Arctic EASE-Grid Freeze and Thaw Depths, 1901 - 2002, Version 1

USER GUIDE

How to Cite These Data

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

Zhang, T., J. McCreight, and R.G. Barry 2006. *Arctic EASE-Grid Freeze and Thaw Depths, 1901 - 2002, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/b3pg-bk18. [Date Accessed].

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National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 File Information

1.1.1 Format

ASCII text files

1.1.2 File and Directory Structure

The data set consists of two tarred and compressed files, "`ease25_frz_depth.tgz`" and "`ease25_thw_depth.tgz`", containing 101 freeze depth and 102 thaw depth files, respectively, plus and one compressed text file, "`E25_lon_lat_nh.gz`", defining the grid points.

1.1.3 File Naming Convention

"`ease25_frz_depth.tgz`" contains 101 files in the format "`ease25_frz_depth.yyyy.txt`", where "`yyyy`" is the four digit year. "`ease25_thw_depth.tgz`" contains 101 files in the format "`ease25_thw_depth.yyyy.txt`", where "`yyyy`" is the four digit year. In addition, "`E25_lon_lat_nh.txt`" contains the grid coordinates.

1.1.4 File Size

Data are in two compressed tar files (freeze depth = 173.8 MB, thaw depth = 305.6 MB) containing 102 text files, 25.6 MB each, plus one 2.6 MB compressed text file. The total uncompressed volume is approximately 5.1 GB.

1.2 Spatial Information

1.2.1 Coverage

Northern Hemisphere

Southernmost Latitude: 50°N
Northernmost Latitude: 90°N
Westernmost Longitude: 180°W
Easternmost Longitude: 180°E

1.2.2 Resolution

25 km

1.2.3 Projection

Lambert-Azimuthal Equal Area projection on a spherical geoid (See All About EASE-Grid)

1.2.4 Geolocation

25-km Northern Hemisphere EASE-Grid (See All About EASE-Grid)

1.3 Temporal Information

1.3.1 Coverage

1901 - 2002

1.3.2 Resolution

Annual

1.4 Parameter or Variable

1.4.1 Parameter Description

Values for each file are, in column order, median, mean, standard deviation in depth, minimum, and maximum freeze and thaw depths. Depths are calculated using median, mean, standard deviation, minimum, and maximum edaphic factors.

1.4.2 Sample Data Record

The following values come from "`ease25_thw_depth.1981.txt`":

1.02822	1.28081	1.00488	0.359907	4.73452
1.26628	1.18782	0.567485	0.584154	2.20349
1.27872	1.19949	0.573059	0.589891	2.22513
1.23724	1.16058	0.554470	0.570756	2.15295
-999.000	-999.000	-999.000	-999.000	-999.000
-999.000	-999.000	-999.000	-999.000	-999.000
-999.000	-999.000	-999.000	-999.000	-999.000
-9999.00	-9999.00	-9999.00	-9999.00	-9999.00

Figure 1. Sample value from “`ease25_thw_depth.1981.txt`”

These values correspond to the latitudes and longitudes of the grid points listed in "`E25_lon_lat_nh.txt`":

52.4834	137.231
52.3213	136.975
52.1583	136.721
51.9945	136.469
51.8299	136.219
51.6645	135.971
51.4982	135.725
51.3311	135.481

Figure 2. Sample data from "`E25_lon_lat_nh.txt`":

-99.00 denotes urban/built up areas.

-999.00 denotes water.

-9999.00 denotes grid points off the earth.

2 DATA ACQUISITION AND PROCESSING

2.1 Theory of Measurements and Processing Steps

Thaw depth can be estimated from a variant of the Stefan solution shown here.

$$Z = \sqrt{2k_t \left(\frac{n_t DDT_a}{P_b wL} \right)}$$ **(Equation 1)**

where:

Z = thaw depth (m)

k_t = the thermal conductivity of the thawed soil (Wm^{-1} $°C^{-1}$)

n_t = the n-factor for the thaw season

DDT_a = the annual thawing index (°C-day), defined as the cumulative number of degree-days above 0°C over a year

P_b = the soil bulk density (kg m^{-3})

w = the soil water content by weight (dimensionless)

L = the latent heat of fusion (J kg^{-1})

The relationship between thaw depth and the annual thawing index can be simplified using an catchall scaling parameter, the edaphic factor, E (Nelson and Outcalt, 1987):

$$Z = E\sqrt{DDT_a}$$ **(Equation 2)**

Where

$$E = \sqrt{\frac{2k_t n_t}{P_b w L}}$$ **(Equation 3)**

By rearranging equation 2, the investigators were able to calculate mean, median, maximum, minimum, and standard deviation edaphic factors for 104 sites in the Circumpolar Active Layer Monitoring (CALM) Network (Nelson et al. 2005). The E values vary spatially due to changes in land cover type and soil type. To evaluate spatial variability of the edaphic factor, the investigators categorized E values based on land cover type using a 1-km resolution global land cover characteristics data set (Knowles 2004). Thawing indices were taken from *Northern Hemisphere EASE-Grid Annual Freezing and Thawing Indices, 1901 - 2002* (Zhang et al. 2005a). Mean, median, maximum, minimum, and standard deviation (in depth) thaw depth values are calculated for the different E values. The approach is described in detail by Zhang et al. (2005b)

A similar approach can be used to calculate freeze depth in seasonally frozen ground areas:

$$Z = E\sqrt{DDF_a}$$ **(Equation 4)**

2.2 Data Source

Circumpolar Active Layer Monitoring Network (CALM) (Nelson et al. 2005): Established in the 1990s, CALM observes the long-term response of the active layer and near-surface permafrost to changes and variations in climate at more than 125 sites in both hemispheres.

Northern Hemisphere EASE-Grid Annual Freezing and Thawing Indices, 1901 - 2002 (Zhang et al. 2005a): These data were derived from the 1901-2002 0.5° gridded monthly global land temperatures from the University of East Anglia Climatic Research Unit (Mitchell and Jones, 2005).

EASE-Grid Land Cover Data Resampled from AVHRR Global 1 km Land Cover, Version 2, March 1992 - April 1993 (Knowles 2004): This data set is derived primarily from 1-km Advanced Very High Resolution Radiometer (AVHRR) satellite images spanning a 12-month period from April 1992 to March 1993 from the Global Land Cover Characteristics Database.

2.3 Quality, Errors, and Limitations

2.3.1 Errors and Uncertainty

The relationship between freeze/thaw depth and freezing and thawing indices has been demonstrated in several places. For example, Brown et al. (2000) review the relationship between thaw depth and the annual thawing index. Romanovsky and Osterkamp (1995), Zhang et al. (1997), Nelson et al. (1998), Klene et al. (2001), and Hinkel and Nelson (2003) all demonstrate the general validity of the approach. Nelson et al. (1997) used the approach to map active layer depth for the Kuparuk River Basin in Alaska. Zhang et al. (2005b) also use the approach to map active layer depth in the Ob, Yenisey, and Lena River Basins of Russia.

The quality of the input freezing and thawing indices is described in Frauenfeld, et al. (submitted) and in the documentation for the data set, Northern Hemisphere EASE-Grid Annual Freezing and Thawing Indices, 1901 - 2002. The investigators conclude they are adequate for broad scale analysis. The difficulty lies in calculating the edaphic factors. There is some uncertainty in the estimation of the edaphic factors as discussed in Zhang et al. (2005b). Overall this approach is reasonable for broad scale calculations and for estimating the response of freeze and thaw depth to different climatological factors.

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4 DOCUMENT INFORMATION

4.1 List of Acronyms

The following acronyms are used in this document:

ASCII: American Standard Code for Information Interchange
CALM: Circumpolar Active Layer Monitoring Network

EASE-Grid: Equal-Area Scalable Earth Grid

FTP: File Transfer Protocol

NSF: National Science Foundation

NSIDC: National Snow and Ice Data Center

URL: Uniform Resource Locator

4.2 Publication Date

31 January 2006

4.3 Date Last Updated

31 January 2006