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 8th edition in a continuing biennial series of Antarctic sea ice atlases prepared by the JIC. The atlas contains weekly charts depicting Southern Hemisphere ice conditions and extent. The significant use of high resolution satellite imagery 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. Satellite data from different sensors is compared and analyzed for ice information content. Table I, located on the inside back cover, summarizes satellite data available during 1987 and 1988.

b. Where insufficient data is available, an estimated boundary will be depicted. Meteorological data and theoretical ice drift data 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
ANTARCTIC SEA ICE ANALYSIS: 1987-1988

These are approximately 7-day analyses of sea ice prepared by the Naval Polar Oceanography Center, Suitland, MD. Included are ice concentrations and ice thickness (age).
NORTHERN ICE LIMIT 22 JAN 87
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND

STAGES OF DEVELOPMENT (THICKNESS)
- Young ice (90-150 m)
- Stranded ice (150-250 m)
- First year ice (250-300 m)
- Second year ice (300-400 m)
- Old ice (400-500 m)
- Ice floe (500-1000 m)
- Ice shelf (1000-2000 m)

Ice legend:
- Sea ice free
- Ice edge
- Sea ice free
NORTHERN ICE LIMIT 19 MAR 87

NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SULTAN

STAGE (THICKNESS)

EXAMPLES

EVENT

STAGE

TYPICAL THICKNESS

MAR 53A

5

300

MAR 53B

5

300

MAR 53C

5

300

Note: Event numbers are unique to each event and may repeat.

- Ice boundary visually by satellite observed
- Ice boundary assumed

Observed events with major and greater than 15 cm will be deleted. Range observed after deletion will be indicated with original designation.

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Type</th>
<th>Thickness</th>
<th>Source</th>
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Note: Event numbers are unique to each event and may repeat.
NORTHERN ICE LIMIT 09 APR 87
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SITTLAND

STAGES OF DEVELOPMENT (THICKNESS)

- Stage 1 (10-15 cm)
- Stage 2 (15-30 cm)
- Stage 3 (30-60 cm)
- Stage 4 (60-120 cm)
- Stage 5 (120-240 cm)
- Stage 6 (240 cm+)

EXAMPLES

C1 C2 C3

C

Legend:

- Fast ice: Sea ice which forms and remains fast along the coast.
- Sea ice free:
- Ice boundaries:
- Ice boundaries estimated.

Observed readings with major ice thicker than 15 cm. Icebergs not observed for 30 days will be omitted. Changes reported after observation will be incorporated with seasonal diagrams.

<table>
<thead>
<tr>
<th>Date</th>
<th>Ice</th>
<th>Observation</th>
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<td>45</td>
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<td>46</td>
<td>30.41 Mm</td>
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<td>47</td>
<td>26.99 Mm</td>
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<tr>
<td>09 APR 87</td>
<td>48</td>
<td>23.47 Mm</td>
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NORTHERN ICE LIMIT 11 JUN 87

NAVY - NOAA JOINT ICE CENTER

NAVAL POLAR OCEANOGRAPHY CENTER, SUIVLAND

C - Total ice concentration in the area in percent.
C1, C2, C3 - Concentration of thicker (C1), 2nd thickest (C2), and 3rd thickest (C3) ice.
C4, C5, C6 - Stage of development of thicker (C4), 2nd thickest (C5), and 3rd thickest (C6) ice.
C7 - Concentration of ice within areas of error and uncertainty.

STAGES OF DEVELOPMENT (THICKNESS)

1. Fast ice (0 - 10 cm)
2. Young ice (10 - 30 cm)
3. First year ice (30 - 100 cm)
4. First year ice (100 - 200 cm)
5. First year ice (200 - 300 cm)
6. Old ice (formed on at least one previous year's ice)

Legend:
- Fast ice: Sea ice which forms and remains fast along the coast.
- Old boundary present or similar observed.
- Old boundary estimated.
- Shown areas where no ice is present for 15 days. (The data from the previous days will be deleted.)
- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

- Ice concentration will be indicated with an ice symbol.

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- Ice concentration will be indicated with an ice symbol.
NORTHERN ICE LIMIT 01 OCT 87

NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUTLAND

Diagram showing the northern ice limit with various symbols and annotations. The diagram includes symbols for different ice types and stages of development, as well as location markers such as A-20B, A-20A, 3-5, 7-9, 9-10, 4-6, 6-8, 2-4, 2-4, 8-10, and 2-10.

Legend:
- Ice types: Fast ice, open water, ice edge, ice tongue.
- Stage of development: 1st year (1Y), 2nd year (2Y), 3rd year (3Y), 4th year (4Y), and 5th year (5Y).
- Concentration of ice: 0%, 25%, 50%, 75%, and 100%.

Key:
- Fast ice: Ice that moves with the current and remains fast along the coast.
- Open water: Water not covered by ice at any point.
- Ice edge: Boundary between fast ice and open water.

Explanations:
- Ice boundaries: Shown in black or gray.
- Ice boundaries: Dotted lines indicate estimated boundaries.
- Observations: Symbols and notes indicate ice concentration and stage of development.

Legend entries include:
- Fast ice
- Open water
- Ice edge
- Ice tongue
- 1st year
- 2nd year
- 3rd year
- 4th year
- 5th year
- Ice concentration
- Data: Dates and locations provided for observed ice conditions.

Note: The text in the image is not legible and cannot be transcribed accurately.
NORTHERN ICE LIMIT 29 OCT 87
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, WASHINGTON

STAGES OF DEVELOPMENT (THICKNESS)
1 = First ice (0 - 10 cm)
2 = Young ice (10 - 30 cm)
3 = First year ice (30 - 100 cm)
4 = First year ice (100 - 150 cm)
5 = First year ice (150 - 250 cm)
6 = First year ice (250 - 300 cm)
7 = Field ice (sea ice which forms and remains fast along the coast)
8 = Sea ice free

Ice boundaries are only approximate

Observed thicknesses with minor error of ±5 cm are given in the thickness column. Data sources include official reports

1. National Oceanic and Atmospheric Administration
2. U.S. Navy
3. University of Washington
4. National Snow and Ice Data Center
5. U.S. Coast Guard

Sea ice-free areas are shown with the conventional symbols.
**NORTHERN ICE LIMIT 05 NOV 87**

**NAVAL POLAR OCEANOGRAPHY CENTER, SITLUAND**

- **F** = Total ice concentration in the area in knots.
  - **C** = Concentration of thick ice, or 3rd thick ice.
  - **D** = Concentration of 2nd thick ice and 3rd thick ice.
  - **E** = Concentration of ice within area of force and current.

**STAGES OF DEVELOPMENT (THICKNESS)**

<table>
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<tr>
<th>Stage</th>
<th>Example</th>
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<td>1/2 1/2</td>
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<td>7.9</td>
<td>7.9 7.9</td>
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<td>2.6</td>
<td>2.6 2.6</td>
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</tbody>
</table>

- **F** = Fast ice. See ice which forms and remains fast along the coast.

**Ice Boundaries (visible or not observed)**

- **Dashed line** = Ice boundaries observed.
- **Solid line** = Ice boundaries not observed, or not observed in 30 days will be deleted. Changes indicated after observation will be indicated with original data.

**Ice Data**

<table>
<thead>
<tr>
<th>Ice Thickness</th>
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</table>
NORTHERN ICE LIMIT 12 NOV 87
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND

- Total ice concentration in the area in percent.
- C = Concentration of thicker ice (1). 2nd thicker ice (2), and 3rd thicker ice (3). ice
- C = Stage of development of thinner (1), 3rd thicker (2), and 3rd thicker (3) ice.
- C = Concentration of ice within areas of open and thin ice.

STAGE OF DEVELOPMENT (THICKNESS)

1. Early ice (1/2-1/3 of mature ice)
2. Mature ice (1/2-1/3 of mature ice)
3. Ice of longer than 30 days
4. Ice of longer than 60 days
5. Ice of longer than 90 days
6. Ice of longer than 120 days
7. Ice of longer than 180 days

Fast ice. Sea ice which forms and remains fast along the coast.

Ice boundary symbols or places observed:

--- Ice boundary outlined

Observed locations with inner ice greater than 1/3 of total ice observed by 30 miles.

<table>
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<th>South</th>
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<td>74°50'</td>
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<td>74°50'</td>
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<td>A-3</td>
<td>12/15/87</td>
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<td>A-7</td>
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<td>A-8</td>
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<td>A-9</td>
<td>12/15/87</td>
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<td>A-10</td>
<td>12/15/87</td>
<td>74°50'</td>
<td>74°50'</td>
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</tbody>
</table>

SEA ICE FREE
NORTHERN ICE LIMIT 25 NOV 87
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUFFIELD

STAG FL SM0F0"
NORTHERN ICE LIMIT 17 DEC 87

NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND

Legend:
- Sea Ice Free
- Ice Edge

Stages of Development:
- 1 = New Ice (0-10 cm)
- 2 = First Year Ice (10-50 cm)
- 3 = Third Year Ice (50-100 cm)
- 4 = Fourth Year Ice (>100 cm)

Ice boundary data and sources:

Date | Pressure | Ice Thickness | Source
---- | -------- |-------------- |------
1987-12-17 | 1000 | 50-100 cm | NOAA
1987-12-18 | 1000 | 50-100 cm | NAVY
1987-12-19 | 1000 | 50-100 cm | NOAA
1987-12-20 | 1000 | 50-100 cm | NAVY
1987-12-21 | 1000 | 50-100 cm | NOAA
1987-12-22 | 1000 | 50-100 cm | NAVY
1987-12-23 | 1000 | 50-100 cm | NOAA
SEA ICE FREE

NORTHERN ICE LIMIT 14 JAN 88
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SULTLAND

STAGES OF DEVELOPMENT PROGRESS:
1. New ice 10-15 cm
2. First-year ice 15-30 cm
3. Second-year ice 30-70 cm
4. Third-year ice 70-250 cm
5. Ice of unknown age (oldest known)

Legend:
- Thick boundary
- Thin boundary

Openings cutting with major axis greater than 70° are not considered for sea ice. Openings with minor axis less than 25° are not considered for sea ice.
NORTHERN ICE LIMIT

NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER
SOUTH AMERICA

Sea ice conditions as of February 88

Legend:
- Open water
- Ice edge
- Sea ice not reported
- Sea ice reported

Legend:
- Open water
- Ice edge
- Sea ice not reported
- Sea ice reported

Ice conditions:
- A: Ice thickness
- B: Ice concentration
- C: Ice type
- D: Ice edge

Map details:
- Map scale
- Map projection
- Map legends
- Map scale
- Map projection

Additional notes:
- Date
- Time
- Weather conditions
- Ice conditions

Map references:
- Navy
- NOAA
- Joint Ice Center
- Naval Polar Oceanography Center

Map symbols:
- A
- B
- C
- D
- E

Map regions:
- Northeast
- Southeast
- Northwest
- Southwest

Map dimensions:
- Width
- Height
NORTHERN ICE LIMIT 11 FEB '88
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND

STAGES OF DEVELOPMENT (THICKNESS)
1 = New ice (9 - 10 cm)
2 = Young ice (10 - 20 cm)
3 = First year ice (20 - 40 cm)
4 = First year + (40 - 120 cm)
5 = Old ice (120 - 200 cm)
6 = Old ice formed at least 4 years

Legend:
- Fast ice
- Sea ice
- Ice edge
- Other

Ice boundaries
- Solid line: Observed
- Dashed line: Estimated

Examples:
- A: Total concentration 90%
- B: Thin ice 70%
- C: Thin ice 40%
- D: Thin ice 10%

Sea ice free

Notes:
- Observed data with error one greater than 10 cm cannot be used
- Range sensors will be checked with original program
- NOAA
- NAVY
- Center
- Suitland

- 100 20 30
- 12.30
- 18.10
- 15.10

- 100

- 50

- 2.4

- 2.6

- 2.8

- 3.0
NORTHERN ICE LIMIT 29 DEC 88
NAVY - NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND

- Thickness of ice in meters./categories:
  - A = First year ice 0.15-0.20 m
  - B = Second year ice 0.20-0.40 m
  - C = Third year ice 0.40-0.80 m
  - D = Fourth year ice 0.80-1.60 m
  - E = Fifth year ice >1.60 m

- Stages of development:
  1. First year ice
  2. Second year ice
  3. Third year ice
  4. Fourth year ice
  5. Fifth year ice

- Ice boundaries:
  - Black line: Ice boundary
  - Dashed line: Sea ice boundary

- Other symbols:
  - Red triangles: Wind direction
  - Blue triangles: Wave direction

- Legend:
  - A: First year ice
  - B: Second year ice
  - C: Third year ice
  - D: Fourth year ice
  - E: Fifth year ice

- Additional notes:
  - Ice coverage:
    - 10% - 20%
    - 20% - 30%
    - 30% - 40%
    - 40% - 50%
    - 50% - 60%
    - 60% - 70%
    - 70% - 80%
    - 80% - 90%
    - 90% - 100%

- Important dates:
  - 29 Dec 88
<table>
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<th>Time period</th>
<th>Satellite Data Utilized During 1978 and 1988 (Antarctic)</th>
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**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
- SMMR: Scanning Multifrequency Microwave Radiometer
- VIS: Visible
- um: Micrometer