IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies, Version 1

USER GUIDE

How to Cite These Data

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

Tinto, K., R. E. Bell, and J. R. Cochran. 2010. *IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/R1RQ6NRIJV89. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/IGGRV1B

NSIDC National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

The AIRGrav data contain gravity measurements including acceleration data in three orthogonal directions. Gravity data include latitude and Eotvos-corrected values, and the free air correction at various along-flight-line time filtering scales.

1.1 Format

Each data file is in space-delimited ASCII text format (`.txt`) with an associated XML file (`.xml`), which contains additional metadata.

1.2 File Naming Convention

Example file names:

```
IGGRV1B_20120517_10222100_V015.txt
IGGRV1B_20120517_10222100_V015.txt.xml
IGGRV1B_20181116_13105600_V019.txt
IGGRV1B_20181116_13105600_V019.txt.xml
```

Files are named according to the following convention, which is described in more detail in Table 1.

```
IGGRV1B_YYYYMMDD_NNNNNNNN_VXXX.xxx
```

Table 1. Gravity Data File Naming Convention

Variable	Description
IGGRV1B	Short name for IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
NNNNNNNN	Seconds of day
VXXX	Mission data version: • V015 for Greenland campaigns • V019 for Antarctica campaigns
.xxx	Indicates file type ASCII text (.txt) or XML metadata file (.txt.xml)

1.3 File Size

ASCII text files range from approximately 5 MB to 23 MB. The entire data set volume is approximately 4.7 GB.

1.4 Spatial Coverage

Spatial coverage includes the Greenland and Antarctic areas, as noted by the two coverages below.

<u>Arctic / Greenland:</u>
Southernmost Latitude: 60° N
Northernmost Latitude: 90° N
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

<u>Antarctic:</u>
Southernmost Latitude: 90° S
Northernmost Latitude: 53° S
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

1.4.1 Spatial Resolution

Spatial resolution depends on the airplane speed and the length of the filter. This is typically 5 km to 7 km, or *aircraft speed* * (70 s to 140 s). Narrow features can be detected, but generally with reduced amplitude.

1.4.2 Projection and Grid Description

Projection: Polar Stereographic.
Grid: 5-7 km spatial grid depending on data line spacing.

1.5 Temporal Coverage

16 October 2009 to 17 November 2018

1.5.1 Temporal Resolution

IceBridge campaigns are conducted on an annually repeating basis. Arctic and Greenland campaigns are typically conducted during March, April, and May; Antarctic campaigns are typically conducted during October and November.

1.6 Parameter or Variable

This data set contains gravity measurements. Gravity data are measured as accelerations along three orthogonal axes, and are reduced to free Air Gravity anomaly values by removing the accelerations due to aircraft motion.

1.6.1 Parameter Description

Gravity Data File Parameters

The format is 19 columns separated by spaces. Columns are shown in Table 2.

Table 2. Gravity Data Parameter Description

Col	Name	Format	Units	Description
1	LAT	F15.7	Degrees	Latitude decimal degrees WGS-84
2	LONG	F15.7	Degrees	Longitude decimal degrees WGS-84
3	DATE	I10	N/A	Date (YYYYMMDD)
4	DOY	I6	N/A	Day of year
5	TIME	F11.2	Seconds	UTC seconds past midnight (continuous, does not roll over)
6	FLT	I8	N/A	Flight number
7	PSX	F15.2	Meters	EPSG:3031 WGS-84 Antarctic Polar Stereographic X
8	PSY	F15.2	Meters	EPSG:3031 WGS-84 Antarctic Polar Stereographic X
9	WGSHGT	F11.2	Meters	Height WGS-84 (height above GRS80 ellipsoid)
10	FX	F15.2	mGal	Gravimeter X acceleration
11	FY	F15.2	mGal	Gravimeter Y acceleration
12	FZ	F15.2	mGal	Gravimeter Z acceleration
13	EOTGRAV	F15.2	mGal	Eotvos and latitude corrected gravity, unfiltered
14	FACOR	F11.2	mGal	Free air correction
15	INTCOR	F11.2	mGal	Intersection levelling correction
16	FAG070	F11.2	mGal	Free Air Gravity, 70s full wavelength line filter

Col	Name	Format	Units	Description
17	FAG100	F11.2	mGal	Free Air Gravity, 100s full wavelength line filter
18	FAG140	F11.2	mGal	Free Air Gravity, 140s full wavelength line filter
19	FLTENVIRO	I11	N/A	-1 = no data, 0 normal conditions, 1 = disturbed conditions

Line Filter Parameters:

70s full wavelength line filter

= 0% pass at 52.5s, 100% pass at 105s full wavelength
= approximately 5.2 km half-wavelength resolution at 150 m/s flying speed

100s full wavelength line filter

= 0% pass at 75s, 100% pass at 150s full wavelength
= approximately 7.5 km half-wavelength resolution at 150 m/s flying speed

140s full wavelength line filter

= 0% pass at 105s, 100% pass at 210s full wavelength
= approximately 10.5 km half-wavelength resolution at 150 m/s flying speed

The flight environment indicates data availability. At present, it is a simple flag based on aircraft flight dynamics.

0 = Normal data
1 = Data present, but acquired during high flight dynamics (such as aircraft manoeuvring) and should be used carefully. The stronger line filtered version should be considered.
−1 = No data due to aircraft motion (such as in turns)

Locational Data:

All positions are corrected to the center of the gravimeter. They are NOT at the GPS antenna locations. Positions are post-processed, differentially corrected GPS, matched to gravimeter system time.

2 SOFTWARE AND TOOLS

NSIDC provides MATLAB readers that can read aircraft gravity data files. The data files also may be opened by any ASCII text reader.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

The gravimeter is located as close to the airplane center of mass as possible. Simultaneously acquired gravimeter output GPS data are recorded on hard disks on the plane. Following the flight this data is downloaded onto a PC for processing.

3.2 Derivation Techniques and Algorithms

The gravity signal is extracted from an inertially based system in which a small mass is suspended within a magnetic field. Tiny variations in the acceleration of the gravimeter produce small electrical signals in the sensor as the mass moves within the magnetic field.

A routine that examines horizontal acceleration was used to determine where lines begin and end for the purposes of gravity data, since gravity data is perturbed by strong maneuvering. The line numbering convention used is 1FFF.XX where FFF is the flight number and XX is the extension number. Each new line in a flight is denoted by an increment in the extension number. For example, 1017.04 is the 4th line detected in flight 17. In some cases, lines were included even though they exceeded the horizontal acceleration limits. These lines have extension numbers greater than 50. For example, 1017.52 is the 2nd line in flight 17 that was retained despite the aircraft maneuvering during the line. The accuracy of data on these lines may be reduced, but they are retained to provide coverage in areas where no other gravity data exist.

3.2.1 Grid Filter Parameters

The FAG140 free Air Gravity 140s full wavelength line filter contains data sampled from a filtered grid. The degree of filtering was chosen to suit the area in question. This represents the best gravity data, as grid filtering can lower noise levels by averaging across adjacent lines if the lines are spaced tightly enough. It also produces a consistent data set by averaging together line crossings.

Table 3. Grid Filters Used for 2009-2011 Antarctica

Area	Grid Filter
Coats / Filchner	7000 m half-wavelength spatial filter
Pine Island / Thwaites	6000 m half-wavelength spatial filter
Abbott	7000 m half-wavelength spatial filter
Larson	7000 m half-wavelength spatial filter
Pine Island (high altitude)	7000 m half-wavelength spatial filter
Peninsula (high altitude)	5000 m half-wavelength spatial filter

3.2.2 Line Filter Parameters

Line filter parameters for 2009-12 Antarctica data are as follows:

- 70s full wavelength line filter = 0% pass at 52.5s, 100% pass at 105s full wavelength = approximately 5.2 km half-wavelength resolution at 150 m/s flying speed
- 100s full wavelength line filter = 0% pass at 75s, 100% pass at 150s full wavelength = approximately 7.5 km half-wavelength resolution at 150 m/s flying speed
- 140s full wavelength line filter = 0% pass at 105s, 100% pass at 210s full wavelength = approximately 10.5 km half-wavelength resolution at 150 m/s flying speed

Line filter parameters for the 2010-2012 Greenland data are as follows:

- 70s full wavelength line filter = 0% pass at 52.5s, 100% pass at 105s full wavelength = approximately 5.2 km half-wavelength resolution at 150 m/s flying speed
- 100s full wavelength line filter = 0% pass at 75s, 100% pass at 150s full wavelength = approximately 7.5 km half-wavelength resolution at 150 m/s flying speed
- 140s full wavelength line filter = 0% pass at 105s, 100% pass at 210s full wavelength = approximately 10.5 km half-wavelength resolution at 150 m/s flying speed

3.2.3 Processing Steps

The following processing steps are performed by the data provider:

1. The gravimeter data are filtered and decimated to 10 Hz to match the GPS data.
2. GPS-derived accelerations are subtracted from the data.
3. The gravity is corrected for the Eotvos effect.
4. The expected gravity at the measurement latitude is subtracted.
5. The resulting anomalies are decimated to 2 Hz and low-pass filtered to suppress noise.
6. The free-air correction is applied.
7. Quality control is performed and artifacts are removed.
8. Data is broken up into straight line segments to remove effects of horizontal accelerations during turns.
9. Final quality control is performed.

3.2.4 Version History

Version 1.1: On 01 October 2010, all of the 2010 Greenland data were replaced by V1.1. Although there were no errors in the data, the transformation to the Scientific Committee of Antarctic Research (SCAR) Polar Stereographic projection was faulty.

Version 1.2: On 27 June 2011, all of the 2009 Antarctica data were replaced by V1.2. The previous version of the data required re-processing because an error was discovered in the aircraft attitude data files that caused a rotation by 180 degrees. Additionally, after 2009, gravity data processing was changed from a simple free air correction formula to a second order free air correction and there have been processing improvements that reduce noise levels, especially at shorter wavelengths (70s) on some lines. Thus, the 2009 Antarctica data files were re-processed for second order free air correction and reduction of noise levels.

Version 1.3: On 21 May 2012, the 2009 and 2010 Antarctica data were replaced by V1.3. The previous data versions were organized regionally by glacier basin. V1.3 gravity data are organized by flight lines.

Version 1.4: On 26 November 2012, the 2010 and 2011 Greenland data were replaced by V1.4. The V1.4 data are arranged by flight, rather than broken into lines grouped by area. The last field in the data files is now a data quality flag, instead of a gridded value. Aircraft attitude data are no longer included.

Version 1.5: On 28 February 2013, the 2009, 2010, and 2011 Antarctica data were replaced by V1.5. The V1.5 data are arranged by flight, rather than broken into lines grouped by area. The file naming convention has changed. The grid column has been removed from the data files. The data have been re-leveled. In a few places the data values may be slightly different than in older versions. The leveling adjustments are very small, approximately 0.1 to 0.3 mGal, and are present only for new lines during 2012 in an area where only a few lines were flown, such as the Foundation/Recovery area. The leveling adjustment is given in data column 18. It is a constant offset for a particular track line and thus does not affect interpretation. The replacement 2010 Antarctica data contain one data file less than the previous version. The file IGGRV1B_V01_20101018.xyz was a transit flight where the meter was being tested, and was removed because it does not apply to Antarctica.

Version 1.6: On 20 August 2013, the IGGRV1B Greenland data files were replaced for the following dates: 05 May 2010 to 28 May 2010, 14 March 2011 to 16 May 2011, and 12 March 2012 to 17 May 2012. For the data captured on these days, the platformID was changed from DC-8 to P-3B.

Version 1.7: On 10 June 2014, all IGGRV1B Greenland and Antarctica data files from 16 October 2009 to 07 November 2012 were replaced. The file format was changed to adhere to the NASA ASCII text standard. There was no change in processing or data values.

Version 1.8: On 26 July 2017, the entire IceBridge IGGRV1B data set was replaced with re-leveled data to ensure consistency within the entire data set. This version uses a different leveling protocol than previous versions. Additionally, the Fall 2016 Antarctica data were added at this time.

3.3 Sensor or Instrument Description

The gravity instrument is a Sander AIRGrav designed for airborne applications. The AIRGrav system consists of a three-axis, gyro-stabilized, Schuler-tuned inertial platform on which three orthogonal accelerometers are mounted. The primary gravity sensor is the vertical accelerometer that is held within 10 arc-seconds (0.0028 degrees) of the local vertical by the inertial platform, monitored through the complex interaction of gyroscopes and two horizontal accelerometers (Sander et al., 2004). An advantage of the AIRGrav system over other airborne gravimeters is that it is capable of collecting high-quality data during draped flights (Studinger et al., 2008). The gravimeter records accelerations arising from variations in the Earth's gravity field and accelerations experienced by the airplane. These accelerations are recorded at 128 Hz. Aircraft accelerations are obtained utilizing differential GPS measurements. The gravity data rate is 2 Hz.

4 REFERENCES AND RELATED PUBLICATIONS

Sander, S., M. Argyle, S. Elieff, S. Ferguson, V. Lavoie, and L. Sander. 2004. The AIRGrav airborne gravity system, in *Airborne Gravity 2004 - Australian Society of Exploration Geophysicists Workshop*, edited by R. Lane, pp. 49-53, Geoscience Australia, http://www.ga.gov.au/image_cache/GA16642.pdf.

Studinger, M., R. E. Bell, and N. Frearson. 2008. Comparison of AIRGrav and GT-1A airborne gravimeters for research applications, *Geophysics*, 73: 151-161.

4.1 Related Data Collections

IceBridge Sander AIRGrav L3 Bathymetry

4.2 Related Websites

IceBridge data website at NSIDC

IceBridge website at NASA

ICESat/GLAS website at NASA Wallops Flight Facility

ICESat/GLAS website at NSIDC

Improving GLAS data using GRACE

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

March 2011

6.2 Date Last Updated

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