**Documentation of Norwegian Polar Institute dataset for reading the processed data from SIMB3 ice mass balance buoys from Cryosphere Innovation**

Version 1

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1. **Background**

This dataset is based on the measurements from SIMB3 ice mass balance (IMB) buoys deployed in the Arctic Ocean during 2019–2024. SIMB3 buoys measure ice surface and bottom elevation via two separate acoustic sounders and in-situ temperature of air, snow, ice, and water via a chain of thermistors with 2 cm vertical spacing. The original data is published at <https://www.cryosphereinnovation.com/data>. Here we provide estimates of snow and ice thickness, and interface of buoys deployed in 2019–2024.

1. **Overview**

The original data from Cryosphere Innovation includes temperature and acoustic sounder measurements from 60 archived SIMB3 buoys (Planck et al., 2019) deployed during 2019–2024. Here we analysed temperature data from those buoys and manually classified them into three groups: (1) 31 buoys with temperature data allowing for estimates of snow and ice thickness; (2) 21 buoys with erroneous temperature data which cannot be converted into accurate snow and ice thickness estimates; (3) 8 buoys deployed in fast ice.

| Buoy group description | Buoy IDs |
| --- | --- |
| 1. Processed (31 buoys) | MOSAiC 2019 #1, MOSAiC 2019 #2, MOSAiC 2019 #3, MOSAiC 2019 #4 (2019), Dartmouth 2019 #1, Dartmouth 2021 #2, Dartmouth 2021 #3, Dartmouth 2021 #4, SIDEx 2021 #2, SIDEx 2021 #3, Dartmouth 2022 #6, Dartmouth 2022 #7, CRREL 2021 #5, Dartmouth 2021 #8, Dartmouth 2021 #9, Dartmouth 2021 #10, Dartmouth 2021 #11, ArcWatch SIMB3 2023E, ArcWatch SIMB3 2023C, ArcWatch SIMB3 2023D, SIMB3 2024B, SIMB3 2024D, SIMB3 2024E, SIMB3 2024F, SIMB3 2024G, SIMB3 2024H, SIMB3 2024I, SIMB3 2024R, SIMB3 2024S, SIMB3 2024U, SIMB3 2024W |
| 2. Temperature measurements do not allow to estimate snow and ice thicknesses (21 buoys) | Dartmouth 2020 #1, Dartmouth 2020 #2 (2020), SIDEx 2021 #1 (2021), AWI 2022 #1, AWI 2022 #2, AWI 2022 #3, CRREL 2021 #4 (2022), ArcWatch 2023 CTD SIMB3 #1, ArcWatch 2023 CTD SIMB3 #2, SIMB3 2023G, SIMB3 2023F, SIMB3 2023B (2023), SIMB3 2024C, SIMB3 2024J, SIMB3 2024K, SIMB3 2024L, SIMB3 2024M, SIMB3 2024O, SIMB3 2024Q, SIMB3 2024X, SIMB3 2024Z (2024) |
| 3. Deployed in fast ice (8 buoys) | McGill 2019 #1, McGill 2019 #2 (2019), UAF 2020 #2 (2020), UAF 2021 #1, CIS 2021 #1 (2020), UAF 2022 #2, UAF 2022 #3 (2022), UAF Chukchi LFI 2024 (2024) |

The updated estimates of interfaces and thicknesses are mainly based on the values from the vertical temperature gradients following this sequence:

1. The interfaces are estimated from the relative difference in the vertical temperature gradients. Snow surface and lower interfaces are lower boundaries of the area with vertical temperature gradient at least two times larger than vertical temperature gradient within ice.
2. After preliminary identification of interfaces, the interface estimates from acoustic sounders are adjusted by a constant value to fit the temperature-based interfaces for the time close to buoy deployment.
3. If there are substantial differences in position of at least one of the three interfaces, they are updated based on a combination of temperature and acoustic measurements.

The updated version of the interface and thickness estimates is published in the same format as in West (2020) and Salganik et al. (2025).

1. **Results and examples of reprocessing**

The median snow thickness from buoys deployed in 2019–2024 was 0.10 m for deployment metadata from Cryosphere Innovation and 0.16 m from the estimates based on temperature data.

A graph of different colored dots

AI-generated content may be incorrect.

Figure 1. The initial snow depth (top) and ice thickness (bottom) for buoys deployed in 2019–2024 based on buoys metadata and processed temperature data.

A graph of different colored lines

AI-generated content may be incorrect.

Figure 2. Evolution of snow depth (top) and ice thickness (bottom) for buoys deployed in 2019–2024 based on processed temperature data.

A screen shot of a graph

AI-generated content may be incorrect.

Figure 3. Vertical temperature gradient from a selected buoy with the evolution of the air-snow interface (blue line), the snow-ice interface (red line) from the processed temperature data, and the initial snow thickness from the metadata (blue dot).

1. **The dataset**

The updated dataset with the identical values of in-situ temperature, geographical location, time, the processed location of interfaces, as well as snow and ice thicknesses are published as NetCDF files in github.com/esalganik/SIMB3\_2019-2024.

1. **References**

Planck, C. J., Whitlock J., Polashenski C., Perovich, D.: The evolution of the seasonal ice mass balance buoy., Cold Regions Science and Technology, 165:102792, <https://doi.org/10.1016/j.coldregions.2019.102792>, 2019.

West, A. E.: Arctic ice mass balance buoy data for use in calculating quantities to evaluate climate models, Version v1\_april\_2020, Zenodo, https://doi.org/10.5281/zenodo.3773811, 2020.

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Perovich, D., Richter-Menge, J., and Polashenski, C.: Observing and understanding climate change: Monitoring the mass balance, motion, and thickness of Arctic sea ice, The CRREL-Dartmouth Mass Balance Buoy Program (Cold Regions Research and Engineering Laboratory, Thayer School of Engineering at Dartmouth), available at: http://imb-crrel-dartmouth.org/results/, last access: 20 March 2025.