AMSR-E/AMSR2 Unified L3 Global Monthly 25 km EASE-Grid Snow Water Equivalent, Version 1

USER GUIDE

How to Cite These Data

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

Tedesco, M. and J. Jeyaratnam. 2019. *AMSR-E/AMSR2 Unified L3 Global Monthly 25 km EASE-Grid Snow Water Equivalent, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/43NH9LHM9YRK. [Date Accessed].

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

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

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This AMSR-E/AMSR2 Unified Level-3 (L3) data set provides monthly estimates of snow water equivalent (SWE) derived from brightness temperature (T_b) measurements acquired by the Advanced Microwave Scanning Radiometer (AMSR) for EOS (AMSR-E) and AMSR2 instruments. SWE data are provided on the azimuthal 25 km Equal-Area Scalable Earth Grid (EASE-Grid) for both the Northern and Southern Hemisphere.

The data are generated from input T_bs which have been resampled by the Japan Aerospace Exploration Agency (JAXA) to intercalibrate, or unify, the AMSR-E and AMSR2 missions.

1.1 Parameters

Each data file contains gridded Snow Water Equivalent (SWE) estimates for the Northern Hemisphere (SWE_NorthernMonth) and Southern Hemisphere (SWE_SouthernMonth). The SWE values have a scale factor of 1 for the Northern Hemisphere and a scale factor of 2 for the Southern Hemisphere. The different scale factors reflect the different algorithms used for each hemisphere (see “Section 2.2.1 | Algorithms“).

Valid SWE parameter values are:

- 0-240: SWE values in millimeters (mm)
- 247: Incorrect spacecraft attitude
- 248: Off-earth
- 252: Land or snow impossible
- 253: Ice sheet
- 254: Water
- 255: Missing value

Data files also includes a gridded SWE flag data field for both hemispheres (Flags_NorthernMonth, Flags_SouthernMonth). The flag values are:

- 241: Non_validated
- 247: Incorrect_spacecraft_attitude
- 248: Off_earth
- 252: Land_or_snow_impossible
- 253: Ice_sheet
- 254: Water
- 255: No_Data

Lastly, an ancillary quality assurance text file is available that contains summary statistics.

1.2 File Information

1.2.1 Format

Data are provided in HDF-EOS5 (.he5) format and are stored as 8-bit unsigned integers. For software and more information, visit the HDF Group website. Additionally, there are two ancillary text files (.qa and .ph) and one ancillary .xml file included with the data. The .qa text file provides summary quality statistics for each data parameter. The .ph text file provides a list of the input data files. The .xml file provides file level metadata.

1.2.2 File Contents

As shown in the figure below, data files are organized into separate groups for the Northern Hemisphere and Southern Hemisphere that contain the corresponding data fields and latitude and longitude grids. The global attributes “CoreMetadata.0” and “StructMetadata.0” are stored in the “HDFEOS INFORMATION” group.

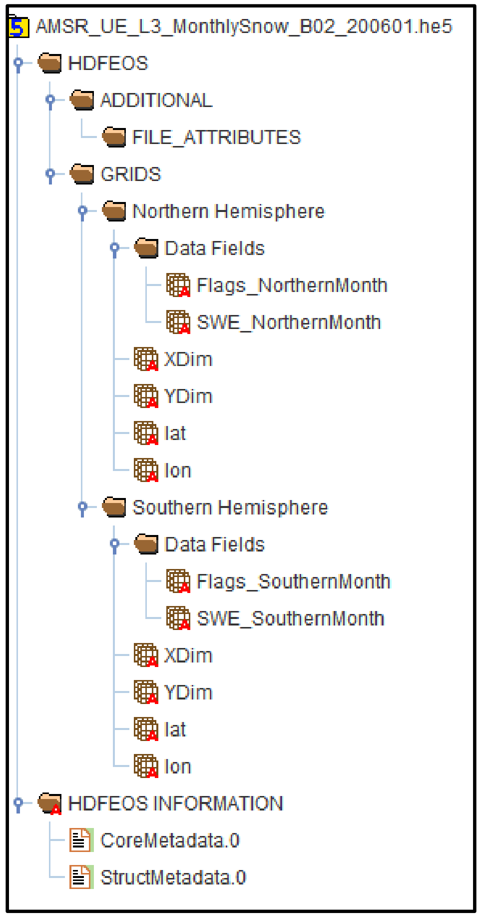

Figure 1. Monthly SWE HDF5 File Structure[1]

1.2.3 Naming Convention

Example

AMSR_UE_L3_MonthlySnow_B02_200601.he5

AMSR_U2_L3_MonthlySnow_B02_201207.he5

Naming Convention

AMSR_U[S]_L3_MonthlySnow_[X##]_[yyyymm].he5

The following tables describe the variables in the file naming convention:

[1] Data file displayed using HDFView.

Table 1. File Name Variables

Variable	Description
AMSR_U	AMSR Unified
S	Sensor code: E = AMSR-E; 2 = AMSR2
L3_MonthlySnow	Level-3 Global Monthly 25 km EASE-Grid Snow Water Equivalent product
X##	Product Maturity Code (X) and Version (##). See Table 2.
yyyymm	Four-digit year (yyyy), two-digit month (mm)
he5	HDF-EOS5 file format

Table 2. Product Maturity Code Variables

Variables	Description
B	Beta: Indicates a developing algorithm with updates anticipated.
T	Transitional: Indicates the period between Beta and Validated where the product is past the Beta stage, but not ready for validation. At this stage, the algorithm matures and stabilizes.
V	Validated: Products are upgraded to Validated once the algorithm is verified and validated by the science team. Validated products have an associated validation stage. For a description of the stages, refer to Table 2 in the Naming Conventions section of the AMSR Unified | Version History page.

1.3 Spatial Information

1.3.1 Coverage

North: 89.24° N

South: 89.24° S

East: 180° E

West: 180° W

Note that a small gap in coverage exists at the poles due to the path of the ascending and descending orbits. Known as the pole hole, this gap is consistent for both AMSR2 and AMSR-E data sets. For additional information see the AMSR-E Pole Hole page.

1.3.2 Resolution

25 km

1.3.3 Geolocation

Data are provided in the Northern Hemisphere and Southern Hemisphere 25 km EASE-Grid projections. See "A Guide to EASE Grids" for details.

Table 3. Projection Details

Region	Northern Hemisphere	Southern Hemisphere
Geographic coordinate system	Lambert Azimuthal Equal Area	Lambert Azimuthal Equal Area
Projected coordinate system	NSIDC EASE-Grid North	NSIDC EASE-Grid South
Longitude of true origin	0°	0°
Latitude of true origin	90° N	90° S
Scale factor at longitude of true origin	1	1
Datum	Unspecified datum based upon the International 1924 Authalic Sphere	Unspecified datum based upon the International 1924 Authalic Sphere
Ellipsoid/spheroid	International 1924 Authalic Sphere	International 1924 Authalic Sphere
Units	Meter	Meter
False easting	0	0
False northing	0	0
EPSG code	3408	3409
PROJ4 string	+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +a=6371228 +b=6371228 +units=m +no_defs	+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +a=6371228 +b=6371228 +units=m +no_defs
Reference	https://epsg.org/crs_3408/NSIDC-EASE-Grid-North.html	https://epsg.org/crs_3409/NSIDC-EASE-Grid-South.html

Table 4. Grid Details

Region	Northern Hemisphere	Southern Hemisphere
Grid cell size (x, y pixel dimensions)	25 km	25 km
Number of rows	721	721
Number of columns	721	721
Geolocated lower left point in grid	-9036843.073845, -9036843.073845	-9036843.073845, 9036843.073845
Nominal gridded resolution	25 km	25 km
Grid rotation	N/A	N/A
ulxmap – x-axis map coordinate for the upper-left pixel	-9036843.073845	-9036843.073845
ulymap – y-axis map coordinate for the upper-left pixel	9036843.073845	9036843.073845

1.3.3.1 Geolocation Tools

For this EASE-Grid product, two .tar files—“Nl_geolocation.tar” and “Sl_geolocation.tar”—are available via FTP that contain map projection parameters (.mpp files), grid parameter definitions (.gpd files), and latitude/longitude binary files that can be read by software packages such as C, FORTRAN, and IDL.

1.3.3.2 Land Masks

A 25 km Northern Hemisphere land mask called amsr_gsfc_25n.hdf and a 25 km Southern Hemisphere land mask called amsr_nic_25s.hdf are available for use with this product. These masks are available via FTP.

1.4 Temporal Information

1.4.1 Coverage

20 June 2002 thru 3 October 2011 (AMSR-E)

02 July 2012 to 31 August 2025 (AMSR2)

1.4.2 Resolution

Monthly

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The purpose of the AMSR Unified Project is to provide the science community with intercalibrated data spanning both the AMSR-E and the AMSR2 data records. To accomplish this task, JAXA resamples Level-1 (L1) observations acquired by the instruments to create unified Level-1R (L1R) T_bs. SWE grids are constructed from resampled data because averaging would dilute the signal due to the nonlinear influence of the atmosphere on T_bs.

The L1 data consist of T_b swath observations with sensor footprints (i.e., instantaneous fields of view) that vary with frequency. Using a Backus-Gilbert method, the input T_bs are remapped to sets of observations with consistent footprint sizes—each set corresponds to a footprint at one frequency and contains that frequency plus all higher-resolution frequencies. As such, the number of channels varies in each set.

The JAXA Level 1R documentation and Maeda et al. (2016) describe this process in more detail.

2.2 Processing

The algorithm described in Tedesco and Jeyaratnam (2016) is used to estimate SWE for the Northern Hemisphere, while the AMSR-E Snow Depth Algorithm described in Kelly (2009) is used for the Southern Hemisphere. The following sections outline the different approaches.

2.2.1 SWE Processing for the Northern Hemisphere

The Northern Hemisphere SWE algorithm utilizes climatological data, an electromagnetic model (also known as a snow emission model), and artificial neural networks to estimate snow depth and compute a spatio-temporal dynamic density scheme that converts snow depth to SWE.

The steps can be summarized as follows:

1. Create a training dataset for use with Artificial Neural Networks (ANNs). A training dataset is required for tuning the Artificial Neural Network (ANN). The training dataset is obtained using the inputs and outputs of the TKK electromagnetic model (Pulliainen, 2006) and consists of simulated T_bs and the corresponding snow depth, snow density, and near-surface temperature inputs. Training is performed using a back propagation algorithm (Tedesco, 2004).
2. Estimate snow grain size using Artificial Neural Networks (ANNs). Snow grain size estimates are obtained from two Artificial Neural Network (ANNs) trained with the TKK electromagnetic model; one ANN for grain size estimates using 36.5 GHz T_b values and a second ANN for grain size estimates using both 18.7 and 36.5 GHz T_b values. Two

different grain size values are used to account for the different penetration depths of the microwave frequencies within the snowpack and the vertical distribution. The ANN used here is a feed forward network (Haykin, 1999) with one hidden layer containing four neurons. This optimal ANN architecture was chosen by comparing the performance of different architectures using the root mean square error (RMSE) between measured and estimated surface T_bs at 18.7 GHz and 36.5 GHz, using both horizontal and vertical polarization channels.

3. Compute retrieval coefficients. Retrieval coefficients relate T_b at different frequencies to snow depth and are computed using estimates of the effective grain size obtained from the ANNs. The retrieval coefficient values are calculated using the equations specified in Section 3.2.1 of Tedesco and Jeyaratnam (2016).
4. Convert snow depth to SWE. Snow depth estimates from retrieval coefficients are converted to SWE using temporally and spatially varying snow density maps (Sturm et al, 2010).
5. Create daily grids by mapping SWE estimates to the 25 km EASE grid. Multiple overpasses in the same grid cell are screened for consistency based on statistical tests. Monthly grids are then produced by computing the mean of all daily SWE values in each grid cell.

2.2.2 SWE Processing for the Southern Hemisphere

In the Southern Hemisphere, the AMSR-E Snow Depth Algorithm uses a three-step process: identify the presence of snow; estimate snow depth at the location; convert snow depth to SWE.

This is achieved by constructing a mean January-to-March global snow density map, using the Canadian data of Brown and Braaten (1998) and the Russian snow survey data of Krenke (1998), and interpolating the seasonal snow classifications system of Sturm et al. (1995). SWE is then computed as the product of depth and density. Both SWE and depth processing streams require calibrated Tb measurements at 10 GHz, 18 GHz, 23 GHz, and 89 GHz, as well as ancillary land cover data. See Kelly (2009) for a detailed description of the AMSR-E snow depth algorithm.

As in the Northern Hemisphere, the value recorded in a grid cell is the mean daily SWE value for the given month.

2.3 Quality, Errors, and Limitations

2.3.1 Assessment

Each HDF-EOS5 data file contains core metadata with Quality Assessment (QA) metadata flags that are set by the operational processing code run by the AMSR Science Investigator-led Processing System (SIPS) prior to delivery to NSIDC. These metadata are also available as a separate XML file.

Three levels of QA are applied to AMSR-E and AMSR2 files: automatic, operational, and science QA. If a file/granule passes automatic and operational QA, the file is forwarded to NSIDC for archive and distribution. If not, the issue is resolved and the file is reprocessed.

Science QA is performed automatically during processing, but only reviewed closely after-the-fact, if questions arise after processing is complete. The three QA stages are described in more detail below.

2.3.2 Automatic QA

Out-of-bounds L1R T_bs are screened out before T_bs are interpolated to the 25 km grid.

2.3.3 Operational QA

AMSR2 L1R data are subject to operational QA by JAXA prior to arriving at the AMSR SIPS for processing to higher level products. Operational QA varies by product, but it typically checks for the following criteria in a given file (Conway 2002):

- File is correctly named and sized
- File contains all expected elements
- File is in the expected format
- Required EOS fields of time, latitude, and longitude are present and populated
- Structural metadata are correct and complete
- File is not a duplicate
- HDF-EOS5 version number is provided in the global attributes
- Correct number of input files were available and processed

2.3.4 Science QA

In the SIPS environment, as part of the processing code, the science QA includes checking the maximum and minimum variable values, and the percentage of missing data and out-of-bounds data per field. At the Science Computing Facility (SCF), co-located with the SIPS, post-processing science QA involves reviewing the operational QA files and browse images, and performing the following additional QA procedures:

- Comparisons with historical data
- Detection of errors in geolocation
- Verification of calibration data
- Detection of trends in calibration data
- Detection of large scatter among data points that should be consistent.

Several tools have been developed to aid in the QA process of the Level 3 AMSR2 products. The AMSR SIPS provides software that creates a QA browse image in Portable Network Graphics

(.png) format that can be used for visual QA. The team lead SCF (TLSCF) provides metadata and QA software specific to each product; these software generate the metadata files discussed above and a QA summary report in text format. The products of these tools are provided to NSIDC along with each data granule.

3 REFERENCES

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4 DOCUMENT INFORMATION

4.1 Publication Date

October 2018

4.2 Date Last Updated

October 2025