IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions, 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. 2008, updated daily. *IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/N52R3PMC. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/G02156

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

Note: The IMS product is considered an operational product; however, NIC, who creates this product, does not guarantee availability or timely delivery of data via the NIC Web server. NSIDC, as the data archive, does not guarantee availability of this product via the NSIDC Web server. These servers should not be used to support operational observation, forecasting, emergency, or disaster mitigation operations, either public or private. Users with real-time operational needs should visit the USNIC Web site and contact the National Ice Center Liaison via email at nic_analyst@noaa.gov or by phone at 301-817-3975 to request access to their operational server.

1.1 Overview

This data set provides maps of snow cover and sea ice for the Northern Hemisphere from February 1997 to the present from the U.S. National Ice Center (USNIC). USNIC analysts produce these using the Interactive Multisensor Snow and Ice Mapping System (IMS). Maps are derived from a variety of data products including satellite imagery and in situ data. The data are provided in ASCII text and GeoTIFF formats in three different resolutions: 1 km, 4 km, and 24 km.

The National Environmental Satellite, Data, and Information Service (NESDIS), part of the National Oceanic and Atmospheric Administration (NOAA), has an extensive history of monitoring snow and ice coverage. Accurate monitoring of global snow and ice cover is a key component in the study of climate and global change as well as daily weather forecasting. By inspecting environmental satellite imagery, NESDIS analysts create a Northern Hemisphere snow and ice map. Initially, the product was produced with a nominal spatial resolution of 190 km and a temporal resolution of seven days. In 1997, the IMS became operational, giving the satellite analysts improved access to imagery and drawing tools. Since the inception of IMS, the charts have been produced daily at a nominal resolution of 24 km.

Beginning in February 2004, further improvements in computer speed and imagery resolution allowed for the production of a higher resolution daily product with a nominal resolution of 4 km. In 2008, NOAA analysts within the USNIC took over production. In December 2014, NIC introduced a 1 km product. NIC distributes the daily products, while relying on NOAA@NSIDC to maintain the long-term archive of those IMS products. NSIDC archives and distributes the 1 km, 4 km, and 24 km data in ASCII format with the 1 km and 4 km also available as GeoTIFF. NSIDC also distributes the browse images in GIF format and latitude and longitude grids for these products.

The IMS product is considered valid at 0000UTC. Analysts complete work on the product a few hours ahead of 0000UTC, using imagery and other data that have been acquired over some variable period of time. They then use their experience to advance the analysis forward in time to 0000UTC as they judge necessary.

USNIC produces a second product valid at 1800UTC. This product goes directly into weather models and is not distributed. The 1800UTC product updates snow and ice only for continental and nearshore regions of North America.

For those interested in only the sea ice component of the IMS product or those who may want it in other formats, please see the Multisensor Analyzed Sea Ice Extent (MASIE) product. MASIE essentially repackages the IMS ice product into other data formats.

NSIDC strongly encourages you to register as a user of this data product. As a registered user, you will be notified of updates and corrections.

1.2 History of Product Development

The NOAA snow and ice chart series begins in 1966, making it the longest running satellite-derived data set in existence (Ramsay 1998). Over the more than 50 years during which the snow and ice maps have been produced, there have been major changes in both the organization producing them and in the methods used.

The charts are used primarily by the NOAA NWS National Centers for Environmental Prediction (NCEP) in initialization fields for numerical weather prediction models. NCEP relies on snow and ice maps because these provide models with the surface area for which a high albedo should be assigned. Fresh snow cover has the highest albedo of any natural surface, reflecting about 90 percent of downwelling shortwave radiation (sunlight). In contrast, the open ocean reflects less than 20 percent (Key et al., 2001). The series is also an excellent long record with which to study how snow and ice are responding to changing climate.

In 1995, due to errors seen in near-surface temperature forecasts caused by the relatively low temporal resolution of what was then a weekly snow product, NOAA began development of the Interactive Multisensor Snow and Ice Mapping System (IMS). To make a daily snow map feasible, IMS production would speed up the laborious manual method, which took eight to ten hours for each weekly chart. According to Ramsay (2000), the IMS is a geographic information system that "was developed to permit meteorologists to interactively prepare daily NH [Northern Hemisphere] snow and ice maps and to take advantage of additional remotely sensed imagery such as that based on Defense Meteorological Satellite Program (DMSP) passive microwave data from the SSM/I instrument."

The IMS allows analysts to create, save, and distribute highly accurate maps depicting the extent of daily hemispheric snow and ice coverage. Prior to the introduction of the IMS, analysts displayed satellite data (primarily AVHRR visible and infrared band imagery, but increasingly, beginning in 1975, data from geostationary satellites as well) on a workstation screen. Then they identified snow and ice by manual inspection and transferred boundaries to a paper chart. An electronic version was created by overlaying a grid onto this chart and digitizing grid cells. The paper version of this pre-IMS product is archived with the NOAA NESDIS National Centers for Environmental Information (NCEI, previously the National Climatic Data Center). A quality-controlled version of this product is available in digital form from Rutgers University Global Snow Lab, and NOAA NCEI maintains a Climate Data Record of this product.

The IMS system greatly improved the speed, accuracy, and resolution with which the maps could be produced by incorporating additional data sources and allowing the analyst to create digital products directly on a workstation. Passive microwave data are used to improve snow detection under cloudy or nighttime conditions. It is possible to automate the creation of a snow cover product using passive microwave data. However, snow detection via this method is subject to error under certain conditions. Therefore, for the greatest possible accuracy, creation of a manual analysis product from a variety of sources continues (Ramsay 1998). See Table 1 for a summary of IMS and pre-IMS snow cover products.

Beginning in February 2004, improvements in computer speed and imagery resolution allowed for the production of a daily product with a nominal resolution of 4 km. NOAA analysts at the National Ice Center took over IMS production in 2008, a move that boosted the accuracy of the sea ice component of the product. In December 2014, IMS introduced a 1 km product.

Note: When NIC took over production of the charts in 2008, the citation was changed. Prior to this, the citation was as follows:

NOAA/NESDIS/OSDPD/SSD. 2004, updated 2006. *IMS daily Northern Hemisphere snow and ice analysis at 4 km and 24 km resolution*. Boulder, CO: National Snow and Ice Data Center. Digital media.

NOAA has many snow and ice products that serve a variety of user needs. For example, higher resolution, basin-scale snow products are produced by NOAA for hydrological forecasting. See section 4.1 Related NSIDC Data Collections of this document for more information.

1.3 Role of NSIDC

By agreement with NOAA, NSIDC archives and makes the IMS products available on a daily basis. It is important to note that the IMS product is produced in near-real time to meet a daily operational need. Therefore, changes in product format or production method may occur from time to time, and errors may exist that only a retrospective analysis can identify and correct. Rutgers University Global Snow Lab provides a consistent and quality-controlled analysis of snow cover derived from IMS and its predecessor products (Robinson 2000), along with an interface for displaying trends, anomalies, and monthly climatologies. The NSIDC Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent includes the Rutgers snow product and sea ice cover from passive microwave data for a consistent representation of snow- and ice-covered surfaces with weekly frequency, along with climatologies.

Table 1. Summary of NESDIS OSDPD Snow and Ice Map Products

Product Name	**Frequency**	**Grid Size**	**Period of Record**	**Notes**
Northern Hemisphere Snow and Ice Boundaries	Weekly	Paper format	Produced by the NESDIS Synoptic Analysis Branch, November 1966 to approximately 1993.	This product is not distributed by NSIDC. It is archived by NOAA NCDC.
IMS Daily Northern Hemisphere Snow and Ice Analysis, 24 km	Daily	1024 x 1024	Began February 1997. Declared operational 1 November 1998 to the present.	This product is distributed by NSIDC along with GIF browse images.
IMS Daily Northern Hemisphere Snow and Ice Analysis, 4 km	Daily	6144 x 6144	Production began in January 2004. Operational from 24 February 2004 to the present.	This product is distributed by NSIDC along with GIF browse images. GeoTIFF images and corresponding .aux files are also available from NSIDC, beginning in June 2006 through 06 December 2014. After that, the GeoTIFF format was changed so that it does not require a .aux file.
IMS Daily Northern Hemisphere Snow and Ice Analysis, 1 km	Daily	24576 x 24576	Production began in December 2014. Operational from 02 December 2014 to the present.	This product is distributed by NSIDC along with GIF browse images. GeoTIFF images are also available from NSIDC, beginning in 02 December 2014.

1.4 Format

The data are provided in three formats: ASCII text (.asc), GeoTIFF (.tif), and NetCDF (.nc). Quick-look browse images of the data are provided in GIF (.gif) format, and ancillary data such as latitude/longitude grids in binary (.bin) format accompany the ASCII text data. For full details, see each section below: 1.4.1 ASCII Data Files, 1.4.2 GeoTIFF Files, 1.4.4 Browse Images, and 1.4.5 Ancillary Data Files

1.4.1 ASCII Data Files

The top of each ASCII data file contains a header with details about that file. Throughout the life time of this data set, the headers have changed slightly due to changes in processing and versioning, so they are not the same size across all files. The header is followed by a grid of data whose size is based on the resolution of the data in the file: 1 km, 4 km, and 24 km. See Table 2 for a list of grid sizes by resolution.

In the grids, the index (1,1) starts at the lower left corner of the grid where the top of the file is South America, the left side is the Pacific Ocean, the right side is Africa, and the bottom is Indonesia. Data values in the files are described in Table 3. Most of the values in the arrays in the ASCII data files are 1-digit integers (I1); this is known as the packed form. However, a small portion of the 24-km ASCII data files contain values that are 3-digit integers instead of 1-digit; this is known as the unpacked form. For a list of files in unpacked form, see the Dates of 24-km IMS Data Files in Unpacked Format text file; and for more information on the differences, see the Note on Packed Versus Unpacked Form below.

Table 2. ASCII Data Grid Size

Resolution	Grid Size
1 km	24576 x 24576
4 km	6144 x 6144
24 km	1024 x 1024

Table 3. Values in the ASCII Data Files

Value	Description
0	Outside the coverage area
1	Sea
2	Land (without snow)

Value	Description
3, 164	Sea Ice Note: The value 164 only pertains to the 24 km ASCII files listed in the Note on Packed Versus Unpacked Format below.
4, 165	Snow covered land Note: The value 165 only pertains to the 24 km ASCII files listed in the Note on Packed Versus Unpacked Format below.

Note: There are no missing values over the mapped hemisphere.

Note on Packed Versus Unpacked Format

Over time, NOAA used two standard formats for the 24-km IMS data files. One format was a packed form in which the data values are stored as one data row per file row, with each ASCII character representing the data value for the corresponding data column. The other format was an expanded form in which a data row spans several rows in the file, with data values stored in 4-column fields, separated by a single space. For a list of dates of the unpacked files, see the Dates of 24-km IMS Data Files in Unpacked Format text file.

1.4.2 GeoTIFF Files

The GeoTIFF files (.tif) are compatible with GIS applications and contain the same values as the ASCII data files. See Table 3 for these values. In Version 1.2 of the GeoTIFFs, each file has an associated metadata file (.aux) containing geographic and projection information that must reside in the same directory as the GeoTIFF file in order to properly retain the projection information. With Version 1.3 of this product, the GeoTIFFs have been updated so that the extra metadata file is no longer needed.

1.4.3 NetCDF Files

The 4 km and 1 km data are available as NetCDF4 files and are compliant with the Climate and Forecast (CF) Metadata Convention CF-1.6 and the Attribute Convention for Data Discovery (ACDD) 1.3. The NetCDF files contain the variables described in Table 4.

Table 4. Description of Variables in the NetCDF Files

Variable	Description
IMS_Surface_Values	The surface types in the IMS product. They are open water, land, sea/lake ice, and snow cover with the following values: 0: Outside Coverage Area, 1: Open Water 2: Land Without Snow, 3: Sea Ice or Lake Ice 4: Snow Covered Land
projection	Projection description for the data

Variable	Description
time	Time stamp for the data in seconds since 1970-01-01T00:00:00Z. This is the 00Z reference time. Note that products are nowcasted to be valid specifically at the time given here.
x	X coordinate of grid cell. Values, in m, are the centers of the grid cells.
y	Y coordinate of grid cell. Values, in m, are the centers of the grid cells.

1.4.4 Browse Images

The quick view browse images are provided in GIF format (.gif). The GIF images display ice as yellow, snow as white, land as green, and water as blue. See Figure 1 for an example.

1.4.5 Ancillary Data Files

Lat/Lon Grids

The ASCII data files provided by NIC do not come with lat/lon grids, so NSIDC created the 24 km, 4 km, and 1 km files and added them to the data set as a courtesy to the data community. The lat/lon grids for the 24 km and 4 km files are provided in flat binary 4-byte, floating point values (decimal degrees) in little-endian byte order. The 1 km files are provided as double-precision floating point flat binary format in little-endian byte order. The array values are stored in row-major order (incrementing across each column of the first row, and then each column of the second row, and so on). Missing data is marked as NaN. Latitude/longitude pairs represent the location of the lower left corner of the corresponding grid cell. See for a full description of the lat/lon grids by resolution. Although the data files that these lat/lon grids correspond to are in ASCII text format, the lat/lon grids are provided in binary format. Therefore, the lat/lon grids cannot be viewed in a text editor like the data files. An NSIDC programmer created an IDL procedure to read the grids. See section 2 Software and Tools of this document for more information.

Note: With respect to the ASCII text data files, the lat/lon grids are flipped in orientation. Specifically, the binary arrays are stored beginning with the upper left corner, whereas the ASCII text data are stored beginning with the lower left corner. Please be aware of this when working with these files.

Table 5. Description of Lat/Lon Grids

Spatial Resolution	**1 km**	**4 km**	**24 km**
File Names	Latitude File: IMS1kmLats.24576x24576x1.tar.gz Longitude File: IMS1kmLons.24576x24576x1.tar.gz	Latitude File: imslat_4km.bin.gz Longitude File: imslon_4km.bin.gz	Latitude File: imslat_24km.bin.gz Longitude File: imslon_24km.bin.gz
File Size	Latitude File: 3.9 GB Longitude File: 3.6 GB	Latitude File: 107 MB Longitude File: 121 MB	Latitude File: 2.7 MB Longitude File: 2.7 MB
Format	Flat binary double precision floating point (decimal degrees) in little-endian byte order	Flat binary 4-byte floating point values (decimal degrees) in little-endian byte order	Flat binary 4-byte floating point values (decimal degrees) in little-endian byte order
Grid Size	24576 x 24576	6144 x 6144	1024 x 1024
Longitude Values	Range from -180° to 180° (with values less than 0° representing west longitudes and values greater than 0° representing east longitudes)	Range from 0° to 360° (with values greater than 180° representing west longitudes and values less than 180° representing east longitudes)	Range from -180° to 180° (with values less than 0° representing west longitudes and values greater than 0° representing east longitudes)
Latitude Values	Range from -22° to 90° representing north latitudes (note that the corners of the grid extend beyond the equator)	Range from -22° to 90° representing north latitudes (note that the corners of the grid extend beyond the equator)	Range from 0° to 90° representing north latitudes
Projection	Polar stereographic ellipsoidal projection with WGS-84 ellipsoid	Polar stereographic ellipsoidal projection with WGS-84 ellipsoid	Polar stereographic spherical projection with a sphere with radius of 6371200.0 meters
Latitude of true scale	60° N	60° N	60° N
Longitude below the pole	80° W	80° W	80° W
Scale	1,000 meters per cell in x and y	4,000 meters per cell in x and y	23,684.997 meters per cell in x and y

Spatial Resolution	1 km	4 km	24 km
Upper left corner of the upper left cell	(x,y) = (-12288000.0 meters, 12288000.0 meters)	(x,y) = (-12288000.0 meters, 12288000.0 meters)	(x,y) = (-12126597.0 meters, 12126840.0 meters)
Missing Data Value	NaN	NaN	NaN

Missing Data File

On rare occasions, a day is not processed for various reasons resulting in no data file being available for the archive. Although this is rare, the ASCII text file, G02156_missing_files.txt, tallies missing files. It provides the missing dates for both the ASCII text data as well as the GeoTIFF files.

Mapx Software Files

For data users who wish to do geographic coordinate transformations using Mapx software, there are two corresponding 4 km and 24 km Grid Projection Description (GPD) files (.gpd) located on the FTP site: Ims4km.gpd and Ims24km.gpd, respectively. The GPD files contain projection and grid parameter definitions used by the mapx software. A 1 km GPD file is not available. Note that the mapx software is not actively supported by NSIDC. We provide these GPD files and links to it here for convenience only. You can access the mapx software at NSIDC's GitHub Mapx repository.

1.5 File and Directory Structure

Data are located on the FTP site in the G02156 directory. Within this directory are five subdirectories as described in Table 6.

Table 6. Directory Descriptions

Directory	Description
24km	Contains the 24 km resolution ASCII text data files (Note that the files are gzipped (.gz) on the FTP site). This directory is further broken down into subdirectories, one for each year that data was collected (1997 - current year) labeled as the 4-digit year (YYYY). The data files reside in their respective year directory.
4km	Contains the 4 km resolution ASCII text data files (Note that the files are gzipped (.gz) on the FTP site). This directory is further broken down into subdirectories, one for each year that data was collected (2004 - current year) labeled as the 4-digit year (YYYY). The data files reside in their respective year directory.

Directory	Description
1km	Contains the 1 km resolution ASCII text data files (Note that the files are gzipped (.gz) on the FTP site). This directory is further broken down into subdirectories, one for each year that data was collected (2004 - current year) labeled as the 4-digit year (YYYY). The data files reside in their respective year directory.
GIS	Contains the 1 km and 4 km resolution GeoTIFF files. This directory is further broken down into subdirectories, one for each year that GeoTIFFs have been produced (2006 - current year) labeled as the 4-digit year (YYYY). The GeoTIFF files reside in their respective year directory.
images	Contains the GIF browse images. This directory is further broken down into subdirectories, one for each year that GIFs have been produced (1997 - current year) labeled as the 4-digit year (YYYY). The GIF files reside in their respective year directory.
metadata	Contains the lat/lon grid files, missing data file, mapx software files, and metadata files.

1.6 File Naming Convention

1.6.1 ASCII Data Files

Daily ASCII text files are named according to the following convention and as described in Table 7. Note that the files are gzipped (.gz) on the FTP site. **Note:** For the v1.3 ASCII data files only, the day of year in the file name is the day after the date of the data in the file.

Generic File Name: `imsYYYYDDD_Xkm_vZ.z.ext.zxt`

Example File Name: `ims2014337_1km_v1.3.ext.zxt`

Where:

Table 7. Naming Convention Description for Daily ASCII Files

Variable	Description
ims	Identifies this as data coming from Interactive Multisensor Snow and Ice Mapping System
YYYY	4-digit year of the data in the file
DDD	3-digit day of year of the data in the file. Note: For the v1.3 ASCII data files only, the day of year in the file name is the day after the date of the data in the file.
Xkm	Resolution (1km, 4km, or 24km)
vZ.z	Version (v1.1, v1.2, or v1.3)
.ext	Tile extension - .asc: ASCII text file, .tif: GeoTiff file, .aux: auxiliary file containing projection information for the .tif files, .nc: NetCDF file
.zxt	Compression format file extension (.gz: gzipped, .zip: zipped)

1.6.2 GeoTIFF Files

Daily GeoTIFFs are named according to the following convention and as described in Table 7. **Note:** On the FTP site, the v1.3 files are compressed using Gzip (.gz) and v1.1 and v1.2 are compressed using Zip (.zip) because they come with associated .aux files that are no longer present in v1.3 files.

Generic File Name: `imsYYYYDDD_Xkm_GIS_vZ.z.ext.zext`

Example File Name: `ims2014340_4km_GIS_v1.3.tif.gz`

1.6.3 NetCDF Files

Daily NetCDF files are named according to the following convention and as described in Table 7.

Generic File Name: `imsYYYYDDD_Xkm_vZ.z.ext.zext`

Example File Name: `ims2021019_4km_v1.3.nc.gz`

1.6.4 Browse Image Files

GIF browse image files are named according to the following convention and as shown in Table 8:

Generic File Name: `imsYYYYDDD.gif`

Example File Name: `ims2014340.gif`

Where:

Table 8. Naming Convention Description for GIF Image Files

Variable	Description
ims	Identifies this as data coming from Interactive Multisensor Snow and Ice Mapping System
YYYY	4-digit year
DDD	3-digit day of year
gif	Identifies this as an GIF image file

1.6.5 Ancillary Data

See the Format section 1.4.5 Ancillary Data Files for a description of file names.

1.7 File Size

Table 9 lists the sizes of the files that comprise this data set.

Table 9. File Size

File Type	Size
1 km ASCII	576 MB unzipped (~2.7 MB gzipped))
4 km ASCII	37 MB unzipped (~450 KB gzipped)
24 km ASCII	1 MB (packed form) or 5 MB (unpacked form) unzipped (25-30 KB gzipped). See the Note on Packed Versus Unpacked Format in section 1.4.1 ASCII Data Files.
1 km GeoTIFF	576 MB unzipped (~2.7 MB gzipped)
4 km GeoTIFF	v1.3: 36 MB unzipped(~415 KB gzipped) v1.1 and v1.2: 37 MB unzipped plus 12 KB for the associated .aux files (~435 KB gzipped)
Lat/Lon grids	4 MB - 121 MB
Browse images	11 KB - 24 KB

1.8 Spatial Coverage

Northern Hemisphere coverage is available at 1 km, 4 km, and at 24 km resolutions. The bounding coordinates are as follows:

Southernmost Latitude: 0° N
Northernmost Latitude: 90° N
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

1.8.1 Spatial Resolution

This product is available at 24 km, 4 km, and 1 km resolutions.

1.8.2 Projection and Grid Description

Data are in a polar stereographic projection centered at 90° N with the vertical longitude from the Pole at 80° W and the standard parallel at 60° N. The grid size for each of the three resolutions is provided in Table 2.

The proj4 string for these data is the following:

+proj=stere +lat_0=90 +lat_ts=60 +lon_0=-80 +k=1 +x_0=0 +y_0=0 +a=6378137 +b=6356257 +units=m +no_defs

The WKT for these data can be obtained from the following text file: ims_wkt2_2018.txt

1.9 Temporal Coverage and Resolution

The data are daily and span 04 February 1997 to present at varying spatial resolutions. Table 10 provides details on the temporal coverage of these data products by spatial resolution and data format. The version number has changed throughout the course of the data set:

Version 1.1: 04 February 1997 - 22 February 2004
Version 1.2: 24 February 2004 - 06 December 2014
Version 1.3: 02 December 2014 – present

Occasionally there are missing data files. The file G02156_missing_files.txt gives a listing of these.

Note: For the v1.3 ASCII data files only, the day of year in the file name is the day after the date of the data in the file.

Table 10. Temporal Coverage

Resolution	Data Format	Date
1 km	ASCII	02 December 2014 to present
1 km	GeoTIFF	02 December 2014 to present
4 km	ASCII	24 February 2004 to present
4 km	GeoTIFF	01 January 2006 to present
24 km	ASCII	04 February 1997 to present

1.10 Parameter or Variable

The parameters in this data set are snow and ice cover over the Northern Hemisphere.

1.10.1 Parameter Description

Sample header information from the data file ims2004016.asc. **Note:** The headers are not the same size across all files.

```
Julian day of IMS data log: 2004016
Processing day: Fri Jan 16 21:12:01 2004
```

```
Total # scientific data sets: 1
File description:
This file contains Northern Hemisphere snow and ice coverage produced by the
NOAA/NESDIS Interactive Multisensor Snow and Ice Mapping System (IMS) developed
under the direction of the Interactive Processing Branch (IPB) of the Satellite
Services Division (SSD). For more information, please contact Mr. Bruce Ramsay
at bramsay@ssd.wwb.noaa.gov
Map Label: Northern Hemisphere 1024 x 1024 snow and ice coverage
Coordinate System: Polar Stereographic
Data Values: 1 (sea), 2 (land), 3 (sea ice), 4 (snow), Data Values: 0 (outside
Northern Hemisphere).
Format: I1
Dimensions: 1024 x 1024
(1,1) starts at: lower left corner
```

1.10.2 Sample Browse Image

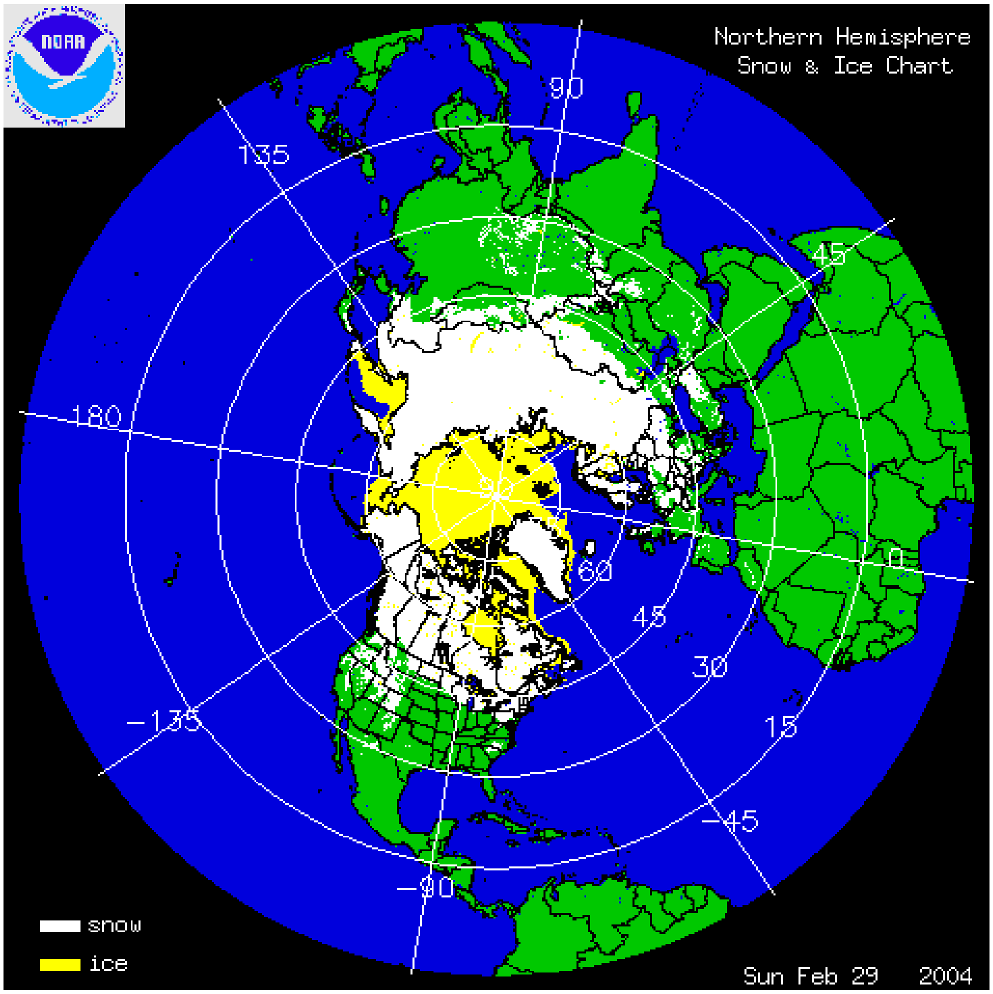

Figure 1. 24 km Northern Hemisphere Snow and Ice Chart Browse Image for 29 February 2004 (ims2004060.gif). Image courtesy of Satellite Services Division.

2 SOFTWARE AND TOOLS

ASCII Data Files

To read the ASCII data files, an NSIDC programmer created an IDL procedure, read_ims.pro, to read the grids. **Note:** The program was created as a courtesy to users of this data set and to provide one example of how to extract the data, however, the code is not supported or updated.

GeoTIFF Files

The GeoTIFF files can be viewed in GIS applications.

NetCDF Files

NetCDF files can be read and used with number of tools, including but not limited to NASA Panoply, Unidata Ncview, PMEL Ncbrowse, Scripps Institution of Oceanography Ncdump, and NetCDF Operators (NCO).

Lat/Lon Grids

To read the lat/lon grid files, an NSIDC programmer created an IDL procedure, read_ims_geolocation.pro, to read the grids. **Note:** The program was created as a courtesy to users of this data set and to provide one example of how to extract the data, however, the code is not supported or updated. Example plots of IMS data created using NCAR Command Language (NCL) are available from the NCL Web site.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

Most input data are acquired, on a daily basis, through the IMS preprocessing system that automatically runs scripts that use FTP to acquire the input files (Helfrich et al., 2019).

3.2 Derivation Techniques and Algorithms

By inspecting environmental satellite imagery, analysts from a NOAA NESDIS satellite product group created a Northern Hemisphere snow and ice map from November 1966 until the U. S. National Ice Center (NIC) took over production in March 2008. The next two sections, 3.2.1 NIC Derivation Techniques (March 2008 to present) and 3.2.2 NESDIS Satellite Product Group Derivation Techniques (through February 2008), describe how the data are processed by the two groups.

3.2.1 NIC Derivation Techniques (March 2008 to present)

Method

When NIC began producing the IMS product in 2008, there were changes in the way sea ice was mapped to create the daily product. Snow mapping, however, did not change, and is as described in section 3.2.2 NESDIS Satellite Product Group Derivation Techniques (through February 2008).

For sea-ice mapping, the IMS product is manually generated by an analyst looking at all available satellite imagery, at output from satellite ice mapping algorithms, and at other data sources. The analyst begins with a map from the previous day to initialize the process. Input satellite data and fields are sampled to a standard 6144 x 6144 grid (~4 km per grid cell). The analyst then integrates all data sources to create the best representation of sea-ice cover at a 4 km resolution.

A cell is considered ice-covered if more than 40 percent of the 4 km cell is covered with ice, regardless of the ice thickness or ice type. Users familiar with satellite passive microwave sea-ice concentration products that NSIDC distributes, in which a 15 percent concentration threshold is used to define the ice edge, should be aware that the IMS 40 percent threshold is not a threshold applied to passive microwave sea-ice concentration or to any single ice concentration product. Rather, analysts start with yesterday's ice product, judging by eye if a cell or cells are more than 40% ice covered based on available data, and edit appropriately. Analysts use data that are of sufficient resolution to allow the concentration to be reasonably well determined in this way. The completed IMS product is then automatically saved in ASCII, GeoTIFF, and GIF formats.

A further description of the IMS system is available on the NIC web site on their IMS Information web page.

In December 2014, NIC began creating a 1km as well as the 4 km and 24 km products. It is produced in the same manner as the 4 km product (S. Helfrich, personal communication).

Generally speaking, there is a new IMS product every day. However, occasionally, the IMS product is not updated for particular regions even though the IMS file date has been incremented by one day. NIC confirmed that this happens when analysts do not have enough information to change the analysis for a region. They may have some data that could be used; but unless the data are sufficient, they will persist the ice boundaries. This can produce areas for which the ice edge seemingly does not change for a day or more when it may actually be changing. NIC would like to flag these areas but are unable to do so at present (S. Helfrich, personal communication to F. Fetterer, October 2016).

Data Sources

For determining sea-ice coverage, IMS analysts consider derived ice charts, modeled ice conditions, and surface observations, as well as visible, passive microwave, and active microwave satellite resources. The use of data sources varies by the timeliness of the data, the resolution of the data, weather conditions, and the time of year. While there is no hierarchy in data sources used for determining ice conditions, analysts tend to prefer visible band imagery. Other satellite sources, such as passive microwave imagers and sounders, Synthetic Aperture Radar (SAR), and scatterometry, are favored when visible imagery is absent or obscured by clouds. In the Arctic, this is quite common. Operational ice charts produced at NIC or by other ice services, modeled ice data, ship observations, oceanographic data, and atmospheric conditions are also considered when satellite sources are analyzed in order to provide context and to support the analyst's interpretation regarding the presence or absence of ice.

Data sources for the IMS product have changed since the 4 km resolution was introduced in February 2004. New satellites and other sources have been introduced to replace those that are no longer available. Metadata that records which imagery was used to generate the snow and ice maps are not kept at this time. Helfrich et al. (2007) include an estimate of the percentage of imagery used from each source. The estimate was made before production was moved from the NOAA satellite products group to NIC in 2008. Table 11 lists the majority of the different input data sources used in IMS production.

Analysts display available sources on large workstation screens, where each day's IMS product is made. As of 2010, the primary visible band imagery that analysts use comes from the Moderate Resolution Imaging Spectrometer (MODIS). Other visible satellite data sources, in 2010, include Advanced Very High Resolution Radiometer visible band (AVHRR-VIS), Geostationary Operational Environmental Satellite (GOES) Imager, Spinning Enhanced Visible and Infrared Imager (SEVIRI), and the Multi-functional Transport Satellite (MTSAT) Imager. AMSR-E 89 GHz brightness temperature at 6.25 m resolution was an important passive microwave data source when the satellite was in service (~2002-2011). Analysts directly interpret areas with high 89 GHz brightness temperatures as areas covered by ice when this interpretation is supported by information from other sources. Other passive microwave sources include the Special Sensor Microwave Imager (SSM/I) derived ice concentrations and Advanced Microwave Sounding Unit (AMSU) derived ice concentrations. When analysts use passive microwave derived ice concentrations, they usually interpret 40 percent to 60 percent concentration in the passive microwave product to be equivalent to about 7/10+ coverage on NIC ice charts.

The automated NOAA ice cover output that make use of AVHRR, SSM/IS, GOES imager, and SEVIRI at the same IMS resolution are also examined as an objective evaluation of ice conditions (Sean Helfrich, citing the work of Peter Romanov, personal communication 08 November 2010). SAR imagery from RADARSAT-2, European Remote Sensing Satellite-2 (ERS-2), Advanced Land Observing Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR), and Envisat Advanced Synthetic Aperture Radar (ASAR) are used but are not analyzed on the same workstation screen with other IMS data sources. SAR data are examined on adjoining NIC Sea Ice Prediction and Analysis System (SIPAS) workstations and referenced as the IMS analysis is produced. The SIPAS workstations are those used by NIC to produce their weekly regional operational analysis products that use the SIGRID-3 sea ice chart designations.

Derived ice conditions from ice charts and ice edge products are also considered. The US, Canadian, Norwegian, Danish, Russian, German, Swedish, and Japanese ice charting agencies also serve as data sources in the absence of direct satellite data or in areas where only passive microwave derived ice data is available. Passive microwave derived data are especially suspect when conditions are right for surface melting or where ice is new and thin. The use of ice charts is limited due to the infrequency of ice chart production. Operational regional ice charts, that is, those that use the WMO egg code to describe ice conditions, are not available every day. The NIC ice edge products are examined thoroughly but are not used directly for the IMS product due to differences in mission ice identification requirements for each product. The NIC and Canadian Ice Service (CIS) ice edge products attempt to delineate not only where ice is present, but also where any ice is likely, regardless of the concentrations, for safety of navigation. The IMS product attempts to demarcate each 4 km x 4 km grid cell that appears to have more than 40 percent ice concentration as ice covered. An ice edge line created from an IMS field will not match an ice edge line from the regular NIC ice edge product. Helfrich et al. (2007) have information on how NIC operational charts tend to differ from NIC operational IMS products.

Modeled ice conditions from the National Centers for Environmental Protection (NCEP) Marine Modeling and Analysis Branch (MMAB) and coupled Numerical Weather Prediction (NWP) models are also available for analysis, though these are generally used only for context and to understand where areas favor ice formation. Ship reports and ice buoys also enhance the analysis by providing limited ground truth, boundary layer weather conditions, and ice motion information.

New data sources for IMS production are continuously introduced as other advanced visible and passive microwave satellite data, coupled ice models, and more SAR imagery become available. NIC wishes to incorporate ancillary information about data quality in future versions of the IMS. Ideas for this include adding a variable to flag when a cell was not updated so that users know, on a cell-by-cell basis, if the surface type assignment of *ice* or *open water* for a given cell was updated or simply carried over from the last analysis. As of January 2017, however, NIC does not have the resources to realize these plans.

3.2.2 NESDIS Satellite Product Group Derivation Techniques (through February 2008)

Through February 2008, the IMS product was manually created by a NOAA NESDIS satellite-product-group analyst looking at all available satellite imagery, automated snow mapping algorithms, and other ancillary data. NESDIS analysts drew snow maps on workstations that displayed these data products and satellite imagery. The visible imagery of the Polar Operational Environmental Satellites (POES) and geostationary orbiting environmental satellites were primary. Moderate Resolution Imaging Spectrometer (MODIS) imagery was used as well. In addition, ground weather observations from many countries were used. Microwave products from POES Advanced Microwave Sounding Unit (AMSU) and the Department of Defense (DOD) DMSP were incorporated into the daily snow and ice chart because, even though they are at relatively low resolution, they allow a view through clouds. A weekly sea ice analysis from NIC, the United States

Air Force Snow and Ice Analysis Product, and snow products from the National Operational Hydrologic Remote Sensing Center (NOHRSC) were made available to the analyst, as well as several automated snow detection layers developed by NOAA NESDIS satellite product group and the NOAA National Centers for Environmental Prediction (NCEP). For sea ice, analysts rely first on visible imagery and radar data, then on passive microwave data, followed by the NIC analysis product, depending on the timeliness of the data, the resolution of the data, and the time of year.

The analyst began with a previous day's map to initialize the process. Input satellite data and fields were resampled to the two IMS grids available then: 6144 x 6144 grid (~4 km/pixel) matrix and 1024 x 1024 grid (~24 km per pixel). All resolutions were saved in ASCII format and the 4 km product was saved as GeoTIFF and GIF formats. The ASCII files were built to NCEP specifications because NCEP was the primary user of this product at the time. NCEP created a Binary Universal Form for the Representation of meteorological data (BUFR) format and a GRIdded Binary (GRIB) format from the ASCII output, but these formats are not archived at NSIDC.

3.2.3 Processing Steps

IMS processing can be broken down into four generalized steps (Helfrich et al., 2019):

1. A preprocessing system takes all input products and imagery from their native formats and resolutions and converts them into the IMS formats and resolutions and places them on a internal server.

2. An IMS GUI system picks up the processed data from the server at intervals throughout the day and displays the data on the IMS projection.

3. The analysts tag locations as snow covered and ice covered over the entire Northern Hemisphere. The GUI system also generates snow depth, ice thickness, and time since last observation via code that analysts can also alter before the analysis is exported.

4. Scripts produce final products and distribute final products to proper destinations.

3.2.4 Quality Assessment

The quality of the snow- and ice-cover charts will depend on the availability of clear sky imagery, the georegistration of that imagery, the quality of other input data sources, and the experience of the OSPS analyst. This is a manually created product which uses multiple images to map the snow/ice regions. Surface data is also made available to the analysts to aid with real-time quality control. Regions covered by cloud during the 24-hour analysis period are generally mapped as persistence, taking lower resolution passive microwave data and surface observations into account where possible. Other than grid points in the square array which, from a hemispheric view, fall off the sphere and are flagged as 0 (outside the northern hemisphere), there should be no missing values over the mapped hemisphere.

Sub-grid scale features may not be detected. The documentation for the Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent (Armstrong and Brodzik 2002) and for snow products at Rutgers University Global Snow Lab includes more information on quality assessment, including the following from the Global Snow Lab:

"Despite the shortwave limitations [...], the NOAA maps are quite reliable at many times and in many regions. These include regions where, 1) skies are frequently clear, commonly in Spring near the snowline, 2) solar zenith angles are relatively low and illumination is high, 3) the snow cover is reasonably stable or changes slowly, and 4) pronounced local and regional signatures are present owing to the distribution of vegetation, lakes and rivers. Under these conditions, the satellite-derived product will be superior to maps of snow extent gleaned from station data, particularly in mountainous and sparsely inhabited regions. Another advantage of the NOAA snow maps is their portrayal of regionally-representative snow extent, whereas maps based on ground station reports may be biased, due to the preferred position of weather stations in valleys and in places affected by urban heat islands, such as airports."

See the NSIDC Sea Ice Index: Interpretation Resources for Sea Ice Trends and Anomalies for a general discussion of passive microwave imagery for sea ice extent. Note that while the NOAA IMS product makes use of both passive microwave and visible band imagery to map ice extent, the NSIDC product, Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent, uses only passive microwave for ice extent.

3.3 Sensor or Instrument Description

Table 11 provides a list of most of the sensors and instruments used as input to this data set. This information was provided to NSIDC by NIC in September 2015. **Note:** A large number and ever-changing types of data sources are available to the ice analysts on a daily basis. We receive information from NIC concerning sources for IMS production intermittently. Therefore, it is difficult to keep this table up-to-date.

> **Note:** Due to the large number and ever-changing types of data sources available to the ice analysts on a daily basis, Table 11 is not necessarily complete or up-to-date.

Table 11. Sensors/Instruments Used as Input.

Sensor or Source	Platform or Organization	Version of Data this Applies to (may not apply exclusively to the named version)
ACNFS sea ice area fraction and sea ice thickness	NIC	1.3
AMSR-2	GCOM-W	1.3
AMSU	NOAA POES Satellites (15 - 18), Aqua, EUMETSAT MetOp-A	1.1, 1.2, 1.3
ASCAT	EUMETSAT MetOp-A	1.2, 1.3
ATMS (MIRS based)	S-NPP	1.3
Automated snow detection layers	NESDIS and NCEP	1.1, 1.2, 1.3
AVHRR	NOAA POES Satellites (14 - 19), EUMETSAT MetOp-A	1.1, 1.2, 1.3
Canadian snow analysis	Environment Canada	1.3
GFS daily snow depth	NCEP	1.3
GMS Imager	JMA GMS-5 (Himawari 5)	1.1, 1.2
GOES Imager	NOAA GOES Satellites (9, 10, 11, 13)	1.1, 1.2, 1.3
Hourly surface weather reports	METAR	1.3
MODIS	Aqua and Terra	1.2, 1.3
MTSAT-1R Imager	JMA MTSAT-1R (Himawari 6)	1.2
MTSAT-2 Imager	JMA MTSAT-2 (Himawari 7)	1.3
MVIRI	MFG	1.1, 1.2
Radar	Various radar published from Europe, Japan, China, South Korea, Canada, or U.S.	1.3
SAR	Radarsat-2	1.3
SAR (C-band)	Sentinel-1A	1.3
SEVIRI	MSG	1.3
SNODAS	NOHRSC	1.1, 1.2, 1.3
SSM/I	DMSP Satellites	1.1, 1.2, 1.3
SSMIS	DMSP Satellites	1.2, 1.3
U.S. Air Force Snow and Ice Analysis Product	USAF	1.1, 1.2, 1.3

Sensor or Source	Platform or Organization	Version of Data this Applies to (may not apply exclusively to the named version)
Various weather reports, ice charts, and snow depth reports	In situ data from U.S. and other foreign countries	1.3
VIIRS Binary Snow Cover EDR	NASA Goddard	1.3
VIIRS Sea Ice Characterization EDR	NASA Goddard	1.3
VIIRS (visible channels 1,2,3, IR channel 15, day/night bands)	S-NPP Satellites	1.3
Weekly sea ice analysis and ice edge	NIC	1.1, 1.2, 1.3

3.4 Version History

Table 12 provides the version history of this product. Note that NSIDC has used minor versions (v1.1, v1.2) to distinguish between IMS versions. The files we download from NIC are labeled with major versions (v1, v2). NSIDC versions align with the NIC versions in the following way: NSIDC v1.1 corresponds to NIC v1, NSIDC v1.2 corresponds to NIC v2, and v1.3 corresponds to v3.

Table 12. Version History

Version	Dates	Description
V1.1	04 February 1997 - 22 February 2004	Initial release of this data set at a 24 km resolution. Note: NSIDC's version 1.1 corresponds to NIC's version 1.
V1.2	23 February 2004 - 02 December 2014	Second release of this data set. Major change is the addition of a 4 km resolution product. Note: NSIDC's version 1.2 corresponds to NIC's version 2.

V1.3	03 December 2014 - present	Third release of this data set. Major changes are the addition of a 1 km resolution product and new input data sources. Note: NSIDC's version 1.3 corresponds to NIC's version 3. Version 1.3 Summary: • New data sources: See Table 11 for a list of some of the new data sources for version 1.3. • Addition of 1 km product: A 1 km ASCII file and GeoTIFF file are now available. • Change to GeoTIFFs: The GeoTIFF files now have their projection information within the GeoTIFF file itself instead of in an extra .aux file. These files are now compressed using gzip instead of zip.

4 REFERENCES AND RELATED PUBLICATIONS

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Robinson, D.A. and A. Frei. 2000. Seasonal variability of northern hemisphere snow extent using visible satellite data. *Professional Geographer* 51: 307-314.

Robinson, D.A., J.D. Tarpley, and B. Ramsay. 1999. Transition from NOAA weekly to daily hemispheric snow charts. *Proceedings of the 10th Symposium on Global Change*, Dallas, TX, American Meteorological Society. 487-490.

4.1 Related NSIDC Data Collections

- Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent
- MEaSUREs Northern Hemisphere State of Cryosphere Daily 25km EASE-Grid 2.0
- Timing and Statistics of Autumn and Spring Annual Snow Cover for the Northern Hemisphere, 1972 to 2000
- Snow Data Assimilation System (SNODAS) Data Products at NSIDC
- Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH) - Based on this IMS product; it provides measurements of daily sea ice extent and sea ice edge boundary for the Northern Hemisphere.
- Environmental Working Group Joint U.S.-Russian Arctic Sea Ice Atlas
- MASAM2: Daily 4 km Arctic Sea Ice Concentration

4.2 Other Related Data Collections

- Rutgers University Global Snow Lab: Analyses of a quality controlled and extended version of these data.
- IMS Snow and Ice Products: NOAA SSD Snow and Ice Products Web site also provides browse images of the data.
- NOAA CDR Snow Cover Extent (Northern Hemisphere): Provides a high quality Climate Data Record (CDR) of Snow Cover Extent for the Northern Hemisphere.

4.3 Related Websites

IMS Snow and Ice Products Web page for the NIC IMS product.

5 CONTACTS AND ACKNOWLEDGMENTS

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5.1 Acknowledgments

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This data set and documentation were developed in 2004 at the instigation of NOAA/NESDIS/OSDPD's Bruce Ramsay and with the support of OSDPD, NOAA SDS Staff, and Donna McNamara, Team Leader of the Environmental Applications Team. NSIDC's Mary Jo Brodzik provided helpful background information and assistance. At the time of the creation of this document, the product team at NSIDC consisted of Lisa Ballagh, Florence Fetterer, Jonathan Kovarik, and Keri Webster.

6 DOCUMENT INFORMATION

6.1 Document Authors

Florence Fetterer and Keri Webster wrote the original product documentation in 2004 based on the cited references, the OSDPD web site, the metadata files supplied by OSDPD, and information from Donna McNamara, Team Leader of the Environmental Applications Team, NOAA/NESDIS/OSDPD in 2004. Since then the document has been updated and edited by a number of different NSIDC personnel.

6.2 Publication Date

December 2004

6.3 Date Revision History

- **August 2021**: A. Windnagel updated the format and file naming convention sections to include the newly available NetCDF format data files.

- **December 2020**: A. Windnagel changed the start date of V1.2 from 23 Feb 2004 to 24 Feb 2004 because the 23 Feb 2004 file was corrupt. Also added the proj4 and WKT to the spatial section and added contact information for the USNIC Ops department.
- **April 2017:** A. Windnagel added information describing the new 1 km lat/lon grids.
- **February 2017:** A. Windnagel updated the doc with more specific information on how the IMS data production is accomplished and updated the ASCAT entry in Table 11 by adding Version 1.2, based on information from NIC.
- **January 2015:** A. Windnagel updated this document with v1.3 information, added a table of source data, and reformatted the guide doc into the newer template.
- **December 2011:** A. Windnagel updated documentation to reflect the fact that the ASCII data files are now being gzipped.
- **December 2010:** A. Windnagel made minor changes to route users to G02186 for more information on how sea ice is mapped in the IMS product. Changed the citation which was originally "NOAA/NESDIS/OSDPD/SSD. 2004, updated 2006. IMS daily Northern Hemisphere snow and ice analysis at 4 km and 24 km resolution. Boulder, CO: National Snow and Ice Data Center. Digital media." This was changed to reflect the production at NIC beginning in 2008.
- **January 2010:** A. Windnagel did a full edit/revision of this document including major additions to the File Naming and Convention section to make the document current.
- **June 2009:** A. Windnagel updated the lat/lon information for the ancillary files
- **July 2008:** A. Windnagel added information about the two different formats of the ASCII text files. Also added some formatting and styling.
- **December 2007:** L. Ballagh added information on missing GeoTIFF files.
- **October 2007:** L. Ballagh updated information about the ancillary grids.
- **June 2006:** F. Fetterer added information on GeoTIFFs.
- **February 2005:** F. Fetterer removed misleading text from the Sample Data Record.
- **December 2004**: F. Fetterer and K. Knowles created the document.