Measurements of ice mass balance and temperature from autonomous Seasonal Ice Mass Balance buoys.

Data abstract:
The dataset contains measurements made from four autonomous Seasonal Ice Mass Balance (SIMB) buoys (2021_8, 2021_9, 2021_10, 2021_11). The buoys were deployed in March 2023 in a south to north line in the Beaufort Sea (Figure 1). This work was performed as part of a project "Ice Mass Balance Buoys for the Arctic Observing Network: Observing and Understanding a Changing Arctic Sea Ice Cover." The project goal is to collect measurements that allow us to determine, delineate, and attribute the thermodynamic changes in the mass balance of the Arctic sea ice cover. Each buoy measured position, barometric pressure, air temperature, and a vertical profile of temperature from the air, through the snow, through the ice, and into the upper ocean. An above ice downward looking sounder tracked the position of the surface and an underwater upward looking sounder tracked the position of the ice bottom. Sensors were placed every 0.02 m on the vertical temperature string. Measurements were made every four hours and results were transmitted via Iridium. There is one csv file for each SIMB.

File Structure:

- Line 1 of the file has the name of the SIMB (2021_8, 2021_9, 2021_10, 2021_11).
- Line 2 has information on the position of the temperature sensors. Positive values are above the snow – ice interface and negative numbers are below.
- Line 3 has labels for the different values. They are time stamp, latitude, longitude, air temperature(°C), barometric pressure (mbar), calculated snow depth (m), calculated bottom position (m), water temperature (°C), temperatures from the temperature string (°C)
- Line 4 to the end have results from the measurements made every four hours.

Data

Data were manually quality controlled to remove bad or missing data.

- -999 or blanks are missing or bad data
- The above ice sounder can be noisy due to snow accumulation on the sensor
- Outliers in ice thickness and snow depth were removed
- Negative snow depths in summer represent the amount of surface melt.
- Bottom positions are negative since they are below the ice surface.
- If $H_s \geq 0$, H_s = snow depth and H_b = ice thickness
- 0 is the ice surface at installation. The ice surface moves downward during summer melt due to surface ablation. At some time, usually in August, surface melt ends and there is a new reference point for the surface.
- If $H_s < 0$, then H_s = amount of surface melt and $H_s - H_b$ = ice thickness
- During the melt season surface melt and bottom melt are delineated by looking at changes in H_i and H_s.
- In all SIMBs there were some dropouts in the upward looking acoustic sensor. These were filled in with linear interpolation.
- In all SIMBs there were many dropouts and bad readings from the above ice sensor during winter. These were deleted.

Specific issues with individual SIMBs

2021_8

- The above ice sensor worked fine until the SIMB melted free.
- It is highly likely that the SIMB melted free from the ice on 8/2/2023 12:00. Acoustic sensor data are reported, but are of dubious quality.
- The temperature chain failed after 7/11/2023.
- There was a data gap between 7/11/2023 and 7/27/2023.

2021_9

- It is highly likely that the SIMB melted free from the ice on 7/23/2023 12:00. Acoustic sensor data are reported, but are of dubious quality.
- The temperature chain failed on 7/30/2023

2021_10

- No additional issues.

2021_11

- The top portion of the temperature profile on 4/25/2023 0:00 has temperatures above 0C. These may be inaccurate.

Sensors

Sensor description	**Model**	**Accuracy**	**Reported precision**
Snow rangefinder	Maxbotix MB7374	±0.001m	0.001m
Underwater rangefinder	Airmar EchoRange+	±0.01m	0.01m
Digital temperature chain	Bruncin 3.85m DTC	0.125 °C	±0.25 °C
Air temperature	DS18B20	0.0625 °C	±0.5 °C
Barometric pressure	Bosch BME280	±0.01 mbar	0.1 mbar
GPS module	MTK3339 GPS	3m	0.1m

Summary of results

	2021_8	2021_9	2021_10	2021_11
Start	3/5/23 0:00	3/5/23 1:38	3/6/23 0:00	3/6/23 4:00
Latitude	73.017	72.027	73.979	75.056
Longitude	-148.375	-148.551	-148.308	-148.344
End	8/13/23 8:00	9/18/23 8:00	5/29/23 12:00	4/28/23 12:00
Latitude	77.053	77.974	76.196	76.955
Longitude	-137.458	-138.666	-143.689	-146.292
Maximum snow depth	0.28	0.43	0.23	0.21
Maximum ice thickness	1.6	0.96	1.23	1.3
Total surface melt (s+i)				
Total surface melt ice				
Total bottom melt				
Total ice growth				
Net annual ice				
Start bottom growth				
Start surface snow melt				
Start surface ice melt				
Start bottom melt	6/2/2023			
End surface ice melt				
End bottom melt				
Freezing degree days				

Units for snow and ice are meters.

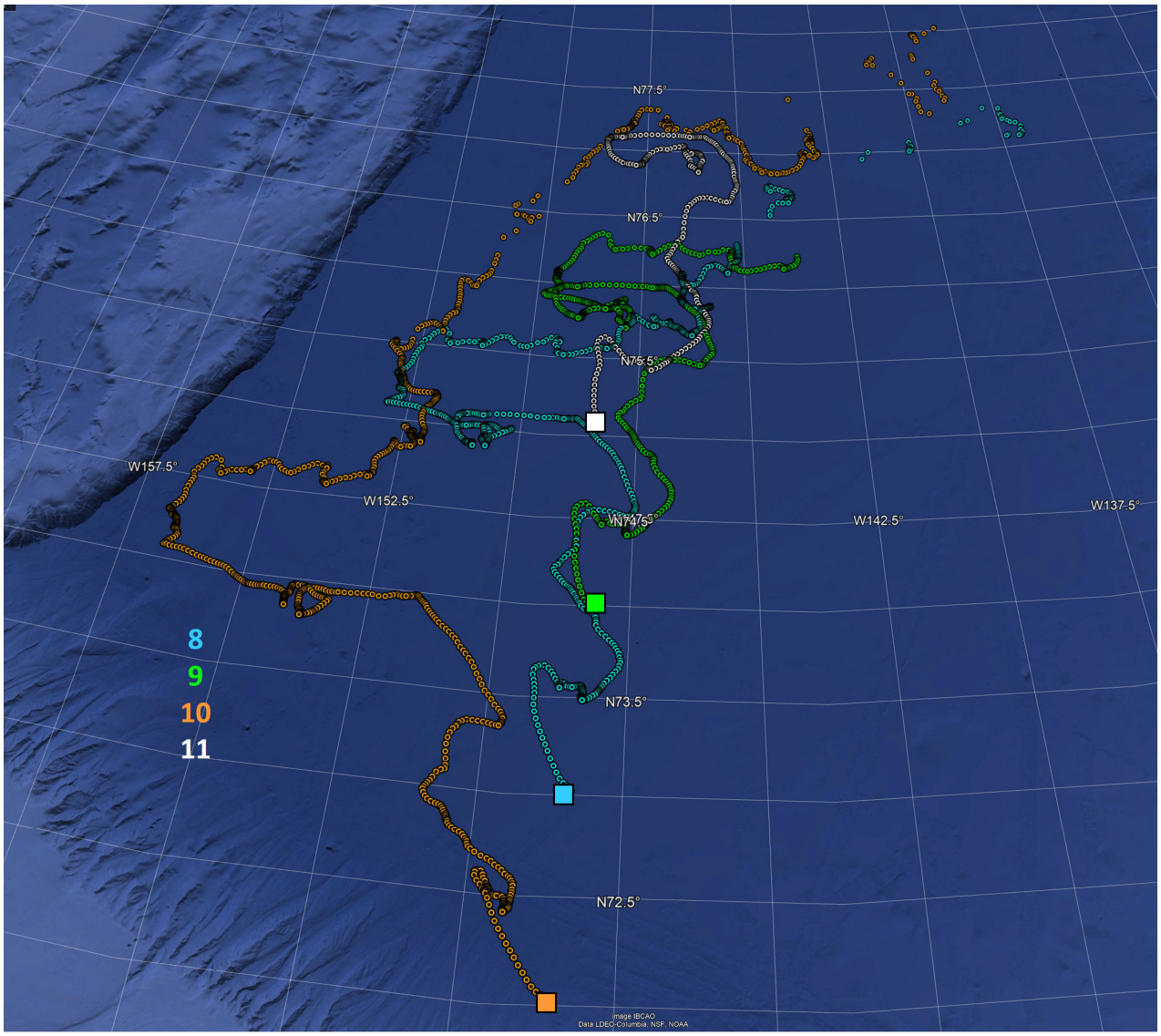

Figure 1. Drift tracks of the four buoys deployed in an array in the Beaufort Sea in March 2023. The squares denote starting points of the drift.