Sea Ice Mass Balance in the Antarctic (SIMBA), Version 1

USER GUIDE

How to Cite These Data

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

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1 OVERVIEW

The Sea Ice Mass Balance in the Antarctic (SIMBA) project was a study conducted in the Southern Ocean from October 2007 through December 2007 with an additional buoy deployment campaign conducted from February 2009 through March 2009. Three ice mass balance (IMB) buoys were deployed on a pack ice floe called the Belgica Floe Drift Station in the Bellingshausen Sea while the research vessel, icebreaker Nathaniel B. Palmer, drifted along with the floe. The goal of the project was to determine the evolution of Antarctic sea ice cover and the mass balance of ice in the Amundsen Sea and the Bellingshausen Sea in the Southern Ocean during the International Polar Year (2007-2008) as part of the IPY Antarctic Sea Ice Program. The SIMBA project used the Nathaniel B. Palmer and employed drifting buoys as a main source of measurements. These buoys were endorsed as an IPY contribution to the World Climate Research Program/Scientific Committee on Antarctic Research (WCRP/SCAR) International Programme on Antarctic Buoys (IPAB).

For this study three IMB's were equipped with thermistor strings, ice and snow thickness measurement gauges, meteorological sensors for measuring atmospheric pressure, temperature, and incoming radiation, and oceanographic sensors just under the ice that measured salinity, temperature, and light transmission. In addition to the buoy data, in situ data were also acquired from ice cores and snow pits in the vicinity of the camp on the Belgica Floe. The data from these three buoys and the drifting station in situ measurements are presented here as this data set.

2 DETAILED DATA DESCRIPTION

The data files in this data set are broken up into three categories by type of data:

- Ice Cores
- Sea Ice Thickness Database (SITD)
- SIMBA Buoy Data

2.1 Format

2.1.1 Ice Cores

All measurements collected from ice cores during the SIMBA project are in one Excel file: SIMBA-ice-core-data.xlsx. It contains 30 sheets: 13 sheets with the data and 17 sheets with graphs. Data were taken at these sites: Brussels, Liege, and Stations 1, 2, and 3. Measurements taken from the ice cores are temperature, salinity, brine volume, and delta-O-18.

2.1.2 Brussels Site

At the Brussels site, five ice cores were taken over a period of five days. These ice cores serve as a time series from the same ice floe (within 10m of each other) where the camp was moored. The first five sheets of the SIMBA-ice-core-data.xlsx file contains the data from these five ice cores and the next four sheets contain graphs of Brussels data. Table 1 describes the sheets for Brussels data and Table 2 describes the columns in the data sheets.

Table 1. Ice Core Spreadsheet Contents: Brussels Site (Sheets 1-9)

Sheet Name	Contents
BXL-Z_data	Data sheets from Brussels site where Z is the ice core number: 1, 2, 3, 4, and 5. See Table 2 for column descriptions. Any data in columns to the right of the ones described in Table 2 are for graphing purposes only and can be ignored.
Br_Frozen_graph	Graph showing the δ18O (‰) versus depth (m) and the frozen salinity (psu) versus depth (m) for the 5 Brussels ice cores. Black = BXL-1, Blue = BXL-2, Green = BXL-3, Orange = BXL-4, Red = BXL-5
Br_InSitu_graph	Graph showing the in situ salinity (psu) versus depth (m) and temperature (°C) versus depth (m) for the 5 Brussels ice cores. Black = BXL-1, Blue = BXL-2, Green = BXL-3, Orange = BXL-4, Red = BXL-5
Br_Brine_Vol_graph	Graph showing the calculated relative brine volume (decimal fraction of total volume) versus depth (m) for the 5 Brussels ice cores. Black = BXL-1, Blue = BXL-2, Green = BXL-3, Orange = BXL-4, Red = BXL-5
Br_Brine_Salinity_graph	Graph showing the calculated brine salinity (psu) versus depth (m) for the 5 Brussels ice cores. Black = BXL-1, Blue = BXL-2, Green = BXL-3, Orange = BXL-4, Red = BXL-5

Table 2. Column Descriptions of the Ice Core Data Sheets

Column Name	Description	Column Name	Description
Depth (m)	Depth, in meters, that measurement was taken.	Computed brine salinity (psu)	The brine salinity is computed using the in situ temperature on a section of ice core and using the phase diagram for sea ice which gives the salinity as a function of temperature, for temperature below the freezing point for seawater of 34 psu (approximately -1.85 °C). Note: BXL and Liege sheets only.
Temp (°C)	Temperature, in °C, for a specific depth.	Sbio Mean Depth (cm)	Average depth, in cm, of the Sbio measurement. The Sbio measurement was an extra set of ice core measurements taken to address biological analysis of the ice cores. Note: BXL and Liege sheets only.
Top in situ salinity sample depth (m)	The ice core was divided into sections, nominally 10 cm long. This is the top depth of a particular section of core where the in situ salinity measurement was taken.	Sbio Mean Depth (m)	Average depth, in m, of the Sbio measurement. Note: BXL sheets only.
Bottom in situ salinity sample depth (m)	This is bottom depth of a particular section of core, usually about 10 cm (.1 m) less than the top limit, where the in situ salinity measurement was taken. Core depth is measured down from the surface.	Sbio Depth Interval (cm)	Depth interval, in cm, of the Sbio measurements. Note: BXL and Liege sheets only.
Mean depth of in situ salinity (m)	Average of the top and bottom depths, in m, of the in situ salinity measurements.	Frozen Salinity (psu)	The salinity of the melted ice core sample, in psu.
In situ Salinity (psu)	In situ salinity, in psu, for a specific depth.	δO^{18}	A measure of the ratio of stable isotopes oxygen-18 (^{18}O) and oxygen-16 (^{16}O) permil (‰) for a specific depth.

Column Name	Description	Column Name	Description
Interpolated temperature (°C)	The temperature corresponding to the mean depth of the in situ salinity is linearly interpolated from the two nearest in situ temperature measurements to that mean depth. Note: BXL and Liege sheets only.	Top Depth frozen Salinity (m)	The ice core was divided into sections, nominally 10 cm long. This is the top depth of a particular section of core where the frozen salinity measurement was taken. Note: Station 1, 2, and 3 sheets only.
Depth of relative brine volume (m)	Depth, in m, of computed relative brine volume measurement. Note: BXL and Liege sheets only.	Bottom Depth frozen salinity (m)	This is bottom depth of a particular section of core, usually about 10 cm (.1 m) less than the top limit, where the frozen salinity measurement was taken. Core depth is measured down from the surface. Note: Station 1, 2, and 3 sheets only.
Computed relative brine volume	Brine volume is computed using the measured in situ temperature taken onsite of an ice core and then measuring the meltwater salinity of the ice core section by section. Expressed as a volume fraction so dimensionless. Note: BXL and Liege sheets only.	Mean Depth frozen salinity (m)	Average of the top and bottom depths, in meters, of the frozen salinity measurements. Note: Station 1, 2, and 3 sheets only.

2.1.3 Liege Site

At the Liege site, five ice cores were taken over a period of five days. These are a time series of ice cores from the same ice floe (within 10 m of each other) where the camp was moored. Sheets 10 through 14 of the SIMBA-ice-core-data.xlsx file contains the data from each of the Liege sub-sites and sheets 15 through 18 contain graphs of Liege data. Table 3 describes the sheets for Liege data and Table 2 describes the columns.

Table 3. Ice Core Spreadsheet Contents: Liege Site (Sheets 10-18)

Sheet Name	Description
LIEGE-Z_data	Data from Liege site where Z is the ice core number: 1, 2, 3, 4, and 5. See Table 2 for column descriptions. Any data in columns to the right of the ones described in Table 2 are for graphing purposes only and can be ignored.
Liege_Frozen_graph	Graph showing the δ18O (‰) versus depth (m) and the frozen salinity (psu) versus depth (m) for the 5 Liege ice cores. Black = Leige-1, Blue = Liege-2, Green = Liege-3, Orange = Liege-4, Red = Liege-5
Liege_InSitu_graph	Graph showing the in situ salinity (psu) versus depth (m) and temperature (°C) versus depth (m) for the 5 Liege ice cores. Black = Leige-1, Blue = Liege-2, Green = Liege-3, Orange = Liege-4, Red = Liege-5
Liege_Brine_Vol_graph	Graph showing the calculated relative brine volume (decimal fraction of total volume) versus depth (m) for the 5 Liege ice cores. Black = Leige-1, Blue = Liege-2, Green = Liege-3, Orange = Liege-4, Red = Liege-5
Liege_Brine_Salinity_graph	Graph showing the calculated brine salinity (psu) versus depth (m) for the 5 Liege ice cores. Black = Leige-1, Blue = Liege-2, Green = Liege-3, Orange = Liege-4, Red = Liege-5

2.1.4 Stations 1, 2, and 3

Stations 1, 2, and 3 were taken on the inbound track to the Ice Station Belgica floe. Sheets 19 through 21 of the SIMBA-ice-core-data.xlsx file contains the data from Stations 1, 3, and 3 and sheets 22 through 30 contain graphs of the data. Table 4 describes the sheets for Stations 1, 2, and 3 data and Table 2 describes the columns.

Table 4. Ice Core Spreadsheet Contents: Stations 1, 2, and 3 (Sheets 19-30)

Sheet Name	Description
StationZ_data	Data from Stations 1, 2, and 3 where Z is the station number: 1, 2, and 3. See Table 2 for column descriptions.
StaZ_Temp_graph	Graph of temperature (°C) versus depth (m) for Stations 1, 2, and 3 where Z is the station number: 1, 2, and 3.
StaZ_Salinity_graph	Graph of in situ salinity (psu) versus depth (m) and frozen salinity versus depth (m) for Stations 1, 2, and 3 where Z is the station number: 1, 2, and 3.
StaZ_O18_graph	Graph of δ18O (‰) versus depth (m) for Stations 1, 2, and 3 where Z is the station number: 1, 2, and 3.

Sea Ice Thickness Database and Snow Pit Measurements

All sea ice thickness data recorded during SIMBA are provided in seven Excel files for seven different sites: Brussels, Fabra, Liege, Patria, Station 1, Station 2, and Station 3. These Excel files were created from the SCAR Sea Ice Thickness Database Data Entry Form provided to the SIMBA team. Table 5 lists the number of transects and pits at each site, and Table 6 describes the sheets in these data files. Tables 7 and 8 describe the data columns for the sheets in the file. Note, if a cell is empty or contains zeros, then that measurement was not recorded at that site.

Table 5. Number of thickness transects and snow pits per site

Site Name	# of Thickness Transects	# of Snow Pits
Brussels	6	5
Fabra	7	5
Liege	0	5
Patria	2	2
Station 1	2	3
Station 2	2	4
Station 3	1	5

Table 6. Description of Sheets in the SITD Excel Files

Sheet Name	Description
metadata	General metadata describing the site and the measurements taken. Items include latitude, longitude, date/time, present weather conditions, and ice station type.
Thickness Gauges	For the Brussels site only, changes in sea ice thickness over time were measured at several locations in the vicinity of the Brussels site. This sheet has the beginning and end thickness of the site. Table 9 provides a description of the columns.
thickness_transect_ZZ	Contains sea ice transect data. If more than one transect was done at a site, each was recorded on its own sheet and numbered accordingly, where ZZ is an alphanumeric counter (for example, 1A, 1B, 2A, 2B). If no transects were done, then the sheet was deleted. Table 7 provides a description of the columns.
snow_pit_ZZ	Worksheets for recording snow pit data. If more than one snow pit was done at a site, each was recorded on its own sheet and numbered accordingly, where ZZ is an alphanumeric counter (for example, 1A, 1B, 2A, 2B). If no snow pits were done, then the sheet was deleted. Table 8 provides a description of the columns.
present_weather_code	Provides the description of the present weather code noted in the metadata sheet.

Table 7. Column Descriptions of Thickness Transect Data Sheets

Column Name	Description
Distance (m)	Distance of the transect in meters
Ice thickness (m)	Ice thickness in meters
Ice freeboard (m)	Ice freeboard in meters
Snow thickness (m)	Snow thickness in meters
Snow surface temp. (°C)	Snow surface temperature in °C
Snow/ice interface temp. (°C)	Snow and ice interface temperature in °C
Total snow/ice thickness derived from EM measurement (m)	Thickness of the snow and ice, in meters, derived from EM measurements. Not available at all sites.

Table 8. Column Descriptions of Snow Pit Data Sheets

Column Name	Description	Column Name	Description
Height (m)	Height, in meters, of the snow pit measurement.	upper limit of wetness sample height range (m)	Depth at the top of one of the snow density tubes in the snow pit. For example, for a 5cm diameter tube, will be bottom tube depth plus 5 cm.
Temp (°C)	Temperature, in °C, at a particular height.	Wetness (vol%)	Wetness of the snow in percent volume. This measurement was not taken at every snow pit.
lower limit of density sample height range (m)	Depth at the bottom of one of the snow density tubes in the snow pit.	Lower limit of isotope sample height range (m)	Depth at the bottom of one of the sampling tubes for isotopes in the snow pit (usually the same tube is used for density, salinity, and isotopes).
upper limit of density sample height range (m)	Depth at the top of one of the snow density tubes in the snow pit. For example, for a 5cm diameter tube, will be bottom tube depth plus 5 cm.	Upper limit of isotope sample height range (m)	Depth at the top of one of the sampling tubes for isotopes in the snow pit.

Column Name	Description	Column Name	Description
Density (kg/m^3)	Density of the snow in kg/m^3.	δO^{18}(o/oo)	A measure of the ratio of stable isotopes oxygen-18 (18O) and oxygen-16 (16O) permil (‰) for a specific depth
lower limit of salinity sample height range (m)	Depth at the bottom of one of the sampling tubes in the snow pit (usually the same as the snow density tube).	Lower limit of snow class height range (m)	Lower depth of layer of constant snow class identified visually in a snow pit
upper limit of salinity sample height range (m)	Depth at the top of one of the sampling tubes in the snow pit. For example, if the 5 cm snow density tube is used for the salinity measurement, will be 5 cm higher than the tube bottom for a 5 cm diameter tube.	Upper limit of snow class height range (m)	Upper depth of layer of constant snow class identified visually in a snow pit
Salinity (psu)	Salinity of the snow, in psu, at a particular height.	SSI 2 digit class and sub-class code	Snow class code. Refer to tables 1 and 2 on the excel sheet.
lower limit of wetness sample height range (m)	Depth at the bottom of one of the snow density tubes in the snow pit		

For the Brussels site only, changes in sea ice thickness over time were measured along two 200 m long track lines in the vicinity of the Brussels site. Each of the two track lines was measured twice, once on 7 October 2007 and once on 21 October 2007. For each track line, freeboard, snow depth, and ice thickness measurements were taken every 20 m on both dates. Table 9 describes the columns in the Thickness Gauges sheet. The top row of that sheet provides the date of the measurements.

Table 9. Column Descriptions of Thickness Gauges Sheet (Brussels Site Only)

Column Name	Description
Distance (m)	Distance along the track line in meters.
Freeboard (m)	The height of the sea ice above the surface of the ocean in meters.
Snow Depth (m)	Depth of the snow on the ice in meters.
Ice Thickness (m)	Thickness of the sea ice in meters.
Δ Ice Thickness (m)	Change in the ice thickness from 7 October 2007 to 21 October 2007 in meters.
SD X (m)	Raw snow depth data for the 21 October 2007 measurements where X goes from 1 to 5. The average of these 5 measurements is used to calculate the snow depth for this date. These 5 measurements were taken at the few isolated thickness gauge sites. The 5 measurements of snow depth were taken within a 1 m radius of the single ice thickness measurement.
Freeboard X (m)	Raw freeboard data for the 21 October 2007 measurements where X goes from 1 to 3. The average of these 3 measurements is used to calculate the freeboard for this date. A block of ice containing the thickness gauge was extracted, and then the 3 freeboard measurements were taken in the hole to determine an average freeboard.
IT X (m)	Raw ice thickness data for the 21 October 2007 measurements where X goes from 1 to 5. The average of these 5 measurements is used to calculate the ice thickness for this date. Ice thicknesses were measured around the hole where the gauge block was extracted and averaged to calculate the ice thickness designated for the site.

2.1.5 SIMBA Buoy Data

During the SIMBA campaign, three IMB buoys were released to record sea ice measurements while drifting. The file SIMBA-Buoy-Overview.xlsx gives start/stop dates, start/stop lat/lon, and comments for the three buoys. Table 10 gives the name, ID, and dates of operation of each buoy. The data from each of the three buoys are contained in three Excel files; one for each buoy. The sheets in these Excel file are described in Table 11. For a list of instrumentation on the buoys, see Table 15.

Table 10. SIMBA Buoys

Name and ID	Site Location	Dates of Operation
SIMBA IMB Argos 29831	Brussels-1	2-Oct-2007 through 14-Dec-2007
SIMBA IMB Argos 29837	Liege	5-Oct-2007 through 23-Oct-2007 and 6-Feb-2009 through 10-Mar-2009
SIMBA IMB Argos 29846	Brussels-2	12-Oct-2007 through 6-Dec-2007

Table 11. Buoy Data Sheet Descriptions

<table>
<tr><th>Sheet Name</th><th>Description</th></tr>
<tr><td>Buoy Data</td><td>All the Buoy Data sheets contain the following seven columns:
<table>
<tr><th>Column Name</th><th>Description</th></tr>
<tr><td>Air_Temp (C)</td><td>Temperature of the air in °C</td></tr>
<tr><td>Barometer (mb)</td><td>Barometric pressure in mb</td></tr>
<tr><td>Snow Surface (m)</td><td>Snow surface height in m</td></tr>
<tr><td>Ice under surface (m)</td><td>Ice under snow height in m</td></tr>
<tr><td>Snow depth (m)</td><td>Snow depth in m</td></tr>
<tr><td>Ice Thickness (m)</td><td>Ice thickness in m</td></tr>
<tr><td>Ht. Ice Surface (cm)</td><td>The distance measured from an acoustic sensor to the top of the snow.</td></tr>
<tr><td>Pressure depth (m)</td><td>Depth pressure(m) is the measurement from a pressure sensor mounted on the frame below sea level.</td></tr>
<tr><td>Change depth (m)</td><td>The change in the pressure depth.</td></tr>
<tr><td>Sea Bird Depth (m)</td><td>Depth of the SeaBird CTD instrument. Note: For Brussels2_SeaBird file only. Although the Liege buoy had a SeaBird CTD, it failed early and was pulled from the buoy.</td></tr>
<tr><td>Sea Bird Water Temp (C)</td><td>Water temperature measured by the SeaBird CTD at a specific depth. Note: For Brussels2_SeaBird file only. Although the Liege buoy had a SeaBird CTD, it failed early and was pulled from the buoy.</td></tr>
<tr><td>Sea Bird Conductivity (S/m)</td><td>Water temperature measured by the SeaBird CTD at a specific depth. Note: For Brussels2_SeaBird file only. Although the Liege buoy had a SeaBird CTD, it failed early and was pulled from the buoy.</td></tr>
<tr><td>AIR, SNOW, ICE WATER</td><td>These are temperature sections on a particular day contoured using temperature from vertical thermistor arrays frozen in the ice with temperature measurements in the Air, Snow, Sea Ice and Ocean taken at 5 cm to 10 cm sensor separation.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Sheet Name</th><th>Description</th></tr>
<tr><td>2Hr Position</td><td>Contains the position as latitude and longitude in decimal degrees of the buoy every two hours. It contains four columns:
<table>
<tr><th>Column Name</th><th>Description</th></tr>
<tr><td>TIMESTAMP</td><td>The date and time that the GPS instrument recorded the latitude and longitude.</td></tr>
<tr><td>RECORD</td><td>The record number which is simply a counter of the measurements.</td></tr>
<tr><td>LAT (Deg)</td><td>The latitude, in decimal degrees, of the buoy at a particular timestamp.</td></tr>
<tr><td>LON (Deg)</td><td>The longitude, in decimal degrees, of the buoy at a particular timestamp.</td></tr>
</table></td></tr>
<tr><td>Radiometer</td><td>Only in Brussels 1 file because this buoy contained this extra instrumentation that the other two did not. The Radiometers sheet in the Brussels 2 file contains five columns:
<table>
<tr><th>Column Name</th><th>Description</th></tr>
<tr><td>Date/Time</td><td>Date and time of the measurement</td></tr>
<tr><td>R1 (442.5nm) µW/cm^2</td><td>442.5 nm channel radiometer measurement in µW/cm^2</td></tr>
<tr><td>R2 (455.35nm) µW/cm^2</td><td>455.35 nm channel radiometer measurement in µW/cm^2</td></tr>
<tr><td>R3 (489.9nm) µW/cm^2</td><td>489.9 nm channel radiometer measurement in µW/cm^2</td></tr>
<tr><td>R4 (554.9nm) µW/cm^2</td><td>554.9 nm channel radiometer measurement in µW/cm^2</td></tr>
</table></td></tr>
</table>

2.2 File and Directory Structure

All the data files reside via HTTPS: https://noaadata.apps.nsidc.org/NOAA/G10014/. This main directory is broken up into three subdirectories; one for each type of data. Table 12 describes the sub-directories.

Table 12. Directory Structure and File Naming Convention

<table>
<tr><th>Directory</th><th>Description</th><th>File Size; Volume</th></tr>
<tr><td>ice-core-data</td><td>Contains the single Excel with the SIMBA ice-core data: SIMBA-ice-core-data.xlsx.</td><td>168 KB/file; 168 KB total</td></tr>
<tr><td>sea-ice-thickness-database</td><td>Contains 7 Excel files with the sea ice thickness measurements from 7 SIMBA sites.
File naming convention:
SIMBA_site_SITD.xlsx
Where<table>
<tr><td>SIMBA</td><td>Indicates that this is a SIMBA data file.</td></tr>
<tr><td>site</td><td>The location where the measurements were acquired: Brussels [1 or 2??], Fabra, Liege, Patria, Station 1, Station 2, and Station 3.</td></tr>
<tr><td>SITD</td><td>Sea Ice Thickness Database</td></tr>
<tr><td>.xlsx</td><td>Excel file extension</td></tr>
</table></td><td>200 - 500 KB/file; 2.2 MB total</td></tr>
</table>

<table>
<tr>
<td>SIMBA-buoys</td>
<td>Contains 4 Excel files: 3 data files and a buoy overview file (SIMBA-Buoy-Overview.xlsx).
File naming convention:
site_instrument_IMBXXXXX.xlsx
Where
<table>
<tr><td>site</td><td>The location where the measurements were acquired: Brussels, Fabra, Liege, Patria, Station 1, Station 2, and Station 3.</td></tr>
<tr><td>instrument</td><td>Sensor on board the buoy: SeaBird CTD or Satlantic Radiometer</td></tr>
<tr><td>IMBXXXXX</td><td>Ice Mass Balance Buoy Number: IMB29831 - Brussels 1, IMB29846 - Brussels 2, IMB29837 - Liege</td></tr>
<tr><td>.xlsx</td><td>File extension for Microsoft Excel file.</td></tr>
</table>
</td>
<td>12 - 350 KB/file; 1.25 MB total</td>
</tr>
</table>

2.3 Spatial and Temporal Coverage/Resolution

2.3.1 Spatial Coverage and Resolution

This data set covers the Western Antarctic waters of the Bellingshausen and Amundsen Seas. The spatial resolution varies, but the approximate spatial coverage bounding box is the following:

Northernmost: -68.5°
Southernmost: -75°
Easternmost: -75°
Westernmost: -120°

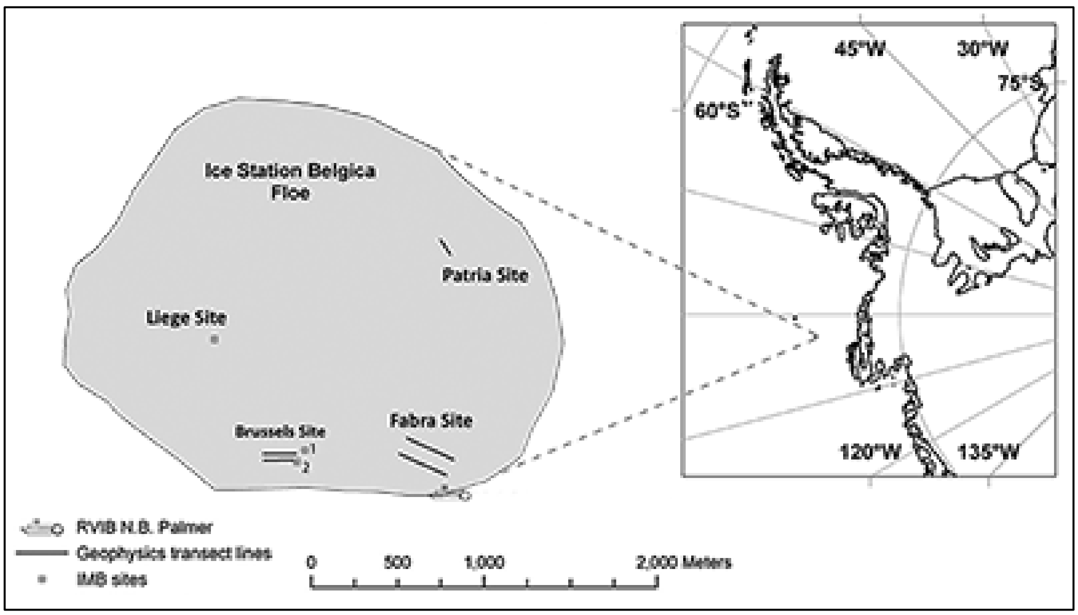


Figure 1. Belgica Floe: IMB buoy deployment sites Oct. 2007. Click for larger image.

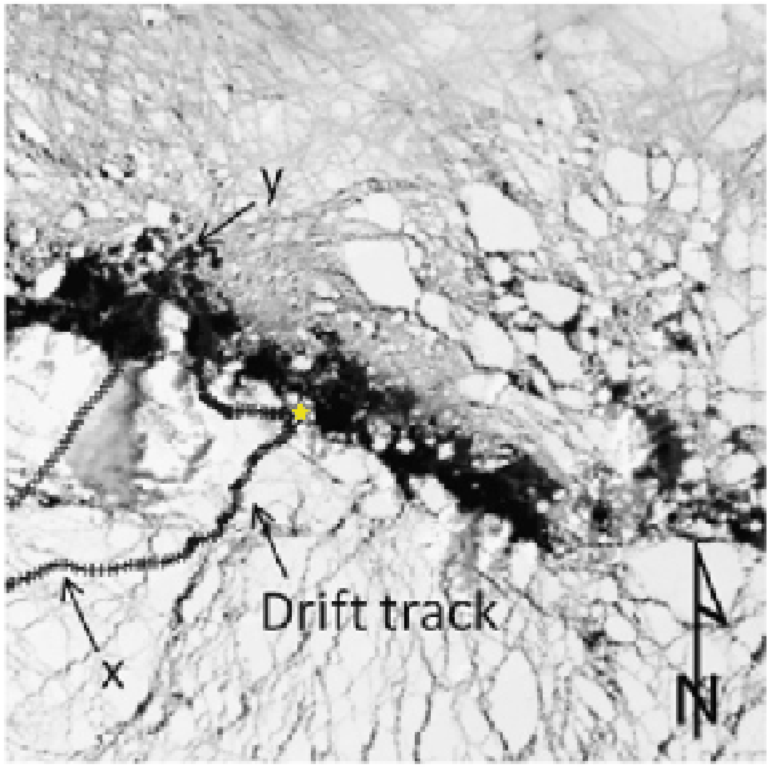


Figure 2. Satellite image of the Belgica Floe showing the regional ice conditions on October 12 at maximum expansion of the lead, with the ships position (yellow star) and a portion of the drift track with ship's position on dates 9 October 2007(X) and 17 October 2007 (Y). Click for larger image.

2.3.2 Temporal Coverage and Resolution

The temporal coverage of the data set is 01 October to 14 December 2007, the spring/summer transition and 06 February to 19 March 2009, the summer/autumn transition. The temporal resolution varies. Figure 3 shows the drift track for each IMB with start and stop dates.

For specific locations and dates, see the sections below broken up by data type:

- Ice Core Data
- Sea Ice Thickness Data
- IMB Buoy Data

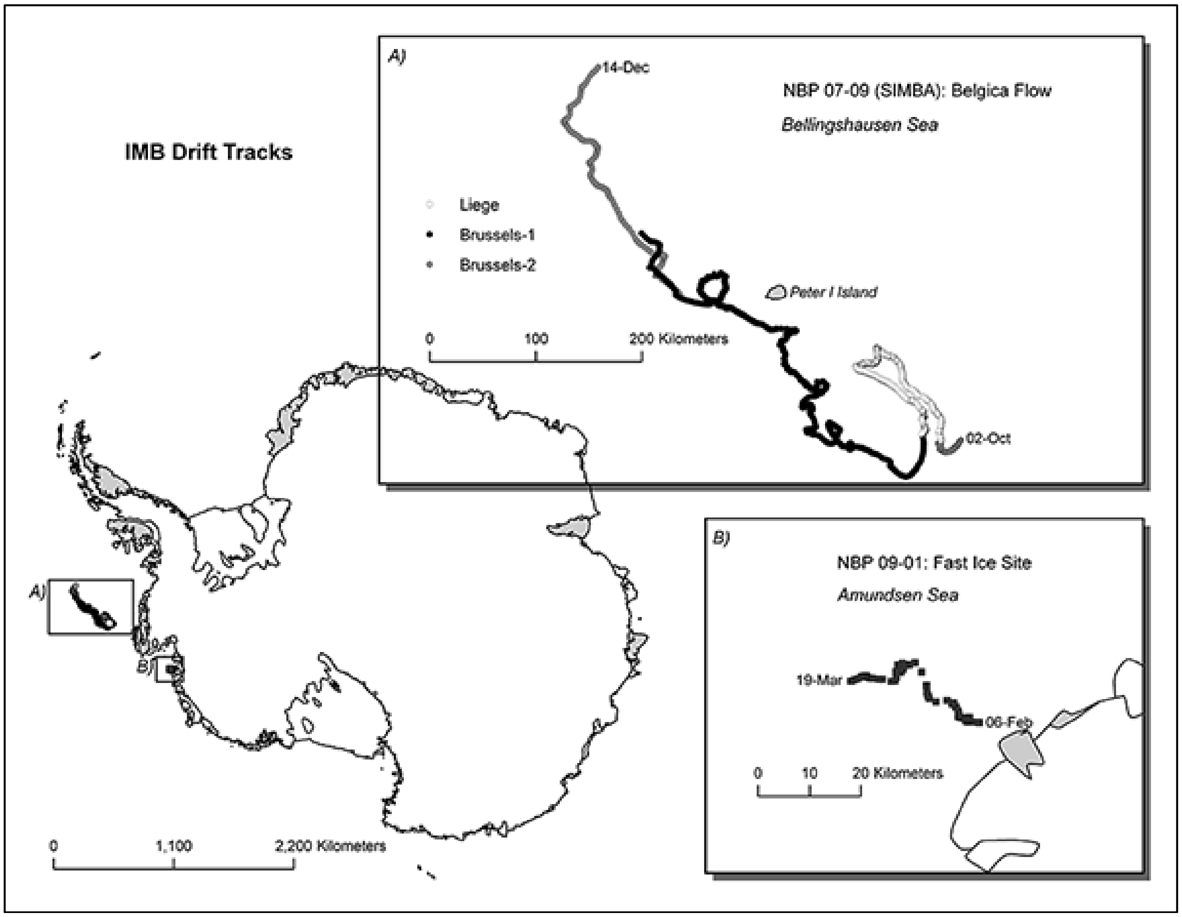
- 

Figure 3. IMB Drift Tracks with start and stop dates. Click for larger version.

2.3.2.1 Ice Core Data

Table 13 lists the locations and dates of the ice core measurements. Note: The location of the Brussels and Liege ice core samples are approximated by taking the known date that the ice core was taken and then cross referencing that with the location of the Brussles-1 and Liege buoy at that time, respectively. The locations of the Station 1, 2, and 3 ice core samples are taken from the same location as those in the sea ice thickness measurement files.

Table 13. Ice Core Measurements' Locations and Dates

Site Name	Location (decimal degrees)	Date (mm/dd/yyyy)
Brussels ice core 1	lat: -70.34865, lon: -94.31901	10/1/2007
Brussels ice core 2	lat: -70.17516, lon: -94.07291	10/6/2007
Brussels ice core 3	lat: -69.810235, lon: -92.16677	10/11/2007
Brussels ice core 4	lat: -69.571205, lon: -92.31858	10/16/2007
Brussels ice core 5	lat: -70.05227, lon: -93.53365	10/21/2007
Liege ice core 1	lat: -70.17648, lon: -94.28498	10/3/2007
Liege ice core 2	lat: -70.03832, lon: -93.16213	10/8/2007
Liege ice core 3	lat: -69.6801, lon: -91.95058	10/13/2007
Liege ice core 4	lat: -69.55305, lon: -92.47013	10/18/2007
Liege ice core 5	lat: -70.05258, lon: -93.96015	10/23/2007
Station 1 ice core	lat: -70.24585, lon: -90.07782	9/25/2007
Station 2 ice core	lat: -70.40908, lon: -90.49424	9/26/2007
Station 3 ice core	lat: -70.63548, lon: -90.73672	9/27/2007

2.3.2.2 Sea Ice Thickness Data Sites

Table 14 lists the dates and locations of the sea ice thickness measurements.

Table 14. Sea Ice Thickness Measurements Location and Dates

Site Name	Location (decimal degrees)	Date (mm/dd/yyyy)
Brussels	lat: -70.25832, lon: -94.57218	10/3/2007
Fabra	lat: -70.40106, lon: -94.12830	10/1/2007
Liege	lat: -70.18416, lon: -93.67301	10/6/2007
Patria	lat: -69.89271, lon: -92.52217	10/9/2007
Station 1	lat: -70.24585, lon: -90.07782	9/25/2007
Station 2	lat: -70.40908, lon: -90.49424	9/26/2007
Station 3	lat: -70.63548, lon: -90.73672	9/27/2007

2.3.2.3 IMB Buoy Data

Table 15 lists the different measurements taken by the three IMB Buoys and the duration of those measurements.

Table 15. Type and Duration of Buoy Measurements

Measurement Type	**NBP 07-09 (SIMBA) – 2007 "Belgica Floe"**			**NBP 09-01 (ITP/IMB) - 2009 "Fast-ice Floe"**
	Brussels-1	Brussel-2	Liege	Liege
Position	2 Oct to 14 Dec	12 Oct to 6 Dec	4 Oct to 22 Oct	6 Feb to 19 Mar
Atmosphere				
Barometric pressure	2 Oct to 14 Dec	12 Oct to 6 Dec	4 Oct to 22 Oct	6 Feb to 19 Mar
Air temperature	2 Oct to 1 Nov	12 Oct to 6 Dec	4 Oct to 22 Oct	6 Feb to 19 Mar
Snow				
Snow depth	2 Oct to 1 Nov	12 Oct to 1 Nov	4 Oct to 22 Oct	6 Feb to 19 Mar
Sea Ice				
Ice thickness	2 Oct to 1 Nov	12 Oct to 1 Nov	4 Oct to 22 Oct	6 Feb to 19 Mar
Under-ice radiation (442.50 nm)	2 Oct to 1 Nov	-	-	-
Under-ice radiation (455.35 nm)	2 Oct to 1 Nov	-	-	-
Under-ice radiation (489.90 nm)	2 Oct to 1 Nov	-	-	-
Under-ice radiation (554.90 nm)	2 Oct to 1 Nov	-	-	-
Depth of radiation measurements	2 Oct to 3 Dec	-	-	-
Water				
Water conductivity	-	12 Oct to 1 Nov	-	6 Feb to 19 Mar
Water temperature	-	12 Oct to 1 Nov	-	6 Feb to 19 Mar
Depth of CTD measurements	-	12 Oct to 1 Nov	-	6 Feb to 19 Mar
Water column temperature profile	-	-	-	6 Feb to 19 Mar
Water column salinity profile	-	-	-	6 Feb to 19 Mar
All				
Temperature Profile (air-snow-ice-water)	2 Oct to 1 Nov	12 Oct to 6 Dec	4 Oct to 22 Oct	6 Feb to 19 Mar

2.4 Parameters

- The parameters covered by this data set are the following:
- Sea ice temperature (°C)
- Sea ice salinity (psu)
- Sea ice thickness (m)
- Oxygen isotope concentrations - δO18 (o/oo)
- Sea ice freeboard (m)
- Snow thickness (m)
- Snow surface temperature (°C)
- Snow density (kg/m3)
- Snow wetness (vol%)
- Snow classification
- Air temperature (°C)
- Barometer (mb)
- Brine volume (decimal fraction of total volume)
- Ice irradiance (μW/cm2)

2.5 Quality Assessment and Error Sources

No quality assessment has been performed on these data due to the complexity of assigning error sources to a variety of data sets and measurements by different sampling and techniques.

3 SOFTWARE AND TOOLS

These data files can be opened with Microsoft Excel, OpenOffice, GoogleDocs, or other similar spreadsheet tool.

4 DATA ACQUISITION AND PROCESSING

4.1 Data Acquisition Methods

All measurements were acquired remotely with instrumentation on floating buoys or in situ measurements of ice core, snow, and sea ice thickness taken from an idividual sea-ice floe. See the Sensor Descriptions section for details on the instrumentation. In October 2007, three IMB's, called Brussels-1, Brussels-2, and Liege, were deployed on a pack ice floe in the Bellingshausen Sea in the Southern Ocean. The floe, called the Belgica Floe, had the research vessel, icebreaker N.B. Palmer, drifting along with the it (NBP 07-09). Each of the IMB's measured geographic position with a Garmin GPS16-HVS, snow depth with a Campbell SR50A-L24 acoustic sensor, ice thickness with a Benthos PSA-916 sonar altimeter, and a temperature profile using YSI-44033-BP thermistors that extended from the air, through the snow, ice, and surface water at

0.05 - 0.10 m intervals. Brussels-1 also measured irradiance at the ice undersurface with an OCR-504 under water radiometer, while Brussels-2 and Liege were equipped to measure conductivity, temperature, and depth below the ice using a Sea-Bird MicroCAT SBE 37-SI CTD with pressure sensor. However, the CTD did not function on the Liege IMB; so, before the N.B. Palmer left the Belgica Floe drift station, the Liege IMB was retrieved. The CTD was repaired, and the Liege IMB was redeployed on another cruise in February 2009 at a fast ice site in the Amundsen Sea (NBP 09-01). All measurements were autonomously sampled at bihourly intervals, sent to the Campbell CR1000-ST-SW-NC data logger, and transmitted through the Advanced Research and Global Observation Satellite (ARGOS) satellite system in hexadecimal code. The sensors and IMB's experienced various life spans, with some transmitting data up to 75 days.

4.2 Sensor Descriptions

4.2.1 Ice Core Instrumentation

Ice cores were primarily acquired with a stainless steel ice corer of 10 cm diameter, driven by an electric drill powered by a remote generator to maintain the cleanliness of the site.

4.2.2 Sea Ice Thickness Database Instrumentation

Sea ice thickness measurements were acquired primarily by an EM-31, electromagnetic induction (EMI) meter. This instrument measured a conductivity proportional to the distance to the conducting layer of seawater beneath the ice and could, therefore, be calibrated to convert conductivity to ice thickness. Other thickness measurements were made using a Kovacs 5 cm ice-thickness auger driven by an electric drill powered by rechargeable batteries.

4.2.3 Ice Mass Balance Buoy Instrumentation

The three IMB buoys used for the SIMBA investigation were built by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL). They were named Brussels-1, Brussels-2, and Liege. The sensors and IMBs experienced life spans varying from 18 days (minimum) to 75 days (maximum). All IMB sensors were autonomously sampled at 30 minute intervals. Data were saved on a Campbell CR1000-ST-SW-NC data logger, transmitted, and downloaded via the ARGOS system. Table 16 describes the different instruments on each buoy and Table 15 provides the dates of the duration of the measurements.

Figure 4. IMB buoy deployment. The IMB buoy is not visible from the top side of the ice. Photograph courtesy of M. Lewis. Click for larger view.

Table 16. Instruments on IMB Buoys

Instrument	Description/Purpose	Brussels-1	Brussels-2	Liege
Garmin GPS16-HVS	Measured geographic position.	x	x	x
Campbell SR50A-L24 acoustic sensor	Monitored surface-elevation changes. Mounted on a surface mast ~2m high.	x	x	x
Benthos PSA-916 sonar altimeter	Monitored changes of the bottom ice surface. Mounted on an underwater mast 1–2m below the ice bottom, within a 14° beamwidth and at 0.01m resolution.	x	x	x
YSI-44033-BP thermistors	Vertical temperature profiler that extended from the air, through the snow, ice and surface water to 1–2m below the ice at 0.05–0.10m intervals with 0.01°C resolution.	x	x	x
Satlantic OCR-504 4-channel underwater radiometer	Measured irradiance at the ice under-surface on an L-arm looking upward at ~1.2m depth.	x		
Sea-Bird MicroCAT SBE 37-SI with pressure sensor	Measure conductivity, temperature and depth (CTD) below the ice. Mounted on an underwater mast ~1.2m below the ice bottom, at 0.002°C temperature resolution and 0.001 psu salinity resolution.		x	x

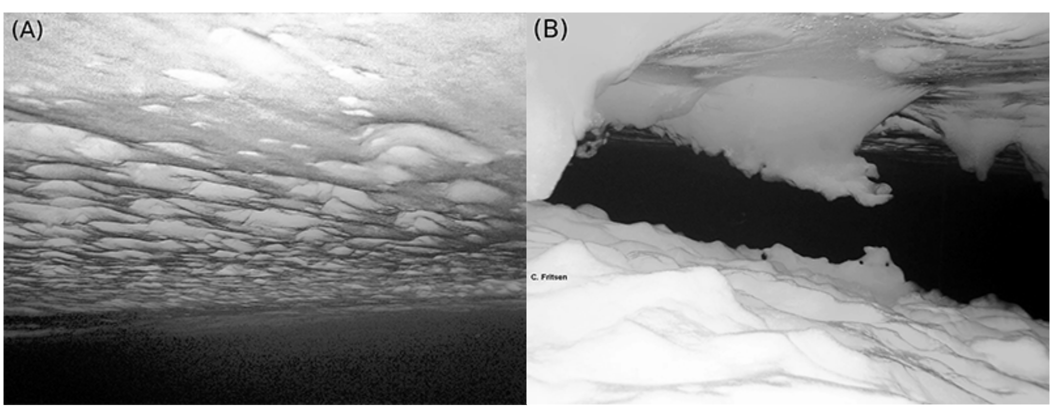


Figure 5. Photographs of the under ice surface at (A) Brussels-1 and (B) Liege. Photographs courtesy of C. Fritsen.

4.3 Version History

Table 17. Version History

Date	Version	Description
December 2016	1	Initial release of data.

5 REFERENCES AND RELATED PUBLICATIONS

5.1 References

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5.2 Related Data Collections

- Unified Sea Ice Thickness Climate Data Record Collection Spanning 1947-2012
- IceBridge L4 Sea Ice Freeboard, Snow Depth, and Thickness
- CRREL Arctic Sea Ice Mass Balance (IMB) Buoy Data
- Ocean measurements in the Amundsen Sea, Nathaniel B. Palmer Cruise 09-01, 05 January - 28 February 2009

6 CONTACTS AND ACKNOWLEDGMENTS

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7 DOCUMENT INFORMATION

7.1 Document Author

This document was created by Ann Windnagel from correspondence with Steve Ackley.

7.2 Document Creation Date

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7.3 Document Revision Date

December 2016: A. Windnagel published the initial release of this document.