IceBridge BGM-3 Gravimeter L2 Geolocated Free Air Anomalies, Version 1

USER GUIDE

How to Cite These Data

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

Blankenship, D. D., Young, D. A., Richter, T. G., & Greenbaum, J. S. (2011, updated 2014). *IceBridge BGM-3 Gravimeter L2 Geolocated Free Air Anomalies* (IGBGM2, Version 1) [Data set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/8DJW56PKY133 [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/IGBGM2

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Summary

This data set contains free air anomaly measurements taken over Antarctica using the BGM-3 Gravimeter. The data were collected by scientists working on the Investigating the Cryospheric Evolution of the Central Antarctic Plate (ICECAP) project funded by the National Science Foundation (NSF) and the Natural Environment Research Council (NERC) with additional support from NASA Operation IceBridge.

1.2 Format

The data files are in space-delimited ASCII text format, with a header offset by # leading characters, corresponding to the NASA Aerogeophysical ASCII data standard. Each data file has an associated XML file which contains location, platform, and instrument metadata.

1.3 File Naming Convention

Files are named according to the following convention and as described in Table 1:

IGBGM2_YYYYDOY_AAA_JKBnx_XXXX_grvfld.xxx
IGBGM2_2011346_TOT_JKB2e_Y25a_grvfld.txt
IGBGM2_2011346_TOT_JKB2e_Y25a_grvfld.txt.xml

Table 1. Naming Convention

Variable	Description
IGBGM2	File name prefix indicating IceBridge BGM-3 Gravimeter L2 Geolocated Free Air Anomalies
YYYY	Four-digit year of survey
DOY	Day of year of survey
AAA	Geographic area
JKBnx	Host platform
XXXX	Geographic track line
grvfld	Gravity field
.xxx	Indicates ASCII text file (.txt), or XML file (.xml)

1.4 File Size

The data files range from approximately 21 KB to 842 KB. XML files range from approximately 10 KB to 54 KB.

1.5 Volume

The entire data set is approximately 61 MB.

1.6 Spatial Coverage

These data were primarily collected over the Wilkes Subglacial Basin and Aurora Subglacial Basin in East Antarctica.

Spatial coverage for this data set is Antarctica, represented by this extent:

Southernmost Latitude: 90° S
Northernmost Latitude: 53° S
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

1.6.1 Spatial Resolution

Smaller features are progressively suppressed due to low pass filtering to create final output. The filter used has a half amplitude point at 185 second wave period corresponding to about a 7.9 km wide gravity feature. For much of the survey, the distance to the gravity anomaly sources due to ice thickness precludes significantly smaller observable features.

1.6.2 Projection and Grid Description

WGS-84 ellipsoid; ITRF 2008

1.7 Temporal Coverage

These data were collected from 08 January 2009 to 21 December 2011* as part of ICECAP, NSF, NERC, and Operation IceBridge funded campaigns. The BGM-3 instrument was not flown during the Antarctica 2012 campaign

*Note: 2008 campaign data were acquired pre-IceBridge.

1.7.1 Temporal Resolution

ICECAP campaigns were conducted on an annual basis. East Antarctic campaigns for this data set typically extend from November to early January.

1.8 Parameter or Variable

1.8.1 Parameter Description

The BGM-3 Gravimeter L2 Geolocated Free Air Anomalies data files contain fields as described in Table 2.

Table 2. File Parameter Description

Parameter	Description	Units
YEAR	Year of survey	UTC
DOY	Day of Year of survey	UTC
SOD	Second of day	UTC
LON	Longitude	Decimal degrees WGS-84
LAT	Latitude	Decimal degrees WGS-84
GRV	Free Air Gravity Disturbance (WGS-84)	mGal
AC-ELEVATION	Aircraft elevation	Meters WGS-84

1.8.2 Sample Data Record

Figure 1 shows the first ten data records from the data file IGBGM2_2011346_TOT_JKB2e_Y25a_grvfld.txt.

```
# YEAR DOY SOD LON LAT GRV AC_ELEVATION
2011 346 24116.1000 114.687432 -66.620831 -5184.60 1281.00
2011 346 24117.1000 114.688261 -66.621525 2549.20 1280.93
2011 346 24118.1000 114.689097 -66.622217 -2486.20 1280.91
2011 346 24119.1000 114.689938 -66.622909 -4469.30 1281.40
2011 346 24120.1000 114.690781 -66.623599 -6449.40 1282.08
2011 346 24121.1000 114.691625 -66.624288 -2256.30 1282.62
2011 346 24122.1000 114.692472 -66.624977 932.70 1282.52
2011 346 24123.1000 114.693318 -66.625666 -2730.00 1282.18
2011 346 24124.1000 114.694161 -66.626355 -3144.40 1281.99
2011 346 24125.1000 114.695002 -66.627045 -1942.40 1281.99
```

Figure 1. Image showing the first ten data records from the data file IGBGM2_2011346_TOT_JKB2e_Y25a_grvfld.txt

1.9 Quality Assessment

The RMS of random error implied by crossover statistics is about 3.6 milligal. This is without the application of leveling algorithms.

2 DATA ACQUISITION AND PROCESSING

2.1 Theory of Measurements

This data set was created using the current standard techniques of use for stabilized platform airborne scalar gravimeters. The gravimeter consists of a high sensitivity accelerometer which is kept vertical via a gimbaled platform. Carrier phase GPS is recorded and post processed to determine the accelerations on the gravimeter which are due to aircraft motions. The vertical accelerations due to aircraft motions are subtracted from the vertical accelerations observed by the gravimeter to create a residual signal which consists of the measured acceleration due to gravity contaminated with noise and deterministic non-gravitational accelerations. This residual is corrected for known meter characteristics and other non-gravitational deterministic effects (Eotvos, etc.) then low pass filtered to produce the best estimate of the actual gravitational acceleration values.

2.2 Data Acquisition Methods

Gravity was measured using a BGM-3 gravity meter 203 on loan from the National Geospatial Intelligence Agency's Geodetic Survey division, St. Louis, MO. The output of the gravimeter consists of accelerations measured in real time. These accelerations are recorded at a rate of 1 Hz by the external data recording system which time stamps the data as they are acquired and recorded.

Dual frequency carrier phase GPS data were recorded separately for use in the gravity data processing.

2.3 Derivation Techniques and Algorithms

2.3.1 Input data

IceBridge BGM-3 Gravimeter L1B Time-Tagged Accelerations (IGBGM1B) and IceBridge GPS/IMU L1B Primary Position and Attitude Solution (IPUTG1B).

2.3.2 Trajectory and Attitude Data

The aircraft trajectory data is available in the position and height data included in the data records. These data were derived from post-processed carrier phase GPS records. Aircraft attitude data is available in the IPUTG1B data set listed above.

2.3.3 Processing Steps

Data were processed using dual carrier phase GPS solutions to estimate aircraft vertical and horizontal accelerations. Horizontal tilts of the stabilized platform were estimated using the equations of motion of the platform and horizontal accelerations derived from GPS positions. These tilts were used to derive tilt corrections to the vertical accelerations measured by the gravimeter. A finite impulse response low-pass filter with half amplitude frequency point of 0.0054 Hz (185 seconds) was then used to smooth the resulting data.

Data were automatically edited based on maximum allowed platform tilt and maximum allowed unfiltered acceleration variance thresholds. Very little manual editing was performed on the results which passed automatic editing. The final result is the disturbance from the WGS-84 model for the global gravity field.

The Free Air Correction was computed using the following formula:

Free Air Correction = (0.3087691) − (0.0004398*sin(LAT)2 * AC_ELEVATION) −(7.2125e-8 * (AC_ELEVATION2))

No continuation or leveling has been applied to the data. Missing values have been replaced by "nan".

3 VERSION HISTORY

On 02 July 2013, the V01 2009, 2010, and 2011 Antarctica data were replaced by V01.1. V01.1 data files include UTC timestamps and re-ordered fields.

On 31 May 2017, the entire data collection was replaced to correct erroneous data found in Column 6 (GRV) for some of the lines.

4 ERRORS AND LIMITATIONS

In Antarctica 2009, the primary platform failed after ICP2/F06 (J316/2009) and was replaced for ICP2/F12 (J331/2009).

In Antarctica 2010, the gravity meter suffered from drift issues, and the sensor cable was replaced post season.

Full leveling corrections were not performed for the Antarctica 2010 data set.

5 SENSOR OR INSTRUMENT DESCRIPTION

Gravity was measured using a BGM-3 gravity meter 203, on loan from the National Geospatial Intelligence Agency's Geodetic Survey division, St. Louis, MO. The BGM-3 is a two-axis stabilized platform system which uses an inertial grade accelerometer as the vertical acceleration sensor. Integrated acceleration data is recorded at 1 Hz by an external data acquisition device.

6 REFERENCES

Holt, J. W., T. G. Richter, S. D. Kempf, D. L. Morse, and D. D. Blankenship. 2006. Airborne Gravity Over Lake Vostok and Adjacent Highlands of East Antarctica, Geochemistry, Geophysics, Geosystems, 7:Q11,012, doi:10.1029/2005GC001177.

Swain, C.J. 1996. Horizontal Acceleration Corrections in Airborne Gravimetry. Geophysics, 61(1):273-276.

7 RELATED DATA COLLECTIONS

- IceBridge BGM-3 Gravimeter L0 Raw Accelerations
- IceBridge BGM-3 Gravimeter L1B Time-Tagged Accelerations
- IceBridge ZLS Dynamic Gravity Meter Time-Registered L1B Vertical Accelerations

8 ACKNOWLEDGMENTS

This data set was funded by NASA's Operation Ice Bridge (grant NNX11AD33G) to the University of Texas at Austin. 2008 campaign data were acquired pre-IceBridge.

9 DOCUMENT INFORMATION

9.1 Publication Date

February 2015

9.2 Date Last Updated

March 2025