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

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. This data set also includes an ancillary quality assurance text file that provides summary statistics for the values included in this field.

Valid parameter values include:

- 0-240: SWE values in millimeters (mm)
- 247: Incorrect spacecraft attitude
- 248: Off-earth
- 252: Land/Snow impossible
- 253: Ice
- 254: Water
- 255: Missing or out-of-bounds data

Each data file also includes a gridded parameter flag field for the Northern Hemisphere (Flags_NorthernMonth) and Southern Hemisphere (Flags_SouthernMonth). The values included in this field are the same as the values in the SWE parameter field with the exception of value 241: Snow Possible. The Snow Possible flag shows all grid cells containing values within the valid SWE data range; 0 and 240 mm.

Valid flag values include:

- 241: Snow possible
- 247: Incorrect spacecraft attitude
- 248: Off-earth
- 252: Land/Snow Impossible
- 253: Ice
- 254: Water
- 255: Missing or out-of-bounds data

The different scale factors for the two hemispheres are due to the fact that two different algorithms are used, for further details see section 2.2.1

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.

1.2.2 File Contents

As shown in the figure below, each data file includes two data fields for the Northern Hemisphere and Southern Hemisphere, and two metadata fields (CoreMetadata and StructMetadata).

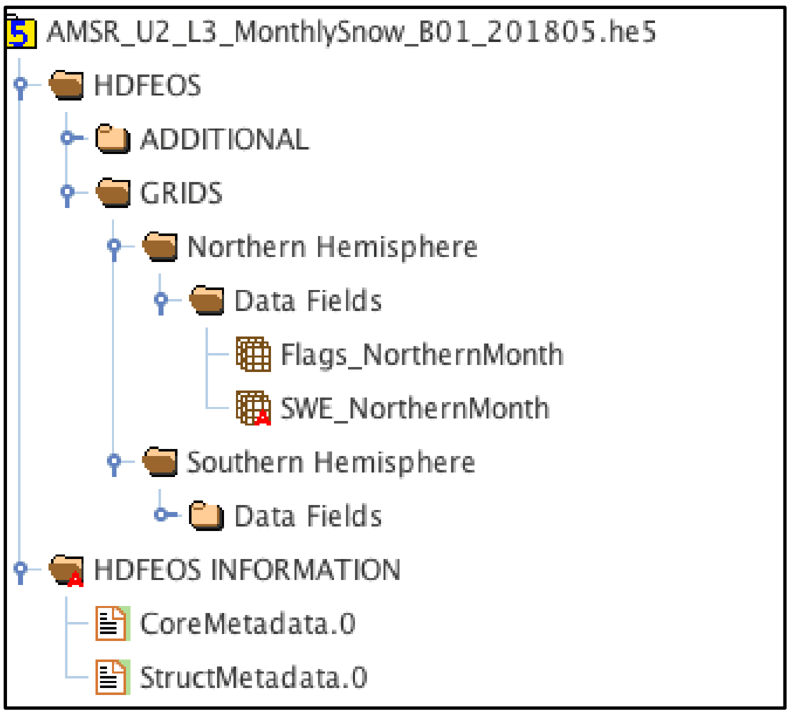

Figure 1. Fields included in this data set as displayed with HDFView software.

1.2.3 Ancillary Data

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.

1.2.4 Naming Convention

Files are named according to the following convention and as described in the tables below.

Example 1: `AMSR_U2_L3_MonthlySnow_X##_yyyymmdd.he5`

Table 1. File Name Variables

Variable	Description
AMSR	Advanced Microwave Sounding Radiometer
U2	Unified AMSR2 data
L3	Level-3 data
MonthlySnow	Monthly SWE data
X##	Product Maturity Code and Version
yyyy	Four-digit year
mm	Two-digit month
dd	Two-digit day
he5	HDF-EOS5 file format

Example 2: `AMSR_U2_L3_MonthlySnow_B01_20180625.he5`

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

The total coverage for this product is the Northern and Southern Hemisphere, from 89.24° S to 89.24° N and from 180° E to 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

The nominal spatial resolution is 25 km.

1.3.3 Geolocation

Projection

Data are provided in Northern Hemisphere and Southern Hemisphere EASE-Grid projections. For details, please see the NSIDC EASE-Grid.

Grid Description

Grids are 721 rows x 721 columns. For details about the EASE-Grid projections, related products, and tools, see the NSIDC EASE-Grid website.

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	http://epsg.io/3408	http://epsg.io/3409

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, the .tar files Nl_geolocation.tar and Sl_geolocation.tar contain geolocation tools. These tools include map projection parameters (.mpp files), grid parameter definitions (.gpd files), latitude/longitude binary files, and conversion software such as C, FORTRAN (FORmula TRANslation), and IDL (Interactive Data Language). These .tar files are available via FTP.

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

The temporal coverage of this data set extends from 01 Dec 2012 to the present.

1.4.2 Resolution

Monthly

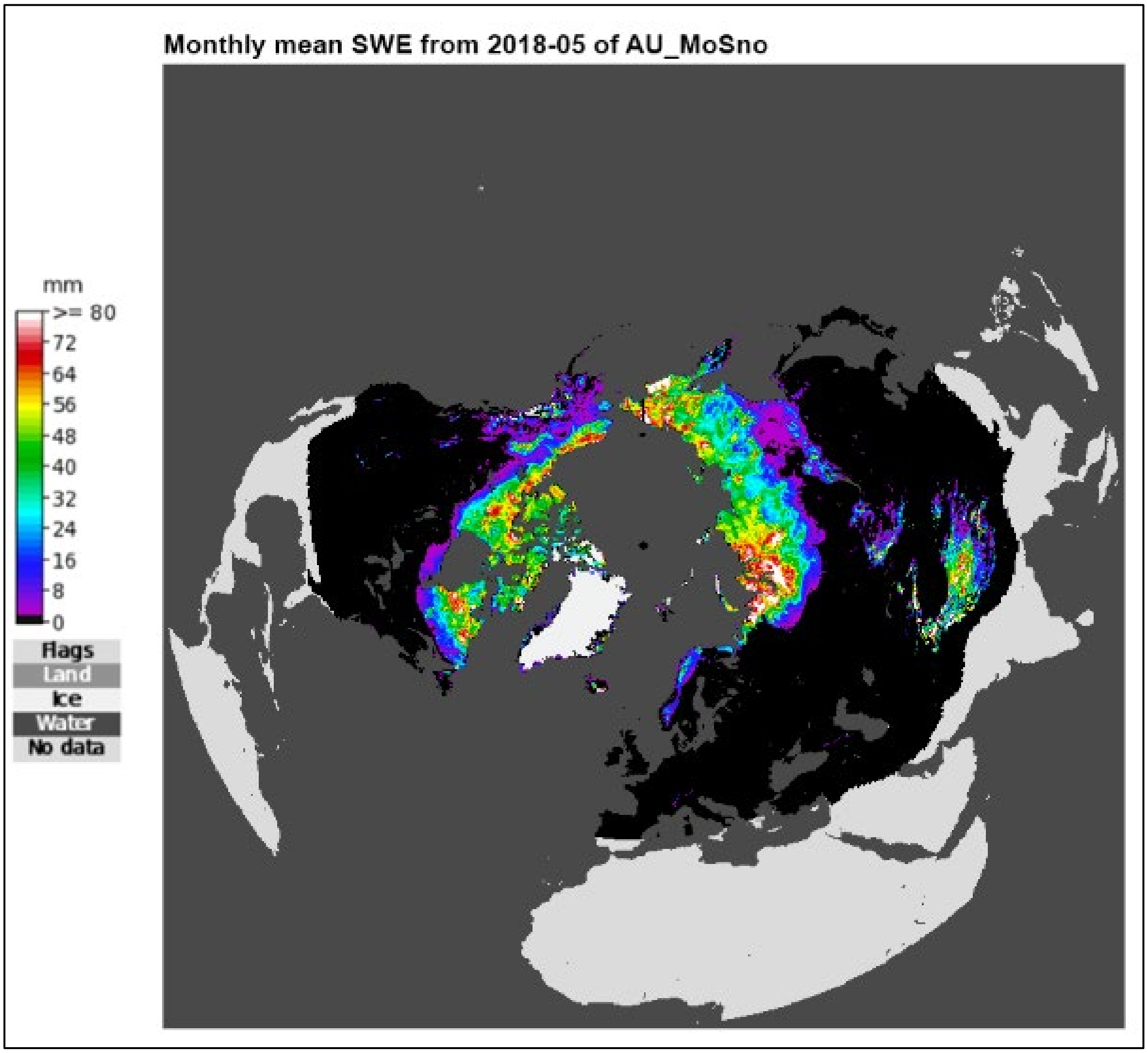

Figure 2. AMSR2 Northern Hemisphere 25 km monthly mean SWE from 2018-05

2 DATA ACQUISITION AND PROCESSING

2.1 Background

This AMSR Unified SWE product is produced using data collected by the Advanced Microwave Scanning Radiometer (AMSR-E) on board the Aqua satellite from June 2002 to October 2011, and from the Advanced Microwave Scanning Radiometer 2 (AMSR2) on board the JAXA GCOM-W1 satellite from July 2012 to the present. The purpose of the AMSR Unified Data Set is to provide the science community with intercalibrated climate products from both the AMSR-E and the AMSR2 instruments. To accomplish this task, JAXA is providing AMSR-E L1R Brightness Temperatures (T_bs), equivalent in content to the AMSR2 L1R T_bs.

The Level-1R input data consist of resampled T_bs. The T_b sensor footprints (instantaneous fields of view) vary with frequency. Resampling remaps the T_bs to sets of consistent footprint sizes using a Backus-Gilbert method. Each resampled set corresponds to the footprint of one frequency and contains that frequency plus all higher-resolution frequencies. Therefore, the number of channels in each resampled set of T_bs varies. See JAXA Level 1R documentation or Maeda et al. (2016) for more information.

Note: The NASA AMSR Unified SWE dataset (AU_MoSno) at the National Snow and Ice Data Center (NSIDC DAAC) presently includes SWE data derived from AMSR2 L1R T_bs. In the future AU_MoSno will also include SWE data derived from AMSR-E L1R T_bs.

2.2 Processing

SWE grids are derived from JAXA AMSR2 L1R resampled T_bs. These observations are equivalent to JAXA AMSR-E L1R T_bs, thus enabling consistent T_b measurements to be used across the JAXA AMSR2 and JAXA AMSR-E SWE products. The use of swath T_bs instead of averaged T_bs is important because atmospheric influence on T_bs is nonlinear, and the use of averaged T_bs would dilute the atmospheric signal.

2.2.1 Algorithms

The current operational SWE algorithm, also known as the Columbia AMSR Snow Water Equivalent (CASWE) algorithm is being used to estimate SWE data for the Northern Hemisphere. The AMSR-E Snow Depth Algorithm described in Kelly (2009) is being used to estimate SWE data for the Southern Hemisphere.

2.2.2 SWE Processing for the Northern Hemisphere

The operational SWE algorithm (Tedesco-Jeyaratnam, 2016) utilizes climatological data, an electromagnetic model; also known as a snow emission model, and artificial neural networks for estimating snow depth as well as a spatial-temporal dynamic density scheme to convert snow depth to SWE. A summary of the processing steps is provided below.

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-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 SWE grids: After the algorithm is run on the AMSR2 JAXA L1R T_b data, daily SWE estimates are mapped to a 25 km EASE grid. The gridding is performed using the drop-in-the-bucket process. The monthly files are then produced from the daily files.

2.2.3 SWE Processing for the Southern Hemisphere

The AMSR-E Snow Depth Algorithm estimates SWE using a three-step process: first, the presence of snow is detected; second, the depth of snow present is estimated; and third, snow depth estimates are converted to SWE. This is achieved through the construction of a mean January to March global snow density map, which was created using the Canadian data of Brown and Brazen (1998), and the Russian snow survey data of Krenke (1998), and interpolated to the seasonal snow classifications system of Sturm et al. (1995). SWE is then the product of depth and density. Both SWE and depth processing streams require calibrated T_b 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.

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. A separate metadata file in .xml format is also delivered to NSIDC with the HDF-EOS5 file.

This file contains the same quality assessment (QA) metadata flags as the core metadata contained in the HDF-EOS5 file. Three levels of QA are applied to AMSR2 files: automatic, operational, and science QA. If a file/granule passes automatic QA 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 nominal processing, but only reviewed (closely, after-the-fact) in conjunction with questions that 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 (Conway 2002):

- 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.

2.3.5 Anomalies

Refer to the AMSR2 LANCE Anomalies Page web page for information regarding data anomalies or gaps in coverage.

2.4 Instrumentation

2.4.1 Description

For a detailed description of the AMSR2 instrument, refer to the AMSR2 Channel Specification and Products web page.

3 CONTACTS AND ACKNOWLEDGMENTS

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4 REFERENCES

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5 DOCUMENT INFORMATION

5.1 Publication Date

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5.2 Date Last Updated

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