IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies, Version 2

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. 2025. *IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/PEN1C60T9EAV. [Date Accessed].

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

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

National Snow and Ice Data Center

T2.0

TABLE OF CONTENTS

1 DATA DESCRIPTION

1.1 Summary

This data set contains gravity measurements, including acceleration data in three orthogonal directions, from the Sander Geophysics AIRGrav airborne gravity system. Gravity data include latitude and Eotvos-corrected values, as well as free air correction at various along-flight-line time filtering scales. The data were collected as part of Operation IceBridge funded campaigns.

1.2 Parameters

1.2.1 Gravity Data File Parameters

The data file parameters are shown in Table 1.

Table 1. 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 designated for gravity processing purposes
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 Y
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	FACOR	F11.2	mGal	Free air correction
14	INTCOR	F11.2	mGal	Intersection leveling correction
15	FAG070	F11.2	mGal	Free air gravity, 70 s full wavelength line filter
16	FAG100	F11.2	mGal	Free air gravity, 100 s full wavelength line filter
17	FAG140	F11.2	mGal	Free air gravity, 140 s full wavelength line filter
18	ACC_HOR	F11.3	m/s^2	Horizontal acceleration
19	ACC_VER	F11.3	m/s^2	Vertical acceleration

The horizontal and vertical accelerations (ACC_HOR and ACC_VER) are provided as a gauge of aircraft motion, which can impact gravity data. Caution should be exercised when using gravity data acquired in a highly dynamic flight environment, such as a turn.

1.3 File Information

1.3.1 Format

Each data file is in space-delimited ASCII text format (`.txt`).

1.3.2 Naming Convention

Files are named according to the following convention, which is described in more detail in Table 2:

`IGGRV1B_YYYYMMDD_NNNNNNnn_VXXX.txt`

Example:

`IGGRV1B_20091016_11515650_V020.txt`

Table 2. File Naming Convention

Variable	Description
`IGGRV1B`	IceBridge Sander AIRGrav L1B Geolocated Free Air Gravity Anomalies data product
`YYYYMMDD`	Four-digit year, two-digit month, and two-digit day of data acquisition
`NNNNNNnn`	Seconds of day up to the half second (e.g., `115156.50`)
`VXXX`	Mission data version: V020

1.4 Spatial Information

1.4.1 Coverage

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

Arctic / Greenland:

Southernmost Latitude: 60° N

Northernmost Latitude: 90° N

Westernmost Longitude: 180° W

Easternmost Longitude: 180° E

Antarctic:

Southernmost Latitude: 90° S

Northernmost Latitude: 53° S

Westernmost Longitude: 180° W

Easternmost Longitude: 180° E

1.4.2 Resolution

Spatial resolution depends on the airplane speed and the length of the filter, typically 5 to 7 km. Narrow features can be detected but generally with reduced amplitude.

1.4.3 Geolocation

WGS 84 / Antarctic Polar Stereographic (EPSG: 3031)

WGS 84 / NSIDC Sea Ice Polar Stereographic North (EPSG: 3413)

1.5 Temporal Information

1.5.1 Coverage

16 October 2009 to 17 November 2018

1.5.2 Resolution

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

2 DATA ACQUISITION AND PROCESSING

2.1 Background

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.

2.2 Acquisition

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

2.3 Processing

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.

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 ellipsoidal normal gravity at the measurement latitude is subtracted.
5. The data are decimated to 2 Hz and low-pass filtered to suppress noise.
6. The free-air correction with respect to ellipsoidal height is applied.
7. Error model and GPS acceleration analysis is conducted to further reduce noise.
8. Leveling corrections are applied based on a statistical analysis of overlapping and intersecting data, then interpolated through turns.
9. Final quality control is performed.

The free air gravity filter parameters are the gravity anomalies (mGal) calculated with different low-pass filters, resulting in different resolutions. FAG070 is the 70-second wavelength line filter (5.2 km half-wavelength resolution at 150 m/s flying speed), FAG100 is the 100-second wavelength line filter (7.5 km half-wavelength resolution at 150 m/s flying speed), and FAG140 is the 140-second wavelength line filter (10.5 km half-wavelength resolution at 150 m/s flying speed).

2.4 Quality, Errors, and Limitations

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.

3 VERSION HISTORY

Table 3. Version History Summary

Version	Date Implemented	Impacted Temporal Coverage	Description of Changes
2.0	6 Feb 2025	16 Oct 2009 to 17 Nov 2018	A re-analysis of the entire data set was performed using continuous flights of data instead of subdividing flights into sections that were defined as “normal”, “disturbed”, and “no data” based on aircraft motion to avoid discontinuities and coverage gaps. The Flight Environment flag (FLTENVIRO) has been replaced with horizontal and vertical acceleration data (ACC_HOR, ACC_VER). Leveling corrections were interpolated through flight turns to maintain continuous data while avoiding the influence of turn effects. The re-analysis also includes general improvements to noise levels throughout the entire data set.
1.8	26 Jul 2017	16 Oct 2009 to 18 Nov 2016	The entire data set was replaced with re-leveled data to ensure consistency. This version uses a different leveling protocol than previous versions. Additionally, Fall 2016 Antarctica data were added.
1.7	10 Jun 2014	16 Oct 2009 to 7 Nov 2012	Greenland and Antarctica data files were replaced with no change in processing or data values. The file format was changed to adhere to the NASA ASCII text standard.
1.6	20 Aug 2013	5 May 2010 to 17 May 2012	Greenland data files were replaced to change the platformID from DC-8 to P-3B.

1.5	28 Feb 2013	16 Oct 2009 to 19 Nov 2011	The 2009, 2010, and 2011 Antarctica data were replaced. In this version, the data were arranged by flight, rather than broken into lines grouped by area. The file naming convention changed, the grid column was removed from the data files, and the data were re-leveled. In a few places, the data values may be slightly different than in older versions. The leveling adjustments were 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 adjustment is a constant offset for a particular track line and 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 removed because it was a transit flight for which the meter was being tested.
1.4	26 Nov 2012	22 Mar 2010 to 16 May 2011	The 2010 and 2011 Greenland data were replaced. The V1.4 data were 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.
1.3	21 May 2012	19 Oct 2009 to 20 Nov 2010	The 2009 and 2010 Antarctica data were replaced. The previous data versions were organized regionally by glacier basin. V1.3 gravity data were organized by flight lines.
1.2	27 Jun 2011	16 Sep 2009 to 18 Oct 2009	All of the 2009 Antarctica data were replaced. 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 180º. Additionally, after 2009, gravity data processing was changed from a simple free air correction formula to a second-order free air correction. Processing improvements have reduced noise levels, especially at shorter wavelengths (70 s) on some lines.
1.1	1 Oct 2010	22 Mar 2010 to 28 May 2010	All of the 2010 Greenland data were replaced. Although there were no errors in the data, the transformation to the Scientific Committee of Antarctic Research (SCAR) Polar Stereographic projection was faulty.
1.0	25 Jun 2010		Initial release

4 RELATED DATA SETS

IceBridge Sander AIRGrav L3 Bathymetry

5 RELATED WEBSITES

IceBridge at NSIDC

IceBridge at NASA

ICESat/GLAS at NSIDC

6 ACKNOWLEDGMENTS

Data collection was supported by NASA grants NNX09AR49G, NNG10HP20C, and NNX10AT69G. Thanks to Stefen Elieff, Kevin James, Sean O'Rourke, and Eric Renaud from Sander Geophysics, as well as Kirsteen Tinto, Indrani Das, and Timothy Creyts from Lamont-Doherty Earth Observatory for participating in data collection.

7 REFERENCES

Sander, S., Argyle, M., Elieff, S., Ferguson, S., Lavoie, V., & Sander, L. (2004). The AIRGrav airborne gravity system. In R. Lane *(Ed.), Airborne Gravity 2004. Abstracts from the ASEG-PESA Airborne Gravity 2004 Workshop* (pp. 49–53). Geoscience Australia. https://www.ga.gov.au/bigobj/GA16642.pdf

Studinger, M., Bell, R. E., & Frearson, N. (2008). Comparison of AIRGrav and GT-1A airborne gravimeters for research applications. *Geophysics*, *73*(6), 151–161. https://doi.org/10.1190/1.2969664

8 DOCUMENT INFORMATION

8.1 Publication Date

February 2025

8.2 Date Last Updated

February 2025