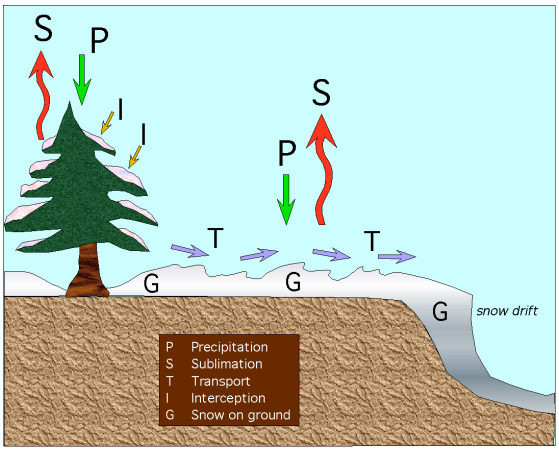
A Prototype Network for Measuring Arctic Winter Precipitation and Snow Cover
Snow-Net



The goal of this project is to develop better and more robust ways to determine the winter water balance in the Arctic. The balance has four components: P (snowfall), S (sublimation), T (transport) and I (interception), with I not a factor where there is tundra. These four terms combine to produce the snow water equivalent on the ground (G):

$$G(t, x, y, z) = P - S - T - I \qquad [1]$$

where t is time and x, y, and z are location coordinates. All the terms on the right side Equation [1] are time-dependent and all vary spatially, consequently, G does also. Historically, there have been considerable difficulties measuring all of the terms in Equation [1], and each term suffers from random and systematic errors. For example, G is easy to measure at a point, but varies greatly from point to point due to T. What is the relevant scale over which to measure G? The premise behind our measurements is that if we measure all the values, we can through error analysis produce better values of each as well as the whole balance. We recognize that some measurements (like S) will always be difficult to do and expensive. We therefore seek ways that will still allow for a balance equation approach, but will have "short-cuts" incorporated that minimize expense and effort.

To measure all of the components of Equation [1] takes many automated instruments, as well as spot surveys. Our network begins with instrumentation at Barrow, Alaska and at Imnaviat Creek, near Toolik Lake, Alaska, the former a site on the Arctic Coastal Plain of Alaska, the latter in the northern foothills of the Brooks Range. It will expand to include Trail Creek Valley near Inuvik in Yukon Territory, as well as Tiksi in Siberia.

Barrow

Our site in Barrow is located generally at 71° 17'N, 156° 34'W in what is called the Barrow Ecological Observatory east of Barrow, Alaska. The consists of a cluster of towers that carry instruments that report times series of things like temperature and wind speed, plus a network of field markers along which spot measurements of depth and snow water equivalent are made, and a site at long a snow fence that is used to measure the drift volume as a function of time.

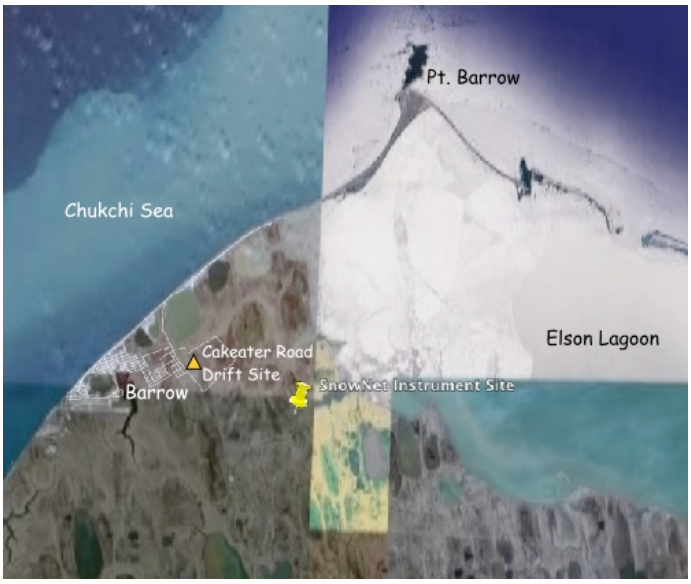


Figure 2: The Barrow Snow-Net site.

The following instrumentation is located at the instrument site:

1. A tower (called Big Tower) holding an sonic anemonmeter, a krypton hygrometer, two humidity-temperature sensors, a Q7 net radiation sensor, long and short wave radiation sensors (both upward and downward looking), and two ground heatflow meters. This tower records data at 20 Hz for computing sublimation by the eddy correlation method.
2. A tower (called Small Tower) carrying temperature and wind sensors at 4 heights, a sonic sounder recording snow depth, a particle counter at the snow surface, a armature buried in the snow measuring the snow temperature along a 50 cm long vertical profile as well as a long a 60 cm horizontal profile, and a heat flow meter.
3. A solid-state snow water equivalent sensor (called SWE Sensor) (3 by 3 m).
4. A Wyoming-shield precipitation gauge with an immersed pressure transducer (called Wyoming Gauge).
5. Two web-cameras, one pointing at the solid-state SWE sensor, another pointing at Big and Small towers. Included in the field-of-view of these cameras are a series of black and white poles (each increment 10 cm long) that can be used to measure snow depth from the images.

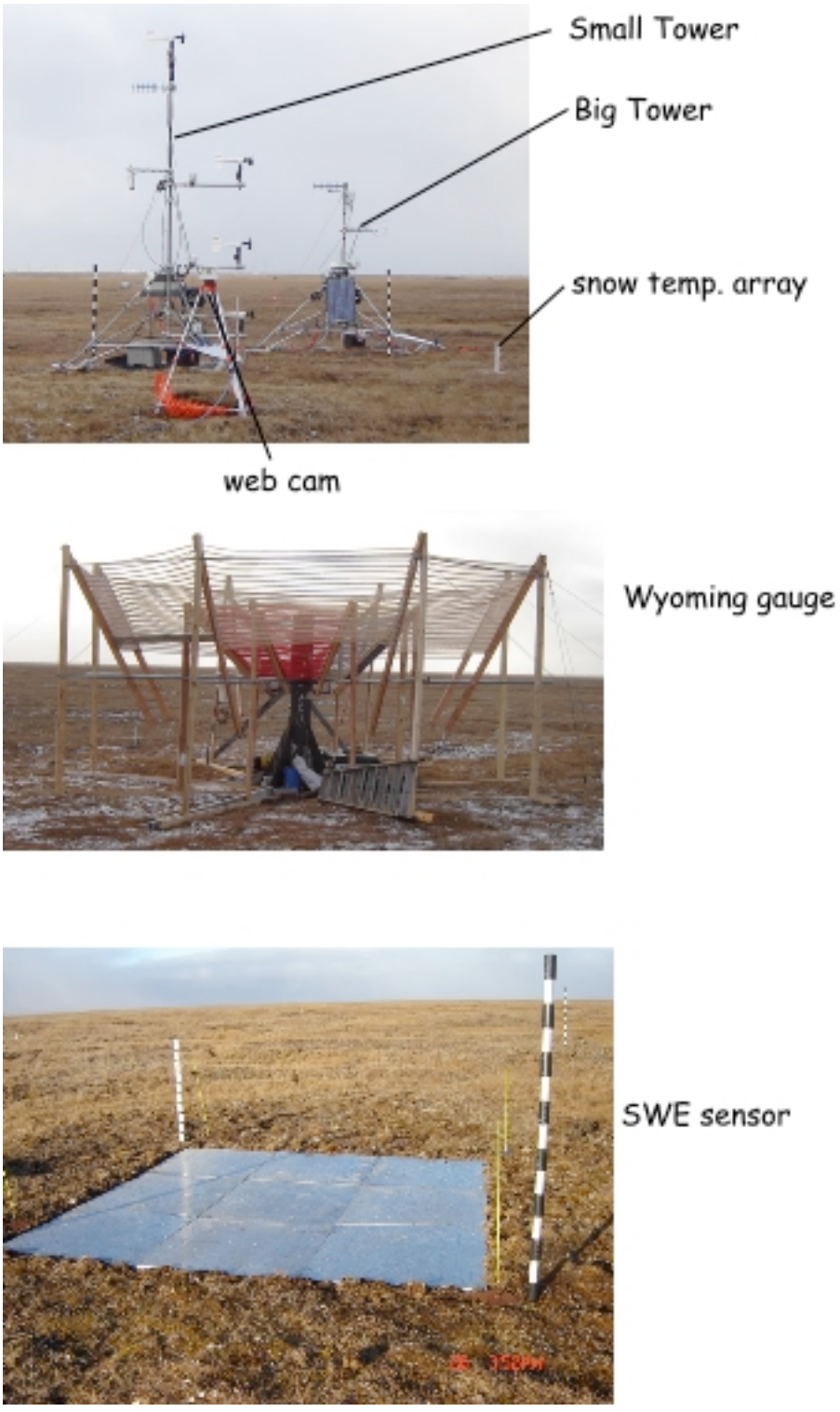


Figure 3: The main instruments at the Barrow site.

The following instrumentation is located at Cakeater Road drift site:

1. Three towers (actually two towers and one cantilever beam off the fence) arranged on a line perpendicular to the fence on the down-wind side that hold sonic sounders that record the distance to the snow surface (hence the drift thickness as a function of time).
2. An anemometer, relative humidity, and air temperature array.
3. A web-cam that looks from the fence downwind over the drift at the 3 towers.

Figure 4: Cakeater Road and the site of our snowdrift monitoring instrumentation.

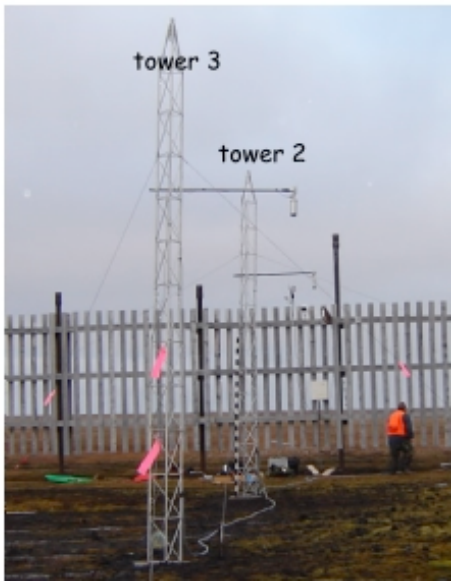


Figure 5: Details of instruments at the Cakeater Road snow fence.

In addition to the records (time series) produced by the instrumentation, field measurements are made during visits that are every 4 to 7 weeks. During these field visits the following measurements are made:

1. Snow depth is measured at about 1-m spacing along a 1-km line (called East-West Line) extending from the BEO Biocomplexity boardwalk through the instrument site to Elson Lagoon. This transect is done using automatic snow depth probes that record both the depth and a GPS position.
2. Snow depth is measured at about a 1-m spacing along a 0.5 km line (Called North-South Line) extending from Elson Lagoon north across East-West Line near the instrument site.
3. Snow depth is measured at 0.5 m spacing along two "L"-shaped lines near the instrument site (called L1 and L2).
4. Snow water equivalent is measured by coring the snow, weighing the core, and dividing the snow mass by the snow depth X the cross-sectional area of the corer. Corers are taken along East-West Line, North-South Line, and near the instrument site. About 20 to 40 values are obtained each survey.
5. The profile of the drift by the Cakeater Road is measured using either optical surveying means, or using a digitial GPS accurate to ±2 cm. This profile is located along the tower line and extends perpendicular to the fence, with distance from the fence (m) positive downwind, and negative upwind.
6. The bulk density of the snow in the drift is measured by coring and weighing the core. Usually 3 to 6 cores are taken on a line perpendicular to the fence on both upwind and downwind sides.
7. Occasionally snow pits are dug near the instrument site to examine the local stratigraphy.

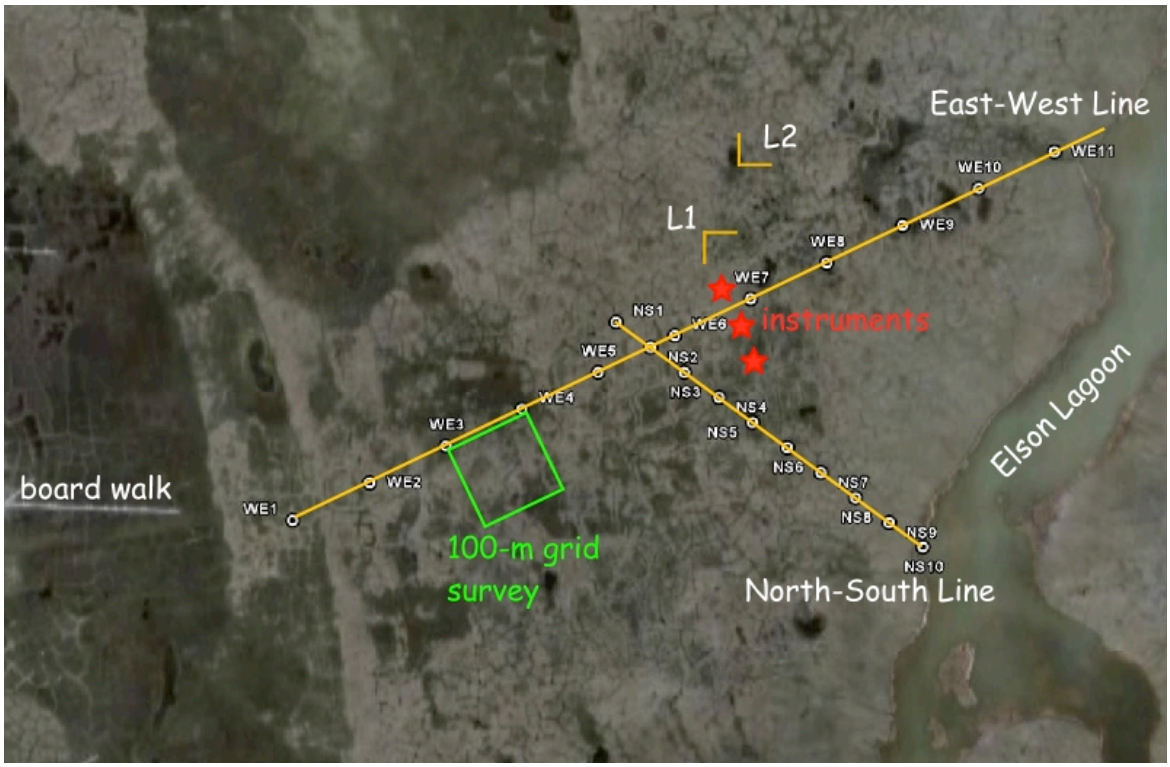


Figure 6: Snow depth and SWE transects at the Barrow instrument site.

Imnavait

Our site in Imnavait Creek is located generally at 68° 37'N, 149° 18'W. This site includes instrumentation from three (3) other networks:

1. Carbon and energy fluxes from two (2) eddy correlation towers run by the University of Alaska's Institute of Arctic Biology. Data available at: http://aon.iab.uaf.edu/index.html

2. Precipitation collected in a Wyoming gage run by the National Resource Conservation Service. Data available at http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=968&state=ak

3. Meteorological data from a 10-meter tower and stream flow from a gauging site run by the University of Alaska, Water and Environmental Research Center. Data available at: http://www.uaf.edu/water/projects/NorthSlope/imnavait/imnavait.html

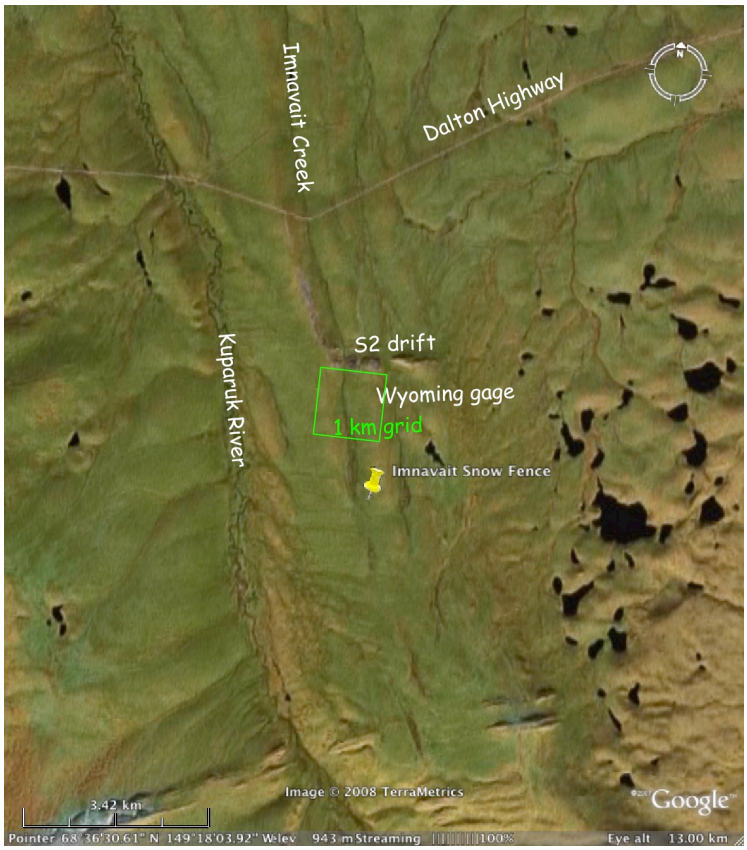


Figure 7: Imnavait Creek near Toolik Lake, Alaska showing components of our AON site.

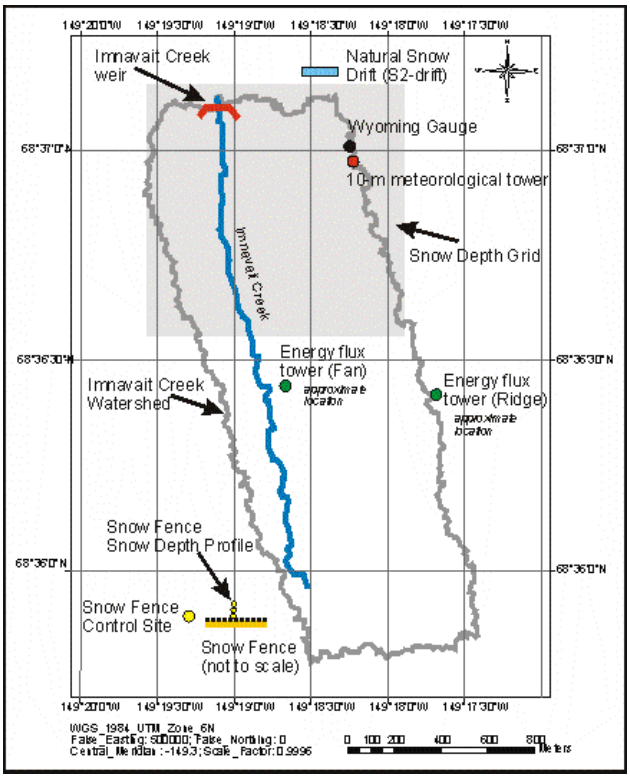


Figure 8: Details of the Imnavait Creek watershed.

As part of SnowNet, we have added to the existing instrumentation:

1. A 71-m long snow fence where we can measure drift profiles.
2. Three towers on the leeward side of the fence from which we measure the snow depth continuously.
3. An adjacent site to the fence where we measure wind speed and direction, temperature etc.
4. Snow depth surveys of a 1000m by 1000m grid centered on the creek (this picks up a set of annual measurements made continuously from 1989 through 1996.
5. Measurements of the profile of a natural snow drift that forms in the lee of a bluff (see Sturm, M., G. E. Liston, C. S. Benson, and J. Holmgren, 2001. Characteristics and growth of a snowdrift in arctic Alaska, U.S.A. *Arctic, Antarctic, and Alpine Research,* ***33***(3), 319-329).

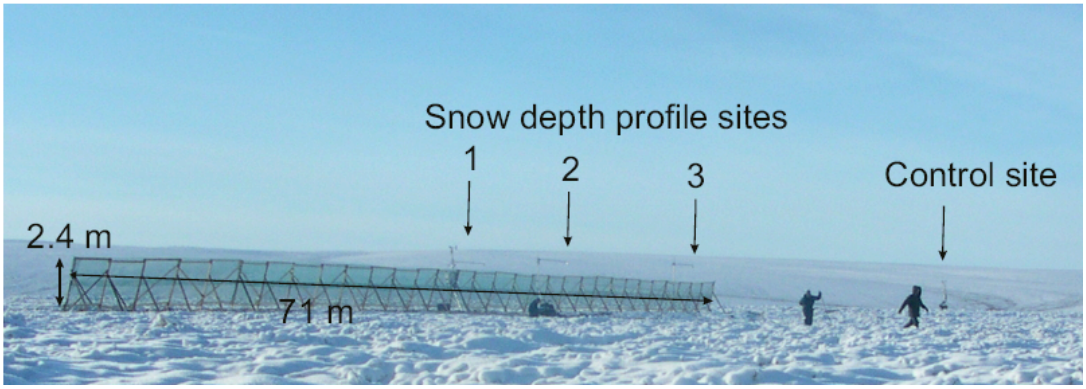


Figure 9: The 71-m snow fence at the upper end of Imnavait Creek.

Detailed Metadata for Barrow and Imnavait Instruments

Small Tower (Barrow)

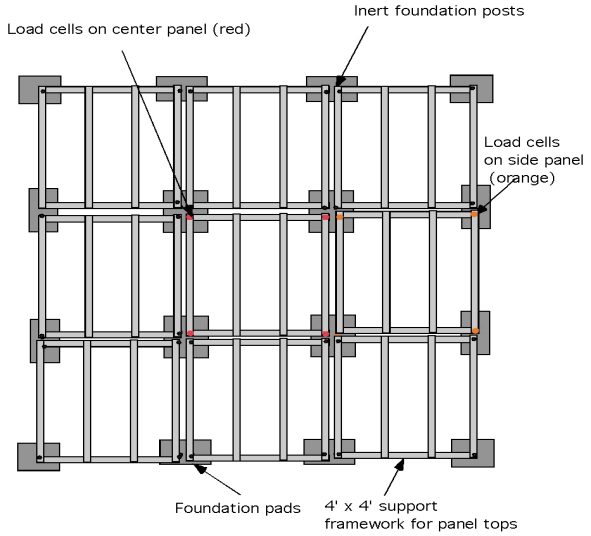
IPY SnowNet Smalltower metadata
Established August 9 2007 Coordinates: N7911013 E586786 UTM Elevation 4.735 m
Data logged using Campbell Scientific CR1000-XT , wind sensors multiplexed using SDMInt8, sensors scanned every 30 seconds, Output every 10 minutes

Parameter	Units	Height	Sensor information	Comments
wndspdlow_Avg	m/s	74 cm	RM Young 05103	Wind speed and direction monitor
wnddirlow	degrees 0 to 359	74 cm	RM Young 05103	Wind speed and direction monitor
wnddirlow_Avg	degrees 0 to 359	74 cm	RM Young 05103	Wind speed and direction monitor
wndspdmid_Avg	m/s	171 cm	RM Young 05103	Wind speed and direction monitor
wnddirmid	degrees 0 to 359	171 cm	RM Young 05103	Wind speed and direction monitor
wnddirmid_Avg	degrees 0 to 359	171 cm	RM Young 05103	Wind speed and direction monitor
wndspdhi_Avg	m/s	283 cm	RM Young 05103	Wind speed and direction monitor
wnddirhi	degrees 0 to 359	283 cm	RM Young 05103	Wind speed and direction monitor
wnddirhi_Avg	degrees 0 to 359	283 cm	RM Young 05103	Wind speed and direction monitor
wndspdtop_Avg	m/s	443 cm	RM Young 05103	Wind speed and direction monitor
wnddirtop	degrees 0 to 359	443 cm	RM Young 05103	Wind speed and direction monitor
wnddirtop_Avg	degrees 0 to 359	443 cm	RM Young 05103	Wind speed and direction monitor
airpress	mbar	120 cm	CS105 Vaisala PTB101B	range 600 to 1060 hPa
lowairt(1) "low"	deg. C	74 cm	model 107 Campbell Scientific	housed in a 41303 radiation shield
lowairt(2) "mid"	deg. C	171 cm	model 107 Campbell Scientific	housed in a 41303 radiation shield
lowairt(3) "high"	deg. C	283 cm	model 107 Campbell Scientific	housed in a 41303 radiation shield
lowairt(4) "top"	deg. C	443 cm	model 107 Campbell Scientific	housed in a 41303 radiation shield
snowdepth	meters	249 cm	Campbell Scientific SR50	Sonic ranging sensor
airkelvin	Kelvin	283 cm	model 107 Campbell Scientific	high air temp used for reference temp for sonic sounder
reftemp_K	Kelvin	283 cm	model 107 Campbell Scientific	
SonicMult				multiplier for temperature compensation of sonic sounder
particles	count	10cm	Pomeroy	1 pulse for every 128 particles, adjusted to be just above the snowpack
hflux	mV	0 cm	Huskeflux HFP01SC	260 cm NorthEast of center pole of tower
therm1(1)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(2)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(3)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(4)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(5)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(6)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(7)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(8)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(9)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(10)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(11)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(12)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(13)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
therm1(14)	Resistance "ohms"	0 cm to 40 cm verticle, 60 cm horizontal	thermister string build at CRREL	5 cm spacing verticle (1 thru 9) , 15 cm spacing horizontal (10 thru 14)
battv	voltage		measured from CR1000	
PanelTemp	deg. C	120 cm	thermister installed in wiring panel	

Thermister	Post processing information
therm1(1)	coef_a = .00130225, coef_b = .000264883, coef_c = 1.37e-07
therm1(2)	coef_a = .00124507, coef_b = .000267646, coef_c = 1.38e-07
therm1(3)	coef_a = .00130425, coef_b = .000264956, coef_c = 1.36e-07
therm1(4)	coef_a = .00126297, coef_b = .000265027, coef_c = 1.45e-07
therm1(5)	coef_a = .00125161, coef_b = .000266746, coef_c = 1.4e-07
therm1(6)	coef_a = .00127064, coef_b = .000266469, coef_c = 1.39e-07
therm1(7)	coef_a = .0012801, coef_b = .000263159, coef_c = 1.31e-07
therm1(8)	coef_a = .0012791, coef_b = .000263541, coef_c = 1.33e-07
therm1(9)	coef_a = .00126403, coef_b = .000264192, coef_c = 1.32e-07
therm1(10)	coef_a = .00127131, coef_b = .000266997, coef_c = 1.4e-07
therm1(11)	coef_a = .001300212, coef_b = .00026444, coef_c = 1.37e-07
therm1(12)	coef_a = .00125219, coef_b = .000267056, coef_c = 1.41e-07
therm1(13)	coef_a = .00126506, coef_b = .000265206, coef_c = 1.35e-07
therm1(14)	coef_a = .00128037, coef_b = .000263443, coef_c = 1.3e-07

SWE Sensor (Barrow)

The electronic SWE sensor a modular sensor that consists of nine 3-ft x 3-ft aluminum panels. All panels are identically constructed. The modularity allows SWE to be measured in the center of the sensor surrounded by inert panels that buffer any sensor stress concentrations that may arise at the edge of the sensor. Construction of the sensor is also simplified since all panels are identical, only the use of a load cell or dummy spacer are used to support the aluminum plate.Three load cells are currently installed on the SWE sensor. Two load cells are placed under the center panel and the third is under the middle outer panel. The load cell type is a hermitically sealed load cell calibrated in compression. The model HSW-2K is manufactured by Transducer Techniques.



Cakeater Fence Site (Barrow)

Cake eater Road Snow Fence metadata
Site established September 28, 2007

Coordinates:	Northing	Easting	Elevation
Tower 1 (3 meters from fence)	7911761.222	583550.169	4.848
Tower 2 (10 meters from fence)	7911765.75	583559.707	4.952
Tower 3 (20 meters from fence)	7911769.414	583569.002	5.069

Data logged using Campbell Scientific CR10X datalogger, scanning every 10 seconds, reporting every 10 minutes.

Parameter	Units/Format	Height	Sensor information	Comments
I.D.	Number			Output identification number
Year	YYYY			Year
JDAY	DDD			Julian day
HRMN	HHMM			Hour and Minutes
Batt_volt	Voltage		determined by CR10X	
107_temp	deg. Celsius	4.57 meters	Campbell Scientific 107 thermister probe/shielded	height is the top of the fence
Distance20m	Meters	3.76 meters	Campbell Scientific SR50 sonic sounder	Tower 20 Meters from fence
Tcdistance20m	Meters	3.76 meters	Campbell Scientific SR50 sonic sounder	Tower 20 Meters from fence
depth 20M	Meters	3.76 meters	Campbell Scientific SR50 sonic sounder	Tower 20 Meters from fence
Distance10m	Meters	3.72 meters	Campbell Scientific SR50 sonic sounder	Tower 10 Meters from fence
Tcdistance10M	Meters	3.72 meters	Campbell Scientific SR50 sonic sounder	Tower 10 Meters from fence
depth 10M	Meters	3.72 meters	Campbell Scientific SR50 sonic sounder	Tower 10 Meters from fence
depth 3 M	mm	3.76 meters	Campbell Scientific UDG01 sonic sounder	Mounted on a 3 meter arm on fence
distance 3M	mm	3.76 meters	Campbell Scientific UDG01 sonic sounder	Mounted on a 3 meter arm on fence
windspd_sam	meters per second	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
windspd_vec_avg	meters per second	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
winddir_vec	degrees	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
winddir_standev	degrees	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
windspd_vec_avg	meters per second	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
windspd_resul	meters per second	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
winddir_result	degrees	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
stand_dev_dir	degrees	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence
winddir_sample	degrees	4.57 meters	R.M. Young 05103 wind monitor	Top of the fence

Parameter	Post processing information
I.D.	
Year	
JDAY	
HRMN	
Batt_volt	
107_temp	none
Distance20m	uncorrected distance to target
Tcdistance20m	temperature corrected distance to target
depth 20M	snow depth measured by initial distance - TCmeasured distance
Distance10m	uncorrected distance to target
Tcdistance10M	temperature corrected distance to target
depth 10M	snow depth measured by initial distance - TCmeasured distance
depth 3 M	snow depth measured by initial distance - TCmeasured distance
distance 3M	initial distance measurement
windspd_sam	sample
windspd_vec_avg	average wind speed vector average
winddir_vec	average unit vector direction
winddir_standev	standard deviation of the direction (Yamartino)
windspd_vec_avg	average wind speed vector average
windspd_resul	resultant U
winddir_result	Average resultant vector direction
stand_dev_dir	Standard deviation of the direction (CSI)
winddir_sample	sample

Big Tower (also called Large Tower-Barrow)

Station Name: Large Tower
established Aug 25, 2007 Coordinates: N7911023.867 E586781.073 Elevation 4.596 meters
Data logged using CR5000 scanned 20 Hz, Flux table output every 10 minutes

Parameter	Units	data type	height	Sensor	Comments
TIMESTAMP	mm/dd/yyyy 00:00	date and time	150 cm	CR5000 Campbell Scientific datalogger	
LE_kh	W/m^2	Smp	213 cm	Kryton hygrometer Campbell Scientific	Latent heat flux from KH20
Hs	W/m^2	Smp	224 cm	CSAT3 Campbell Scientific	Sensible heat flux using sonic temperature
TCsnow_Avg	C	Avg	ground	TCAV Campbell Scientific	4-sensor averaging thermocouple probe
hf1_Avg	W/m^2	Avg	ground	Huskeflux self calibrating heat flow meter	HFP01SC
Q_star_Avg	W/m^2	Avg	276 cm	Rebs Q 7 net radiometer	net radiation
kh_Avg	mV	Avg	213 cm	Kryton hygrometer Campbell Scientific	KH20 millivolt output
Ts_Avg	C	Avg	224 cm	CSAT3 Campbell Scientific	sonic temperature
panel_temp_Avg	C	Avg	150 cm	CR5000 Campbell Scientific datalogger	temperature of panel thermister
t_hmp_upper_Avg	C	Avg	265 cm	HMP45C Vaisala temperature and humidity probe	Average Air temperature Upper sensor
t_hmp_lower_Avg	C	Avg	69 cm	HMP45C Vaisala temperature and humidity probe	Average Air temperature Lower sensor
rh_hmp_upper_Avg	fraction	Avg	265 cm	HMP45C Vaisala temperature and humidity probe	Average Relative Humidity Upper sensor
rh_hmp_lower_Avg	fraction	Avg	69 cm	HMP45C Vaisala temperature and humidity probe	Average Relative Humidity Lower sensor
h2o_hmp_upper_Avg	g/m^3	Avg	265 cm	HMP45C Vaisala temperature and humidity probe	Average Vapor density Upper probe
h2o_hmp_lower_Avg	g/m^3	Avg	69 cm	HMP45C Vaisala temperature and humidity probe	Average Vapor density Lower probe
rho_a_upper_Avg	kg/m^3	Avg	265 cm	HMP45C Vaisala temperature and humidity probe	Average moist air density Upper sensor
rho_a_lower_Avg	kg/m^3	Avg	69 cm	HMP45C Vaisala temperature and humidity probe	Average moist air density Lower sensor
VisUp_Avg	W/M^2/V	Avg	123 cm	Kipp and Zonen Radiometer	Up facing
VisDn_Avg	W/M^2/V	Avg	123 cm	Kipp and Zonen Radiometer	Down facing
Vac_up_Avg	mVolts	Avg	123 cm	Eppley PIR pyranometer	Up facing
Vac_down_Avg	mVolts	Avg	123 cm	Eppley PIR pyranometer	Down facing
IRup_ohms_Avg	ohms	Avg	123 cm	Eppley PIR pyranometer	thermister reading of PIR
IRdn_ohms_Avg	ohms	Avg	123 cm	Eppley PIR pyranometer	thermister reading of PIR
R_in_up_Avg	W m^-2	Avg	123 cm	Eppley PIR pyranometer	infra-red radiation
R_in_down_Avg	W m^-2	Avg	123 cm	Eppley PIR pyranometer	infra-red radiation
wnd_dir_compa_Avg	degrees	Avg	224 cm	CSAT3 Campbell Scientific	3 dimensional sonic anemometer
wnd_dir_csat3_Avg	degrees	Avg	224 cm	CSAT3 Campbell Scientific	3 dimensional sonic anemometer
wnd_spd_Avg	m/s	Avg	224 cm	CSAT3 Campbell Scientific	3 dimensional sonic anemometer
rslt_wnd_spd_Avg	m/s	Avg	224 cm	CSAT3 Campbell Scientific	3 dimensional sonic anemometer
std_wnd_dir_Avg	degrees	Avg	224 cm	CSAT3 Campbell Scientific	3 dimensional sonic anemometer
fw_Avg	C	Avg	224 cm	FW03 Campbell Scientific	.03 mm Fine Wire thermocouple type e

Imnavait Snow Fence (SF)
Dimensions: length 71 m, height 2.4 m, bottom gap 0.33 m
Location (WGS 84): west corner 68.59705N, -149.3096W, 2996ft (913m)
east corner 68.59698N, -149,3080W, 2996ft (913m)
Orientation: west-east

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Imnavait Snow Fence Meteorological Site (CS)
Location: 70 m west of the snow fence
68.59712N, -149,3113W, 3004ft(916m)
Instrumentation: Young Wind Monitor Model 05103
Campbell Scientific Snow Depth Sensor Model SR50M-45
Temperature and Relative Humidity Probe Model HMP45C
Solar panel and battery
Campbell Scientific CR10X datalogger
FreeWave data radio, omnidirectional antenna
Height of the SR50M's: 2.17 m
SR50M's reading: 2.21 m (no offset put in the program)
Logging interval: scanning and reporting 1 hour

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Imanvait Snow Fence snow depth profile sites (SDP)
Location: 40 m from the west SF corner, perpendicular to SF
SDP1 3 m from snow fence; no coordinates taken
SDP2 8 m from snow fence; 68.59709N, -149,3085W, 2996ft(913m)
SDP3 15 m from snow fence; 68,59712N, -149,3086W, 2996ft (913m)

Instrumentation:
SD1 Campbell Scientific Snow Depth Sensor Model SR50A
Campbell 107 temperature probe
Young Wind Monitor Model 05103
Radio, antenna
Solar panel and battery
Campbell Scientific CR1000 datalogger
FreeWave data radio, yagi directional antenna
SD2;SD3 Campbell Scientific Snow Depth Sensor Model SR50A
Heights of the SR50a's: 2.615 m @ 3 meters, 2.698 m @ 8 meters and 2.795 m @ 15 meters
SR50a's readings: 2.503 m @ 3 meters, 2.716 m @ 8 meters and 2.783 m @ 15 meters (offsets put in the program)
Logging interval: scanning the sensor's at a 20 sec. interval; reporting every 10 minutes

Site Name: Imnaviat Creek Snow Fence
Site established October 26, 2007
Data logged using Campbell Scientific CR1000 datalogger, scanned every 10 seconds, reported every 10 minutes

Parameter	**Units/Format**	**Height**	**Sensor Information**	**Comments**
WS_ms	m/s , sample	305 cm	R.M. Young 05301	Wind speed and direction sensor
WindDir	degrees , sample	305 cm	R.M. Young 05301	Wind speed and direction sensor
WS_ms_S_WVT	m/s vector average	305 cm	R.M. Young 05301	Wind speed and direction sensor
WS_ms_U_WVT	m/s resultant speed	305 cm	R.M. Young 05301	Wind speed and direction sensor
WindDir_DU_WVT	degrees, resultant	305 cm	R.M. Young 05301	Wind speed and direction sensor
WindDir_SDU_WVT	degrees, standdev	305 cm	R.M. Young 05301	Wind speed and direction sensor
T107	deg. C	295 cm	Campbell Scientific 107 probe	temperture sensor used for correcting sonics
Snow_depth_3m	meters	2.503 m	SR50A Campbell Scientific	Sonic sounder
SignalQuality_3m	code	2.503 m	SR50A Campbell Scientific	signal quality code number
Snow_depth_8m	meters	2.716 m	SR50A Campbell Scientific	Sonic sounder
SignalQuality_8m	code	2.716 m	SR50A Campbell Scientific	signal quality code number
Snow_depth_15m	meters	2.783 m	SR50A Campbell Scientific	Sonic sounder
SignalQuality_15m	code	2.783 m	SR50A Campbell Scientific	signal quality code number
Batt_Volt	volts	1.5 m	CR1000 datalogger	
PanelTemp,	deg. C	1.5 m	CR1000 datalogger	thermister on panel