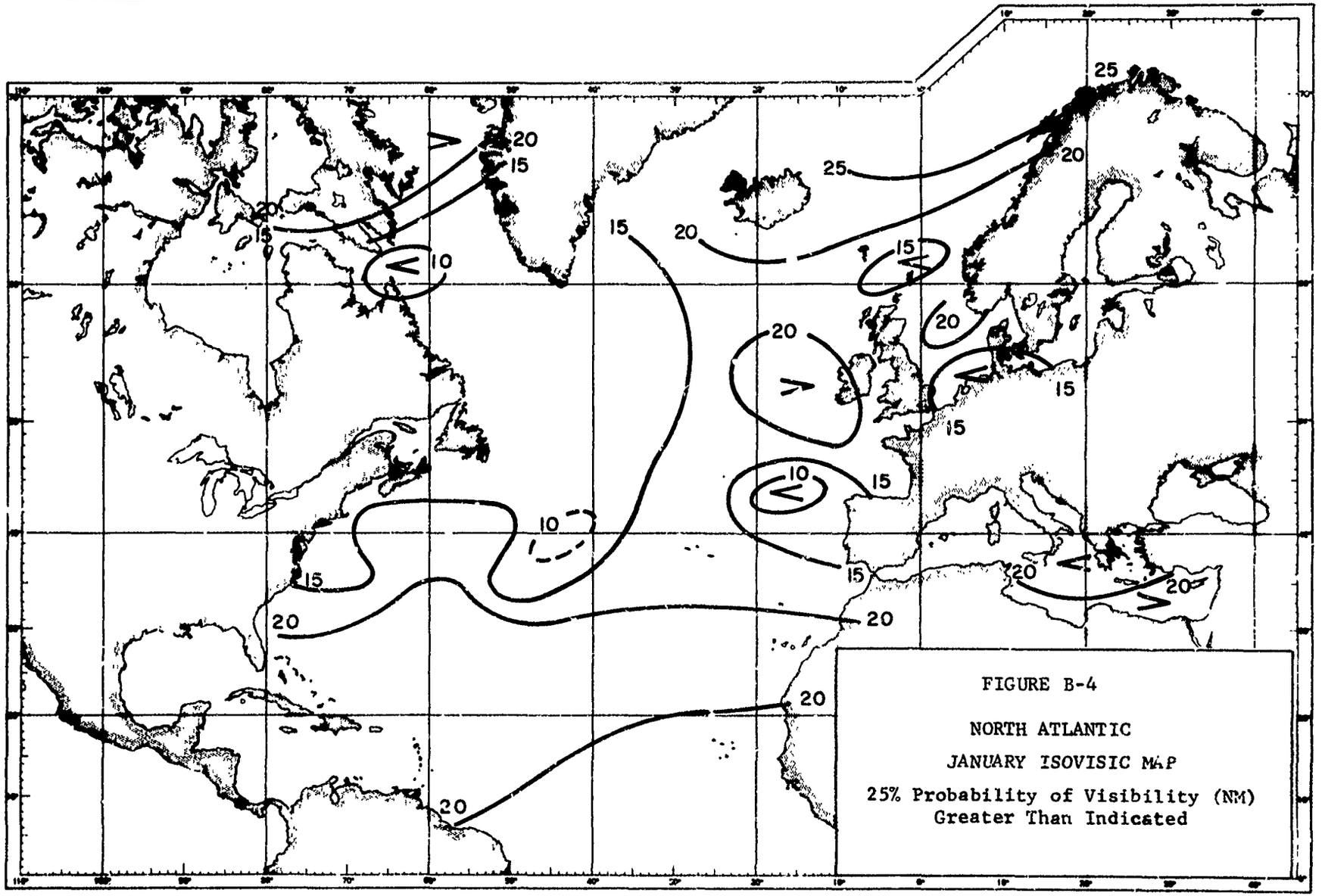


FIGURE B-4

NORTH ATLANTIC

JANUARY ISOVISIC MAP

25% Probability of Visibility (NM)
Greater Than Indicated

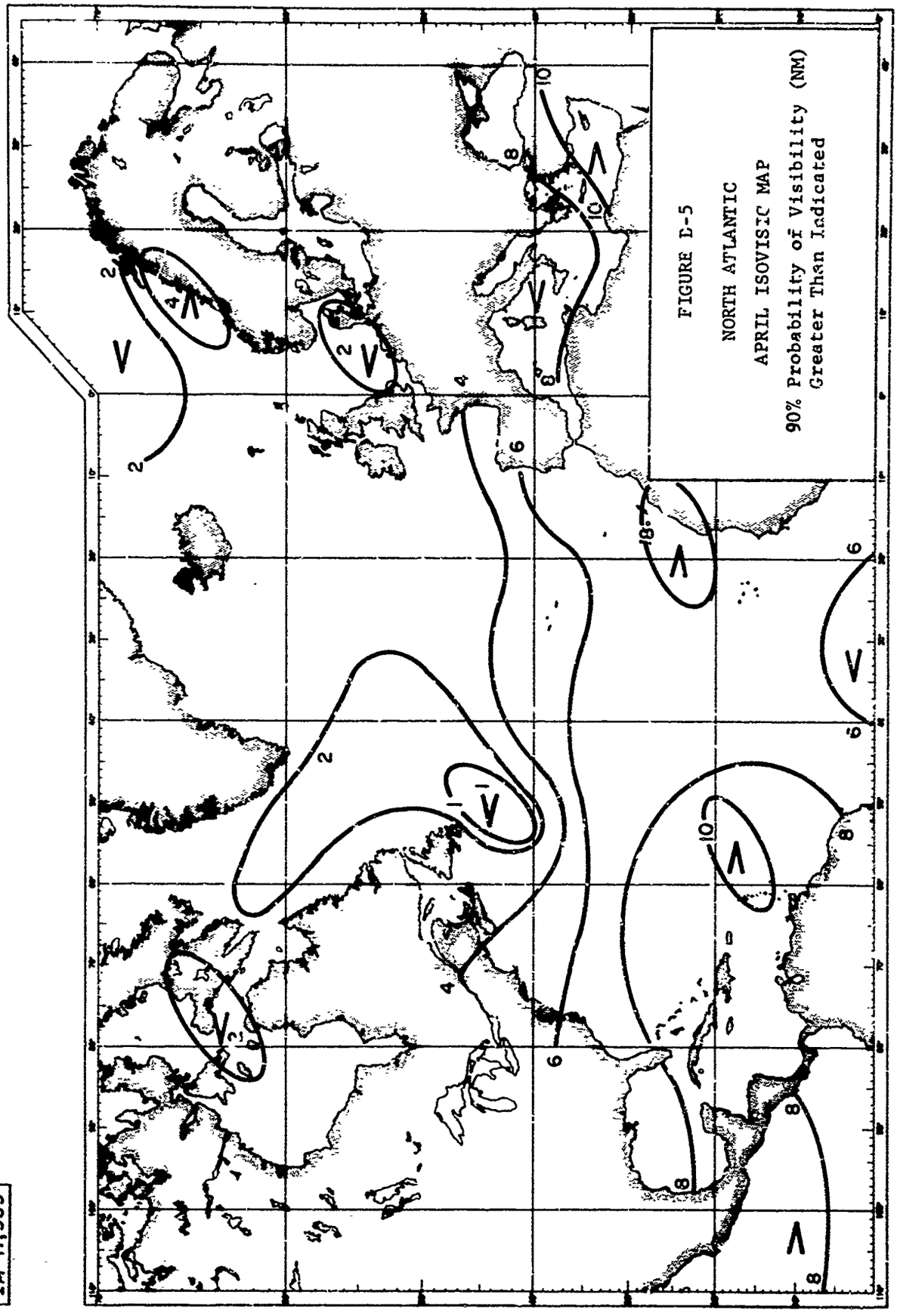


FIGURE E-5
NORTH ATLANTIC
APRIL ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated

IA-17,959

IA-17,960

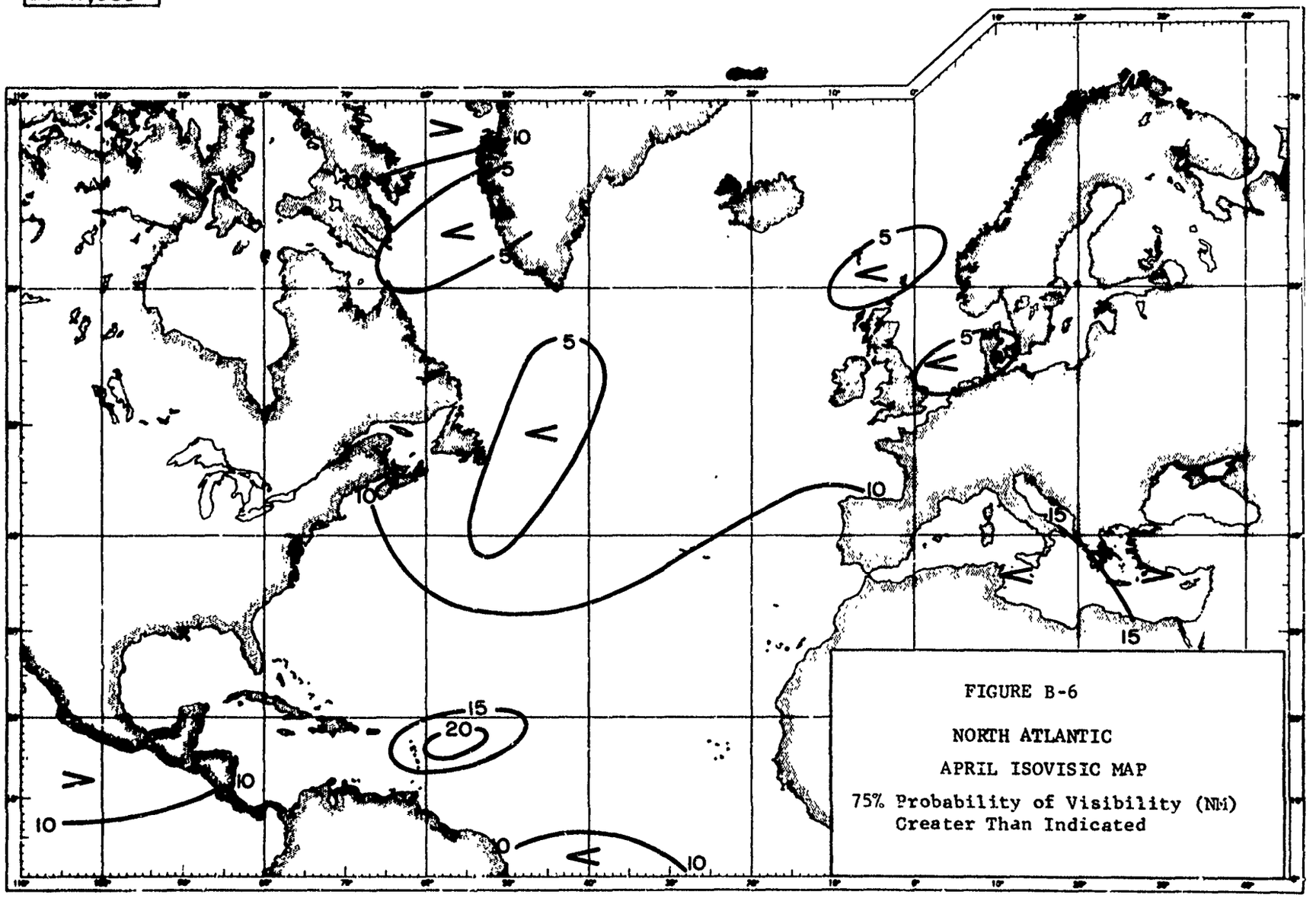


FIGURE B-6

NORTH ATLANTIC

APRIL ISOVISIC MAP

75% Probability of Visibility (NM)
Greater Than Indicated

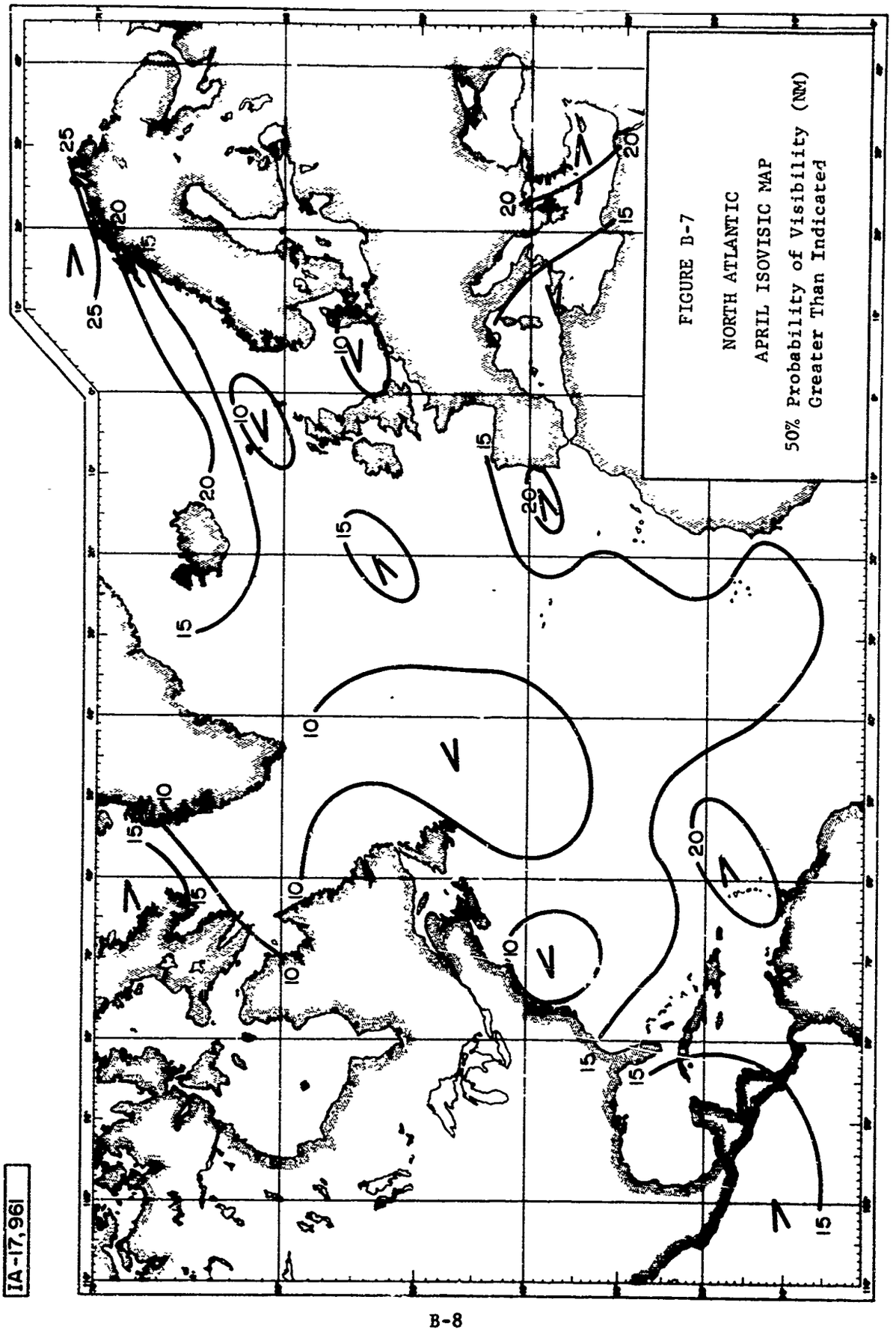


FIGURE B-7
NORTH ATLANTIC
APRIL ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
IA-17,961

IA-17,962

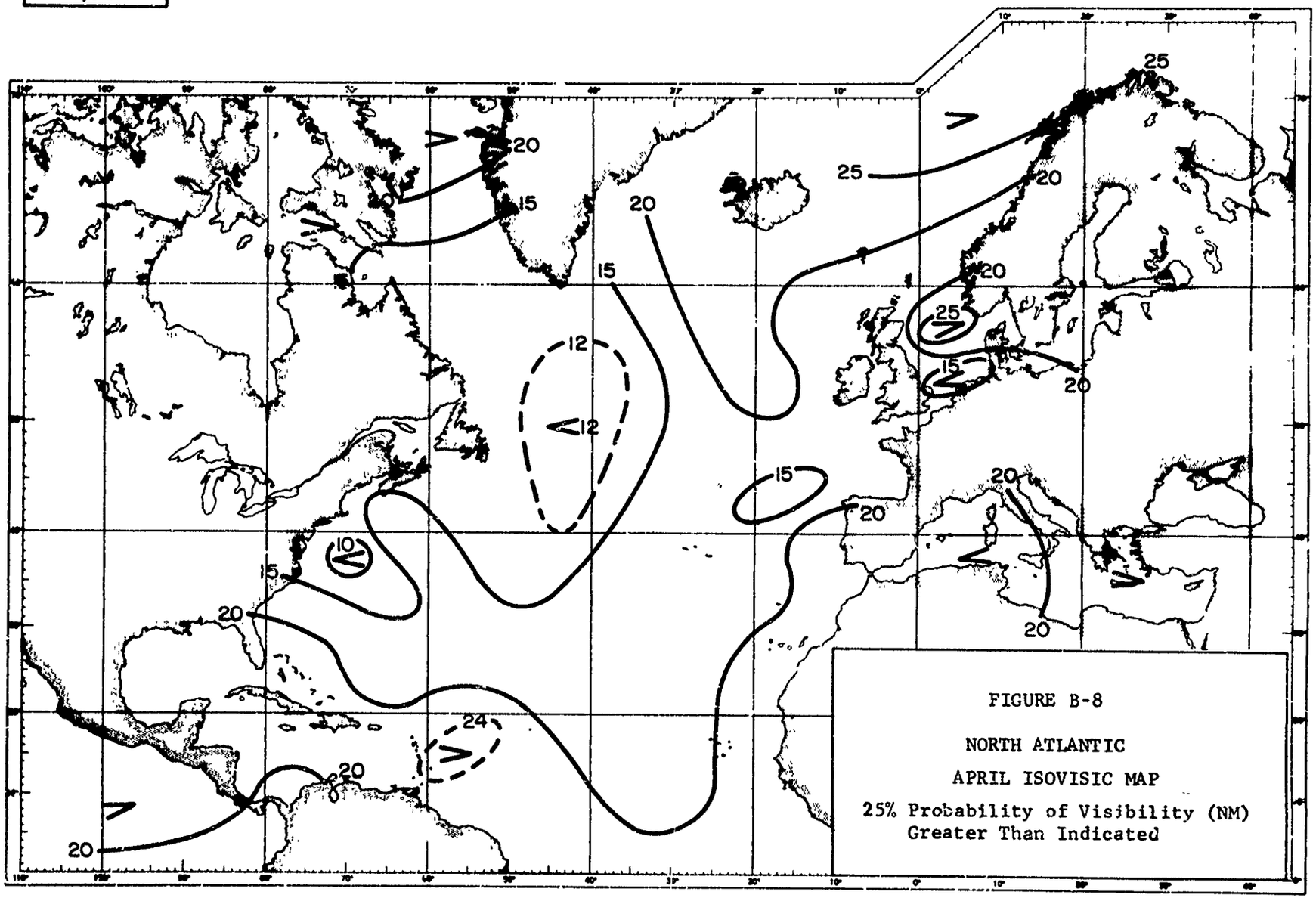


FIGURE B-8

NORTH ATLANTIC

APRIL ISOVISIC MAP

25% Probability of Visibility (NM)
Greater Than Indicated

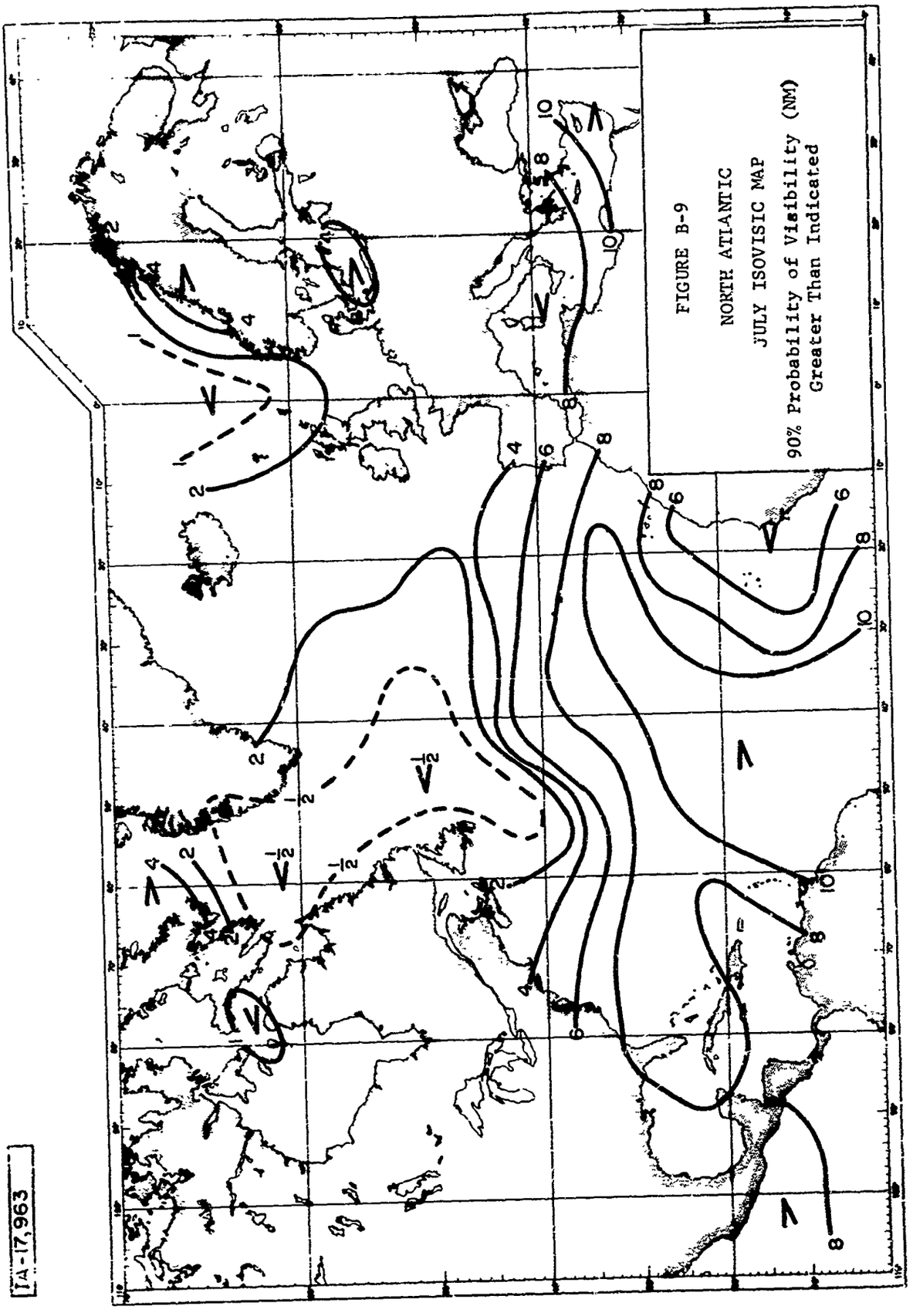


FIGURE B-9
NORTH ATLANTIC
JULY ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
TA-17,963

17964

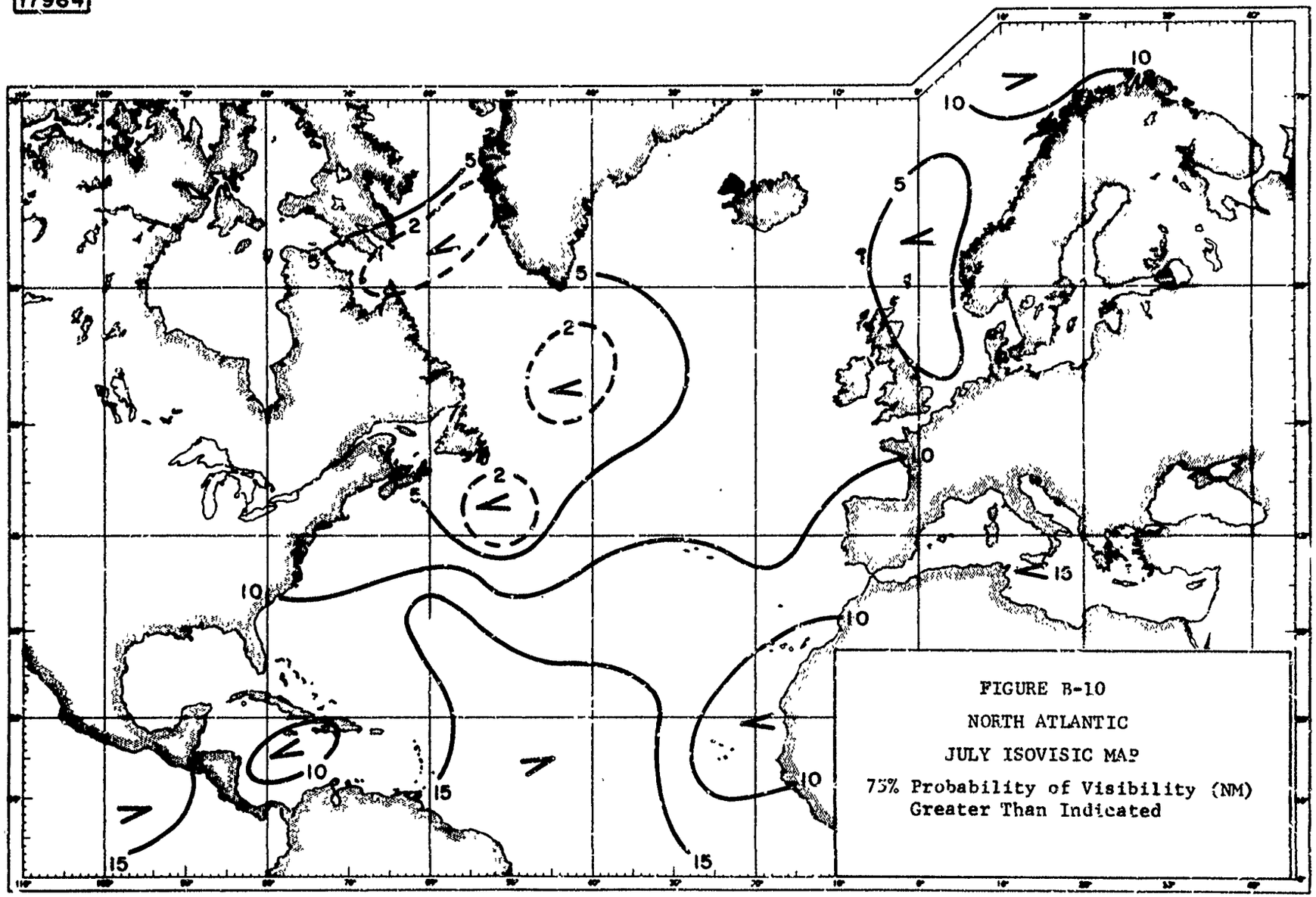


FIGURE B-10

NORTH ATLANTIC

JULY ISOVISIC MAP

75% Probability of Visibility (NM)
Greater Than Indicated

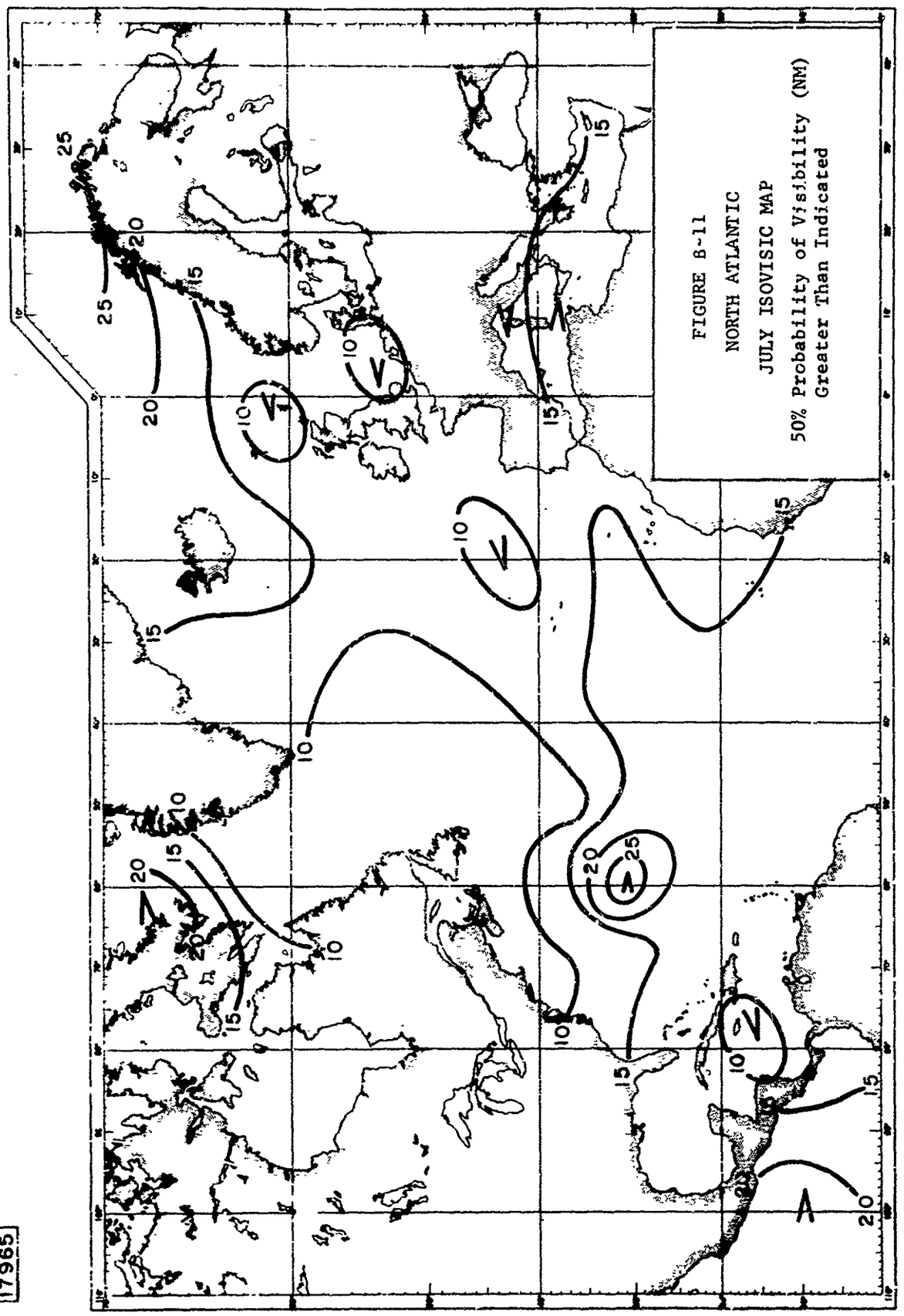


FIGURE B-11
NORTH ATLANTIC
JULY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
25
20
15
10
5
2
1
17965

17966

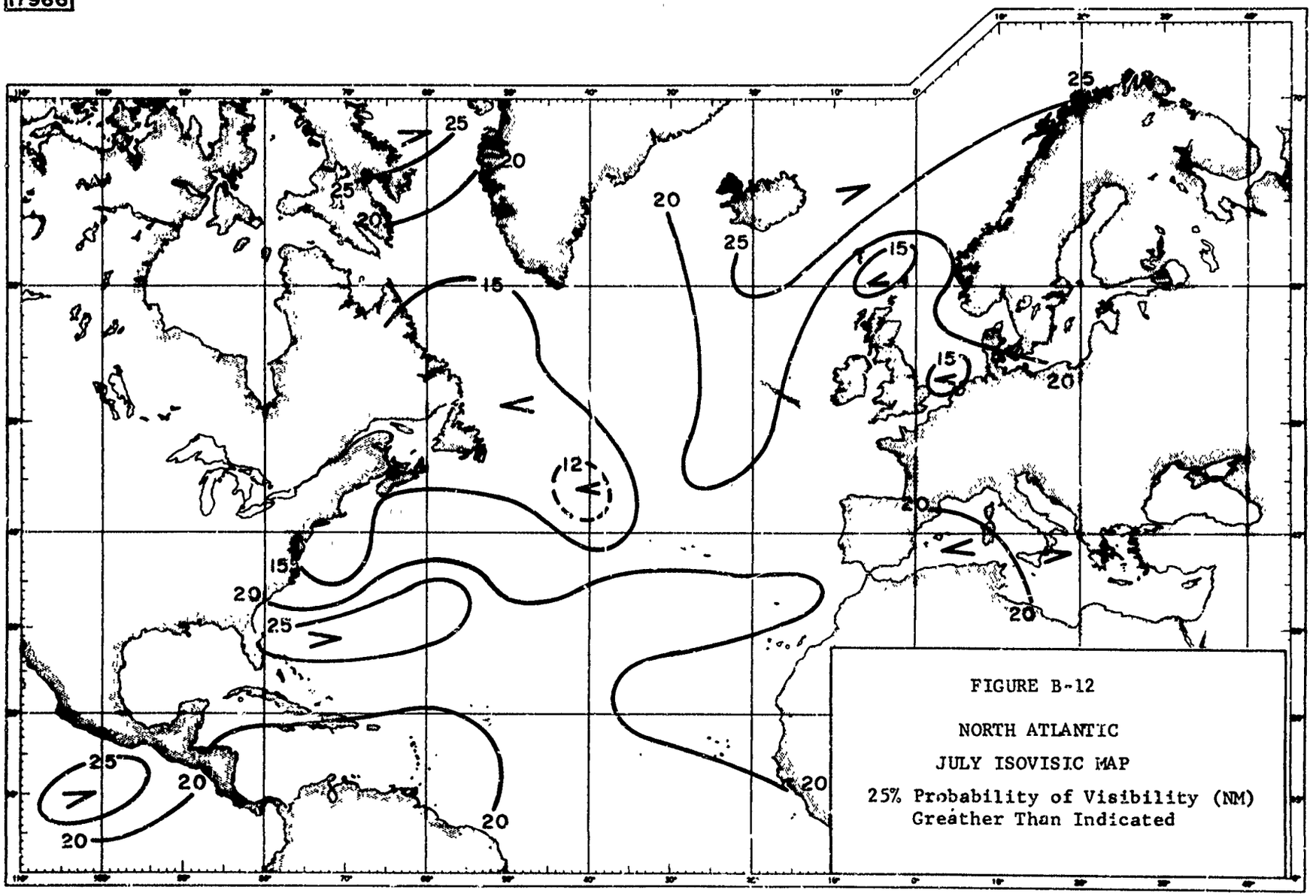


FIGURE B-12

NORTH ATLANTIC

JULY ISOVISIC MAP

25% Probability of Visibility (NM)
Greather Than Indicated

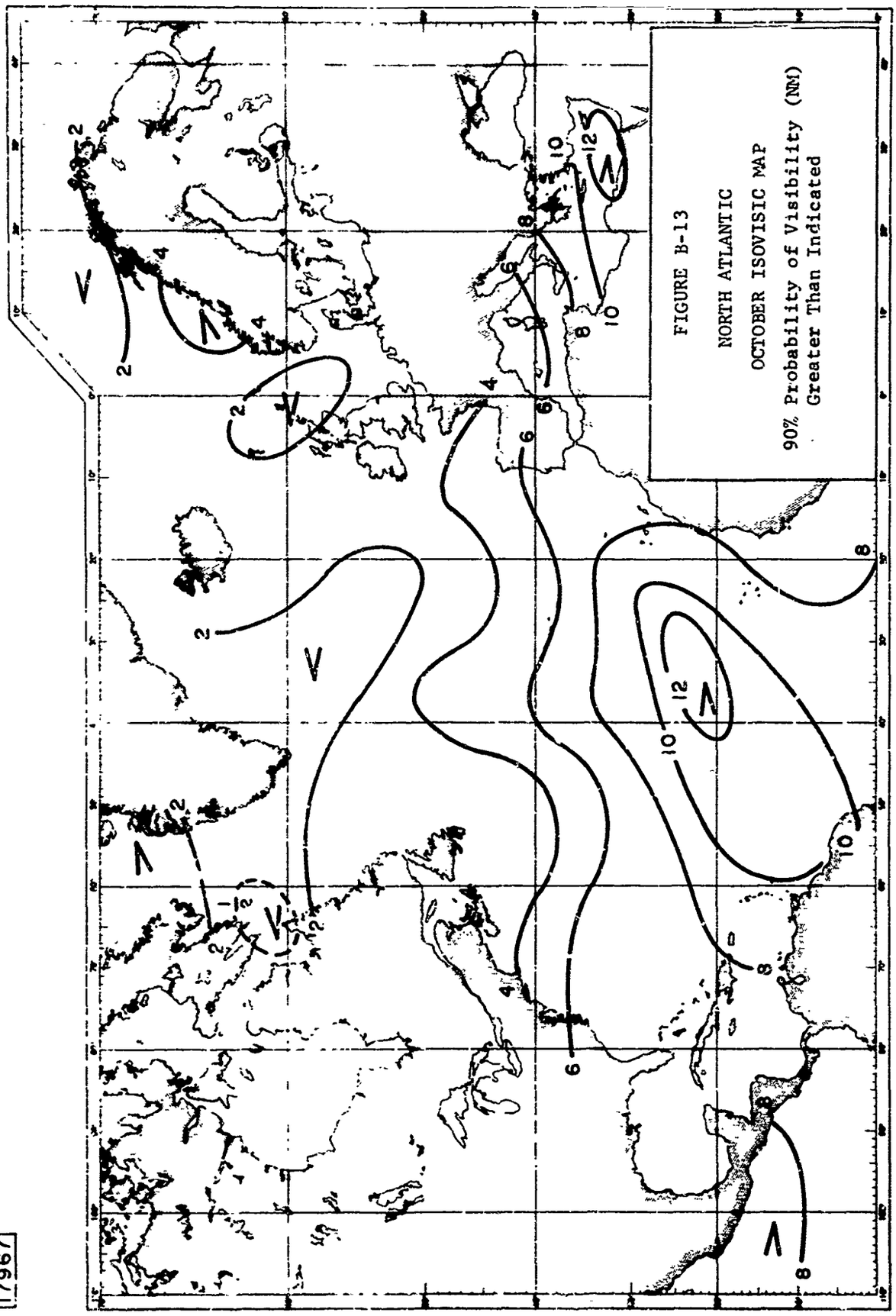


FIGURE B-13
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
17967

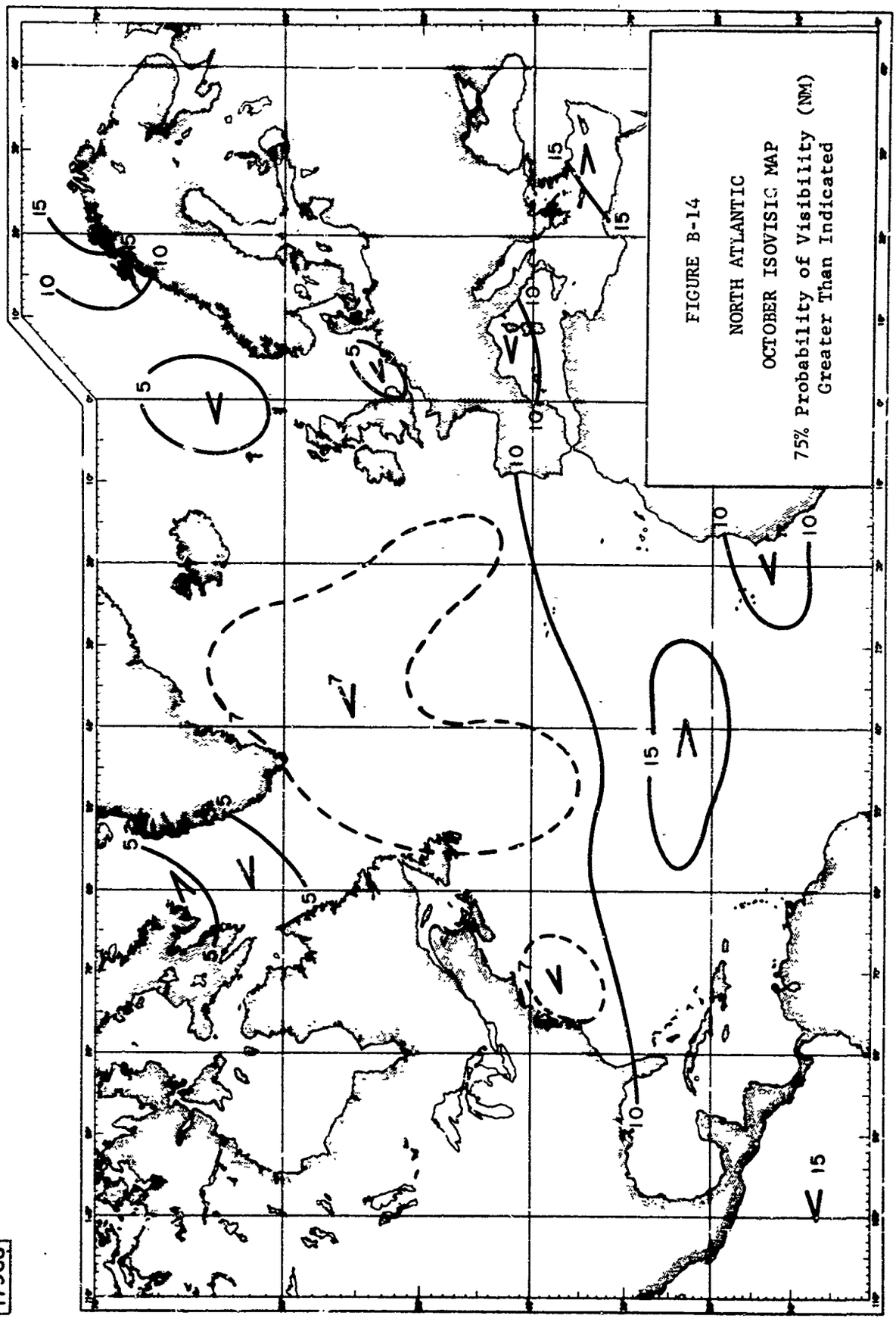


FIGURE B-14
NORTH ATLANTIC
OCTOBER ISOVISIS MAP
75% Probability of Visibility (NM)
Greater Than Indicated
17968

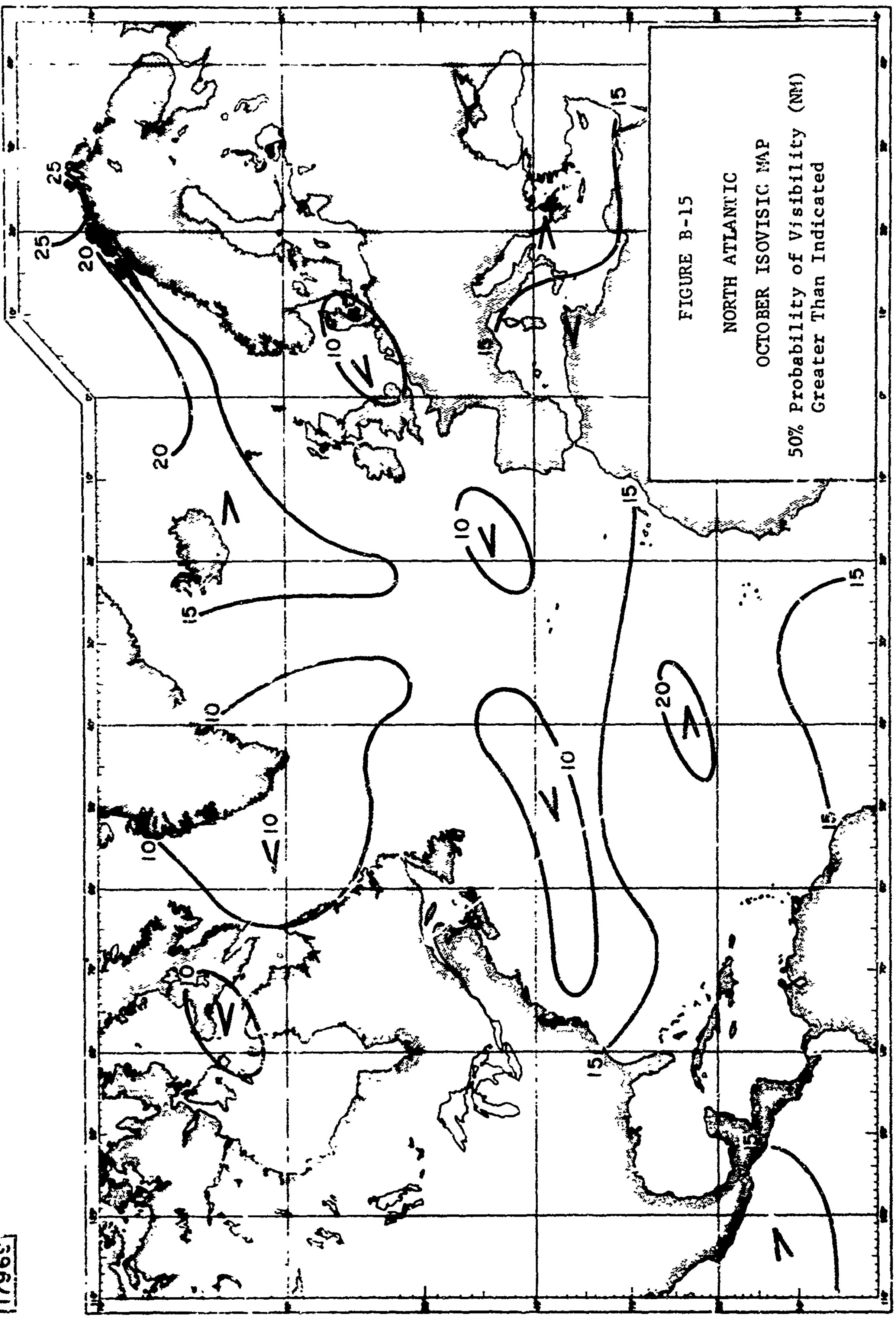


FIGURE B-15

NORTH ATLANTIC

OCTOBER ISOVISIC MAP

50% Probability of Visibility (NM)
Greater Than Indicated

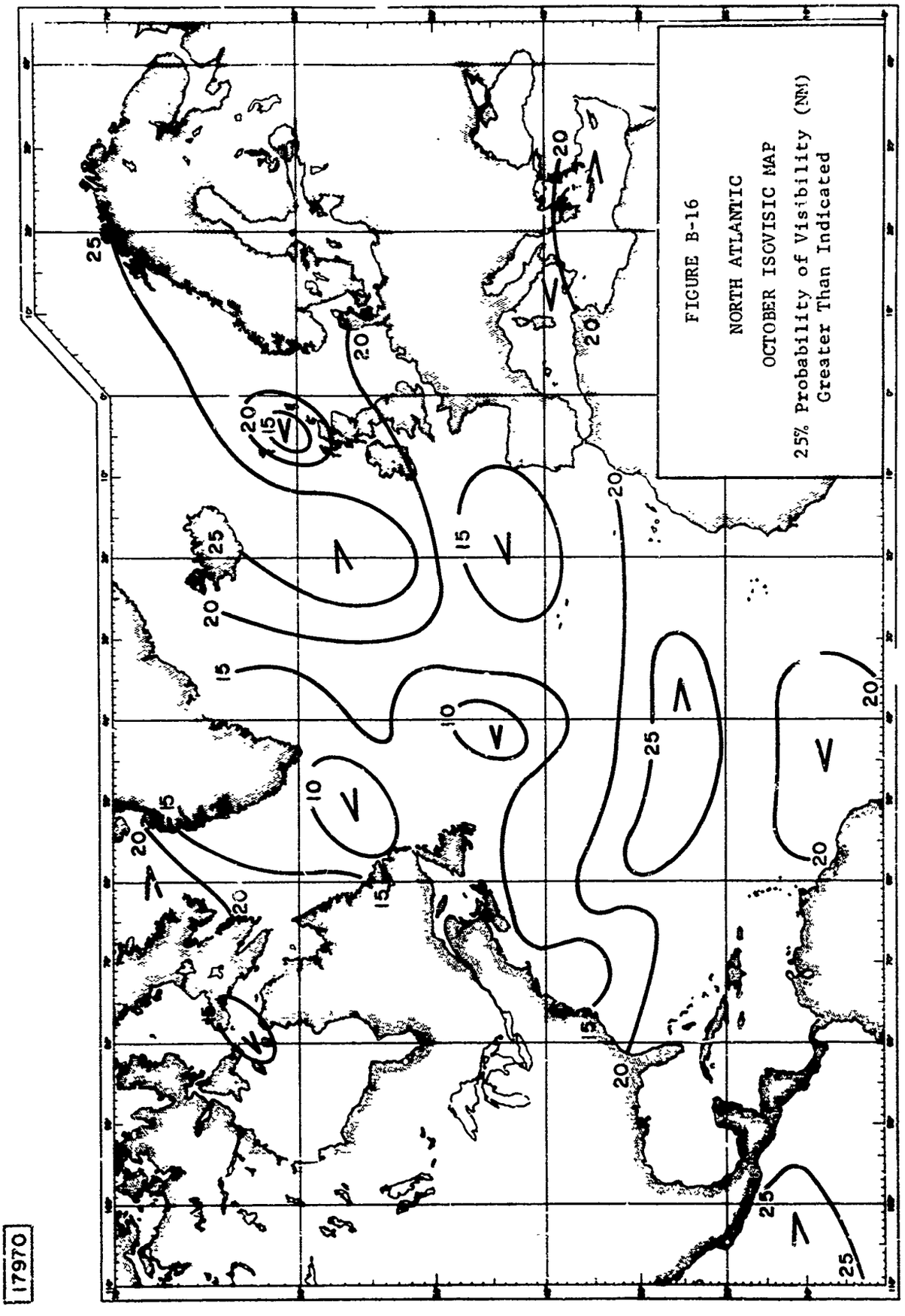


FIGURE B-16
NORTH ATLANTIC
OCTOBER ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
17970

IA-17,971

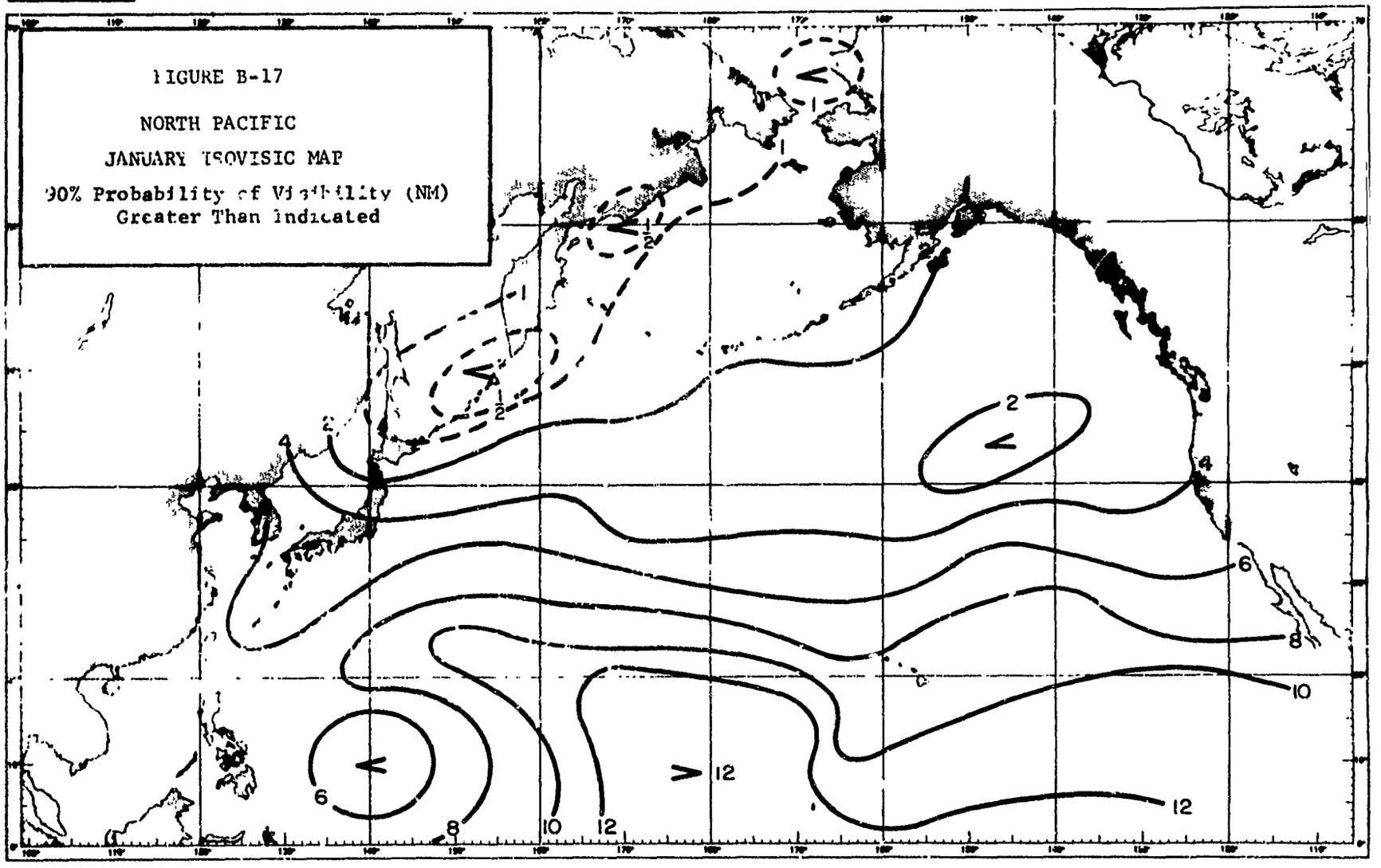


FIGURE B-17
NORTH PACIFIC
JANUARY ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
1/2
1
2
4
6
8
10
12

IA-17,972

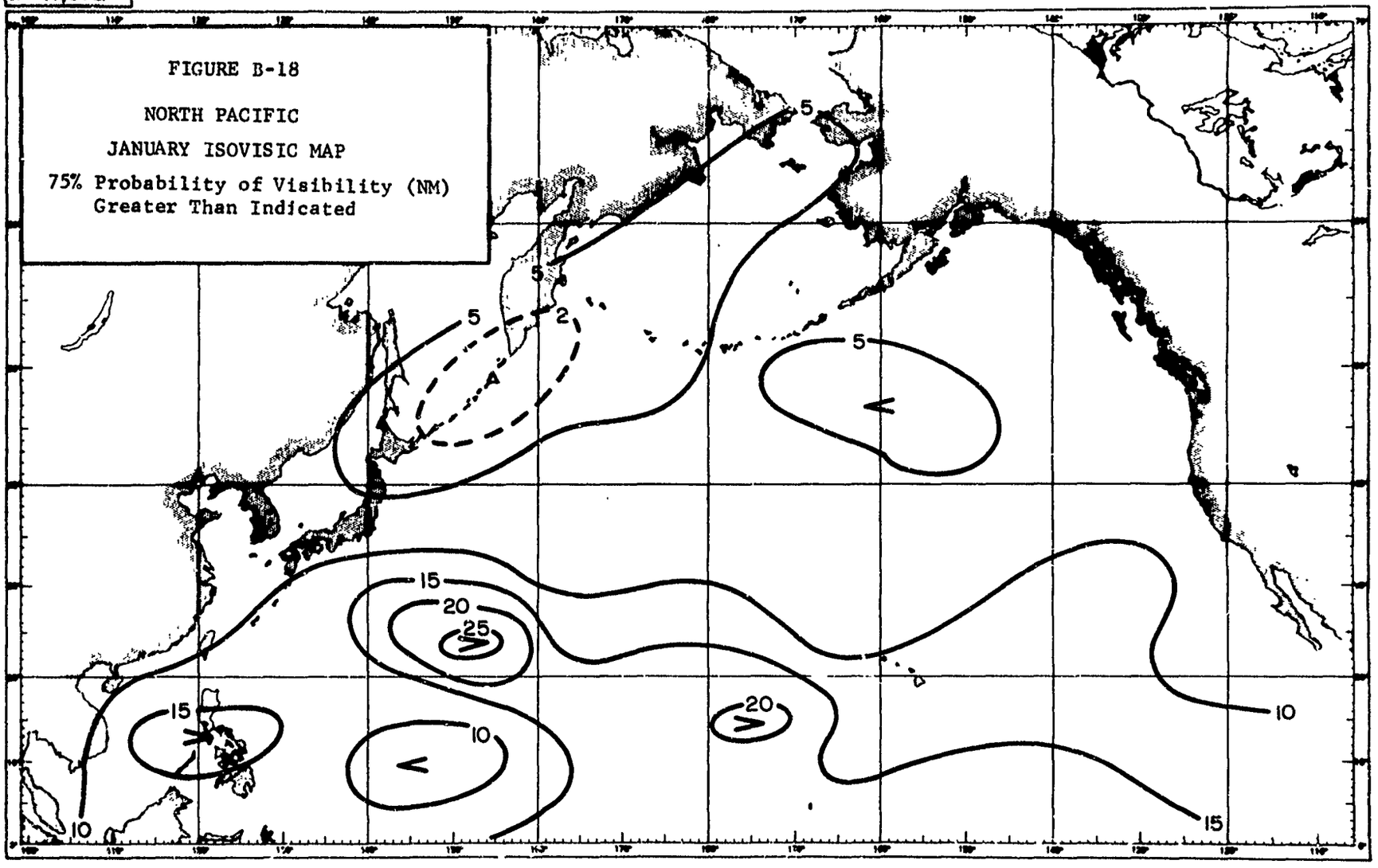
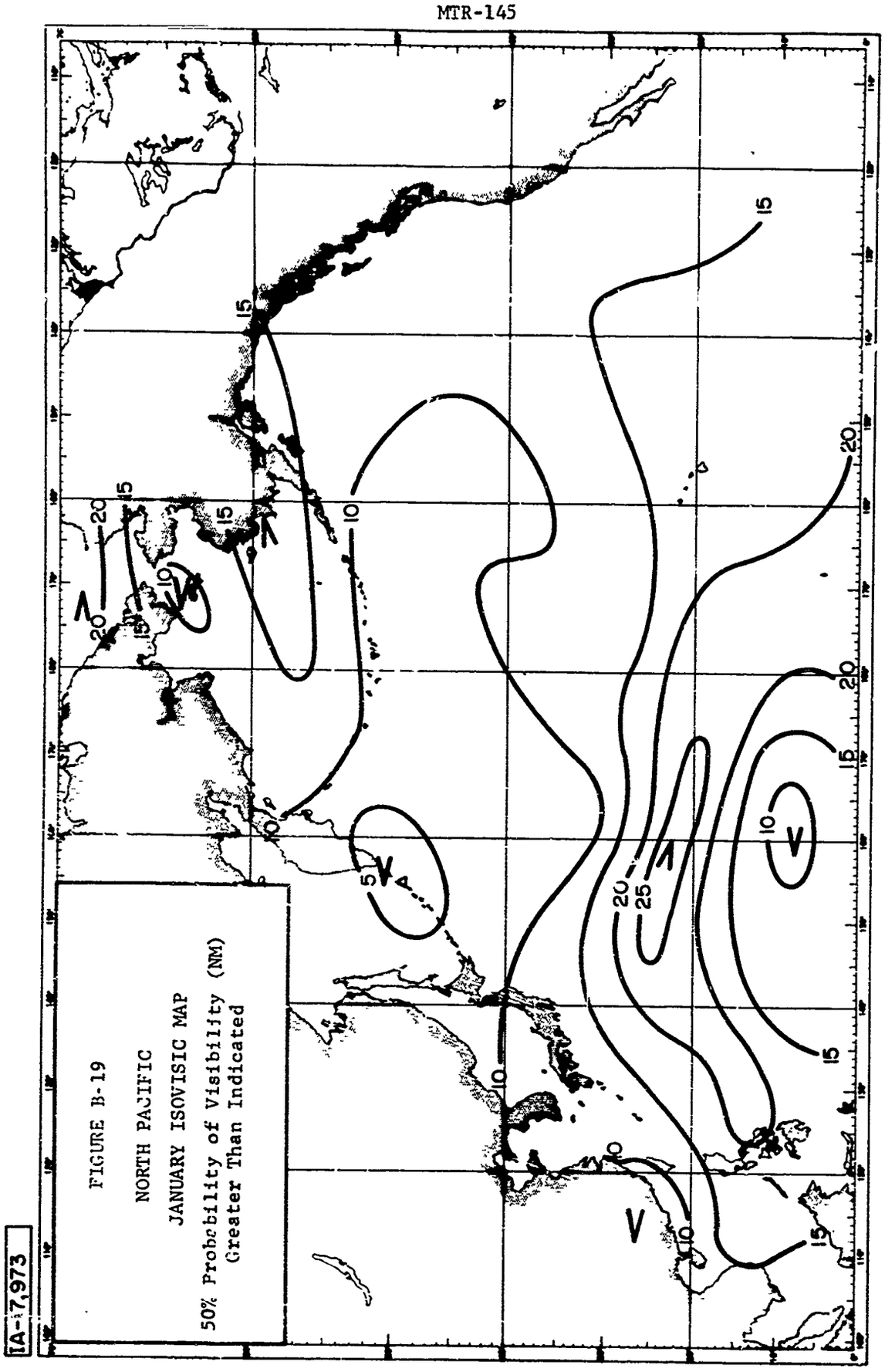


FIGURE B-18
NORTH PACIFIC
JANUARY ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
5
5
5
2
5
15
20
25
15
10
20
10
10
15


IA-7,973
FIGURE B-19
NORTH PACIFIC
JANUARY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated

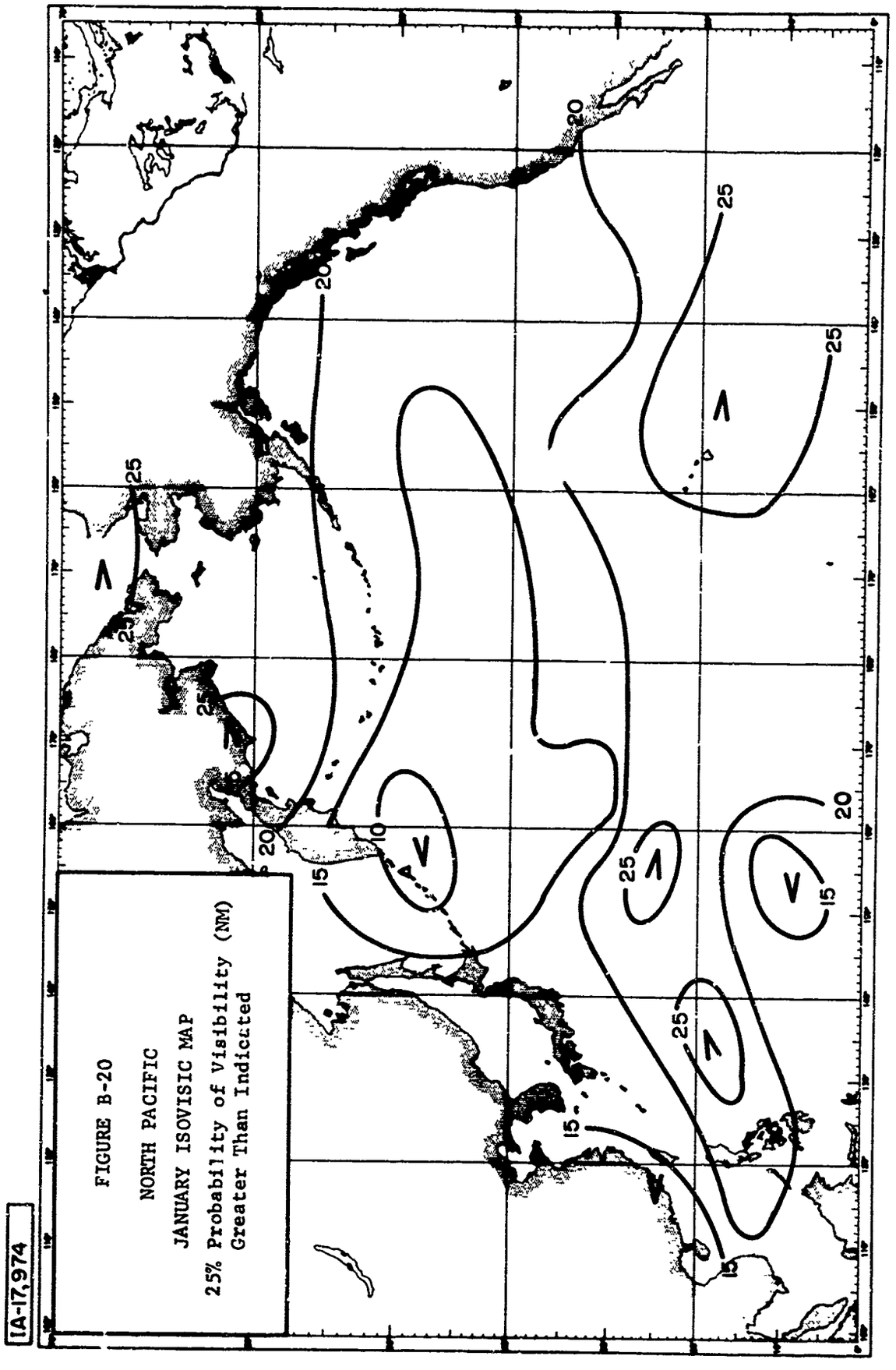
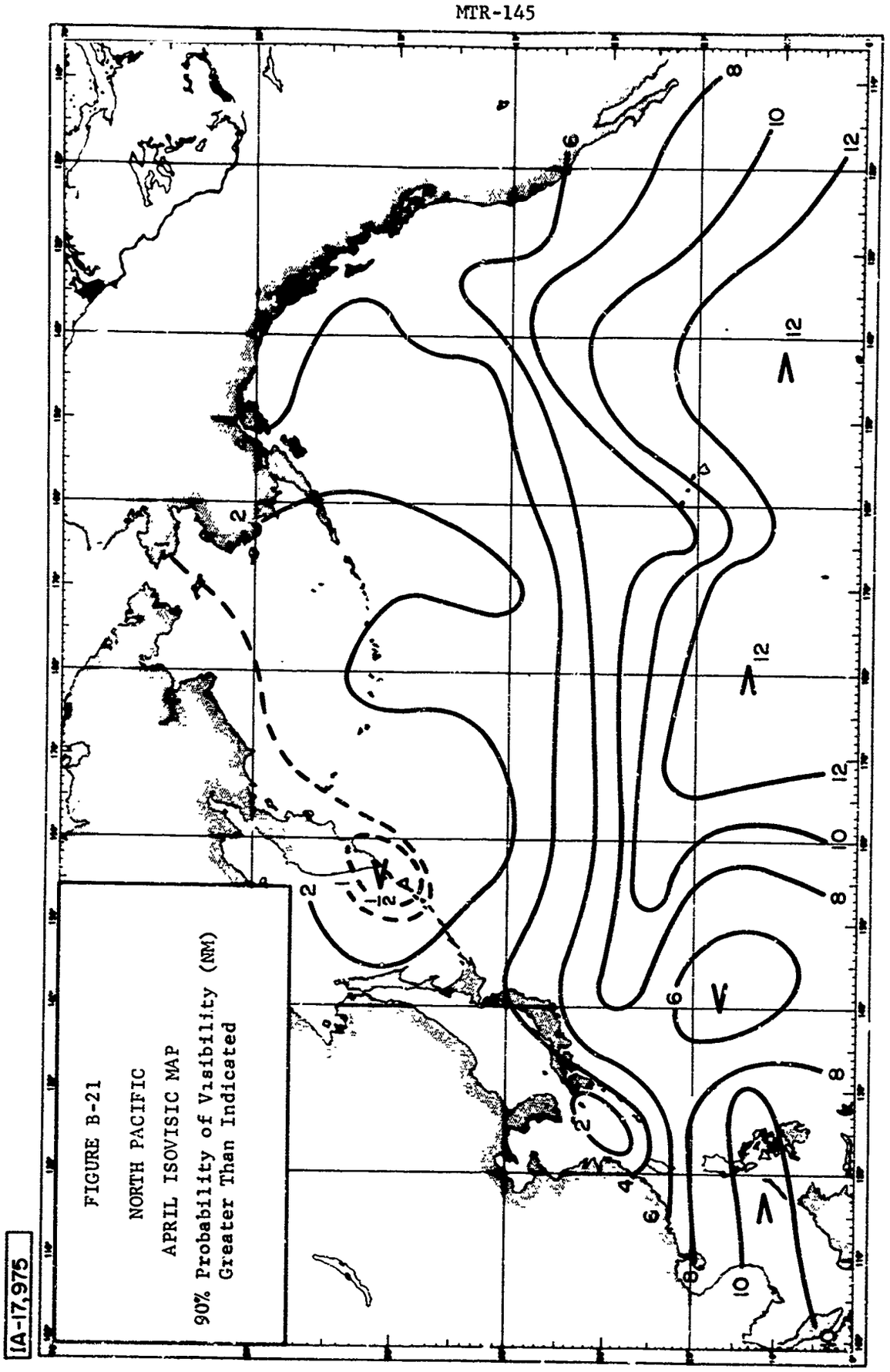
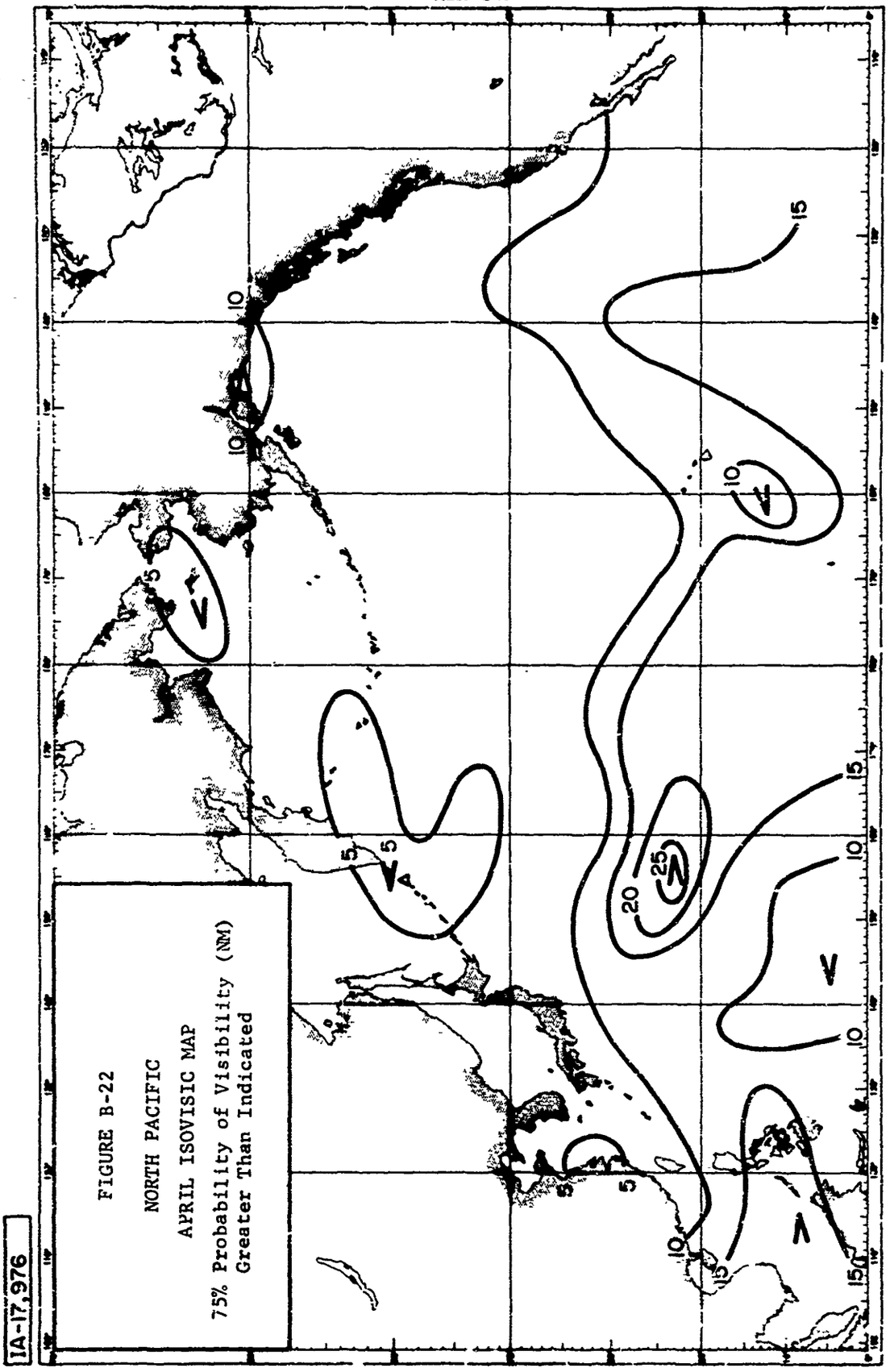


FIGURE B-20
NORTH PACIFIC
JANUARY ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
IA-17,974


IA-17,975
FIGURE B-21
NORTH PACIFIC
APRIL ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated


IA-17,976
FIGURE B-22
NORTH PACIFIC
APRIL ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated

[A-17,977]

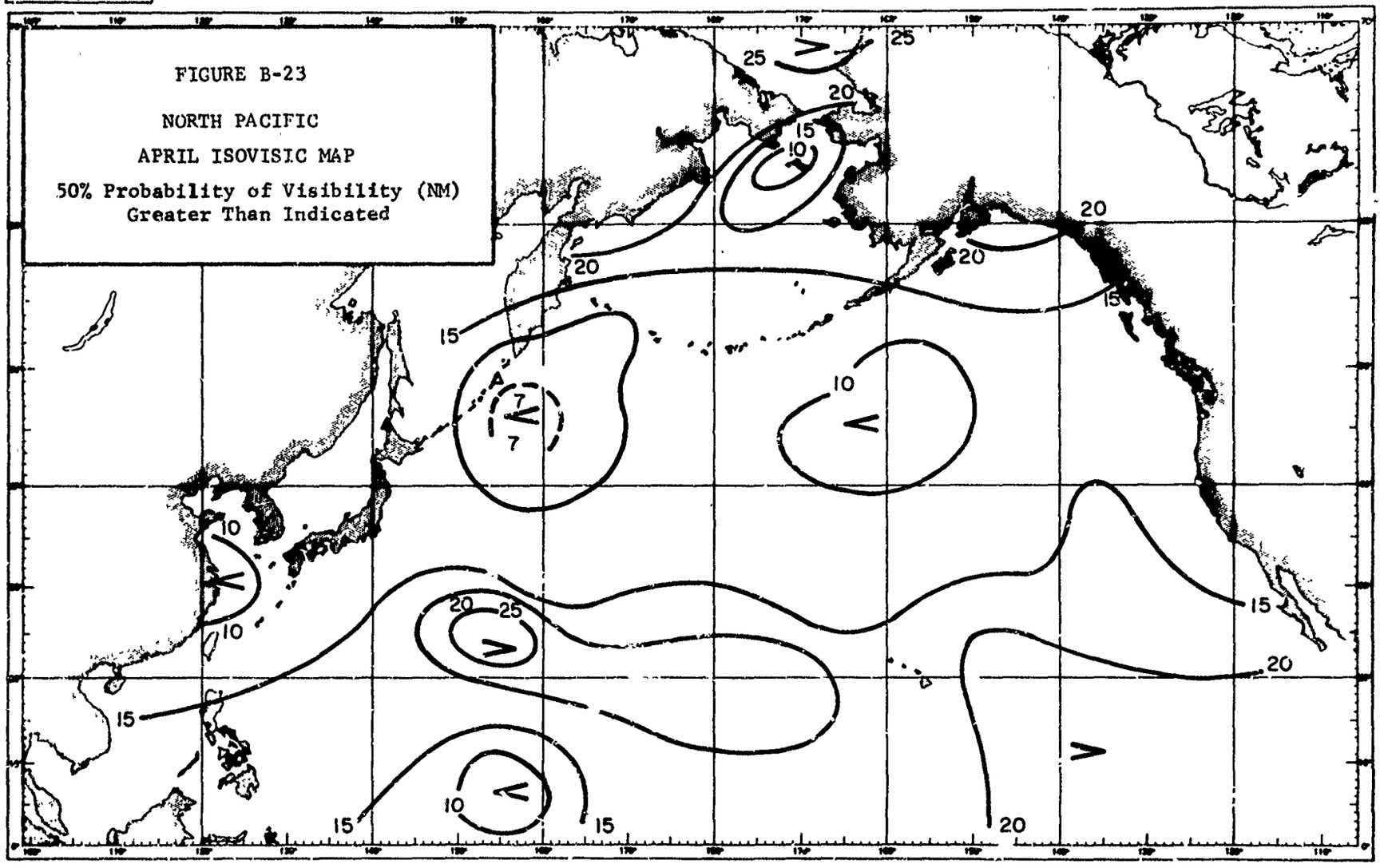


FIGURE B-23
NORTH PACIFIC
APRIL ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
25
20
15
10
7
A
C

IA-17,978

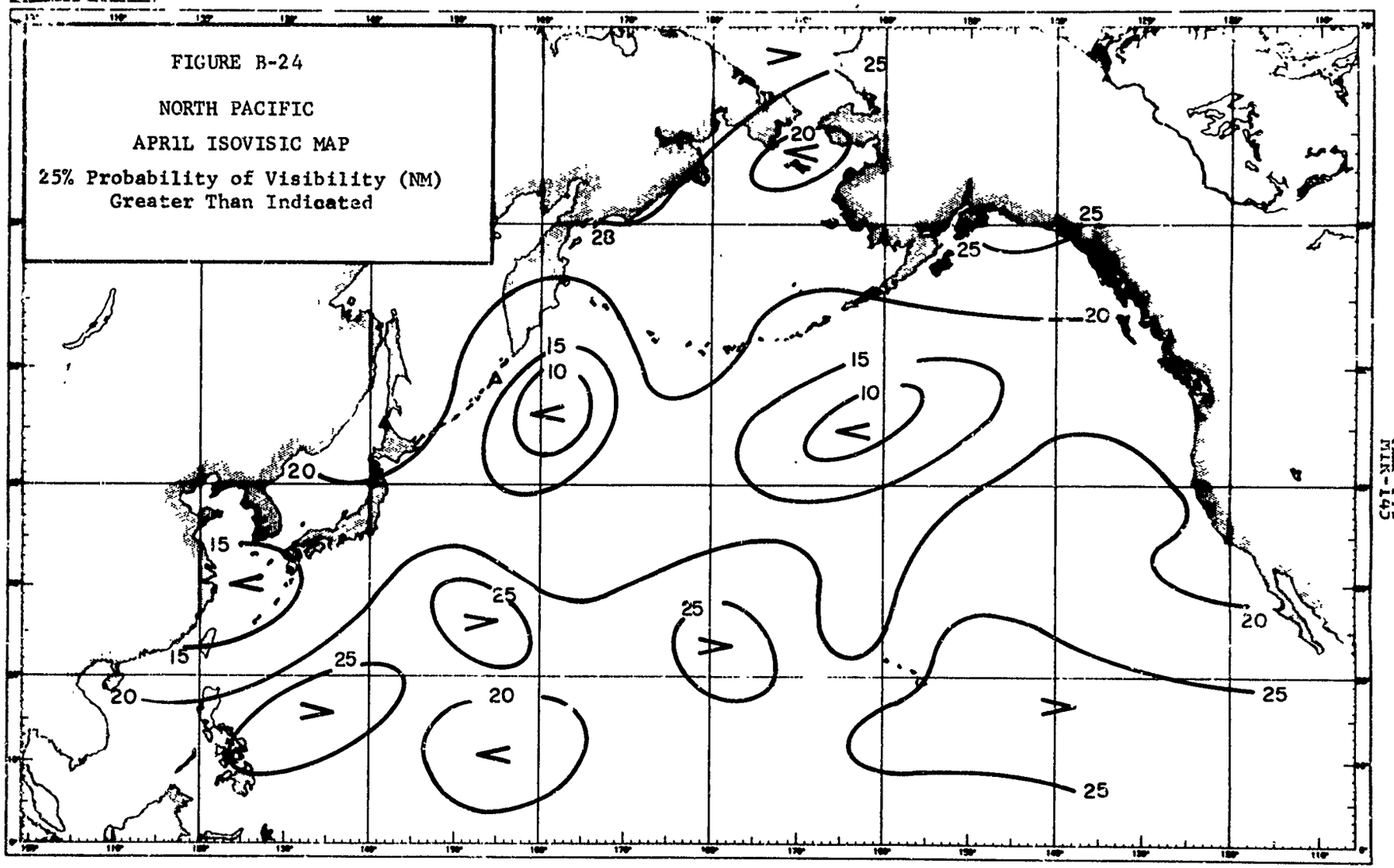


FIGURE B-24
NORTH PACIFIC
APRIL ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
25
20
28
25
25
20
15
10
15
10
20
15
25
25
20
15
25
20
20
25
25

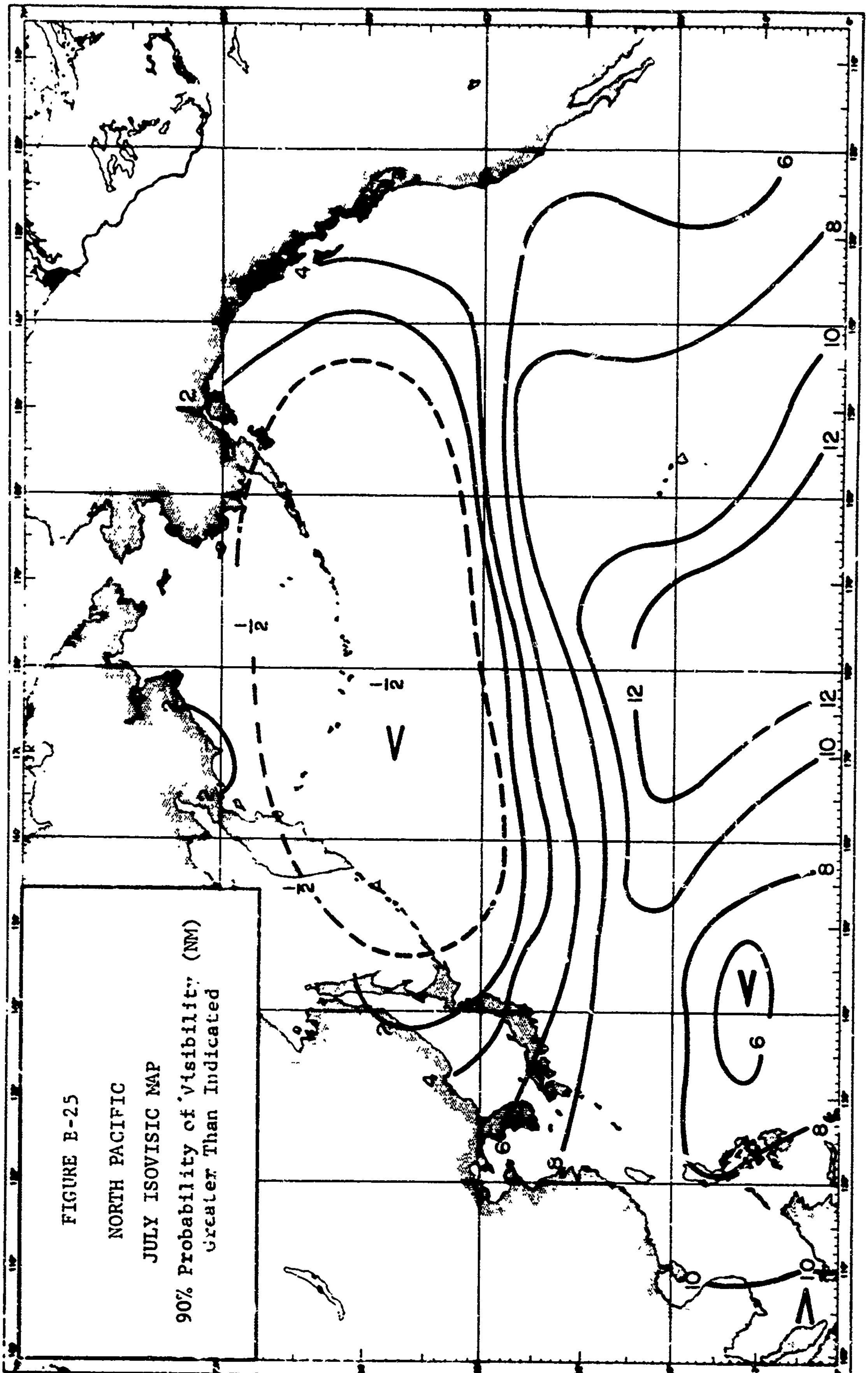


FIGURE B-25

NORTH PACIFIC

JULY ISOVISIC MAP

90% Probability of Visibility (NM) Greater Than Indicated

IA-17,979

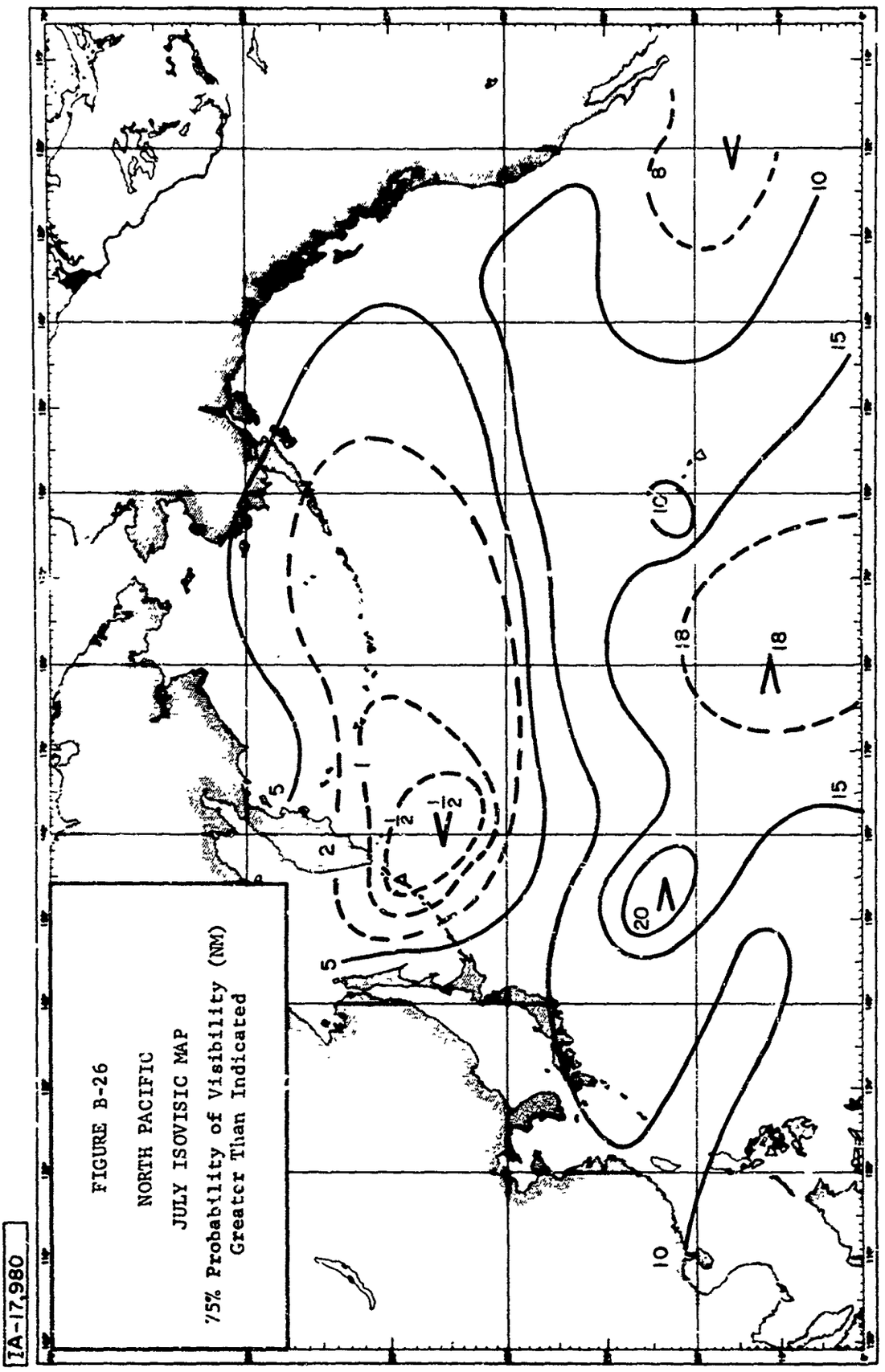
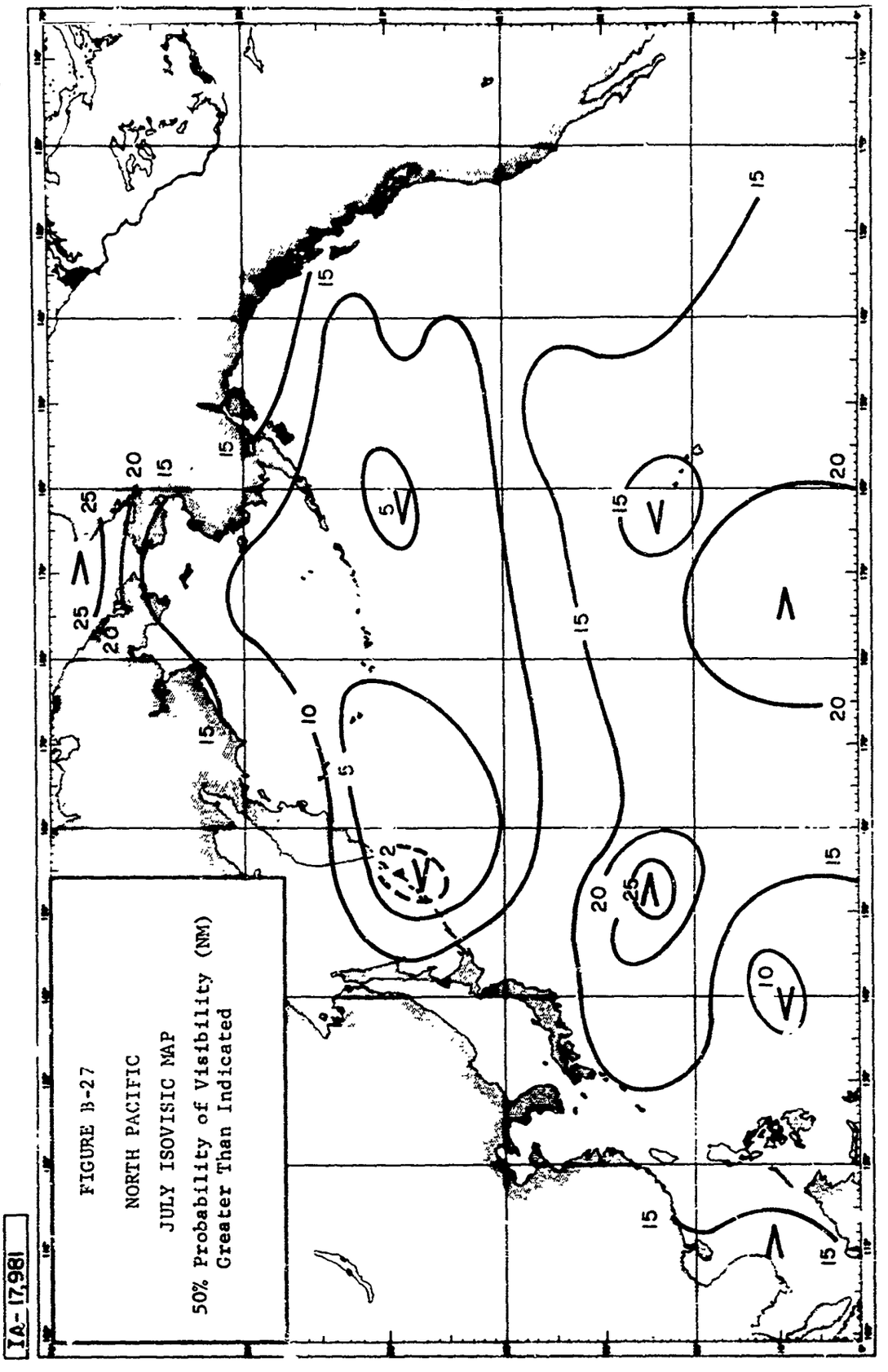


FIGURE B-26
NORTH PACIFIC
JULY ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
IA-17,980
½
1
2
5
10
15
18
20


IA-17,981
FIGURE B-27
NORTH PACIFIC
JULY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated

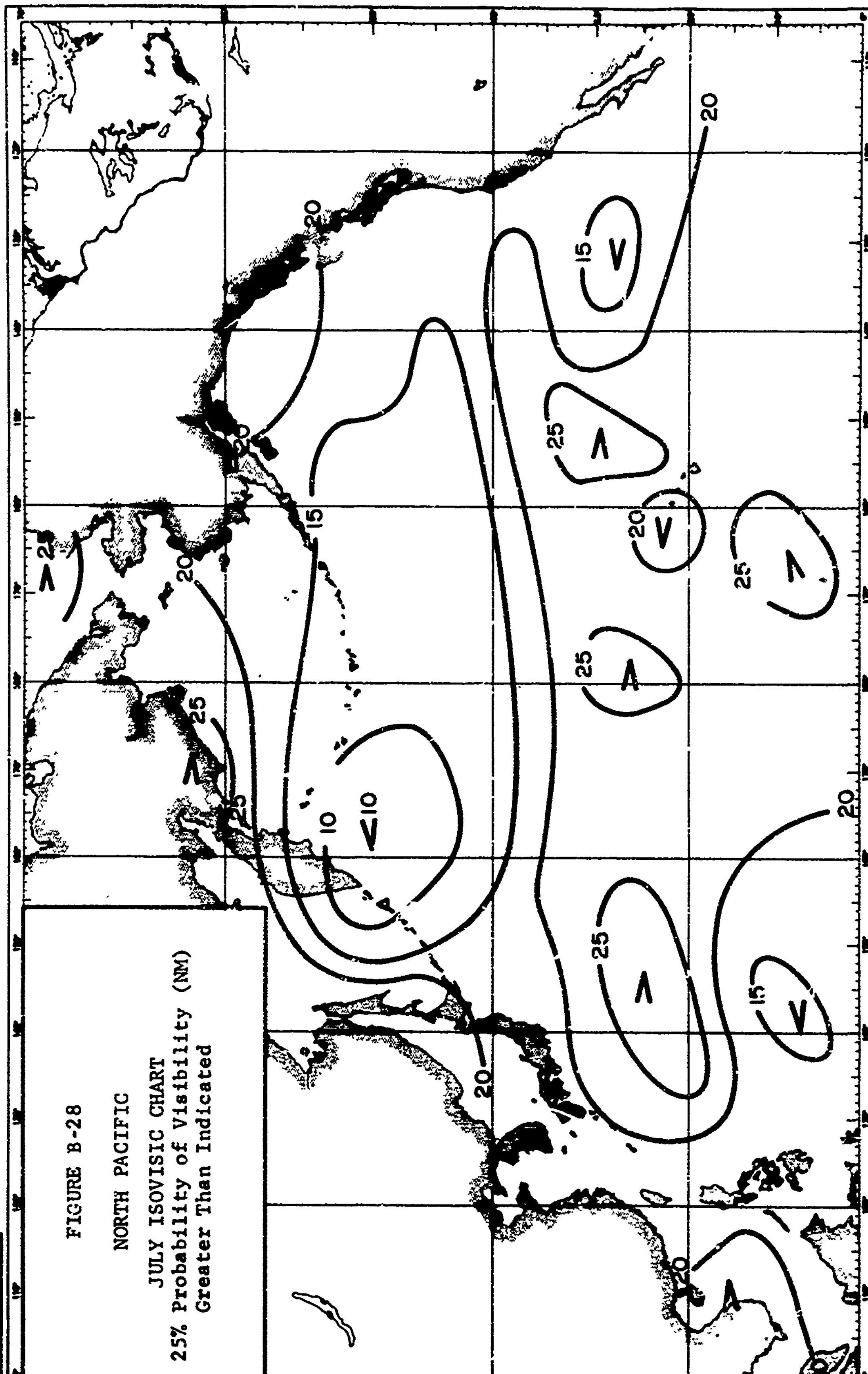
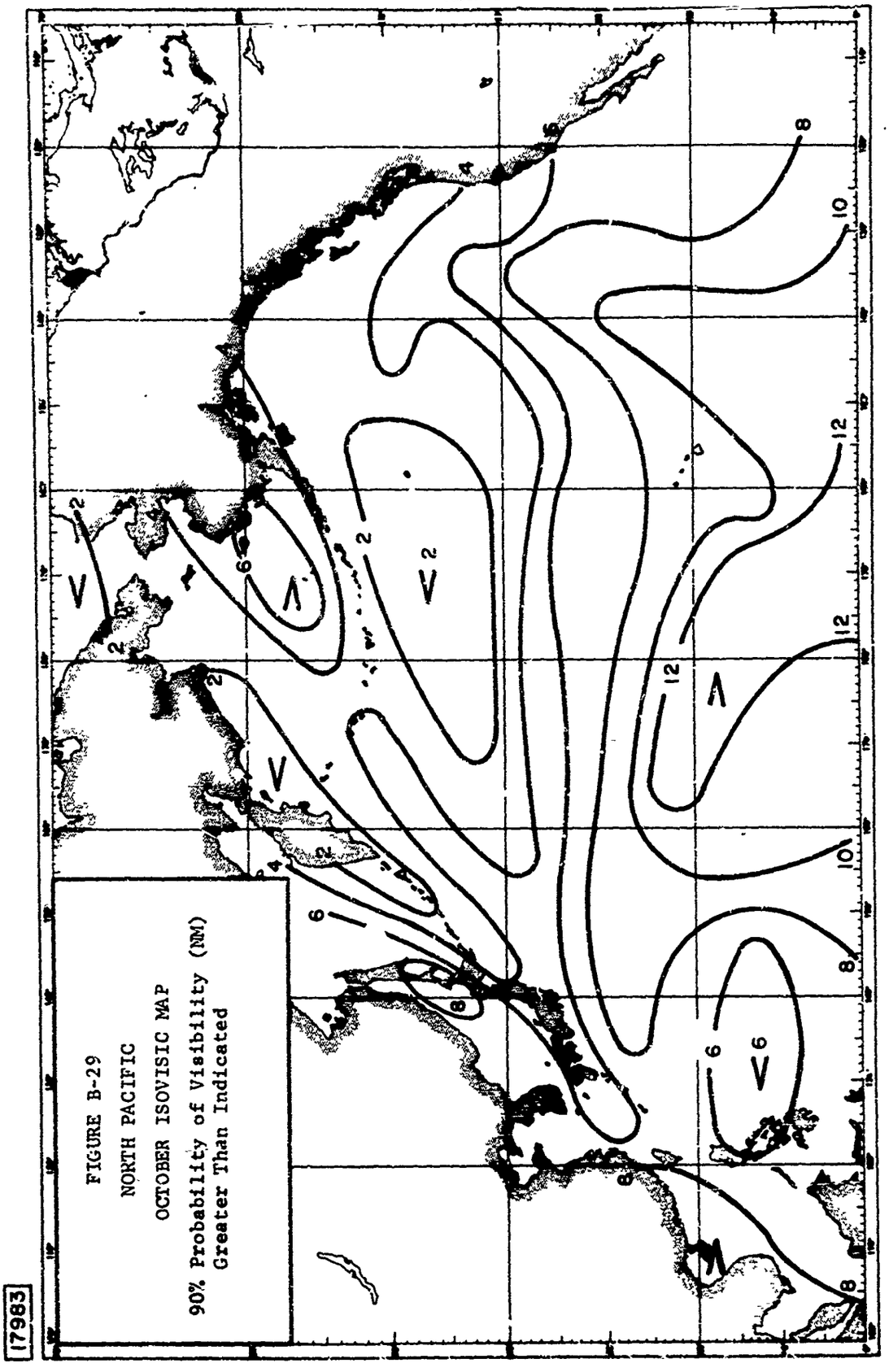


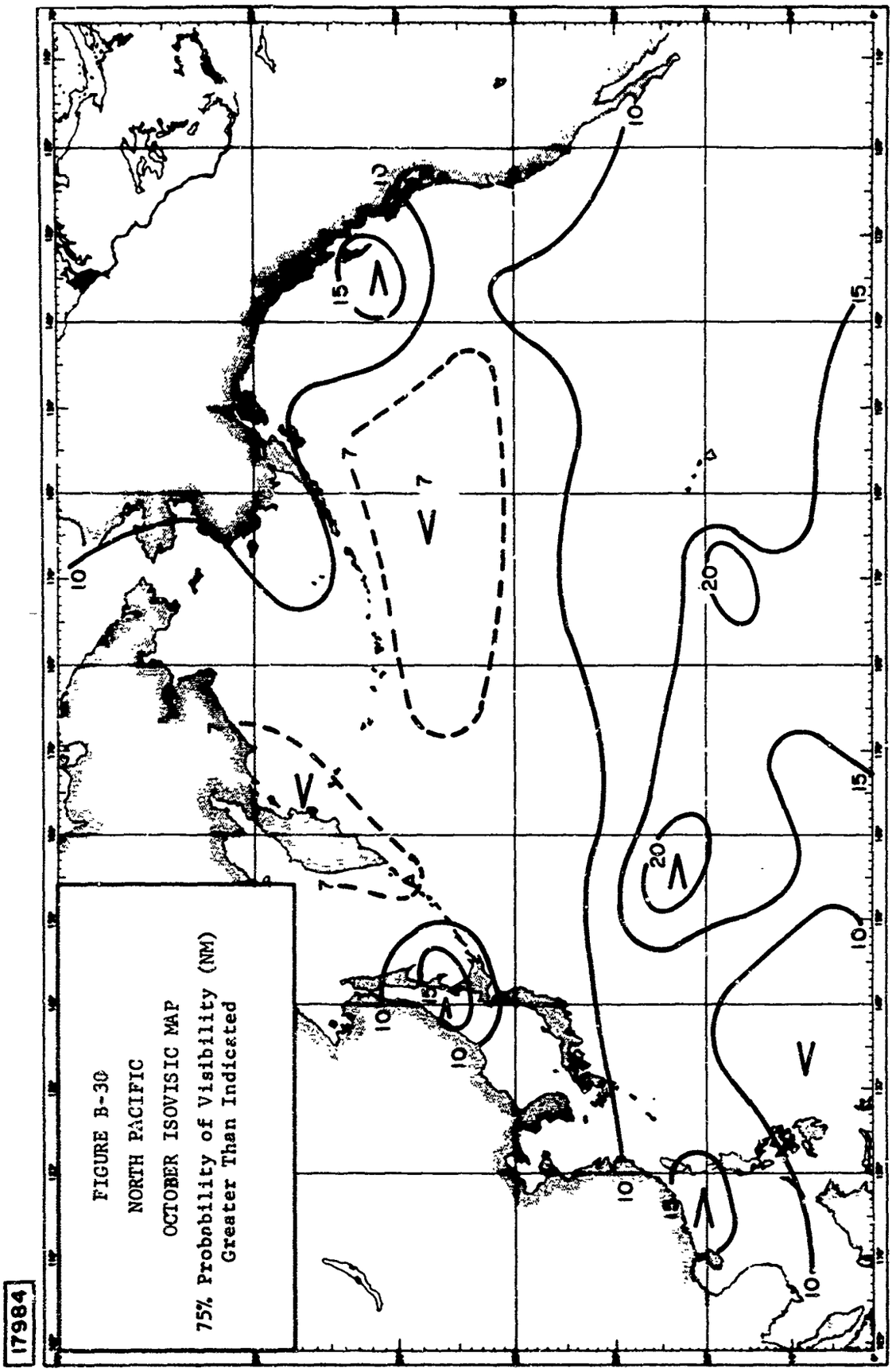
FIGURE B-28

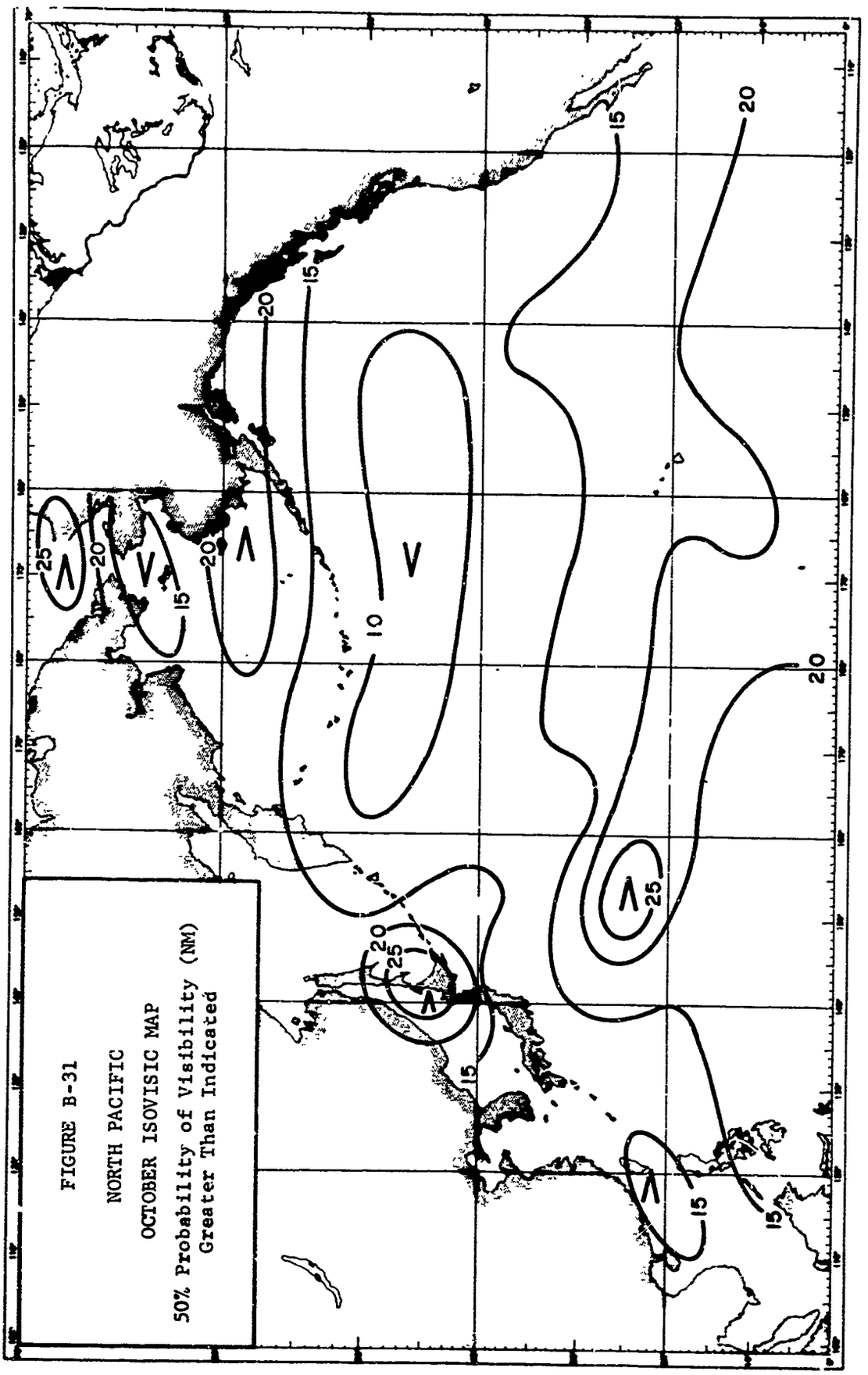
NORTH PACIFIC

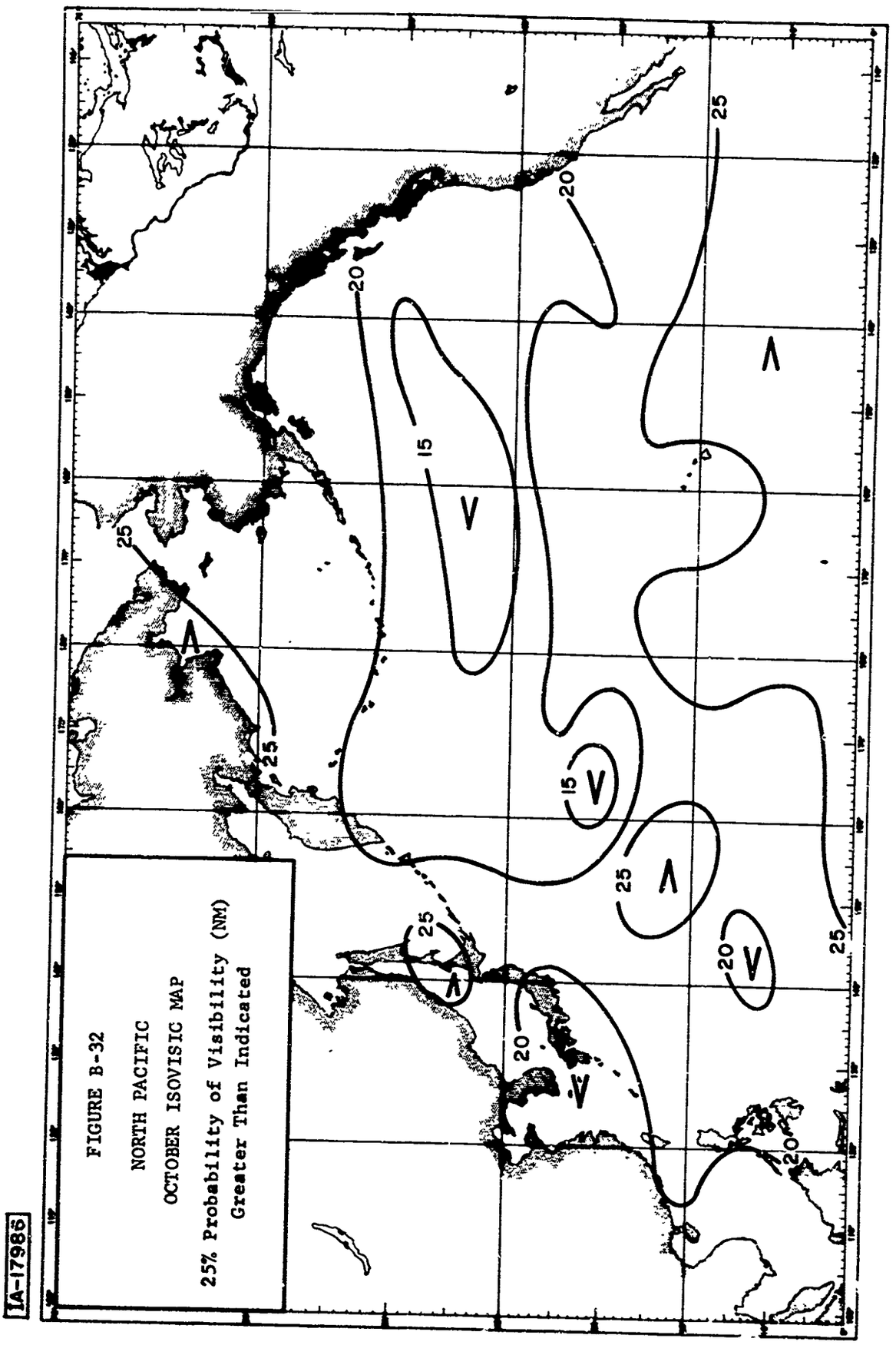
JULY ISOVISIC CHART
25% Probability of Visibility (NM)
Greater Than Indicated

IA-17,982


17983
FIGURE B-29
NORTH PACIFIC
OCTOBER ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
2
6
8
10
12


17984
FIGURE B-30
NORTH PACIFIC
OCTOBER ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
V
7
10
15
20


IA-17985
FIGURE B-31
NORTH PACIFIC
OCTOBER ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
10
15
20
25


IA-17986
FIGURE B-32
NORTH PACIFIC
OCTOBER ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
25
20
15

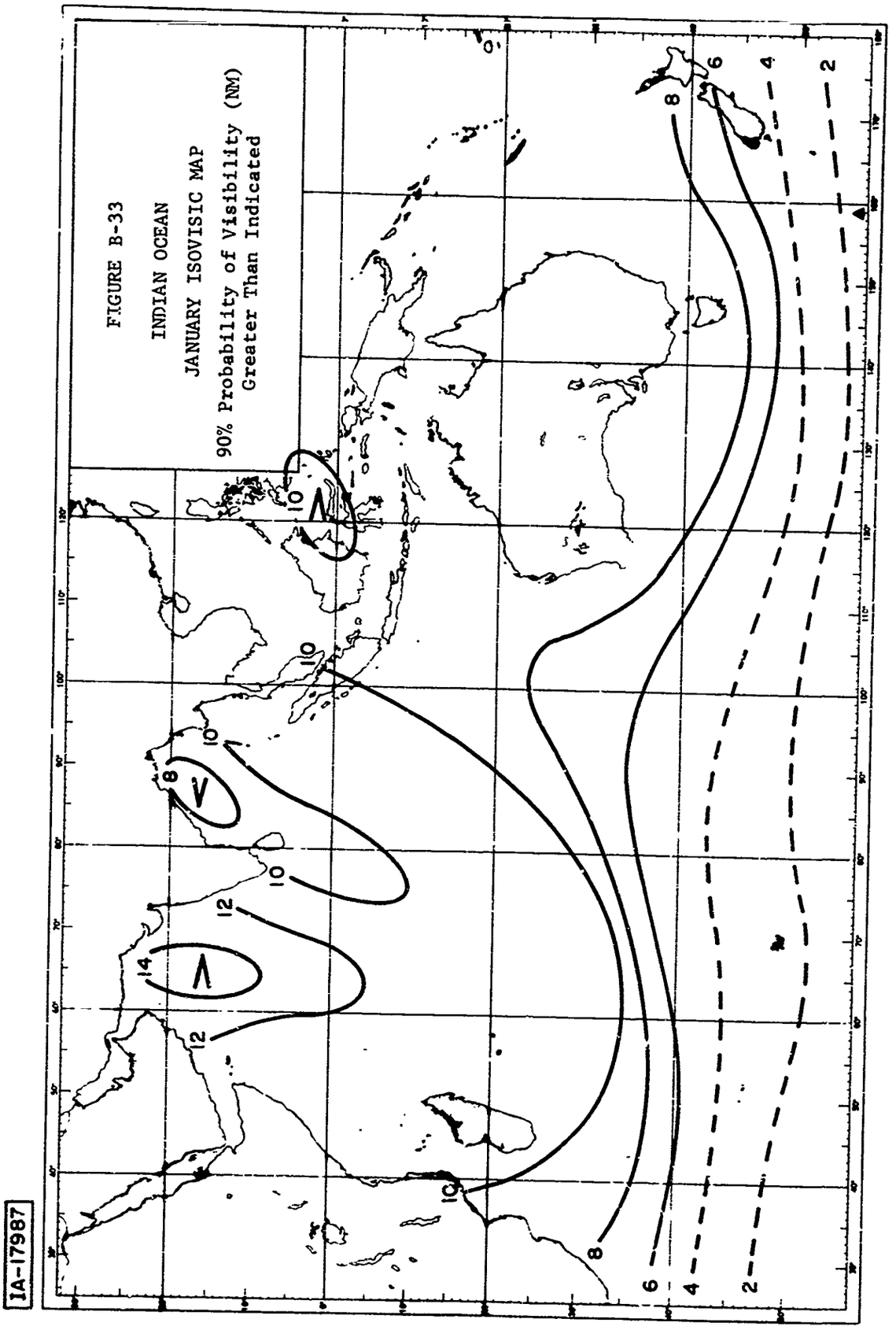


FIGURE B-33
INDIAN OCEAN
JANUARY ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
IA-17987

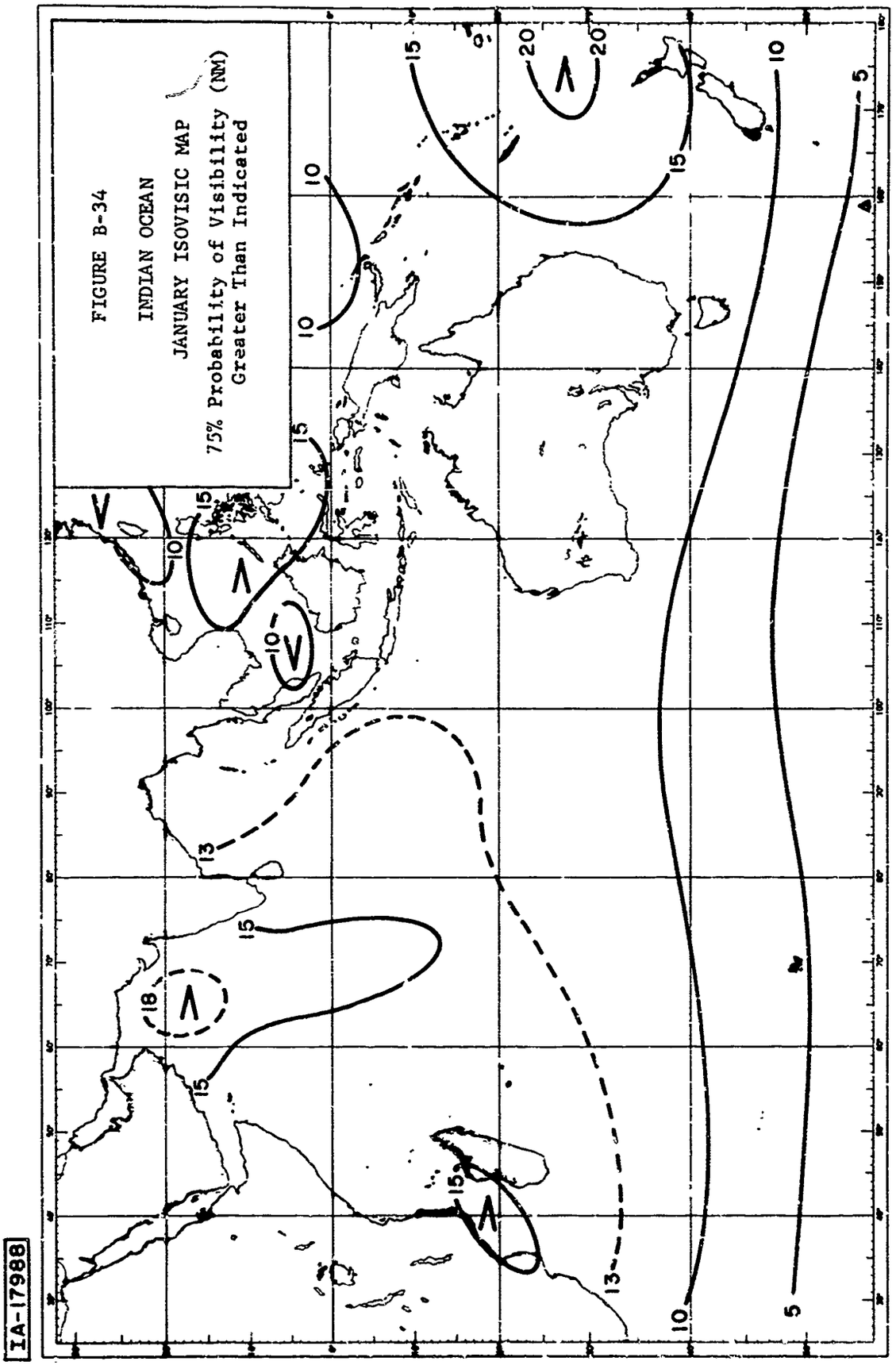


FIGURE B-34
INDIAN OCEAN
JANUARY ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
IA-17988

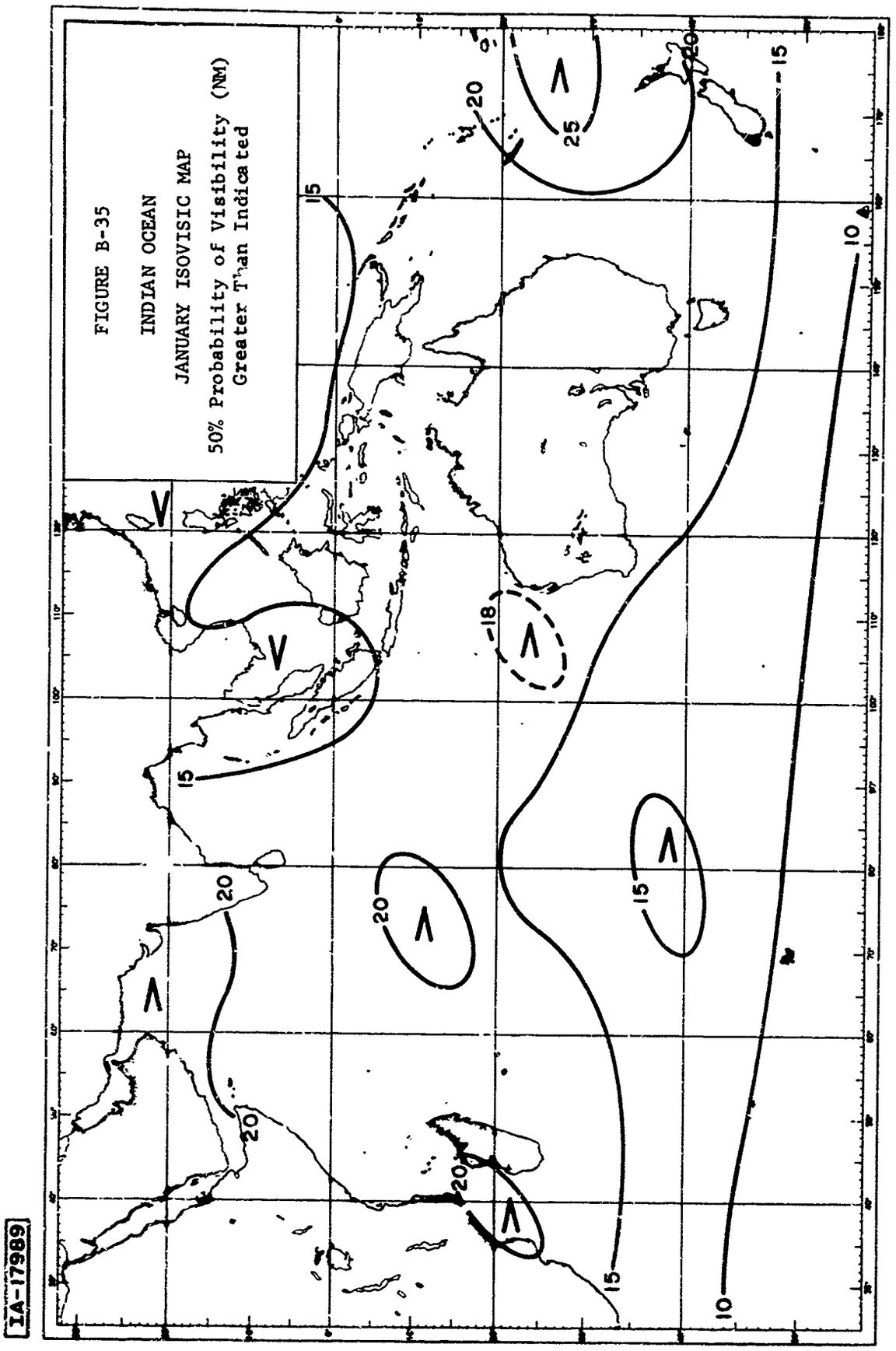


FIGURE B-35
INDIAN OCEAN
JANUARY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
IA-17989

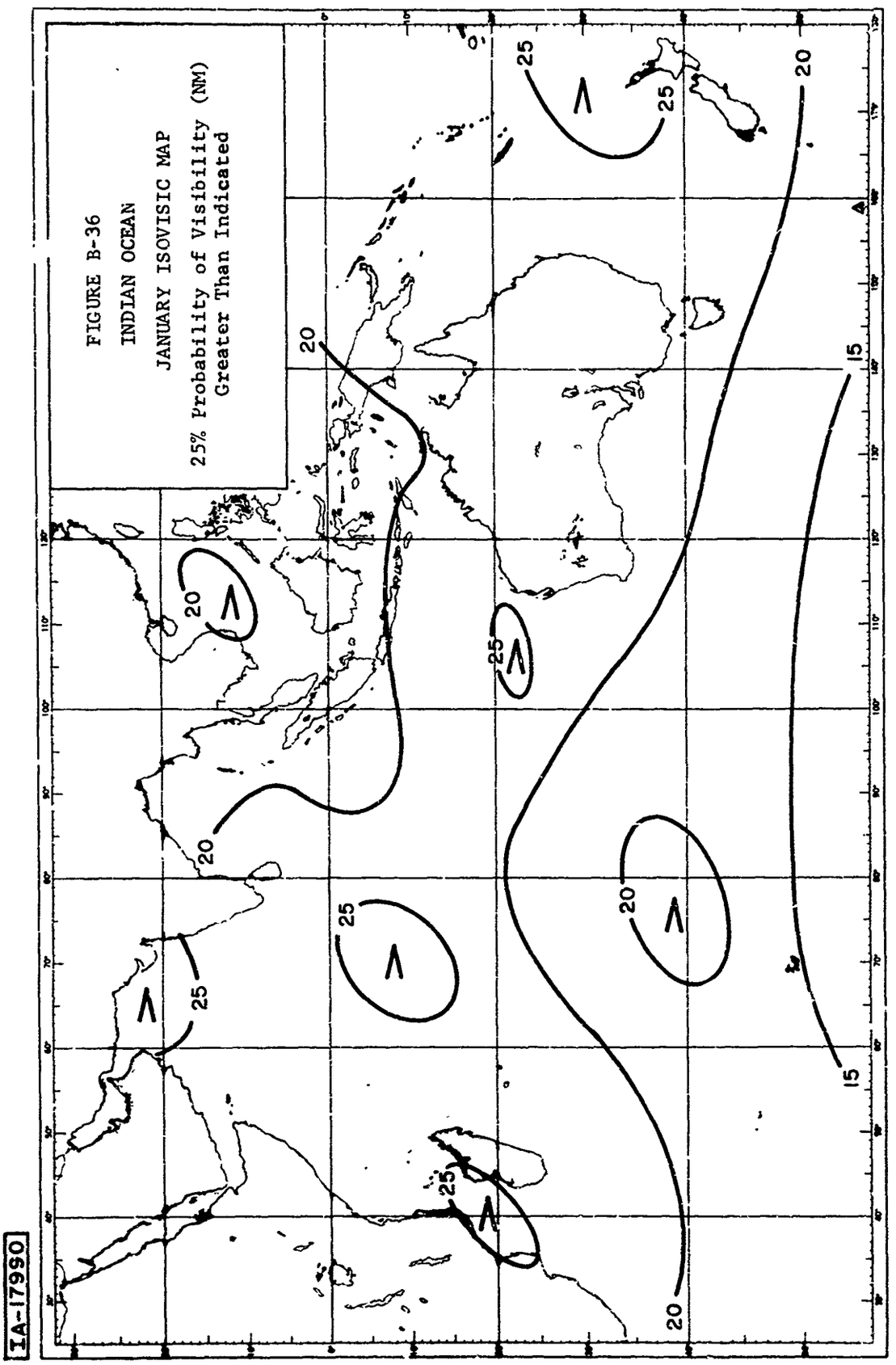


FIGURE B-36
INDIAN OCEAN
JANUARY ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
20
25
15
IA-17990

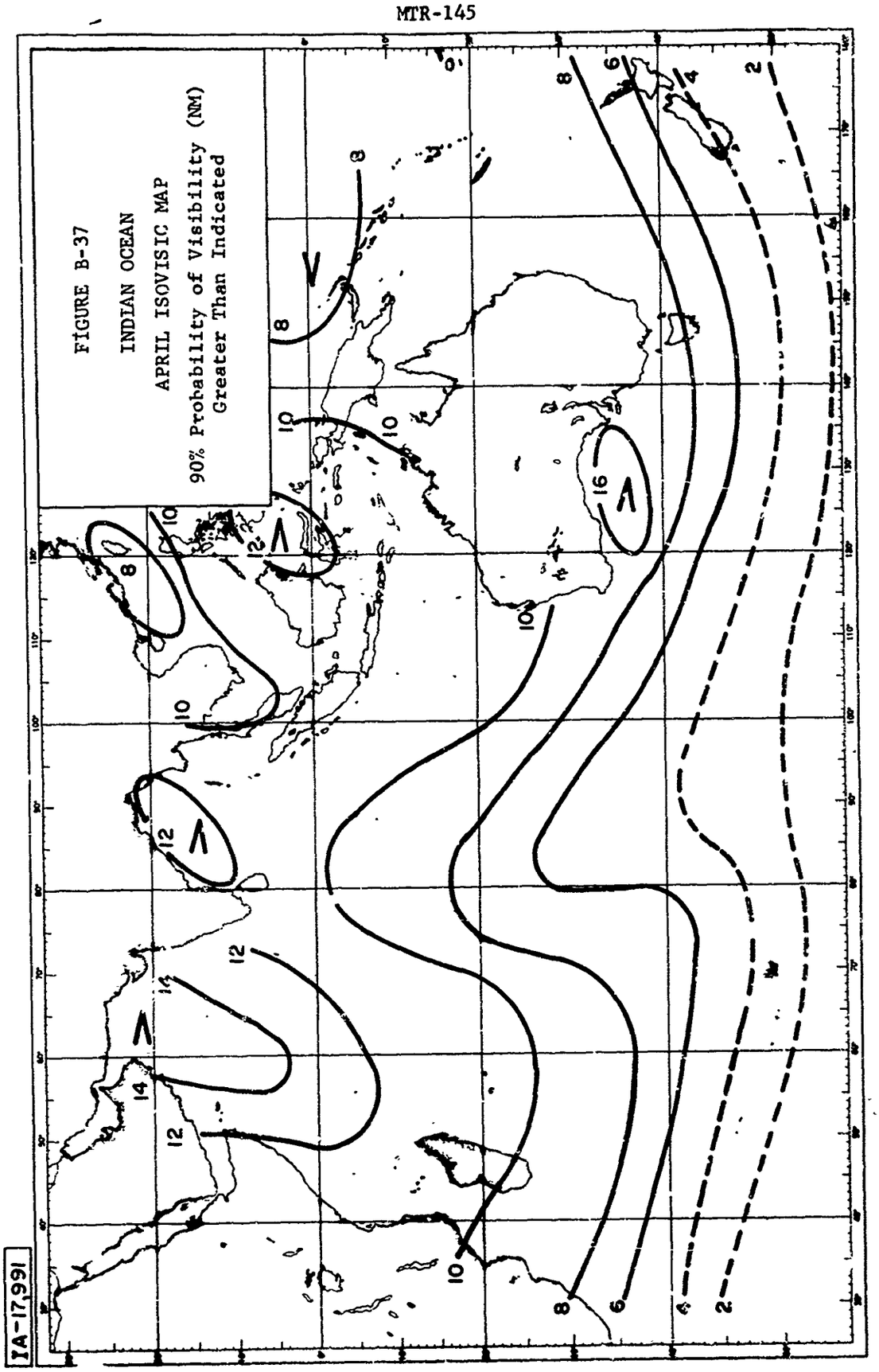


FIGURE B-37
INDIAN OCEAN
APRIL ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
IA-17991

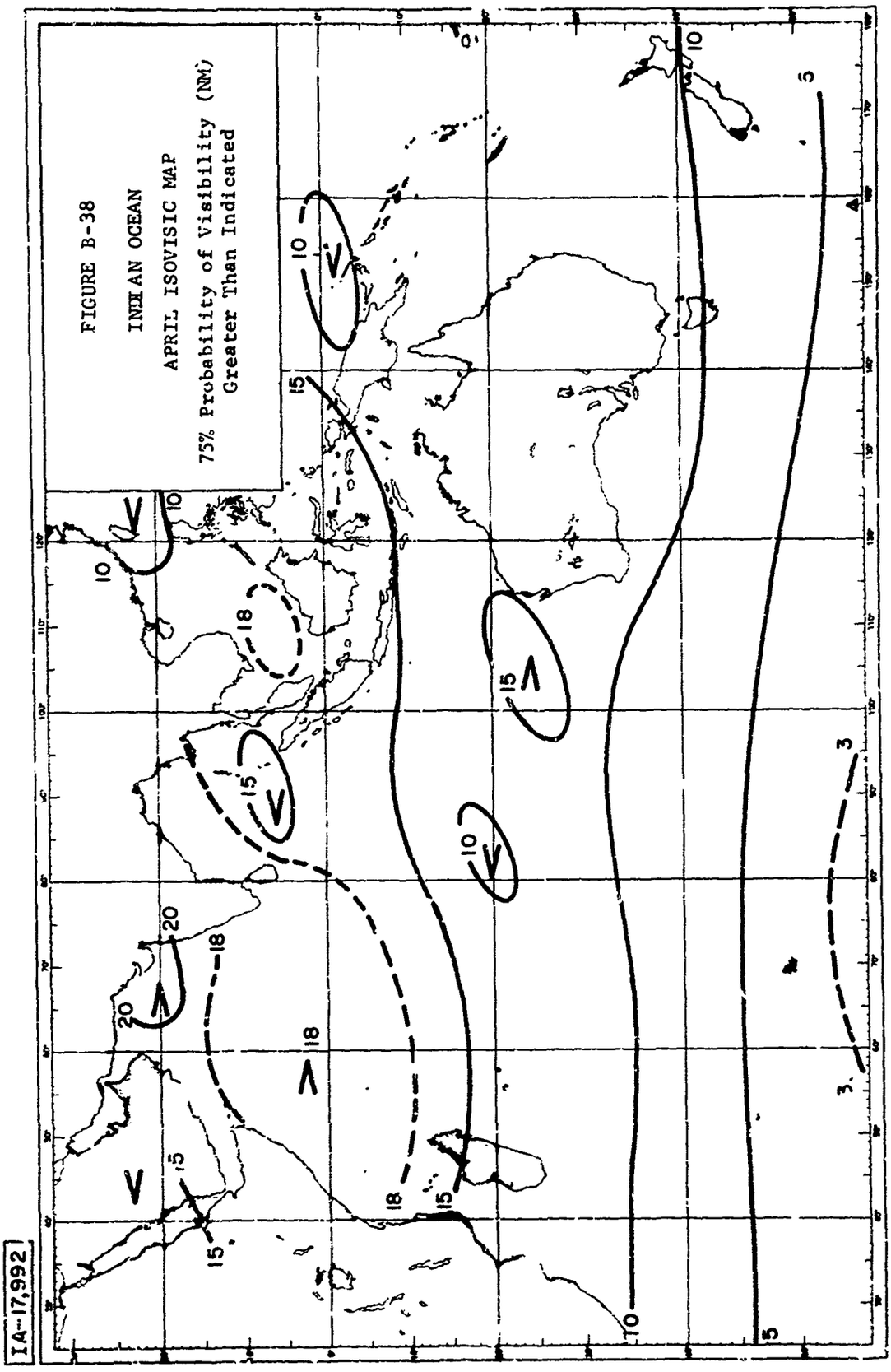


FIGURE B-38
INDIAN OCEAN
APRIL ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
IA-17,992

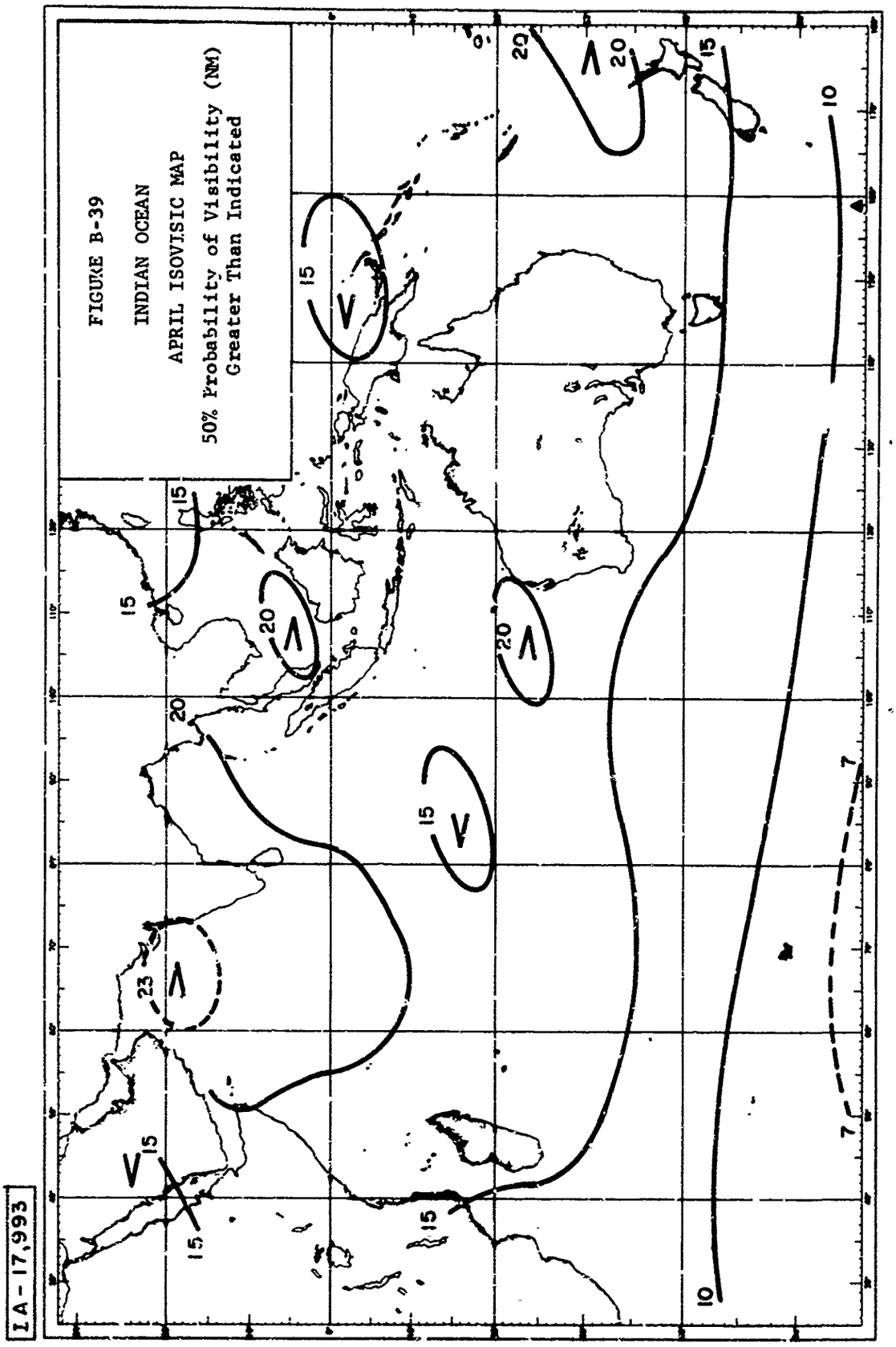
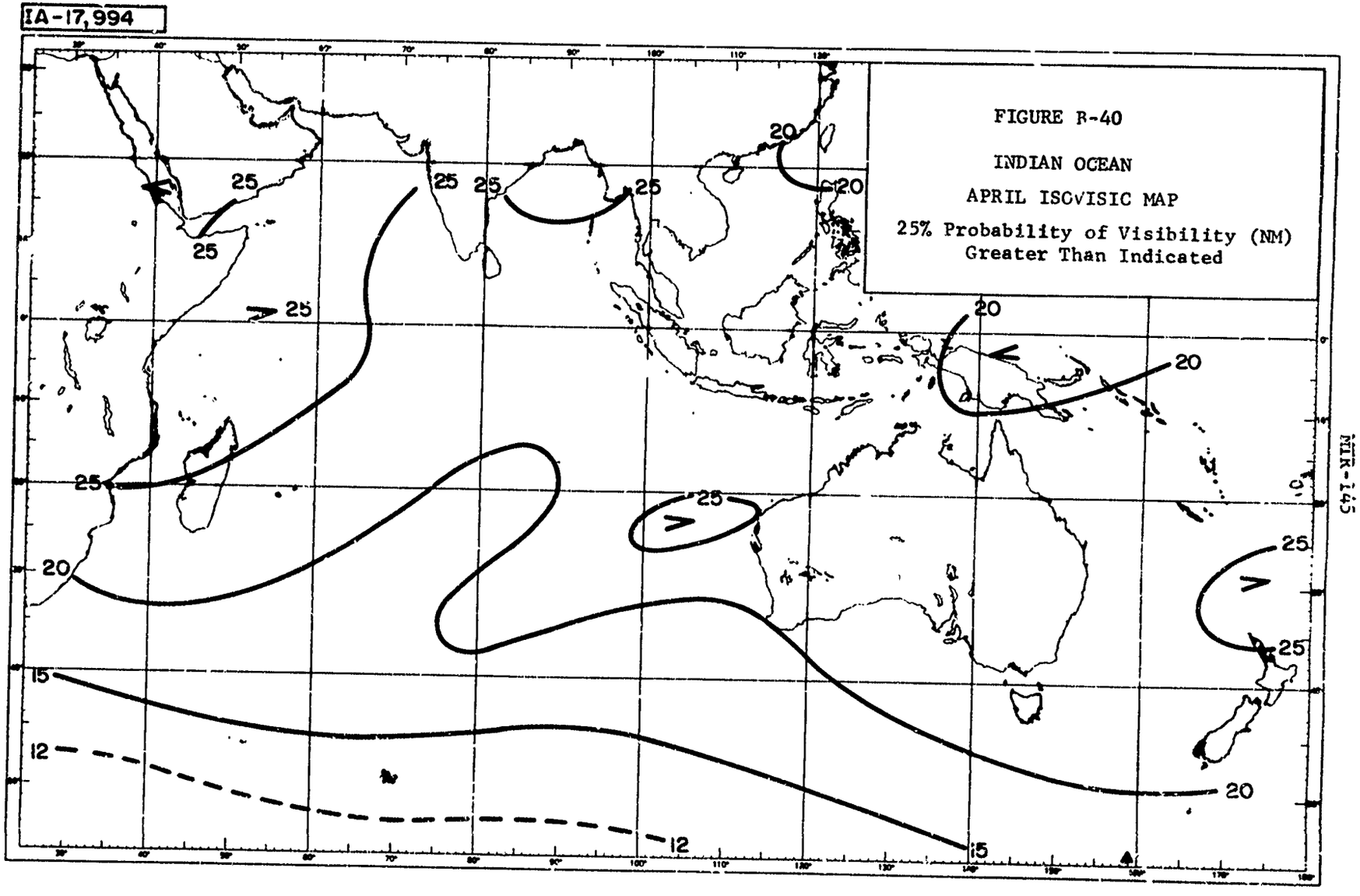


FIGURE B-39
INDIAN OCEAN
APRIL ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
IA-17,993


IA-17,994
FIGURE B-40
INDIAN OCEAN
APRIL ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
25
20
15
12

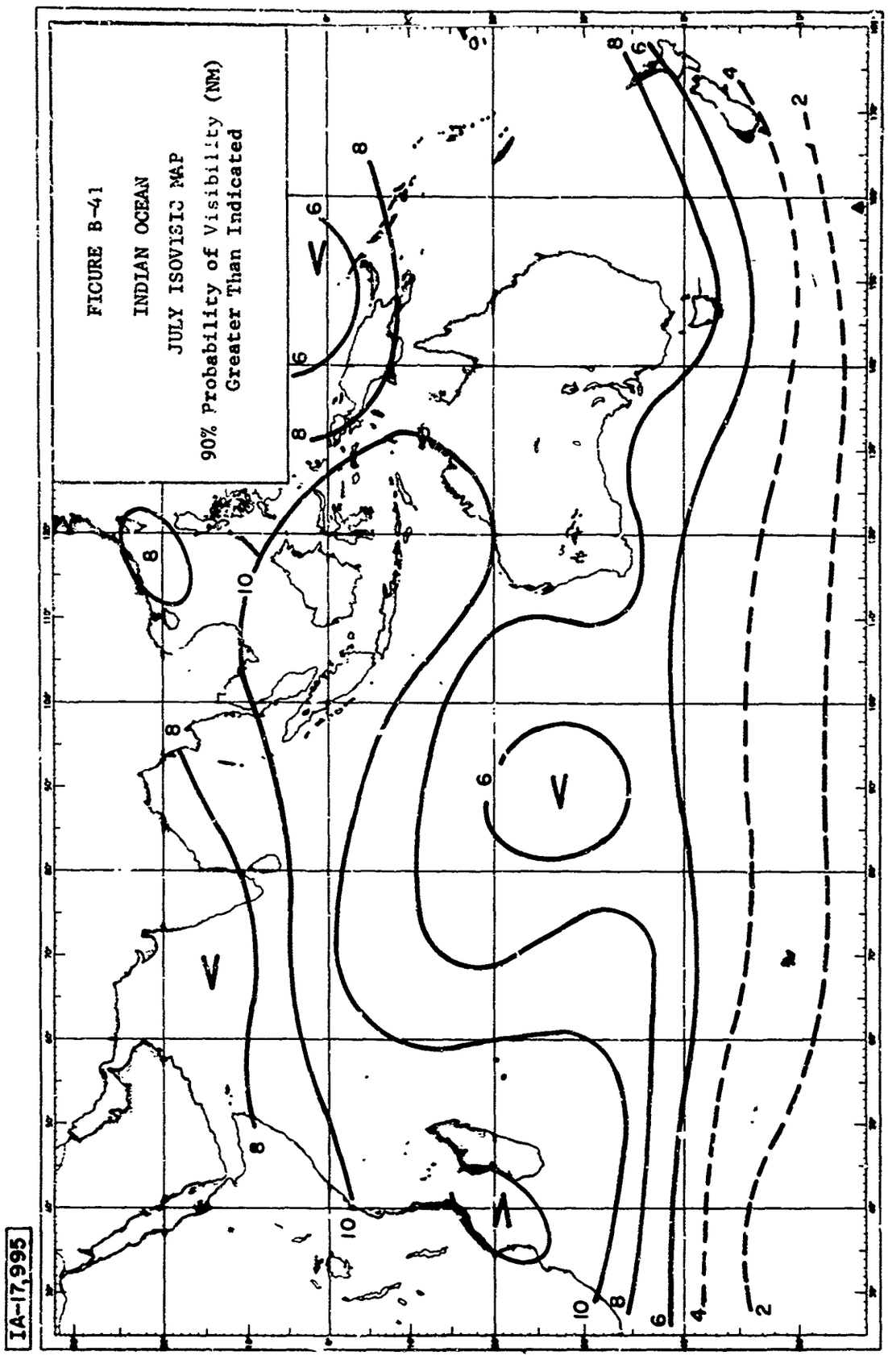
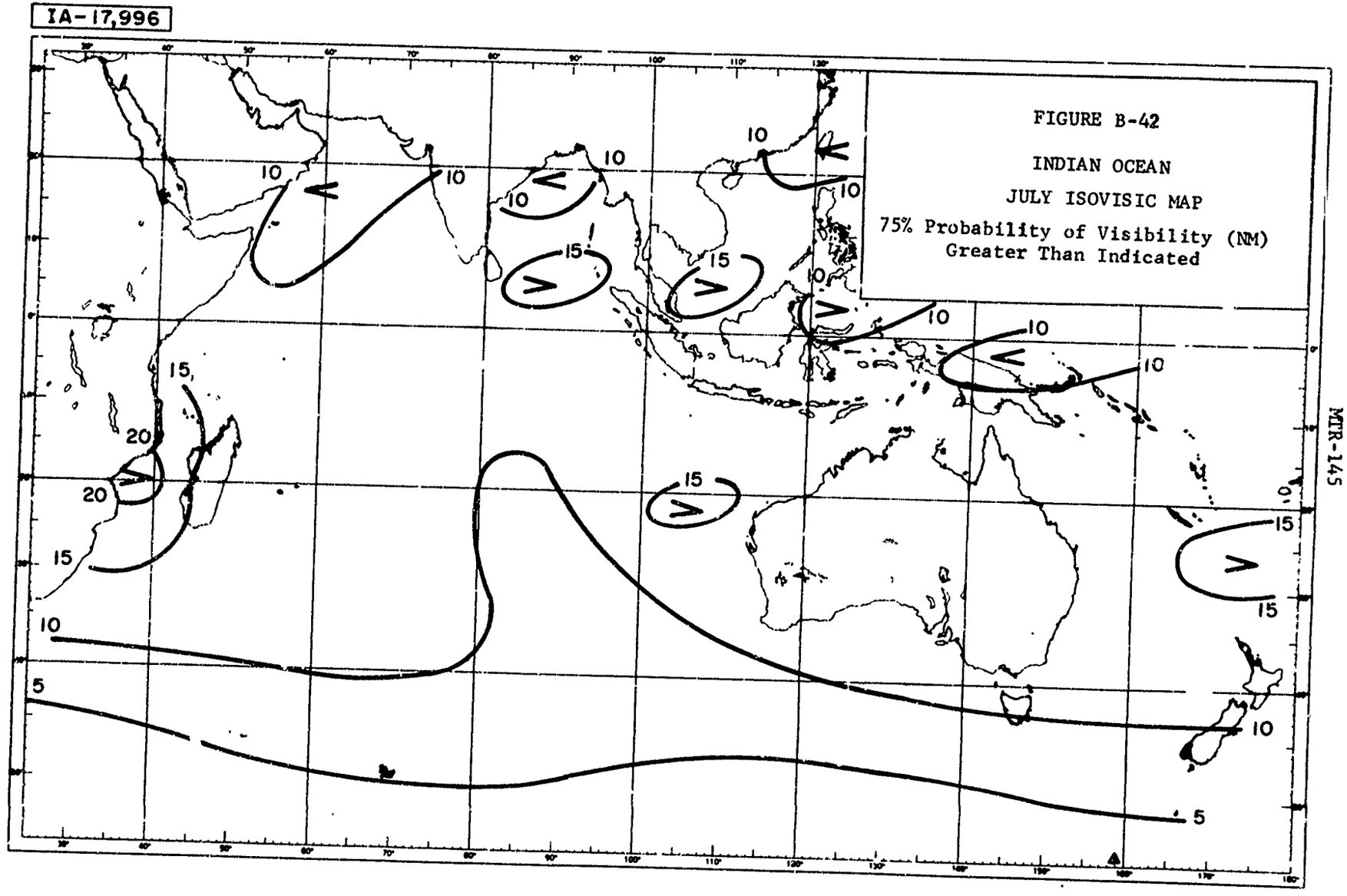


FIGURE B-41
INDIAN OCEAN
JULY ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
IA-17,995


IA-17,996
FIGURE B-42
INDIAN OCEAN
JULY ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
10
15
20
5

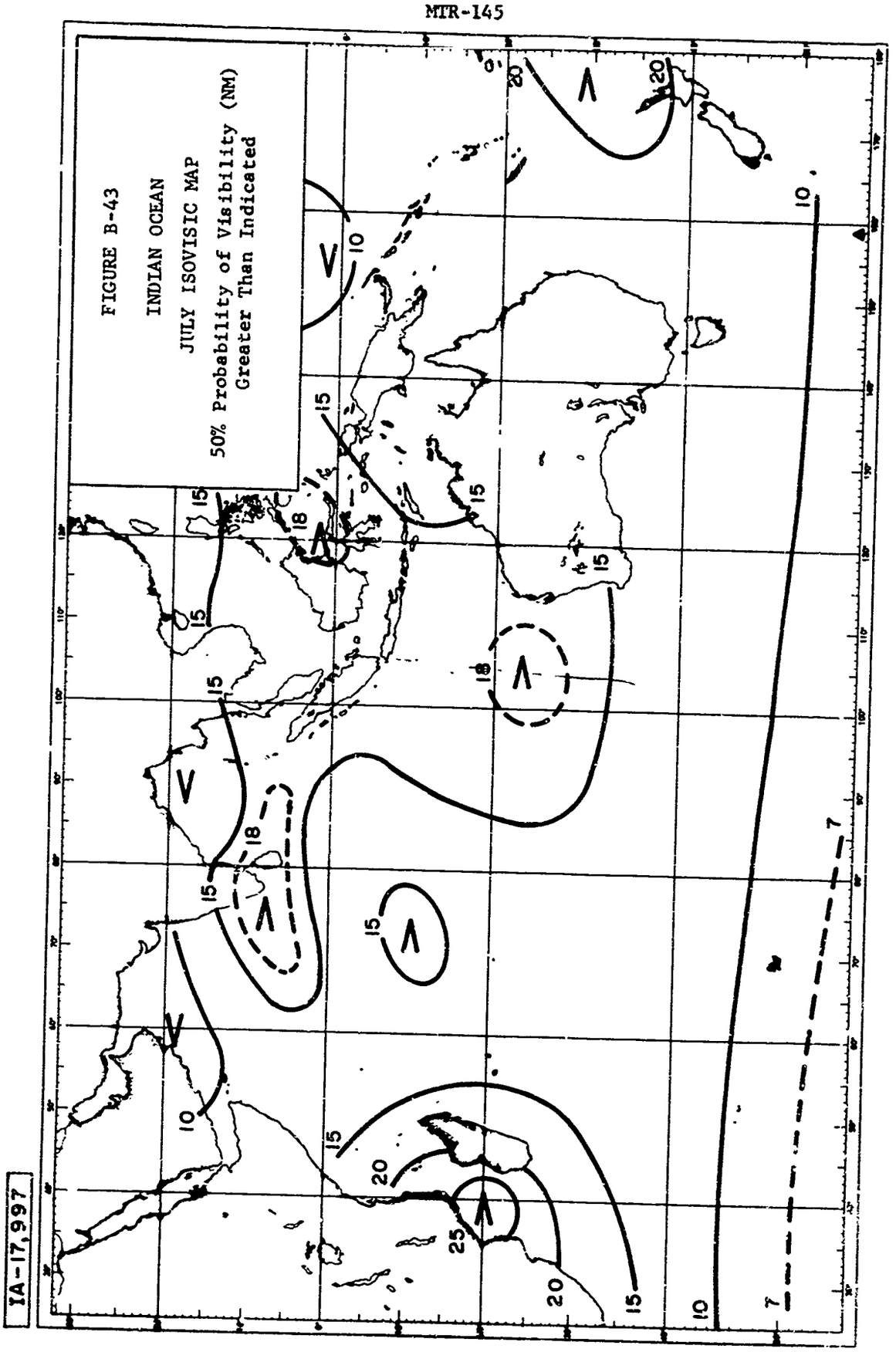


FIGURE B-43
INDIAN OCEAN
JULY ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
IA-17,997

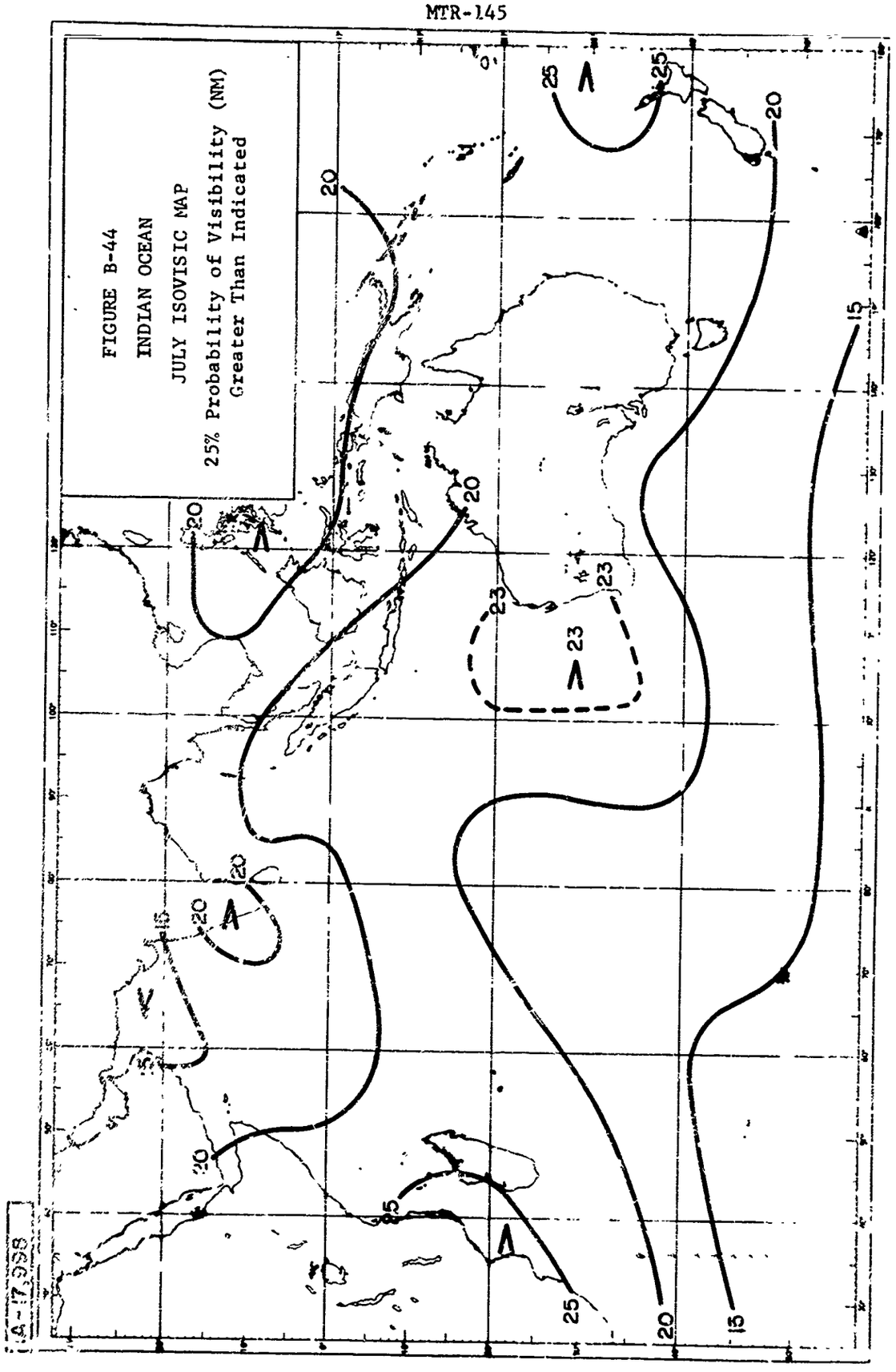


FIGURE B-44
INDIAN OCEAN
JULY ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
A-17,998

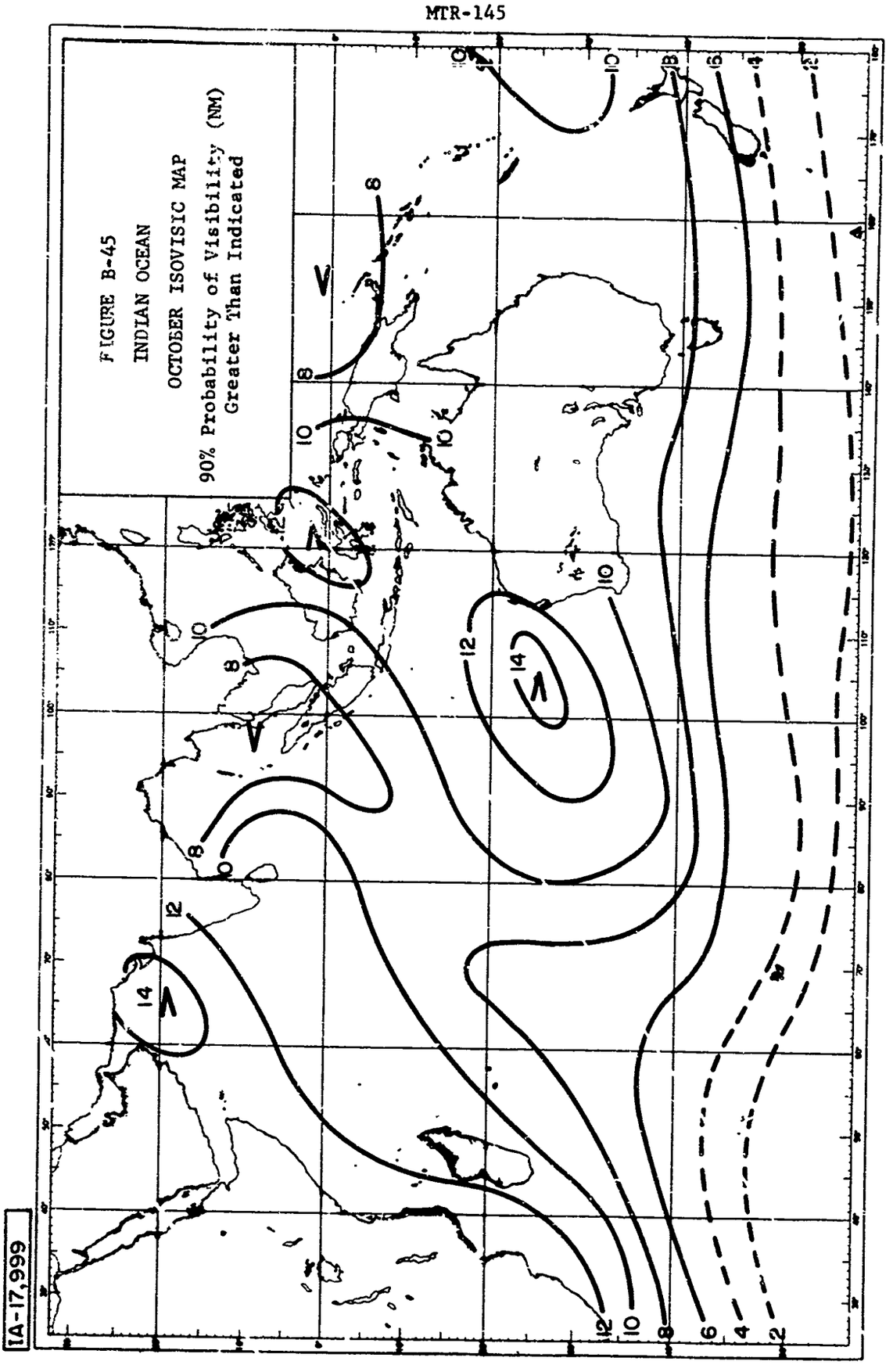


FIGURE B-45
INDIAN OCEAN
OCTOBER ISOVISIC MAP
90% Probability of Visibility (NM)
Greater Than Indicated
IA-17,999

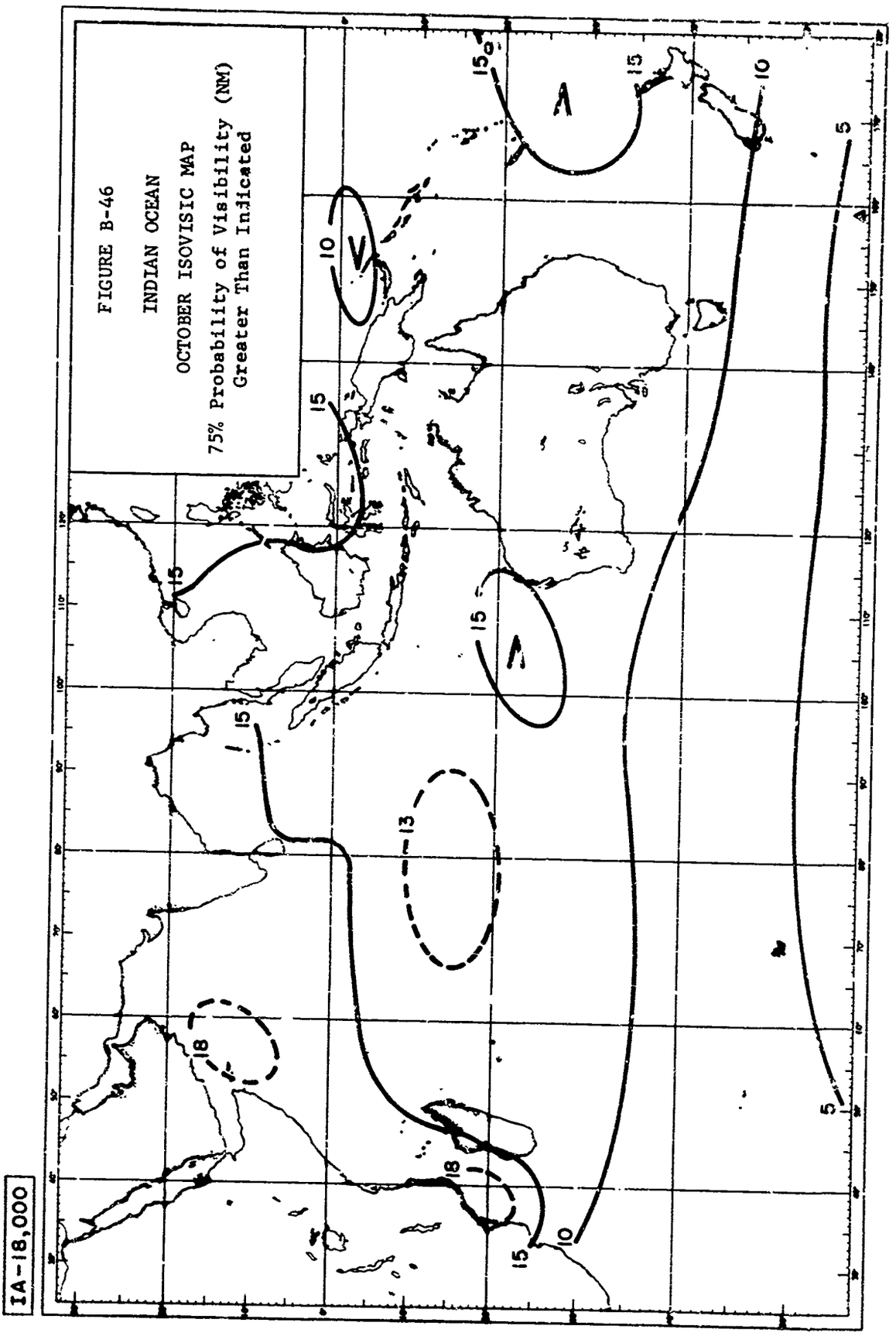


FIGURE B-46
INDIAN OCEAN
OCTOBER ISOVISIC MAP
75% Probability of Visibility (NM)
Greater Than Indicated
IA-18,000
15
10
5
13
18

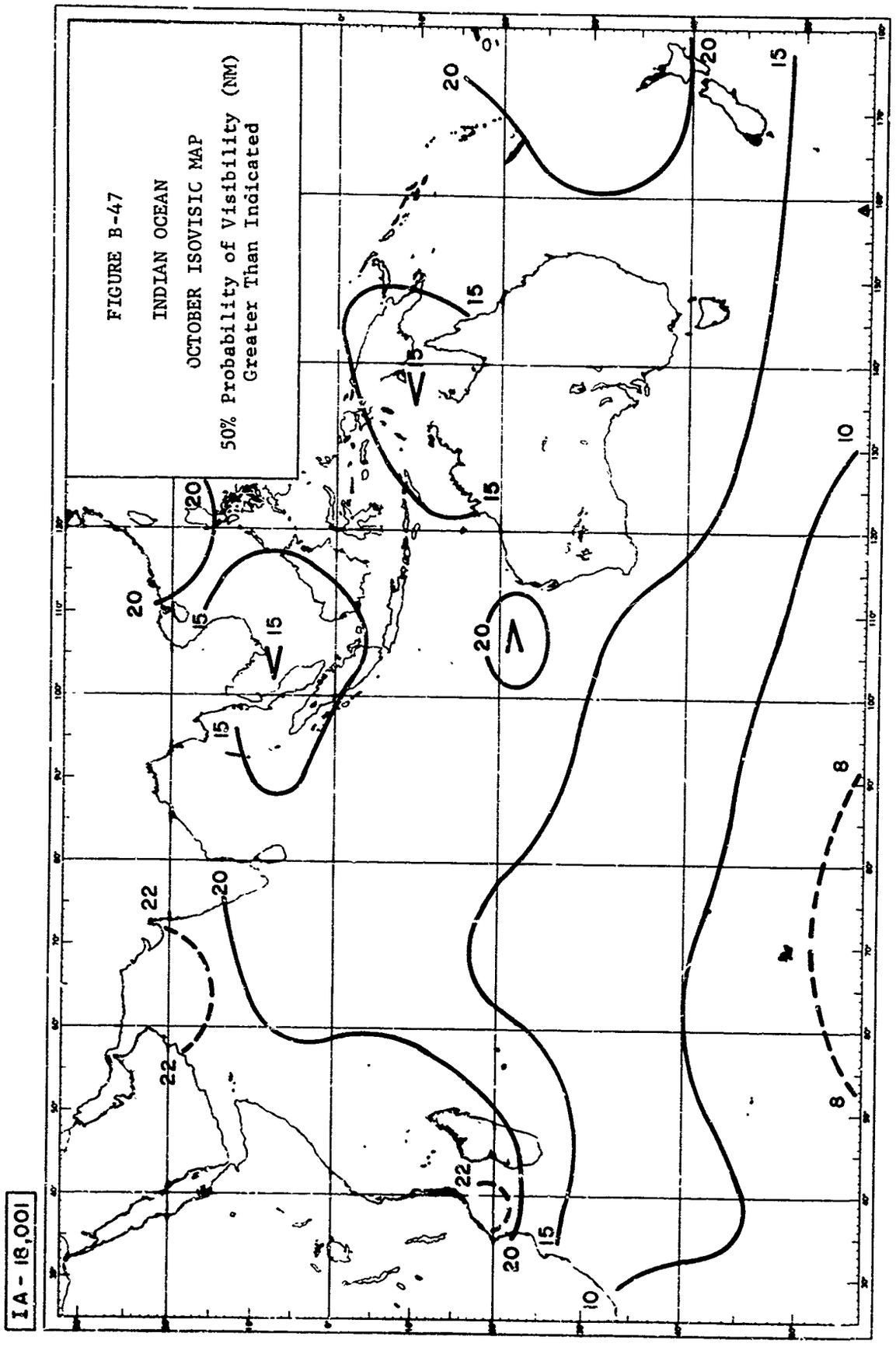


FIGURE B-47
INDIAN OCEAN
OCTOBER ISOVISIC MAP
50% Probability of Visibility (NM)
Greater Than Indicated
IA - 18,001

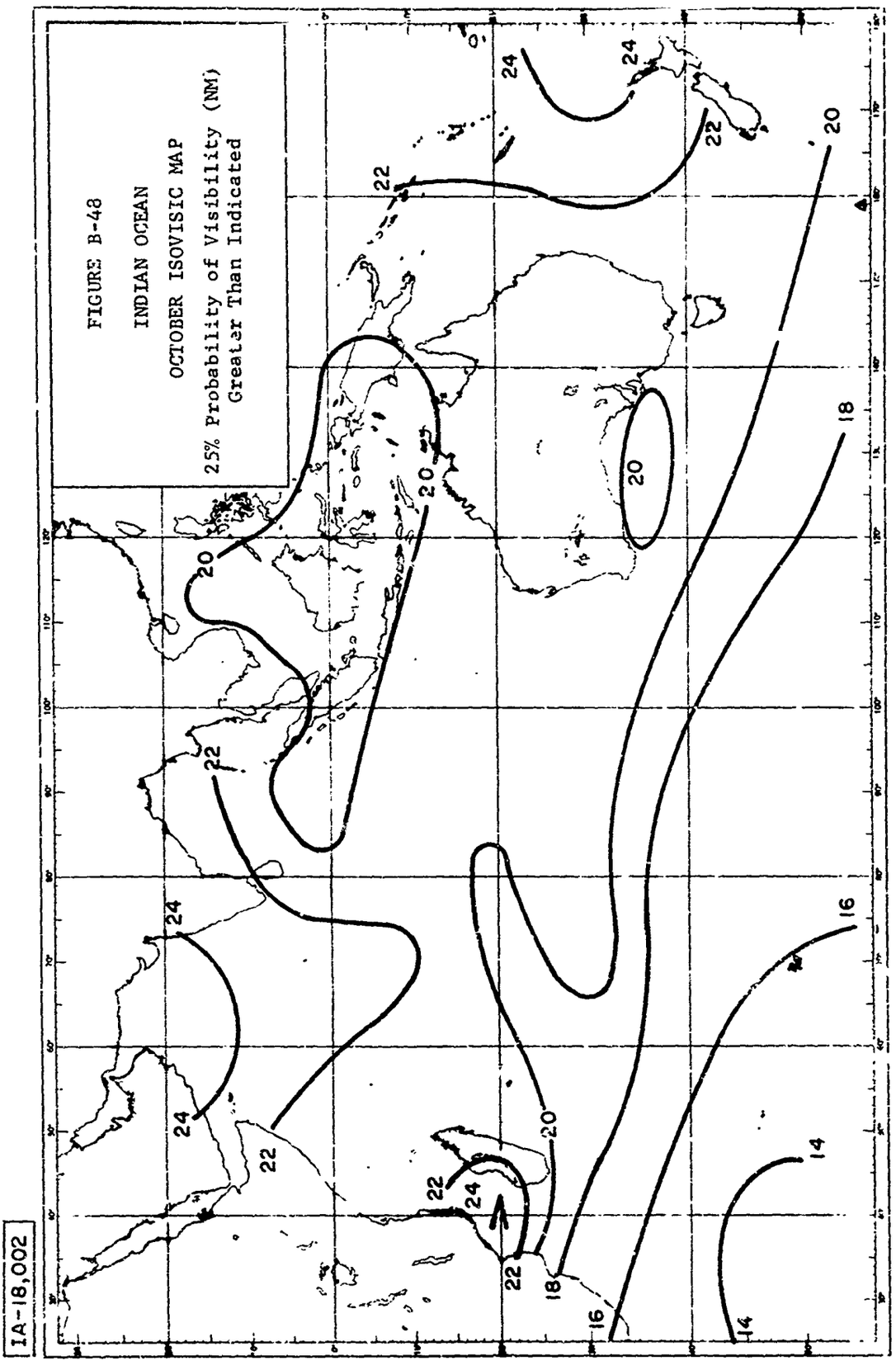


FIGURE B-48
INDIAN OCEAN
OCTOBER ISOVISIC MAP
25% Probability of Visibility (NM)
Greater Than Indicated
IA-18,002

APPENDIX C

NEPHANALYSIS - PERCENTAGE FREQUENCY OF TOTAL CLOUD COVER ≥7/8

IA-18,063

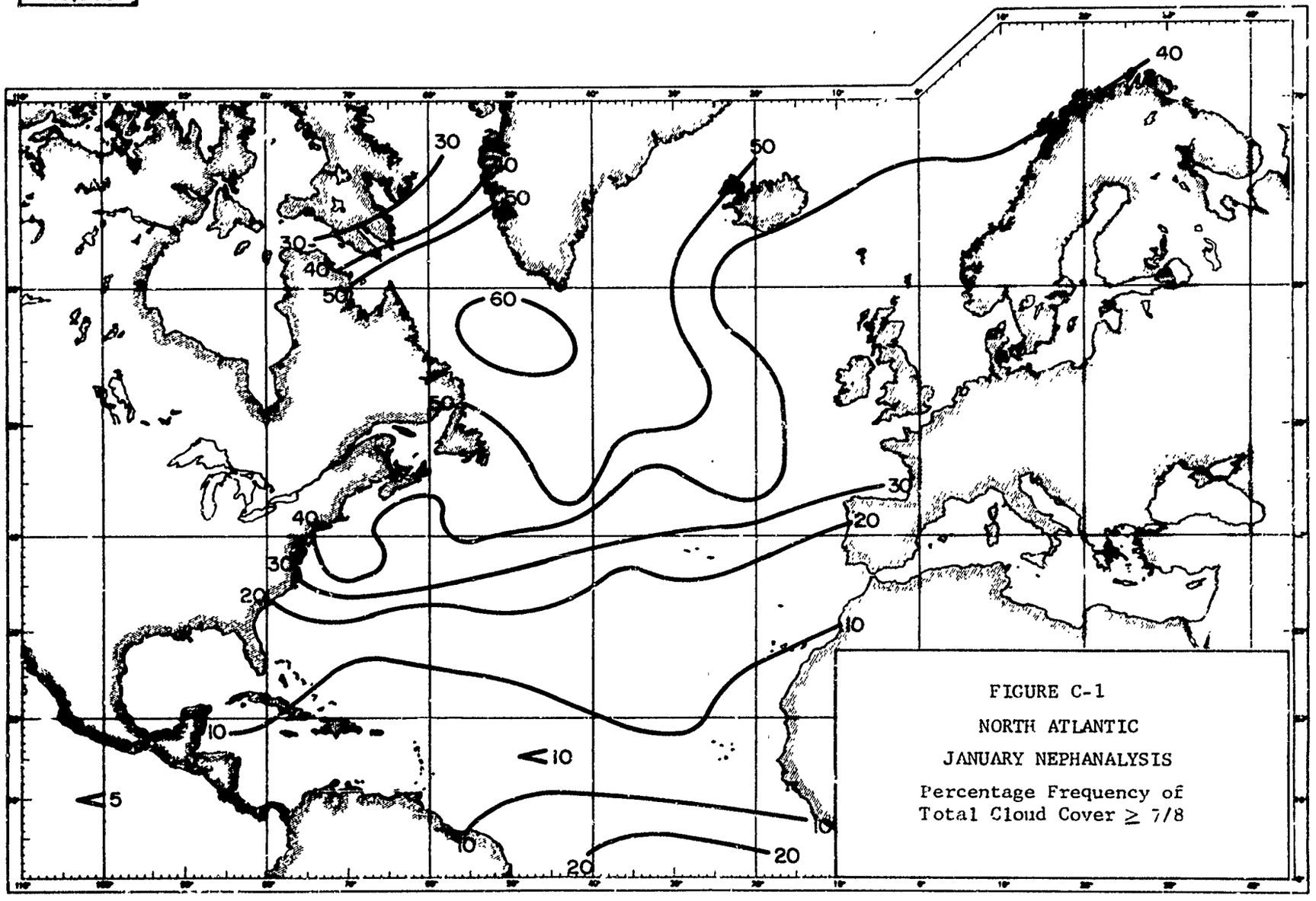


FIGURE C-1

NORTH ATLANTIC

JANUARY NEPHANALYSIS

Percentage Frequency of
Total Cloud Cover ≥ 7/8

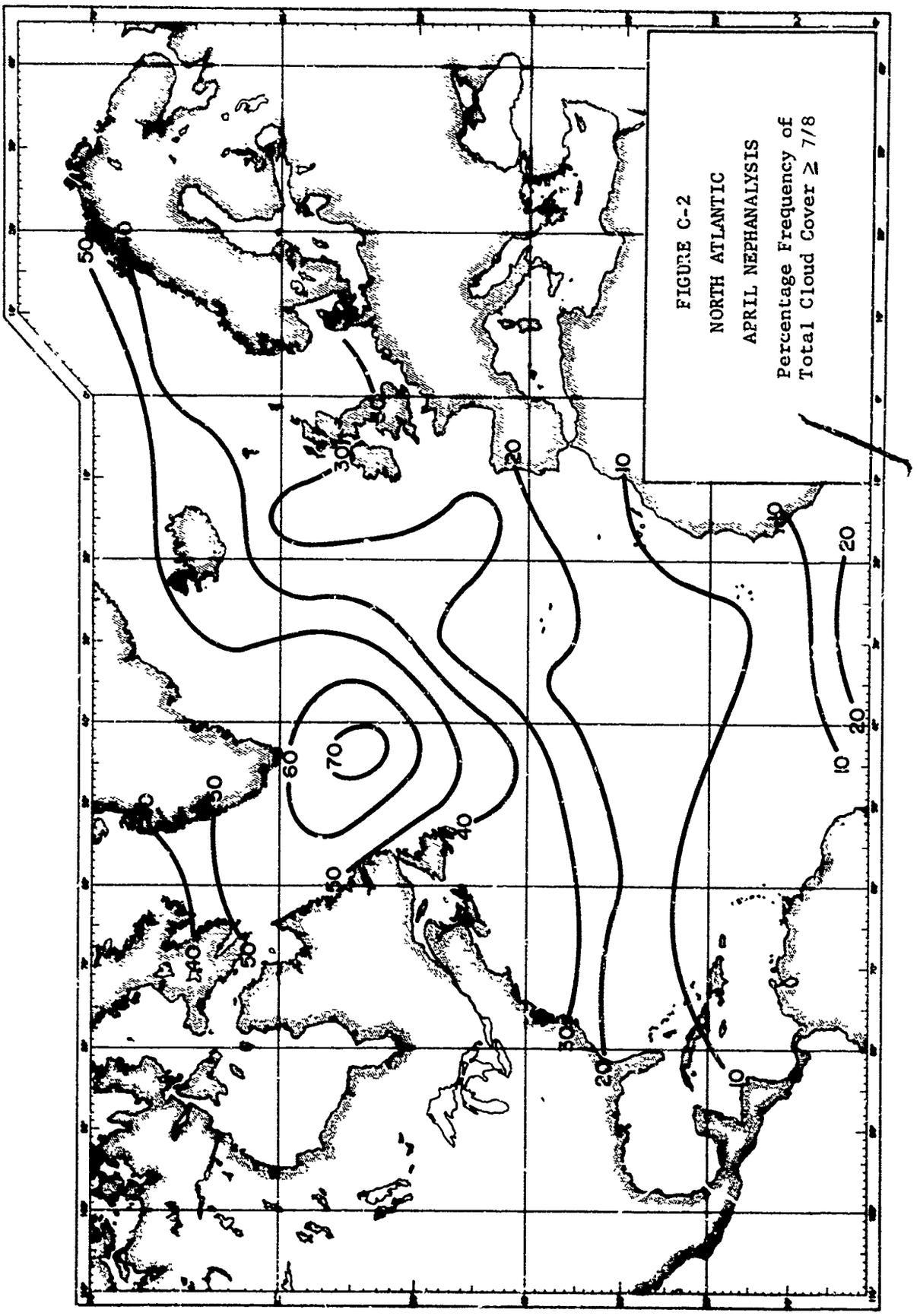


FIGURE C-2
NORTH ATLANTIC
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
50
30
20
10
60
70
40
0

IA.18.064

IA-18,065

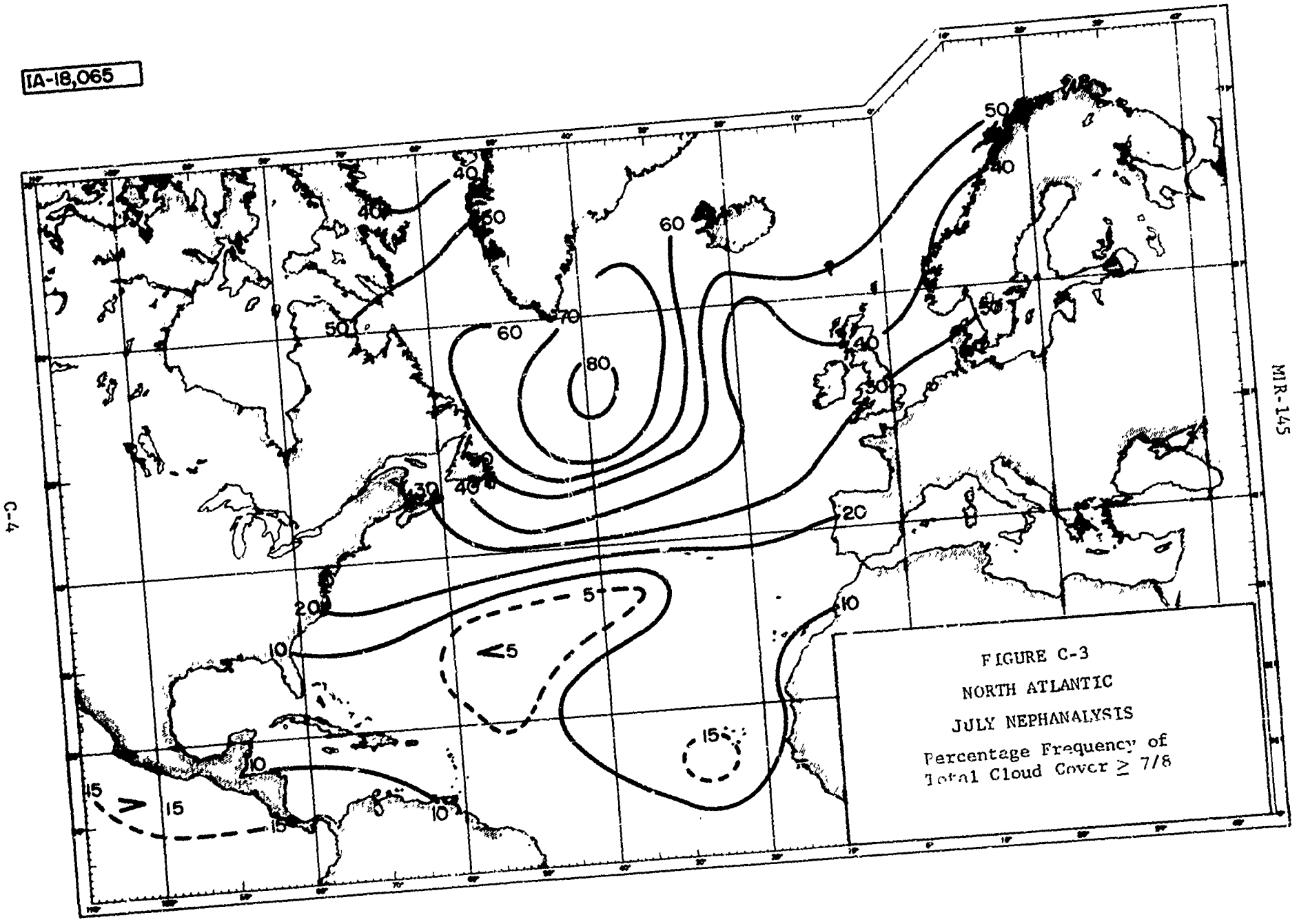


FIGURE C-3
NORTH ATLANTIC
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8

MIR-145

IA-18,066

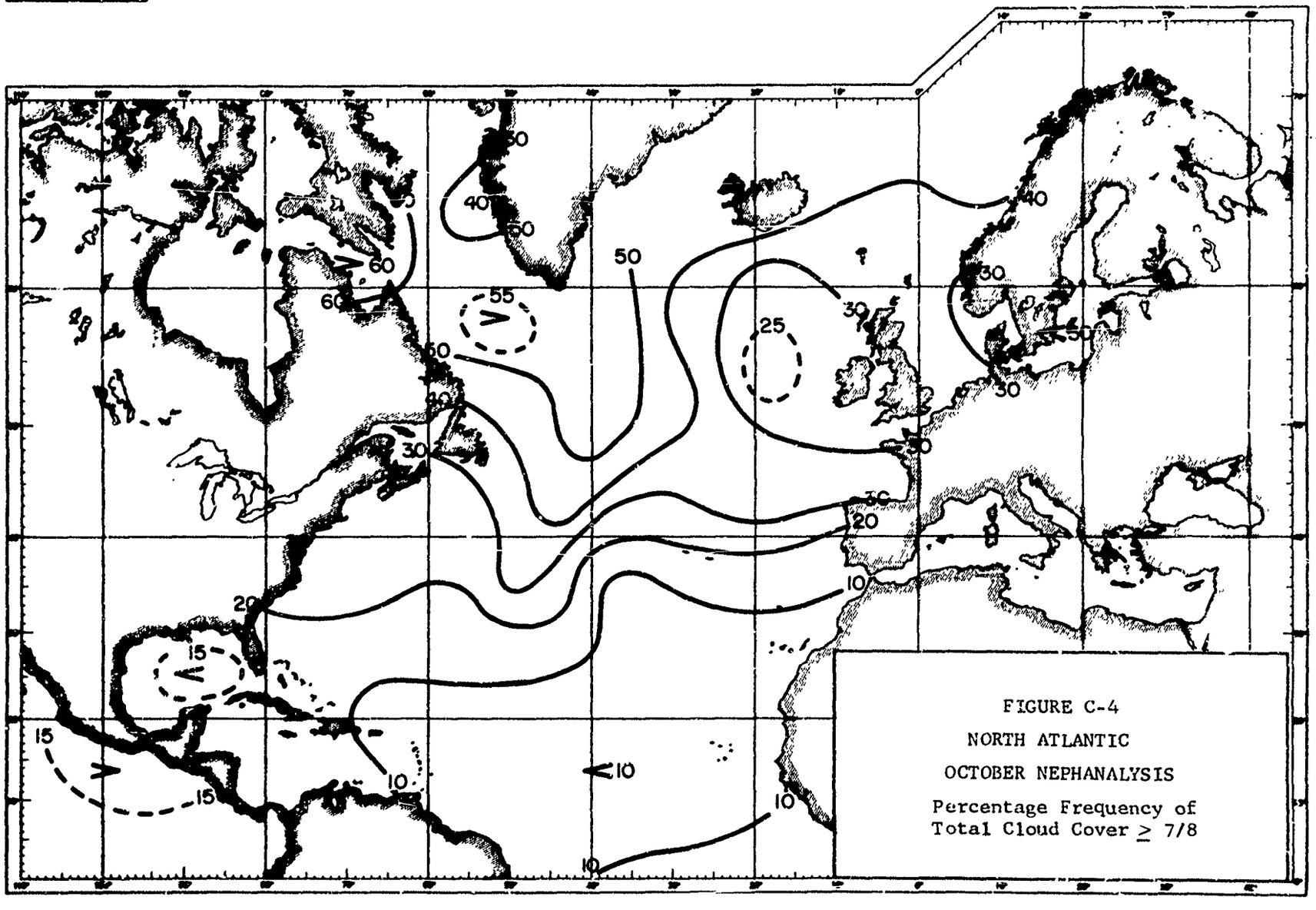
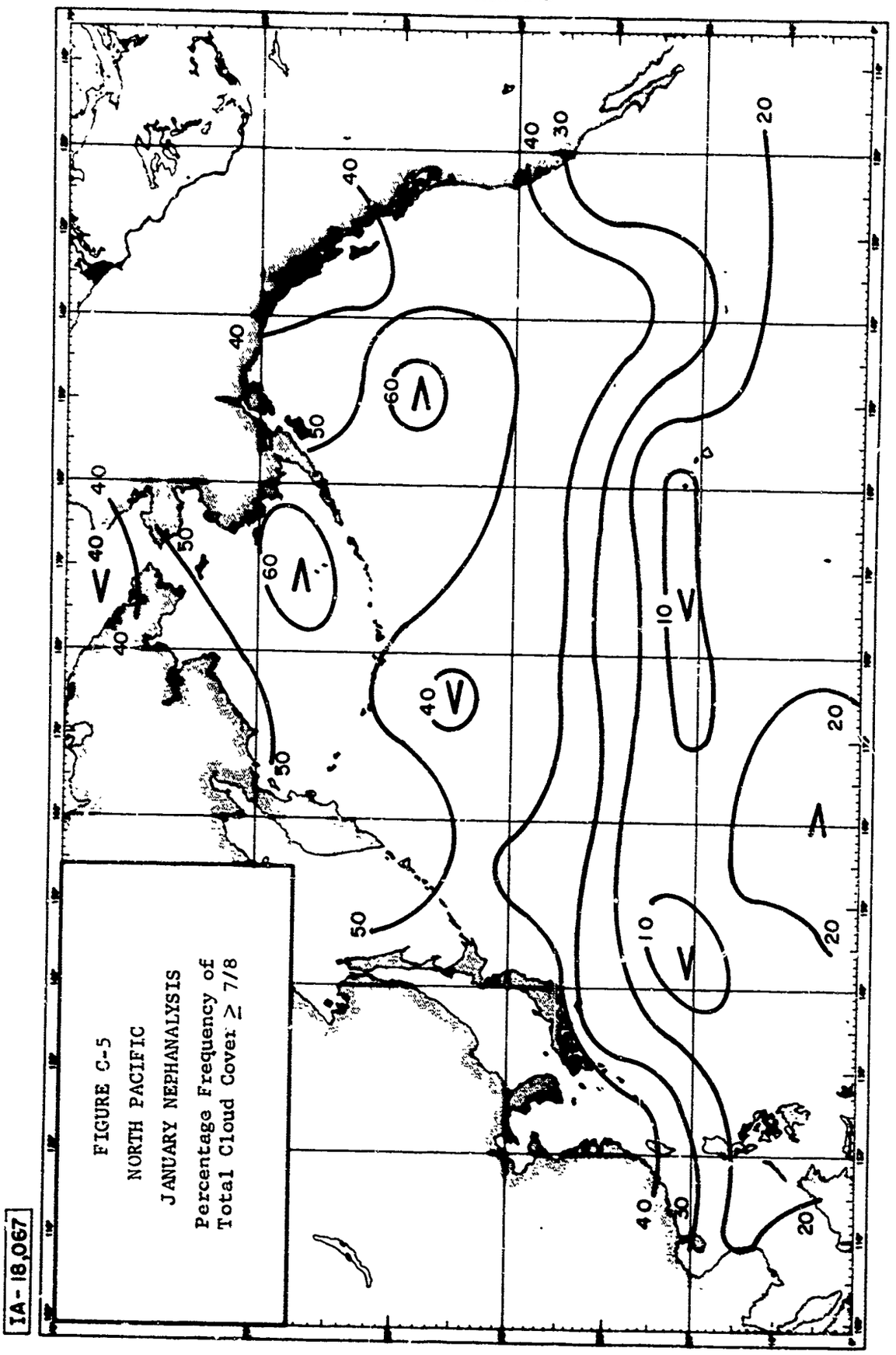


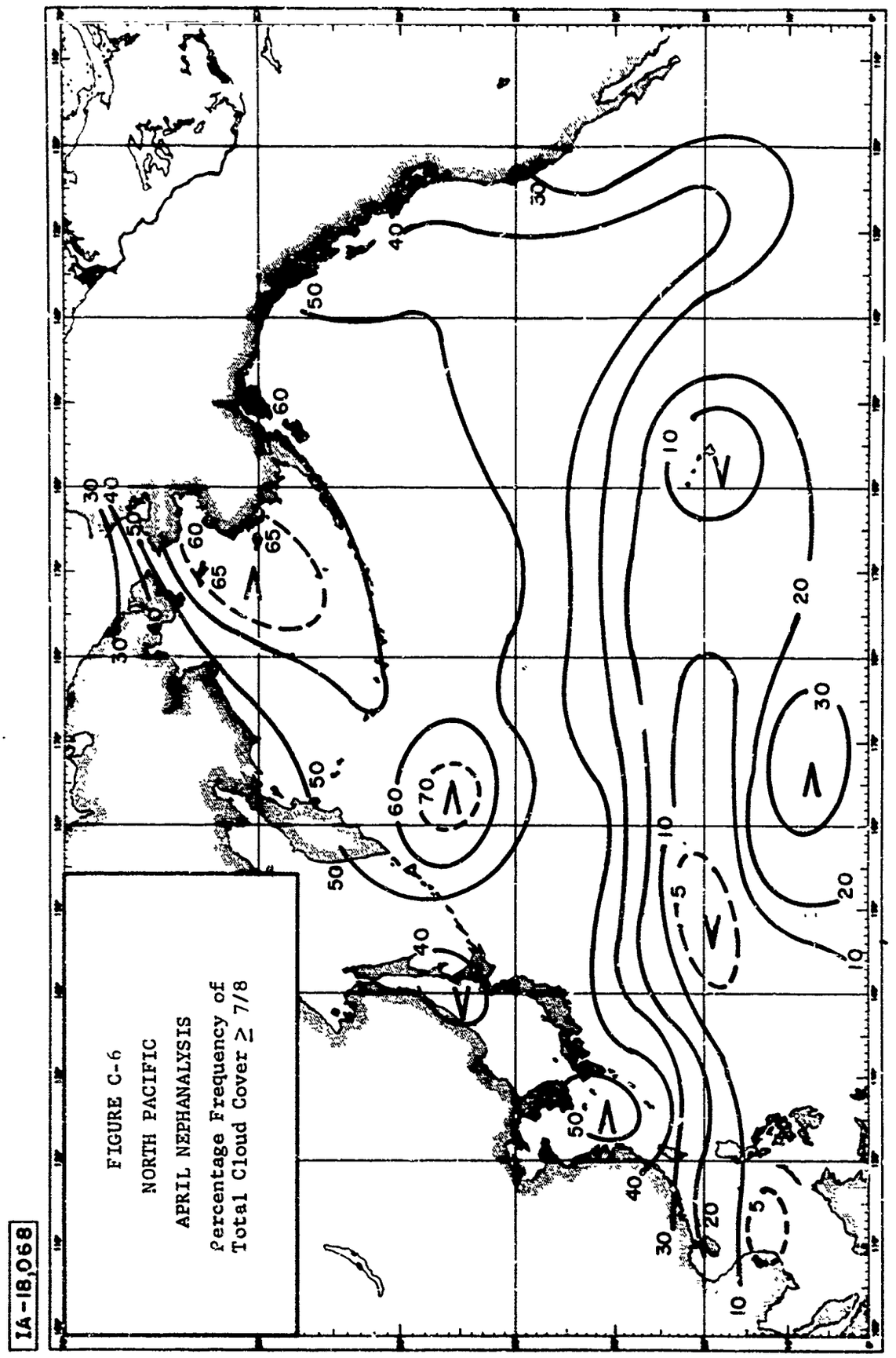
FIGURE C-4

NORTH ATLANTIC

OCTOBER NEPHANALYSIS

Percentage Frequency of
Total Cloud Cover $\geq$ 7/8


IA-18,067
FIGURE C-5
NORTH PACIFIC
JANUARY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8


IA-18,068
FIGURE C-6
NORTH PACIFIC
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8

IA-18,069

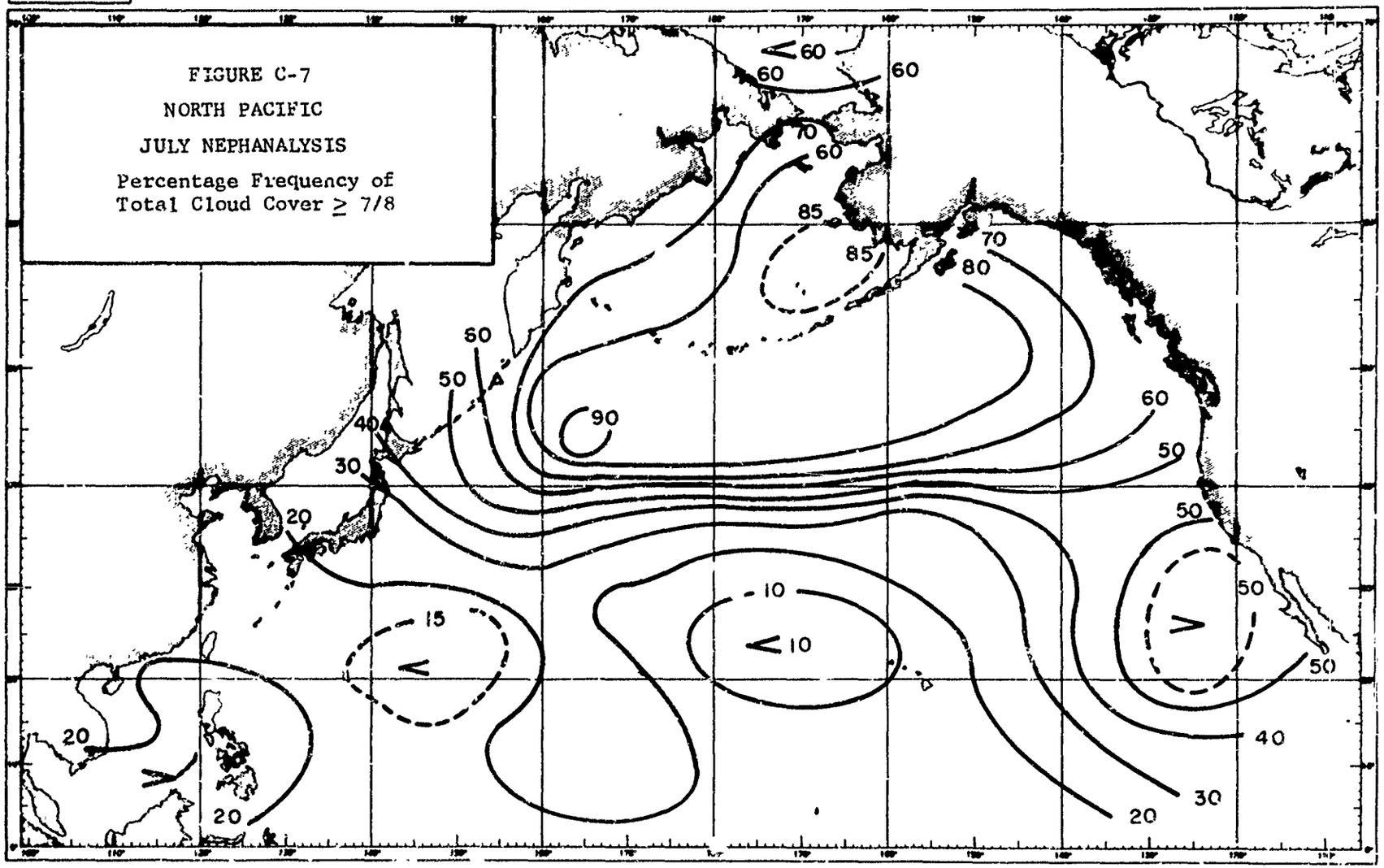
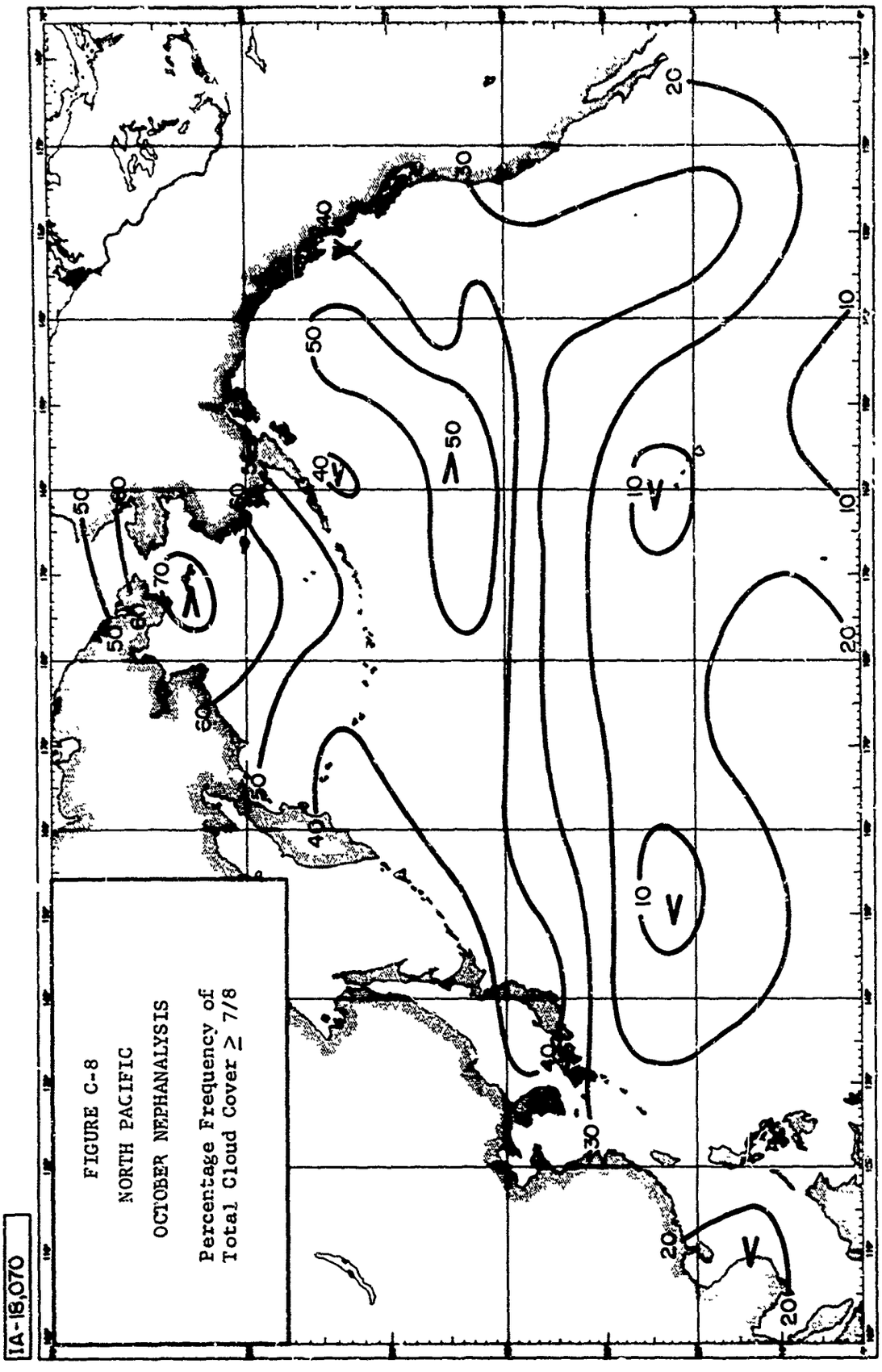


FIGURE C-7
NORTH PACIFIC
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
<60
60
60
70
60
85
85
70
80
50
50
40
90
60
30
50
20
50
10
15
<10
50
20
40
20
30
20


IA-18,070
FIGURE C-8
NORTH PACIFIC
OCTOBER NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
≥50
70
60
50
40
30
20
10
V

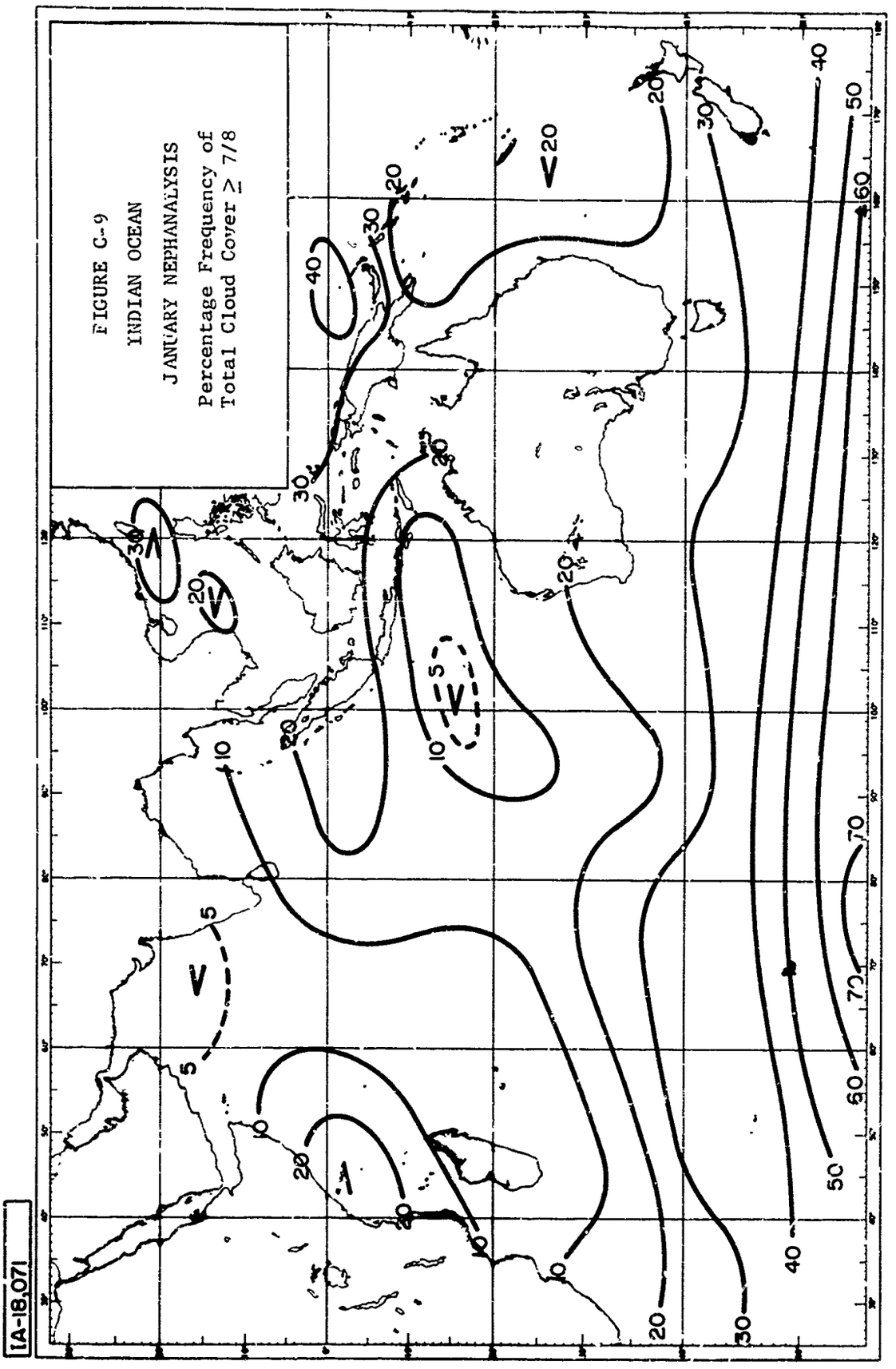


FIGURE C-9
INDIAN OCEAN
JANUARY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
IA-18,071

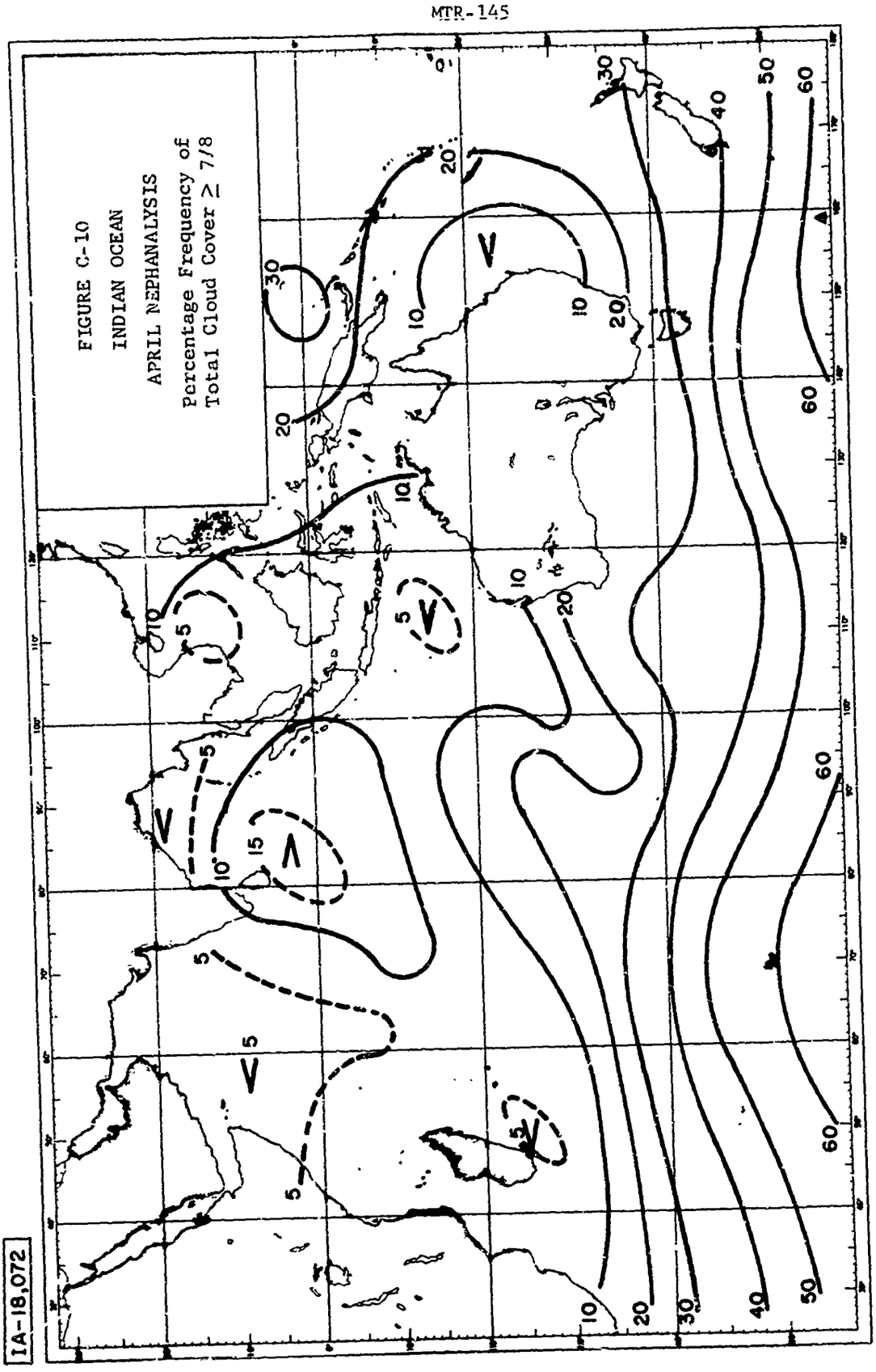


FIGURE C-10
INDIAN OCEAN
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
IA-18,072

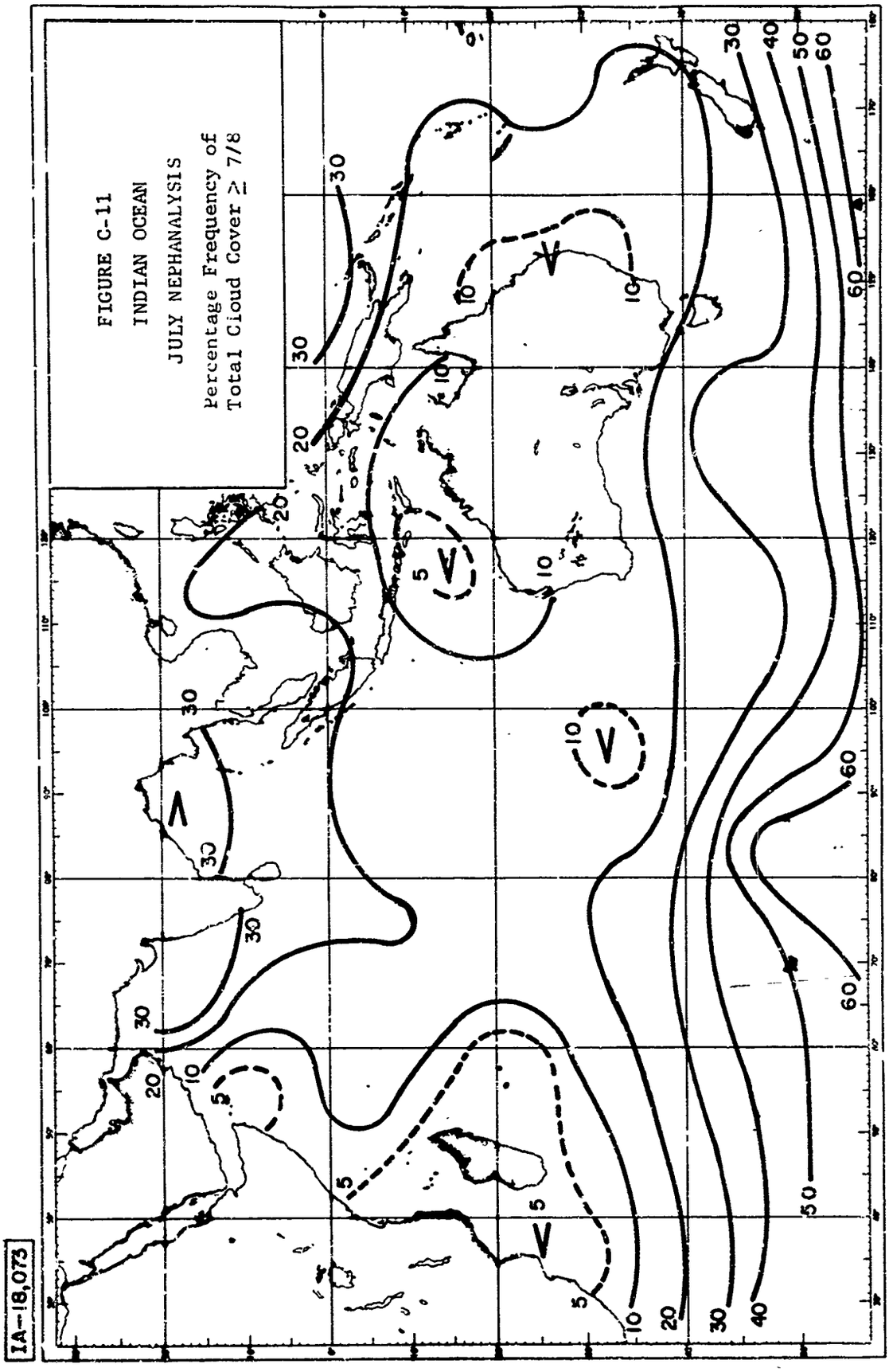


FIGURE C-11
INDIAN OCEAN
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
IA-18,073

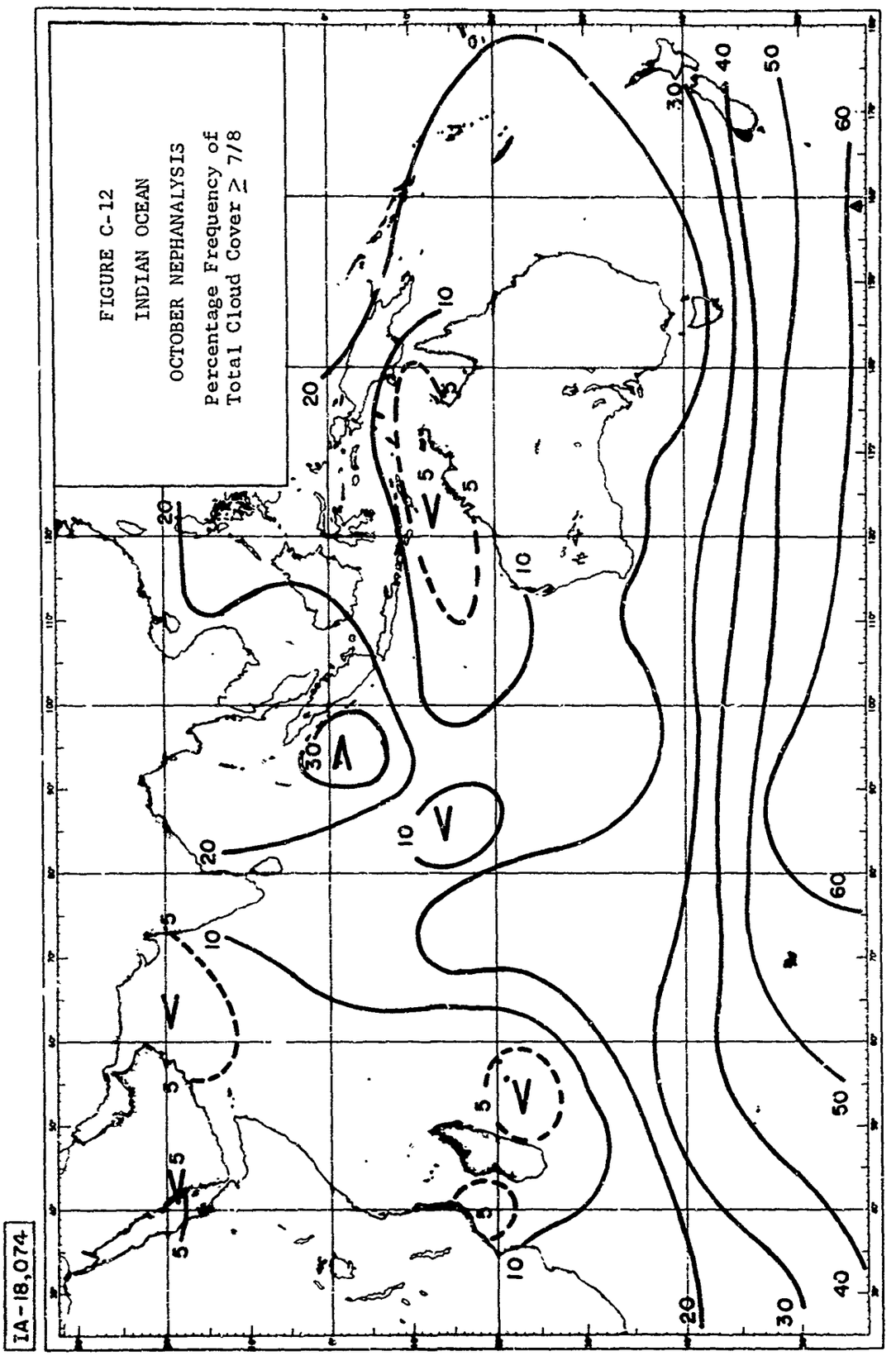


FIGURE C-12
INDIAN OCEAN
OCTOBER NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≥ 7/8
IA-18,074

APPENDIX D

NEPHANALYSIS - PERCENTAGE FREQUENCY OF TOTAL CLOUD COVER $\leq$ 2/10

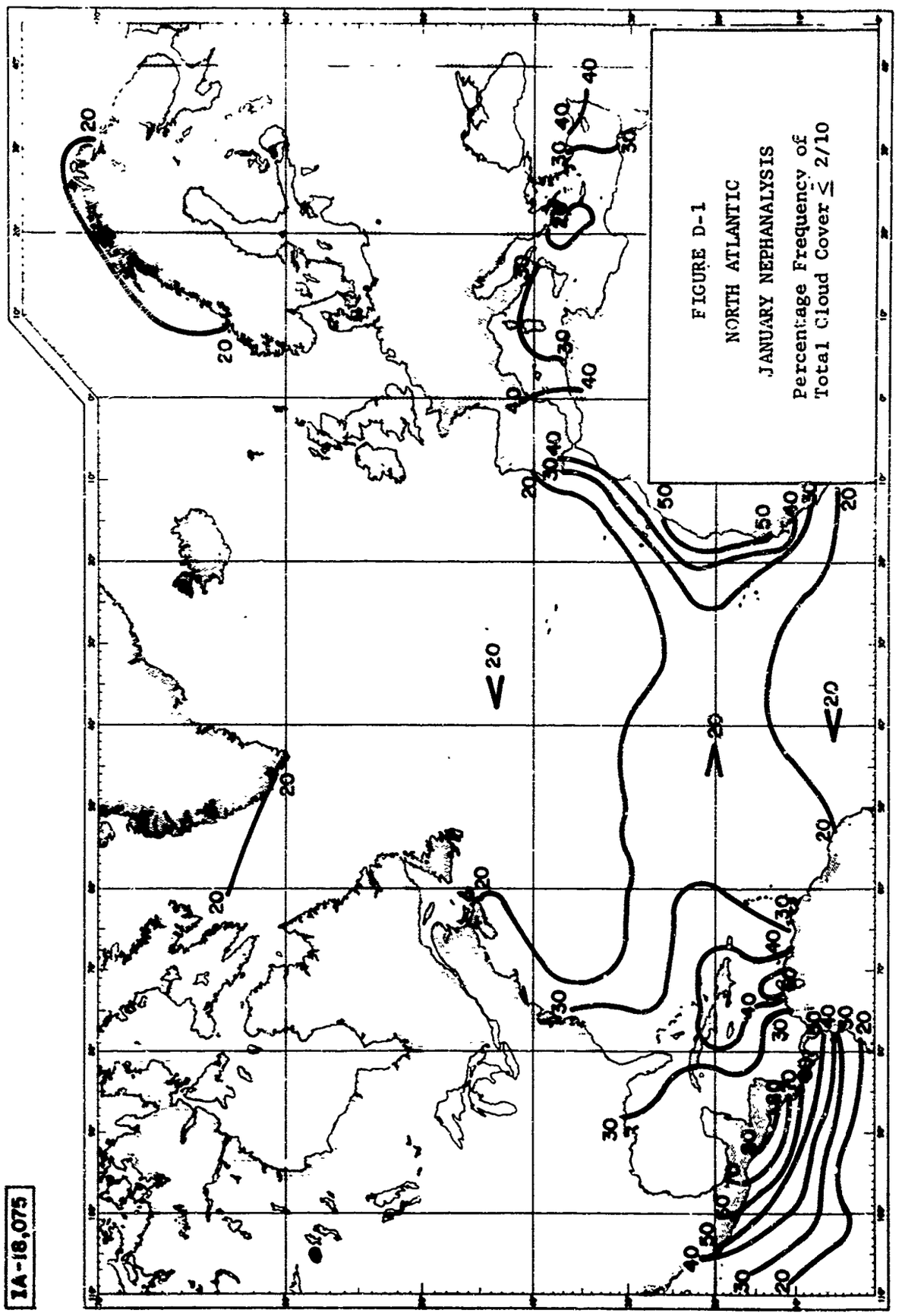


FIGURE D-1
NORTH ATLANTIC
JANUARY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
IA-18,075

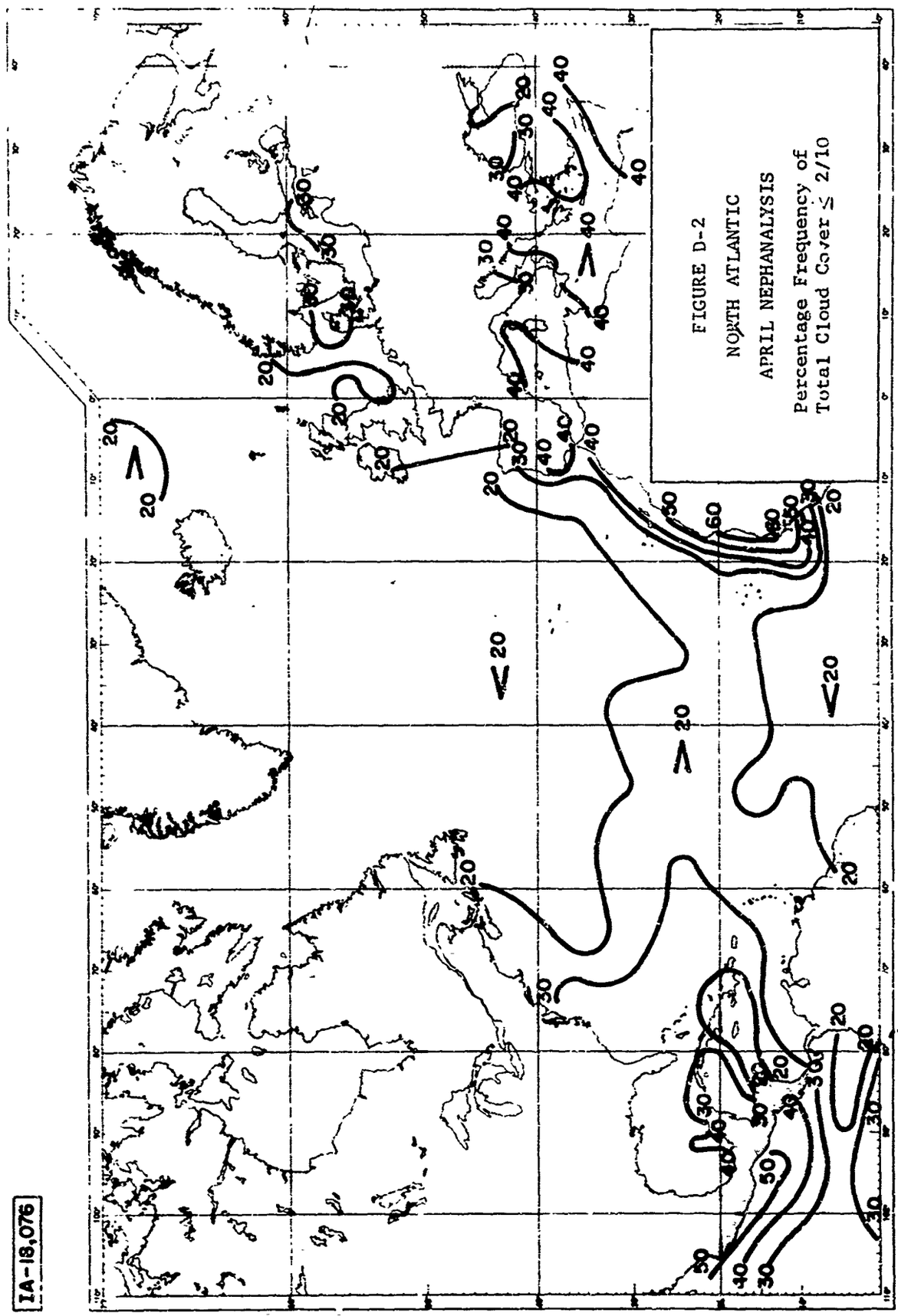


FIGURE D-2
NORTH ATLANTIC
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
IA-18,076

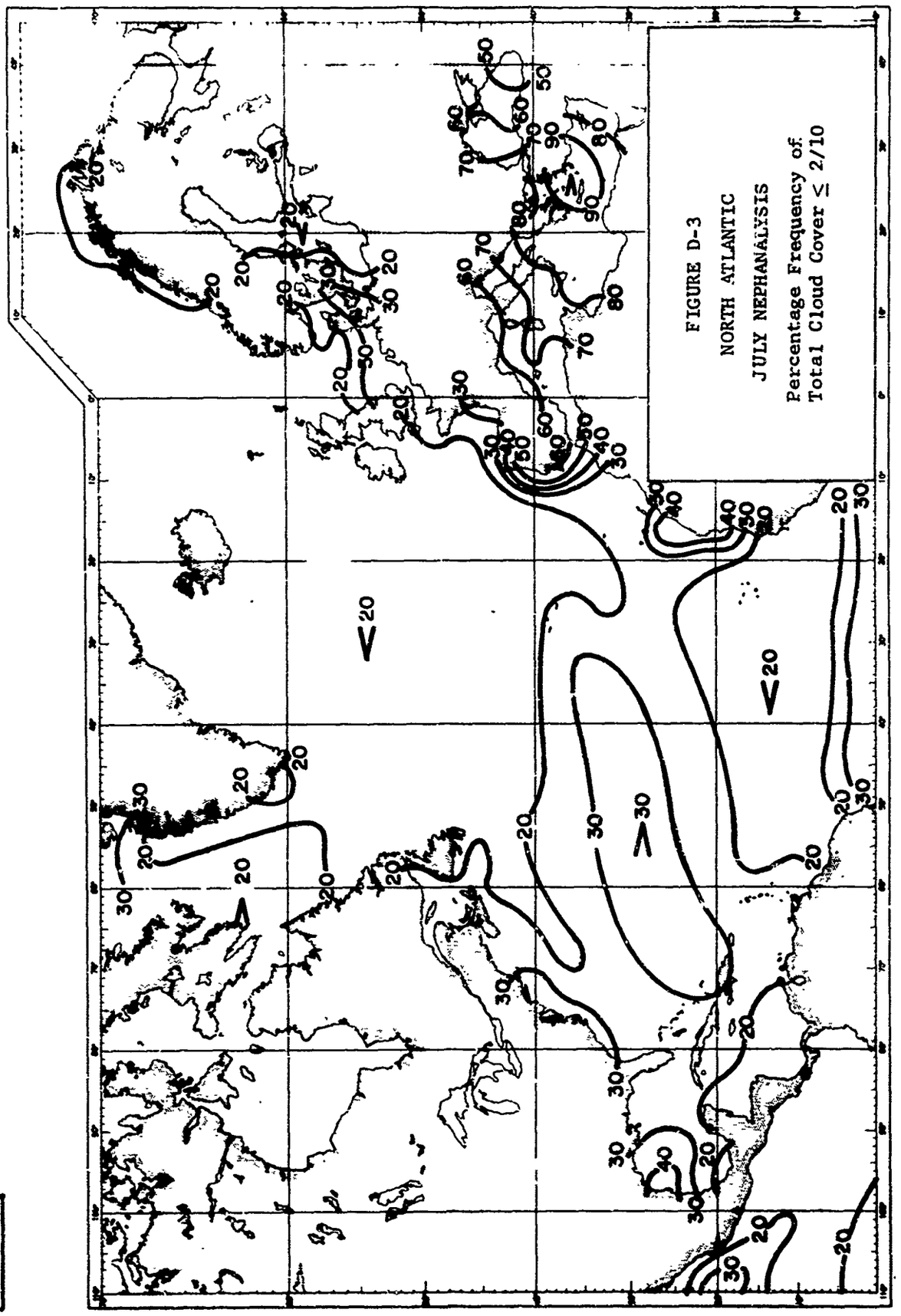


FIGURE D-3
NORTH ATLANTIC
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
<20
>30
<20

ZA-18077

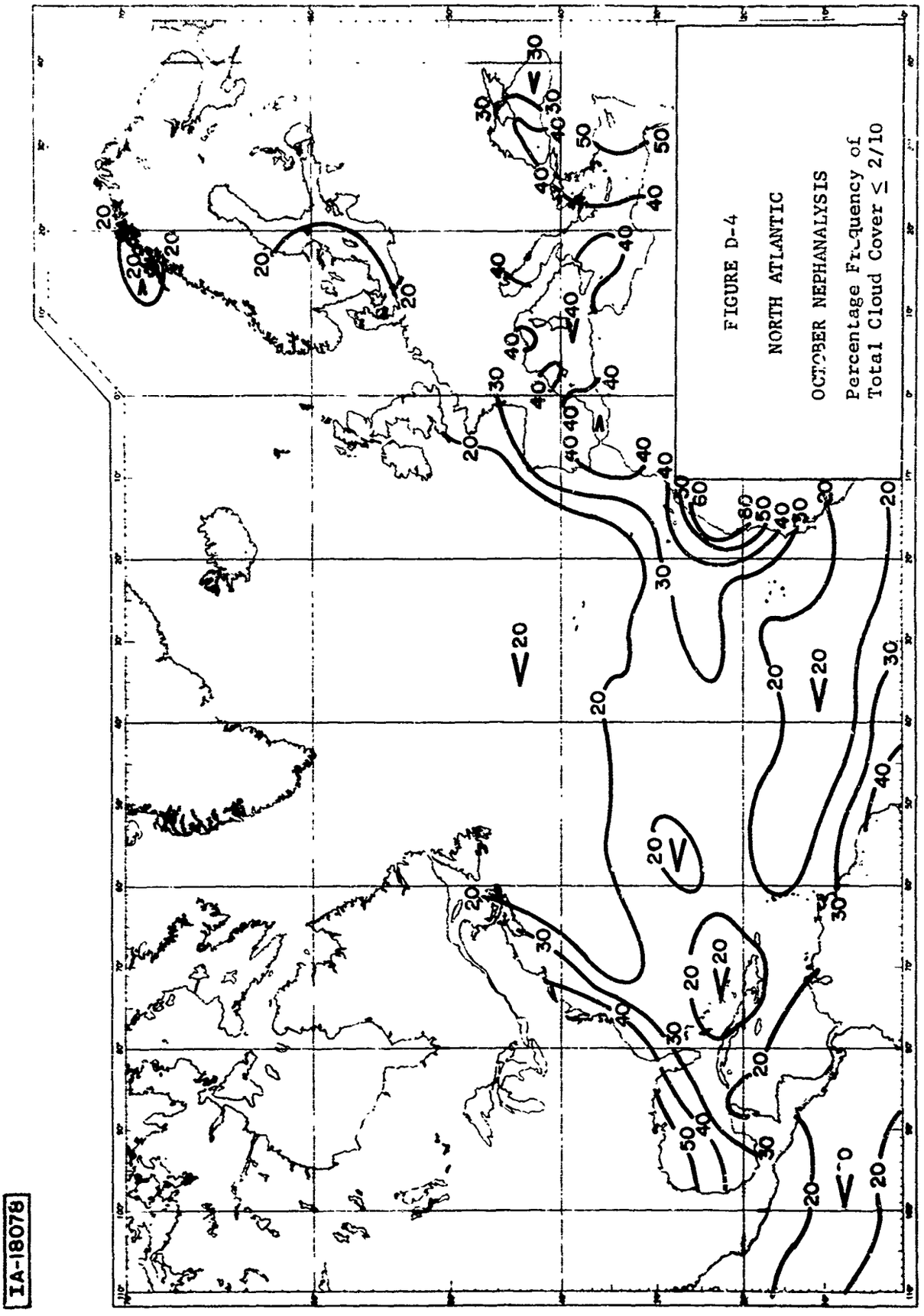
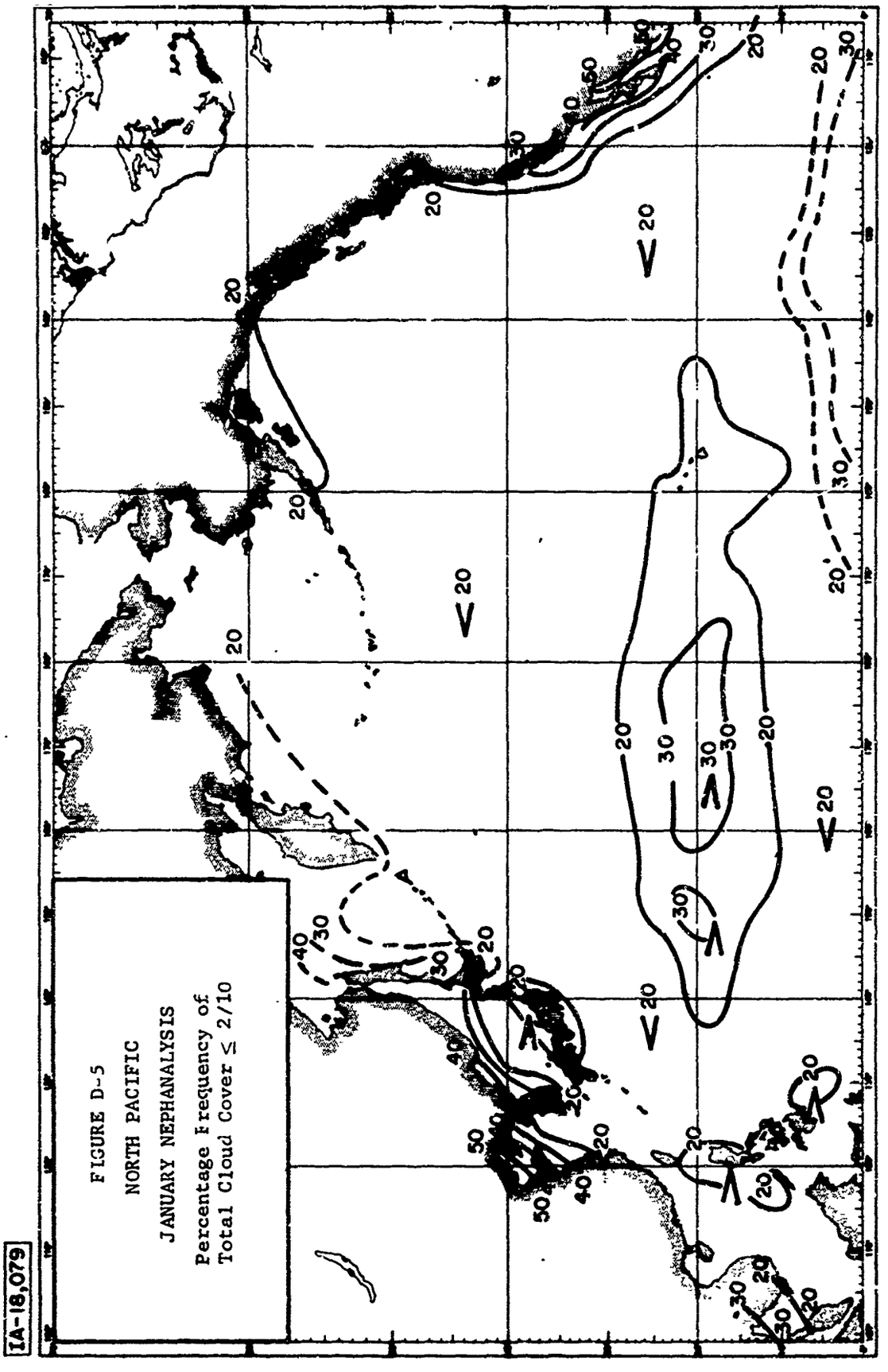


FIGURE D-4
NORTH ATLANTIC
OCTOBER NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
IA-18078


IA-18,079
FIGURE D-5
NORTH PACIFIC
JANUARY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10

IA-18,080

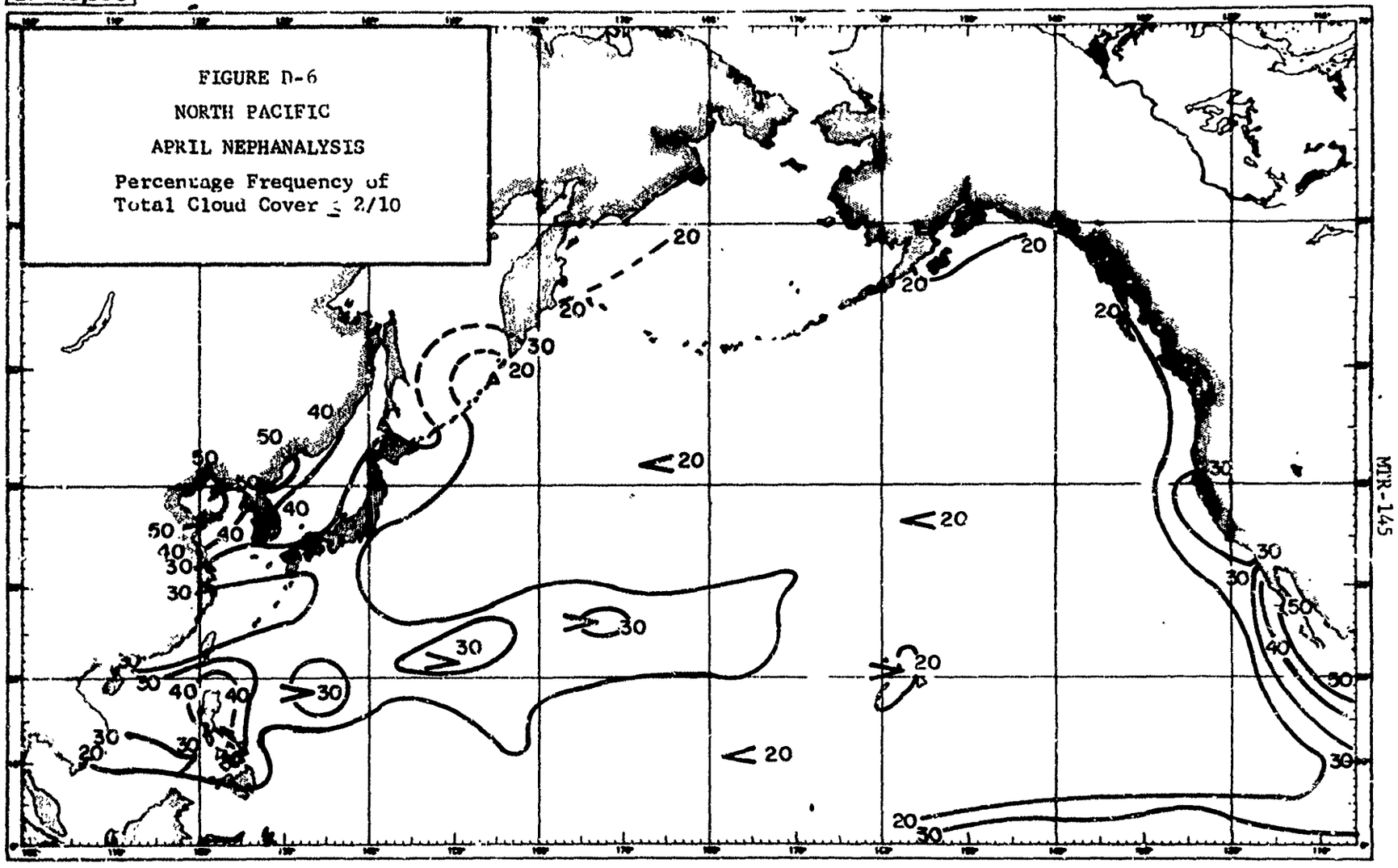


FIGURE D-6
NORTH PACIFIC
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
20
30
40
50
< 20
> 30

IA-18,081

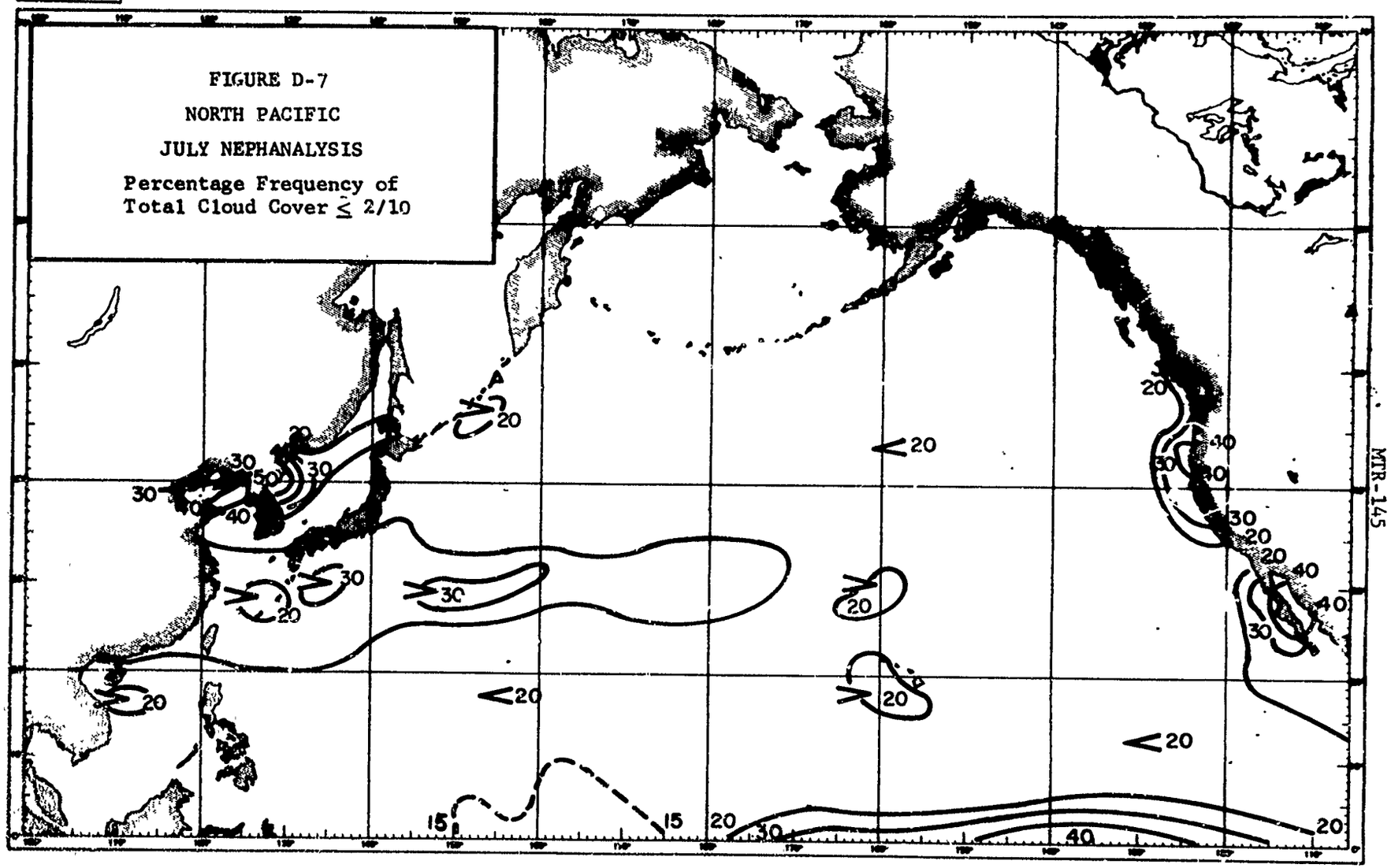


FIGURE D-7
NORTH PACIFIC
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
20
30
40
50
15

IA-18,082

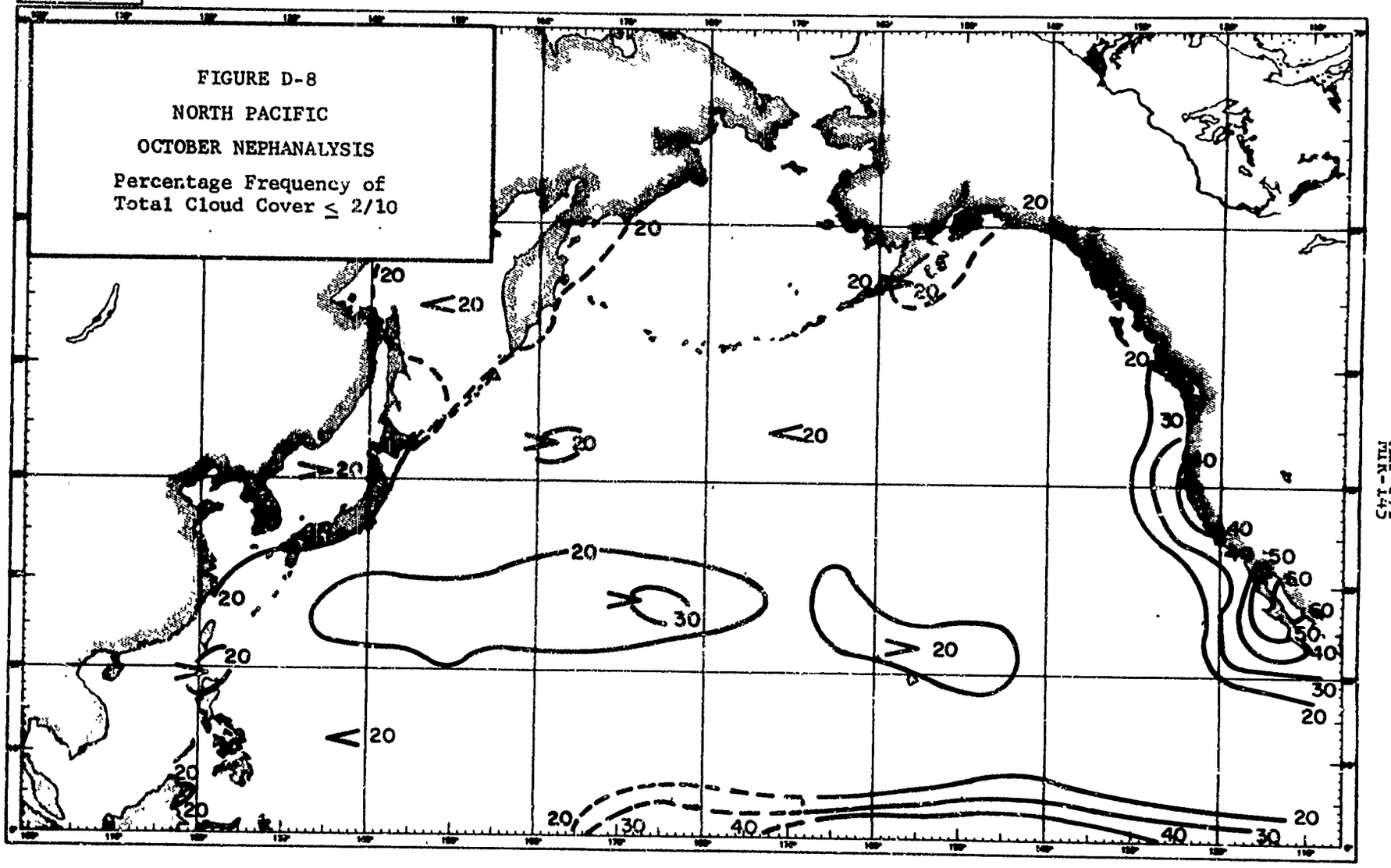


FIGURE D-8
NORTH PACIFIC
OCTOBER NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
20
30
40
50
60

IA-18083

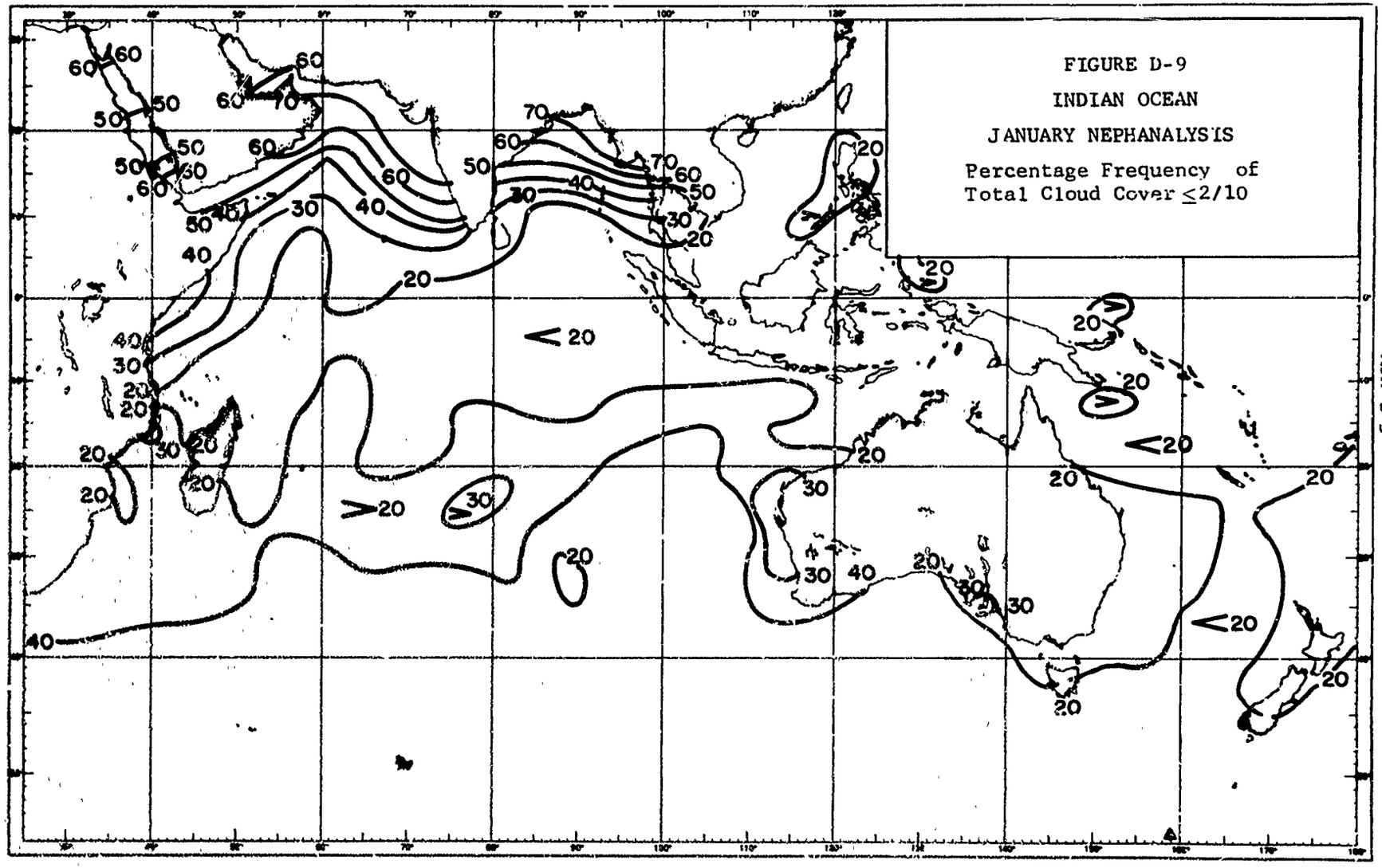


FIGURE D-9
INDIAN OCEAN
JANUARY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤2/10

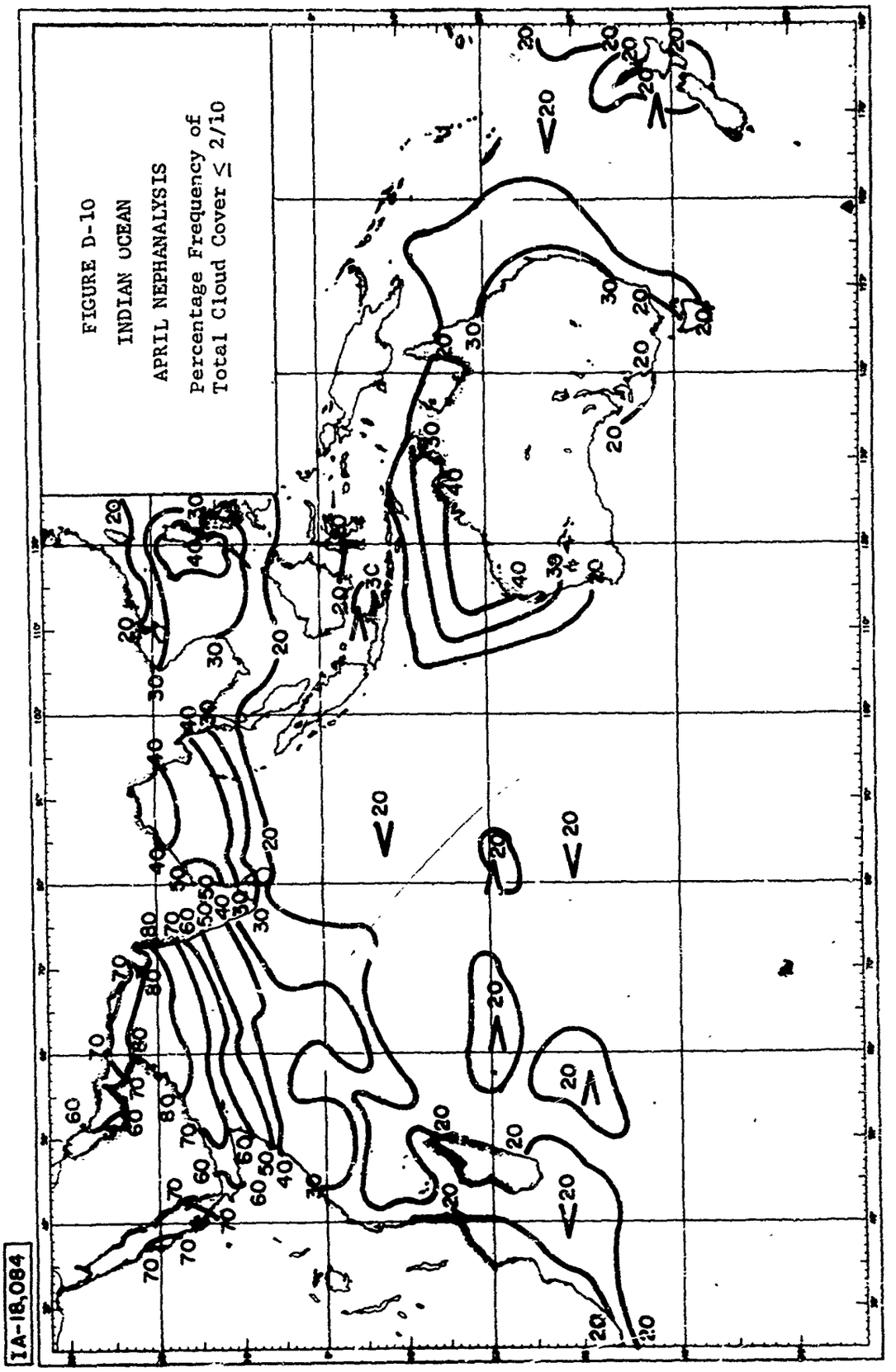


FIGURE D-10
INDIAN OCEAN
APRIL NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤ 2/10
IA-18,084

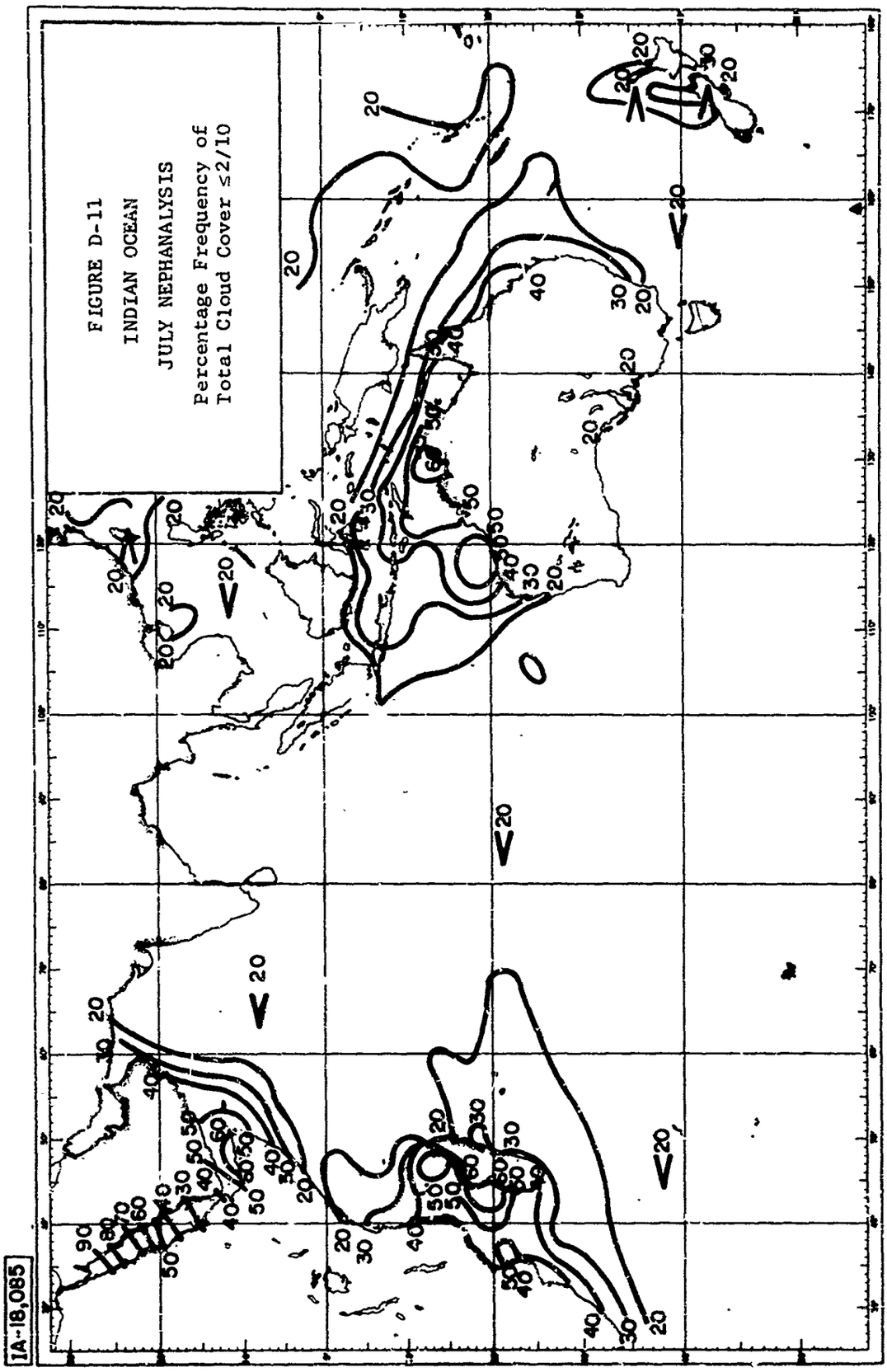


FIGURE D-11
INDIAN OCEAN
JULY NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤2/10
IA-18,085

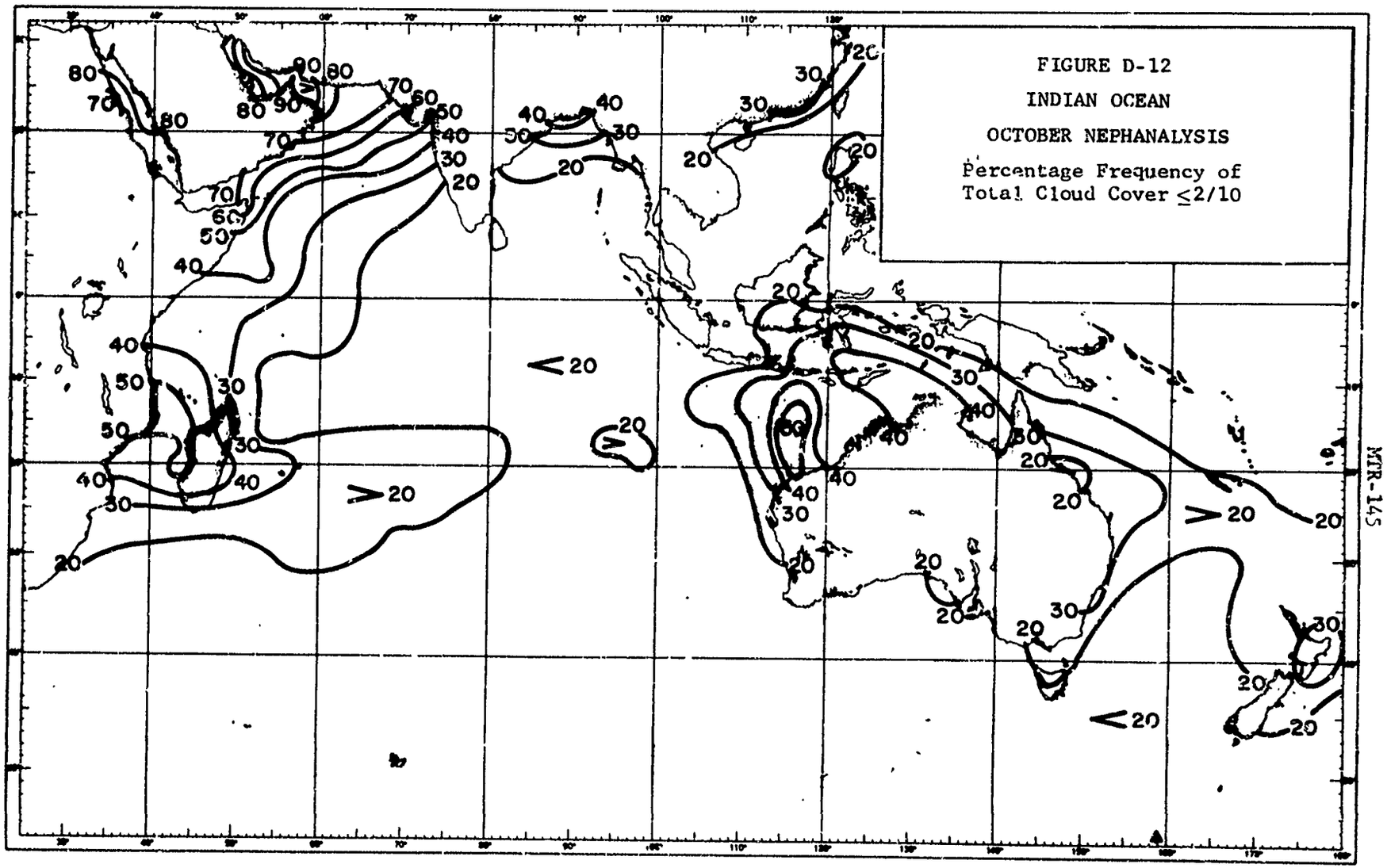


FIGURE D-12
INDIAN OCEAN
OCTOBER NEPHANALYSIS
Percentage Frequency of
Total Cloud Cover ≤2/10

APPENDIX E

REFERENCES

1. W. E. Middleton, "Vision Through the Atmosphere," University of Toronto Press, 1963.

2. R. G. Eldridge, "A Climatic Isovisic Atlas of the United States," The MITRE Corporation, TM-4144, 3 February 1965.

3. U. S. Navy Marine Climatic Atlas of the World.

   Volume I North Atlantic Ocean, NAVAER 50-IC-528, 1 July 1956.
   Volume II North Pacific Ocean, NAVAER 50-IC-529, 1 July 1956.
   Volume III Indian Ocean, NAVAER 50-IC-530, 1 September 1957.