Nimbus Ice Edge Points from Nimbus Visible Imagery L2, CSV, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Gallaher, D. and G. Campbell. 2014. *Nimbus Ice Edge Points from Nimbus Visible Imagery L2, CSV, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/NIMBUS/NmIcEdg2. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NmIcEdg2

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

This data set consists of geographical points (longitude, latitude) that indicate the likely location of the North and South Pole sea ice edges at various times during the mid to late 1960s, based on recovered visible imagery from the Nimbus 1, Nimbus 2, and Nimbus 3 satellite missions. The ice edge was located by manually inspecting thousands of images from the Nimbus Advanced Vidicon Camera System Visible Imagery L1, HDF5 (before 1968) and Image Dissector Camera System Visible Imagery L1, HDF5 (after 1968) data sets. Data are provided in approximately 1-week increments (7 or 8 days) with separate files for the North and South Pole.

1.1 Format

Data are provided as Comma Separated Value (CSV) formatted files. Browse images are also available.

1.2 File Naming Convention

NmIcEdg2 data files use the following file naming convention:

Example file name: `NmIcEdg2.1970.1.1.1970.1.8.south.csv`

NmIcEdg2.[YYYY.MM.DD].[yyyy.mm.dd].[north or south].csv

Table 1 describes the file name variables listed above:

Table 1. NmIcEdg2 File Naming Convention

Variable	Description
NmIcEdg2	Data product
YYYY.MM.DD	Start year, month, and day
yyyy.mm.dd	End year, month, and day
north or south	Hemisphere

1.3 File Size

Data files are approximately 500 KB.

1.4 Spatial Coverage

North and South Pole data are provided as separate files that extend from the corresponding pole to 50° N or 50° S. However, some regions, for example parts of Alaska, are not available due to technological limitations at the time of the missions.

1.4.1 Spatial Resolution

Roughly 5 km

1.4.2 Projection and Grid Description

Latitude, Longitude

1.5 Temporal Coverage

Intermittent data are available within the following date ranges:

Table 2. Temporal Coverage by Satellite

Satellite	Date Range
Nimbus 1	28 August to 22 September, 1964
Nimbus 2	15 May to 2 September, 1966
Nimbus 3	24 April, 1969 – 16 January, 1970

1.5.1 Temporal Resolution

Data are provided in approximately 1-week increments (7 or 8 days), however this interval is arbitrary. Users should feel free to merge data files and average over larger intervals.

1.6 Parameter or Variable

Data files contain rows of ASCII text, with each row corresponding to an ice edge point. Columns specify latitude, longitude, and edge type plus ancillary information as detailed in Table 3:

Table 3. NmIcEdge2 Column Headings and Descriptions

Longitude	Latitude	File_name	EdgeType[1,2]	ishift[3]	jshift[3]	Analyst
0° – 360° (CW)	50° N – 90° N 50° S – 90° S	AVCS/IDCS file used to identify edge point.	1 - possible edge (green) 2 - certain edge (red) 3 - edge of lead (magenta) 4 - edge in region of broken ice (orange)	Horiz. shift (pixels)	Vert. shift (pixels)	Analyst initials (internal use)

[1]Color denotes edge type in browse images. [2]EdgeType = -1 specifies that the reported lat/lon corresponds to the center of an AVCS/IDCS image evaluated for the data file (black squares in browse images). [3]Shift applied to better align original image with visible landmarks. See Section 3.2.1.

1.7 Sample Data Record

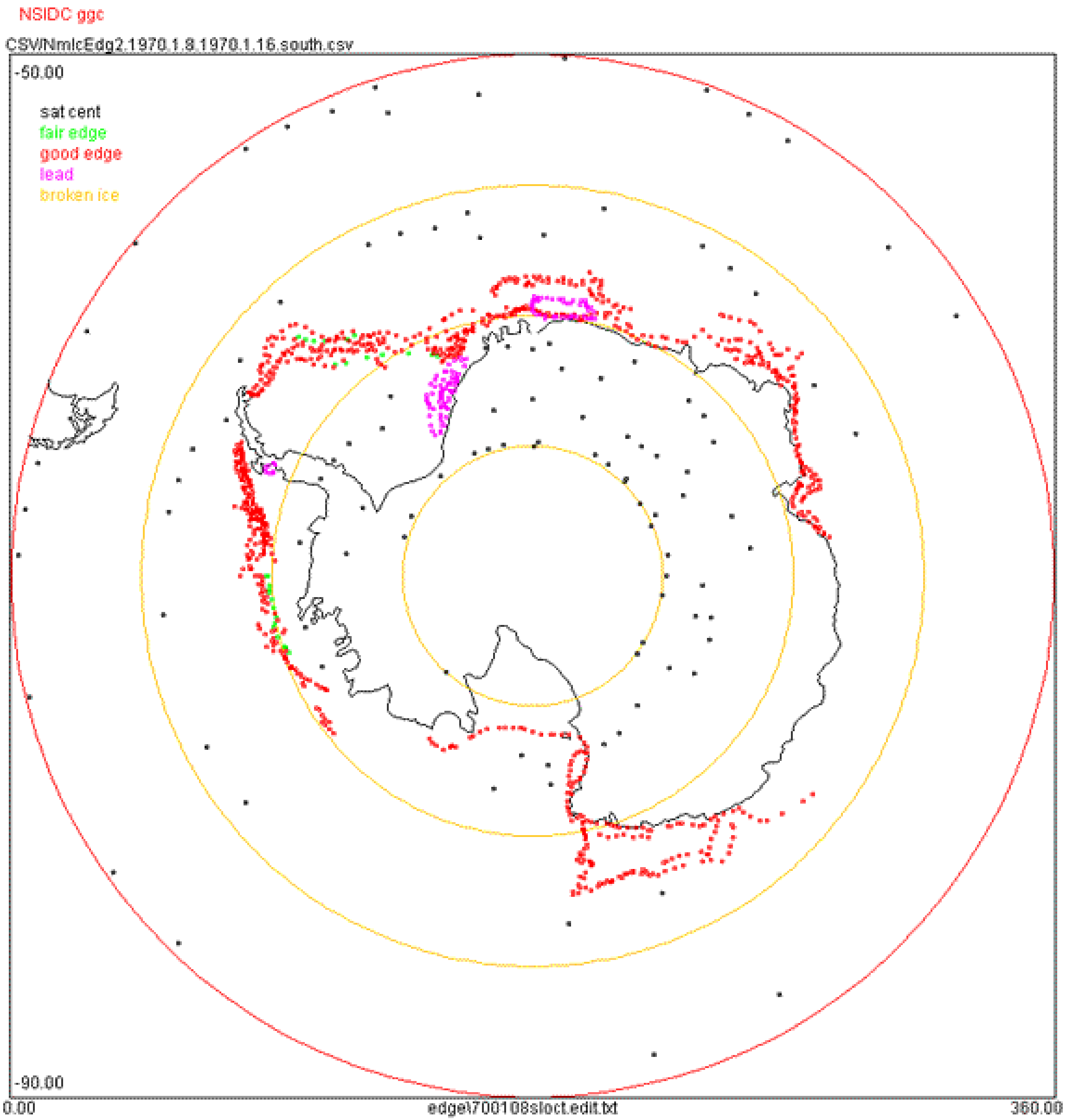

Figure 1. Ice edge points for 1/8/70 plotted on map of Antarctica. Colors indicate ice edge type. Black squares correspond to centers of IDCS images used for analysis. See: Table 3

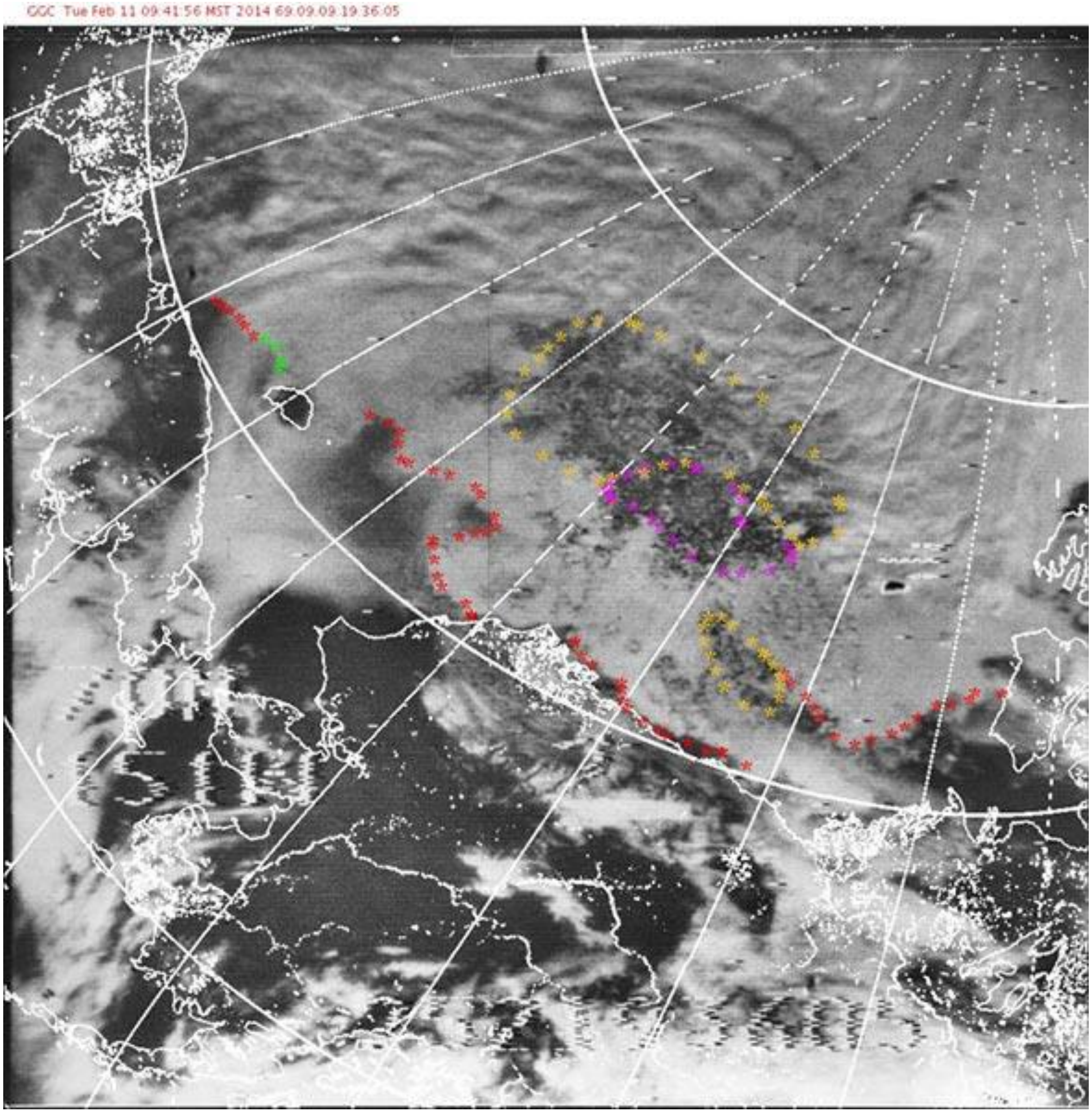

Figure 2. NmIcEdg2 ice edge analysis from 9 September, 1969 overlaid on IDCS source image. Colors indicate ice edge type. See: Table 3.

2 SOFTWARE AND TOOLS

2.1 Software and Tools

CSV data files can be accessed using spreadsheet software or applications that can read ASCII text.

2.2 Quality Assessment

In an attempt to automate ice edge detection, the PIs estimated ice extent by remapping and compositing the minimum brightness for all the images to derive a clear-sky radiance. Although this approach proved inadequate, it does produce a qualitative impression of the ice margin that can be used as independent validation. Visually, the average manually derived ice edge solidly matches the composite minimum brightness image.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

Ice edges were estimated from AVCS and IDCS imagery obtained by the Nimbus 1, Nimbus 2, and Nimbus 3 satellite missions. For details, see the Data Acquisition and Processing sections of the user guides: Nimbus Advanced Vidicon Camera System Visible Imagery L1, HDF5 Version 1 and Nimbus Image Dissector Camera System Visible Imagery L1, HDF5.

3.2 Derivation Techniques and Algorithms

3.2.1 Processing Steps

Analysts at NSIDC visually inspected thousands of Nimbus AVCS and IDCS images for the presence of open water and sea ice. Some automated methods were tested; however, the imprecise navigation and inconsistent quality of the original images, combined with the challenge of distinguishing cloud edges from sea ice, required that human observers determine each point by hand. Once identified, points were ranked as either possible or certain based on the analyst's experience and confidence that the edge was distinguishable from clouds (often based on the assumption that ice moves more slowly than clouds). No attempt was made to analyze lake ice or to look for ice over land.

Images were manually shifted by a few pixels from the original navigation to best match obvious visual landmarks such as coastlines. These shifts are stored in the ishift (horizontal) and jshift (vertical) columns of data files.

In regions with broken ice, the edge was estimated using the 15% SSMI threshold, which defines ice extent as the total area covered by all pixels with at least 15 percent ice concentration. This cut-off was adopted to allow comparisons with modern records.

Although every attempt was made to completely categorize all unobscured ice edges in the original AVCS and IDCS images, leads and broken ice regions were not exhaustively evaluated. As such, references to these features in the data are subjective at best and some images that contain broken ice and leads have not been included. Note that the absence of an ice edge may reflect missing data from a given region or time and some weeks and months were not analyzed because the pole of interest was dark.
In addition, although independent contemporaneous sources of Antarctic sea ice extent are lacking, Arctic sea ice charts from the 1960s agree very well with this data set (where the data overlap), lending further credibility to the results.

3.2.2 Errors and Limitations

The greatest source of uncertainty lies in distinguishing homogeneous clouds from homogeneous ice. Fortunately, ice edges are visually different from cloud edges, even in these images from the late 1960s. Furthermore, because clouds tend to move faster than sea ice, viewing multiple images of the same location often differentiates an ice edge from cloud.

The ice edge was assumed to lie between ice and open ocean. This approach works well in the Southern Hemisphere where the ice extends more or less continuously from the pole to the leading edge; however, determining ice extent in the north is more complicated due to islands and regions of open water that lie north of fast-moving ice.

As with all derived data, errors in the input can propagate to the output. The following documents contain details about error sources in original Nimbus images used to produce this data set:

- Nimbus Advanced Vidicon Camera System Visible Imagery L1, HDF5: Error Sources
- Nimbus Image Dissector Camera System Visible Imagery L1, HDF5: Error Sources

3.3 Sensor or Instrument Description

3.3.1 Advanced Vidicon Camera System

The Advanced Vidicon Camera System (AVCS) consisted of three earthward-facing cameras deployed in a fan-like array to produce a three-segment, composite picture. Each camera's field of view covered 37 degrees; the center camera pointed straight down while the optical axes of the other two were directed 35 degrees to either side. The cameras utilized an f/4 lens with a focal length of 16.5 mm. A potentiometer attached to the solar array controlled the lens opening from f/16 when the spacecraft was over the equator to f/4 when it was near the poles. Eight-hundred scan-line, 2.54-cm-diameter vidicon pickup tubes yielded a linear resolution of better than 1 km at nadir from an altitude of 800 km. The camera array produced a composite picture covering an area of 830 km by 2700 km.

For additional information about the Nimbus AVCS, see the National Space Science Data Center's Advanced Vidicon Camera System (AVCS) Web page.

3.3.2 Image Dissector Camera System

The Image Dissector Camera System (IDCS) was a shutterless, electronic scan and step tube mounted behind a 108 degree wide-angle, 5.7 mm focal length lens. The camera was installed on the bottom of the satellite sensory ring and pointed vertically down toward the earth at all times. The optical field of view was 73.6 degree in the direction of flight and 98.2 degree in the plane perpendicular to flight. The instrument optics focused the image on the dissector tube's photosensitive surface, while a line-scanning beam scanned the surface at 4 Hz with a frame period of 200 seconds. At the nominal spacecraft altitude of 1100 km, the resulting pictures covered approximately 1400 km on a side with a ground resolution of 3 km at nadir. Scanning and stepping functions occurred continuously as the satellite progressed along its orbital path. Pictures were either transmitted to ground stations in real time or stored on magnetic tape for subsequent transmission.

For additional information about the Nimbus IDCS, see the National Space Science Data Center's Image Dissector Camera System (IDCS) Web page.

4 REFERENCES AND RELATED PUBLICATIONS

4.1.1 References

Gallaher, D., G. G. Campbell, and W. N. Meier. In Press. Anomalous Variability in Antarctic Sea Ice Extents During the 1960's with the Use of Nimbus Satellite Data. *Journal of Selected Topics in Applied Earth Observations and Remote Sensing*.

Meier, W. N., D. Gallaher, and G. G. Campbell. 2013. New Estimates of Arctic and Antarctic Sea Ice Extent During September 1964 from Recovered Nimbus I Satellite Imagery. *The Cryosphere Discuss 7:35-53*.: 10.5194/tcd-7-35-2013.

4.1.2 Related Data Collections

See the Nimbus Data Rescue Project | Data Sets page.

4.1.3 Related Websites

- NASA Science | Missions: Nimbus

- Advanced Vidicon Camera System (AVCS)
- High-Resolution Infrared Radiometer (HRIR)
- Image Dissector Camera System (IDCS)

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

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6.2 Date Last Updated

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