



The SUMup dataset: Compiled measurements of surface mass balance components over ice sheets and sea ice

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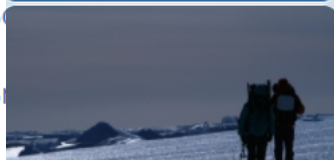
Basic information

More information

Download DATA

Link to KESAACO

Webmapping



Blended & Global

The GLACIOCLIM Surface Mass Balance of Antarctica Observations

PLEASE KEEP US INFORMED OF YOUR USES OF THE GLACIOCLIM-SAMBA DATA. THIS IS IMPORTANT FOR THE SURVIVAL OF THE OBSERVATORY.

AN UPDATED SMB DATABASE FOR ANTARCTICA (FAVIER ET AL., TC, 2013)

We present an updated and quality controlled surface mass balance (SMB) database for the Antarctic ice sheet. Importantly, the database includes data with limited spatial and temporal representativeness, too small measurement accuracy, or lack of quality control were discarded. This filtering process gives four times more reliable data than when applied to previously available databases. New data with high spatial resolution, long traverses, and at low elevation in some areas. However, the quality control led to a considerable reduction in the spatial density of measurements, particularly over West Antarctica. Over interior plateaus, where the SMB is low, the spatial density of measurements remains high.

The database is presented in a paper published in *The Cryosphere*

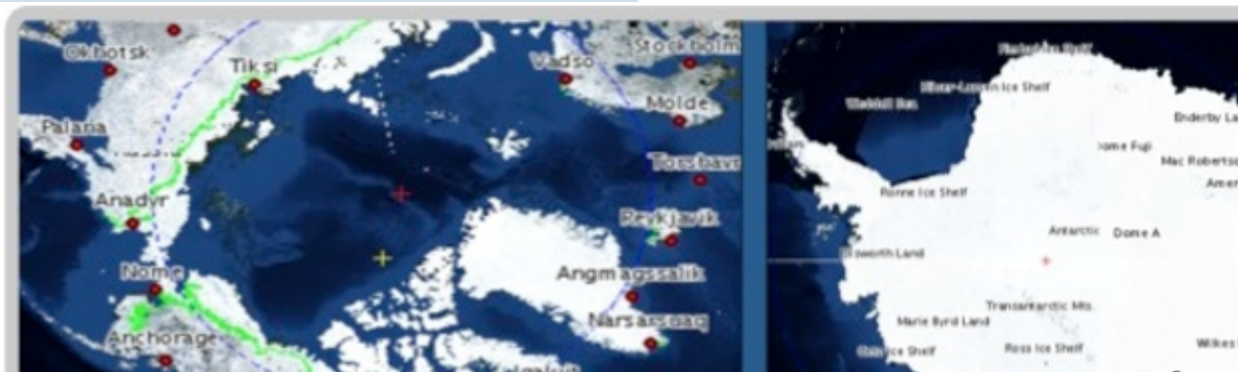
OUR PURPOSE IS PERFORMING A LIVING DATABASE: LAST UPDATE: MAY 14, 2013

We expect an interaction with researchers interested in the mass balance of Antarctica to allow updates, but also corrections and removals.

If you observe that new or old data were not included in the database, please contact [us](#), and we will update the database.

In order to allow us to send you information on potential important updates, we suggest you to fill in a form with your name, email, and organization.

- Satellite
- Geostationary
- monitor and



catalogue

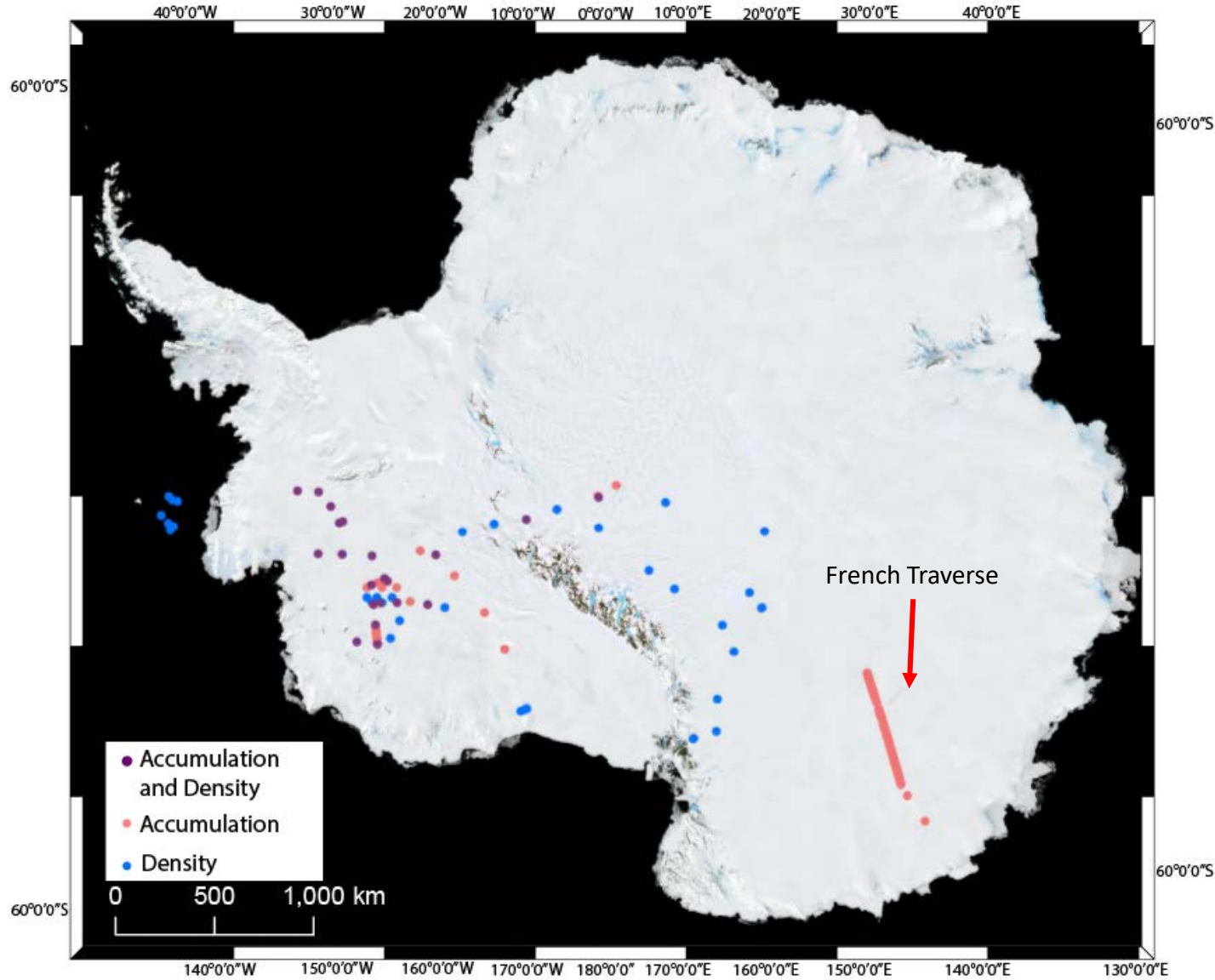
Metadata and data that describes, indexes, a follow ISO 19115 and Federal Geographic wide range of disciplines from natural science researchers alike and allows searching data using

start searching for datasets or [sign in to the](#)

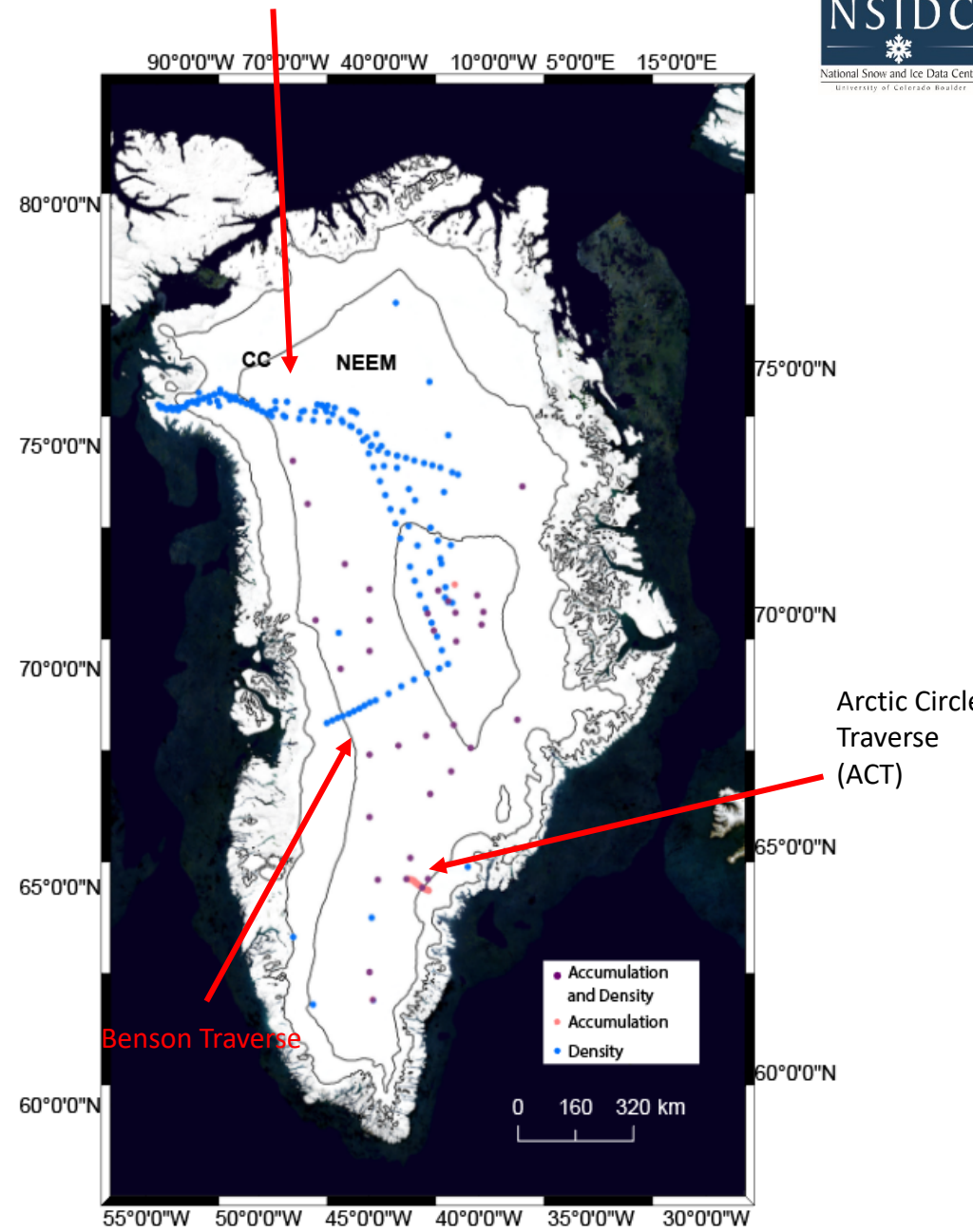
with limited Internet speed.

Usefulness of community datasets

- SUMup provides:
 - 3 subdatasets – density, accumulation, and snow depth on sea ice
 - Spatial and temporal variability across the Arctic and Antarctic
 - Decadal timeframes (1950-Present)
 - High depth resolution (density) and High Spatial Resolution (accumulation)
- What it can be used for:
 - Model Validation
 - Remote Sensing validation
 - Algorithm development
 - Monitoring efforts

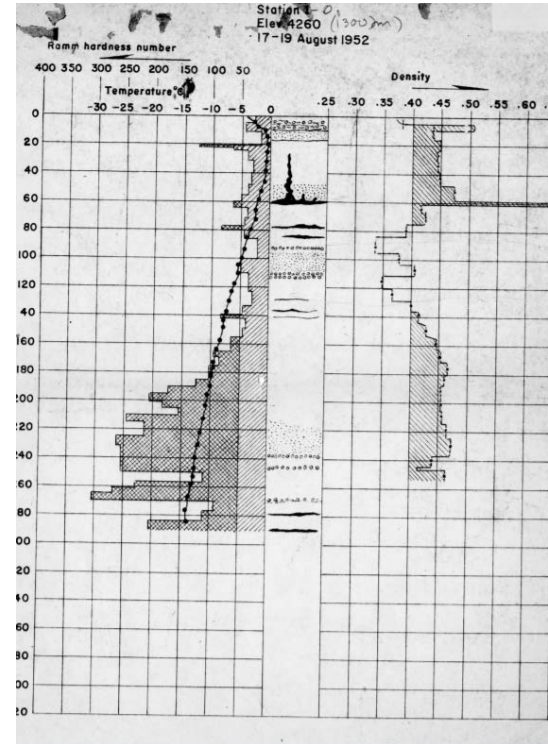


Greenland Inland Traverse (GIT)



Notable Additions

- Notable additions to the 2015 SUMup database:
 - 1) snow pit data from Carl Benson's Greenland traverses in the early 1950's
 - 2) snow accumulation measurements from Summit Station, Greenland's stake network call the Bamboo Forest (year round)
 - 3) density measurements from Summit, Greenland at monthly temporal resolution (year round)
 - Very high resolution density data (mm scale) and accumulation radar data (10's of meters)



PROFILE DATA

DATE: 17 Aug 1952 TIME: LOCATION: Station 1 Point Alpha.

OBSERVERS: Benson

D _s cm	TEMP °C	TUBE NO	GROSS WT. grams	TARE WT. grams	NET WT. grams	DENSITY g/cm ³	HARDNESS g/cm ²	REMARKS
4	3.0	5	408.0	418.0	19.0.0	0.380	2.1, 0.4, 3.0	0.4 1-4 x 10 ³
7	2.5	10	440.1	447.8	218.3	0.437	6.7, 5.6, 5	0.4 0.7 x 10 ³
10	1.0	20	636.0	411.0	225.0	0.450	8.9, 4.5, 5.5	0.4 2-8 x 10 ³
14	1.0	27	636.0	444.8	221.2	0.442	7.8, 4.6, 2	
20	0.5	34	643.4	421.3	222.1	0.444	2.0, 4.2, 4.0	
25	0.6	43	640.8	447.2	223.6	0.447	1.9, 3.2, 3.4	
32	0.8	53	653.9	417.0	236.9	0.474	3.3, 3.4, 4.9	
38.5	1.0	65	621.9	443.2	208.7	0.416	1.1, 1.5, 3.3	
46	1.0	70	621.8	411.0	210.8	0.422	2.2, 2.3, 3.2, 4.4	
53	1.7	81	606.8	412.0	194.8	0.390	1.1, 1.3, 3.3, 3.3	100 Scale < 1000 C.H x 10 ³
58	2.0	91	585.9	413.6	167.3	0.335	4.2, 4.4, 4.5	
65.5	2.5	100	603.7	415.9	187.8	0.376	1.1, 1.5, 1.8, 2.2	
72.0	2.6	108	615.8	413.8	202.0	0.404	3.3, 4.2, 2.5	
80	3.3	115	588.7	414.0	174.7	0.344	1.1, 1.5, 1.5, 1.5	
86	4.0	124	604.2	421.2	183.0	0.366	0.5, 1.1, 1.2, 2	
93	4.5	133	614.3	414.0	200.3	0.400	2.2, 2.2, 2.2, 1.3, 3	
99	5.0	141	620.5	424.1	206.4	0.413	3.3, 3.3, 3.5, 4.4	
104	5.5	150	625.5	410.8	214.7	0.424	5.6, 4.2, 4.5	
110	5.6	159	637.0	443.4	223.6	0.447	7.9, 3.8, 3.2	
118	6.0	168	—	—	—	—	—	
124	6.5	176	646.5	420.1	226.4	0.453	3.8, 3.7, 3	
130	7.0	176	658.3	425.0	233.3	0.447	4.8, 4.6, 4.0	

D_s = depth of thermometer below surface
D_{wt} = depth of density tube and/or hardness gage below surface

Snow Ice and Permafrost Research Establishment
CPO 40138

SIPRE-BR3-FIO



Images from Polartrec and NSIDC database.

Snow Density

- ~830,000 Datapoints
- 94% from Arctic ~280 Arctic Sites majority from ice cores or snow pits
- <6% from Antarctica ~50 sites Antarctica majority ice cores
- <1% from Summit Station, Greenland
- 7 locations snow density measurements on sea ice in the Bellinghausen Sea

Measurement methods include different sized density cutters (generally from 100 - 1000 cc) used in snow pits, ice core sections, neutron-density methods, X-ray microfocus computer tomography, Gamma-ray attenuation and pycnometers.



Accumulation

- Over 230,000 Datapoints
- 62% of dataset with ~35 sites in Greenland (one radar traverse spanning ~75 km in southeast Greenland)
- <38% of dataset with ~30 locations in Antarctica (two radar traverses that span 100's of km, one in west and one in east Antarctica)
- <1% from Summit Station, Greenland

The measurement methods include ice cores, radar isochrons, and stake measurements.



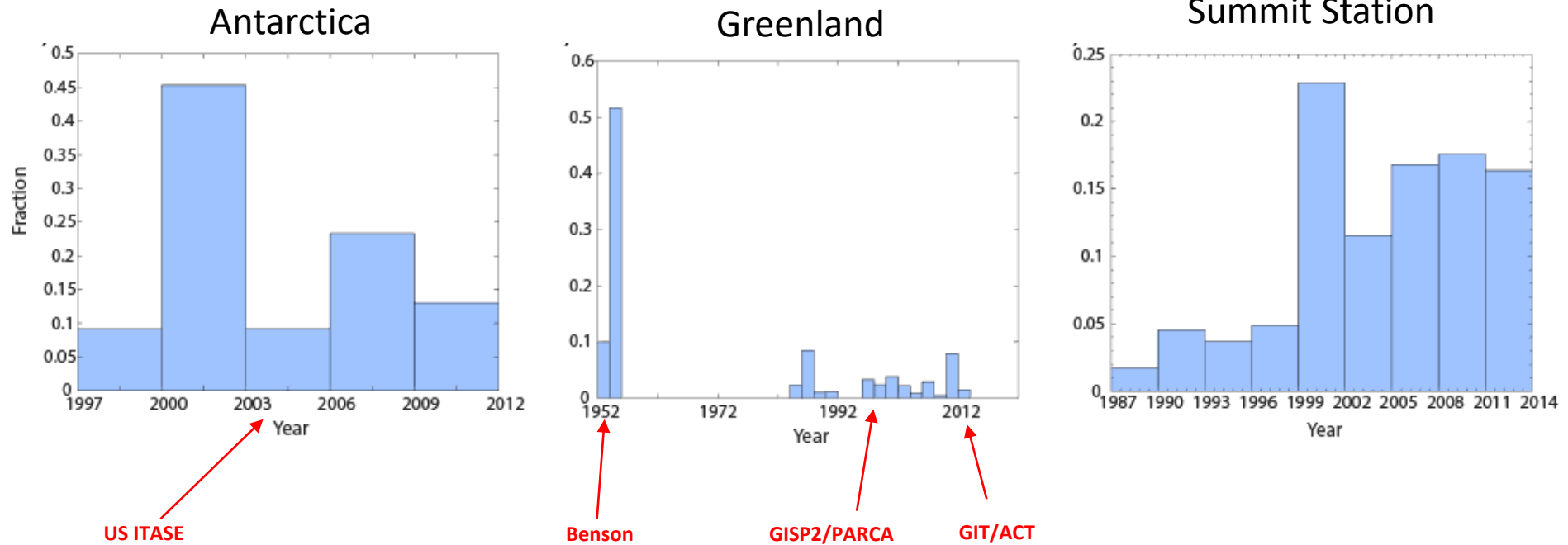
Snow Depth on Sea Ice

- ~14,000 Datapoints
- 22% Antarctic - 7 locations off of the Antarctic Peninsula in the Bellingshausen sea.
- Measurements from 2007.
- 78% Arctic - 40 locations directly off the coast of Finland in the Baltic sea.
- Measurements from 1990-2013.
- The measurement methods include rulers and magnaprobes.



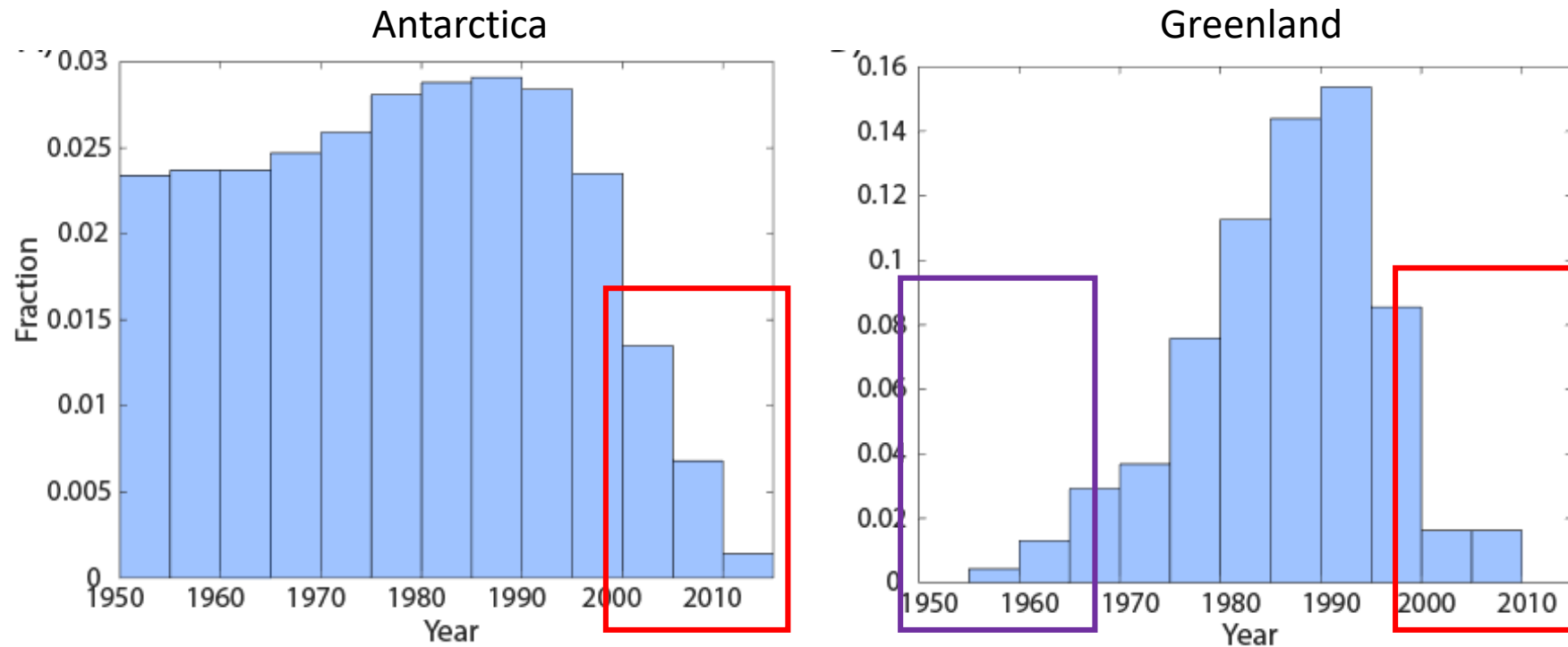
Photo Credit to Chris Linder UW

Density Time Series



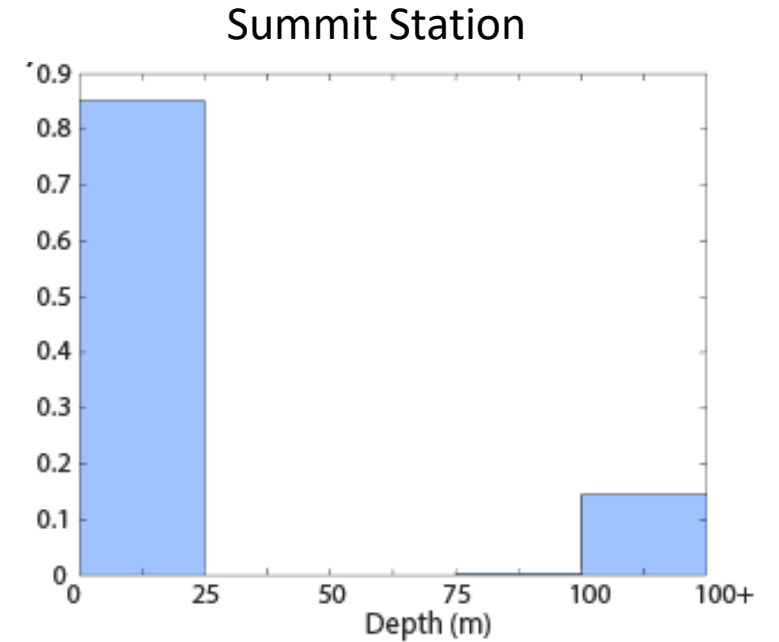
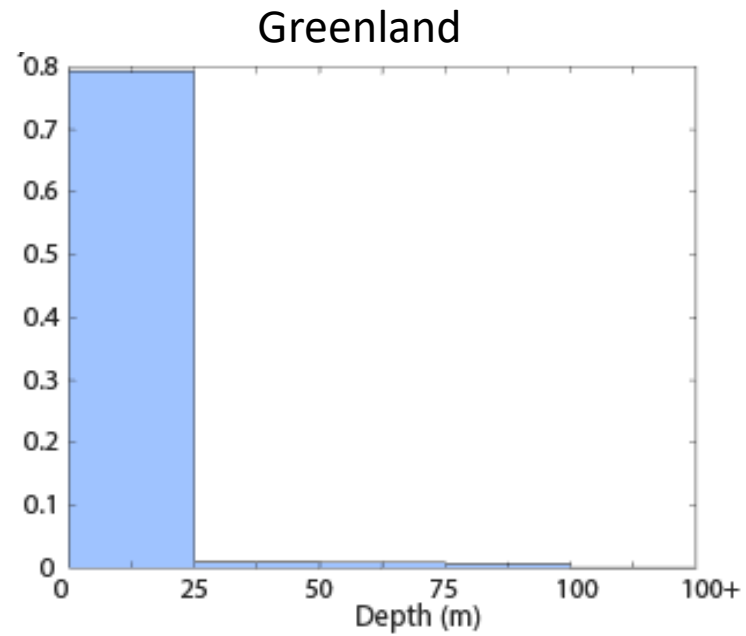
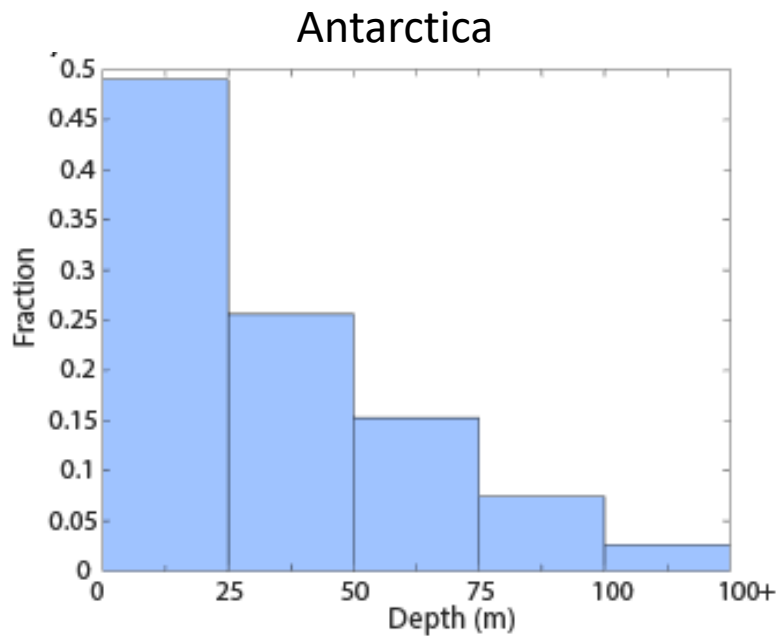
Sporadic sampling based around major field expeditions.

Distribution of Accumulation by Dated Ice Cores



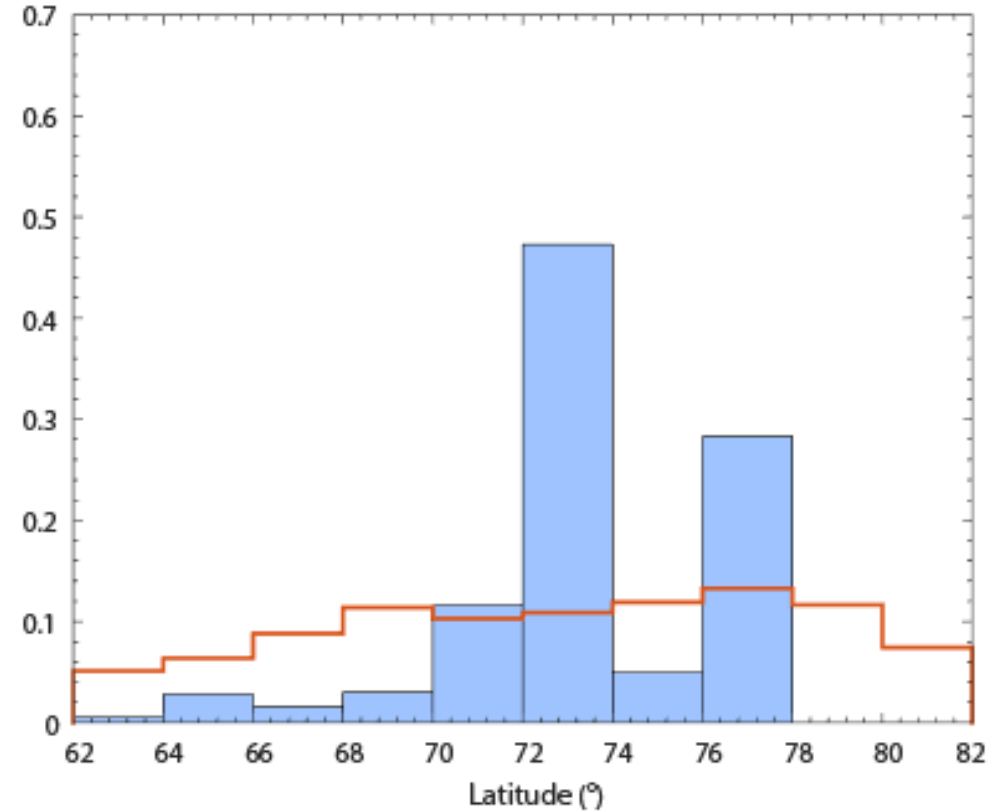
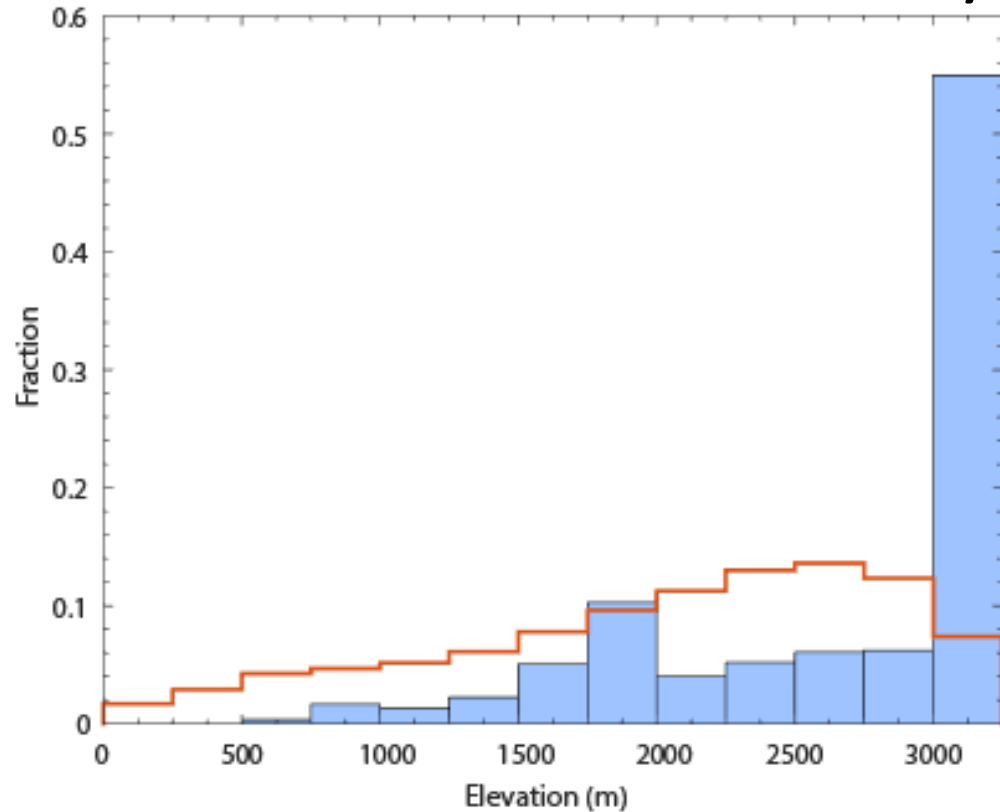
- Need to be taking ice cores now to fill in recent accumulation gaps.
- Accumulation signal can be lost in ice cores, so other future methods should be considered where you don't have to preserve stratigraphy. (Stakes/SNOWFOX)

Analysis of Density by Depth



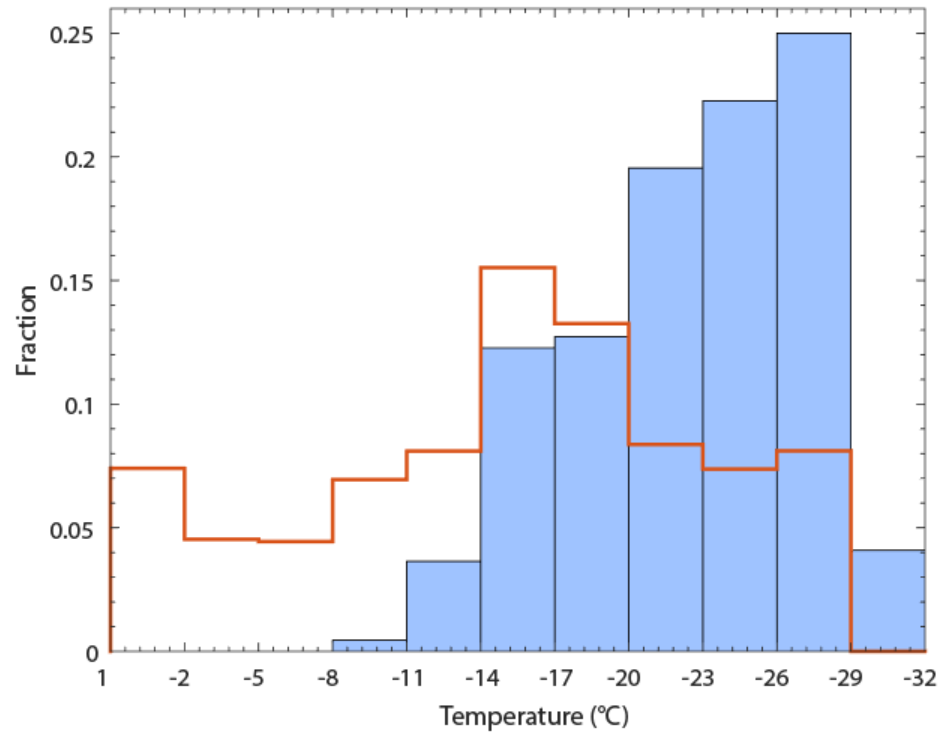
- Larger number of deeper ice cores in Antarctica.
- Mainly shallow cores collected across Greenland
- Majority of Summit Station measurements taken above 1 m in snow pits.
- 100m+ ice core from GISP2 Ice Core

Elevation and Latitude Distribution of Density for Greenland



- Elevations below 3000 m are undersampled, with the exception of the 1750-2000 m bin, and elevations above 3000 m are largely oversampled.
- Sampled best over Greenland’s mid-latitudes. More measurements are required from lower elevations and southern (< 70N) and northern (> 78N) latitudes to fill the gaps in the current dataset and reduce spatial bias

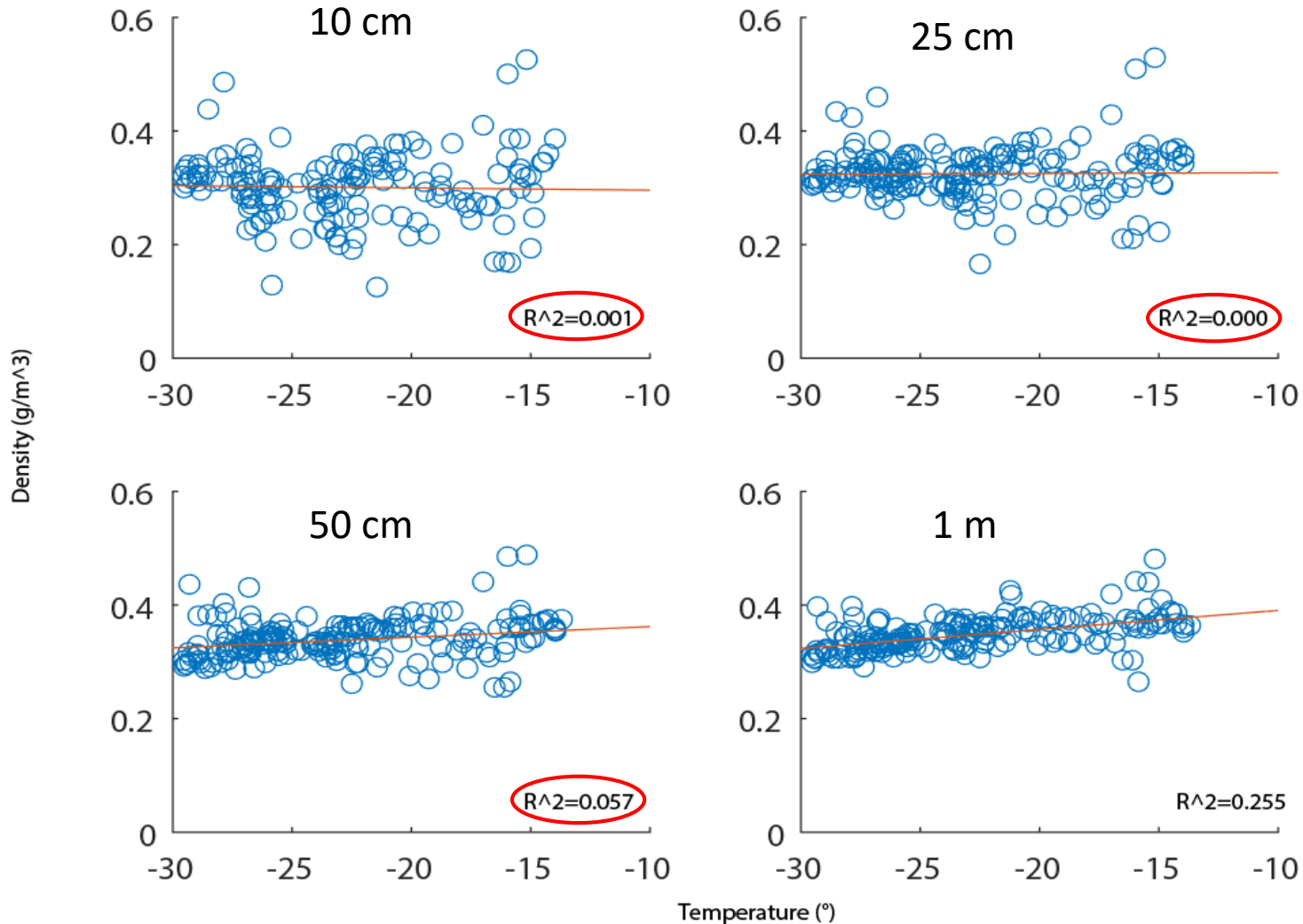
Distribution of density measurements in Greenland by the mean annual temperature



Red line - distribution of annual average temperatures (derived from 1990-2015) for the entire GrIS.

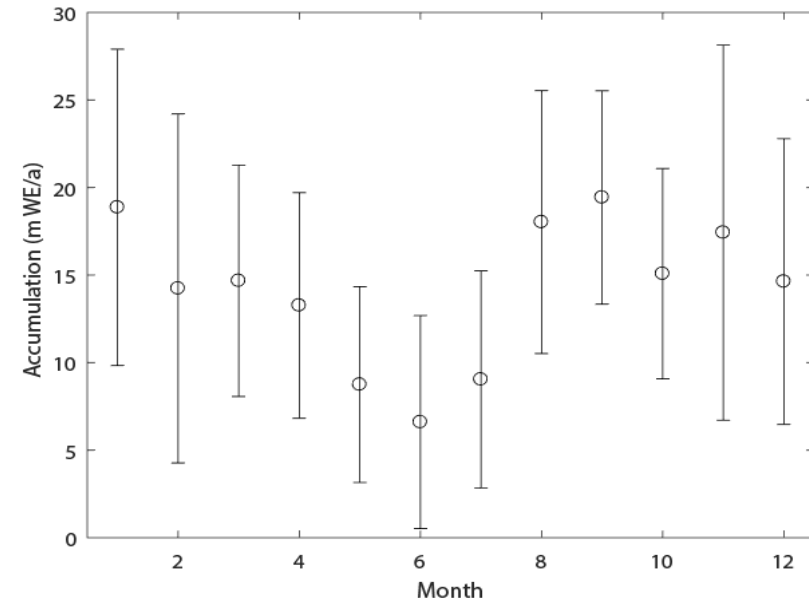
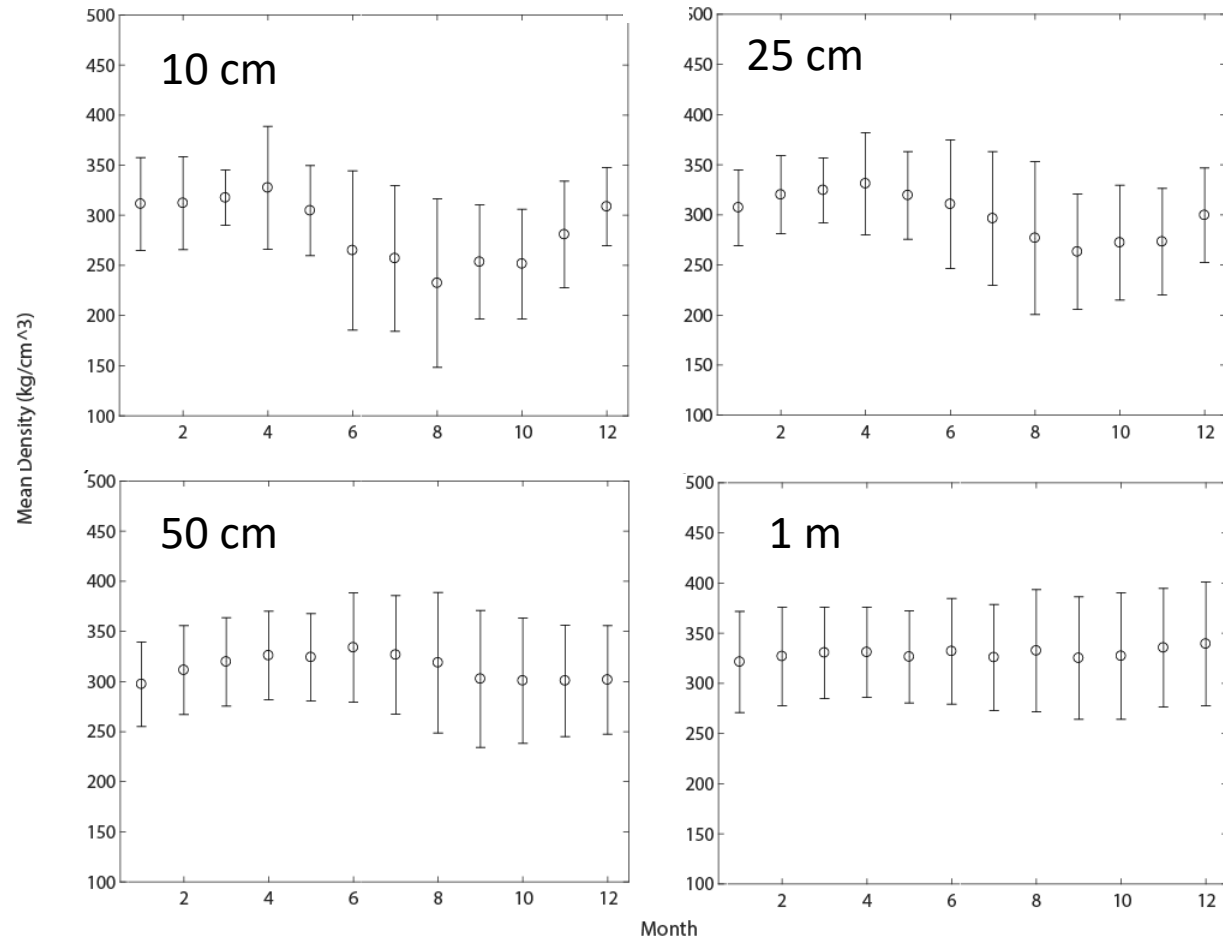
- Density measurements at each location were matched to (NCEP-NCARv1) forced MAR 3.5 simulation (run from 1948–2015) to find the mean annual 3 m air temperature for the year the measurement was taken.
- In general, the density measurements in SUMup across the GrIS oversample cooler, inland regions and undersample coastal, warmer regions.
- Extremely under sampled in the percolation zone.

Mean Annual MAR temp and Density Comparison



- No clear relationship between mean annual temperature and density seen until ~1 m depth where higher temperatures correspond to higher density.
- Top meter needs additional parameterizations.
- Solar radiation and wind processes are likely important in these region and require snow density models that account for these processes.

Mean monthly density and accumulation at Summit Station, Greenland



Future Additions

- Arctic Density data from 1950-1980 and current decades
 - Accumulation and Density data from the percolation zone
 - Ablation Stake Measurements
 - Antarctic accumulation and density data
 - Future datasets may include radiative processes and albedo.
 - Please contact Lynn Montgomery or Lora Koenig (lynn.Montgomery@Colorado.edu or lora.koenig@Colorado.edu) to contribute data.
-
- What would you like to see?

Find out more about SUMup at ADC

Lora Koenig and Lynn Montgomery. 2017. Snow Depth on Sea Ice Working Group (SUMup) snow density, accumulation on land ice, and snow depth on sea ice datasets. Arctic Data Center. urn:uuid:4cefadb-82cc-4d3a-977b-c83ad0af230e.

[Copy Citation](#) [Quality report](#)

Files in this dataset Package: resource_map_urn:uuid:4cefadb-82cc-4d3a-977b-c83ad0af230e

Name	File type	Size	Downloads	Download All
Metadata: science_metadata.xml	EML v2.1.1	11 KB	36 views	Download
SUMup_snow_density_dataset_readme.pdf	PDF	383 KB	68 downloads	Download
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SUMup_snow_depth_on_sea_ice_dataset_readme.pdf	PDF	205 KB	58 downloads	Download

[Show 5 nested datasets](#)

We would like to acknowledge and thank NASA and NSF for funding SUMup.

References

- https://nsidc.org/cryosphere/sotc/ice_sheets.html (title slide background)

Snow Density

<u>Column</u>	<u>Description</u>	<u>Unit</u>
Date Taken	Date the data was taken	yyyymmdd
Latitude	Latitude of measurement	Decimal degree
Longitude	Longitude of measurement	Decimal degree
Start Depth	Top depth of the measurement in m from the snow/air interface (snow surface).	m
Stop Depth	Bottom depth of the measurement in m from the snow/air interface (snow surface).	m
Midpoint Depth	Midpoint depth of the measurement in m from the snow/air interface (snow surface).	m
Density	Snow density measurement	g/cm ³
Error	Uncertainty in density measurement	g/cm ³
Elevation	Elevation above sea level	m
Method	How the measurement was collected (see metadata for more details)	-
Citation	Cited source of data (see metadata for more details)	-

Accumulation

<u>Column</u>	<u>Description</u>	<u>Unit</u>
Date Taken	Date the data was taken	yyyymmdd
Latitude	Latitude of measurement	Decimal degree
Longitude	Longitude of measurement	Decimal degree
Start Year	First year of measurement if accumulation is not annual	year
End Year	Last year of measurement if accumulation is not annual	year
Year	Year of accumulation if accumulation is annual	year
Accumulation	Accumulation in m of water equivalent	m WE/a
Error	Uncertainty in measurement	m WE/a
Elevation	Elevation above sea level	m
Radar Horizontal Resolution	Horizontal resolution of radar data along track	m
Method	How the measurement was collected (see metadata for more details)	-
Name	Name of field campaign (see metadata for more details)	-
Citation	Cited source of data (see metadata for more details)	-

Snow Depth on Sea Ice

<u>Column</u>	<u>Description</u>	<u>Unit</u>
Date Taken	Date the data was taken	yyyymmdd
Latitude	Latitude of measurement	Decimal degree
Longitude	Longitude of measurement	Decimal degree
Distance Along Transect	Distance along a transect of in-situ snow depth measurements over sea ice from the initial Lat, Long. Used for snow-depth measurements where point by point Lat, Long was not recorded.	m
Snow Depth	Snow depth measurement	m
Snow Depth Error	Uncertainty in snow depth measurement	m
Density Taken	If density measurement was taken = 1, if no measurement =0.	-
Sea Ice Thickness	Sea ice thickness measurement	m
Sea Ice Thickness Error	Uncertainty in sea ice thickness measurement	m
Sea Ice Type	1=first year ice, 2=multilayer ice, -9999 = unknown	-
Sea Ice Freeboard	Sea Ice freeboard measurement	m
Sea Ice Freeboard Error	Uncertainty in sea ice freeboard	m
Snow Ice Thickness	Snow ice thickness measurement	m
Snow Ice Thickness Error	Uncertainty in snow ice thickness measurement	m
Radar Horizontal Resolution	Horizontal resolution of radar data along track	m
Method	How the measurement was collected (see metadata for more details)	-
Citation	Cited source of data (see metadata for more details)	-

Supplementary Material

Hydroinnova

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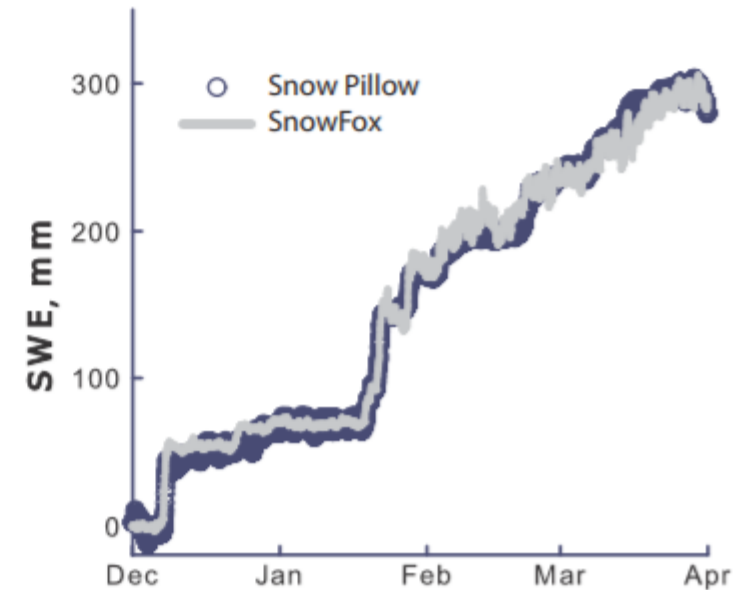
fact sheet

SnowFoxtm: snow-water equivalent depth made easy

SnowFox is a portable, affordable and highly adaptable sensor capable of measuring the water equivalent depth of snow (SWE) over a small area.

How it works

The sensor is placed on or just beneath the ground where it is allowed to be buried by falling snow. The sensor records the intensity of downward-directed secondary cosmic-rays that penetrate the snow pack. This intensity is proportional to the mass of snow traversed by cosmic-rays, and is related to SWE through a calibration function. Measurements are typically averaged over one hour.



Modelled (MAR) vs. Observed Densities

