AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures, Version 4

USER GUIDE

How to Cite These Data

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

Ashcroft, P. and F. J. Wentz. 2019. *AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures, Version 4*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/YL62FUZLAJUT. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/AE_L2A

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1 DATA DESCRIPTION

1.1 Parameters

As shown in the list below, each data file contains Low Res Swath brightness temperature (Tb) fields, High Res Swath A Tb fields, High Res Swath B Tb fields, ancillary parameter fields, and geolocation fields. See the Appendix to access a detailed description of the file parameter contents and global attributes.

- Low Res Swath Data Fields
- High Res A Swath and High Res B Swath Data Fields
- Geolocation Fields
- Global Attributes

Note, Level-2A files contain data elements transferred directly from Level-1A antenna temperatures. For more information on the L1 data fields transferred to L2A, see the AMSR-E/Aqua L1A Raw Observation Counts, Version 3 user guide.

Missing brightness temperature data are indicated by 0. Antenna temperature coefficients, effective hot load temperatures, calibration counts, and antenna coefficients are only provided for users who want to see how brightness temperatures were calculated for this data set. They are not required to view brightness temperatures.

Antenna temperature coefficients are stored as three-dimensional arrays, such as 185,12,3. The first array value (185) indicates the number of scans per swath. Each row in the data set table represents a scan. The second array value (12) indicates the number of data set variables. Each column in the data set table represents a variable. The third array value (3) indicates there are 3 coefficient parameters; slope, offset, and a quadratic term. The values for each of these parameters are provided in the data set tables.

For data with scale and offset values, the data values can be obtained with the following equation:

- data value in units = (stored data value * scale factor) + offset
- T_b (kelvin) = (stored data value * 0.01) + 327.68

Scaling factors and offsets are provided in the variable attributes of each HDF-EOS file. Since scaling factors can vary by file, its recommended that users check each file to ensure that the correct values are being applied in the conversion equation.

1.2 File Information

1.2.1 Format

Data are in HDF-EOS 32-bit signed integer format. For software and more information, visit the HDF-EOS website.

1.2.2 File Contents

Each half-orbit granule is approximately 58 MB using HDF compression.

The daily data rate is approximately 2.5 GB. Each half-orbit granule is approximately 58 MB using HDF compression.

1.2.3 Naming Convention

This section explains the file naming convention used for this product with an example. The date and time correspond to the first scan of the granule.

Example file names:

```
AMSR_E_L2A_BrightnessTemperatures_V13_200206010011_D.hdf
```

```
AMSR_E_L2A_BrightnessTemperatures_X##_yyyymmddhhmm_f.hdf
```

Refer to Table 1 for the valid values for the file name variables listed above.

Table 1. Valid Values for the File Name Variables

Variable	Description
X	Product Maturity Code
##	file version number
yyyy	four-digit year
mm	two-digit month
dd	two-digit day
hh	hour, listed in UTC time, of first scan in the file
mm	minute, listed in UTC time, of first scan in the file
f	orbit direction flag (A = ascending, D = descending)
hdf	HDF-EOS data format

Table 2. Valid Values for the Product Maturity Code

Product Maturity Code	Description
P	Preliminary - refers to non-standard, near-real-time data available from NSIDC. These data are only available for a limited time until the corresponding standard product is ingested at NSIDC.
B	Beta - indicates a developing algorithm with updates anticipated.
T	Transitional - period between beta and validated where the product is past the beta stage, but not quite ready for validation. This is where the algorithm matures and stabilizes.
V	Validated - products are upgraded to Validated once the algorithm is verified by the algorithm team and validated by the validation teams. Validated products have an associated validation stage. Refer to Table 3 for a description of the stages.

Table 3. Validation Stages

Validation Stage	Description
Stage 1	Product accuracy is estimated using a small number of independent measurements obtained from selected locations, time periods, and ground-truth/field program efforts.
Stage 2	Product accuracy is assessed over a widely distributed set of locations and time periods via several ground-truth and validation efforts.
Stage 3	Product accuracy is assessed, and the uncertainties in the product are well-established via independent measurements made in a systematic and statistically robust way that

Table 4 provides examples of file name extensions for related files that further describe or supplement data files.

Table 4. Related File Extensions and Descriptions

Extensions for Related Files	Description
.jpg	Browse data
.qa	Quality assurance information
.ph	Product history data

.xml	Metadata files

1.3 Spatial Information

1.3.1 Coverage

The coverage is global between 89.24°N and 89.24°S.

See the AMSR-E Pole Hole document for a description of holes that occur at the North and South Poles.

Figure 1 shows a map of a typical day of coverage with 28 half-orbits.

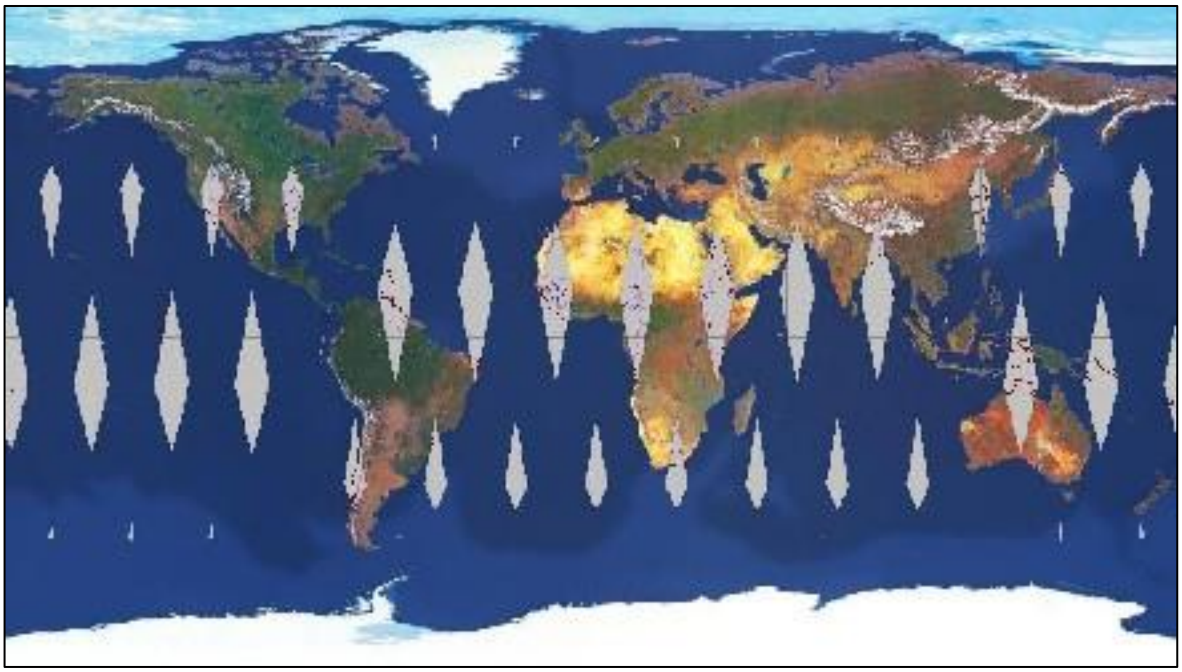

Figure 1. Spatial Coverage Map

1.3.2 Resolution

Data are resampled to spatial resolutions ranging from 5.4 km to 56 km. The sampling interval at the Earth's surface is 10 km for all channels. The 89.0 GHz channel also contains data sampled to 5 km. Please see 89 GHz Scan Spacing for a figure that illustrates A and B scan interleaving.

All channels are available at an unsampled Level-1B resolution. The higher-resolution channels are resampled to correspond to the footprint sizes of the lower-resolution channels. The Level-2A algorithm spatially averages the multiple samples of the higher-resolution data into the coarser resolution Instantaneous Field of View (IFOV) of the lower-resolution channels with the Backus-Gilbert method. The resulting brightness temperatures are called effective observations in contrast to the original or actual observations. The following table summarizes these relationships (Marquis et al. 2002):

Table 5. Spatial Characteristics of Observations

Resolution	**Footprint size**	**Mean spatial resolution**	**Channels**					
			89.0 GHz	**36.5 GHz**	**23.8 GHz**	**18.7 GHz**	**10.7 GHz**	**6.9 GHz**
Res.1_TB*	75 km x 43 km	56 km	•	•	•	•	•	• o
Res.2_TB*	51 km x 29 km	38 km	•	•	•	•	• o	
Res.3_TB*	27 km x 16 km	21 km	•	•	• o	o		
Res.4_TB*	14 km x 8 km	12 km	•	o				
Res.5A_TB*	6 km x 4 km	5.4 km	o					

• Includes Level-2A (smoothed) data
o Includes Level-1B (un-smoothed) data at original spatial resolution
* Specified in the T_b parameter naming convention to provide a channel reference key.

1.3.3 Geolocation

Aqua's position, velocity, and attitude vectors are given in terms of the J2000 inertial coordinate system. To compute Earth latitudes and particularly longitudes, it is necessary to compute the Earth rotation relative to the J2000 systems. The proper calculation requires using the UT1 time, which can be as much as one second different from UTC time. To obtain UT1, the Level-2A algorithm accesses the U.S. Naval Observatory database each day to obtain the current UT1. One advantage of this procedure is that it is independent of leap seconds; therefore, there is no discontinuity in the geolocation parameters when a leap second occurs.

A separate geolocation analysis was done for each channel, which showed that for a given frequency the v-pol and h-pol channels are well aligned. The 7 and 11 GHz channels were resampled to match the locations of the higher frequencies since it was determined that the 7-GHz and 11-GHz horns are pointing in a slightly different direction than the 19, 23, and 37 GHz horns. This required re-deriving the sampling weights with the center of the target cell positioned at the location of the 19 GHz Channel rather than at the 7 or 11 GHz footprint position. One drawback is that the un-resampled 7 and 11 GHz observations are missing an exact specification of latitudes and longitudes.

Note: Due to this correction the un-resampled 7 and 11 GHz observations are missing an exact latitude and longitude specification.

1.4 Temporal Information

1.4.1 Coverage

01 June 2002 to 04 October 2011

1.4.2 Resolution

Daily

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

2.1.1 Data Source

AMSR-E/Aqua L1A Raw Observation Counts are used as input to calculating the Level-2A brightness temperatures.

2.2 Derivation Techniques and Algorithms

The objective of the Level-2A algorithm is to bring the Level-1A antenna temperatures to a set of common spatial resolutions using a set of weighted coefficients. The algorithm resamples Level-1A antenna temperatures and converts them to Level-2A brightness temperatures.

The resampled antenna temperature (T_{ac}) is defined as a weighted sum of observed antenna temperatures (T_{ai}):

$$T_{ac} = \sum_{i=1}^{N} a_i \, T_{ai}$$

Equation 1

Where:

a_i = weighting coefficients

Antenna temperature observations are corrected for cold-space spillover and cross-polarization effects to obtain brightness temperatures averaged over the normalized crossover-polarization antenna pattern. The observed brightness temperatures (T_{bi}) are expressed as:

$$T_{bi} = \int T_b\,(\rho) G_i(\rho) dA$$

Equation 2

Where:

$T_b(\rho)$ = brightness temperature at location ρ

$G_i(\rho)$ = antenna gain pattern corresponding to the specific observation

Each Level-2A (effective) observation within a single instrument scan is calculated using coefficients that describe the relative weights of the neighboring Level-1A (actual) observations. Coefficients are unique for every position along the instrument scan, yet they do not vary from scan to scan. The Backus-Gilbert method produces the weighting coefficients for Level-1A data. Antenna patterns and relative geometry are known a priori, allowing weighting coefficients to be calculated before observations are collected. Although the Backus-Gilbert method can, in principle, be used to construct effective observations corresponding to gain patterns either smaller or larger than those in the actual observations, the noise amplification from smaller gain patterns (deconvolution) is typically very high.

Calculation of weighting coefficients requires specification of the shape of the target pattern, the location of the target pattern relative to the actual measurements, the set of actual observations used, and the smoothing parameter for each constructed observation. Actual observations within an 80 km radius of the constructed pattern are considered for possible contributors to the construction. Observations that are too far from the target pattern to play a role in the construction are assigned a weight of zero by the algorithm. Weighting coefficients are computed based on a simulation of the antenna patterns for a portion of a circular orbit around a spherical earth.

The smoothing factor at each point across the scan of each Level-2A data set is chosen in the following way: The algorithm applies the same amount of smoothing at the center to observations close to the edges. This ensures that noise decreases as the spatial density of the actual observations increases toward the edges. For construction of observations at the extreme edges, sufficient smoothing is added to keep noise at the edges from exceeding the noise at the center. For a given Level-1A channel, noise decreases as the resolution of the constructed pattern becomes larger, and the number of useful actual observations increases (Ashcroft and Wentz 2000).

2.3 Processing

The algorithm reads an entire file (one half orbit) of Level-1A data at a time and uses calibration coefficients to convert antenna temperatures to brightness temperatures. Coefficients embedded in the data are discarded, and new values are calculated. The algorithm applies weighting coefficients from a table of values to resample the Level-1A data using Equation 1, specified above. The weighting coefficients corresponding to each constructed observation are stored as a 29 x 29 array, which applies weights to actual observations ± 14 scans and ± 14 locations along the scan from the constructed observation. Most of the coefficients in the array are zero. In an ideal case, weighting coefficients are applied to each corresponding constructed target pattern within the scan. Level-1A data produce unsmoothed Level-1B brightness temperatures and smoothed Level-2A brightness temperatures using Equation 2 (Ashcroft and Wentz 2000).

2.3.1 Adjustment to Match the 89A and 89B Observations During Resampling

When the 89 GHz Channels are resampled to lower spatial resolutions, the observations from the A-horn and the B-horn are combined. However, the incidence angles for these two horns are different with the B-horn incidence angle being about 0.6 degrees smaller than the A-horn. To compensate for the difference in incidence angle, the following adjustments were made to the A-horn measurements before resampling

$$T_{AV,adj} = 0.130671 + 0.99325T_{AV}$$

Equation 3A

$$T_{AH,adj} = 0.472994 + 0.992742T_{AH}$$

Equation 3B

These expressions were found from doing linear regression of actual A-horn and B-horn observations over the first two mission years of AMSR-E.

2.3.2 Geolocation

Aqua's position, velocity, and attitude vectors are given in terms of the J2000 inertial coordinate system. To compute Earth latitudes and particularly longitudes, it is necessary to compute the Earth rotation relative to the J2000 systems. The proper calculation requires using the UT1 time, which can be as much as one second different from UTC time. To obtain UT1, the Level-2A algorithm accesses the U.S. Naval Observatory database each day to obtain the current UT1. One advantage of this procedure is that it is independent of leap seconds; therefore, there is no discontinuity in the geolocation parameters when a leap second occurs.

A separate geolocation analysis was done for each channel, which showed that for a given frequency the v-pol and h-pol channels are well aligned. The 7 and 11 GHz channels were resampled to match the locations of the higher frequencies since it was determined that the 7-GHz and 11-GHz horns are pointing in a slightly different direction than the 19, 23, and 37 GHz horns. This required re-deriving the sampling weights with the center of the target cell positioned at the location of the 19 GHz Channel rather than at the 7 or 11 GHz footprint position. One drawback is that the un-resampled 7 and 11 GHz observations are missing an exact specification of latitudes and longitudes.

Note: Due to this correction the un-resampled 7 and 11 GHz observations are missing an exact latitude and longitude specification.

2.4 Calibration

2.4.1 Intercalibration with GMI, and TMI

All AMSR-E calibration parameters have been re-derived so that brightness temperatures are consistent within the 14 microwave radiometer constellation: GMI, WindSat, AMSR-2, TMI, AMSR-E, SSMI(S) F08, F10, F11, F13, F14, F15, F16, F17, F18. The Global Precipitation Measurement Microwave Imager (GMI) was launched in 2014 and provides the most advanced radiometer calibration to date. GMI's absolute calibration provided the starting point for RSS Version 8 intercalibration, and GMI's inclined orbit provides many coincident collocations with other sensors. The Tropical Rainfall Measuring Mission Microwave Imager (TMI) overlapped AMSR-E for the entirety of its main mission of 9 plus years. Direct comparisons with TMI collocations bring AMSR-E to a high degree of consistency with other sensors.

2.4.2 Calibration with improved Ocean Radiative Transfer Model

The Ocean-Atmosphere Radiative Transfer Model (OA-RTM) is used as a sensor calibration target, specifically to overcome the difficulties posed by hot load calibration targets. The OA-RTM was introduced in RSS Version-7 and refined in RSS Version-8. Behavior parameters for each sensor are derived so that each sensor's observations are consistent with the OA-RTM.

The OA-RTM provides a consistent and stable target for deriving the calibration parameters which describe the behavior of each sensor. Cool ocean scenes also provide a range of temperature values which help specify non-linearities in calibration curves. A significant advantage of this approach is that all sensors use literally the exact same calibration target, and it does not change over time.

The Global Precipitation Measurement Microwave Imager (GMI) largely validated the accuracy of the RSS Version-7 OA-RTM, but also revealed some residual errors that led to improving the atmospheric component of the OA-RTM in RSS Version 8. Specifically, the water vapor continuum and oxygen continuum were revised and the width of the 22-GHz water vapor line was reduced by about 4%.

2.4.3 Calibration with improved Land Radiative Transfer Model

The Rain Forest Radiative Transfer Model (RF-RTM) is used to compare emissions predicted by the land model to actual AMSR-E observations. This model focuses on warm rainforest scenes and is limited to calibration sites located in heavily canopied rainforest areas. Rainforest scenes provide some of the most stable, and least variable calibration targets among Earth's warm scenes. The RF-RTM model is based on well calibrated GMI observations and provides the best estimate of rainforest emissivity to date, resulting in better warm scene accuracy.

2.4.4 Calibration for Cold Load

The sensor employs a cold mirror to obtain space emission for cold load calibration. Corrections are done when there is lunar radiation entering the cold mirror.

2.4.5 Other Calibrations

The Antenna Pattern Coefficients (APC) were adjusted for cross-polarization and spillover and the 18.7 GHz center observation frequency was shifted back to nominal.

> Note: RSS Version 7 updates are included in AE_L2A Version 3 and RSS Version 8 updates are included in AE_L2A Version 4.

2.5 Quality, Errors, and Limitations

2.5.1 Error Sources

The Level-2A data set includes unsmoothed Level-1B data derived from antenna temperatures. See the AMSR-E Instrument Description document for a description of the error sources associated with radiometer calibration.

Error on a constructed brightness temperature observation arises from two sources. The first source of error is a mismatch between the ideal antenna pattern and the construction, and the second is random measurement error. The variance of a constructed brightness temperature is independent of the actual temperature field, depending only on the weighting coefficients and the observation error of each observed brightness temperature. The effect of random measurement error is more easily quantified than the effect of fit error. Increased smoothing reduces the noise factor but degrades the fit. This tradeoff is most noticeable at the edges of the scan. Fit and noise factor near the center of the scan are optimized for fit. As a result of the spatial averaging that produces the Level-2A data, errors of neighboring observations within any single channel are somewhat correlated. Errors between channels are not correlated in any case. While the Level-2A data set is well-suited for applications that require a combination of multiple channels of observations, the user should recognize that errors pertaining to observations within a single channel are not necessarily independent (Ashcroft and Wentz 2000).

2.5.1.1 Along-Scan Error

An along-scan error is caused by AMSR-E's cold mirror or warm load entering the FOV of the feedhorns, or by the main reflector seeing part of the spacecraft. RSS performed an analysis of the AMSR-E along-scan error and developed a correction. RSS version 8 has enhanced corrections through the use of the RF-RTM to improve performance over rainforests. Based on previous NSIDC analysis, Antarctica is a region subject to bias at the beginning of scan lines even after corrections are applied. RSS version 8 may or may not address this bias, so users are still advised to use caution in this region.

2.5.1.2 Geolocation Error

The un-resampled 6.9 and 10.7 GHz observations are missing an exact specification of latitudes and longitudes.

2.5.2 RFI Flagging

When the RFI angle is less than 12 degrees the observation should be flagged as RFI contaminated. However, in the North Sea, the RFI is particularly strong. For this region, an RFI angle of 17 degrees is the threshold.

2.6 Assessment

Each HDF-EOS file contains core metadata with Quality Assessment (QA) metadata flags that are set by the Science Investigator-led Processing System (SIPS) at the Global Hydrology Resource Center (GHRC) prior to delivery to NSIDC. A separate metadata file with an .xml file extension is also delivered to NSIDC with the HDF-EOS file; it contains the same information as the core metadata. Three levels of QA are conducted with the AMSR-E Level-2 and -3 products: automatic, operational, and science QA. If a product does not fail QA, it is ready to be used for higher-level processing, browse generation, active science QA, archive, and distribution. If a granule fails QA, the SIPS does not send the granule to NSIDC until it is reprocessed. Level-3 products that fail QA are never delivered to NSIDC (Conway 2002). Only a QA file is produced when there are no Level-2A brightness temperature data that qualify for retrieval.

2.6.1 Automatic QA

The Level-2A data files contain data flags set by JAXA for the Level-1A files and flags set by RSS. RSS quality assessment is performed when Level-2A files are generated. Resampled observations are generated wherever a valid Level-1A observation exists. This occurs when the Level1A_Scan_Chan_Quality_Flag is acceptable, and the actual observation at that location is within a plausible range. If neighboring observations are not acceptable, either because the entire neighboring scan is not acceptable, or because particular observations are implausible, the weights corresponding to the remaining acceptable observations are renormalized in order to calculate the resampled observation.

2.6.2 JAXA Data Quality Flags

The Data_Quality element contains the primary JAXA data quality flags. Aside from this element, JAXA provides additional quality information through reserved data values. For example, -9999 counts indicate missing data. RSS does not use the JAXA Data_Quality data element in Level-2A processing, but this element is included in the Level-2A data set for the benefit of other users.

2.6.3 RSS Quality Assessment

RSS adds three types of quality assessment indicators for each scan:

- 4-Byte Scan_Quality_Flag
    - Identical flag repeated for the Low Swath, High 89A Swath, and High 89B Swath
- 2-Byte Channel_Quality_Flag for each channel
    - 10 channels for the Low Swath
    - channels for the High 89A Swath
    - channels for the High 89B Swath
- 2-Byte Resampled_Channel_Quality_Flag for each resampled channel
    - 30 channels for the Low Swath

The summary bit 0 of the Channel_Quality_Flag is automatically set whenever any of the bits in the Scan_Quality_Flag are set. Thus, the user can determine whether the data are useable by examining only the Channel_Quality_Flag without examining the Scan_Quality_Flag.

2.6.4 Scan_Quality_Flag

A Scan_Quality_Flag is provided for each scan. These flags pertain to all observations of a scan including all Level-1A and resampled channels.

Table 6. Summary of Scan_Quality_Flag

Bit	Meaning	Value = 0	Value = 1	Description
0	Summary Flag	All higher bits are equal to zero	Otherwise	The Scan Summary bit captures the conditions of all the other bits in the Scan_Quality_Flag. It is set to one if any of the bits 2 through 31 are set. The summary flag does not describe those characteristics that apply to a single channel.
1	Antenna Spin Rate	Within range	Missing or out of range	Bit 1 is set if the antenna spin rate is out of range, which is defined as 4.167 percent from nominal.
2	Navigation	Within range	Missing or out of range	Bit 2 is set if the position or velocity of the navigation data for that scan is out of bounds. The bounds are 6500-8000 km from the Earth's center to the satellite and 4-10 km/sec for spacecraft velocity. Note that these bounds are extremely large, and this flag is intended to identify bogus data rather than real anomalies in the navigation.
3	RPY Variability	Within range	Out of range	Bit 3 is set if the roll, pitch, or yaw variability from scan to scan is out of bounds. Only Midori-2 AMSR has this problem. A scan-to-scan variation in either roll, pitch, or yaw that exceeds 0.05 degrees is considered out of bounds.
4	RPY	Within range	Out of range	Bit 4 is set whenever the roll, pitch, or yaw exceeds 2.0 degrees.
5	Earth Intersection	All on earth	Some not on Earth	Bit 5 is set if any of the observation locations fail to fall on the Earth. This occurs during large orbit maneuvers.
6	Hot Load Thermistors	Within range	Missing or out of range	Bit 6 is set whenever the thermistors on the AMSR hot load are out of bounds, which is defined as their Root Mean Square (RMS) variance being greater than 10K or any single thermistor being outside the range 283.17K - 317.16K for AMSR-E and 285.17K - 316.94K for Midori-2 AMSR. When these temperature limits are converted to thermistor counts, they correspond to the minimum and maximum allowable count values.

Bit	Meaning	Value = 0	Value = 1	Description
7-31	Not Used, Always 0	N/A	N/A	N/A

2.6.5 Channel_Quality_Flag

All flags in this data element are set in response to characteristics of the calibration measurements for a specific AMSR channel. In general, calibration measurements (hot and cold) are averaged over adjacent scans to compute the antenna temperatures from raw counts. The default process is to average calibration counts over a range from one scan before the scan to one scan after the scan although only a subset of these calibration measurements is used if some are unacceptable. The Calibration Quality Flags are set on the basis of the same calibration measurements over which the calibration averaging is performed. See the AMSR-E Instrument Description document for details on AMSR-E calibration. Also, it is important to note that the flag called Level1A_Scan_Chan_Quality_Flag was replaced by three new flags:

- Channel_Quality_Flag_6_to_52 for Low_Res_Swath
- Channel_Quality_Flag_89A for High_Res_A_Swath
- Channel_Quality_Flag_89B for High_Res_B_Swath

Table 7. Summary of Channel Quality Flag

Bit	Meaning	Value = 0	Value = 1	Description
0	Summary Flag	Good	Questionable or bad	Bit 0 is a summary flag. This bit is set if any of the bits 2 through 15 are set. Note that bit 11 is set if any of the geolocation error bits in the Scan_Quality_Flag are set. Hence, if any errors are reported by the Scan_Quality_Flag, Bit 0 of all Channel_Quality_Flags is set to 1.
1	TbAvailability	Yes	No	Bit 1 indicates whether Level-2A brightness temperatures are computed for this channel. When there are severe problems, as indicated by any of the bits 2, 3, 4, or 12 being set, no brightness temperature is computed and bit 1 is set to 1.
2	Scan Number	Not first or last scan	First or last scan	Bit 2 is set for the first and last scans of each Level-2A file. Because the calibration and quality checking of each scan uses both the adjacent scans, the calibration and quality checking cannot be performed on the first and last scan of the file.

Bit	Meaning	Value = 0	Value = 1	Description
3	Serious Calibration Problem	No, all is good	Yes	Bit 3 is set if one of the following occurs: 1. The automatic gain control has changed from either the preceding or succeeding scan. 2.The receiver automatic gain control is out of bounds. 3.All calibration counts for either or both the hot load and cold sky are out of bounds.
4	Hot-cold Counts Check 1	> 0	<= 0	Bit 4 is set if the cold calibration counts are the same or greater than the hot calibration counts.
5	Thermistors	Within bounds	Out of bounds	Bit 5 is set if the hot load thermistors are out of range. The acceptable range for the thermistors is described above for bit 6 of the Scan_Quality_Flag.
6	Teff Type	Dynamic Teff	Static Teff	Bit 6 equals 0 denotes that the dynamic Teff is used. This is the usual condition. Bit 6 equals 1 denotes that the static Teff is used, which should rarely if ever occur.
7	No.of Cold Counts	>= 8	< 8	Bit 7 is set if there are fewer than 8 cold counts that are in bounds.
8	No. of Hot Counts	>= 8	< 8	Bit 8 is set if there are fewer than eight hot counts that are in bounds.
9	Hot-cold Counts Check 2	>= 100	< 100	Bit 9 is set if the difference between hot and cold counts is less than 100.
10	Hot-cold Counts Check 3	>= Channel minimum	< Channel minimum	Bit 10 is set if the difference between hot and cold counts is less than a channel-dependent threshold.
11	Geolocation	No problem exists	Problem exists	Bit 11 is set if there is a geolocation error as reported by the Scan_Quality_Flag.
12	Teffavailability	Yes	No	Bit 12 is set to 1 if Teff is not available. This should rarely if ever occur.
13-15	Not Assigned, Always 0			

2.6.6 Resampled_Channel_Quality_Flag

A Resampled_Channel_Quality_Flag is provided with the L2A data, but it is redundant with the Channel_Quality_Flag and does not usually need to be used. For the lower frequency channels, the first two bits (0 and 1) of the Channel_Quality_Flag are copied to the first two bits of the corresponding Resampled_Channel_Quality_Flag. For the 89A Channels, the first two bits (0 and 1) of the Channel_Quality_Flag are copied to the first two bits of the corresponding Resampled_Channel_Quality_Flag. For the 89B Channels, the first two bits (0 and 1) of the Channel_Quality_Flag are copied to bits 2 and 3 of the corresponding Resampled_Channel_Quality_Flag.

Table 8. Resampled_Scan_Chan_Quality_Flag

Bit	Meaning
0-1	Equal to corresponding bits of corresponding channels
2-15	Not assigned

Before working with any channel of data, users should confirm that both the Scan_Quality_Flag and the Channel_Quality_Flag indicate that the scan is acceptable.

2.6.7 Operational QA

AMSR-E Level-2A data arriving at GHRC are subject to operational QA prior to use in processing 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 is correct and complete
- The file is not a duplicate
- The HDF-EOS version number is provided in the global attributes
- The correct number of input files were available and processed

2.6.8 Science QA

AMSR-E Level-2A data arriving at GHRC are also subject to science QA prior to use in processing higher-level products. If less than 50 percent of a granule's data is good, the science QA flag is marked suspect when the granule is delivered to NSIDC. In the SIPS environment, the science QA includes checking the maximum and minimum variable values, the percentage of missing data, and out-of-bounds data per variable value. At the Science Computing Facility (SCF) and also at GHRC, science QA involves reviewing the operational QA files, generating browse images, and performing the following additional automated QA procedures (Conway 2002):

- Historical data comparisons
- Detection of errors in geolocation
- Verification of calibration data
- Trends in calibration data
- Detection of large scatter among data points that should be consistent

Geolocation errors are corrected during Level-2A processing to prevent processing anomalies such as extended execution times and large percentages of out-of-bounds data in the products derived from Level-2A data.

The Team Lead SIPS (TLSIPS) developed tools for use at SIPS and SCF for inspecting the data granules. These tools generate a QA browse image in Portable Network Graphics (PNG) format and a QA summary report in text format for each data granule. Each browse file shows Level-2A and Level-2B data. These are forwarded from RSS to GHRC along with associated granule information where they are converted to HDF raster images prior to delivery to NSIDC.

Please refer to the AMSR-E Validation Data for information about data used to check the accuracy and precision of AMSR-E observations.

2.7 Instrumentation

2.7.1 Description

Please refer to the AMSR-E Instrument Description document.

3 SOFTWARE AND TOOLS

The NASA Earthdata Search tool provides subsetting, reformatting, and reprojections services for AMSR-E data sets.

4 RELATED DATA SETS

- AMSR-E/Aqua Daily EASE-Grid Brightness Temperatures
- AMSR-E/Aqua Daily Global Quarter-Degree Gridded Brightness Temperatures
- DMSP SSM/I-SSMIS Daily Polar Gridded Brightness Temperatures
- DMSP SSM/I-SSMIS Pathfinder Daily EASE-Grid Brightness Temperatures
- Near-Real-Time DMSP SSM/I-SSMIS Daily Polar Gridded Brightness Temperatures
- NIMBUS-5 ESMR Polar Gridded Brightness Temperatures
- NIMBUS-7 SMMR Antenna Temperatures
- NIMBUS-7 SMMR Pathfinder Brightness Temperatures
- Nimbus-7 SMMR Pathfinder Daily EASE-Grid Brightness Temperatures
- Nimbus-7 SMMR Polar Gridded Radiances and Sea Ice Concentrations

5 CONTACTS AND ACKNOWLEDGMENTS

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6 REFERENCES

Ashcroft, Peter and Frank Wentz. 2000. Algorithm Theoretical Basis Document: AMSR Level-2A Algorithm, Revised 03 November. Santa Rosa, California USA: Remote Sensing Systems. (PDF file, 610 KB)

Conway, D. 2002. Advanced Microwave Scanning Radiometer - EOS Quality Assurance Plan. Huntsville, AL: Global Hydrology and Climate Center.

Japan Aerospace Exploration Agency (JAXA). Aqua AMSR-E Level 1 Product Format Description document.

Marquis, M., Richard Armstrong, Peter Ashcroft, Mary Jo Brodzik, D. Conway, Siri Jodha Singh Khalsa, E. Lobl, J. Maslanik, Julienne. Stroeve, and Vince Troisi. 2002.Research Applications and Opportunities Using Advanced Microwave Scanning Radiometer-Earth Observing System (AMSR-E) Data (poster). International Society for Optical Engineering Symposium (SPIE), Hangzhou, China, October 23-27, 2002.

For more information regarding related publications, see the AMSR-E web page.

7 DOCUMENT INFORMATION

7.1 Publication Date

11 June 2019

7.2 Date Last Updated

25 March 2021

APPENDIX A – LEVEL–2A DATA FIELDS

NOTATIONS USED IN THIS DOCUMENT

Refer to Table A - 1. Notations Used in this Document for the notations used throughout this document.

Table A - 1. Notations Used in this Document

Notation	Description
Int8	8-bit (1-byte) signed integer
Int16	16-bit (2-byte) signed integer
Int32	32-bit (4-byte) signed integer
Uint8	8-bit (1-byte) unsigned integer
Uint16	16-bit (2-byte) unsigned integer
Float32	32-bit (4-byte) floating-point integer
Float64	64-bit (8-byte) floating-point integer
Char	8-bit character
Res. 1	56-km footprint
Res. 2	37-km footprint
Res. 3	21-km footprint
Res. 4	11-km footprint
Res. 5	5-km footprint
JAXA	Japan Aerospace Exploration Agency
RSS	Remote Sensing Systems (U.S.)

Note: For data with scale and offset values, the data values can be obtained in the specified units with the following equation:

Data value in units = (stored data value * scale factor) + offset

Example: T_b; (kelvin) = (stored data value * 0.01) + 327.68

Scaling factors and offsets are provided with the local attributes of each HDF-EOS file. You should check each file to ensure correct values.

For more information on the L1 data fields' format descriptions transferred to L2A, see Aqua AMSR-E Level-1 Product Format Description document.

LOW_RES_SWATH DATA FIELDS

Table A - 2. Low_Res_Swath Data Fields

Field	Type	Dimension per Scan	Units	Scale Factor	Offset	Source
Antenna_Temp_Coefficients_6_to_52	12 x 3	kelvin, kelvin/count, kelvin/countsq	n/a	n/a	RSS	JAXA
Data_Quality	Float32	128	n/a	n/a	n/a	JAXA
Observation_Supplement	Uint16	27	n/a	n/a	n/a	JAXA
Interpolation_Flag_6_to_52	Int8	12 x 16	n/a	n/a	n/a	JAXA
Position_in_Orbit	Float64	1	JAXA_convention_for_fractional_orbit	n/a	n/a	JAXA
Navigation_Data	Float32	6	m, m/s	n/a	n/a	JAXA
Attitude Data	Float32	3	degree	n/a	n/a	JAXA
SPC_Temperature_Count	Uint16	20	count	n/a	n/a	JAXA
Earth_Incidence	Int16	243	degree	0.0050	n/a	JAXA
Earth_Azimuth	Int16	243	degree	0.01	n/a	JAXA
Sun_Elevation	Int16	243	degree	0.1	n/a	JAXA
Sun_Azimuth	Int16	243	degree	0.1	n/a	JAXA
RX_Offset_Gain_Count	Uint16	32	count	n/a	n/a	JAXA
SPS_Temperature_Count	Uint16	32	count	n/a	n/a	JAXA
Land/Ocean_Flag_for_6_10_18_23_36_50_89A	Uint8	243 x 7	%	n/a	n/a	JAXA
Cold_Sky_Mirror_Count_6_to_52	Int16	16 x 12	radiometer_counts	n/a	n/a	JAXA
Hot_Load_Count_6_to_52	Int16	16 x 12	radiometer_counts	n/a	n/a	JAXA

Field	Type	Dimension per Scan	Units	Scale Factor	Offset	Source
6.9V_Res.1_TB_(not-resampled) 6.9H_Res.1_TB_(not-resampled) 10.7V_Res.2_TB_(not-resampled) 10.7H_Res.2_TB_(not-resampled) 18.7V_Res.3_TB_(not-resampled) 18.7H_Res.3_TB_(not-resampled) 23.8V_Approx._Res.3_TB_(not-resampled) 23.8H_Approx._Res.3_TB_(not-resampled) 36.5V_Res.4_TB_(not-resampled) 36.5H_Res.4_TB_(not-resampled)	Int16	243	kelvin	0.01	327.68	RSS, calculated from JAXA counts

6.9V_Res.1_TB 6.9H_Res.1_TB 10.7V_Res.1_TB 10.7V_Res.2_TB 10.7H_Res.1_TB 10.7H_Res.2_TB 18.7V_Res.1_TB 18.7V_Res.2_TB 18.7H_Res.1_TB 18.7H_Res.2_TB 23.8V_Res.1_TB 23.8V_Res.2_TB 23.8V_Res.3_TB 23.8H_Res.1_TB 23.8H_Res.2_TB 23.8H_Res.3_TB 36.5V_Res.1_TB 36.5V_Res.2_TB 36.5V_Res.3_TB 36.5H_Res.1_TB 36.5H_Res.2_TB 36.5H_Res.3_TB 89.0V_Res.1_TB 89.0V_Res.2_TB 89.0V_Res.3_TB 89.0V_Res.4_TB 89.0H_Res.1_TB 89.0H_Res.2_TB 89.0H_Res.3_TB 89.0H_Res.4_TB	Int16	243	kelvin	0.01	327.68	RSS
Scan_Quality_Flag	Int32	1	flag	n/a	n/a	RSS

Field	Type	Dimension per Scan	Units	Scale Factor	Offset	Source
Channel_Quality_Flag_6_to_52	Int16	12	flag	n/a	n/a	RSS
Resampled_Channel_Quality_Flag	Int16	30	flag	n/a	n/a	RSS
Effective_Cold_Space_Temperature_6_to_52	Float32	12	kelvin	n/a	n/a	RSS
Effective_Hot_Load_Temperature_6_to_52	Float32	12	kelvin	n/a	n/a	RSS
Res1_Surf Res2_Surf Res3_Surf Res4_Surf	Int8	243	%land	0.4	n/a	RSS
Sun_Glint_Angle	Int16	243	degree	0.01	n/a	RSS
Geostationary_Reflection_Latitude	Int16	243	degree	0.01	n/a	RSS
Geostationary_Reflection_Longitude	Int16	243	degree	0.01	n/a	RSS

HIGH_RES_A_SWATH AND HIGH_RES_B_SWATH DATA FIELDS

Beginning 4 November 2004, the 89 GHz A-horn developed a permanent problem resulting in a loss of those observations. Consequently, after 3 November 2004, the High_Res_A_Swath data fields contain values of 0.

Table A - 3. High_Res_A_Swath and High_Res_B_Swath Data Fields

Element	Type	Dimension per Scan	Unit	Scale Factor	Offset	Source
Antenna_Temp_Coefficients_89A	Float32	2 x 3	kelvin, kelvin/count, kelvin/countsq	n/a	n/a	RSS
Interpolation_Flag_89_A	Int8	2 x 32	n/a	n/a	n/a	RSS
Cold_Sky_Mirror_Count_89A	Int16	32 x 2	radiometer_counts	n/a	n/a	JAXA

Element	Type	Dimension per Scan	Unit	Scale Factor	Offset	Source
Hot_Load_Count_89A	Int16	32 x 2	radiometer_counts	n/a	n/a	JAXA
89.0V_Res.5A_TB_(not-resampled)	Int16	486	kelvin	0.01	327.68	RSS
89.0H_Res.5A_TB_(not-resampled)	Int16	486	kelivn	0.01	327.68	RSS
Scan_Quality_Flag_89A	Int32	1	flag	n/a	n/a	RSS
Channel_Quality_Flag_89A	Int16	2	flag	n/a	n/a	RSS
Effective_Cold_Space_Temperature_89A	Float32	2	kelvin	n/a	n/a	RSS
Effective_Hot_Load_Temperature_89A	Float32	2	kelvin	n/a	n/a	RSS
Res5A_Surf	Int8	486	%land	4.0	n/a	RSS

GEOLOCATION FIELDS

The Geolocation fields for the High_Res_A_Swath and the High_Res_B_Swath are completely analogous to those of the Low_Res_Swath with 486 observations per scan rather than 243.

Table A - 4. Geolocation Fields

Field	Type	Dimension per scan	Source	Units
Time	Float64	1	JAXA	TAI93 (seconds since midnight, 01 January 1993)
Latitude	Float32	243	RSS	degree
Longitude	Float32	243	RSS	degree

GLOBAL ATTRIBUTES

The swath attribute fields of the High_Res_A_Swath and the High_Res_B_Swath are identical to those of the Low_Res_Swath except that the Resampled_Channel_Sequence field is omitted because high-resolution swaths have no resampled channels. Also, the Level1A_Channel_Sequence field was modified to describe the order of the elements of the High_Res_A_Swath Level1A_Scan_Chan_Quality_Flag rather than that of the Low_Res_Swath quality flag.

Table A - 5. Global Attributes

Attribute	Type	Description
HDFEOSVersion	Char	HDF-EOS Version of product
StructMetadata.0	Char	HDF-EOS structural metadata
ProcessingLevelID	Char	Product processing level
ProcessingFacility	Char	Product processing facility
SensorShortName	Char	Sensor short name
EquatorCrossingLongitude	Char	Longitude at which instrument crosed equator
OrbitSemiMajorAxis	Char	Diameter of platform orbit at the equator
OrbitEccentricity	Char	How far the elliptical platform orbit deviates from a circle
OrbitArgumentPerigee	Char	Point at which platform orbit is closest to Earth in degrees from ascending equatorial node
OrbitInclination	Char	Degree by which platform orbit deviates from polar (north / south) orbit
OrbitPeriod	Char	Orbit period in minutes
EllipsoidName	Char	Reference ellipsoid name
SemiMajorAxisofEarth	Char	Diameter of Earth (geoid) at the equator
FlatteningRatioofEarth	Char	The amount by which the polar geoid diameter is smaller than the equatorial geoid diameter
L1AProductionDataTime	Char	Production date and time of input L1A file
L1ANumerofMissingScans	Char	Number of missing scans in input L1A file

Attribute	**Type**	**Description**
L2AProcessingDate	Char	Production date and time of L2A file
PlatformShortName	Char	Platform short name
EquatorCrossingTime	Char	Time at which instrument crossed equator
EquatorCrossingDate	Char	Date at which instrument crossed equator
EphemerisType	Char	Definitive or Predicted
EphemerisGranulePointer	Char	Ephemeris input file
EphemerisQA	Char	Ephemeris Quality Assessment
NumberofMissingPackets	Char	Number of missing L1A packets, generally from spacecraft to ground transmission
QAPercentParityErrorData	Char	Percent parity error on spacecraft to ground transmission
Altitude	Char	Average altitude of instrument above geoid
RangeBeginningDate	Char	Beginning date of file coverage
RangeBeginningTime	Char	Beginning time of file coverage
RangeEndingDate	Char	Ending date of file coverage
RangeEndingTime	Char	Ending time of file coverage
InputPointer	Char	Input L1A file
PlatinumThermistorWbCoeff	Char	Thermistor Count to Temperature Coefficients: T = Wc + Wb (counts - segment)
PlatinumThermistorWcCoeff	Char	Thermistor Count to Temperature Coefficients: T = Wc + Wb (counts - segment)
PlatinumThermistorSegment	Char	Thermistor Count to Temperature Coefficients: T = Wc + Wb (counts - segment)
CoefficientAvv	Char	APC Coefficients: Tbv = Avv * Tav + Ahv * Tah + Aov
CoefficientAhv	Char	APC Coefficients: Tbv = Avv * Tav + Ahv * Tah + Aov
CoefficientAovTimesCold	Char	APC Coefficients: Tbv = Avv * Tav + Ahv * Tah + Aov
CoefficientAhh	Char	APC Coefficients: Tbh = Ahh * Tah + Avh * Tav + Aoh
CoefficientAvh	Char	APC Coefficients: Tbh = Ahh * Tah + Avh * Tav + Aoh

Attribute	Type	Description
CoefficientAohTimesCold	Char	APC Coefficients: Tbh = Ahh * Tah + Avh * Tav + Aoh
PGE_Version	Char	Product maturity code and version number
StartOrbitNumber	Float32	Orbit number at start of data acquisition
StopOrbitNumber	Float32	Orbit number at stop of data acquisition
OrbitDirection	Char	Direction of orbit (ascending or descending)
NumberofScans	Int32	Number of scans
SoftwareRevisionDate	Char	Date of last product software revision
CoreMetadata.0	Char	HDF-EOS core metadata