Elevation Change of the Southern Greenland Ice Sheet from 1978-88, Version 1

USER GUIDE

How to Cite These Data

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

Curt Davis, Craig Kluever, Bruce Haines 2001. *Elevation Change of the Southern Greenland Ice Sheet from 1978-88, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.

https://doi.org/10.5067/10JHXYLCEFVX. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0223

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DATA DESCRIPTION 2
1.1 Parameters 2
1.2 File Information 2
1.2.1 Format 2
1.2.2 Naming Convention 3
1.3 Spatial Information 3
1.3.1 Coverage 3
1.3.2 Resolution 3
1.4 Temporal Information 3
1.4.1 Coverage 3
2 DATA ACQUISITION AND PROCESSING 3
2.1 Processing 3
2.2 Quality, Errors, and Limitations 6
2.3 Instrumentation 6
2.3.1 Description 6
3 RELATED WEBSITES 7
4 CONTACTS AND ACKNOWLEDGMENTS 7
5 REFERENCES 7
6 DOCUMENT INFORMATION 8
6.1 Publication Date 8
6.2 Date Last Updated 8

1 DATA DESCRIPTION

Southern Greenland ice sheet elevation change estimates are derived from SEASAT and GEOSAT radar altimetry data from 1978 to 1988. Data are confined to 61-72 deg N, 30-50 deg W, above 1700 m elevation. The addition of GEOSAT Geodetic Mission (GM) data results in twice as many crossover points and 50% greater coverage than previous studies. Coverage above 2000 m elevation is improved to 90%, and about 75% of the area between 1700 m and 2000 m is now covered. Data are in ASCII text format, available via FTP, and consist of elevation change rate (dH/dt, cm/year) and corresponding error estimates in 50 km grid cells.

1.1 Parameters

Following are the first several lines of data in the file "JGRdHdtGridData.txt."

```
                    Radar dH/dt (cm/yr)
Lat 1    Lon1    Lat2    Lon2    Elev (m)        Original dH/dt  Revised dH/dt   Error (1 SE)
71.692   308.467 72.148  309.935 1964    -8.4    4.3     4.0
71.692   309.935 72.148  311.402 2146    -8.9    2.1     2.0
71.692   311.402 72.148  312.869 2424    -7.3    1.2     1.5
71.692   312.869 72.148  314.337 2597    -6.9    0.0     1.5
71.692   314.337 72.148  315.804 2767    -4.6    0.8     1.5
```

Figure 1. Sample Data

1.2 File Information

1.2.1 Format

Data are in tab-delimited ASCII text format with the following columns:

Lat 1: Latitude of lower-left corner point of each 50 km grid cell (decimal degrees)

Lon1: Longitude of lower-left corner point of each 50 km grid cell (decimal degrees)

Lat2: Latitude of upper-right corner point of each 50 km grid cell (decimal degrees)

Lon2: Longitude of upper-right corner point of each 50 km grid cell (decimal degrees)

Elev: Approximate average surface elevation of the ice sheet within each grid cell (m)

Original dH/dt: Elevation change (cm/year), uncorrected for problem of negative biases in the northwest part of the study area resulting from differences in surface conditions from strong melt years in 1977 and 1978. See Processing Steps in this document.

Revised dH/dt: Corrected elevation change (cm/year)

Error (1 SE): Reported as one standard error (SE), including contributions from random sampling variability and uncertainties in systematic corrections applied to data. These values are only valid for the "Original dH/dt" data.

File Size: The file "JGRdHdtGridData.txt" is 10 KB

1.2.2 Naming Convention

Data are provided in the file "JGRdHdtGridData.txt."

1.3 Spatial Information

1.3.1 Coverage

Southernmost Latitude: 61°N

Northernmost Latitude: 72°N

Westernmost Longitude: 30°W

Easternmost Longitude: 50°W

1.3.2 Resolution

Gridded spatial resolution is 50 km.

1.4 Temporal Information

1.4.1 Coverage

SEASAT: 28 June 1978 to 10 October 1978

GEOSAT Geodetic Mission (GM): March 1985 to September 1986

GEOSAT Exact Repeat Mission (ERM): November 1986 to December 1989

2 DATA ACQUISITION AND PROCESSING

2.1 Processing

Elevation change $dH = H(t_2) - H(t_1)$ over a given time interval $dt = t_2 - t_1$ was determined for each cell using the following equation (Davis et al. 2000):

$$dH = \frac{1}{2}\left\{\frac{1}{N_{AD}}\sum\left[H_A(t_2) - H_D(t_1)\right] + \frac{1}{N_{DA}}\sum\left[H_D(t_2) - H_A(t_1)\right]\right\}$$

Figure 2. Where A and D denote ascending and descending passes, respectively.

A global ocean reference network was constructed from four years of Topex/Poseidon altimeter data (Repeat Cycles 11-158, 01 January 1993 to 31 December 1996). This network provides an ideal framework for estimating radial orbit errors and systematic intersatellite and intrasatellite biases. Ice sheet elevation differences were computed at the crossover points between the GEOSAT (GM and ERM) and SEASAT satellite tracks. The crossover data were initially screened to ensure that instrument and environmental corrections were consistently applied to surface elevations. An editing procedure was used to eliminate altimeter waveforms where the initial waveform samples were exceptionally large and noisy (Davis et al. 2001).

The altimeter waveforms were retracked using a threshold algorithm designed specifically for measuring ice sheet elevation change. The Topex/Poseidon orbit error and intersatellite bias corrections were applied to the ice sheet crossover data using a root-difference-square as a measure of the magnitude of the orbit-error reduction in ocean and ice sheet data.

Elevation change data were spatially averaged to 50 x 50 km grid cells. This coarse spatial resolution provides a representative estimate of ice sheet change, because the elevation change data are heavily biased toward the northern interior of the ice sheet. A spatial average was then computed by averaging the individual results for all available cells. The following map shows estimated surface elevation change (Davis et al. 2001):

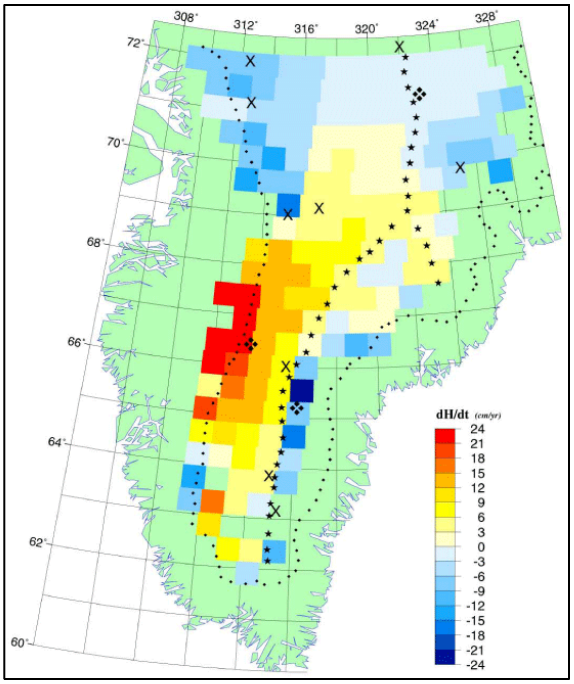

Figure 3. Uncorrected surface elevations.

This map is similar to the one published in Davis et al. (2000), with two important changes. First, Davis computed the average elevation change estimate for each 50 km grid cell after excluding individual elevation change measurements that exceeded two standard deviations (SD) from the primary Gaussian distribution (2 SD edit). This reduced the spatial variability of the dH/dt estimates between adjacent cells in a few areas with low numbers of measurements within a given cell. Second, Davis excluded dH/dt estimates for a given cell when the random error estimate exceeded ± 4 cm/yr after the 2 SD edit.

Many of the radar-based dH/dt estimates in the northwest part of the study area are negatively biased because of differences in surface conditions resulting from strong melt years in 1977 and 1978. Davis computed a linear regression between dH/dt estimates from 1993-1998 laser altimetry and 1978-1988 radar altimetry as a function of elevation. Radar dH/dt cells north of 70.5°N and west of 38°W were used in the regression along with radar dH/dt cells west of 43.5°W and 69.5 to 70.5°N (west of the radar dH/dt discontinuity). These areas show viable evidence that radar dH/dt measurements are erroneous (Davis et al. 2001).

Davis corrected the dH/dt values in these two areas using the average elevation within each radar dH/dt cell and a linear regression described in Davis et al. (2001). The following map shows the resulting corrected dH/dt estimates; the negative radar estimates in the northwest part of the study area are now slightly positive.

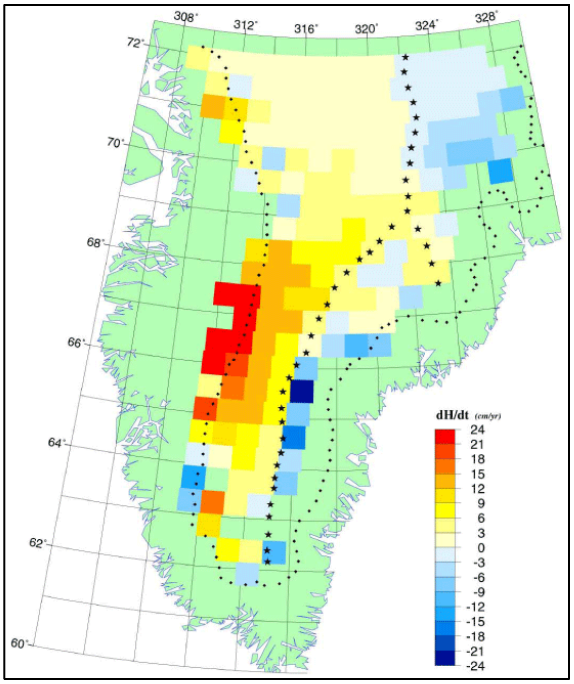

Figure 4. Corrected surface elevations.

2.2 Quality, Errors, and Limitations

Refer to Davis et al. 2000 for details of orbit error analysis with SEASAT and GEOSAT. Comparison with laser dH/dt results and other in-situ data indicates that a typical error value for elevation change estimates in a 50 km cell is approximately ± 2 cm/yr (Davis et al. 2001).

2.3 Instrumentation

2.3.1 Description

Although designed for data collection over oceans, SEASAT collected over 600,000 altimeter measurements from the continental Antarctic and Greenland ice sheets during a 90-day period. Over sloping and undulating surfaces or surfaces with variable reflective characteristics, SEASAT altimeter radar pulse measurements accelerated faster than the response capability of the altimeter tracking circuit, necessitating a retracking correction for each range value. GEOSAT was launched in 1985 and placed in a nearly identical orbit to SEASAT. The orbit was designed to provide high-density measurements over the Earth's surface, at a maximum grid spacing of 2.7 km at the equator and much denser spacing over polar ice sheets.

Refer to the GEOSAT and SEASAT instrument descriptions for further details.

3 RELATED WEBSITES

- Program for Arctic Regional Climate Assessment (PARCA)
- Documentation for GLAS/ICESat L1 and L2 Global Altimetry Data

4 CONTACTS AND ACKNOWLEDGMENTS

Curt Davis
Dept. of Electrical Engineering
University of Missouri

Craig Kluever
Dept. of Mechanical & Aerospace Engineering
University of Missouri

Bruce Haines
NASA Jet Propulsion Laboratory
California Institute of Technology

5 REFERENCES

Davis, C.H., J.R. McConnell, J. Bolzan, J.L. Bamber, R.H. Thomas, and E. Mosley-Thompson. 2001. Elevation change of the southern Greenland ice sheet from 1978 to 1998: interpretation. Journal of Geophysical Research 106(D24): 33,743-33,754.

Davis, C.H., C.A. Kluever, B.J. Haines, C. Perez, and Y. Yoon. 2000. Improved elevation change measurement of the southern Greenland ice sheet from satellite radar altimetry. IEEE Transactions on Geoscience and Remote Sensing 38(3): 1367-1378.

Davis, C.H, C.A. Kluever, and B.J. Haines. 1998a. Elevation change of the southern Greenland ice sheet. Science 279: 2086-2088.

Davis, C.H., C.A. Kluever, and B.J. Haines. 1998b. Comment: Growth of the southern Greenland ice sheet. Science 281: 1251.

Krabill, W., W. Abdalati, E. Frederick, S. Manizade, C. Martin, J. Sonntag, R. Swift, R. Thomas, W. Wright, and J. Yungel. 2000. Greenland ice sheet: high-elevation balance and peripheral thinning. Science 289: 428-430.

Krabill, W., E. Frederick, S. Manizade, C. Martin, J. Sonntag, R. Swift, R. Thomas, W. Wright, and J. Yungel. 1999. Rapid thinning of parts of the southern Greenland ice sheet. Science 283: 1522-24.

McConnell, J.R., R.J. Arthern, E. Mosley-Thompson, C.H. Davis, R.C. Bales, R. Thomas, J.F. Burkhart, and J.D. Kyne. 2000. Changes in Greenland ice sheet elevation attributed primarily to snow accumulation variability. Nature 406(6798): 877-879.

Thomas, R., T. Akins, B. Csatho, M. Fahnestock, P. Gogineni, C. Kim, and J. Sonntag. 2000. Mass balance of the Greenland ice sheet at high elevations. Science 289: 426-428.

Thomas, R.H., C.H. Davis, E. Frederick, S. Manizade, W. Krabill, J. McConnell, and J. Sonntag. 1999. Greenland ice-sheet elevation change since 1978 from radar and laser altimetry. Polar Geography 23(3): 169-184.

Zwally, H.J. 1989. Growth of Greenland ice sheet: interpretation. Science 246: 1589-1591.

Zwally, H.J., A.C. Brenner, J.P. DiMarzio. 1998. Comment: Growth of the southern Greenland ice sheet. Science 281: 1251.

Zwally, H.J., A.C. Brenner, J.A. Major, R.A. Bindschadler, and J.G. Marsh. 1989. Growth of Greenland ice sheet: measurement. Science 246: 1587-1589.

6 DOCUMENT INFORMATION

6.1 Publication Date

April 2004

6.2 Date Last Updated

24 May 2021