The SUMup collaborative database: Surface mass balance, subsurface temperature and density measurements from the Greenland and Antarctic ice sheets

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Abstract. The SUMup database is a compilation of surface mass balance (SMB), subsurface temperature and density measurements from the Greenland and Antarctic ice sheets available at https://www.doi.org/10.18739/A2M61BR5M (Vandecrux et al., 2024). This 2024 release contains 7 462 419 data points: 2 857 256 SMB measurements, 2 705 755 density measurements and 1 899 408 subsurface temperature measurements. This is respectively 1 078 716, 21 894 and 1 893 938 additional observations of SMB, density and temperature compared to the 2023 release. Since 2023, SUMup provides not only snow accumulation on ice sheets, like its predecessors, but all types of SMB measurements, including from ablation areas. Note that the accumulated SMB is given, not accumulation rates. The data files are provided in both CSV and NetCDF format and contain, for each measurement, the following metadata: latitude, longitude, elevation, timestamp, method, reference of the data source and, when applicable, the name of the measurement group it belongs to (core name for SMB, profile name for density, station name for temperature). Data users are asked to cite all the original data sources that are being used. Issues about this release as well as suggestions of datasets to be added in next releases can be done on a dedicated user forum. We also provide example scripts to use the SUMup 2024 files as well as the compilation scripts used to build the database. SUMup is a community effort and help to compile and curate the database is welcome.

Contents

1 The SUMup project

1.1 Background

The SUMup database is a community effort to distribute easy-to-use in-situ data to improve surface mass balance modeling and remote sensing efforts, and it is a compilation of work from many individual researchers. It covers measurements of snow and firn density, subsurface temperatures, surface mass balance on the Greenland and Antarctic ice sheets and their peripheral glaciers. After being sponsored by NASA, and by the Scientific Committee on Antarctic Research (SCAR), it is now continued by the Geological Survey of Denmark and Greenland until another group carries it forward. For questions regarding the dataset, please contact the current compiler, Baptiste Vandecrux (bav@geus.dk).

1.2 Terms of use

When using this dataset, please cite both the individual studies who provided the data (see the reference key given for each measurement and associated reference list) as well as the SUMup dataset itself:

Vandecrux, B., Amory, C., Ahlstrøm, A.P., Akers, P.D., Albert, M., Alley, R.B., Alves de Castro, M., Arnaud, L., Baker, I., Bales, R., Benson, C., Box, J.E., Brucker, L., Buizert, C., Chandler, D.M., Charalampidis, C., Cherblanc, C., Clerx, N., Colgan, W., Covi, F., Dattler, M., Denis, G., Derksen, C., Dibb, J.E., Ding, M., Dixon, D., Eisen, O., Fahrner, D., Fausto, R., Favier, V., Fernandoy, F., Freitag, J., Gerland, S., Harper, J., Hawley, R.L., Heuer, J., Hock, R., Hou, S., How, P., Hubbard, B., Humphrey, N., Iizuka, Y., Isaksson, E., Kameda, T., Karlsson, N.B., Vladimirova, D., Kjær, H.A., Kreutz, K., Kuipers Munneke, P., Lazzara, M.A., Lemeur, E., Lenaerts, J.T.M., Lewis, G., Lindau, F.G.L., Lindsey-Clark, J., MacFerrin, M., Machguth, H., Magand, O., Mankoff, K.D., Marquetto, L., Martinerie, P., Mayewski, P.A., McConnell, J.R., Medley, B., Miège, C., Miles, K.E., Miller, H., Miller, O., Montgomery, L., Morris, E., Mosley-Thompson, E., Mulvaney, R., Niwano, M., Oerter, H., Osterberg, E., Otosaka, I., Picard, G., Polashenski, C., Reijmer, C., Rennermalm, A., Rutishauser, A., Scanlan, K.M., Simoes, J.C., Simonsen, S.B., Smeets, P.C., Smith, A., Solgaard, A., Spencer, M., Steen-Larsen, H.C., Stevens, C.M., Sugiyama, S., Svensson, J., Tedesco, M., Thomas, E.R., Thompson-Munson, M., Tsutaki, S., van As, D., Van den Broeke, M.R., van Tiggelen, M., Wang, Y., Wilhelms, F., Winstrup, M., Xiao, J., Xiao, C.: The SUMup collaborative database: Surface mass balance, subsurface temperature and density measurements from the Greenland and Antarctic ice sheets (2024 release), Arctic Data Center, https://www.doi.org/10.18739/A2M61BR5M, 2024.

1.3 Contributing to the Dataset

If you would like to contribute to the dataset, reach out to Baptiste Vandecrux (bav@geus.dk) for more details.

1.4 Acknowledgement

The SUMup working group was previously supported by the NASA Cryospheric Sciences Program and the National Science Foundation and the SCAR AntClimNow Dataset Stewardship grant. Now the maintenance of this dataset is supported

by the Programme for Monitoring of the Greenland ice sheet (PROMICE), which is supported by the Danish Ministry for Environment, Energy and Utilities.

We are also grateful to all the people that helped collecting these data. We here thank H. Anschütz, J.R. Banta, N. Bertler, H. Conway, D. Dahl-Jensen, D. Divine, A. Ekaykin, H. Fischer, R. Forster, M. Frezzotti, T. Fudge, S. Fujita, J. Gallet, N.P. Gerhard, B. Goodwin, K. Graeter, W. Graf, M. Hastings, A. Heilig, K. Jezek, K. Keegan, T.V. Khodzher, L. Koenig, P. Mayewski, H. Oerter, A. Ohmura, M. Philippe, M.B. Portella, J.L. Roberts, C. Schaller, E. Schlosser, F. Schwank, J.P. Steffensen, B. Stenni, K. Takahashi, F.A. Tavares, P. Vallelonga, B. Vinther, D. Vladimirova, and C. Vos who either declined co-authorship or failed to answer the invitation. We also acknowledge the contributions of J. Bolzan, M.Strobel, A.J. Gow, A. Kovacs, V.N. Nijampurkar and A.J. Aristarain, whose updated contact detail could not be found. We also thank L. Koenig, P. Zens, L. Lolk Hauge and M. Schwager, who continued their career in the private sector and eventually our departed colleagues and pioneers of the field: H.B. Clausen (2013), D. Wagenbach (2016), K. Steffen (2020).

Eventually, the SUMup database could not exist without all the institutions funding research, expeditions, and monitoring in Greenland and Antarctica.

Greenland Data

- **Canada:** Natural Sciences and Engineering Research Council (NSERC).
- **Denmark:** PROMICE, GC-Net (Geological Survey of Denmark and Greenland), Center for Ice and Climate (Niels Bohr Institute, University of Copenhagen), Denmark's Independent Research Fund, Villum Foundation, Carlsberg Foundation, A. P. Møller Foundation, University of Copenhagen, Danish Ministry for Environment, Energy and Utilities, Technical University of Denmark (DTU Space, DTU Byg).
- **Germany:** German Research Foundation (DFG), Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Helmholtz Association of German Research Centres (HGF).
- **Greenland:** CH2M HILL Polar Services, Asiaq Greenland Survey, KISS, Greenland Institute of Natural Resources.
- **Japan:** Society for the Promotion of Science, National Institute of Polar Research, Arctic Challenge for Sustainability, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japanese Arctic Research Expedition (JAGE).
- **Monaco:** Fondation Albert 2 de Monaco.
- **Norway:** University of Bergen, Trond Mohn Foundation.
- **Sweden:** Swedish National Nuclear Waste Management Organisation (SKB) through the Greenland Analog Project (GAP).
- **Switzerland:** Swiss National Science Foundation, Swiss Federal Research Institute (WSL) in Davos, University of Fribourg (Department of Geosciences), Swiss Polar Institute (SPI).
- **USA:** Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado Boulder, National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), U.S. Army Cold Regions Research

and Engineering Laboratory (CRREL), UNAVCO, U.S. Ice Drilling Program, U.S. Air National Guard, University of Wisconsin, Montana, Rutgers University.

- **International Agencies and Consortia:** European Space Agency (CryoVex), European Research Council (ERC), GRIP, EastGRIP, NGRIP, GISP, GISP2.

Antarctic Data

- **Australia:** Australian Antarctic Division, Australian Government Department of Industry, Science, Energy and Resources, Australian Research Council (Discovery Project, Special Research Initiative for Antarctic Gateway Partnership), Antarctic Climate & Ecosystems Cooperative Research Centre.
- **Belgium:** Belgian Federal Science Policy Office, Research Programme on the Antarctic, Belgian Fund for Scientific Research.
- **Brazil:** Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Chilean-Brazilian Antarctic Traverse.
- **Chile:** Instituto Antártico Chileno (INACH), FONDECYT (ANID), Chilean-Brazilian Antarctic Traverse.
- **China:** National Key Research and Development Program, National Natural Science Foundation of China, Chinese Academy of Sciences, Shandong Normal University, Tibetan Plateau and Polar Meteorology Institute (Chinese Academy of Meteorological Sciences), Shanghai Jiao Tong University, State Key Laboratory of Earth Surface Processes and Resource Ecology (Beijing Normal University).
- **France:** Institut des Géosciences de l'Environnement (Université Grenoble Alpes), Institut Polaire Français Paul-Émile Victor (IPEV), Agence Nationale de la Recherche (ANR), National Centre for Scientific Research (CNRS), International TASTE-IDEA, ASUMA, EAIIST, VANISH, GlacioClim SAMBA Observatory.
- **Italy:** National Research Council of Italy (CNR), Italian National Agency for New Technologies, Energy, and Sustainable Economic Development (ENEA), Ca' Foscari University of Venice, Italian Antarctic Research Program (PNRA).
- **India:** Physical Research Laboratory, National Centre for Polar and Ocean Research (NCPOR), Ministry of Earth Sciences.
- **Japan:** Society for the Promotion of Science, National Institute of Polar Research, Arctic Challenge for Sustainability, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japanese Antarctic Research Expedition (JARE).
- **Netherlands:** Netherlands Institute for Scientific Research, Earth System Science Centre, Royal Academy of Sciences, Institute for Marine and Atmospheric Research (Utrecht University).
- **Russia:** Climate and Environmental Research Laboratory (CERL), Russian Antarctic Expedition (RAE), drillers from St. Petersburg Mining University, Irkutsk's Limnological Institute, Russian Foundation for Basic Research.
- **United Kingdom:** British Antarctic Survey, Natural Environment Research Council, Climate Change Consortium of Wales.

- **USA:** National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), UNAVCO, U.S. Ice Drilling Program, U.S. Air National Guard, University of Wisconsin.
- **International Agencies and Collaborations:** SCAR, EUROCORE, TALDICE, International Polar Foundation, International Associated Laboratory "Vostok."

2 Important notes for the 2024 release

All SMB observations are given as cumulative values in meters water equivalent. Users therefore need to always use the `SMB` value in combination with the `start_year` and `end_year` or `start_date` and `end_date`. A yearly `SMB` value given for year `Y` will be reported with `start_year = end_year = Y` and with `start_date = end_date = NaN`. Subannual `SMB` values will be reported, for instance, with `start_year = end_year = Y` and `start_date = 'YYYY-01-01',end_date = 'YYYY-02-01'`.

To preserve all special characters in references and location names, all strings in the netCDF files have been saved as UTF-8 instead of the ASCII format used previously. To ensure that the strings are decoded properly, you can use the following code:

```
import xarray as xr
import numpy as np

path_to_sumup = '.'
# loading data
df_sumup = xr.open_dataset(path_to_sumup+'/SUMup_2024_SMB_greenland.nc',
                           group='DATA')
# loading metadata
ds_meta = xr.open_dataset(path_to_sumup+'/SUMup_2024_SMB_greenland.nc',
                           group='METADATA')

# small function to decode the string
decode_utf8 = np.vectorize(lambda x: x.decode('utf-8') if isinstance(x, bytes) else x)
# applying this function to all variables that have string as type
for v in ['name','reference','reference_short','method']:
    ds_meta[v] = xr.DataArray(decode_utf8(ds_meta[v].values), dims=ds_meta[v].dims)
```

See example scripts to use the SUMup files here: https://github.com/SUMup-database/SUMup-example-scripts

3 List of datasets added to the 2024 release

3.1 New surface mass balance data

Greenland:

- Daily ablation data from the Leverett glacier Chandler et al. (2015, 2021)
- Daily ablation from at the Historical GC-Net AWS (Steffen et al., 1996, Vandecrux et al., 2023)
- Daily ablation from the IMAU AWS (Smeets et al., 2018)
- Continuous measurement of SWE from SnowFox instruments (Fausto, 2021)
- Accumulation from Operation Ice Bridge radar surveys from Koenig et al. (2016)
- Added historical ice cores from Crete and Milcent
- Re-added ACT10 radar profiles with original coordinates
- Re-added the PARCA cores from Mosley-Thompson et al. (2001) including three datation techniques
- Fixed issues inherited from previous releases

Antarctica:

- Added all data from Ant2k compilation (Thomas et al., 2017)
- Added all data from AntSMB compilation (Wang et al., 2021)
- Fixed coordinates and references in the compiled data
- Added monthly accumulation measurement from stake farm at the Amundsen-Scott South Pole station (South Pole Meteorology Office, 2024)

3.2 New density data

Greenland:

- GC-Net 2024 field work snow pit and firn cores (Vandecrux et al., 2023)
- Harper and Humphrey (2023) cores on EGIG line
- Rasmussen et al., (2023) densities at EastGRIP

Antarctica:

- Sipple Dome 1996-1997 data
- RICE core densiies (Winstrup et al., 2019)
- Densities compiled by Picard et al., (2022)
- South Pole ice core densities from Winski et al. (2019)
- GlacioClim-SAMBA densities for traverses between 2004-2024
- Brazilian ice cores: Taveres et al. (2020), Marques et al. (2014), Portella et al. (2023), Hammes et al. (2009), Schwanck et al. (2014, 2016), Marcher et al. (2022), Ferreira et al. (2024), Marquetto et al. (2020), Simoes et al. (2004a, 2004b), Gerhard et al. (2018)
- Ice cores from Dome C and, D47 and D57 from Verfaillie et al. (2012), Raynaud and Barnola (1985) and Arnaud et al. (1998)
- Fixed issues inherited from previous releases

3.3 New temperature data

Greenland:

- In 2023, data prepared for Vandecrux et al. (2024) were distributed as monthly averaged, 10 m temperatures. In this new release, all the data collected for Vandecrux et al. (2024) is distributed at all available depths and on daily averages.
- 2024 data for PROMICE and GC-Net stations (Fausto et al., 2021, How et al., 2022)
- 2024 data for the deep temperature string at Camp Century (Colgan et al., 2017, Vandecrux et al., 2021)
- 2023 and 2024 temperature data from Saito et al. (2024); Harper and Humphrey (2023, 2023)
- Snow temperature data from SIGMA-A station: Nishimura et al. (2023)

Antarctica: No temperature addition for 2024.

4 The density data files

4.1 NetCDF files

All variables are packed in

- SUMup_2024_density_antarctica.nc
- SUMup_2024_density_greenland.nc

Due to different dimensionality, the DATA and METADATA variables are saved as two different groups in the NetCDF files

In python:

```
import xarray as xr
import numpy as np

path_to_SUMup_folder = "."
ds_density = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_density_greenland.nc',
    group='DATA'
    )
ds_meta = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_density_greenland.nc',
    group='METADATA'
    )
# small function to decode the string
decode_utf8 = np.vectorize(lambda x: x.decode('utf-8') if isinstance(x, bytes) else x)
# applying this function to all variables that have string as type
for v in ['name','reference','reference_short','method']:
    ds_meta[v] = xr.DataArray(decode_utf8(ds_meta[v].values), dims=ds_meta[v].dims)
```

4.2 CSV files

The “DATA” variables are given in the following comma-delimited (CSV) files

- SUMup_2024_density_antarctica.csv
- SUMup_2024_density_greenland.csv

while the “METADATA” variables are given in the tab-delimited (TSV) files

- SUMup_2024_density_methods.tsv
- SUMup_2024_density_profile_names.tsv
- SUMup_2024_density_references.tsv

Table 1. Variables within the density NetCDF file

Variable	Long name	Unit	Description
DATA VARIABLES			
measurement_id	measurement_index	-	index of density measurement (unique for each observation)
timestamp	timestamp	days since 1900-01-01	date at which measurement <measurement_id>was measured
start_depth	start_depth_of_measurement	m	top depth of density measurement <measurement_id>
stop_depth	stop_depth_of_measurement	m	bottom depth of density measurement <measurement_id>
midpoint	midpoint_depth_of_measurement	m	midpoint depth of density measurement <measurement_id>
density	density	kg m^{-3}	measured density for measurement <measurement_id>
error	error	kg m^{-3}	Error associated with the density measurement <measurement_id>
latitude	latitude	degree North	latitude of measurement <measurement_id>
longitude	longitude	degree East	longitude of measurement <measurement_id>
elevation	elevation	m	elevation of measurement <measurement_id>(datum may vary)
profile_key	profile_key	-	profile key associated with measurement <measurement_id>
method_key	method_key	-	method key of measurement <measurement_id>
reference_key	reference_key	-	reference key of measurement <measurement_id>
METADATA VARIABLES			
profile	profile	-	name of the profile <profile_key>
reference	reference	-	full reference associated with <reference_key>
reference_short	reference_short	-	short reference associated with <reference_key>
method	method	-	method associated with <method_key>

5 The SMB data files

5.1 NetCDF files

All variables are packed in

- SUMup_2024_SMB_antarctica.nc
- SUMup_2024_SMB_greenland.nc

Due to different dimensionality, the DATA and METADATA variables are saved as two different groups in the NetCDF files

In python:

```
import xarray as xr
import numpy as np

path_to_SUMup_folder = "./"
```

```
ds_SMB = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_SMB_greenland.nc',
    group='DATA'
    )
ds_meta = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_SMB_greenland.nc',
    group='METADATA'
    )
# small function to decode the string
decode_utf8 = np.vectorize(lambda x: x.decode('utf-8') if isinstance(x, bytes) else x)
# applying this function to all variables that have string as type
for v in ['name','reference','reference_short','method']:
    ds_meta[v] = xr.DataArray(decode_utf8(ds_meta[v].values), dims=ds_meta[v].dims)
```

5.2 CSV files

The "DATA" variables are given in

- SUMup_2024_SMB_antarctica.csv
- SUMup_2024_SMB_greenland.csv

while the "METADATA" variables are given in the tab-delimited (TSV) files

- SUMup_2024_SMB_methods.tsv
- SUMup_2024_SMB_profile_names.tsv
- SUMup_2024_SMB_references.tsv

Table 2. Variables within the SMB NetCDF file

Variable	Long name	Unit	Description
DATA VARIABLES			
measurement_id	measurement_index	-	index of smb measurement (unique for each observation)
start_date	start_date_of_smb_measurement	days since 1900-01-01	start date of measurement <measurement_id> (can be an estimation)
end_date	end_date_of_smb_measurement	days since 1900-01-01	end date of measurement <measurement_id> (can be an estimation)
smb	surface_mass_balance	m w.e.	measured surface mass balance for measurement <measurement_id>
error	error	m w.e.	error associated with the SMB measurement <measurement_id>
latitude	latitude	degree North	latitude of measurement <measurement_id>
longitude	longitude	degree East	longitude of measurement <measurement_id>
elevation	elevation	m	elevation of measurement <measurement_id>
name_key	name_key	-	name key associated to measurement <measurement_id>(core name or location)
method_key	method_key	-	method key of measurement <measurement_id>
reference_key	reference_key	-	reference key of measurement <measurement_id>
METADATA VARIABLES			
name	name	-	name of the core or location associated with the key <name_key>
reference	reference	-	full reference corresponding to <reference_key>
reference_short	reference_short	-	short reference corresponding to <reference_key>
method	method	-	method corresponding to <method_key>

6 The temperature data files

6.1 NetCDF files

All variables are packed in

- SUMup_2024_temperature_antarctica.nc
- SUMup_2024_temperature_greenland.nc

Due to different dimensionality, the DATA and METADATA variables are saved as two different groups in the NetCDF files

In python:

```
import xarray as xr
import numpy as np

```

```
path_to_SUMup_folder = "./"
ds_temperature = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_temperature_greenland.nc',
    group='DATA'
    )
ds_meta = xr.open_dataset(
    path_to_SUMup_folder + 'SUMup_2024_temperature_greenland.nc',
    group='METADATA'
    )
# small function to decode the string
decode_utf8 = np.vectorize(lambda x: x.decode('utf-8') if isinstance(x, bytes) else x)
# applying this function to all variables that have string as type
for v in ['name','reference','reference_short','method']:
    ds_meta[v] = xr.DataArray(decode_utf8(ds_meta[v].values), dims=ds_meta[v].dims)
```

6.2 CSV files

The "DATA" variables are given in

- SUMup_2024_temperature_antarctica.csv
- SUMup_2024_temperature_greenland.csv

while the "METADATA" variables are given in the tab-delimited (TSV) files (because of commas being used in references)

- SUMup_2024_temperature_methods.tsv
- SUMup_2024_temperature_profile_names.tsv
- SUMup_2024_temperature_references.tsv

Table 3. Variables within the temperature NetCDF file

Variable	Long name	Unit	Description
DATA VARIABLES			
measurement_id	measurement_index	-	index of temperature measurement (unique for each observation)
timestamp	timestamp_of_temperature_measurement	days since 1900-01-01	start date of measurement <measurement_id> (can be an estimation)
temperature	subsurface_temperature	deg C	measured temperature for measurement <measurement_id>
depth	depth_of_subsurface_temperature	m	depth of temperature measurement <measurement_id>
error	error	deg C	error associated with the temperature measurement <measurement_id>
duration	duration	days	The number of days over which the measurement <measurement_id> was taken or averaged
latitude	latitude	deg North	latitude of measurement <measurement_id>
longitude	longitude	deg East	longitude of measurement <measurement_id>
elevation	elevation	m	elevation of measurement <measurement_id>
name_key	name_key	-	name key associated to measurement <measurement_id> (instrument name or location)
method_key	method_key	-	method key of measurement <measurement_id>
reference_key	reference_key	-	reference key of measurement <measurement_id>
METADATA VARIABLES			
name	name	-	name of the instrument or location associated with the key <name_key>
reference	reference	-	full reference corresponding to <reference_key>
reference_short	reference_short	-	short reference corresponding to <reference_key>
method	method	-	method corresponding to <method_key>

7 Dataset overview

7.1 Density

Table 4

reference_short	start_year	end_year	num_measurements
Alley (1987) as in Spencer et al. (2001)	1987	1987	109
Johnsen S. pers. comm. as in Spencer et al. (2001)	1990	1990	74
Adolph et al. (2014)	2007	2008	829
Alley et al. (1999)	1999	1999	1018

reference_short	start_year	end_year	num_measurements
Ambach 1970	1967	1967	19
BPRC 1993 in Jezek (2012)	1993	1993	212
Bader (1954) as in Spencer et al. (2001)	1954	1954	16
Baker et al. (2009)	2009	2009	718
Benson (1962 2010 2013)	1952	1955	7282
Bolzan and Strobel (1999a b c d e f g h i j k l m n o)	1987	1987	2016
Bolzan and Strobel (2001a b)	1987	1987	583
Chellman et al. (2009)	2003	2013	3828
Clausen H.B. pers. comm. as in Spencer et al. (2001)	1983	1983	409
Clausen et al. (1988) as in Spencer et al. (2001)	1988	1988	950
Clerx et al. (2022)	2021	2021	567
Colgan et al. (2018) Colgan (2021)	2017	2017	558
Cooper et al. (2018)	2016	2016	81
Dibb and Fahnestock (2004)	2000	2002	815
Dibb et al. (2007)	1997	1998	226
Dibb et al. (2007b)	2003	2004	681
Dibb et al. (2017)	1990	1996	482
Fain et al. (2009)	2006	2006	250
Fischer et al. (1995)	1990	1990	523
Fourteau (2019a b c)	1989	1989	202
Freitag et al. (2021)	2012	2012	3388
GEUS snow and firn data (2023)	1996	2024	3963
Gow (1973) as in Spencer et al. (2001)	1973	1973	19
Graeter et al. (2018)	2016	2016	756
Harper and Humphrey (2022)	2022	2022	564
Harper and Humphrey (2023)	2018	2023	1549
Harper et al. (2012)	2007	2009	784
Hastings et al. (2017)	2012	2012	134
Hawley et al. (2014)	2010	2011	677
Jülg (1939) as in Abermann et al. (2023)	1930	1931	211
Kameda et al. (1995)	1989	1989	634
Kawakami et al. (2023)	2021	2021	230466
Koenig et al. (2014)	2013	2013	170
Kovacs et al. (1969) as in Spencer et al. (2001)	1963	1963	113
Langway (1967) as in Spencer et al. (2001)	1965	1965	150
Lewis et al. (2019)	2017	2017	731
MacFerrin et al. (2019)	2016	2017	509

reference_short	start_year	end_year	num_measurements
MacFerrin et al. (2022)	2015	2017	4898
Machguth et al. (2016)	2012	2015	2081
Mayewski and Whitlow (2016)	1989	1990	170
Mayewski et al. (2016b)	1988	1988	119
Mayewski et al. (2016c)	1987	1987	59
Mayewski et al. (2016d)	1984	1984	270
Miller and Schwager (2000a b)	1995	1995	208545
Miller et al. (2018)	2015	2016	1019
Miège et al. (2013)	2010	2014	652
Morris and Wingham (2014)	2004	2011	62609
Mosley-Thompson et al. (2001)	1995	1998	1434
NGT: Wilhelms (1996)	1994	1994	995
Niwano et al. (2020)	2018	2018	104
Ohmura (1991 1992)	1990	1991	101
Otosaka et al. (2020)	2016	2016	104
Otosaka et al. (2020b)	2017	2017	70
Polashenski et al. (2015)	2013	2014	1694
Porter and Mosley-Thompson (2014)	2007	2007	242
Rasmussen et al. (2023)	2016	2018	168
Reed (1966)	1963	1963	297
Renaud et al. (1959)	1959	1959	148
Rennermalm et al. (2021)	2017	2019	2674
Sarah et al. (2018)	2015	2015	576
Schaller et al. (2016)	2015	2015	273857
Schaller et al. (2017)	2016	2016	861533
Sigl et al. (2013)	2011	2011	162
Sorge et al. (1935) as in Abermann et al. (2023)	1930	1931	123
Steen-Larsen et al. (2011)	2007	2007	143
Tedesco et al. (2019)	2010	2010	102
Trusel et al. (2018)	2015	2015	1830
Vallelonga et al. (2014)	1999	2012	234
Wilhelms et al. (2000a b c d)	1993	1994	278109
van der Veen et al. (2001)	1981	1987	3914

Table 5: Origins and temporal coverage of the density data in Antarctica

reference_short	start_year	end_year	num_measurements
Alley (1987) as in Spencer et al. (2001)	1986	1986	149
Akers et al. (2022)	2014	2014	96
Albert et al. (2007)	2004	2004	199
Alley (1980) as in Spencer et al. (2001)	1979	1979	50
Anschütz et al. (2007)	2003	2003	9849
Arnaud et al. (1998)	1989	1989	104
Cole et al. (2004)	2001	2001	4747
Conway et al. (2003)	1997	1997	160
Courville et al. (2007)	2003	2004	265
Cunde et al. (2008)	2005	2005	114
Doumani and Pirritt (1960) as in Spencer et al. (2001)	1959	1960	3504
Ethderidge and Wookey (1989) as in Spencer et al. (2001)	1987	1987	112
Fernandoy (2010a b c)	2002	2002	35
Ferreira et al. (2024)	2015	2015	15
Fourteau (2019a b c)	1991	1992	701
Fujiwara et al. (1968)	1969	1969	88
Gallet et al. (2011)	2009	2009	67
Gerhard et al. (2018)	1997	1997	25
Gerland et al. (1999)	1995	1995	51174
GlacioClim-SAMBA (2024)	2004	2024	11880
Gow (1968) as in Spencer et al. (2001)	1956	1956	143
Graf and Oerter (2006a b c d e f g h i j k l m n o p q r s t u v w x y z)	1990	1992	5301
Graf et al. (1988a b c d e f g h i j k l m n o p q)	1980	1990	1065
Graf et al. (1999a b c d e f g h i j k l m n o p)	1995	1995	2621
Graf et al. (2002a b c d e f g h i j k l m n o)	1995	2000	11223
Gregory et al. (2014) Albert (2015)	2005	2005	239
Hammes et al. (2009)	2004	2004	143
Hubbard et al. (2013)	2014	2015	84501
Isaksson and Karlén (1994) as in Spencer et al. (2001)	1989	1989	1348
Jones et al. (2014); Lamorey (2003)	1996	1997	482
Kreutz et al. (2011)	2006	2006	48764
Kusunoki and Suzuki (1978) as in Spencer et al. (2001)	1970	1978	334
Larue et al. (2021) Picard et al. (2022)	2012	2019	1311
Marcher et al. (2022)	2015	2015	45
Marques et al. (2014)	2004	2004	144

reference_short	start_year	end_year	num_measurements
Marquetto et al. (2020)	2015	2015	71
Mayewski et al. (1990) as in Spencer et al. (2001)	1984	1984	81
Mayewski et al. (1998)	1998	1998	60
Medley et al. (2013)	2010	2011	259
Minghu et al. (2011)	2008	2008	590
Montgomery et al. (2020)	2018	2018	381
Morgan et al. (1997) as in Spencer et al. (2001)	1988	1988	31
Morris et al. (2017)	2013	2014	27559
Oerter et al. (1999a b c d e f g h)	1997	1997	9560
Oerter et al. (2000a b c d e f g h i)	1997	1998	43291
Oerter et al. (2002)	2001	2001	98
Oerter et al. (2004)	1997	1997	1511
Oerter et al. (2008a b c d e f g h i j k l m n o p)	2005	2006	455
Portella et al. (2023)	2004	2004	77
Raynaud and Barnola (1985)	1981	1981	46
SEAT11: Brucker and Koenig (2011)	2011	2011	119
SIMBA: Lewis et al. (2007)	2007	2007	24
SPICE cores	2015	2015	222
Schaller et al. (2017)	2017	2017	248590
Schlosser et al. (2002)	1989	1989	452
Schwanck et al. (2014)	2004	2004	131
Schwanck et al. (2016)	2008	2008	283
Severinghaus et al. (2010)	2004	2004	45
Simoes et al. (2004a)	1995	1996	483
Stevens et al. (2023)	2016	2016	273
Stuart and Heine (1961) as in Spencer et al. (2001)	1959	1960	1040
Sugiyama et al. (2012)	2007	2008	46
TalDIce ice core	1996	1996	119
Taveres et al. (2020)	2004	2004	117
US ITASE: Mayewski and Dixon (2013)	1999	2007	2048
Verfaillie et al. (2012)	2004	2009	1331
WAIS cores	2005	2005	195
Wagenbach (1994a b c d)	1990	1990	415
Watanabe et al. (1970)	1970	1971	296
Watanabe et al. (1997) as in Spencer et al. (2001)	1996	1996	695
Weinhart et al. (2021)	2016	2017	22
Wever et al. (2022)	2016	2019	119

reference_short	start_year	end_year	num_measurements
Wilhelms (2007a b)	2007	2007	75089
Wilhelms et al. (2007)	2007	2007	68955
Winski et al. (2019)	2015	2015	222
Winstrup et al. (2019); Winstrup (2019)	2013	2013	2711
pers. comm. T. Sowers 1994 as in Spencer et al. (2001)	1994	1994	37
pers. comm. T. Sowers 1996 as in Spencer et al. (2001)	1996	1996	306

Figure 1. Spatial distribution of the density measurements in Greenland (left) and Antarctica (right)

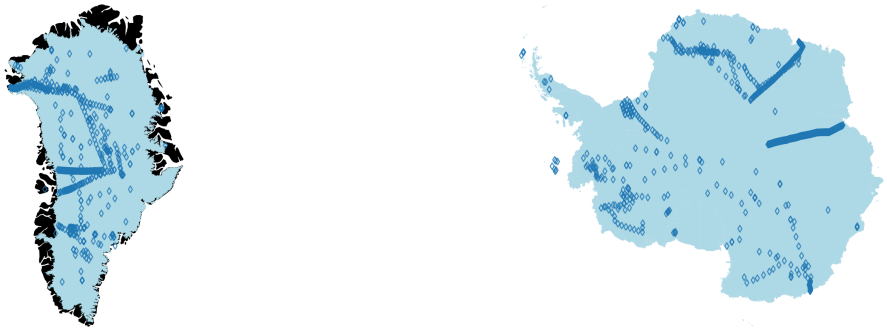
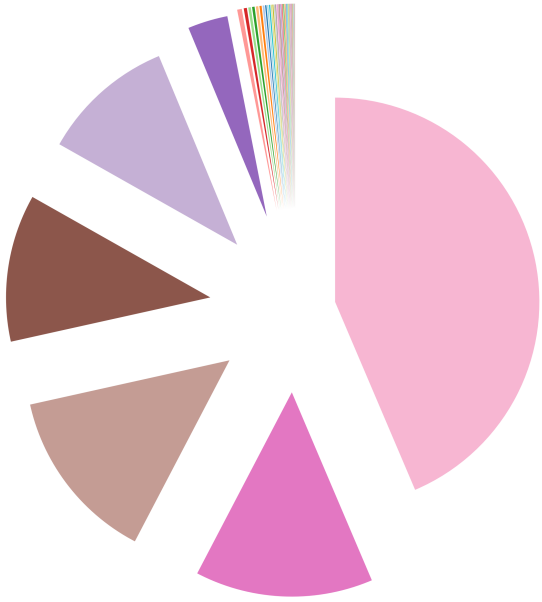


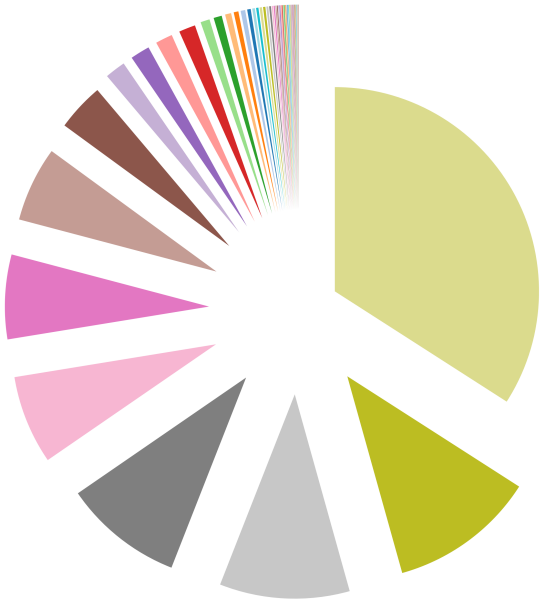
Figure 2. Composition of the density dataset in Greenland



Data origin (listed clock-wise)

- Schaller et al. (2017) 43.593 %
- Wilhelms et al. (2000a,b,c,d) 14.072 %
- Schaller et al. (2016) 13.857 %
- Kawakami et al. (2023) 11.661 %
- Miller and Schwager (2000a,b) 10.552 %
- Morris and Wingham (2014) 3.168 %
- Benson (1962, 2010, 2013) 0.368 %
- MacFerrin et al. (2022) 0.248 %
- GEUS snow and firn data (2023) 0.201 %
- van der Veen et al. (2001) 0.198 %
- Chellman et al. (2009) 0.194 %
- Freitag et al. (2021) 0.171 %
- Rennermalm et al. (2021) 0.135 %
- Machguth et al. (2016) 0.105 %
- Bolzan and Strobel (1999a,b,c,d,e,f,g,h,i,j,k,l,m,n,o) 0.102 %
- Trusel et al. (2018) 0.093 %
- Polashenski et al. (2015) 0.086 %
- Harper and Humphrey (2023) 0.078 %
- Mosley-Thompson et al. (2001) 0.073 %
- Miller et al. (2018) 0.052 %
- Alley et al. (1999) 0.052 %
- NGT: Wilhelms (1996) 0.05 %
- Clausen et al. (1988) as in Spencer et al. (2001) 0.048 %
- Adolph et al. (2014) 0.042 %
- Dibb and Fahnestock (2004) 0.041 %
- Harper et al. (2012) 0.04 %
- Graeter et al. (2018) 0.038 %
- Lewis et al. (2019) 0.037 %
- Baker et al. (2009) 0.036 %
- Dibb et al. (2007b) 0.034 %
- Hawley et al. (2014) 0.034 %
- Miège et al. (2013) 0.033 %
- Kameda et al. (1995) 0.032 %
- Bolzan and Strobel (2001a,b) 0.029 %
- Sarah et al. (2018) 0.029 %
- Clerx et al. (2022) 0.029 %
- Harper and Humphrey (2022) 0.029 %
- Colgan et al. (2018), Colgan (2021) 0.028 %
- Fischer et al. (1995) 0.026 %
- MacFerrin et al. (2019) 0.026 %
- Dibb et al. (2017) 0.024 %
- Clausen H.B., pers. comm. as in Spencer et al. (2001) 0.021 %
- Reed (1966) 0.015 %
- Mayewski et al. (2016d) 0.014 %
- Fain et al. (2009) 0.013 %
- Porter and Mosley-Thompson (2014) 0.012 %
- Vallelonga et al. (2014) 0.012 %
- Dibb et al. (2007) 0.011 %
- BPRC 1993 in Jezek (2012) 0.011 %
- Jülg (1939) as in Abermann et al. (2023) 0.011 %
- Fourteau (2019a,b,c) 0.01 %
- Mayewski and Whitlow (2016) 0.009 %
- Koenig et al. (2014) 0.009 %
- Rasmussen et al. (2023) 0.009 %
- Sigl et al. (2013) 0.008 %
- Langway (1967) as in Spencer et al. (2001) 0.008 %
- Renaud et al. (1959) 0.007 %
- Steen-Larsen et al. (2011) 0.007 %
- Hastings et al. (2017) 0.007 %
- Sorge et al. (1935) as in Abermann et al. (2023) 0.006 %
- Mayewski et al. (2016b) 0.006 %
- Kovacs et al. (1969) as in Spencer et al. (2001) 0.006 %
- Alley (1987) as in Spencer et al. (2001) 0.006 %
- Niwano et al. (2020) 0.005 %
- Otosaka et al. (2020) 0.005 %
- Tedesco et al. (2019) 0.005 %
- Ohmura (1991, 1992) 0.005 %
- Cooper et al. (2018) 0.004 %
- Johnsen, S. pers. comm. as in Spencer et al. (2001) 0.004 %
- Otosaka et al. (2020b) 0.004 %
- Mayewski et al. (2016c) 0.003 %
- Gow (1973) as in Spencer et al. (2001) 0.001 %
- Ambach 1970 0.001 %
- Bader (1954) as in Spencer et al. (2001) 0.001 %

Figure 3. Composition of the density dataset in Antarctica



Data origin (listed clock-wise)

- Schaller et al. (2017) 34.079 %
- Hubbard et al. (2013) 11.584 %
- Wilhelms (2007a,b) 10.294 %
- Wilhelms et al. (2007) 9.453 %
- Gerland et al. (1999) 7.015 %
- Kreutz et al. (2011) 6.685 %
- Oerter et al. (2000a,b,c,d,e,f,g,h,i) 5.935 %
- Morris et al. (2017) 3.778 %
- GlacioClim-SAMBA (2024) 1.629 %
- Graf et al. (2002a,b,c,d,e,f,g,h,i,j,k,l,m,n,o) 1.539 %
- Anschütz et al. (2007) 1.35 %
- Oerter et al. (1999a,b,c,d,e,f,g,h) 1.311 %
- Graf and Oerter (2006a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z) 0.727 %
- Cole et al. (2004) 0.651 %
- Doumani and Pirritt (1960) as in Spencer et al. (2001) 0.48 %
- Winstrup et al. (2019) Winstrup (2019) 0.372 %
- Graf et al. (1999a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p) 0.359 %
- US ITASE: Mayewski and Dixon (2013) 0.281 %
- Oerter et al. (2004) 0.207 %
- Isaksson and Karlén (1994) as in Spencer et al. (2001) 0.185 %
- Verfaillie et al. (2012) 0.182 %
- Larue et al. (2021) Picard et al. (2022) 0.18 %
- Graf et al. (1988a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q) 0.146 %
- Stuart and Heine (1961) as in Spencer et al. (2001) 0.143 %
- Fourteau (2019a,b,c) 0.096 %
- Watanabe et al. (1997) as in Spencer et al. (2001) 0.095 %
- Minghu et al. (2011) 0.081 %
- Simoes et al. (2004a) 0.066 %
- Jones et al. (2014) Lamorey (2003) 0.066 %
- Oerter et al. (2008a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p) 0.062 %
- Schlosser et al. (2002) 0.062 %
- Wagenbach (1994a,b,c,d) 0.057 %
- Montgomery et al. (2020) 0.052 %
- Kusunoki and Suzuki (1978) as in Spencer et al. (2001) 0.046 %
- personal communication from T. Sowers 1996 as in Spencer et al. (2001) 0.042 %
- Watanabe et al. (1970) 0.041 %
- Schwanck et al. (2016) 0.039 %
- Stevens et al. (2023) 0.037 %
- Courville et al. (2007) 0.036 %
- Medley et al. (2013) 0.036 %
- Gregory et al. (2014), Albert (2015) 0.033 %
- SPICE cores 0.03 %
- Winski et al. (2019) 0.03 %
- Albert et al. (2007) 0.027 %
- WAIS cores 0.027 %
- Conway et al. (2003) 0.022 %
- Alley (1987) as in Spencer et al. (2001) 0.02 %
- Marques et al. (2014) 0.02 %
- Hammes et al. (2009) 0.02 %
- Gow (1968) as in Spencer et al. (2001) 0.02 %
- Schwanck et al. (2014) 0.018 %
- SEAT11: Brucker and Koenig (2011) 0.016 %
- TalDIce ice core 0.016 %
- Wever et al. (2022) 0.016 %
- Taveres et al. (2020) 0.016 %
- Cunde et al. (2008) 0.016 %
- Ethderidge and Wookey (1989) as in Spencer et al. (2001) 0.015 %
- Arnaud et al. (1998) 0.014 %
- Oerter et al. (2002) 0.013 %
- Akers et al. (2022) 0.013 %
- Fujiwara et al. (1968) 0.012 %
- Mayewski et al. (1990) as in Spencer et al. (2001) 0.011 %
- Portella et al. (2023) 0.011 %
- Marquetto et al. (2020) 0.01 %
- Gallet et al. (2011) 0.009 %
- Mayewski et al. (1998) 0.008 %
- Alley (1980) as in Spencer et al. (2001) 0.007 %
- Raynaud and Barnola (1985) 0.006 %
- Sugiyama et al. (2012) 0.006 %
- Marcher et al. (2022) 0.006 %
- Severinghaus et al. (2010) 0.006 %
- personal communication from T. Sowers 1994 as in Spencer et al. (2001) 0.005 %
- Fernandoy (2010a,b,c) 0.005 %
- Morgan et al. (1997) as in Spencer et al. (2001) 0.004 %
- Gerhard et al. (2018) 0.003 %
- SIMBA: Lewis et al. (2007) 0.003 %
- Weinhart et al. (2021) 0.003 %
- Ferreira et al. (2024) 0.002 %

7.2 SMB

Table 6: Origins and temporal coverage of the SMB data in Greenland

reference_short	start_year	end_year	num_measurements
ACFEL 1963 as in Machguth et al. (2016)	1957	1957	7
Ahlmann 1941 as in Machguth et al. (2016)	1938	1940	36
Ahlstrøm 2003 as in Machguth et al. (2016)	1980	2000	85
Ahlstrøm 2007 as in Machguth et al. (2016)	1981	1990	422
Bales et al. (2009)	1741	2002	1031
Banta and McConnell (2007)	1701	2002	865
Bolzan and Strobel (1994 1999a b c d e f g 2001a b)	1940	1987	305
Box et al. (2013)	1742	2008	267
Braithwaite 1982 as in Machguth et al. (2016)	1979	1981	58
Braithwaite 1983 as in Machguth et al. (2016)	1981	1982	34
Braithwaite 1989 as in Machguth et al. (2016)	1981	1988	124
Burgress et al. (2010)	2003	2005	2
Bøggild 1995 as in Machguth et al. (2016)	1994	1995	27
Chandler et al. (2015 2021)	2012	2012	74
Clausen and Hammer (1988)	1763	1974	347
Clausen et al. (1988)	1001	1985	3405
Clausen 2001 as in Machguth et al. (2016)	1970	1995	13
Clement (1981a b c d) as in Machguth et al. (2016)	1977	1980	180
Clement (1982a b c) as in Machguth et al. (2016)	1980	1982	120
Clement (1983a b c d) as in Machguth et al. (2016)	1981	1983	130
Clement 1980 as in Machguth et al. (2016)	1979	1979	1
Davis 1967 as in Machguth et al. (2016)	1960	1964	16
Davis 1971 as in Machguth et al. (2016)	1955	1959	17
Dibb and Fahnestock (2004)	2003	2016	161
Fausto (2021)	2018	2020	249
Freitag et al. (2022a b c d)	1864	2012	457
Fristrup 1952 as in Machguth et al. (2016)	1948	1950	4
GC-Net (Steffen et al. 2023) as in Machguth et al. (2016)	1999	2009	16
GEUS unpublished	1977	2023	349
GRIP Hammer and Dahl-Jensen (1999)	1000	1989	439
Graeter et al. (1002)	1966	2015	268
Griffiths 1961 as in Machguth et al. (2016)	1954	1956	52
Hanna et al. (2006)	1957	2002	1281

reference_short	start_year	end_year	num_measurements
Hanna et al. (2011)	1773	2003	465
Hermann et al. (2018)	2013	2017	19
Historical GC-Net: Steffen et al. (1996 2001 2023); Vandecrux et al. (2023)	1996	2018	3713
Hynek 2014b as in Machguth et al. (2016)	2007	2013	93
Jung-Rothenhäusler 1995 as in Machguth et al. (2016)	1989	1994	53
Karlsson et al. (2016)	1311	2011	5558
Kawakami and Iizuka (2023)	1800	2020	221
Kjær et al. (2021)	2014	2018	29
Koenig et al. (2016)	1982	2012	844374
Kuhlman 1959 as in Machguth et al. (2016)	1957	1957	1
LaChapelle 1955 as in Machguth et al. (2016)	1952	1953	6
Lewis et al. (2017)	1712	2014	278157
Lewis et al. (2019)	1955	2016	869199
Loewe 1933 as in Machguth et al. (2016)	1929	1931	14
Machguth et al. (2016)	1982	2014	1104
Miller and Schwager (2000a b c d e)	871	1994	3245
Miège et al. (2013 2014a)	1992	2009	142975
Miège et al. (2013 2014b)	1762	2010	419
Montgomery et al. (2020)	2009	2017	286162
Mosley-Thompson et al. (2001)	1700	1998	1851
NEEM-08	1746	1999	254
Niwano et al. (2020)	2017	2018	4
Nobles 1960 as in Machguth et al. (2016)	1953	1954	17
Oerter 1995a as in Machguth et al. (2016)	1993	1994	23
Osman et al. (2021)	1000	2012	5507
PROMICE (2023)	2007	2023	17993
PROMICE (Fausto et al. 2023) as in Machguth et al. (2016)	2000	2020	242
Pert 1971 as in Machguth et al. (2016)	1963	1963	20
Podlech 2004 as in Machguth et al. (2016)	2001	2003	3
Rundle 1965 as in Machguth et al. (2016)	1952	1964	42
Schaller et al. (2016)	2011	2012	2
Schytt 1955 as in Machguth et al. (2016)	1953	1954	48
Smeets et al. (2018 2022)	2003	2015	1861
Thomsen 1984 as in Machguth et al. (2016)	1982	1983	1
Vinther et al. (2022)	1928	2010	83
White 1956 as in Machguth et al. (2016)	1953	1953	8
de Quervain 1925 as in Machguth et al. (2016)	1912	1912	5

reference_short	start_year	end_year	num_measurements
von Drygalski 1897 as in Machguth et al. (2016)	1892	1893	60

Table 7: Origins and temporal coverage of the SMB data in Antarctica

reference_short	start_year	end_year	num_measurements
Agosta et al. 2011 as in Wang et al. (2021)	2004	2010	91
Anschutz et al. 2009 as in Wang et al. (2021)	1815	2007	5
Anschutz et al. 2011 as in Wang et al. (2021)	1815	2008	13
Anschütz et al. (2007a b c d e f)	1966	2003	174
Aristarain et al. 1982 as in Wang et al. (2021)	1955	1978	1
Aristarain et al. 1987 as in Wang et al. (2021)	1955	1981	17
Aristarain et al. 2004 as in Thomas et al. (2017)	1832	1997	166
Baeza et al. 1996 as in Wang et al. (2021)	1970	1994	1
Banta et al. (2008)	1521	2004	714
Bertler et al. 2018. as in Thomas et al. (2017)	-45	2010	2056
Bishop and Walton 1981 as in Wang et al. (2021)	1969	1980	4
Bliss et al 2011 as in Wang et al. (2021)	2002	2011	164
Boutron and Lorius 1977; Mulvaney and Wolff 1994 as in Wang et al. (2021)	1955	1972	11
Brecher 1967 as in Wang et al. (2021)	1963	1966	6
Brunk 1986 as in Wang et al. (2021)	1966	1985	1
Budd 1963 as in Wang et al. (2021)	1957	1962	1
Budd 1982 as in Wang et al. (2021)	1962	1970	8
Bull 1971; Crary et al. 1962 as in Wang et al. (2021)	1957	1960	7
Clausen et al. 1979 as in Wang et al. (2021)	1955	1977	69
Cole-Dai et al. 2000 as in Wang et al. (2021)	1815	1987	2
Dattler et al. 2019 as in Wang et al. (2021)	1980	2017	175373
Ding et al. 2011 as in Wang et al. (2021)	1998	2009	7
Ding et al. 2017 as in Wang et al. (2021)	1709	2001	293
Dome-F Coring Group 1998 as in Wang et al. (2021)	1966	1985	1
Eicken 1994 as in Wang et al. (2021)	1973	1990	2
Ekaykin et al. 2002 as in Wang et al. (2021)	1941	1999	9
Ekaykin et al. 2014 as in Thomas et al. (2017)	1774	1999	225
Ekaykin et al. 2016 as in Thomas et al. (2017)	1640	1988	349
Ekaykin et al. 2017 as in Wang et al. (2021)	1254	2009	4
Fernandoy et al. (2010a b c d)	1935	2006	247
Fernandoy et al. 2010 as in Wang et al. (2021)	1960	2006	69
Ferris et al. (2011)	1800	2003	204

reference_short	start_year	end_year	num_measurements
Frezzotti et al. 2004 as in Wang et al. (2021)	1816	2002	41
Frezzotti et al. 2004; 2007 as in Thomas et al. (2017)	1777	2004	228
Frezzotti et al. 2004; 2013 as in Wang et al. (2021)	1670	2003	334
Frezzotti et al. 2004; 2014 as in Thomas et al. (2017)	1854	2004	151
Frezzotti et al. 2005 as in Wang et al. (2021)	1966	2002	10
Frezzotti et al. 2007 as in Wang et al. (2021)	1816	2006	1719
Frezzotti et al. 2013 as in Thomas et al. (2017)	1745	2003	392
Fudge et al. 2016 as in Thomas et al. (2017)	-51	2005	2057
Fudge et al. 2016 as in Wang et al. (2021)	1000	2006	1007
Fujita et al. 2011 as in Wang et al. (2021)	1964	2008	6
Fujiwara and Endo 1971 as in Wang et al. (2021)	1968	1975	36
Giovinetto 1960 as in Wang et al. (2021)	1958	1962	1
Glacioclim-BELARE as in Wang et al. (2021)	2009	2012	59
Goodwin et al. 1988; Jones et al. 1985 as in Wang et al. (2021)	1980	1985	5
Goodwin et al. 1994 as in Wang et al. (2021)	1975	1992	3
Goodwin et al. 2016 as in Thomas et al. (2017)	1900	2009	110
Goodwin 1988 as in Wang et al. (2021)	1973	1986	391
Goodwin 1995 as in Wang et al. (2021)	1941	1992	52
Gow 1972 as in Wang et al. (2021)	1655	1970	2
Graf and Oerter (2006a b c d e f g h i j k l m n o p q r s t u v w x y z)	1936	1990	397
Graf et al. (1988a b c d e f g h i j k l m n o p q)	1461	1985	565
Graf et al. (1999a b c d e f g h i j k l m n o p)	1946	1994	454
Graf et al. 1994 as in Wang et al. (2021)	1962	1989	7
Graf et al. 2002 as in Thomas et al. (2017)	1299	2010	712
Hammer et al. 1994 as in Wang et al. (2021)	1259	1968	1
Higham et al. 1997 as in Wang et al. (2021)	1983	1995	527
Hoffmann et al. 2020 as in Wang et al. (2021)	1973	2014	183
Hofstede et al. 2004 as in Wang et al. (2021)	1171	2001	3
Holmlund et al. 2000 as in Wang et al. (2021)	1955	1998	2
Hou et al 2007 as in Wang et al. (2021)	1966	2004	1
Igarashi et al. 2011 as in Wang et al. (2021)	1994	2001	1
Isaksson and Karlén 1994 as in Wang et al. (2021)	1955	1988	3
Isaksson et al. 1996 as in Wang et al. (2021)	1865	1991	129
Isaksson et al. 1999 as in Thomas et al. (2017)	1956	1996	41
Isaksson et al. 1999 as in Wang et al. (2021)	1965	1996	85
Jouzel et al. 1983 as in Wang et al. (2021)	1930	1978	1
Kaczmarska et al. 2004 as in Thomas et al. (2017)	1737	1999	263

reference_short	start_year	end_year	num_measurements
Kameda et al. 2008 as in Wang et al. (2021)	1995	2006	1
Kameda et al. 2008; Motoyama et al. 2016 as in Wang et al. (2021)	1985	2014	25
Kamiyama et al 1989 as in Wang et al. (2021)	1966	1985	1
Karlöf et al. 2000 as in Wang et al. (2021)	1815	1997	1
Karlöf et al. 2005 as in Wang et al. (2021)	1955	2000	10
Kaspari et al. 2004 as in Wang et al. (2021)	1716	2001	397
Khodzher et al. 2014 as in Wang et al. (2021)	2006	2010	13
Koide et al. 1979 as in Wang et al. (2021)	1950	1976	1
Konrad et al. (2019)	1985	2014	61334
Kreutz et al. 2000 as in Wang et al. (2021)	1964	1994	3
Langway et al. 1994 as in Wang et al. (2021)	628	1989	1
Legrand and Delmas 1985 as in Wang et al. (2021)	1959	1969	2
Lorius et al. 1968 as in Wang et al. (2021)	1955	1969	5
Magand et al. 2004 as in Wang et al. (2021)	1965	2001	1
Magand et al. 2004; Frezzotti et al. 2007 as in Wang et al. (2021)	1965	2001	2
Magand et al. 2005; Frezzotti et al. 2007 as in Wang et al. (2021)	1965	2001	1
Magand et al. 2007 as in Wang et al. (2021)	1965	2001	14
Mayewski and Dixon 2013 as in Thomas et al. (2017)	1888	2000	113
Mayewski and Dixon 2013 as in Wang et al. (2021)	1637	2001	331
Mayewski and Legrand 1990 as in Wang et al. (2021)	0	1984	1
McConnell et al. 1997 as in Wang et al. (2021)	1988	1995	1
McCrae 1984 as in Wang et al. (2021)	1970	1984	25
Medley et al. (2013)	1800	2010	448
Medley et al. 2014 as in Wang et al. (2021)	1980	2009	6616
Melvold et al. 1998 as in Wang et al. (2021)	1965	1998	8
Melvold 1999 as in Wang et al. (2021)	1976	1993	5
Meyerson et al. 2002 as in Wang et al. (2021)	1430	1989	560
Moore et al. 1991 as in Wang et al. (2021)	1259	1984	4
Morris et al. (2017)	1985	2013	21
Mosley-Thompson et al. 1999 as in Thomas et al. (2017)	1801	1991	191
Mosley-Thompson et al. 1999 as in Wang et al. (2021)	1801	1997	428
Mosley-Thompson et al. 1999; Giovinetto et al. 1966; Picciotto et al . 1964 as in Wang et al. (2021)	1958	1964	1
Mosley-Thompson et al. 1995 as in Wang et al. (2021)	1955	1985	24
Mosley-Thompson et al. 1995; Lazzara et al. 2012 as in Wang et al. (2021)	1985	2014	23
Mosley-Thompson et al. 2001 as in Wang et al. (2021)	1955	1994	20
Motoyama et al. (2015) Wang et al. (2015 2021) as in Wang et al. (2021)	1979	2013	504
Mulvaney and Wolff 1993 as in Wang et al. (2021)	1962	1982	2

reference_short	start_year	end_year	num_measurements
Mulvaney and Wolff 1993; Mulvaney et al. 1990 as in Wang et al. (2021)	1964	1987	1
Mulvaney et al. (2002)	1000	1994	995
Mumford and Peel 1982 as in Wang et al. (2021)	1964	1974	1
My et al. 2012; Roberts et al. 2015 as in Thomas et al. (2017)	-22	2010	2033
Neethling 1970 as in Wang et al. (2021)	1963	1967	1
Nijampurkar et al. 1993 as in Wang et al. (2021)	1963	1993	2
Nishio et al. 2002 as in Thomas et al. (2017)	1832	1999	168
Oerter H. 2008 as in Wang et al. (2021)	1964	2005	105
Oerter et al. (2000)	1025	1996	5437
Oerter et al. (2008a b c d e f g h i j k l m n o p)	1990	2005	204
Oerter et al. 1999 as in Thomas et al. (2017)	1895	1996	838
Oerter et al. 1999 as in Wang et al. (2021)	1801	1997	367
Oerter et al. 2000 as in Thomas et al. (2017)	1801	1997	391
Oerter et al. 2000 as in Wang et al. (2021)	1801	1997	1
Oerter et al. 2004 as in Wang et al. (2021)	0	0	2
Orheim et al. 1986 as in Wang et al. (2021)	1965	1976	5
Palais et al. 1982 as in Wang et al. (2021)	1955	1985	2
Pasteur and Mulvaney 2000 as in Thomas et al. (2017)	1949	1991	43
Peel and Clausen 1982 as in Wang et al. (2021)	1954	1976	14
Peel and Davison. 1988 as in Wang et al. (2021)	1964	1986	2
Petit et al. 1982 as in Wang et al. (2021)	1955	1979	2
Pettre et al. 1986 as in Wang et al. (2021)	1955	1983	21
Pettre et al. 1986; Petit et al. 1982 as in Wang et al. (2021)	1955	1983	2
Philippe et al. 2016 as in Thomas et al. (2017)	1744	2010	267
Picciotto et al . 1964 as in Wang et al. (2021)	1955	1963	1
Picciotto et al. 1968 as in Wang et al. (2021)	1955	1968	73
Potter et al. 1984 as in Wang et al. (2021)	1965	1976	19
Pourchet et al. 1983 as in Wang et al. (2021)	1955	1977	12
Pourchet et al. 1997 as in Wang et al. (2021)	1955	1990	6
Pourchet et al. 2003 as in Wang et al. (2021)	1955	2000	6
Reinwarth et al 1982 as in Wang et al. (2021)	1960	1980	1
Ren and Qin 1999 as in Wang et al. (2021)	1942	1992	51
Ren et al. 1995 as in Wang et al. (2021)	1970	1988	3
Ren et al. 2010 as in Wang et al. (2021)	1963	1999	1
Reusch et al. 1999 as in Wang et al. (2021)	1939	1993	55
Rotscky et al. 2007ab as in Wang et al. (2021)	1816	1997	9
Rott et al. 1998 as in Wang et al. (2021)	1980	1996	4

reference_short	start_year	end_year	num_measurements
SEAT10 et al. (2013)	1966	2010	198
Schlosser et al. (2002)	1975	1988	14
Schlosser et al. (2002b)	1955	1997	43
Schlosser et al. 1999 as in Thomas et al. (2017)	1892	1981	90
Schlosser et al. 2012 as in Wang et al. (2021)	1981	2009	100
Schlosser et al. 2014 as in Wang et al. (2021)	1991	2009	52
Schwander and Stauffer 1984 as in Wang et al. (2021)	1800	1983	1
Sinisalo et al. 2003 as in Wang et al. (2021)	1988	2002	26
Sinisalo et al. 2013 as in Wang et al. (2021)	2009	2012	8
Skvarca et al. 2004 as in Wang et al. (2021)	2001	2010	1
Sommer et al. 2000 as in Wang et al. (2021)	1965	1997	1
South Pole Meteorology Office (2024)	1960	2023	585
Spikes et al. (2005)	1815	2000	59768
Stenni et al. 1999 as in Wang et al. (2021)	1937	1992	2
Stenni et al. 2000 as in Thomas et al. (2017)	1770	1992	223
Stenni et al. 2000 as in Wang et al. (2021)	1297	2010	714
Stenni et al. 2002 as in Wang et al. (2021)	0	1996	4
Stuart 1961; Stuart and Heine 1961 as in Wang et al. (2021)	1951	1960	17
Takahashi et al. 1994 as in Wang et al. (2021)	1955	1988	9
Takahashi et al. 2009 as in Wang et al. (2021)	1965	2002	1
Thomas et al. 1984 as in Wang et al. (2021)	1971	1974	2
Thomas et al. 2008 as in Thomas et al. (2017)	1856	2006	151
Thomas et al. 2015 as in Thomas et al. (2017)	1703	2010	607
Thompson et al. 1994 as in Thomas et al. (2017)	1840	1989	150
US-ITASE et al. (2013)	1430	2002	4336
Urbini et al. 2008 as in Wang et al. (2021)	1965	1998	1
Van Ommen and Morgan 2010 as in Wang et al. (2021)	1966	2005	1
Van den Broeke et al. 1999 as in Wang et al. (2021)	1955	1997	13
Vaughan et al. 1999; Venteris and Whillans 1998 as in Wang et al. (2021)	1955	2009	153
Verfaillie et al. (2012)	1799	2009	20841
Vladimirova et al. 2014 as in Thomas et al. (2017)	1757	1981	154
Wagenbach et al. (1994a b)	1962	1989	48
Wang et al. (2021) as in Wang et al. (2021)	1979	2013	1
Wang et al. 2013 as in Wang et al. (2021)	1963	2009	2
Wang et al. 2015; Motoyama et al. 2015 as in Wang et al. (2021)	1971	2014	11145
Wang et al. 2016; Ding et al. 2011 as in Wang et al. (2021)	1994	2011	72
Wang et al. 2016 as in Wang et al. (2021)	1999	2011	509

reference_short	start_year	end_year	num_measurements
Wen et al. 2006 as in Wang et al. (2021)	1942	1996	55
Winski et al. 2019 as in Wang et al. (2021)	-7503	2014	9518
Winstrup et al. 2019 as in Wang et al. (2021)	1965	2012	1
Wolff and Suttie 1994 as in Wang et al. (2021)	1954	1964	1
Xiao et al. 2004 as in Thomas et al. (2017)	1670	2003	334
Yokohama 1975 as in Wang et al. (2021)	1969	1974	8
Young et al. 1982 as in Wang et al. (2021)	0	0	56
Young et al. 1982; Vinogradovand Lorius 1971 as in Wang et al. (2021)	1955	1969	10
Zanolini et al. 1985 as in Wang et al. (2021)	1815	1980	1

Figure 4. Spatial distribution of the SMB measurements in Greenland (left) and Antarctica (right)

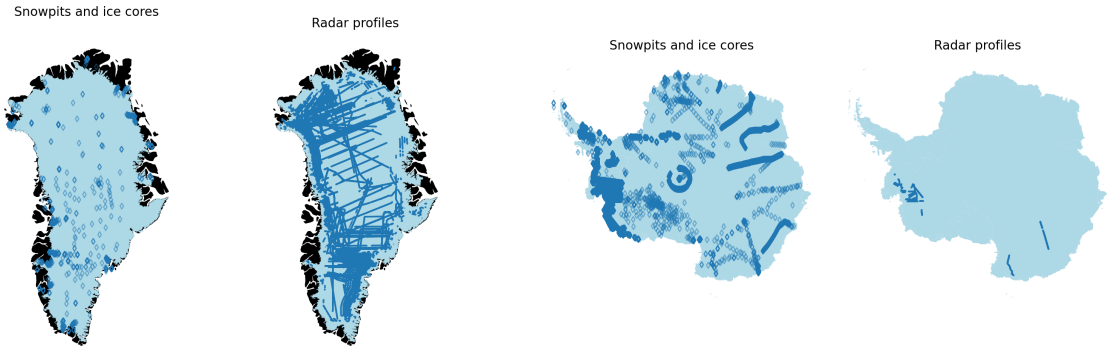
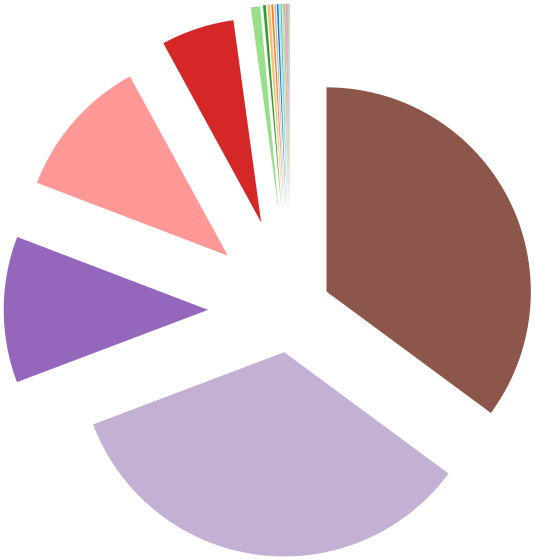


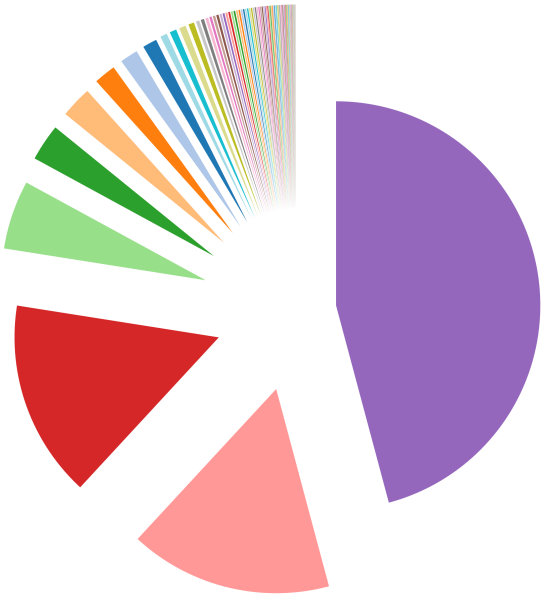
Figure 5. Composition of the SMB dataset in Greenland



Data origin (listed clock-wise)

- Lewis et al. (2019) 35.124 %
- Koenig et al. (2016) 34.121 %
- Montgomery et al. (2020) 11.564 %
- Lewis et al. (2017) 11.24 %
- Miège et al. (2013, 2014a) 5.778 %
- PROMICE (2023) 0.727 %
- Karlsson et al. (2016) 0.225 %
- Osman et al. (2021) 0.223 %
- Historical GC-Net: Steffen et al. (1996, 2001, 2023) Vandecrux et al. (2023) 0.15 %
- Clausen et al. (1988) 0.138 %
- Miller and Schwager (2000a,b,c,d,e) 0.131 %
- Smeets et al. (2018, 2022) 0.075 %
- Mosley-Thompson et al. (2001) 0.075 %
- Hanna et al. (2006) 0.052 %
- Machguth et al. (2016) 0.045 %
- Bales et al. (2009) 0.042 %
- Banta and McConnell (2007) 0.035 %
- Hanna et al. (2011) 0.019 %
- Freitag et al. (2022a,b,c,d) 0.018 %
- GRIP, Hammer and Dahl-Jensen (1999) 0.018 %
- Ahlstrøm, 2007 as in Machguth et al. (2016) 0.017 %
- Miège et al. (2013, 2014b) 0.017 %
- GEUS unpublished 0.014 %
- Clausen and Hammer (1988) 0.014 %
- Bolzan and Strobel (1994, 1999a,b,c,d,e,f,g, 2001a,b) 0.012 %
- Graeter et al. (1002) 0.011 %
- Box et al. (2013) 0.011 %
- NEEM-08 0.01 %
- Fausto (2021) 0.01 %
- PROMICE (Fausto et al., 2023) as in Machguth et al. (2016) 0.01 %
- Kawakami and Iizuka (2023) 0.009 %
- Clement (1981a,b,c,d) as in Machguth et al. (2016) 0.007 %
- Dibb and Fahnestock (2004) 0.007 %
- Clement (1983a,b,c,d) as in Machguth et al. (2016) 0.005 %
- Braithwaite, 1989 as in Machguth et al. (2016) 0.005 %
- Clement (1982a,b,c) as in Machguth et al. (2016) 0.005 %
- Hynek, 2014b as in Machguth et al. (2016) 0.004 %
- Ahlstrøm, 2003 as in Machguth et al. (2016) 0.003 %
- Vinther et al. (2022) 0.003 %
- Chandler et al. (2015, 2021) 0.003 %
- von Drygalski, 1897 as in Machguth et al. (2016) 0.002 %
- Braithwaite, 1982 as in Machguth et al. (2016) 0.002 %
- Jung-Rothenhäusler, 1995 as in Machguth et al. (2016) 0.002 %
- Griffiths, 1961 as in Machguth et al. (2016) 0.002 %
- Schytt, 1955 as in Machguth et al. (2016) 0.002 %
- Rundle, 1965 as in Machguth et al. (2016) 0.002 %
- Ahlmann, 1941 as in Machguth et al. (2016) 0.001 %
- Braithwaite, 1983 as in Machguth et al. (2016) 0.001 %
- Kjær et al. (2021) 0.001 %
- Bøggild, 1995 as in Machguth et al. (2016) 0.001 %
- Oerter, 1995a as in Machguth et al. (2016) 0.001 %
- Pert, 1971 as in Machguth et al. (2016) 0.001 %
- Hermann et al. (2018) 0.001 %
- Davis, 1971 as in Machguth et al. (2016) 0.001 %
- Nobles, 1960 as in Machguth et al. (2016) 0.001 %
- GC-Net (Steffen et al., 2023) as in Machguth et al. (2016) 0.001 %
- Davis, 1967 as in Machguth et al. (2016) 0.001 %
- Loewe, 1933 as in Machguth et al. (2016) 0.001 %
- Clausen, 2001 as in Machguth et al. (2016) 0.001 %
- White, 1956 as in Machguth et al. (2016) 0.0 %
- ACFEL, 1963 as in Machguth et al. (2016) 0.0 %
- LaChapelle, 1955 as in Machguth et al. (2016) 0.0 %
- de Quervain, 1925 as in Machguth et al. (2016) 0.0 %
- Fristrup, 1952 as in Machguth et al. (2016) 0.0 %
- Niwano et al. (2020) 0.0 %
- Podlech, 2004 as in Machguth et al. (2016) 0.0 %
- Schaller et al. (2016) 0.0 %
- Burgress et al. (2010) 0.0 %
- Thomsen, 1984 as in Machguth et al. (2016) 0.0 %
- Kuhlman, 1959 as in Machguth et al. (2016) 0.0 %
- Clement, 1980 as in Machguth et al. (2016) 0.0 %

Figure 6. Composition of the SMB dataset in Antarctica



Data origin (listed clock-wise)

- Dattler et al., 2019 as in Wang et al. (2021) 45.839 %
- Konrad et al. (2019) 16.032 %
- Spikes et al. (2005) 15.622 %
- Verfaillie et al. (2012) 5.447 %
- Wang et al., 2015
  Motoyama et al., 2015 as in Wang et al. (2021) 2.913 %
- Winski et al., 2019 as in Wang et al. (2021) 2.488 %
- Medley et al. 2014 as in Wang et al. (2021) 1.729 %
- Oerter et al. (2000) 1.421 %
- US-ITASE et al. (2013) 1.133 %
- Fudge et al., 2016 as in Thomas et al. (2017) 0.538 %
- Bertler et al., 2018. as in Thomas et al. (2017) 0.537 %
- My et al., 2012
  Roberts et al., 2015 as in Thomas et al. (2017) 0.531 %
- Frezzotti et al., 2007 as in Wang et al. (2021) 0.449 %
- Fudge et al., 2016 as in Wang et al. (2021) 0.263 %
- Mulvaney et al. (2002) 0.26 %
- Oerter et al., 1999 as in Thomas et al. (2017) 0.219 %
- Stenni et al., 2000 as in Wang et al. (2021) 0.187 %
- Banta et al. (2008) 0.187 %
- Graf et al., 2002 as in Thomas et al. (2017) 0.186 %
- Thomas et al., 2015 as in Thomas et al. (2017) 0.159 %
- South Pole Meteorology Office (2024) 0.153 %
- Graf et al. (1988a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q) 0.148 %
- Meyerson et al., 2002 as in Wang et al. (2021) 0.146 %
- Higham et al., 1997 as in Wang et al. (2021) 0.138 %
- Wang et al.,2016 as in Wang et al. (2021) 0.133 %
- Motoyama et al. (2015), Wang et al. (2015, 2021) as in Wang et al. (2021) 0.132 %
- Graf et al. (1999a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p) 0.119 %
- Medley et al. (2013) 0.117 %
- Mosley-Thompson et al. 1999 as in Wang et al. (2021) 0.112 %
- Kaspari et al., 2004 as in Wang et al. (2021) 0.104 %
- Graf and Oerter (2006a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z) 0.104 %
- Frezzotti et al., 2013 as in Thomas et al. (2017) 0.102 %
- Goodwin, 1988 as in Wang et al. (2021) 0.102 %
- Oerter et al., 2000 as in Thomas et al. (2017) 0.102 %
- Oerter et al., 1999 as in Wang et al. (2021) 0.096 %
- Ekaykin et al., 2016 as in Thomas et al. (2017) 0.091 %
- Frezzotti et al., 2004
  2013 as in Wang et al. (2021) 0.087 %
- Xiao et al., 2004 as in Thomas et al. (2017) 0.087 %
- Mayewski and Dixon, 2013 as in Wang et al. (2021) 0.087 %
- Ding et al., 2017 as in Wang et al. (2021) 0.077 %
- Aristarain et al., 1987 as in Wang et al. (2021) 0.004 %
- Magand et al., 2007 as in Wang et al. (2021) 0.004 %
- Peel and Clausen, 1982 as in Wang et al. (2021) 0.004 %
- Schlosser et al. (2002) 0.004 %
- Khodzher et al.,2014 as in Wang et al. (2021) 0.003 %
- Van den Broeke et al., 1999 as in Wang et al. (2021) 0.003 %
- Anschutz et al., 2011 as in Wang et al. (2021) 0.003 %
- Pourchet et al., 1983 as in Wang et al. (2021) 0.003 %
- Boutron and Lorius, 1977
  Mulvaney and Wolff, 1994 as in Wang et al. (2021) 0.003 %
- Frezzotti et al., 2005 as in Wang et al. (2021) 0.003 %
- Young et al., 1982
  Vinogradovand Lorius, 1971 as in Wang et al. (2021) 0.003 %
- Karlöf et al., 2005 as in Wang et al. (2021) 0.003 %
- Takahashi et al. 1994 as in Wang et al. (2021) 0.002 %
- Rotscky et al., 2007ab as in Wang et al. (2021) 0.002 %
- Ekaykin et al., 2002 as in Wang et al. (2021) 0.002 %
- Sinisalo et al., 2013 as in Wang et al. (2021) 0.002 %
- Budd, 1982 as in Wang et al. (2021) 0.002 %
- Melvold et al., 1998 as in Wang et al. (2021) 0.002 %
- Yokohama, 1975 as in Wang et al. (2021) 0.002 %
- Bull, 1971
  Crary et al., 1962 as in Wang et al. (2021) 0.002 %
- Ding et al., 2011 as in Wang et al. (2021) 0.002 %
- Graf et al. 1994 as in Wang et al. (2021) 0.002 %
- Fujita et al., 2011 as in Wang et al. (2021) 0.002 %
- Brecher, 1967 as in Wang et al. (2021) 0.002 %
- Pourchet et al., 1997 as in Wang et al. (2021) 0.002 %
- Pourchet et al., 2003 as in Wang et al. (2021) 0.002 %
- Lorius et al., 1968 as in Wang et al. (2021) 0.001 %
- Orheim et al., 1986 as in Wang et al. (2021) 0.001 %
- Melvold, 1999 as in Wang et al. (2021) 0.001 %
- Anschutz et al., 2009 as in Wang et al. (2021) 0.001 %
- Goodwin et al., 1988
  Jones et al., 1985 as in Wang et al. (2021) 0.001 %
- Stenni et al., 2002 as in Wang et al. (2021) 0.001 %
- Bishop and Walton, 1981 as in Wang et al. (2021) 0.001 %
- Moore et al., 1991 as in Wang et al. (2021) 0.001 %
- Ekaykin et al., 2017 as in Wang et al. (2021) 0.001 %
- Rott et al., 1998 as in Wang et al. (2021) 0.001 %
- Isaksson and Karlén, 1994 as in Wang et al. (2021) 0.001 %
- Goodwin et al., 1994 as in Wang et al. (2021) 0.001 %
- Rep et al., 1995 as in Wang et al. (2021) 0.001 %

7.3 Temperature

Table 8: Origins and temporal coverage of the temperature data in Greenland

reference_short	start_year	end_year	num_measurements
Alley and Koci (1990)	1989.0	1989.0	1
Ambach (1979)	1959.0	1967.0	39
Benson (1962)	1954.0	1955.0	59
Braithwaite (1993)	1991.0	1992.0	78
Charalampidis et al. (2016 2022)	2012.0	2013.0	11642
Clausen and Hammer (1988)	1977.0	1977.0	1
Clausen and Stauffer (1988)	1978.0	1978.0	20
Clausen et al. (1988)	1974.0	1985.0	11
Clement (1984)	1983.0	1983.0	28
Colbeck and Gow (1979)	1973.0	1973.0	3
Covi et al. (2022 2023)	2017.0	2019.0	58724
Davies (1954)	1960.0	1960.0	7
Davies (1967)	1962.0	1962.0	1
Diamond (1960)	1951.0	1951.0	1
Echelmeyer et al. (1992)	1984.0	1984.0	15
Fischer et al. (1995)	1990.0	1992.0	31
GC-Net unpublished	1991.0	2010.0	60735
Giese and Hawley (2015)	2004.0	2008.0	2838
Graeter et al. (2018)	2016.0	2016.0	6
Griffiths (1960)	1955.0	1956.0	225
Harrington et al. (2015)	2010.0	2012.0	5
Hawley (2014) GrIT	2011.0	2011.0	4
Heilig et al. (2018)	2016.0	2021.0	13517
Heuberger (1954)	1954.0	1954.0	1
Heuberger (1954)	1950.0	1950.0	2
Hills et al. (2017)	2015.0	2016.0	426
Hills et al. (2018)	2011.0	2017.0	71666
Historical GC-Net: Steffen et al. (1996 2001 2023); Vandecrux et al. (2023)	1995.0	2022.0	113323
Humphrey et al. (2012)	2007.0	2009.0	90836
Iizuka et al. (2016)	2015.0	2015.0	1
Kjær et al. (2015)	2015.0	2015.0	8
Koch (1913)	1912.0	1913.0	5
Langway (1961)	1959.0	1959.0	14

reference_short	start_year	end_year	num_measurements
Laternser (1994)	1992.0	1992.0	214
Law et al. (2021)	2019.0	2019.0	1
Lewis et al. (2019)	2017.0	2017.0	8
MacFerrin et al. (2021 2022)	2015.0	2019.0	179360
Matoba et al. (2015)	2014.0	2014.0	2
Meier et al. (1957)	1955.0	1955.0	25
Miller et al. (2020)	2013.0	2017.0	97316
Mock (1965)	1964.0	1964.0	12
Mock and Ragle (1963)	1964.0	1964.0	31
Nishimura et al. (2023)	2012.0	2020.0	14389
Nobles (1960)	1954.0	1954.0	14
Ohmura et al. (1992)	1990.0	1990.0	3
PROMICE/GC-Net How et al. (2023)	1995.0	2024.0	999452
Polashenski et al. (2014)	2013.0	2013.0	20
Saito et al. (2024); Harper and Humphrey (2023)	2019.0	2021.0	34080
Saito et al. (2024); Harper and Humphrey (2024)	2019.0	2019.0	15264
Schwager (2000)	1993.0	1995.0	23
Schytt (1955)	1954.0	1954.0	311
Smeets et al. (2018)	2009.0	2016.0	19697
Stauffer and Oeschger (1979)	1978.0	1978.0	1
Thomsen et al. (1991)	1990.0	1991.0	40
U.S. Army Transportation Board (1960)	1960.0	1960.0	4
Vandecrux et al. (2021); Colgan and Vandecrux (2021)	2017.0	2024.0	113894
Weertman et al. (1968)	1966.0	1966.0	1
Wegener (1930)	1930.0	1930.0	14
Yamaguchi et al. (2014)	2012.0	2012.0	4
de Quervain (1969)	1957.0	1964.0	19
van der Veen et al. (2001)	1980.0	1981.0	142

Table 9: Origins and temporal coverage of the temperature data in Antarctica

reference_short	start_year	end_year	num_measurements
Anderson et al. (1958)	1957	1957	46
Aughenbaugh et al. (1959)	1957	1958	22
Brecher et al. (1964)	1960	1960	26
Cameron et al. (1964)	1957	1957	1
Cameron et al. (1968)	1963	1965	29

reference_short	start_year	end_year	num_measurements
Crary et al. (1962)	1957	1959	54
Crary et al. (1963)	1958	1959	15
Fernandoy et al. (2010)	2007	2007	1
Fourteau et al. (2019)	2016	2016	1
Fujiwara et al. (1971)	1968	1969	23
Giovinetto et al. (1963)	1961	1961	14
Goodwin et al. (1959)	1958	1959	22
Graf et al. (1988)	1984	1990	11
Graf et al. (1999)	1990	1992	2
Inoue et al. (2023)	2018	2018	1
Kojima et al. (1964)	1958	1958	5
Long et al. (1961)	1958	1959	26
Magand et al. (2004)	2002	2021	20
Maggi et al. (1998)	1994	1994	1
Martin et al. (1978)	1975	1975	54
Mulvaney et al. (2017)	2013	2014	21
Oerter et al. (2000)	1996	1998	6
Oerter et al. (2006)	1990	1990	1
P.J. et al. (1959)	1957	1958	15
Peel et al. (1976)	1970	1970	7
Peel et al. (1982)	1975	1975	6
Picciotto et al. (1971)	1965	1968	33
Pirrit et al. (1961)	1959	1969	27
Potter et al. (1984)	1975	1975	19
Reinwarth et al. (1981)	1982	1982	1
Satow et al. (1977)	1974	1975	36
Schwanck et al. (2016)	2009	2009	1
Shimizu et al. (1964)	1960	1962	63
Shimizu et al. (1972)	1969	1970	25
Stenni et al. (2000)	1992	1992	1
Stuart et al. (1961)	1959	1960	12
Taldiceproject	1996	1996	1
Taylor et al. (1971)	1962	1963	24
Thomas et al. (1984)	1974	1978	96
Van Den Broeke et al. (1999)	1996	1996	15
Xiao et al. (2008)	2005	2005	1
Yamada et al. (1975)	1972	1973	8

reference_short	start_year	end_year	num_measurements
Zagorodnov et al. (2012)	2010	2010	1

Figure 7. Spatial distribution of the temperature measurements in Greenland (left) and Antarctica (right)

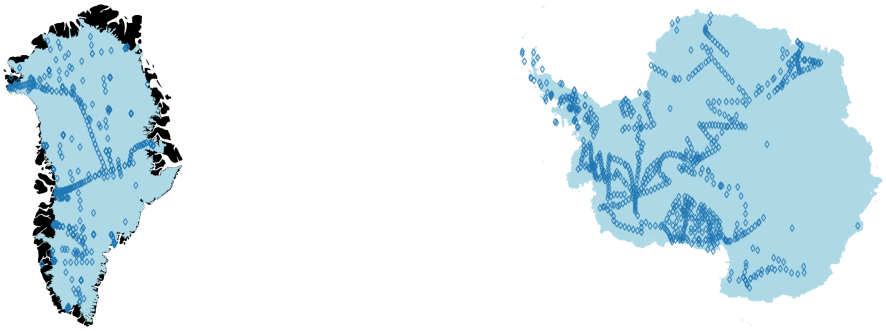


Figure 8. Composition of the temperature dataset in Greenland

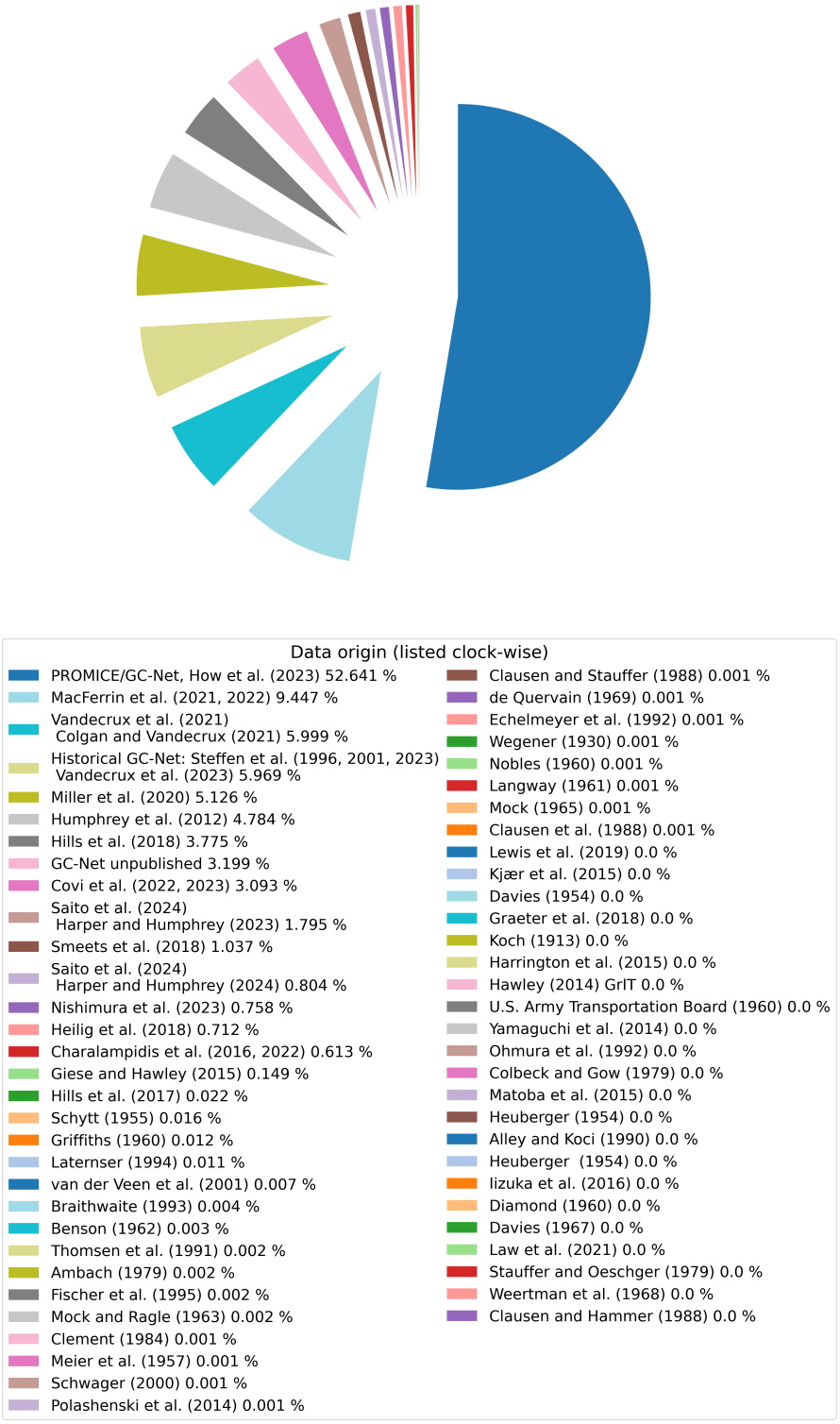
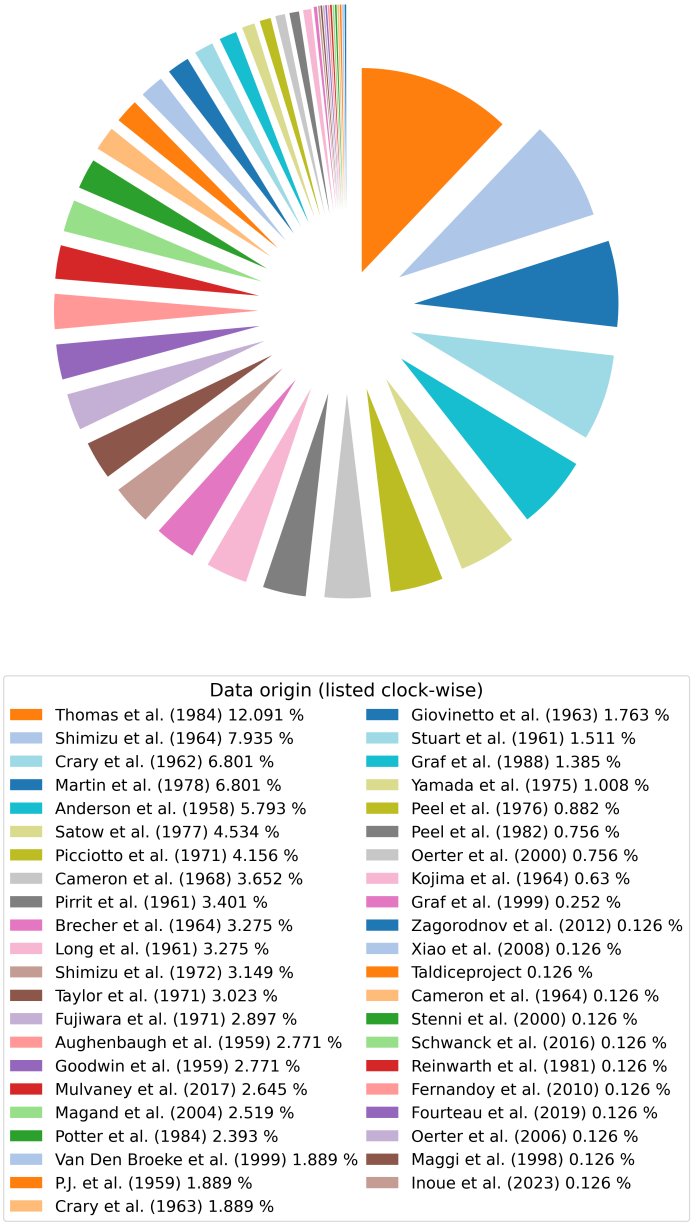


Figure 9. Composition of the temperature dataset in Antarctica



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