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

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Photocredit to Ted Scambos

Home > Data Access

GLACIOCLIM

Basic information

More information

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link to KESAACO

webmapping

The GLACIOCLIM SurfAce Mass Balance of Antarctica Obse

PLEASE KEEP *US* INFORMED OF YOUR USES OF THE GLACIOCLIM-SAMBA DATA. *THIS IS IMPORTAN*
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 datab
such as measurement technique, elevation, time covered, etc, which allows any user to filter out the data. Here, we propose the full da
which data with limited spatial and temporal representativeness, too small measurement accuracy, or lack of quality control were disca
filtering process gives four times more reliable data than when applied to previously available databases. New data with high spatial re
long traverses, and at low elevation in some areas. However, the quality control led to a considerable reduction in the spatial density of
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 rema

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, i

NSIDC
National Snow and Ice Data Center
University of Colorado Boulder

d Data

atalogue

etadata and data that describes, indexes, a
llow **ISO 19115** and **Federal Geographic**
wide range of disciplines from natural scien
rchers alike and allows searching data using

start searching for datasets or sign in to t

rs with limited Internet speed.

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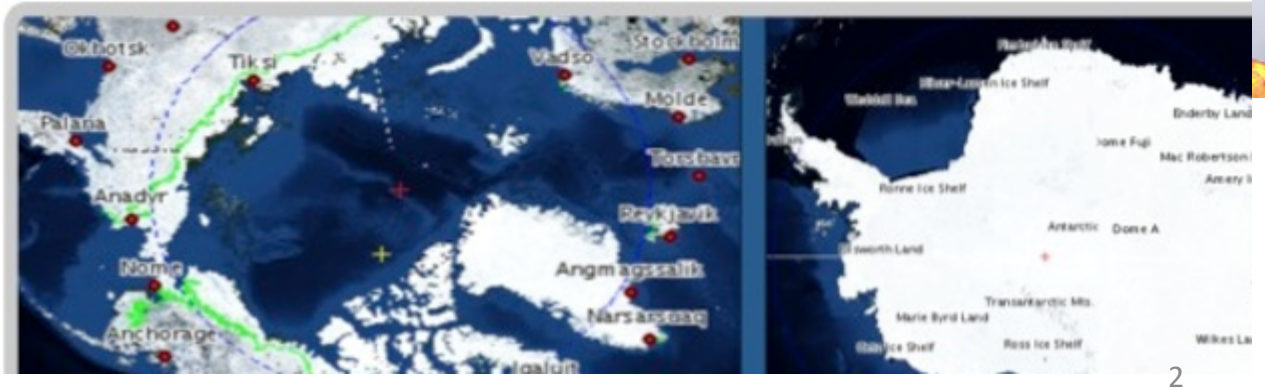
Blended & Global

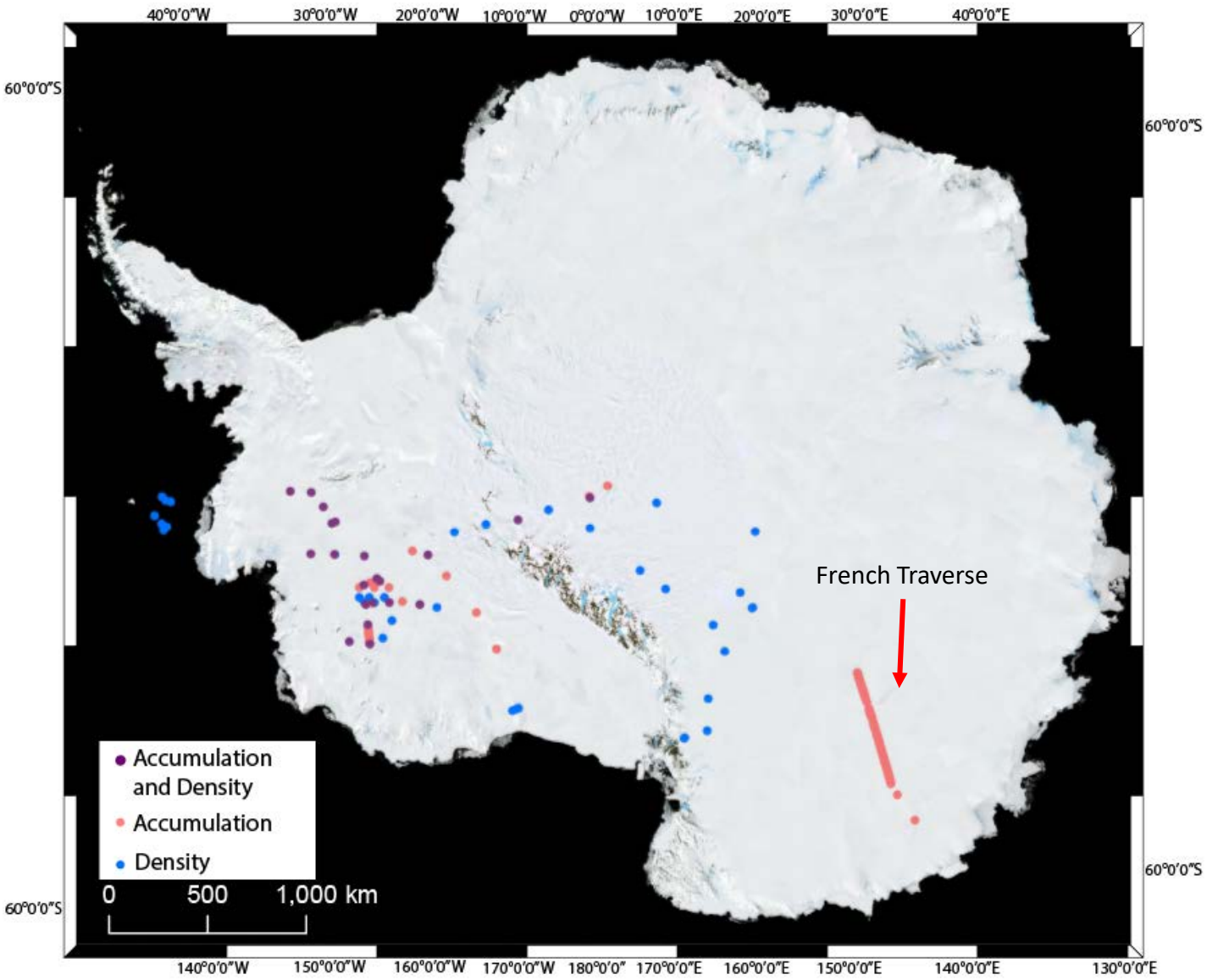
fog, and thund

- Satellite
  Geostationary



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


40°0'0"W
30°0'0"W
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10°0'0"W
0°0'0"W
10°0'0"E
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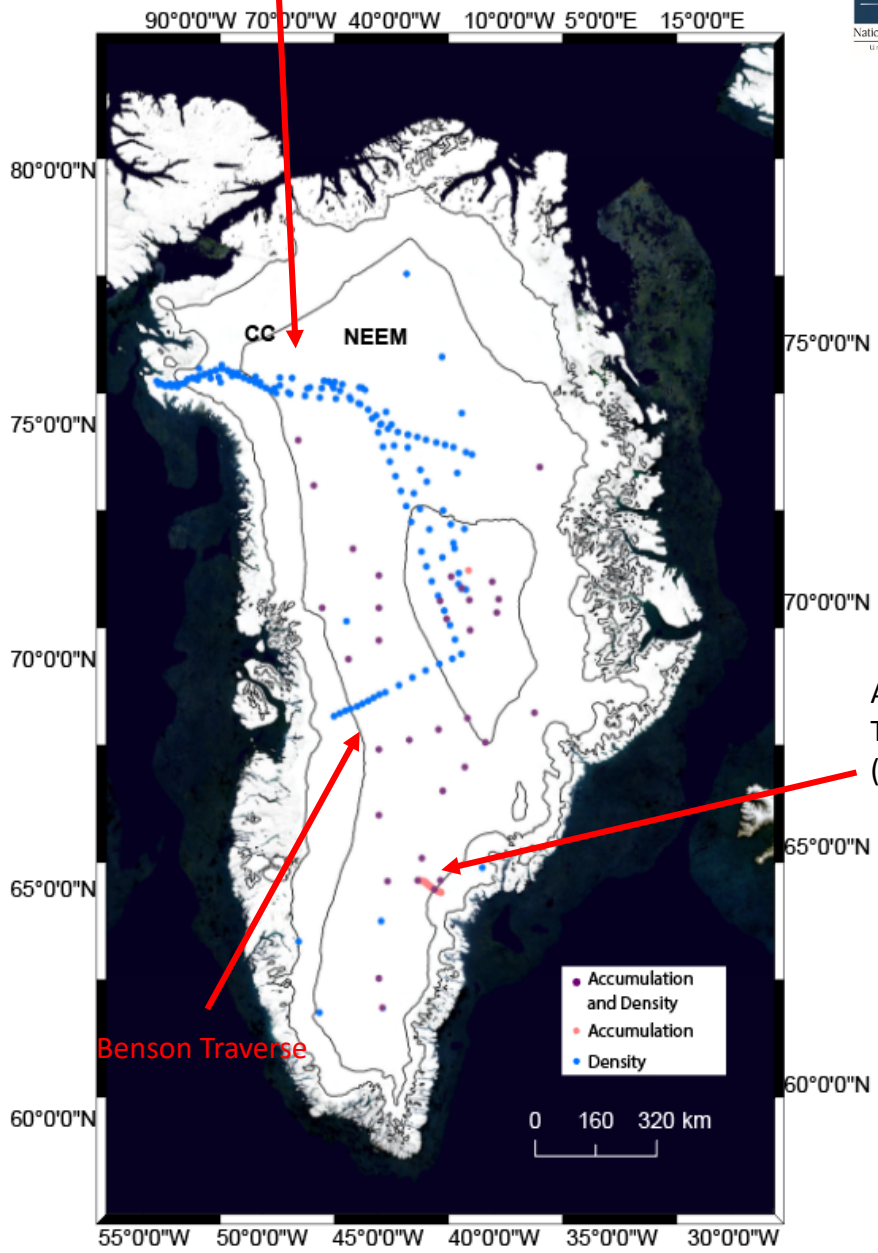
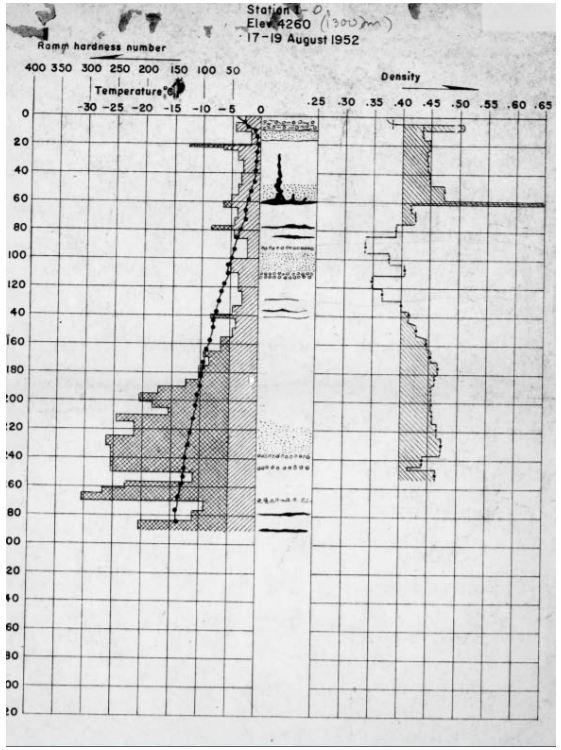
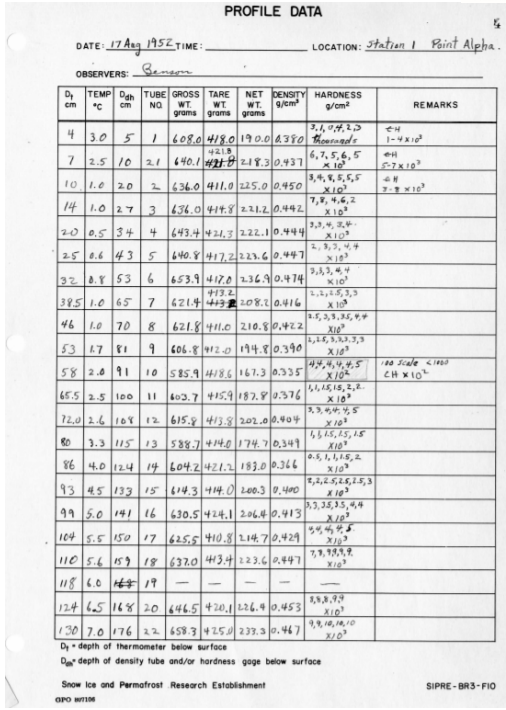
30°0'0"E
40°0'0"E
60°0'0"S
140°0'0"W
150°0'0"W
160°0'0"W
170°0'0"W
180°0'0"
170°0'0"E
160°0'0"E
150°0'0"E
140°0'0"E
130°0'0"E
French Traverse
Accumulation and Density
Accumulation
Density
0
500
1,000 km


Greenland Inland Traverse (GIT)
90°0'0"W
70°0'0"W
40°0'0"W
10°0'0"W
5°0'0"E
15°0'0"E
80°0'0"N
75°0'0"N
70°0'0"N
65°0'0"N
60°0'0"N
55°0'0"W
50°0'0"W
45°0'0"W
40°0'0"W
35°0'0"W
30°0'0"W
CC
NEEM
Arctic Circle Traverse (ACT)
Benson Traverse
Accumulation and Density
Accumulation
Density
0
160
320 km

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_t cm	TEMP °C	D_{dh} cm	TUBE NO.	GROSS WT. grams	TARE WT. grams	NET WT. grams	DENSITY g/cm³	HARDNESS g/cm²	REMARKS
4	3.0	5	1	608.0	418.0	190.0	0.380	3,1,0,4,2,3 Penetrometer	CH 1-4×10³
7	2.5	10	21	640.1	421.8	218.3	0.437	6,7,5,6,5 ×10³	CH 5-7×10³
10	1.0	20	2	636.0	411.0	225.0	0.450	3,4,8,5,5,5 ×10³	CH 7-8×10³
14	1.0	27	3	636.0	414.8	221.2	0.442	7,8,4,6,2 ×10³	
20	0.5	34	4	643.4	421.3	222.1	0.444	3,3,4,3,4 ×10³	
25	0.6	43	5	640.8	417.2	223.6	0.447	2,3,3,4,4 ×10³	
32	0.8	53	6	653.9	417.0	236.9	0.474	3,3,3,4,4 ×10³	
38.5	1.0	65	7	621.4	413.2	208.2	0.416	2,2,2,3,3 ×10³	
46	1.0	70	8	621.8	411.0	210.8	0.422	2,3,3,3,4,4 ×10³	
53	1.7	81	9	606.8	412.0	194.8	0.390	1,2,3,3,3,3,3 ×10³	
58	2.0	91	10	585.9	418.6	167.3	0.335	4,4,4,4,4,5 ×10⁴	100 Scale <1000 CH ×10⁴
65.5	2.5	100	11	603.7	415.9	187.8	0.376	1,1,1,3,1,8,2,2 ×10³	
72.0	2.6	108	12	615.8	413.8	202.0	0.404	3,3,4,4,4,5,5 ×10³	
80	3.3	115	13	588.7	414.0	174.7	0.349	1,1,1,5,1,5,1,5 ×10³	
86	4.0	124	14	604.2	421.2	183.0	0.366	0,5,1,1,1,5,2 ×10³	
93	4.5	133	15	614.3	414.0	200.3	0.400	2,2,2,5,2,1,5,3 ×10³	
99	5.0	141	16	630.5	424.1	206.4	0.413	3,3,3,3,3,5,4,4 ×10³	
104	5.5	150	17	625.5	410.8	214.7	0.429	4,4,4,4,5 ×10³	
110	5.6	159	18	637.0	413.4	223.6	0.447	7,8,8,8,8 ×10³	
118	6.0	163	19	—	—	—	—	—	
124	6.5	168	20	646.5	420.1	226.4	0.453	8,8,8,9,9 ×10³	
130	7.0	176	22	658.3	425.0	233.3	0.467	9,9,10,10,10 ×10³	

D_t = depth of thermometer below surface

D_{dh} = depth of density tube and/or hardness gage below surface

Snow Ice and Permafrost Research Establishment SIPRE-BR3-FIO

GPO 807106

Images from Polartrec and NSIDC database.

Snow Density

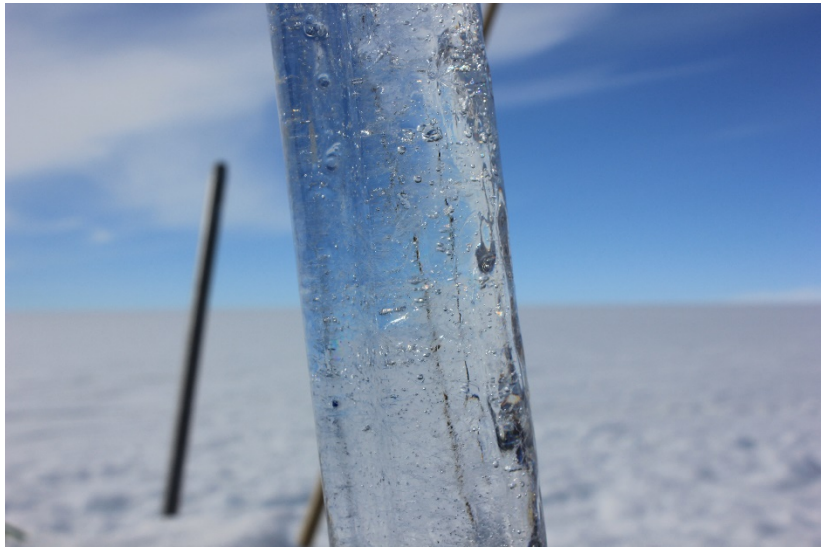
- ~830,000 Datapoints
- 94% from Arctic ~280 Arctic Sites majority from ice cores or snow pits
- <6% from Antarctica ~50 sites Antarctica majority ice cores
- <1% from Summit Station, Greenland
- 7 locations snow density measurements on sea ice in the Bellinghausen Sea

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

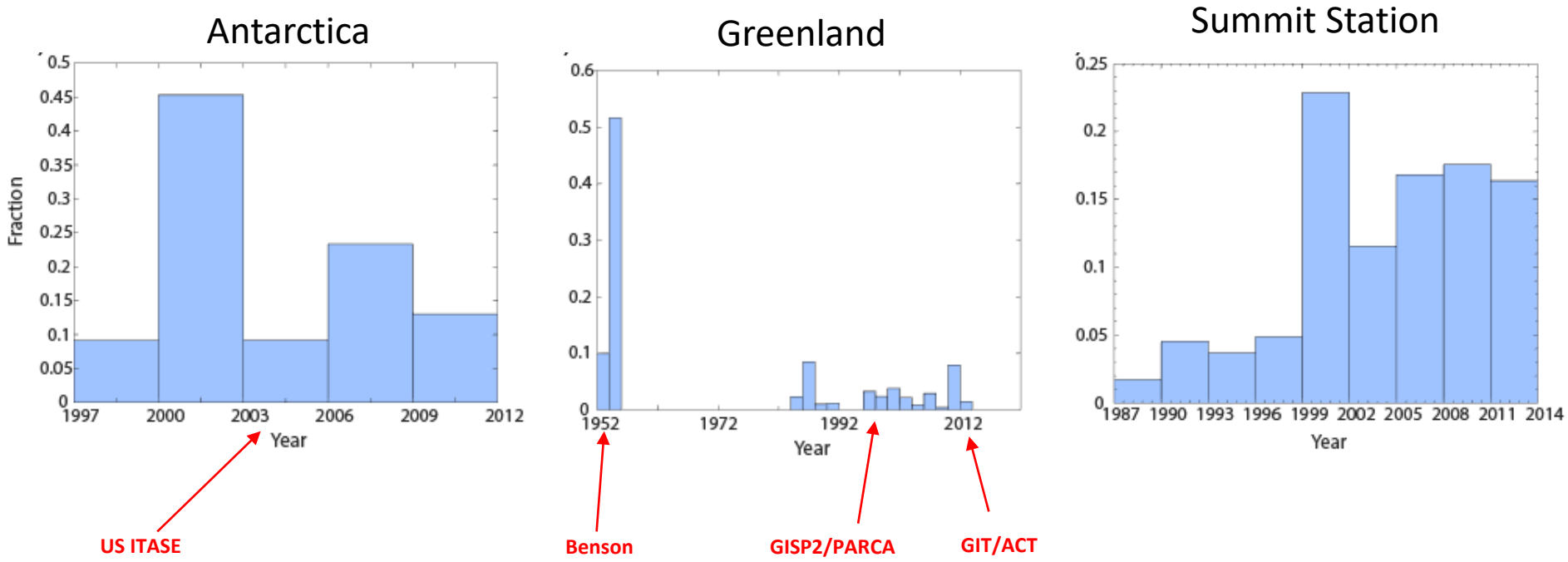
- 22% Antarctic - 7 locations off of the Antarctic Peninsula in the Bellingshausen sea.
- Measurements from 2007.

- 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

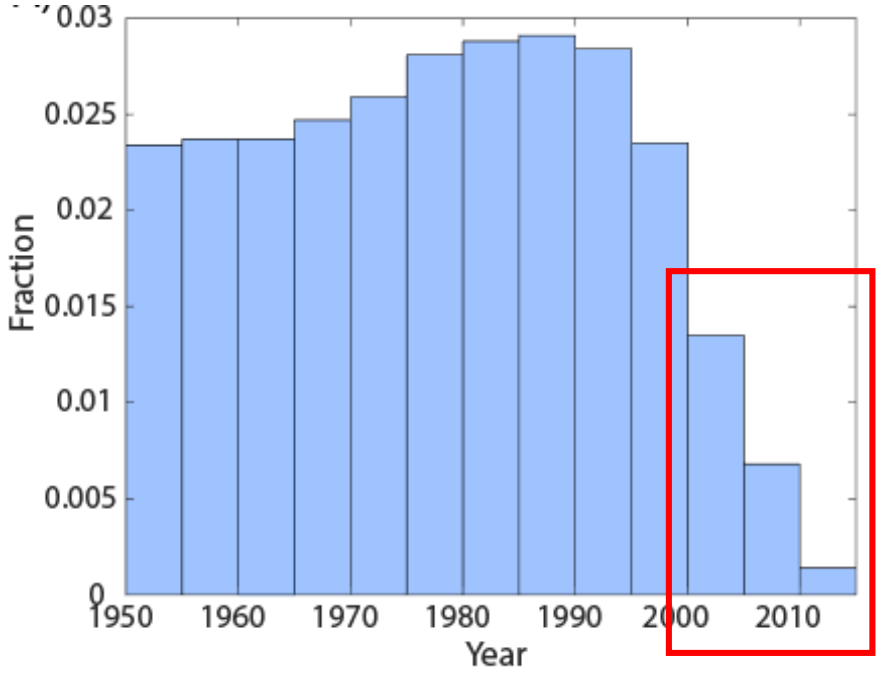
Density Time Series



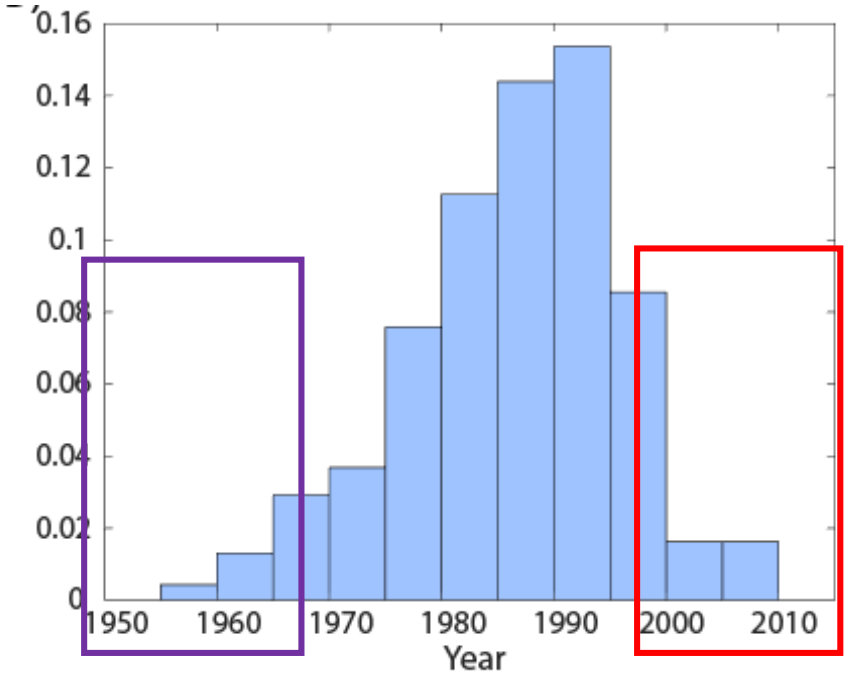
Sporadic sampling based around major field expeditions.

Distribution of Accumulation by Dated Ice Cores

Antarctica



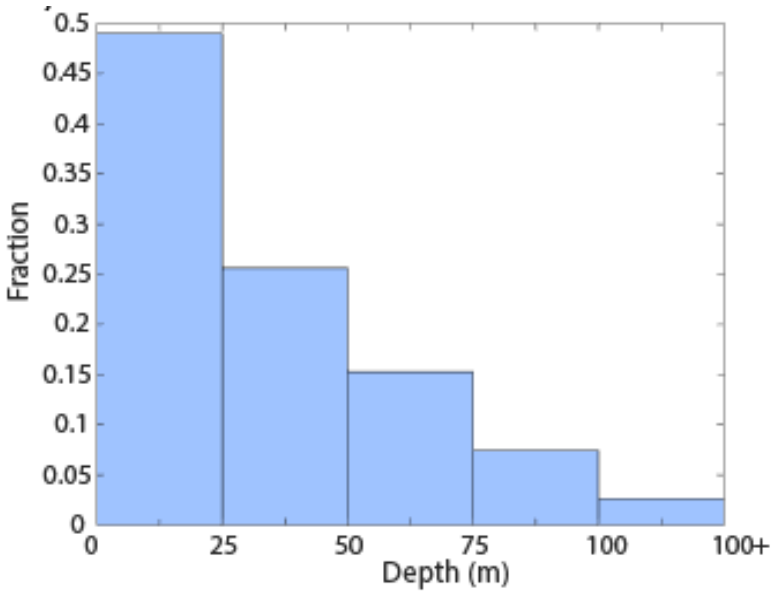
Greenland



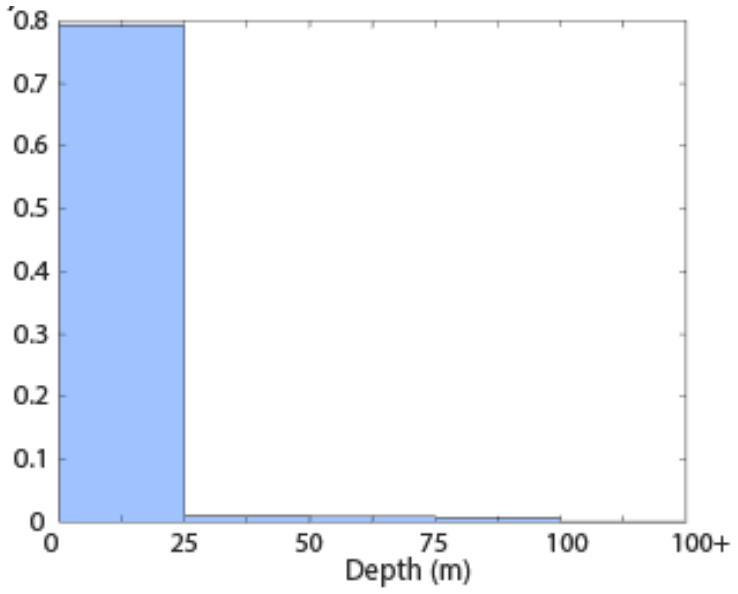
- Need to be taking ice cores now to fill in recent accumulation gaps.
- Accumulation signal can be lost in ice cores, so other future methods should be considered where you don't have to preserve stratigraphy. (Stakes/SNOWFOX)

Analysis of Density by Depth

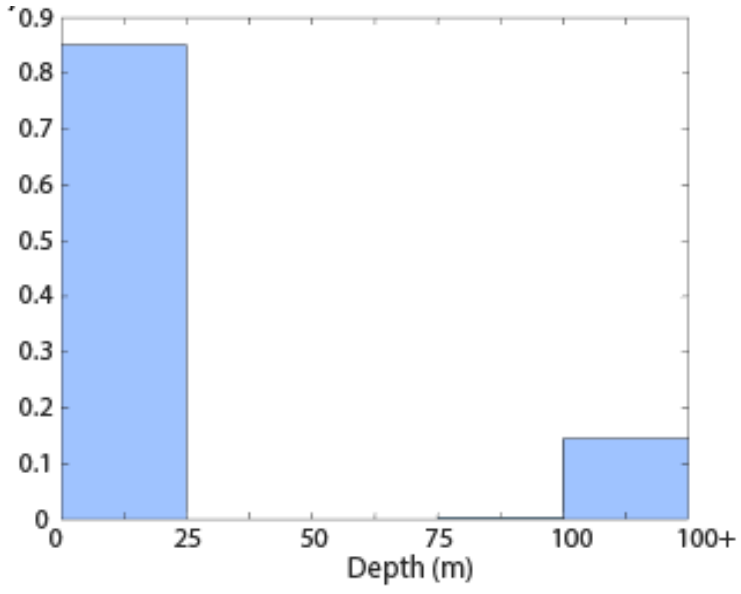
Antarctica



Greenland

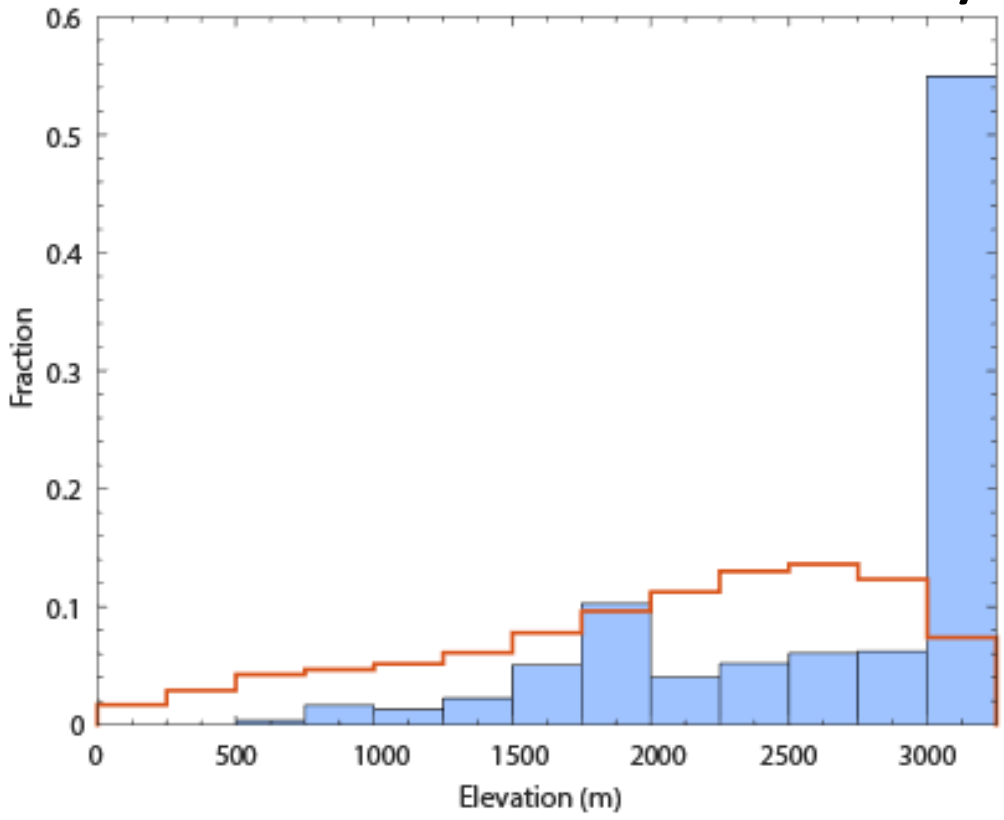


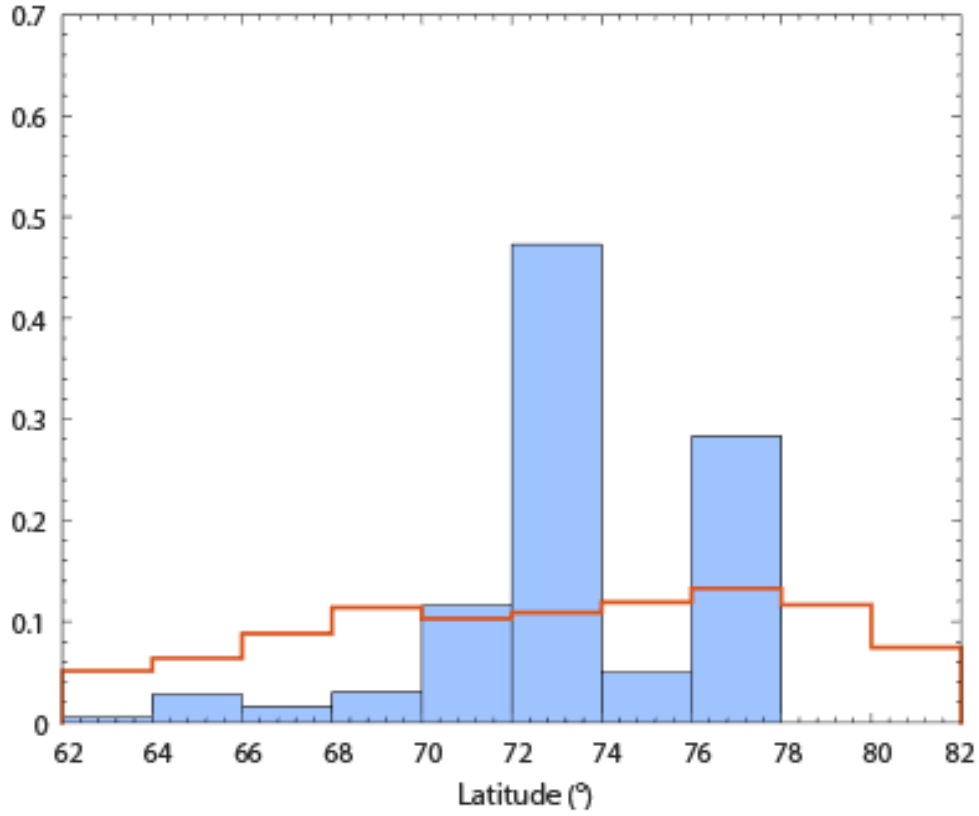
Summit Station



- 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

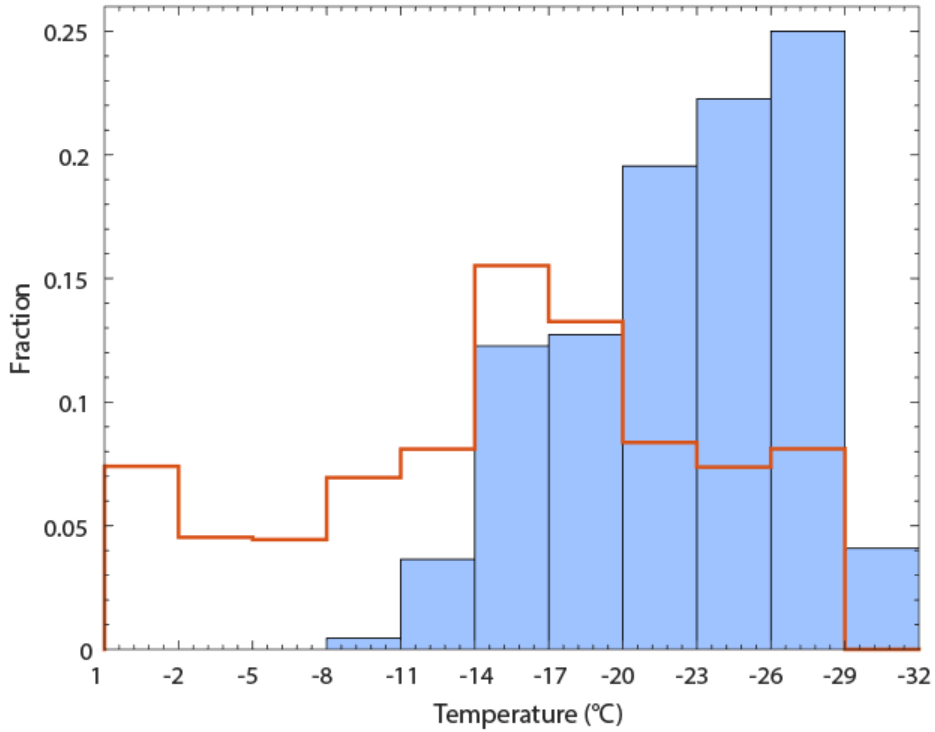
Elevation and Latitude Distribution of Density for Greenland





- 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

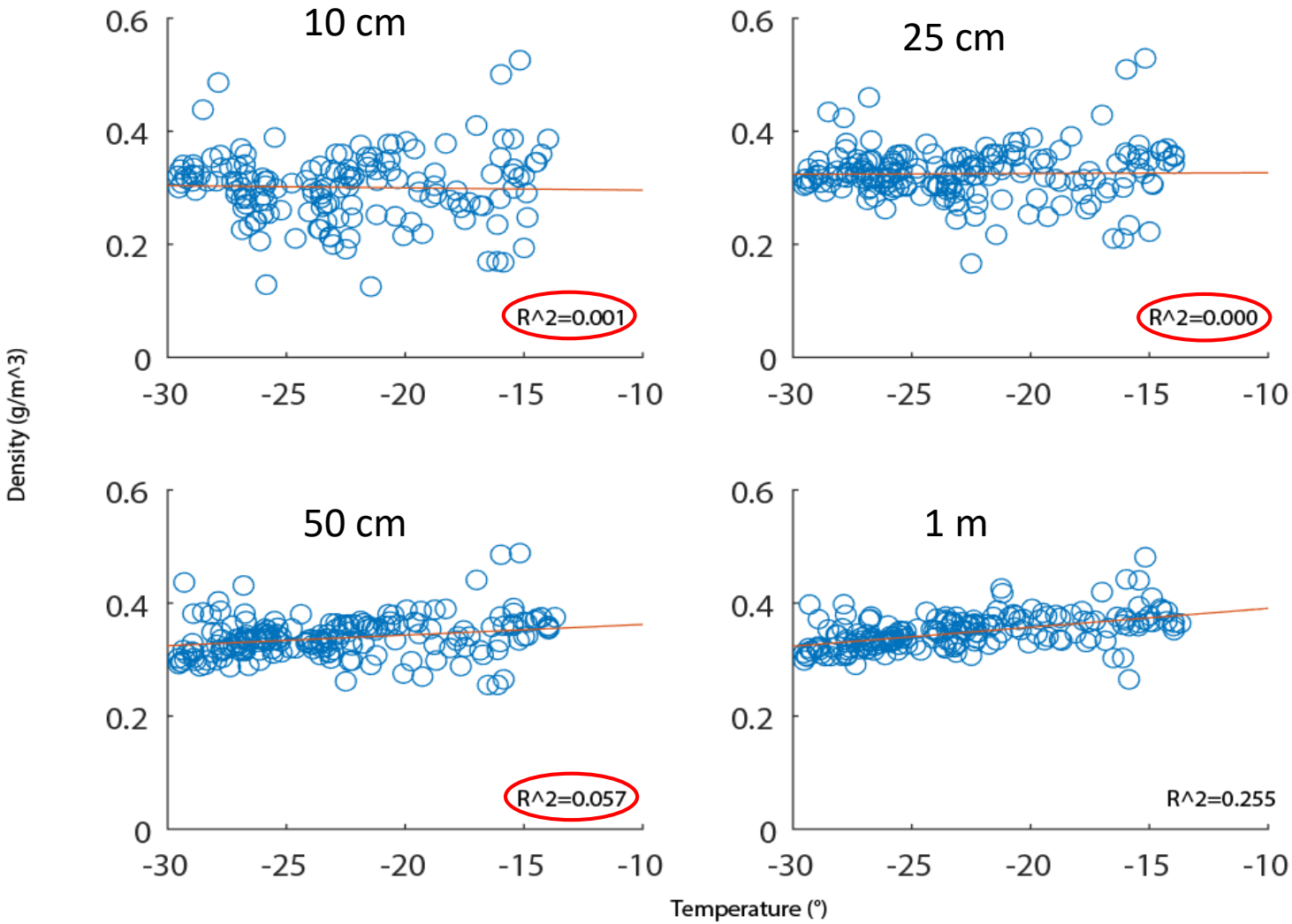
Distribution of density measurements in Greenland by the mean annual temperature



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

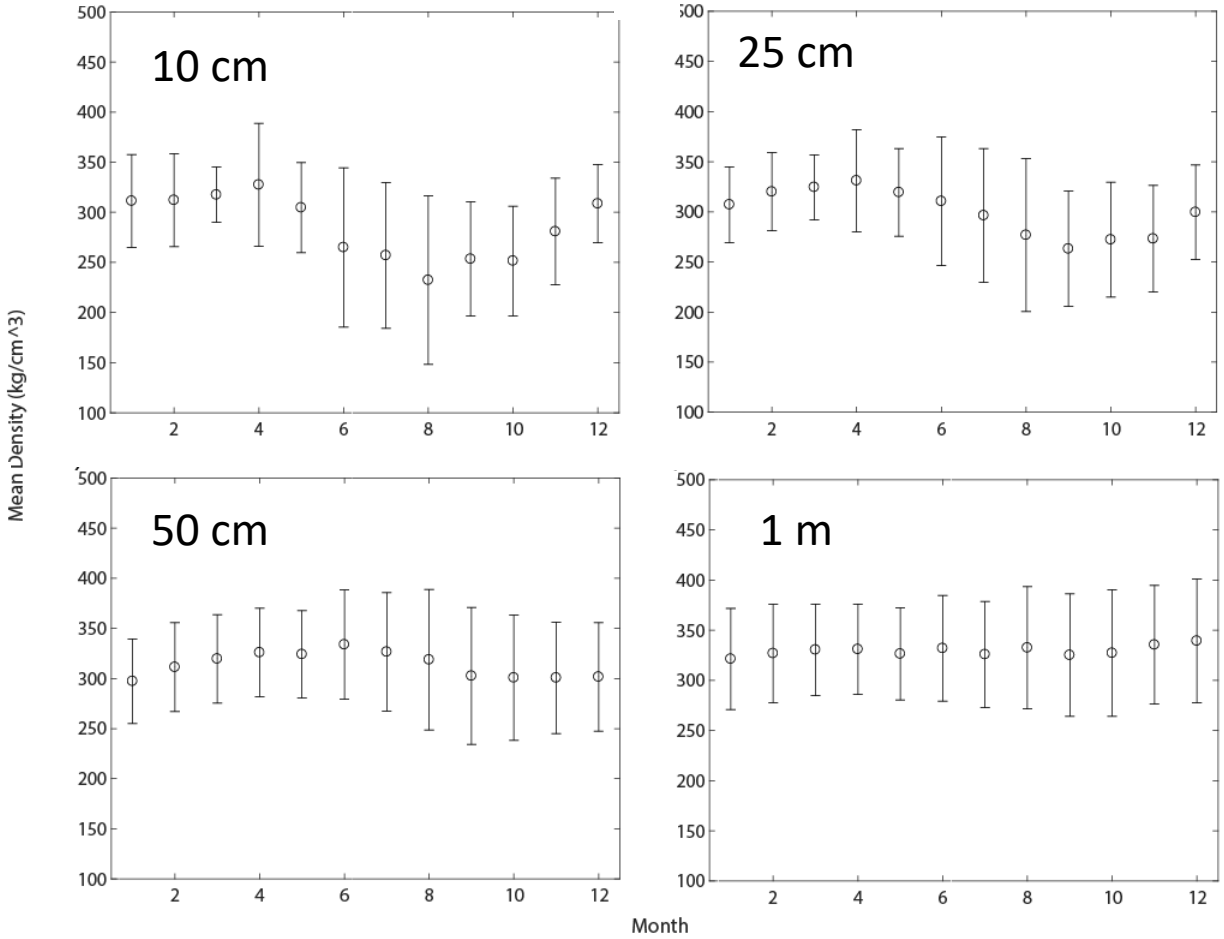
- Density measurements at each location were matched to (NCEP-NCARv1) forced MAR 3.5 simulation (run from 1948–2015) to find the mean annual 3 m air temperature for the year the measurement was taken.
- In general, the density measurements in SUMup across the GrIS oversample cooler, inland regions and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

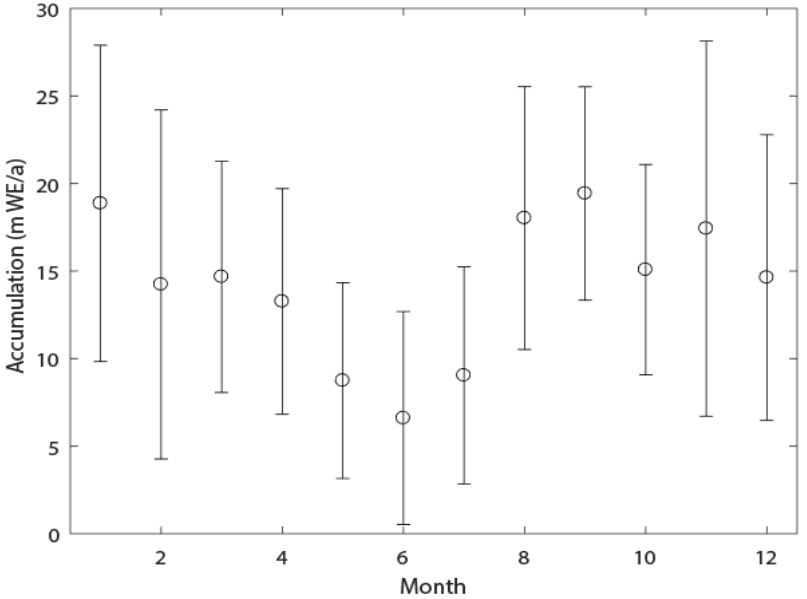
Mean Annual MAR temp and Density Comparison



- 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:4cefadbd-82cc-4d3a-977b-c83ad0af230e.

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Files in this dataset Package: resource_map_urn:uuid:4cefadbd-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	More info	PDF	383 KB	68 downloads	Download
SUMup_snow_accumulation_on_land_ice_dataset_readme.pdf	More info	PDF	308 KB	70 downloads	Download
SUMup_snow_depth_on_sea_ice_dataset_readme.pdf	More info	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

Column	Description	Unit
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

Column	Description	Unit
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

Column	Description	Unit
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

Fact sheet

Hydroinnova

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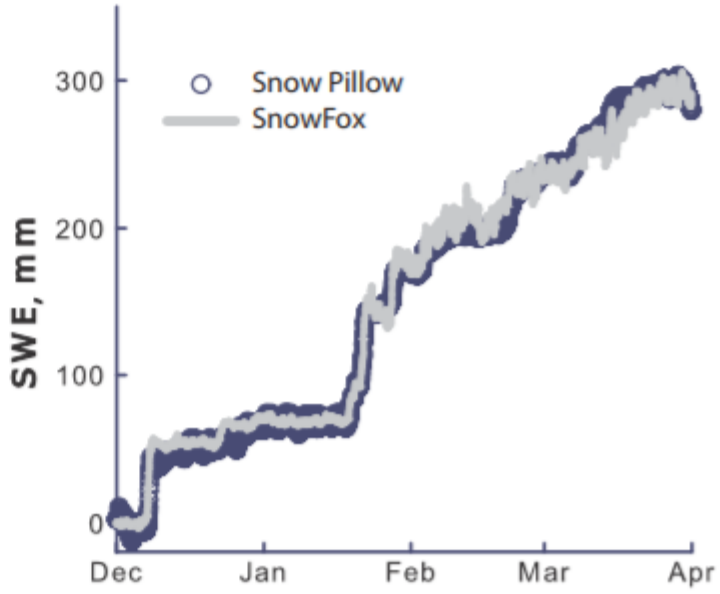
SnowFox™: snow-water equivalent depth made easy

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