AMSR-E/Aqua Monthly Global Microwave Land Surface Emissivity, Version 1

USER GUIDE

How to Cite These Data

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

Norouzi, H., M. Temimi, W. B. Rossow, and R. Khanbilvardi. 2013. *AMSR-E/Aqua Monthly Global Microwave Land Surface Emissivity, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/SFBY6Q6JYS3L. [Date Accessed].

Literature Citation

As a condition of using these data, we request that you acknowledge the author(s) of this data set by referencing the following peer-reviewed publication.

Norouzi, H., M. Temimi, W. B. Rossow, R. Khanbilvardi, C. Pearl, and M. Azarderakhsh. 2011. The Sensitivity of Land Emissivity Estimates from AMSR-E at C- and X-Bands to Surface Properties, *Journal of Hydrology, Earth Systems Science*. 15. 3577-3589. https://doi.org/10.5194/hess-15-3577-2011

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National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

Land surface emissivity estimates for this data set were collected at the following vertically and horizontally polarized (H- and V-pol) frequencies: 6.9, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz. Valid land surface emissivity values range from 0.000 to 1.000. Missing values are filled with -999.

1.2 File Information

1.2.1 Format

Data are stored as 64-bit (8-byte) floating-point integers in Version 4 Hierarchical Data Format (HDF4) files. The files contain a data layer for each channel, such as the 6.9 V layer, which contains all the 6.9 GHz vertically-polarized measurements.

Data in compressed HDF files are arranged in a table format that image processing programs can easily visualize. This data compression should be transparent to most users since HDF-capable software tools automatically uncompress the data. Various software packages, such as HDFView, Panoply, or similar HDF-compatible applications, support the HDF data format. Visit the HDF–EOS Tools and Information Center web page for more information about the HDF format, and for instructions on uncompressing and converting the data to binary format.

1.2.2 File Contents

Each file is approximately 95 MB. The volume of this data set is approximately 7.2 GB.

	0	1	2	3	4	5	6	7	8	9
677	0.8247666...	0.8247666...	0.8247666...	0.8247666...	0.8247666...	0.8263400...	0.8263400...	0.8263400...	0.8263400...	0.8263400...
678	0.8497600...	0.8497600...	0.8497600...	0.82134	0.82134	0.82134	0.82134	0.82134	0.83782	0.83782
679	0.854025	0.854025	0.854025	0.8252599...	0.8252599...	0.8252599...	0.8252599...	0.8252599...	0.8252599...	0.8414
680	0.9061	0.9061	0.9061	0.82685	0.82685	0.82685	0.82685	0.82685	0.82685	0.8784454...
681	0.9061	0.9061	0.9061	0.82685	0.82685	0.82685	0.82685	0.82685	0.82685	0.8953833...
682	0.8865666...	0.8865666...	0.8865666...	0.8586	0.8586	0.8586	0.8586	0.8586	0.8586	0.8965090...
683	0.8488083...	0.8488083...	0.8488083...	0.8488083...	0.8488083...	0.8488083...	0.89375	0.89375	0.89375	0.89375
684	0.84902	0.84902	0.84902	0.84902	0.84902	0.84902	0.8666222...	0.8666222...	0.8666222...	0.8666222...
685	0.8575666...	0.8575666...	0.8575666...	0.8575666...	0.8575666...	0.8575666...	0.8575666...	0.8562249...	0.8562249...	0.8562249...
686	0.8740749...	0.8740749...	0.8740749...	0.8740749...	0.8740749...	0.8740749...	0.8740749...	0.8545875	0.8545875	0.8545875
687	0.8760199...	0.8760199...	0.8760199...	0.8760199...	0.8760199...	0.8760199...	0.8760199...	0.8545875	0.8545875	0.8545875
688	0.876925	0.876925	0.876925	0.876925	0.8838545...	0.8838545...	0.8838545...	0.8838545...	0.8838545...	0.8838545...
689	0.8844200...	0.8844200...	0.8844200...	0.8844200...	0.86289375	0.86289375	0.86289375	0.86289375	0.86289375	0.86289375
690	0.8839454...	0.8839454...	0.8839454...	0.8839454...	0.8762222...	0.8762222...	0.8762222...	0.8762222...	0.8762222...	0.8762222...
691	0.8599916...	0.8599916...	0.8599916...	0.8599916...	0.8612	0.8612	0.8612	0.8612	0.8612	0.8612
692	0.8060333...	0.8060333...	0.8060333...	0.8060333...	0.8060333...	0.8060333...	0.8060333...	0.8060333...	0.8734882...	0.8734882...
693	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.8665200...	0.87584
694	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8944571...	0.8661090...
695	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8699833...	0.8802846...
696	0.8541333...	0.8541333...	0.8541333...	0.8541333...	0.8541333...	0.8766733...	0.8766733...	0.8766733...	0.8766733...	0.8766733...
697	0.8600277...	0.8600277...	0.8600277...	0.8600277...	0.8600277...	0.8403083...	0.8403083...	0.8403083...	0.8403083...	0.8403083...
698	0.8589399...	0.8589399...	0.8589399...	0.8589399...	0.8589399...	0.8123428...	0.8123428...	0.8123428...	0.8123428...	0.8123428...
699	0.8756999...	0.8756999...	0.8756999...	0.8756999...	0.8756999...	0.8756999...	0.89326	0.89326	0.89326	0.89326
700	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...	0.9310999...
701	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...	0.9102909...
702	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...	0.9132888...
703	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...	0.8996833...
704	0.8620368...	0.8620368...	0.8620368...	0.8620368...	0.8620368...	0.8620368...	0.8620368...	0.9263999...	0.9263999...	0.9263999...
705	0.8731578...	0.8731578...	0.8731578...	0.8731578...	0.8731578...	0.8731578...	0.8731578...	0.8731578...	0.9117866...	0.9117866...
706	0.8673000...	0.8673000...	0.8673000...	0.8673000...	0.8673000...	0.8673000...	0.8673000...	0.8673000...	0.9190190...	0.9190190...

Figure 1. This sample data record shows land surface emissivity data values in the vertically-polarized 10.7 GHz channel for December 2005.

1.2.3 Directory Structure

Data files are organized on the HTTPS site at:

https://daacdata.apps.nsidc.org/pub/DATASETS/nsidc0543_amsre_emiss/

1.2.4 Naming Convention

The files are named according to the following convention, which is parsed and described in Table 1:

```
CREST-AMSR-E-Emissivity-Monthly-yyyymm-VX.hdf
```

Where:

Table 1. File Naming Convention Description

Variable	Description
CREST	Identifies this as a file containing data compiled at the National Oceanic and Atmospheric Administration Cooperative Remote Sensing Science and Technology Center (NOAA-CREST)
AMSR-E	Sensor
Emissivity	Parameter
Monthly	Temporal resolution

Variable	Description
`yyyy`	4-digit year
`mm`	2-digit month
`VX`	Version number (`V1`: Version 1)
`.hdf`	HDF file extension

1.3 Spatial Information

1.3.1 Coverage

Data provide full global coverage at a quarter-degree latitude and longitude resolution.

1.3.2 Geolocation

The quarter-degree data are in one global cylindrical, equidistant latitude-longitude projection, and are gridded with 1440 columns and 720 rows.

1.4 Temporal Information

1.4.1 Coverage

The data span from July 2002 to June 2008 and are provided at a monthly resolution.

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

2.1.1 Emissivity Data

Land surface emissivity estimates for this data set were derived from the AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures data set.

AMSR-E is a twelve-channel, six-frequency, total power passive-microwave radiometer system. It measures brightness temperatures at 6.925, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz (Njoku and Li, 1999). Vertically and horizontally polarized measurements are made at all frequencies. The Earth-emitted microwave radiation is collected by an offset parabolic reflector 1.6 m in diameter that scans across the Earth along an imaginary conical surface, maintaining a constant Earth incidence angle of 55 degrees. The spatial resolution of the individual measurements varies from 5.4 km at 89.0 GHz to 56 km at 6.9 GHz. AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures (for both ascending and descending overpasses) were used for the analysis and were obtained from the National Snow and Ice Data Center (NSIDC). Higher frequency observations are resampled to match the lower frequencies spatial resolution. For each frequency, we select the resampled data having the closest location to the original satellite footprint and re-project these footprints to a 0.25 degree grid that is equidistant at the equator.

2.1.2 Ancillary Data

Satellite infrared-visible-based products from the International Satellite Cloud Climatology Project (ISCCP) provide cloud cover and surface skin temperatures. The ISCCP-DX data provides information every three hours since 1983 at approximately 30 km spatial resolution, based on merged observations from geostationary and polar-orbiting satellites (Rossow and Schiffer, 1999). The ISCCP quantities were chosen for the satellite view closest to nadir from among all available results and resampled to match the quarter-degree equidistant grid adopted for the passive microwave observations. The infrared-based skin temperatures represent the top surface temperature, which can be the top of very dense vegetation canopies or a mix of canopy and soil temperatures for less dense vegetation.

The TOVS data set available with ISCCP (Rossow and Schiffer, 1991) provides global information on air temperature and water vapor profiles at nine vertical layers ranging from the surface to 1 mb pressure. These profiles are available on a daily basis. We assume that the impact of diurnal variations on the observed brightness temperature is minimal. Data are originally available in a 280 km equal-area map, but are regridded to coincide with the AMSR-E data. These atmospheric parameters are used to calculate the upwelling and downwelling brightness temperatures, as well as the atmospheric transmission. TOVS data were selected in this study to be consistent with ISCCP products such as skin temperature, which is also based on TOVS data. See Zhang et al. 2006 for comparisons of the TOVS product with other atmospheric data sets.

2.2 Processing

2.2.1 Theory of Measurements

This product is a global land emissivity product using passive microwave observations from the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E). The developed product complements existing land emissivity products from the Special Sensor Microwave Imager (SSM/I) and from the Advanced Microwave Sounding Unit (AMSU) by adding land emissivity estimates at two lower frequencies, 6.9 and 10.65 GHz (in the C- and X-band, respectively). Observations at these low frequencies penetrate deeper into the soil layer.

Ancillary data used in the analysis, such as surface skin temperature and cloud mask, are obtained from International Satellite Cloud Climatology Project (ISCCP). Atmospheric properties are obtained from the TIROS Operational Vertical Sounder (TOVS) observations to determine the small upwelling and downwelling atmospheric emissions as well as the atmospheric transmission. This data set was extracted from instantaneous emissivity estimates.

2.2.2 Derivation Techniques and Algorithms

The following is adapted from Prigent et al, 1997 and Norouzi et al., 2011:

Assuming that land surface is flat and specular, and considering the atmosphere as a non-scattering plane-parallel medium, the emissivity can be written as:

$$\varepsilon_{(p,v)} = \frac{Tb_{(p,v)} - T_{atm}^{\uparrow} - T_{atm}^{\downarrow}\, e^{-\tau(0,h)/\mu}}{e^{-\tau(0,H)/\mu (T_S - T_{atm}^{\downarrow})}} \qquad \text{Equation 1}$$

Where $\varepsilon_{(p,v)}$ and $Tb_{(p,v)}$ are the land surface emissivity and the measured brightness temperatures at polarization p (horizontal, H, or vertical, V) and frequency v, respectively. T_s is the skin temperature and $T_{atm}^{\uparrow}$ and $T_{atm}^{\downarrow}$ are the downwelling and upwelling brightness temperatures from the atmosphere, respectively:

$$T^{\downarrow}{}_{atm} = \int_H^0 T(z).\left[\frac{\alpha(z)}{\mu}\right].e^{-\frac{\tau(0,h)}{\mu}} dz \qquad \text{Equation 2}$$

$$T_{atm}^{\uparrow} = \int_0^H T(z).\left[\frac{\alpha(z)}{\mu}\right].e^{-\frac{\tau(z,h)}{\mu}} dz \qquad \text{Equation 3}$$

In these equations, $T(z)$ is the atmospheric temperature profile, $\alpha(z)$ the atmospheric absorption at altitude z, μ the cosine of incidence angle, and τ the atmospheric extinction between two altitudes, which is written as:

$$\tau(z0, z1) = \int_{z0}^{z1} \alpha(z) dz \qquad \text{Equation 4}$$

The implementation of this algorithm requires an accurate characterization of the atmospheric temperature and humidity to determine atmospheric transmissivity. Another key parameter is the thermal skin temperature.

AMSR-E overpass times are near 1:30 a.m. (ascending) and 1:30 p.m. (descending) local time at the equator. Since skin temperatures from ISCCP-DX data are available every three hours, microwave and thermal observations are not necessarily coincident. Therefore, a Spline interpolation between the eight available skin temperature measurements every day is used to infer the complete skin temperature diurnal cycle. The Spline method estimates the daily maxima and minima that can occur between two 3-hour samples (Aires et al., 2004). Actual acquisition time for each microwave pixel at each swath is used in the Spline interpolation to estimate more accurately the physical temperature. This may be critical in arid regions where the temperature diurnal cycle has much larger amplitude. Also, if either of two consecutive (before and after AMSR-E acquisition times) cloud flags indicate cloudy conditions, the microwave pixel is flagged as cloudy.

The upwelling and downwelling atmospheric emissions are estimated using the Liebe MPM model to determine the atmospheric absorption (Liebe et al., 1993). Upwelling and downwelling brightness temperatures, as well as atmospheric transmission, are calculated using Equations 2, 3, and 4 for the AMSR-E incidence angle of 55 degrees. Atmospheric corrections are applied to the ascending and descending overpasses. Because of the TOVS daily resolution, the same atmospheric profiles are used to correct atmospheric effects for both the ascending and descending overpasses.

Monthly composite emissivity maps are created for each frequency and polarization from the instantaneous cloud-free land surface emissivity maps. In the case of persistent cloud cover (longer than 30 days, which is possible in some tropical locations), land emissivity is not retrieved (resulting in a data value of -999).

2.3 Quality, Errors, and Limitations

Several quality controls have been conducted and the standard deviation of instantaneous emissivity estimates within each month to be less than 0.015. The results have been also evaluated with other available global data such as SSM/I.

2.3.1 Error Sources

The uncertainty in the atmospheric water vapor profile can be as much as 20-25 percent (English, 1995; Lin and Rossow, 1994; Zhang et al., 2006). A 25 percent change in water vapor leads to a global mean 0.0016 change of emissivity at 6.9 GHz and 0.03 at 89.0 GHz. TOVS data may include climatological values when actual measures are missing which can introduce an error in the atmospheric corrections (Prigent et al., 1998).

The physical skin temperature plays an important role at lower frequencies, since the microwave radiation is more sensitive to the surface than to the atmosphere. Recent studies show that available global skin temperatures have significant differences, generally only a few degrees but up to 20 K in deserts (Jimenez et al., 2011). ISCCP skin temperature has some uncertainties that tend to increase as temperature increases. The recent study shows that root mean square (rms) differences between ISCCP and MODIS skin temperature could be 5 K and 2.5 K for day and night, respectively (Moncet et al., 2011). The sensitivity analysis showed that the difference in global mean emissivity retrieval could be as much as 0.025 for skin temperature differences of 5 K. Although possible biases in skin temperatures from ISCCP can affect the absolute emissivity value, its effect on emissivity variability should not be significant during the AMSR-E operational life time because the ISCCP results are homogeneous in quality over this time period (Zhang et al., 2006). ISCCP-DX also was used for cloud detection. Possible discrepancies in cloud mask can affect the retrieval.

A 3 K decrease in observed brightness temperature leads to 0.01 decrease of emissivity at 36.5 GHz (H. polarization). The absolute accuracy of AMSR-E brightness temperatures has been reported as 1.0 K (Kawanishi et al., 2003).

2.4 Instrumentation

2.4.1 Description

See the AMSR-E Instrument Description document.

3 CONTACTS AND ACKNOWLEDGMENTS

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5 DOCUMENT INFORMATION

5.1 Publication Date

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5.2 Date Last Updated

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