U.S. National Ice Center Daily Marginal Ice Zone Products, Version 1

USER GUIDE

How to Cite These Data

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

U.S. National Ice Center. 2020, updated daily. *U.S. National Ice Center Daily Marginal Ice Zone Products, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/ggcq-1m67. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/G10017

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Summary

The marginal ice zone (MIZ) is defined by the World Meteorological Organization (WMO) as “the region of an ice cover which is affected by waves and swell penetrating into the ice from the open ocean” (WMO, 2014). This data product is a U.S. National Ice Center (USNIC) rendering of the MIZ as the band of ice in concentrations between 1/10 and 8/10, or about 10% to 80% concentration, that surrounds Arctic and Antarctic pack ice with higher concentrations. The time series begins in September 2004 for the Arctic and January 2010 for the Antarctic.

1.2 Parameters

These files are of ice concentration in two ranges: 10%-80% and 80%-100%.

1.3 File Information

1.3.1 Format

These data are provided in vector shapefile, Google Earth Keyhole Markup Language Zipped (KMZ), and ASCII formats. The files are named as shown in Table 1 and in the sections below.

Table 1. Daily MIZ File Naming Convention

Variable	Description
`nic`	Identifies this as data coming from USNIC
`miz`	Identifies this as a marginal ice zone product
`YYYY`	4-digit year of the data in the file
`YY`	2-digit year of the data in the file
`DDD`	3-digit day of year of the data in the file.
`Hc`	Hemisphere (for shapefiles only): `nc` = Arctic, `sc` = Antarctic
`pl`	Stands for “polygon” (for shapefiles only)
`a`	Version letter, meaning the first version or version “a” (for shapefiles only)
`hemisphere`	Hemisphere (for KMZ files only): `arctic` or `antarctic`
`line`	When this is in a file name it identifies the file as containing an outline of the MIZ and pack ice as opposed to a filled polygon (for KMZ files only)
`Hmiz`	Hemisphere (for ASCII files only): `nmiz` = Arctic, `smiz` = Antarctic
`.kmz`	Indicates that this is a zipped Google Earth file
`.zip`	Indicates that this file is zip compressed

1.3.2 Shapefiles

The shapefiles contain polygons of the MIZ at 10% - 80% ice concentration colored in yellow and of the pack ice at greater than 80% concentration colored in red, as illustrated in Figure 1. Zip files hold the .shp, .dbf, .shx, .prj, and .xml files and range in size from approximately 3 MB to 7 MB. Note that the .prj and .xml files are not included in the zip files until 23 August 2006.

The shapefiles are named according to the following convention and as described in Table 1.

Generic File Names: `nic_mizYYYYDDDHc_pl_a.zip`
Example File Name: `nic_miz2014007nc_pl_a.zip`

1.3.3 Google Earth KMZ

Google Earth-compatible KMZ files (zipped KML files) range in size from 5 MB to 7 MB. These files show either the filled MIZ and pack ice areas (Figure 1, left), or the 10% and 80% contour lines (Figure 1, right).

The files are named according to the following convention and as described in Table 1.

Arctic Generic File Names: `hemsiphere_YYYYDDD.kmz` and `hemisphere_line_YYYYDDD.kmz`
Example File Names: `arctic_2014007.kmz` and `arctic_line_2014007.kmz`

In the example shown, the attribute table for the filled polygon (Figure 1, left) identifies it as ranging in concentrations from 1/10 to 8/10. This is indicated with the code `CT18`., where CT stands for concentration, 1 stands for 1/10, and 8 stands for 8/10. The attribute table for the contour polygon from the *line* file (Figure 1, right) identifies it as ranging in concentrations from 8/10 to 10/10, as indicated by code `CT81`. The attributes use the Sea Ice Georeferenced Information and Data (SIGRID 3) code (IOC, 2004).

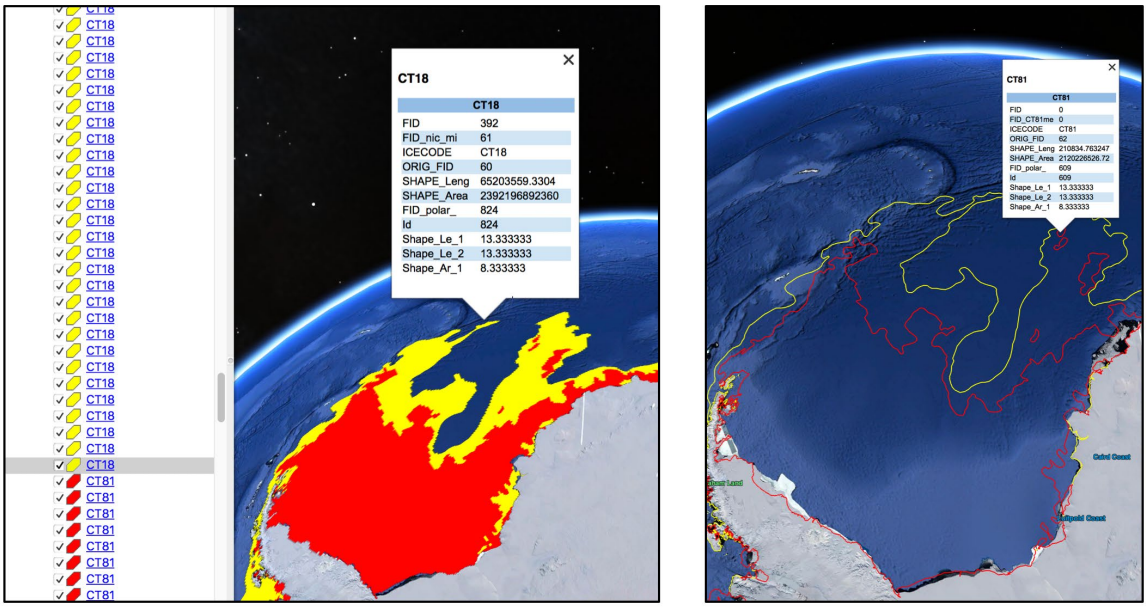

Figure 1. The MIZ and pack ice in the Weddell Sea area on 31 December 2019, on Google Earth with filled MIZ file, antarctic_2019365.kmz (left) and contour line file, antarctic_line_2019365.kmz (right).

1.3.4 ASCII

The text files range in size from approximately 100 KB to 600 KB and are named according to the following convention and as described in Table 1.

Arctic Generic File Name: `HmizYY.DDD`
Example File Name: `nmiz14.007`

These are text files with the MIZ ice edge and pack ice edge lines identified by latitude and longitude pairs. Pair sequences are produced by the analyst tracing a line and clicking points along it. These pair sequences follow a two-line header and several lines beginning with the word `LINE`. The files are in Rainform Over the Horizon (OTH) format, which is a Department of Defense format that some users require.

The first 25 lines of the `smiz19.365` ASCII data file are shown in Figure 2 and illustrate the form of these files. These files include extraneous elements that users should ignore. To use these data, read the records starting with the first record after the last occurrence of the word `LINE`. The first line of data from `smiz19.365` is highlighted in red in Figure 2. Note that there is not a break to indicate which line segments belong to the 1/10 contour line and which line segments belong to the 8/10 contour line.

The first latitude-longitude pair in the example shown in Figure 2 is `/650042S7/0644043W1` which corresponds to 65°00’42” South and 064°40’43” West.

```
MSGID/NAVICECEN/OVLY2/0031/DEC
OVLY/MIZ1/311237Z7/DEC/1OF1/MIZ1/METOC
LINE/4/0/A/640021S3/0612739W8/640021S3/0612739W8/640209S1/0614542W2
/640151S7/0615305W0
LINE/2/0/A/640025S7/0620055W8/635955S3/0620239W2
LINE/3/0/A/635938S4/0620341W6/635916S0/0620456W3/640343S0/0621635W3
LINE/4/0/A/641000S1/0623445W4/641200S3/0624119W3/641448S7/0625559W2
/641649S0/0631620W8
LINE/255/0/A/644310S8/0641154W1/644443S5/0641420W7/645029S6/0642559W1
/650042S7/0644043W1/650547S7/0645902W6/651816S7/0655404W4
/652330S9/0660648W0/653400S8/0661948W4/654239S9/0663606W7
/655304S3/0670002W5/655859S8/0672042W1/660250S9/0674334W7
/661012S6/0681701W3/662121S8/0685145W9/663020S7/0691339W1
/663951S0/0692702W6/665014S2/0695625W3/665526S0/0701635W2
/665537S2/0704122W6/665314S5/0710820W8/665218S8/0713244W1
/665018S6/0720718W5/665050S2/0725230W9/665457S3/0732312W8
/670144S2/0734611W2/670717S8/0741938W2/671136S4/0744705W7
/672015S1/0752219W6/672520S2/0760457W9/673120S9/0763524W7
/675451S8/0782257W1/675850S1/0783957W9/680406S4/0790223W3
/681215S3/0792218W9/681833S9/0794210W3/682420S2/0795509W5
/683306S6/0801257W3/684001S9/0803036W0/684654S3/0805552W5
/684908S5/0811937W9/685204S5/0815801W3/685323S7/0822445W5
/685600S5/0825217W5/685632S0/0831424W2/685637S5/0833754W0
/685847S8/0835932W0/690315S4/0842420W0/690739S4/0844918W4
/691249S1/0851300W7/691700S3/0853436W9/691731S7/0855433W8
```

Figure 2. First 25 lines of the smiz19.365 ASCII data file

1.3.5 Directory Structure

Each day's Arctic or Antarctic MIZ map is available in shapefile, Google Earth KMZ, and ASCII text formats. NSIDC does not archive the daily PNG-format browse files, like those shown in Figure 3. To access those image files go to the USNIC site.

The data files are organized on the HTTPS site: https://noaadata.apps.nsidc.org/NOAA/G10017/ in two main directories by hemisphere: `north` and `south`. Within each of these, there are sub-directories for each year. Each year's directory holds the daily files for all three file types.

The entire data collection has a volume of about 37 GB as of 2019. The volume grows by about 4 GB per year.

1.4 Spatial Coverage and Resolution

The MIZ is mapped using a variety of source data with varying coverages and resolutions. The MIZ products are vector products, which do not have an inherent resolution. The products cover portions of both the Northern and Southern Hemispheres as shown in the maps in Figure 3 and as described in Table 2 with approximate bounding boxes.

Table 2. Approximate latitude/longitude bounding coordinates

Northern Hemisphere	Southern Hemisphere
Northernmost Latitude: 90° N Southernmost Latitude: 43° N Easternmost Longitude: 180° E Westernmost Longitude: 180° W	Northernmost Latitude: 59° S Southernmost Latitude: 90° S Easternmost Longitude: 180° E Westernmost Longitude: 180° W

1.5 Temporal Information

1.5.1 Coverage

The dates for these data depend on the file format and the region. See Table 3 for a listing of the dates.

Table 3. Dates of data by format and region

	Arctic	Antarctic
ASCII files	19 October 2004 to present	01 January 2010 to present
Shapefiles	07 December 2004 to present	18 March 2010 to present
Google Earth KMZ filled MIZ files	22 June 2010 to present	22 June 2010 to present
Google Earth KMZ contour line MIZ files	13 December 2010 to present	13 December 2010 to present

1.5.2 Resolution

All files are updated daily. Generally, NSIDC has data updated through the previous day. There may be occasional gaps in the record.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The mission of the USNIC is to provide ice and snow products, ice forecasting, and other environmental intelligence services for the U.S. government. The USNIC products are designed to meet operational needs. In cooperation with the USNIC, NOAA@NSIDC archives and distributes a selection of these products (Table 5). See the Appendix for more information about the USNIC products and NOAA@NSIDC's role in archiving them.

The MIZ is defined by the WMO as "the region of an ice cover which is affected by waves and swell penetrating into the ice from the open ocean" (WMO, 2014). The data set described here, *U.S. National Ice Center Daily Marginal Ice Zone Products*, is an archive of USNIC MIZ products in shapefile, ASCII, and Google Earth KMZ formats.

The USNIC defines the MIZ as areas of ocean covered by ice between 1/10 and 8/10 concentrations. The USNIC defines the sea ice pack as the area of ocean covered by ice at greater than 8/10 concentration. Here, we use *MIZ products* to refer to products that demarcate both the MIZ/open ocean boundary and the MIZ/pack ice boundary.

Note: the MIZ/open ocean boundary, which in this MIZ product is the 1/10 or 10% contour, is also referred to as the *ice edge* in some contexts. Figure 3 illustrates the MIZ product.

The MIZ shifts and changes shape as floating ice responds to winds and ocean currents. It responds most dynamically to changes in wind direction and strength. On-ice winds may compact the ice, resulting in a narrow MIZ, while off-ice winds can widen it. In the absence of winds or currents, the position and makeup of this band of ice can change when winter freeze-up is occurring or at times when ice is melting rapidly.

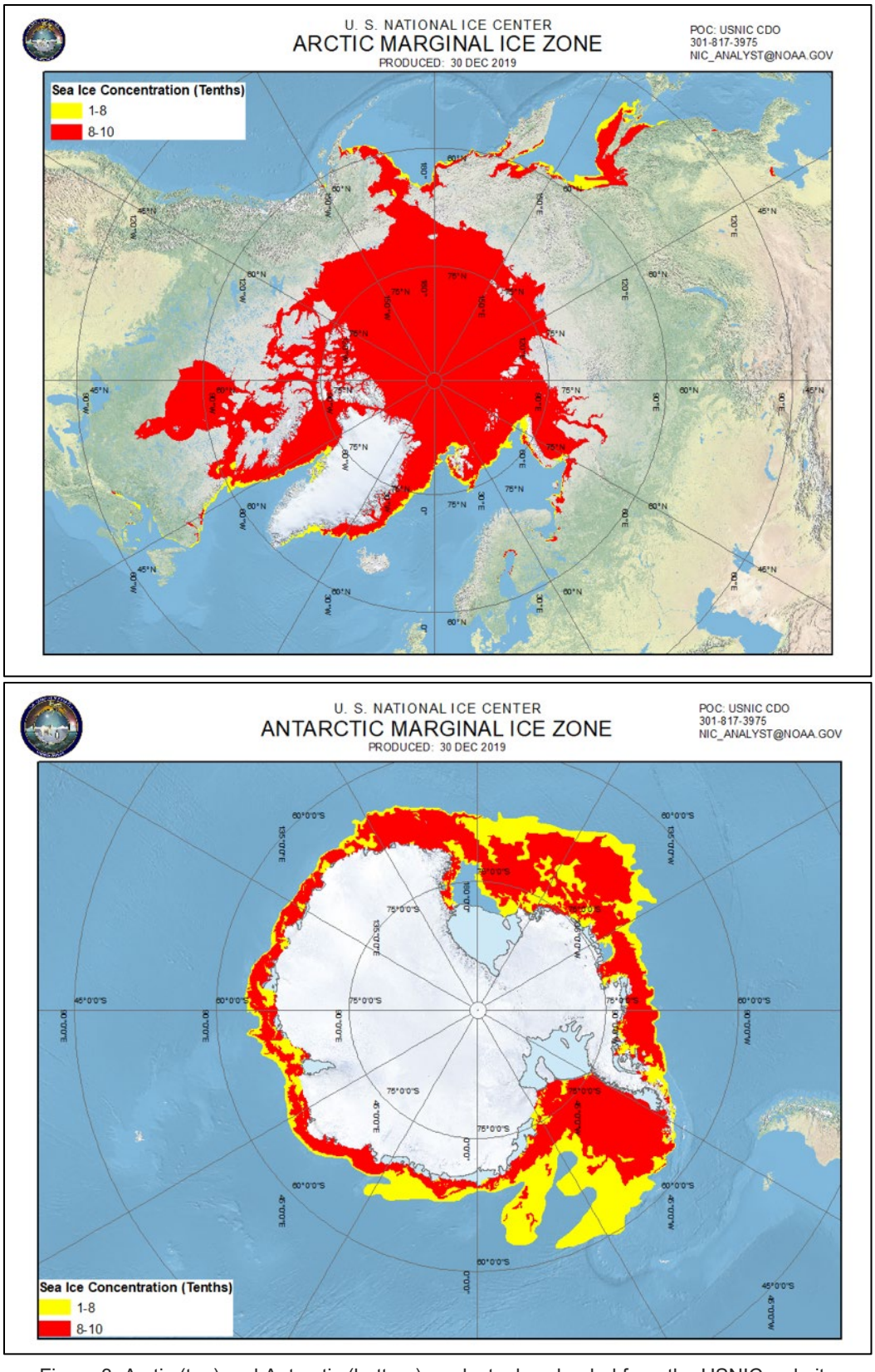

Figure 3. Arctic (top) and Antarctic (bottom) products downloaded from the USNIC website. These image files illustrate the MIZ products that are archived by NSIDC in several formats. The MIZ is shown in yellow. The pack ice is shown in red.

2.2 Acquisition

2.2.1 Constructing the MIZ products

To chart the MIZ, sea ice experts use “multiple sources of near-real-time satellite data, derived satellite products, buoy data, weather, and analyst interpretation of current sea ice conditions” (from the USNIC website, accessed 30 Dec 2019). These sources may be used for other USNIC products as well. See the IMS product User Guide for a listing of many of the sources available to analysts. Analysts display information sources on GIS workstations, where image processing techniques may be employed to maximize the information derived from satellite imagery. Manual analysis allows the sea ice experts at the USNIC to use contextual information, like local weather and climate, and to draw on their own and other’s experience with data sources as they map the ice.

Analysts zoom in for a close look, flipping between satellite images from various sensors and at varying resolutions. They make judgements as to where to draw the 8/10 concentration contour line and the boundary between 1/10 ice concentration and open ocean on the GIS workstation screen. Mariners would not expect to encounter sea ice in significant concentrations when sailing outside of that line. Therefore, while it can be thought of as a 10% contour, on a practical level it functions as a contour between open ocean and ice at any concentration.

Analysts identify concentration in tenths because they are often visually estimating ice concentration from satellite imagery or aerial data. Analysts can assess ice concentration quite accurately to within tenths. See “Chapter 2 Ice Observations” in MANICE (Environment Canada, 2005) for descriptions of how this is done. Most researchers prefer to use percentages for ice concentration. In this document, tenths and percentages are used interchangeably. Ice concentration expressed in percentage, however, may imply a precision greater than that which the data have.

The MIZ shapefile product is made using satellite imagery and other data that have been received over a period of hours. Analysts use the most recent satellite data available. Each day’s product is considered valid at 12Z (1200 UTC) on that day. After the shapefile product is made, Google Earth KMZ and ASCII text format products are output from the shapefile analysis on the GIS workstation using custom-made scripts. Lines are overlaid with any new image data on a workstation, and the analysts may make corrections to line positions before writing out the data files. For that reason, the ASCII text overlay lines may not exactly correspond with the edges of the filled shapefile MIZ and pack ice polygons.

2.2.2 How the MIZ product ice edge compares with the IMS product ice edge

USNIC also produces the *IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions*, from which NSIDC makes the *Multisensor Analyzed Sea Ice Extent (MASIE)* product. The MIZ and IMS products are produced independently on dedicated workstations. The MIZ analysts may look at the IMS analysis, but they do not use it directly. They may incorporate data that are different from the set of sources that IMS analysts use. These may be satellite data and other data that become available over a period of several hours.

The MIZ and IMS product ice-edge position lines have characteristic differences that come from how they are assembled and the formats that they are in. Figure 4, from Posey et al. (2015), illustrates these differences.

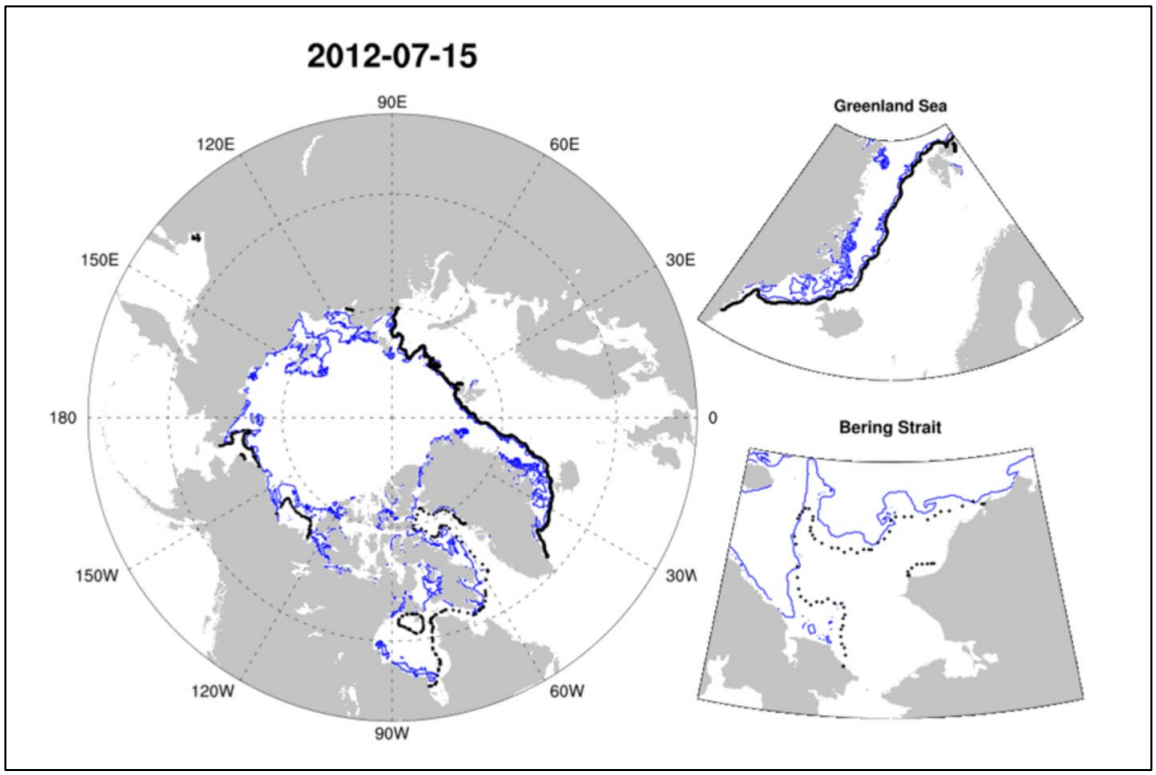

Figure 4. The ice edge location on a single day in July 2012, demarcated in the USNIC IMS product (blue line), and by the USNIC MIZ product ice edge (10% contour, black dots). Figure from Posey et al. (2015), used with permission.

In the MIZ product, the analyst uses the presence of any known ice to determine an edge location. It is a conservative analysis, used for navigational purposes to avoid nearly all ice hazards. Posey et al. (2015) note that “(t)he location of the ice edge can shift, based on the resolution of the data sources.” In contrast, the IMS edge is determined by an analyst generating a gridded field in which all “ice” grid cells, at up to 1 km resolution, are covered with ice at 40% or greater concentration.

The spatial complexity of the IMS edge is often greater than that of the MIZ edge. The two products are derived independently of each other.

2.2.3 Applications for the MIZ products

The USNIC-produced MIZ daily maps may be preferable to other daily sea ice products for applications that benefit from accuracy and high resolution and do not require ice concentration information that is more precise than the MIZ product's 10% - 80% and greater than 80% ranges. Applications may include initializing or validating ice-forecast models and assessing the accuracy of satellite-data-derived products. For example, Posey et al. (2015) use the NIC 10% contour ice edge to evaluate the performance of the U.S. Navy's ice forecast model. The Argo float program has used the Antarctic MIZ product to verify that floats that stop reporting likely encountered the ice edge (personal communication, K. Johnson, Monterey Bay Aquarium Research Institute, 2016).

The MIZ is a dynamic area of ice at relatively low concentration. Satellite passive-microwave-derived sea ice concentration algorithms often fail to detect ice when it is newly forming and thin, or present at low concentrations. Even when ice is detected, the concentration of the ice is generally underestimated by many passive-microwave-based sea ice products. On the other hand, passive-microwave-derived sea ice concentration products are widely used by researchers for good reasons. NSIDC's passive-microwave-based products like those underlying the *Sea Ice Index* are long time series that have been consistently processed, making them suitable for climate studies. Products from the operational community may benefit shorter-term process studies and may be used for satellite algorithm validation.

The *NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice Concentration, Version 3* User Guide Error Sources section has useful information for those seeking to understand how passive-microwave-derived sea ice concentration products are likely to differ from operational products like the MIZ maps.

2.3 Quality, Errors, and Limitations

These data have not been independently assessed. The USNIC has standard procedures by which analysts operate to produce the MIZ products. As an operational service in touch with users, they are continually monitoring the quality of the product informally and adapting data sources and methods as appropriate.

3 VERSION HISTORY

Table 4. Version History Summary

Version	Release Date	Description of Changes
1	August 2020	Initial release of this data set at NSIDC

4 RELATED DATA SETS

NSIDC archives the USNIC products listed in Table 5. Those listed without a full citation have not yet been published and made publicly accessible by NSIDC as of April 2024.

Table 5. US National Ice Center data products currently archived at NSIDC

Data set identifier	NSIDC product name or citation
G10013	U.S. National Ice Center. (2022). U.S. National Ice Center Arctic and Antarctic Sea Ice Charts in SIGRID-3 Format, Version 1 [Data Set]. Boulder, Colorado USA. National Snow and Ice Data Center. https://doi.org/10.7265/4b7s-rn93.
G10017	U.S. National Ice Center. 2020, updated daily. *U.S. National Ice Center Daily Marginal Ice Zone Products, Version 1*. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/ggcq-1m67.
G10019	U.S. National Ice Center Daily Outer Ice Edge
G10020	U.S. National Ice Center Daily 48 Hour Edge Forecast
G02172	U.S. National Ice Center. 2006, updated 2009. Compiled by F. Fetterer and C. Fowler. *National Ice Center Arctic Sea Ice Charts and Climatologies in Gridded Format*. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5X34VDB.
G02156	U.S. National Ice Center. 2008, updated daily. *IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions.* Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N52R3PMC.
G10033	U.S. National Ice Center. Compiled by F. Fetterer and J. S. Stewart. 2020. *U.S. National Ice Center Arctic and Antarctic Sea Ice Concentration and Climatologies in Gridded Format, Version 1*. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/46cc-3952.

Other data sets originating with operational ice charting organizations and archived at NSIDC are the following:

- G00807 - International Ice Patrol Iceberg Sightings Database
  Cite as: International Ice Patrol. 1995, updated 2020. International Ice Patrol (IIP) Iceberg Sightings Database, Version 1. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N56Q1V5R.

- G00874 - International Ice Patrol Iceberg Drift Tracks
  Cite as: National Snow and Ice Data Center (comp.). 1995. International Ice Patrol Iceberg Drift Tracks, Version 1. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N52Z13FD.
- G10028 - International Ice Patrol Annual Count of Icebergs South of 48 Degrees North, 1900 to Present
  Cite as: International Ice Patrol. 2020. International Ice Patrol Annual Count of Icebergs South of 48 Degrees North, 1900 to Present, Version 1. doi: https://doi.org/10.7265/z6e8-3027.
- G02186 - Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH)
  Cite as: U.S. National Ice Center and National Snow and Ice Data Center. Compiled by F. Fetterer, M. Savoie, S. Helfrich, and P. Clemente-Colón. 2010, updated daily. Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH), Version 1. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5GT5K3K.
- G02171 - Canadian Ice Service Arctic Regional Sea Ice Charts in SIGRID-3 Format
  Cite as: Canadian Ice Service. 2009. Canadian Ice Service Arctic Regional Sea Ice Charts in SIGRID-3 Format, Version 1. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N51V5BW9.

5 RELATED WEBSITES

- The International Ice Charting Working Group is a forum where the world's national ice services meet to share and improve methods of serving maritime clients.
- The Global Digital Sea Ice Data Bank fostered international collaboration to develop digital formats for archiving and sharing ice charts produced by national services. The group promoted and further developed the WMO SIGRID code for describing ice conditions.

6 ACKNOWLEDGMENTS

NOAA's National Weather Service and USNIC provide support for this product at NSIDC through a service agreement with NOAA's National Centers for Environmental Information (NCEI).

7 REFERENCES

Environment Canada. 2005. Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE). Issuing authority: Assistant Deputy Minister, Meteorological Service of Canada: https://nsidc.org/sites/nsidc.org/files/files/data/noaa/g02176/MANICE.pdf

Fetterer, F., J. S. Stewart and B. R. Brasher. 2021. U.S. National Ice Center Arctic and Antarctic Sea Ice Charts Become a Research Dataset. Poster presented at: American Meteorological Society 101st Annual Meeting, 10-15 January 2021, virtual. Retrieved from https://ams.confex.com/ams/101ANNUAL/meetingapp.cgi/Paper/383484

Fetterer, F., M. Dorfman, B. R. Brasher, and A. Windnagel. Edge of Antarctica: Two Differing Perspectives on Where Ice and Water Mix. Poster presented at: American Meteorological Society 101st Annual Meeting, 10-15 January 2021, virtual. Retrieved from https://ams.confex.com/ams/101ANNUAL/meetingapp.cgi/Paper/381502

Intergovernmental Oceanographic Commission of UNESCO. 2004. SIGRID-3 : A Vector Archive Format for Sea Ice Charts. JCOMM Technical Report No. 23, WMO/TD-No. 1214: https://library.wmo.int/index.php?lvl=notice_display&id=11295#.XnvfLS2ZNTE.

Posey P. G., E. J. Metzger, A. J. Wallcraft, D. A. Hebert, R. A. Allard, O. M. Smedstad, M. W. Phelps, F. Fetterer, J. S. Stewart, W. N. Meier, and S. R. Helfrich. 2015. Improving Arctic sea ice edge forecasts by assimilating high horizontal resolution sea ice concentration data into the US Navy's ice forecast systems. *Cryosphere* 9: 1735-1745. doi:10.5194/tc-9-1735-2015.

World Meteorological Organization (WMO). 2014. WMO Sea-Ice Nomenclature. Volume 1 – Terminology and Codes, Volume II – Illustrated Glossary, Volume III – International System of Sea-Ice Symbols. Fifth Session of Joint Commission on Marine Meteorology (JCOMM) Expert Team on Sea Ice. WMO Publication No. 259.

U.S. National Ice Center. 2019 October 28. U.S. National Ice Center Products Catalog Version 1.0

7.1 Research Papers That Use These Data

This is not an exhaustive list but is a list of research that has come to our attention that use these data.

Chiodi, A.M., Zhang, C., Cokelet, E.D., Yang, Q., Mordy, C.W., Gentemann, C.L., Cross, J.N., Lawrence-Slavas, N., Meinig, C., Steele, M., Harrison, D.E., Stabeno, P.J., Tabisola, H.M., Zhang, D., Burger, E.F., O'Brien, K.M., and Wang, M. (2021). Exploring the Pacific Arctic Seasonal Ice Zone with Saildrone USVs. *Frontiers in Marine Science*, 8. doi: 10.3389/fmars.2021.640697.

8 DOCUMENT INFORMATION

8.1 Author

This document was drafted by Florence Fetterer in April 2020 based on a series of conversations with USNIC representatives. It was reviewed by the USNIC Science Officer. It was reviewed and edited by Ann Windnagel.

8.2 Publication Date

August 2020

9 APPENDIX - USNIC DATA PRODUCTS AT NSIDC: AN OVERVIEW

The U.S. National Ice Center (USNIC) is operated by the United States Navy (USN), the National Oceanic and Atmospheric Administration (NOAA), and the United States Coast Guard (USCG). The USNIC's mission is to provide ice and snow products, ice forecasting, and other environmental intelligence services for the U.S. government. The organization's website has information that includes a short history: History of the National/Naval Ice Center.

At the USNIC, analysts from the U.S. Navy and from NOAA produce an evolving suite of products. Most of these products are designed to meet the needs of operational users – that is, those planning or conducting operations in ice-infested waters. USNIC products and services that are available to external customers are listed and described in a product catalog (U.S. National Ice Center, 2019).

While the USNIC exists to serve operational users, many USNIC products are valued by environmental scientists because they tend to be accurate, timely, and of high spatial resolution. Their use in scientific studies may be hampered by the fact that they are not necessarily produced in a uniform way from day to day and year to year. Analysts at the USNIC strive to make the best possible product on a given day, without regard to long-term consistency. If researchers understand the limitations, the information contained in the USNIC products can be exploited for projects such as validating algorithms for satellite data analysis or for initializing or validating sea ice forecast model output.

With support from the USNIC, NSIDC redistributes a subset of the USNIC products that have been selected for their research value. We add documentation that describes how analysts assemble each product, how products interrelate, and what potential limitations for research may be. We may reformat products to make them easier to use for research. The User Guide includes standard metadata and a citation with digital object identifier (DOI). NSIDC's User Services office answers or fields questions about the products.

During a 2015 visit by USNIC representatives to NSIDC, we discussed the potential value to scientific researchers and others of archiving and serving USNIC products from NSIDC. Thereafter, we began downloading and archiving the data files. NSIDC's role was formalized in agreements with the USNIC in 2019. We thank John Woods, Caryn Panowicz, and Sean Helfrich for early discussions and support that led to these products being available through NSIDC.

USNIC products are archived with the NOAA@NSIDC collection. We serve as an informal intermediary between the operations-focused USNIC and the research community that uses their data products. Many of the products are also archived at the USNIC and can be obtained through

the USNIC public-facing website. The NSIDC archive therefore acts as a redundant archive for some products.