



MASAM2: Daily 4 km Arctic Sea Ice Concentration, Version 1

USER GUIDE

How to Cite These Data

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

Fetterer, F., J. S. Stewart, and W. N. Meier. 2015, updated daily. *MASAM2: Daily 4 km Arctic Sea Ice Concentration, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. <https://doi.org/10.7265/N5ZS2TFT>. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT <https://nsidc.org/data/G10005>



National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

The MASIE-AMSR2 (MASAM2) daily 4 km sea ice concentration is a prototype concentration product that is a blend of two other daily sea ice data products: ice coverage from the Multisensor Analyzed Sea Ice Extent (MASIE) product at a 4 km grid cell size and ice concentration from the Advanced Microwave Scanning Radiometer 2 (AMSR2) at a 10 km grid cell size. MASAM2 was developed to meet a need for greater accuracy and higher resolution in ice concentration fields that are used to initialize an operational sea ice forecast model. By applying some simple rules to blend the two sources, a 4 km concentration product is produced that can be used in the model. This prototype covers July 2012 to present.

1.1 Summary

The MASAM2 daily 4 km sea ice concentration product is a prototype sea ice concentration that blends two other daily sea ice data products: ice coverage from MASIE at a 4 km grid cell size and ice concentration from AMSR2 at a 10 km grid cell size. Blending takes advantage of the best features of both the MASIE and AMSR2 products. MASIE is more likely to be accurate in showing where ice is present than AMSR2, but the AMSR2 sea ice concentration product gives concentration information not available from MASIE alone. While AMSR2 passive microwave sea ice concentrations are derived using an algorithm, MASIE applies human assisted analysis to classify each 4 km grid cell as either ice-covered or not ice-covered using passive microwave, synthetic aperture radar, IR, visible band, and in situ data. The 10 km resolution AMSR2 data are bilinearly interpolated to the 4 km MASIE grid before blending.

MASAM2 was developed to meet a need for greater accuracy and higher resolution in ice concentration fields that are used to initialize an operational sea ice forecast model. By applying some simple rules to blend the two sources, a 4 km concentration product is produced that can be used in the model. If MASIE indicates ice, the corresponding MASAM2 grid cell is set to the AMSR2 sea ice concentration if that concentration value is greater than 70 percent, else it is set to 70 percent. Other rules for setting the MASAM2 concentration values are described in the Data Acquisition and Processing section of this document.

This blended product is a more accurate map of where ice truly is compared to AMSR2 alone. AMSR2 can underestimate ice concentration during melt conditions and can show ice where none exists by misinterpreting weather effects on the open ocean. The MASIE product does not have these systematic errors. MASIE can, however, be inaccurate. If the NIC analysts do not have what they judge to be a sufficient amount of information with which to update an analysis for a region or regions, they may not change the ice extent in the IMS product upon which MASIE is based. Later

data may show that the area was ice free when MASIE showed it as ice covered, for example. The products are not corrected for earlier errors. We do not know how frequently this type of error happens.

The data are provided in monthly NetCDF files that hold daily sea ice concentration fields. Two daily PNG format browse images are also provided. One shows a quick-view map of the MASAM2 sea ice concentration, and the other is an ice-source map indicating which data sets show the presence of ice: AMSR2, MASIE, both, or neither.

1.2 Background

MASAM2 was developed in order to provide improved daily initialization fields for short-term ice prediction models. It was designed in partnership with an Oceanography Division modeling group at the [U.S. Naval Research Laboratory \(NRL\)](#) and is a contribution to the [Sea Ice Prediction Network \(SIPN\)](#). The [Naval Oceanographic Office \(NAVO\)](#) adopted the method for operational use in February 2015. Please send feedback on this product to NSIDC. This is a prototype covering only 27 months, but we hope to make a version that is updated daily if there is demand for such a product.

MASAM2 is based on the understanding that [MASIE](#) is more accurate than other daily products at showing where ice is present (Meier et al., 2015). If MASIE shows ice at a location, we believe ice exists there because National Ice Center (NIC) analysts labeled it as ice when creating the IMS product that MASIE uses as its input data source. However, sea ice prediction model initialization fields need an ice concentration value for every location in which ice is present. For concentration, AMSR2 currently gives the best available daily arctic-wide product. A blend of AMSR2 and MASIE yields a high-resolution ice concentration product for model initialization that improves short-term, on the order of days to weeks, forecast capability.

1.3 How MASAM2 Compares with Other Sea Ice Concentration Products

Figure 1 visually shows how the MASAM2 sea ice concentration product (left) often differs from traditional passive microwave sea ice concentration products (middle and right). First, passive microwave products usually show continuous ice at variable concentrations across the Arctic, without so many holes as seen in this MASAM2 example. The "Swiss cheese" effect in the East Siberian Sea, where there are many holes in the MASAM2 concentration field (left), is not present in the passive microwave concentration images (middle and right). Second, MASAM2 shows 70

percent ice south of Hudson Bay, in the middle of Baffin Bay, and off east Greenland where one might assume ice is at a lower concentration. The example illustrates a positive aspect of MASAM2 that ice is more likely to be represented where it is present; but with ice concentration pegged at a low of 70 percent, the concentration of that ice may not be accurately represented.

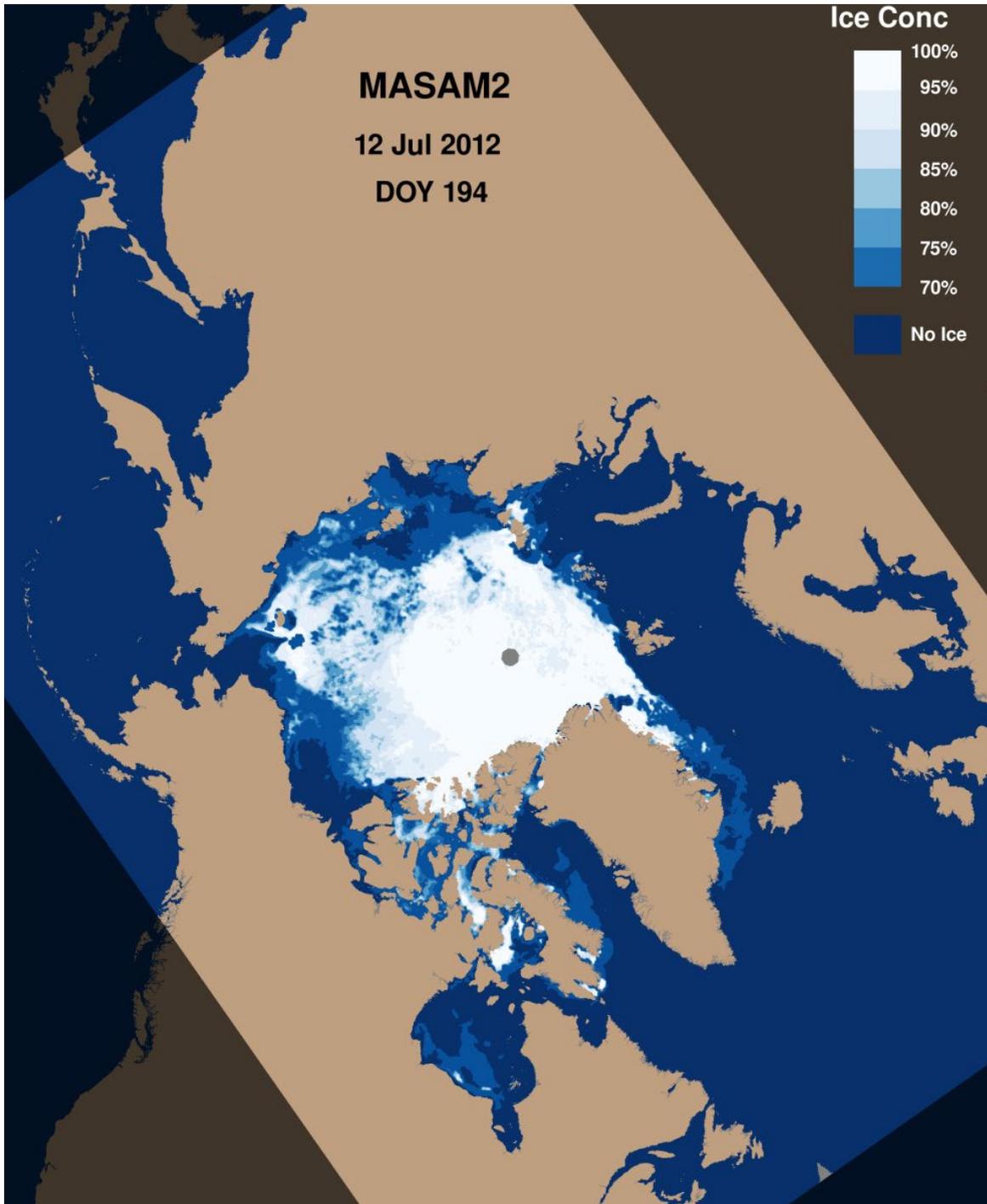


Figure 1. Browse image of MASAM2 sea ice concentration for 12 July 2012.

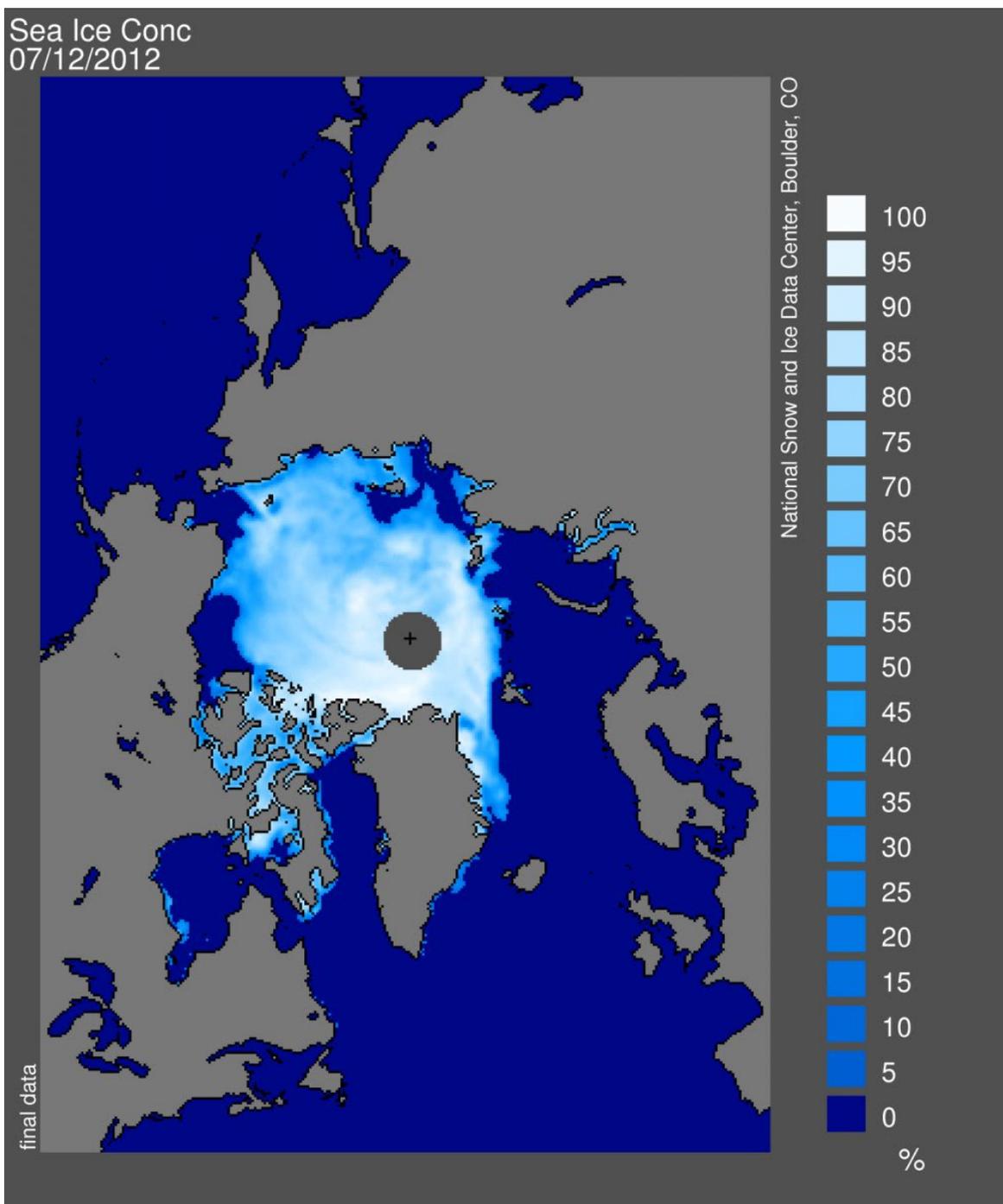


Figure 2. Browse image of sea ice concentration from the Sea Ice Index for 12 July 2012 which uses the SSMIS sensor on DMSP-17.

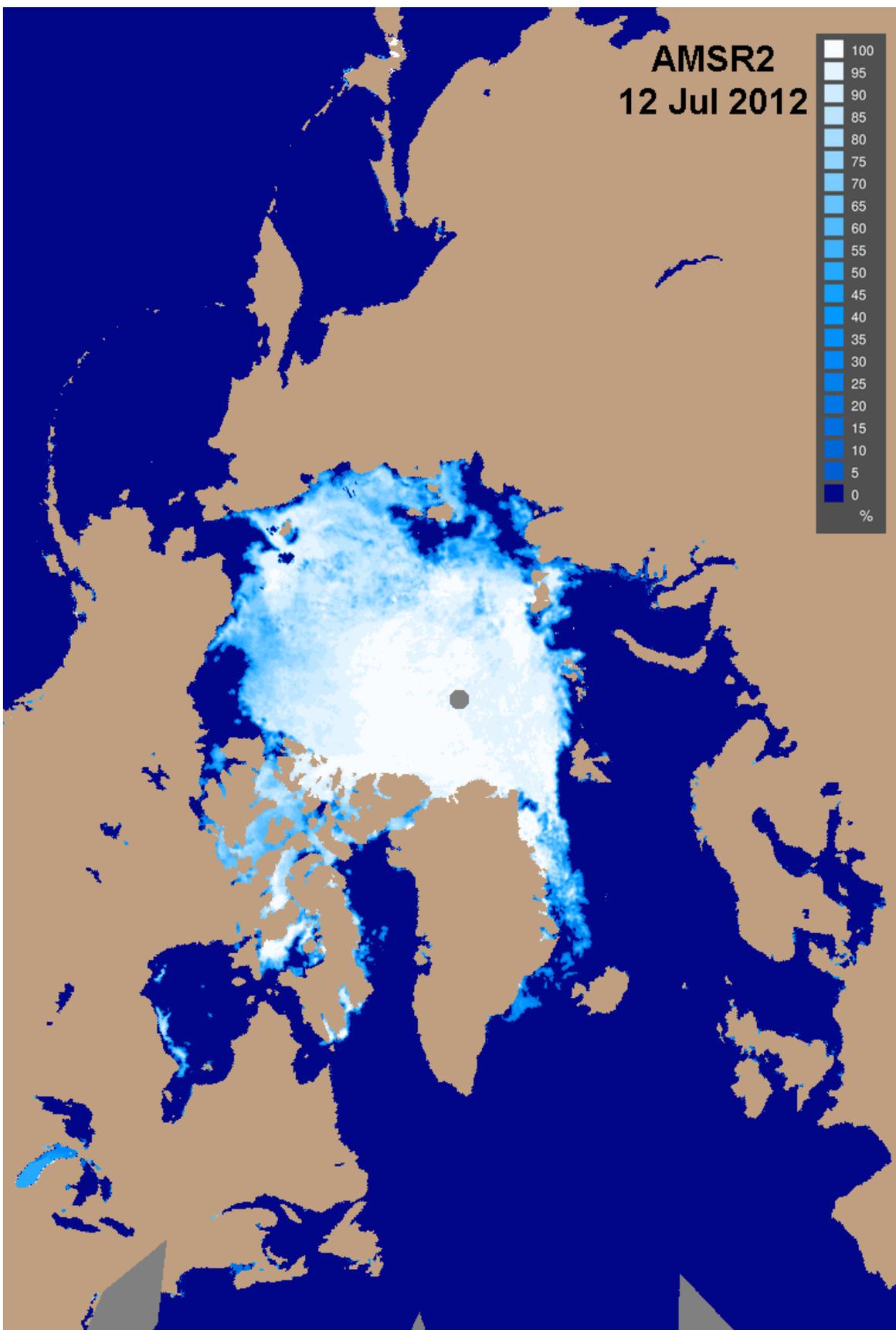


Figure 3. Browse image of AMSR-2 sea ice concentration for 12 July 2012

1.4 Format

The daily MASAM2 data are at a 4 km resolution provided in NetCDF format (.nc). The daily data have been bundled into monthly NetCDF files, so each .nc file contains 28 to 31 days of data depending on the month. Browse images in PNG format are provided for quickly previewing the concentration data, in addition, browse images showing the source of the data are also made available. Table 1 describes the variables in the NetCDF files, and Table 2 lists the file sizes.

Table 1. NetCDF Variable Description

Variable	Description												
Longitude	Degrees east of the longitude of the data. Dimensions: [2100, 2550]												
Latitude	Degrees north of the latitude of the data. Dimensions: [2100, 2550]												
Day of Month	Day of month for the month and year noted in the file name. Dimensions range from [28] to [31] depending on the month.												
Sea ice concentration	Sea ice concentration in percent. Dimensions: [2100, 2550, days in month].												
	<table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0 and 70-100</td> <td>Sea ice concentration in percent</td> </tr> <tr> <td>104</td> <td>Ocean out of AMSR2 bounds</td> </tr> <tr> <td>110</td> <td>Indeterminate or missing</td> </tr> <tr> <td>119</td> <td>Land out of AMSR2 bounds</td> </tr> <tr> <td>120</td> <td>Land</td> </tr> </tbody> </table>	Value	Description	0 and 70-100	Sea ice concentration in percent	104	Ocean out of AMSR2 bounds	110	Indeterminate or missing	119	Land out of AMSR2 bounds	120	Land
	Value	Description											
	0 and 70-100	Sea ice concentration in percent											
	104	Ocean out of AMSR2 bounds											
	110	Indeterminate or missing											
119	Land out of AMSR2 bounds												
120	Land												

Table 2. File Sizes

File Type	Size per File
NetCDF Data File	37 MB - 41 MB
PNG Browse Data Image	213 KB - 362 KB
PNG Browse Source Image	210 KB - 253 KB

1.5 File and Directory Structure

Data are available on the FTP site in the <ftp://sidacs.colorado.edu/pub/DATASETS/NOAA/G10005/> directory. Within this directory, there are three sub-directories: Data, BrowseData, and BrowseSource. The Data directory contains the NetCDF data files; the BrowseData directory contains the PNG browse images, and the BrowseSource directory contains the PNG images describing the source of the data. The data are subdivided into directories by year within each of these sub-directories.

1.6 File Naming Convention

Generic File Name: `masam2[-source]-YYYYMM.ext`

Example File Name: `masam2-201402.nc`

Where:

Table 3. Data File Naming Convention Description

Variable	Description
masam2	Identifies this as containing MASAM2 sea ice concentrations
[-sources]	If this is in the file name, then this file is a source browse image file.
YYYY	4-digit year
MM	2-digit month of year
.ext	File extension (<code>.nc</code> : NetCDF file, <code>.png</code> : PNG image file)

1.7 File Size

The NetCDF data files are approximately 50 MB each and the associated browse imagery are approximately 300 KB each.

1.8 Spatial and Temporal Coverage

The MASAM2 data cover the Northern Hemisphere at a 4 km spatial resolution with the following bounding coordinates:

Southernmost latitude: 29.08° N

Northernmost latitude: 90° N

Westernmost longitude: 180° W

Easternmost longitude: 180° E

The data span 03 July 2012 to the present at a daily resolution. Table 4 provides a list of the missing dates for MASAM2 data within this time period.

Table 4. Dates Missing from MASAM2 because either MASIE or AMSR2 are Missing (YYYYMMDD)

Missing AMSR2 Data	Missing MASIE Data
20130511	20120906
20130512	20120908
20130513	20140829
	20141017
	20141020
	20141021

1.9 Projection and Grid Description

The MASAM2 grid is a 2100 x 2550 subsection of the full 6144 x 6144 MASIE array which was selected as the most relevant area for operational ice forecasts. The subregion begins at grid cell (2000,1688) of the MASIE array. For more information on the MASIE grid, see the [Multisensor Analyzed Sea Ice Extent - Northern Hemisphere \(MASIE-NH\)](#) documentation.

1.10 Parameter or Variable

The parameter in this data set is sea ice concentration. Because these data were created with particular model requirements in mind, their values are zero percent sea ice concentration (open water) and values ranging from 70 percent to 100 percent, inclusive. The values 1 to 69 are not used. Table 1. NetCDF Variable Description lists all the variables in the NetCDF files and their values.

1.11 Sample Images

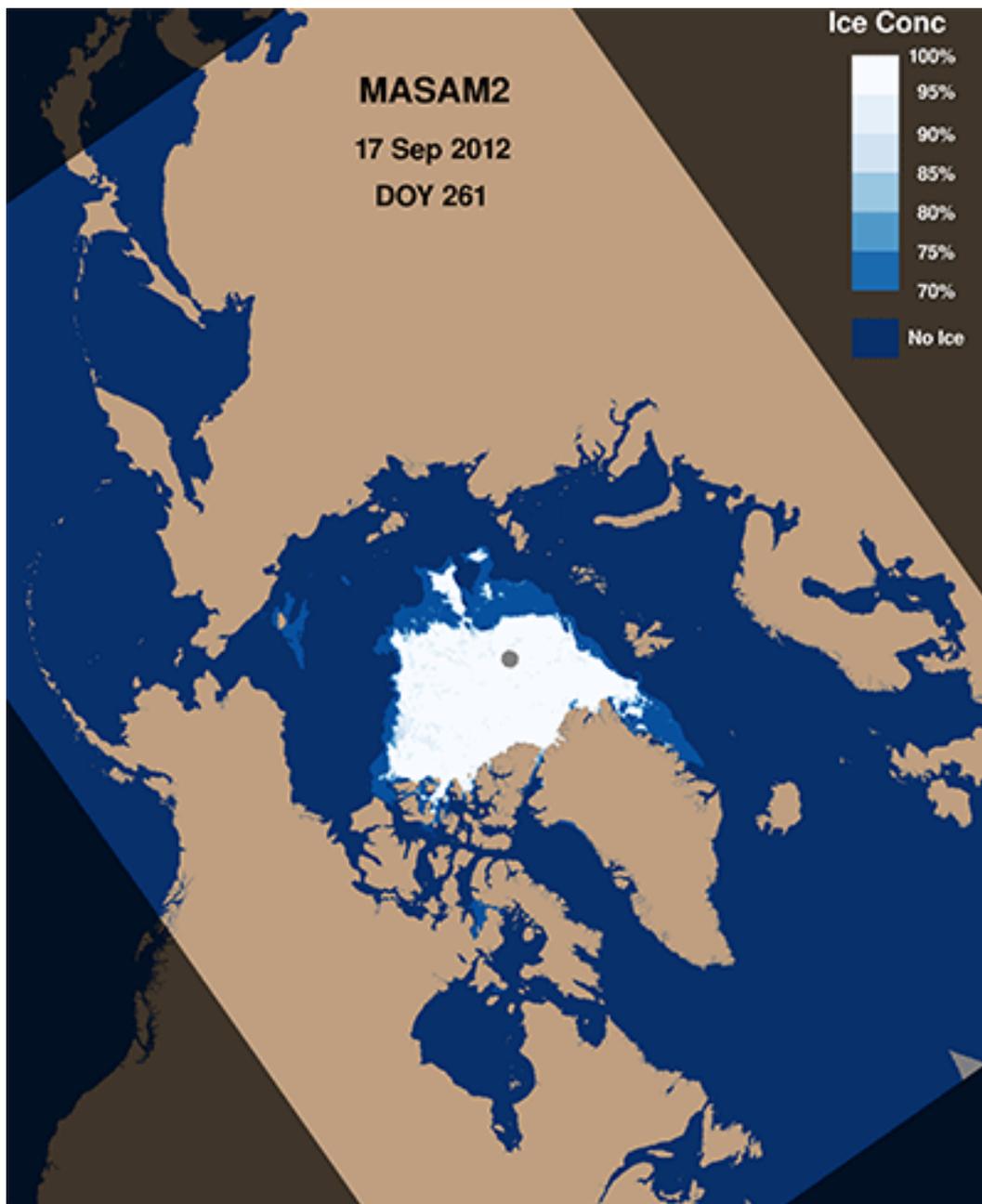


Figure 4. Browse image of MASAM2 sea ice concentration for 17 September 2012.

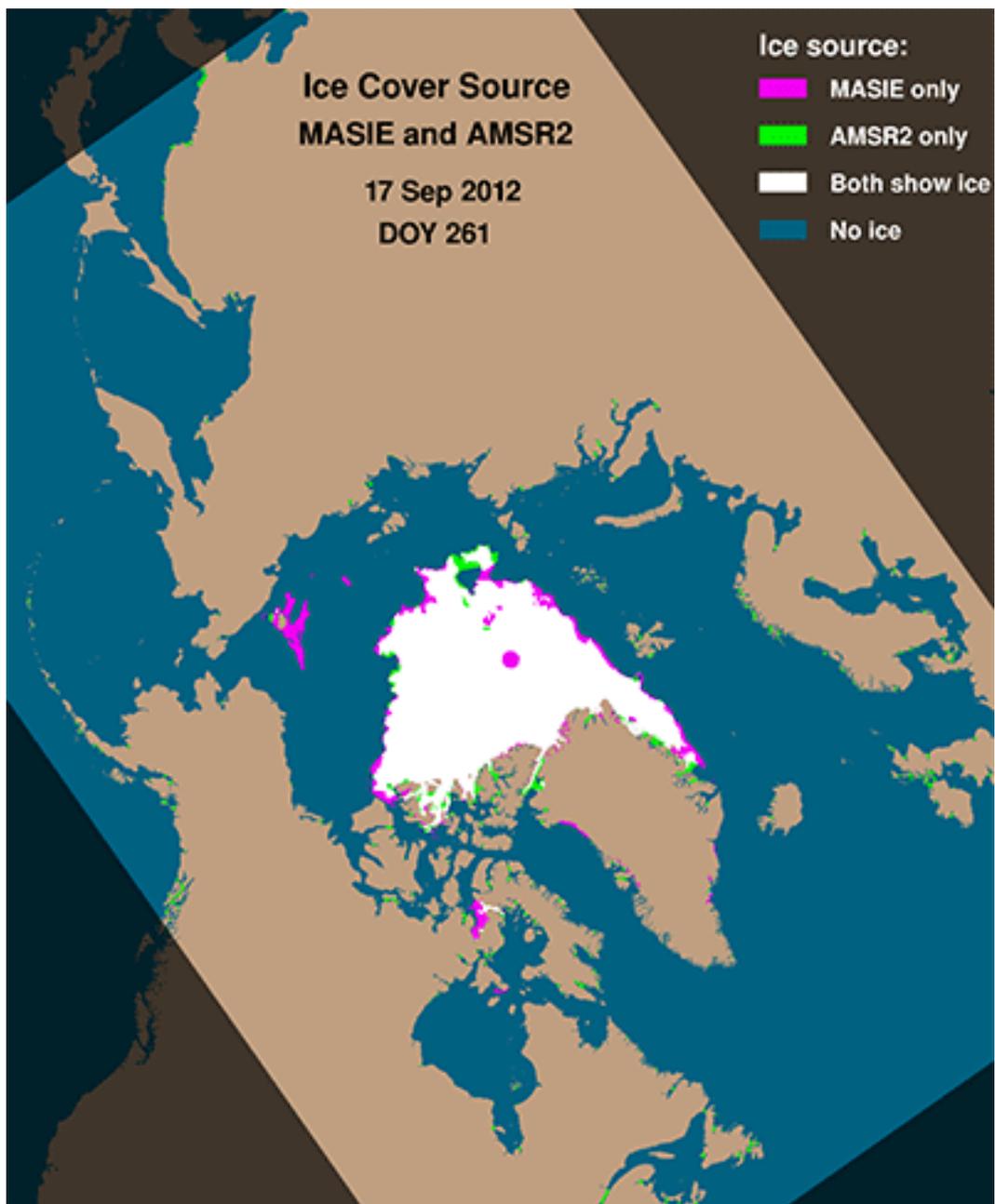


Figure 5. Browse image showing the source of the concentration data (MASIE, AMSR2, both, or no ice) for 17 September 2012.

2 SOFTWARE AND TOOLS

2.1 Software and Tools

For a list of tools to read NetCDF files, see NSIDC's [NetCDF Software Tools](#) Web page.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

MASIE data were acquired from NSIDC. The input data for the MASIE product is the National Ice Center's (NIC) 4 km daily hand-analyzed sea ice extents. To learn more about MASIE, see the [Multisensor Analyzed Sea Ice Extent - Northern Hemisphere \(MASIE-NH\)](#) documentation.

AMSR2 Level 3 gridded high resolution (10 km) passive microwave sea ice concentration fields are downloaded from the [Japan Aerospace Exploration Agency \(JAXA\)](#) supported by the GCOM-W1 Data Providing service. See the [JAXA](#) Web site for details on these data and JAXA's [AMSR2 Version History](#) documentation for more information on the versions.

Table 5. AMSR2 Data Versions Used

Version	Dates Used
Version 1100100	03 July 2012 through 24 September 2013
Version 1100110	25 September 2013 through 31 December 2014
Version 2220220	01 January 2015 to 27 December 2017
Version 3300300	28 December 2017 to present

3.2 Derivation Techniques and Algorithms

The MASAM2 data product is derived by mapping the AMSR2 10 km daily gridded sea ice concentration fields to a modified version of the NIC 4 km daily hand-analyzed sea ice extent product known as [MASIE](#). MASIE and AMSR2 were blended to take advantage of MASIE's accuracy in showing ice presence while AMSR2 provides a relatively high-resolution sea ice concentration product.

Daily files were created for all days for which both AMSR2 and MASIE data are available for the short temporal coverage provided in this data set. See Spatial and Temporal Coverages section of this document for details. A 2100 x 2550 grid subsection of the full 6144 x 6144 MASIE array was selected as the most relevant area for operational ice forecasts. The subregion begins at grid cell (2000,1688) of the MASIE array. The lower-resolution AMSR2 data are bilinearly interpolated to the 4 km MASIE grid subregion. The sea ice concentration values at each 4 km grid cell are assigned using simple empirically derived rules. See Table 1 for a list of possible values for the grid cells in the NetCDF files.

The following considerations were taken into account when formulating these rules:

1. The AMSR2 sea ice concentration product from JAXA has a different spatial resolution and therefore a different land mask than MASIE.
2. The MASIE land mask is more precise than the AMSR2 land mask, therefore:
 - If AMSR2 indicates ocean but MASIE indicates land, MASIE is trusted; and MASAM2 is set to land for that grid cell.
 - If AMSR2 indicates land but MASIE indicates ocean, neither is trusted; and MASAM2 is set to indeterminate for that grid cell.
3. The MASIE extent field is considered to be a more accurate map of where ice is present than the ice extent from AMSR2, therefore:
 - If MASIE indicates no ice, MASIE is trusted and the corresponding MASAM2 grid cell is set to zero percent sea ice concentration.
 - If MASIE indicates ice, the corresponding MASAM2 grid cell is set to the bilinearly interpolated AMSR2 sea ice concentration if that concentration value is greater than 70 percent, else it is set to 70 percent sea ice concentration.

A PNG browse image of the MASAM2 sea ice concentrations fields is also created with the NetCDF files to provide a way to quickly view the data. A PNG image comparing the AMSR2 and MASIE ice extent fields is also generated. This indicates to users where AMSR2 sea ice concentration estimates have either been set to zero percent in the MASAM2 product or to a minimum of 70 percent sea ice concentration.

3.3 Processing Steps

The steps for creating the MASAM2 product are as follows:

1. Read in a day's worth of MASIE data and take a subset of the 6144 x 6144 MASIE grid from grid cell (2000,1688) to create a 2100 x 2550 subsection of the full MASIE array.
2. Read in AMSR2 data and bilinearly interpolate it to the MASIE grid.
3. Look at MASIE subset and AMSR2 data to decide the concentration value for MASAM2
 - a. If MASIE grid cell is land and AMSR2 is ocean, MASAM2 is set to land (119) for that grid cell.
 - b. If MASIE grid cell is ocean and AMSR2 land, MASAM2 is set to indeterminate (110) for that grid cell.
 - c. If MASIE grid cell indicates no ice, the corresponding AMSR2 value is ignored and the MASAM2 grid cell is set to zero percent sea ice concentration.
 - d. If MASIE grid cell indicates ice and the AMSR2 concentration value is greater than or equal to 70 percent, MASAM2 is set to the AMSR2 sea ice concentration value for that grid cell.
 - e. If MASIE grid cell indicates ice but AMSR2 concentration value is less than 70 percent, the MASAM2 sea ice concentration is set to 70 percent for that cell.
4. Repeat for all days in this month for which both MASIE and AMSR2 data are available.
5. Save daily data to monthly NetCDF files.

6. Repeat for each month of available data.

3.4 Discussion

The rule to use a minimum of 70 percent concentration for each 4 km grid cell in which MASIE shows ice is based on the need of the NRL modeling group; and the experience of the authors of the MASAM2 data product, in consultation with NIC scientists and ice analysts. For the IMS product that is used by MASIE, analysts label a 4 km cell to be ice, if it is judged to have more than 40 percent ice concentration. For MASAM2, then, an alternative rule would be that if MASIE indicates ice, the corresponding MASAM2 grid cell is set to the AMSR2 sea ice concentration if that concentration value is greater than 40 percent, else it is set to 40 percent sea ice concentration. The choice of 70 percent for a lower limit where there was ice at any concentration was dictated by the sea ice forecast model's data assimilation algorithm. MASAM2 users should keep in mind that the product was developed to improve the performance of an operational ice forecast model. It has been found to do so (Posey et al. 2015). It has not been evaluated for usefulness in any other study.

For further discussion of sources of error or uncertainty in passive microwave sea ice concentration, see the discussion on this subject in the [Sea Ice Index](#) documentation and the references therein. For a discussion of sources of error or uncertainty in the [MASIE product](#), see that product's documentation section on Error Sources. For the [IMS product](#), see the IMS documentation sections on Derivation Techniques and Algorithms and Quality Assessment.

3.5 Sensor or Instrument Description

The MASAM2 product has two input data sources: MASIE sea ice extent and AMSR2 sea ice concentrations.

The MASIE sea ice extents use the 4 km [IMS Daily Northern Hemisphere Snow and Ice Analysis](#) as its input data source. The IMS product uses multiple satellites, in situ data, and manual analysis as input. For more information on MASIE uses the IMS product, see the [Multisensor Analyzed Sea Ice Extent - Northern Hemisphere \(MASIE-NH\)](#) documentation.

AMSR2 is on board JAXA's Global Change Observation Mission - Water (GCOM-W) satellite. It is a passive microwave instrument that provides, among other products, sea ice concentration at a 10 km resolution. For more information about AMSR2, see JAXA's [About AMSR2](#) Web page.

Table 6. MASAM2 Version History

Version	Date	Description
Version 1.0	October 2015	Addition of a near-real-time product.
Version 1.0	March 2015	Initial release of the MASAM2 prototype for 03 July 2012 to 12 November 2014.

4 REFERENCES AND RELATED PUBLICATIONS

Japan Aerospace Exploration Agency. 2012. AMSR2 Level 3 10 km Sea Ice Concentration. Tokyo, Japan: JAXA.

Japan Aerospace Exploration Agency. 2012. Global Change Observation Mission Water (GCOM - W1): AMSR2 Higher Level Product Format Specification. Tokyo, Japan: JAXA.

Meier, W. N., F. Fetterer, J. Scott Stewart, and S. Helfrich. 2015. How do sea-ice concentrations from operational data compare with passive microwave estimates? Implications for improved model evaluations and forecasting. *Annals of Glaciology* 56(69): 332-340. doi:3189/2015AoG69A694.

National Ice Center and National Snow and Ice Data Center. 2010, updated daily. Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH). Compiled by F. Fetterer, M. Savoie, S. Helfrich, and P. Clemente-Colón. Boulder, Colorado USA: National Snow and Ice Data Center. <http://dx.doi.org/10.7265/N5GT5K3K>.

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.

4.1 Related Data Collections

National Ice Center (NIC) and NSIDC. 2010, updated daily. Multisensor Analyzed Sea Ice Extent - Northern Hemisphere. Developed by F. Fetterer, M. Savoie, S. Helfrich, and P. Clemente-Colón. Boulder, Colorado USA: National Snow and Ice Data Center. doi: [10.7265/N5GT5K3K](https://doi.org/10.7265/N5GT5K3K).

4.2 Related Websites

- [U.S. National Ice Center \(NIC\)](#)
- [U.S. Naval Research Laboratory](#)
- [Japan Aerospace Exploration Agency \(JAXA\) data repository](#)

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

March 2015

6.2 Date Last Updated

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