MEaSUREs Greenland Surface Melt Daily 25km EASE-Grid 2.0, Version 1

USER GUIDE

How to Cite These Data

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

Mote, T. L. 2014. *MEaSUREs Greenland Surface Melt Daily 25km EASE-Grid 2.0, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/MEASURES/CRYOSPHERE/nsidc-0533.001. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0533

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

This data set consists of daily files that report the presence of surface/near-surface melting in 25 km x 25 km grid cells spanning the Greenland Ice Sheet. The onset of melting is determined from satellite brightness temperature data acquired from 1 January 1979 through 31 December 2012.

1.1 Format

Data files are formatted in Network Common Data Form, Version 4 (NetCDF-4) (.nc) following version 1.6 of the Climate and Forecast (CF) metadata conventions. For more information about working with NetCDF formatted data, visit the UCAR Unidata Network Common Data Form Web site.

1.2 File Naming Convention

This section explains the file naming convention used for this data set with an example.

Example File Name:
GLSMD25E2_19790102_v01r01.nc
GLSMD25E2_yyyymmdd_v01r01.nc

Refer to Table 2 for descriptions of the file name variables listed above.

Table 1. File Naming Convention Description

Variable	Description
GLSMD25E2	Greenland Snow Melt Daily 25 km Ease-Grid 2.0
yyyy	Four-digit year
mm	Two-digit month
dd	Two-digit day of month
v01r01	Version 1.1
.nc	netCDF-formatted file

1.3 File Size

Data files are approximately 1.9 MB. The entire data set is approximately 19 GB.

1.4 Spatial Coverage

Data files are provided in the EASE-Grid 2.0 Northern Hemisphere projection with all non-Greenland Ice Sheet areas masked. As such, each data file covers:

Southernmost Latitude: 0° N
Northernmost Latitude: 90° N
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

1.4.1 Spatial Resolution

25 km

1.4.2 Projection and Grid Description

Data are provided in the 25 km Northern Hemisphere Equal Area Scalable Earth Grid 2.0 (EASE-Grid 2.0). Grid dimensions are 720 x 720. For a complete description of EASE-Grid 2.0, visit NSIDC's EASE-Grid 2.0 Format Description page.

1.4.3 Masking

Grid cells not classified as ice sheet have been masked (assigned a value of 91) in this data set. Non-ice sheet cells were identified using a 25 km Land-Ocean-Coast-Ice (LOCI) mask that was adapted for EASE-Grid 2.0 from the Boston University MOD12Q1 V004 Land Cover Product (BU-MODIS). For more information about the BU-MODIS LOCI mask, see EASE-Grid 2.0 Land-Ocean-Coastline-Ice Masks Derived from Boston University MODIS/Terra Land Cover Data.

1.5 Temporal Coverage

1 January 1979 – 31 December 2012

1.5.1 Temporal Resolution

Every other day:
2 January 1979 – 9 July 1987 (SMMR)

Daily:
10 July 1987 – 31 December 2012 (SSM/I, SSMIS)

Users should note that melt data are only available on alternating days from 2 January 1979 through 9 July 1987. This reflects the operating mode of the SMMR instrument, which only acquired data on alternating days due to spacecraft power limitations.

1.6 Parameter or Variable

The parameter of interest in this data set is snow melt.

1.6.1 Parameter Description

Data files contain the variables listed in Table 3.

Table 2. Variable Names and Descriptions

Variable Name	Description	Dimensions	Data Type
greenland_surface_melt	Surface/near-surface melting flag	720 x 720	byte (signed)
latitude	Latitude of center of each 25 km EASE_Grid 2.0 cell	720 x 720	float[1]
longitude	Longitude of center of each 25 km EASE_Grid 2.0 cell	720 x 720	float[1]
cols	x coordinate, center of 25 km EASE-Grid 2.0 cell (m from origin)	1 x 720	int
rows	y coordinate, center of 25 km EASE-Grid 2.0 cell (m from origin)	720 x 1	int
coord_system	EASE-Grid 2.0 grid and projection parameters	—	char
time	Days since 12-31-1978	—	int
[1]32-bit single precision floating point			

The parameter of interest is stored in the NetCDF variable greenland_surface_melt. Coded integers specify the surface/near-surface condition as melt, no melt, missing data, or masked. Refer to Table 3 for the key to this coding scheme.

Table 3. Coding Scheme for greenland_surface_melt

Value	Description
50	No surface melt
51	Surface melt
90	Missing
91	Masked
-99	Fill value for grid corners

2 SOFTWARE AND TOOLS

2.1 Software and Tools

Unidata at the University Corporation for Atmospheric Research maintains an extensive list of freely available Software for Manipulating or Displaying NetCDF Data.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

The introduction of liquid water to snow produces a sharp increase in emissivity and a corresponding increase in microwave brightness temperature. As such, a sharp increase in the brightness temperature of the snowpack indicates liquid water due to the onset of melting.

3.2 Data Acquisition Methods

The presence of surface/near-surface melting on the Greenland Ice Sheet was derived from the following brightness temperature data sets availabe from NSIDC:

- Nimbus-7 SMMR Polar Gridded Radiances and Sea Ice Concentrations
- DMSP SSM/I-SSMIS Daily Polar Gridded Brightness Temperatures

3.3 Derivation Techniques and Algorithms

3.3.1 Processing Steps

Melt onset is identified by comparing SMMR, SSM/I, and SSMIS 37GHz, horizontally polarized (37 GHz H-Pol) brightness temperatures with dynamic thresholds. These thresholds are generated by using a microwave emission model to simulate 37 GHz H-Pol brightness temperatures associated with melting snowpack. Scattering coefficients needed for the model are first empirically derived for

each year from brightness temperatures observations prior to the onset of melt. The emission model is then used to simulate summer melt conditions by adding one percent volumetric liquid water to each grid cell. The resulting brightness temperatures are used as threshold values to distinguish melt from non-melt during the summer of a given year. New scattering coefficients and melt thresholds are calculated every year to reduce the impact from variations in surface temperature and winter accumulation that can affect the scattering properties of the snow. For a detailed description of this approach, see Mote and Anderson, 1995 and Mote, 2007.

To construct the melt data set, SMMR, SSM/I, and SSMIS polar gridded brightness temperatures were first subset from their 304 x 448 grid to a 61 x 111 grid encompassing Greenland. The 37GHz, horizontally polarized, brightness temperatures each day were then compared with the corresponding brightness temperature thresholds for each grid cell. Cells with values greater than or equal to the threshold were assigned a code of 51 (melt), while cells with brightness temperatures below the threshold were assigned a value of 50 (no melt). Missing data was assigned a value of 90 (missing). Once populated, the 61 x 111 grid of melt data was embedded in a 304 x 448 polar grid, which was then re-projected to EASE Grid 2.0 using the Mapx utility Regrid. Lastly, all areas not classified as ice sheet were located and assigned a value of 91 (masked) using the 25 km EASE Grid 2.0 version of the BU-MODIS land cover mask. Refer to the section on Masking for futher information.

3.3.2 Version History

Version 1.1 was released in July, 2015. Refer to Table 5 for this data set's version history:

Table 4. Version History

Version	Description
V1.1 (Jul, 2015)	Added 1D arrays named cols and rows that contain x and y coordinates (meters from origin) of the projection. v01r01 appended to data file names.
V1 (Nov, 2014)	Initial version

3.3.3 Error Sources

The individual sensors and platforms differ slightly in view angle, radiometric resolution, calibration, and swath width. However, the impact of these differences is minimized because the model explicitly accounts for sensor frequency and view angle and because new thresholds were derived annually for each grid cell. The only exception occurs in 1987—the crossover period from SMMR to SSM/I—when one set of threshold brightness temperatures was used for SMMR from January to July and a second for SSM/I for the remainder of year. In this instance, SMMR brightness

temperatures were adjusted using a linear regression of SMMR to SSM/I from the dry snow zone of the ice sheet. The model was then run from August to December using pre-melt SMMR values to generate SSM/I thresholds.

3.4 Sensor or Instrument Description

The Scanning Multichannel Microwave Radiometer (SMMR) on board Nimbus 7 measured dual-polarized microwave radiances, at 6.63, 10.69, 18.0, 21.0, and 37.0 GHz. The instrument operated from 25 October 1978 until 20 August 1987.

The Special Sensor Microwave Imager (SSM/I) on board DMSP satellites F8, F11, and F13 is a seven-channel, four-frequency, orthogonally polarized, passive microwave radiometric sensor system that measures atmosphere, ocean, and land microwave brightness temperatures at 19.35, 22.2, 37.0, and 85.5 GHz. The SSM/I brightness temperature data record spans 09 July 1987 to 31 December 2007.

The Special Sensor Microwave Imager/Sounder (SSMIS) was deployed on DMSP satellite F17 to replace the SSM/I. The sensor is a passive conically scanning microwave radiometer that measures microwave energy at 24 discrete frequencies from 19 to 183 GHz. SSMIS brightness temperatures begin on 14 December 2006.

See the following Web pages for additional details about these instruments:

- Scanning Multi-channel Microwave Radiometer (SMMR)
- Special Sensor Microwave Imager (SSM/I)
- Special Sensor Microwave Imager/Sounder (SSMIS)

4 REFERENCES AND RELATED PUBLICATIONS

Mote, Thomas L. 2007. Greenland surface melt trends 1973-2007: Evidence of a large increase in 2007. Geophysical Research Letters 34, L22507. doi: http://dx.doi.org/10.1029/2007GL031976

Mote, Thomas L. and Mark R. Anderson. 1995. Variations in snowpack melt on the Greenland ice sheet based on passive microwave measurements. J. Glac. 41(137):51-60

4.1 Related Data Collections

- MEaSUREs Northern Hemisphere Terrestrial Snow Cover Extent Daily 25km EASE-Grid 2.0
- MEaSUREs Northern Hemisphere Terrestrial Snow Cover Extent Weekly 100km EASE-Grid 2.0
- MEaSUREs Arctic Sea Ice Characterization Daily 25km EASE-Grid 2.0

- MEaSUREs Northern Hemisphere State of Cryosphere Daily 25km EASE-Grid 2.0
- MEaSUREs Northern Hemisphere State of Cryosphere Weekly 100km EASE-Grid 2.0
- Nimbus-7 SMMR Polar Gridded Radiances and Sea Ice Concentrations
- DMSP SSM/I-SSMIS Daily Polar Gridded Brightness Temperatures

4.2 Related Websites

- MEaSUREs Data: Overview
- Northern Hemisphere Snow and Ice Climate Data Records at Rutgers University

5 CONTACTS AND ACKNOWLEDGMENTS

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5.1 Acknowledgments:

These data were generated with support from Award NNX08AP34A to David A. Robinson, Rutgers University, from the NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Program.

Special thanks go to:

- Gina R. Henderson at the United States Naval Academy and Thomas W. Estilow at Rutgers University for their assistance with prototyping and netCDF generation;
- Mark Anderson at University of Nebraska-Lincoln for collaborating on earlier versions of these data;
- Mary Jo Brodzik at NSIDC for technical assistance, gridding and software support, and for advice particularly regarding the EASE Grid-2.0 format;
- Members of the Northern Hemisphere Snow and Ice MEaSUREs team lead by David Robinson, including Mark Anderson, Angela Bliss, Sheldon Drobot, Dorothy Hall, Gina Henderson, and Mark Tschudi.

6 DOCUMENT INFORMATION

6.1 Publication Date

November 2014

6.2 Date Last Updated

July 2015