National Snow and Ice Data Center

IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions

This data set provides snow and ice cover maps for the Northern Hemisphere from February 1997 to the present from the National Ice Center's Interactive Multisensor Snow and Ice Mapping System (IMS). It is 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.

Overview

Parameters	Snow cover Ice cover
Spatial Coverage and Resolution	Northern Hemisphere with the following bounding box: Southernmost Latitude: 0° N Northernmost Latitude: 90° N Westernmost Longitude: 180° W Easternmost Longitude: 180° E Resolution: 1 km, 4 km, and 24 km nominal resolution
Temporal Coverage and Resolution	04 February 1997 to present at a daily resolution, however, temporal coverage varies by spatial resolution. See Table 10 for full details.
Platform/Sensor	Multiple platforms and sensors were used to create this data set. See Table 12 for a complete list.
Data Format	**Data**: ASCII text (`.asc`) one-digit integer (I1) (Except as noted in the ASCII Data Files section of the Detailed Data Description) GeoTIFF (4 km only) **Lat/Lon Grids**: Flat binary (`.bin`), 4-byte floating point values (little endian) **Browse images**: GIF format (`.gif`) **Ancillary Data**: See the Ancillary Data Format section of this document
Metadata Access	View Metadata Record
Registration	Register for data updates and announcements
Version	Version 1.1: 04 February 1997 - 22 February 2004 Version 1.2: 23 February 2004 - 06 December 2014 Version 1.3: 02 December 2014 - present
Data Access	FTP

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Citing These Data

We kindly request that you cite the use of this data set in a publication using the following citation. For more information, see our Use and Copyright Web page.

National Ice Center. 2008, updated daily. *IMS daily Northern Hemisphere snow and ice analysis at 1 km, 4 km, and 24 km resolutions*. Boulder, CO: National Snow and Ice Data Center. Digital media.

1. Summary

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, analysts from the Satellite Analysis Branch (SAB) at the Office of Satellite Data Processing and Distribution (OSDPD), Satellite Services Division (SSD), created a Northern Hemisphere snow and ice map from November 1966 until the U. S. National Ice Center (NIC) took over production in 2008. Initially, the product was produced with a nominal spatial resolution of 190 km and a temporal resolution of seven days. In 1997, the Interactive Multisensor Snow and Ice Mapping System (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 December 2014, IMS introduced a 1 km product. NSIDC archives and distributes the 1 km, 4 km, and 24 km data in ASCII and GeoTIFF formats. NSIDC also distributes the browse images in GIF format and latitude and longitude grids for these products.

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 NIC Web site and contact the National Ice Center Liaison to request access to their operational server.

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.

History of Product Development

From November 1966 through 2008, NESDIS produced weekly snow and ice charts until NIC took over their production. These charts are the longest satellite-derived data set in existence (Ramsay 1998) and are primarily used as initialization fields for numerical weather prediction models but also provide an excellent, high-quality climate record of snow and ice. For information on higher resolution, basin-scale snow products produced by NOAA for hydrological forecasting, see the Related NSIDC Data Collections section of this document.

In 1995, due to errors seen in near surface temperature forecasts caused by the relatively low temporal resolution of the snow product, NOAA began development of the Interactive Multisensor Snow and Ice Mapping System (IMS) in order to make a daily snow map feasible. 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 DMSP passive microwave data from SSM/I. The previously used manual method in production of the weekly chart took eight to ten hours depending upon the season. Meteorologists using IMS routinely produce daily maps in under 90 minutes." See Table 1 for a summary of IMS and pre-IMS snow cover products.

The purpose of the IMS is to provide SAB analysts with the ability to interactively 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, 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 at the NOAA NESDIS National Climatic Data Center (NCDC). A quality controlled derived version of this product is available in digital form from Rutgers University Global Snow Lab.

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 as well 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).

A 4-km product was implemented in 2004 and a 1 km product was implemented in 2014. The primary user of these products is the National Centers for Environmental Prediction (NCEP) where the product is used as input to numerical weather prediction models.

Note: When NIC took over production of the charts in 2008 the citation was changed to reflect this. When NESDIS was producing the charts 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.

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 Version 3 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 23 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.

2. Detailed Data Description

Format

The data are provided in two formats: ASCII text (`.asc`) and GeoTIFF (`.tif`). 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:

- ASCII Data Files
- GeoTIFF Data Files
- Browse Images
- Ancillary Data

ASCII Data Files

The top of each ASCII data file contains a header with details about that file. Through out 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. For information on reading these files, see the Tools section of this document.

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)
3, 164	Sea Ice **Note:** The value 164 only pertains to the 24 km ASCII files listed in Files in Unpacked Format.
4, 165	Snow covered land **Note:** The value 165 only pertains to the 24 km ASCII files listed in Files in Unpacked Format.

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.

GeoTIFF Data 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.

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.

Ancillary Data Files

- Lat/Lon Grids
- Missing Data File
- Mapx Data Files

Lat/Lon Grids

The ASCII data files provided by NESDIS do not come with lat/lon grids, so NSIDC created the 4 km and 24 km files and added them to the data set in 2004 as a courtesy to the data community. **Note**: The 1 km product, recently released in December 2014, does not yet have corresponding lat/lon files. The lat/lon grids are provided in flat binary 4-byte, floating point values (decimal degrees) 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 Table 4 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 the Tools section 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 4. Description of Lat/Lon Grids

Spatial Resolution	4 km	24 km
File Names	Latitude File: `imslat_4km.bin.gz` Longitude File: `imslon_4km.bin.gz`	Latitude File: `imslat_24km.bin.gz` Longitude File: `imslon_24km.bin.gz`
Format	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	6144 x 6144	1024 x 1024
Longitude Values	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 0° to 90° representing north latitudes	Range from 0° to 90° representing north latitudes
Projection	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
Longitude below the pole	80° W	80° W
Scale	4,000 meters per cell in x and y	23,684.997 meters per cell in x and y
Upper left corner of the upper left cell	(x,y) = (-12288000.0 meters, 12288000.0 meters)	(x,y) = (-12126597.0 meters, 12126840.0 meters)
Missing Data Value	`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 use Mapx software, the two corresponding 4-km and 24-km Grid Projection Description (GPD) files (`.gpd`) are 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. The 1 km GPD file is not, yet, available.

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 5 and Figure 2.

Table 5. 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.
`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.

File Naming Convention

ASCII Data Files

Daily ASCII text files are named according to the following convention and as described in Table 6. Note that the files are gzipped (.gz) on the FTP site.

Generic File Name: imsYYYYDDD_Xkm_vZ.z.asc.gz

Example File Name: ims2014337_1km_v1.3.asc.gz

Where:

Table 6. 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)
.asc	Identifies this as an ASCII text file
.gz	Indicates that this file is gzipped

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

Where:

Table 7. Naming Convention Description for Compressed GeoTIFF 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
Xkm	Resolution (1km or 4km)
vZ.z	Version (v1.2 or v1.3)
.ext	File extension (.tif: GeoTIFF file, .aux: auxiliary file containing projection information)
.zext	Compression format file extension (.gz: gzipped, .zip: zipped)

Browse Image Files

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

imsYYYYDDD.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

Ancillary Data

Lat/Lon Grids

See the Lat/Lon Grids Format section of this document for a complete description of the files and their names.

Missing Data File

See the Missing Data File section in the Format section of this document for a complete description.

Mapx Software Files

See the Mapx Software Files section in the Format section of this document for a complete description.

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 Note on Packed Versus Unpacked Format
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

Spatial Coverage and Resolution

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

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. For more information about polar stereo projections, see NSIDC's Polar Stereographic Projection and Grid Web page.

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.

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	23 February 2004 to present
4 km	GeoTIFF	01 January 2006 to present
24 km	ASCII	04 February 1997 to present

Parameter

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

Sample Data Record

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
```

Sample Browse Image

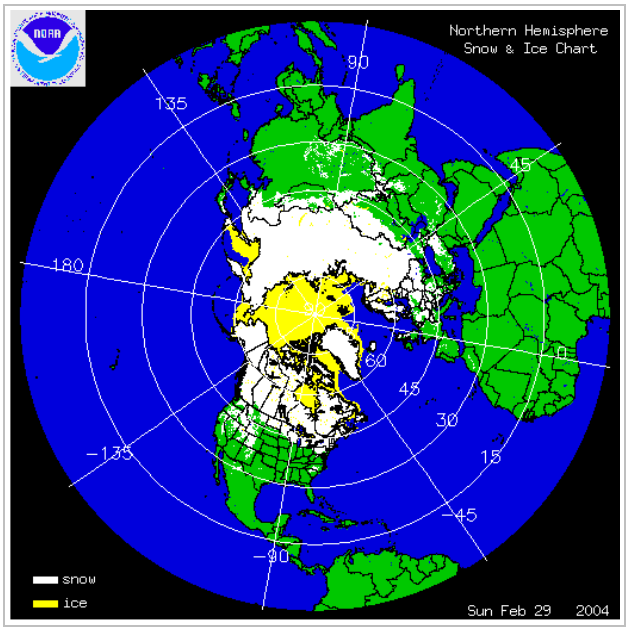

Figure 1. 24 km Northern Hemisphere Snow and Ice Chart Browse Image for 29 February 2004 (`ims2004060.gif`). Image courtesy of Satellite Services Division.

3. Data Access and Tools

Data Access

Data are available via FTP.

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.

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.

4. Data Acquisition and Processing

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, Li, and Kongoli 2012).

Derivation Techniques and Algorithms

The IMS product is manually created by a NOAA NESDIS Office of Satellite and Product Operations (OSPS) satellite analyst looking at all available satellite imagery, automated snow

mapping algorithms, and other ancillary data. OSPS analysts draw snow maps on workstations that display these data products and satellite imagery. The visible imagery of the Polar Operational Environmental Satellites (POES) and geostationary orbiting environmental satellites are primary. Moderate Resolution Imaging Spectrometer (MODIS) imagery is used as well. In addition, ground weather observations from many countries are used. Microwave products from POES Advanced Microwave Sounding Unit (AMSU) and the Department of Defense (DOD) Defense Meteorological Satellite Program (DMSP) are 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 the National Ice Center (NIC), the United States Air Force Snow and Ice Analysis Product, and snow products from the National Operational Hydrologic Remote Sensing Center (NOHRSC) are made available to the analyst, as well as several automated snow detection layers developed by NESDIS and the National Centers for Environmental Prediction (NCEP). A complete list of input data products is provided in Table 12.

The OSPS analyst begins with a previous day's map as a first guess. Input satellite data and fields are resampled to a the three IMS grids: 24576 x 24576 (~1 km/pixel) , 6144 x 6144 (~4 km/pixel) matrix, and 1024 x 1024 (~24 km per pixel). All resolutions are saved in ASCII, GeoTIFF, and GIF formats. The ASCII files are built to NCEP specifications because they are the primary users of this product. The NOAA National Center for Environmental Prediction (NCEP) creates a Binary Universal Form for the Representation of meteorological data (BUFR) format file and a GRidded Information in Binary (GRIB) format file, but they are not archived at NSIDC.

For snow extent, analysts rely primarily on visible band satellite imagery. For sea ice, analysts rely first on visible imagery, 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. When analysts use passive microwave imagery, the 40 percent or 60 percent concentration edge is most often used to correlate with about 7/10+ coverage on NIC ice charts. Analysts are conservative in adding ice. The IMS ice edge will generally depict an ice edge that is less advanced than the NIC ice edge.

Processing Steps

IMS processing can be broken down into four generalized steps (Helfrich, Li, and Kongoli 2012):

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 sever at intervals throughout the day and displays the data on the IMS projection.
3. The OSPS 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.

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 Version 3 (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 Version 3, uses only passive microwave for ice extent.

Sensor or Instrument Description

Table 12 provides a list of all of the sensors and instruments used as input to this data set.

Table 12. Sensors/Instruments Used as Input

Sensor or Source	Platform or Organization	Version of Data this Applies to
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	1.3
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
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

Version History

Table 13 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 13. 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 12 for a list 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.

5. References and Related Publications

Armstrong, R.L. and M.J. Brodzik. 2002. *Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent Version 2.* Boulder, CO: National Snow and Ice Data Center. CD-ROM.

Dye, D. 2005. *Timing and statistics of autumn and spring annual snow cover for the Northern Hemisphere.* Boulder, CO: National Snow and Ice Data Center. Digital media.

Helfrich, S. R., M. Li, and C. Kongoli. 2012. Interactive Multisensor Snow and Ice Mapping System Version 3 (IMS V3) Algorithm theoretical basis document version 2.1. Noaa NESDIS Center for Satellite Applications and Research (STAR). 61 pp.

Helfrich, S. R., D. McNamara, B. H. Ramsay, T. Baldwin, and T. Kasheta. 2007. Enhancements to, and forthcoming developments to the Interactive Multisensor Snow and Ice Mapping System (IMS), *Hydrological Processes* 21: 12, 1576-1586.

National Operational Hydrologic Remote Sensing Center. 2004. *SNODAS Data Products at NSIDC.* Boulder, CO: National Snow and Ice Data Center. Digital media.

Ramsay, B. H. 2000. Prospects for the Interactive Multisensor Snow and Ice Mapping System (IMS). *57th Eastern Snow Conference*, Syracuse, NY, 2000: ramsayECS57.

Ramsay, B. H. 1998. The Interactive Multisensor Snow and Ice Mapping System. *Hydrological Processes* 12: 1537-1546.

Ramsay, B. H. 1995. An Overview of NOAA/NESDIS's Interactive Multisensor Snow and Ice Mapping System. *Proceedings of 1995 First Moderate Resolution Imaging Spectrometer (MODIS) Workshop*, Greenbelt, MD, National Aeronautics and Space Administration Conference Publication 3318: 23-27.

Robinson, D.A. 2000. Weekly Northern Hemisphere snow maps: 1966-1999. *12th Conference on Applied Climatology*, Asheville, NC, American Meteorological Society. 12-15.

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.

Related Data Collections

NSIDC has many snow cover products. Three are closely related to the IMS: Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent Version 2 (Armstrong and Brodzik 2002), and Timing and Statistics of Autumn and Spring Annual Snow Cover for the Northern Hemisphere (Dye, 2005), which both make use of the quality controlled NOAA snow cover record beginning in 1966 (provided by Robinson), and Snow Data Assimilation System (SNODAS) Data Products at NSIDC (National Operational Hydrologic Remote Sensing Center 2004). The IMS product is one of several data sources for the NOHRSC SNODAS grids.

The Multisensor Analyzed Sea Ice Extent - Northern Hemisphere (MASIE-NH) product is based on this IMS product and provides measurements of daily sea ice extent and sea ice edge boundary for the Northern Hemisphere.

Additionally, NSIDC has many sea ice data products. Please refer to Sea Ice Products at NSIDC for a comparison of the products. The IMS product sea ice extent will be similar to that from passive microwave ice extent products, but the IMS also uses operational ice chart data, like those in Environmental Working Group Joint U.S.-Russian Arctic Sea Ice Atlas.

Other Related Data Collections

Analyses of a quality controlled and extended version of these data are available from Rutgers University Global Snow Lab.

NOAA SSD Snow and Ice Products Web site also provides browse images of the data on their IMS Products Web page.

Related Web Sites

- IMS Products Web page for the NIC IMS product.

6. Contacts and 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.

7. Document Information

Acronyms and Abbreviations

The acronyms used in this document are listed in Table 14.

Table 14. Acronyms and Abbreviations

Acronym	Description
ACNFS	Arctic Cap Nowcast/Forecast System
AMSU	Advanced Microwave Sounding Unit
ASCAT	Advanced Scatterometer
ASCII	American Standard Code For Information Interchange
AVHRR	Advanced Very High-Resolution Radiometer
BUFR	Binary Universal Form for the Representation of Meteorological Data
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
EDR	Environmental Data Record
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol
GCOM-W	Global Change Observation Mission - Water
GeoTIFF	Geospatial Tagged Image File Format
GFS	Global Forecast System

GIF	Graphics Interchange Format
GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellite
IDL	Interactive Data Language
IMS	Interactive Multisensor Snow and Ice Mapping System
JMA	Japan Meteorological Satellite
MIRS	(Operational) Microwave Integrated Retrieval System
MFG	Meteosat First Generation
MODIS	Moderate Resolution Imaging Spectrometer
MSG	Meteosat Second Generation
MTSAT-1R	Meteorological Satellite 1R
MTSAT-2	Meteorological Satellite 2
MVIRI	Meteosat Visible and Infrared Imager
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NIC	National Ice Center
NESDIS	NOAA National Environmental Satellite, Data, and Information Service
NH	Northern Hemisphere
NOAA	National Oceanic and Atmospheric Administration
NOHRSC	National Operational Hydrologic Remote Sensing Center
NSIDC	National Snow and Ice Data Center
OSDPD	Office of Satellite Data Processing and Distribution
OSPO	Office of Satellite Products and Operations
POES	Polar Operational Environmental Satellite
SAB	OSDPD SSD Satellite Analysis Branch
SAR	Synthetic Aperture Radar
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SNODAS	Snow Data Assimilation System
S-NPP	Suomi-National Polar-orbiting Partnership
SSD	OSDPD Satellite Services Division
SSM/I	Special Sensor Microwave/Imager
SSMIS	Special Sensor Microwave Imager/Sounder
USAF	United States Air Force
VIIRS	Visible Infrared Imaging Radiometer Suite

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. See the Document Revisions section for details.

Document Creation Date

December 2004

Document Revisions

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.

Document URL

http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html

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