

Metadata file for SIZONet mass balance probe, Barrow, AK, 2010

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Revision History

19 Jan 2010: document creation

Overview

Date of deployment (season 2009/10):

12–16 Jan 2010

Location:

- Chukchi Sea, landfast ice between Niksuiraq and Point Barrow, Alaska
- 71.37055° North, 156.51363° West
- location with a comparatively light sediment load in the ice, confined to the upper 25 cm

Installed by:

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Project:

SIZONet Phase II, NSF grant number 0856967

Features

The design of this mass balance probe underwent only little change since the season 2005/6. It comprises of a thermistor string, acoustic rangefinders for snow depth, ice thickness, and sealevel changes, air temperature and humidity sensor, and a wind turbine. All sensors and equipment operate over a wide voltage range, down to 9 V or below. They are powered by a wind turbine and lead-acid batteries that provide power at a voltage between 10.5 V and 15 V. In 2010, a suite of radiometers was deployed 15 m North of the Mass Balance probe with snow depth sounders operated by this mass balance probe.

Remote Site

- Location: on Chukchi Sea ice, South of Point Barrow
- Cables: protected from fox bites with Aluminum Flexible Conduit
- Data logger: Campbell Scientific
 - CR10X Data Logger
 - AM1664 Multiplexer
 - SM5M Data storage module
 - SC32A Adaptor
- Data link:
 - FreeWave FGR 115-WC radio (slave mode)
 - bridging RS232 connection
 - 900 MHz, spread-spectrum, no-licence
 - Bluewave 10 dB directional Yagi Antenna (BMY89K)
- Batteries: 2x Exide 85 Ah in parallel
- Thermistor string (CRREL-type, built in fall 2009)
 - white PVC rod, white potting, cold flex cable
 - 2 sections of 15 thermistors each, type YSI 44033 (approx. 10k Ω at -6 °C)
 - 10 cm vertical separation
 - upper-most thermistor is 70 cm above ice–snow interface
 - thermistors are partially exposed at the North-side of the string
- Under-ice measurements, attached to a dedicated mast penetrating sea ice
 - Ice thickness sounder: upward-looking acoustic altimeter Benthos PSA-916
 - Sealevel sounder: downward-looking acoustic altimeter Benthos PSA-916
 - Seawater temperature: thermistor, Campbell Scientific 107
- 3 Snow depth sounders, downward-looking Campbell Scientific
 - SR50 (SID 2) above Benthos ice thickness sounder
 - SR50a (SID 1) above in/under-ice radiometers
 - SR50a (SID 0) at downward-looking radiometer
- Air temperature and humidity:
 - Campbell Scientific CS500 with shielding (new relative humidity sensor as of Jan 2010)
 - 2 m above ground
- Wind turbine:
 - Aero4Gen, 12 V, 100 W max.
 - LVM4SB12-T temperature-compensated charge controller, connected to the batteries in parallel

Base Station

- Located at NARL, supported by BASC
- Data link:
 - FreeWave FGR 115-RC radio (master mode)
 - bridging RS232 connection

- 900 MHz, spread-spectrum, no-licence
- Bluewave 10 dB omni-directional antenna
- Dedicated PC
 - running MS Windows Vista
 - LoggerNet 3.5.1 for scheduled data retrieval from data logger (polling data logger every 5 minutes)
 - Python 2.5 scripts tranfering data for processing at the University of Alaska Fairbanks (UAF) (sending new data every minute, if available)

Data Acquisition and Processing

- File name of data logger program: BRW_MBS10_JAN05_900.CSI
- Data are acquired every 15 minutes as instantaneous measurements. Thermistor string readings are averages of 20 measurements taken in quick succession.
- Snow depths, ice thickness, and water depth are measured as distances from the acoustic transducers. The transducer has a measurement cone of $\pm 10^\circ$ and evaluates the time of the first return signal. This eliminates systematic errors if the transducer is not mounted exactly perpendicular to the measured surface. A correction for the temperature-dependence of the speed of sound in water and air is applied, based on the water temperature measured with the Campbell Scientific 107 and the CS500, respectively. An offset is applied to convert a distance measurement to depth or thickness.
- The lowest temperature reading returned by the CS500 is -39.66°C . This reading is also reported for lower temperatures.
- Thermistor string measurements are performed as voltage measurements across the thermistor in a bridge with $10\text{ k}\Omega$ reference resistor (tolerance $\pm 0.1\%$), excited with 2500 mV . The thermistor resistance is determined from the measured voltage (assuming the reference resistor and excitation voltage are exactly $10\text{ k}\Omega$ and 2500 mV , respectively) and converted to temperature with the Steinhart–Hart equation using coefficients fitted to the manufacturer's specifications of typical thermistors. Specifically,

$$1/T = A + B \ln(R) + C [\ln(R)]^3$$

with $A = 1.46843\text{e-}03$, $B = 2.38214\text{e-}04$, $C = 1.01608\text{e-}07$, R in Ω and T in K.
The temperature error of this equation is less than 10 mK between -50 and $+10^\circ\text{C}$.

- Each thermistor string uses its own reference resistor. After measuring the 15 thermistors of any string, the voltage over a bridge with $10\text{ k}\Omega$ control resistor is measured. The control resistor is mounted on the multiplexer board, and this reading should not change with time. Deviations likely indicate problems with at least one of: internal data logger measurement circuit, reference resistor, or control resistor.
- Data gaps are filled with *invalid values* in the processed data file.

Calibration and Errors

No calibration is performed on any measurement apart from the processing steps outlined above.

Note

Temperatures are not calibrated.

In particular, the following errors are not accounted for:

- Water depth is referenced to the ice–snow interface at the time of deployment rather than to the surface water level. Corrections need to be applied for ice growth and changing snow load.
- Temperature measurements are accurate to typically ± 0.2 °C.
- Relative humidity is specified by the manufacturer to be accurate to 10%.
- Readings of the ice thickness sounder fluctuate. This could be due to changing acoustic path lengths as a result of brine release.
- All depths and thicknesses in the processed data file are referenced to the ice–snow interface at the time of deployment. Interpretation of these numbers may differ due to surface ablation in June, and possibly from mid May due to the potential for superimposed ice formation.
- The data logger clock is expected to remain accurate to better than 5 minutes from January through June.

File Format

Processed Data

File Name: BRW_MBS_2010.txt

Format: ASCII, columns TAB-delimited, rows terminated by LF

Header: TAB-delimited column headers in first row; first character is hash sign (#)

Invalid Values: -9999

Col.	
1	Fractional day of 2010, UTC (1.0 for midnight January 1st)
2	Year (always 2010)
3	Integer day of year, UTC (1 for January 1st)
4	Time of day (HHMM), UTC
5	Internal data logger temperature (°C)
6	Supply voltage (V)
7	Water temperature from 107 probe (°C)
8	Relative Humidity from CS500 (%) (typ. 60–80%)
9	Air temperature from CS500 (°C), always above -40°C
10	Snow depth (m) from SR50a, SID 0 (albedo radiometer)
11	Snow depth (m) from SR50a, SID 1 (underwater radiometer)
12	Snow depth (m) from SR50, SID 2 ("pinger mast")
13	Ice thickness (m)
14	Water depth plus freeboard (m)
15	Control voltage (mV), upper thermistor string (typ. 1250)
16	Control voltage (mV), lower thermistor string (typ. 1250)
17	Thermistor temperature (°C) 70 cm above ice–snow interface
18	Thermistor temperature (°C) 60 cm above ice–snow interface
...	...

23	Thermistor temperature (°C) 10 cm above ice–snow interface
24	Thermistor temperature (°C) at ice–snow interface (in ice)
25	Thermistor temperature (°C) 10 cm below ice–snow interface
...	...
46	Thermistor temperature (°C) 220 cm below ice–snow interface

Raw Data

File Name: BRW_MBS_2010_raw.txt

Format: ASCII, columns TAB-delimited, rows terminated by LF

Header: none

Invalid Values:

- CS500: RH negative or Temperature below -40 °C
- PSA-916: distances below 0.5 m or above 5 m
- SR50(a): -99999

Col.	
1	Record identifier (always 110)
2	Year (always 2010)
3	Day of year Alaska Standard Time (AKST), UTC-9 (1 for January 1st)
4	Time of day (HHMM, leading zeros are dropped) in Alaska Standard Time (AKST), UTC-9
5	Internal data logger temperature (°C)
6	Supply voltage (V)
7	Water temperature from 107 probe (°C)
8	Relative Humidity from CS500 (%) (typ. 60–80%)
9	Air temperature from CS500 (°C)
10	Distance (m) measured by SR50a (SID 0)
11	Distance (m) measured by SR50a (SID 1)
12	Distance (m) measured by SR50 (SID 2)
13	Distance (m) measured by upward-looking PSA-916
14	Distance (m) measured by downward-looking PSA-916
15	Thermistor string voltage bridge reading 70 cm above ice–snow interface (mV)
16	Thermistor string voltage bridge reading 60 cm above ice–snow interface (mV)
...	...
21	Thermistor string voltage bridge reading 10 cm above ice–snow interface (mV)
22	Thermistor string voltage bridge reading at ice–snow interface (in ice) (mV)
23	Thermistor string voltage bridge reading 10 cm below ice–snow interface (mV)
24	Thermistor string voltage bridge reading 20 cm below ice–snow interface (mV)
...	...
29	Thermistor string voltage bridge reading 70 cm below ice–snow interface (mV)

30	Voltage bridge reading over control resistor for upper thermistor string (mV), should be about 1250
31	Thermistor string voltage bridge reading 80 cm below ice–snow interface (mV)
32	Thermistor string voltage bridge reading 90 cm below ice–snow interface (mV)
...	...
45	Thermistor string voltage bridge reading 220 cm below ice–snow interface (mV)
46	Voltage bridge reading over control resistor for lower thermistor string (mV), should be about 1250