Global Annual Freezing and Thawing Indices, Version 1

USER GUIDE

How to Cite These Data

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

Zhang, T. Z. 1998. *Global Annual Freezing and Thawing Indices, Version 1*. [Indicate subset used].
Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.
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National Snow and Ice Data Center

TABLE OF CONTENTS

1   DETAILED DATA DESCRIPTION

This data set consists of global, annual freezing and thawing indices calculated from monthly mean air temperatures compiled by Legates and Willmott (1990). The data have been interpolated to a 0.5° latitude by 0.5° longitude lattice.

In permafrost regions, annual freezing and thawing indices have been used to predict permafrost distribution and active layer extent, providing researchers with important information on climate variability as well as offering engineers information specific to cold region structural design. These indices can also be used in more temperate, permafrost-free regions to classify snow-type, estimate depth of ground-frost penetration, and predict the maximum thickness of sea, river and lake ice.

The freezing and thawing indices are defined as the cumulative number of degree-days below and above 0 degrees Celsius for a given time period (Permafrost Subcommittee 1988). Generally, four main types of freezing and thawing indices have been used: (i) approximate freezing and thawing indices; (ii) total annual freezing and thawing indices; (iii) seasonal freezing and thawing indices; and (iv) design freezing and thawing indices.

Global annual freezing and thawing indices were calculated at NSIDC from air temperature data compiled by Legates and Willmott (1990).

Strictly speaking, the indices should be called the 'Global Approximate Annual Freezing and Thawing Indices'. The global annual freezing and thawing indices measure the magnitude of air temperatures below (e.g., Northern Hemisphere late fall, winter and early spring) and above (e.g., Northern Hemisphere late spring, summer and early fall) 0 degrees Celsius over the course of one year. Most of the global mean monthly air temperatures were compiled between 1920 and 1980 over the terrestrial surface and between 1950 and 1979 over the oceanic surface (Legates and Willmott 1990). The global annual freezing and thawing indices are generally representative of the freezing and thawing climatology during that period.

The source data compiled by Willmott and Legates is a global climatology of mean monthly surface air temperatures. Terrestrial station records and oceanic grid-point records were interpolated to a 0.5 degree latitude by 0.5 degree longitude lattice using a spherically-based interpolation algorithm (Willmott and Legates 1990).

Willmott and Legates' data were acquired from various sources including Wernstedt 1972, Willmott et al. 1981, the National Center for Atmospheric Research (Spangler and Jenne 1984), the Commonwealth Scientific and Industrial Research Organization (CSIRO 1962-1971), the Australian Department of National Development (ADND 1965), and individual research stations in Antarctica

(van Rooy 1957; Schwerdtfeger 1984), China and the Far East (Nuttonson 1947; Terjung et al. 1985). Oceanic surface air temperature data were obtained from the Comprehensive Ocean-Atmospheric Data Set for the period 1950-1979 (Fletcher et al. 1983; Slutz et al. 1985; Woodruff 1985; Woodruff et al. 1987).

Potential errors in the freezing and thawing indices may include error from relocation of individual stations, exposure of instruments to the elements, human error in instrument readings, and instrument malfunction due to relocation. In addition, errors may have resulted from the compilation of the station air temperatures into the 0.5 by 0.5 grids. A detailed discussion of these errors can be found in Legates and Willmott (1990). Errors may also result from using monthly mean air temperature to calculate the annual freezing and thawing indices without making corrections for positive (above 0 degree Celsius) and negative (below 0 degree Celsius) degree-days in spring and fall, respectively. In the high Arctic, errors in calculating the annual freezing and thawing indices using both monthly mean and daily mean air temperatures are generally less than five percent (Zhang et al. 1996). However, in temperate regions, the errors can potentially become larger.

1.1 Format

Gridded data are available in *either* ASCII or binary format. The ASCII files are flat arrays (720 columns by 360 rows) consisting of a maximum of five characters (i.e., tens of thousands) to the left of the decimal place and two to the right (i.e., hundredths). Each ASCII entry is separated by a space. The binary data files are flat arrays (720 columns by 360 rows) of 4-byte floating point values.

The resolution of the data is 0.5 degrees latitude by 0.5 degrees longitude with the first grid cell located at 90 degrees North latitude, 180 degrees West longitude. The freeze_a.dat ASCII files (or freeze.dat binary files) contain the annual freezing index for each 0.5 by 0.5 grid cell, while the thaw_a.dat (and thaw.dat) files contain the annual thaw index. Each uncompressed file contains approximately one megabyte of data. Below is a short program to read the data using FORTRAN77:

```
parameter (COL = 720, ROW = 360)
REAL*4 DATA(ROW, COL)
OPEN(40, FILE = 'freez.dat', ACCESS = 'DIRECT',
RECL = 1036800, FORM='UNFORMATTED')
READ(40, REC = 1), ((DATA(I,K), K = 1, COL), I = 1,ROW)
```

1.2 File and Directory Structure

Data are available via HTTPS on the Download Data tab. The top-level directory contains five files:

00README

freez.dat

freez_a.dat (ASCII)

thaw.dat

thaw_a.dat (ASCII)

1.3 File Size

Data files are approximately 1 MB. ASCII files are approximately 2.2 MB.

1.4 Spatial Coverage

Global

1.4.1 Spatial Resolution

0.5°

1.5 Temporal Coverage

1920–1980

1.5.1 Temporal Resolution

Annual

2 REFERENCES AND RELATED PUBLICATIONS

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2.1 Related Data Collections

MEaSUREs Global Record of Daily Landscape Freeze/Thaw Status

3 CONTACTS AND ACKNOWLEDGMENTS

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4   DOCUMENT INFORMATION

4.1 Publication Date

August 1998

4.2 Date Last Updated

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