

Interannual variability of snow and ice thickness across the Transpolar Drift as derived from drifting sea ice mass balance buoys

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**ARCTIC
PASSION**

Pan-Arctic Observing
System of Systems:
Implementing Observations
for Societal Needs

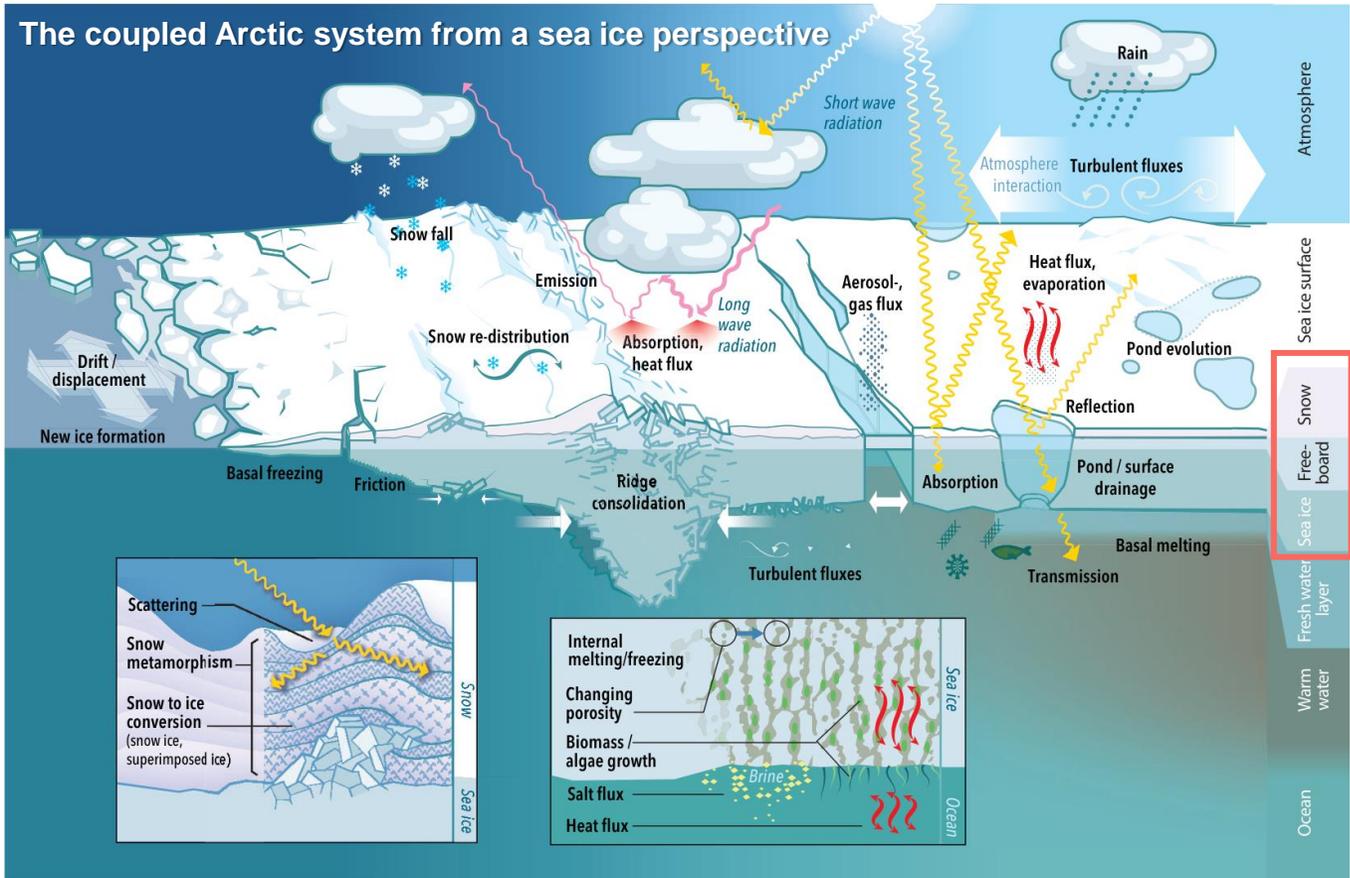


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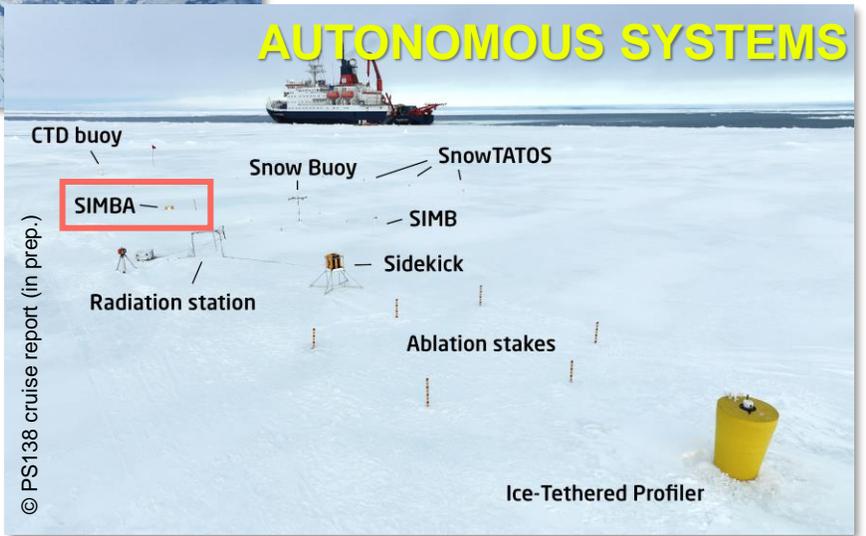
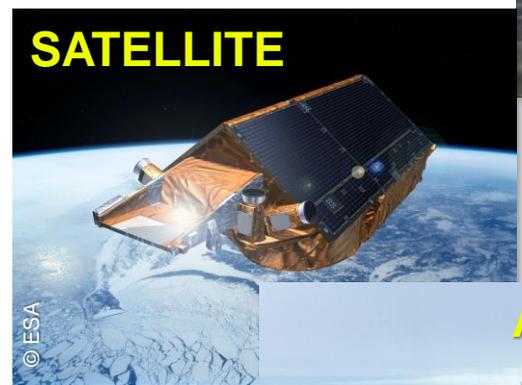
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**ARCTIC
FRONTIERS**

Intro: Observations of sea ice in the coupled Arctic system



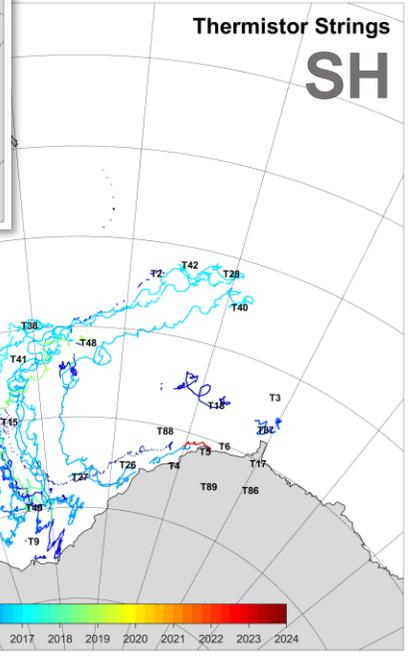
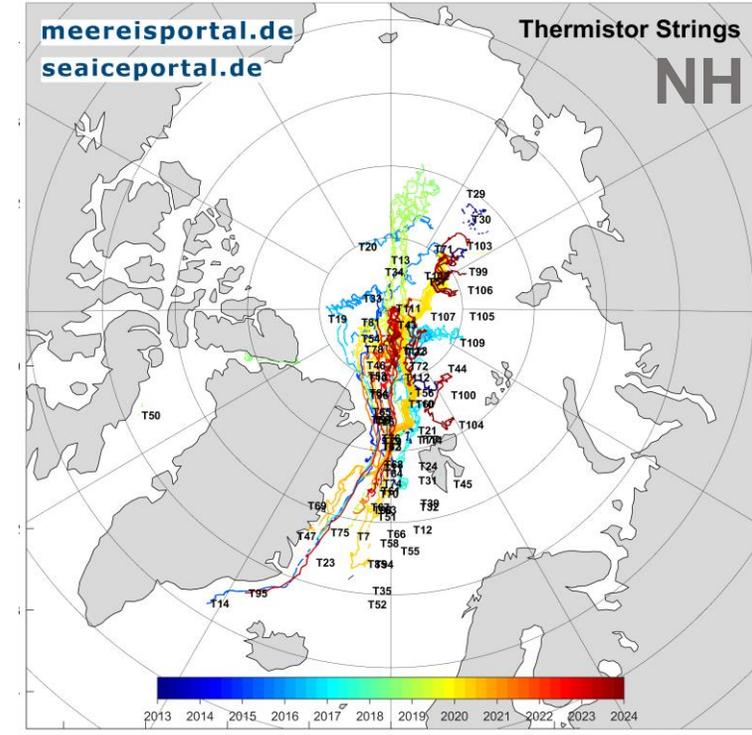
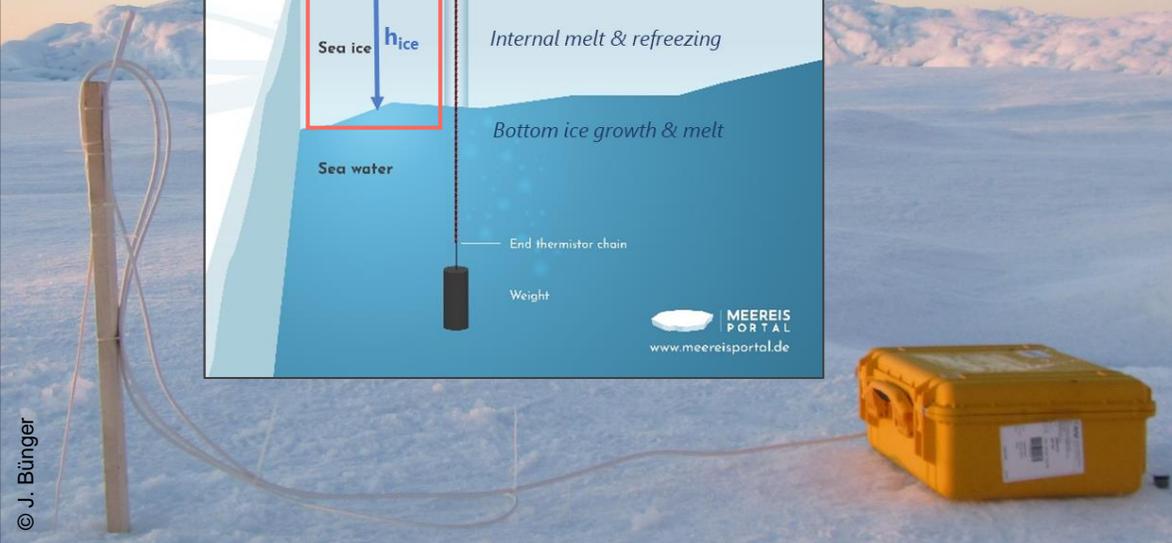
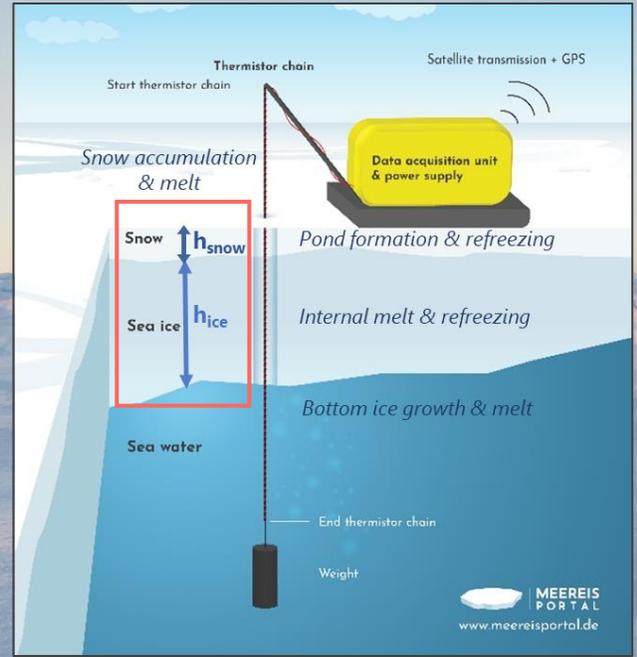
Nicolaus et al. (2022) - DOI:10.1525/elementa.2021.000046.f4



- **Thickness & temperature of sea ice & snow:** Central to many physical, chemical & biological processes
- **Spatial and temporal (scale-)differences** in sea ice observations
- **Autonomous systems** crucial for bridging in-situ observation gaps, data provision for validation exercises & process studies

SIMBA / thermistor buoys

SIMBA = Snow Ice Mass Balance Apparatus



SIMBA buoy archive at AWI (data.seaiceportal.de)

- > 100 buoys deployed/archived
- 2012 – 2023
- NH & SH (majority Arctic; incl. MOSAiC)
- Drift, temperature & heating temperature data
- No consistent thickness data until recently

SIMBA data as part of the EU-funded Arctic PASSION project (WP1)

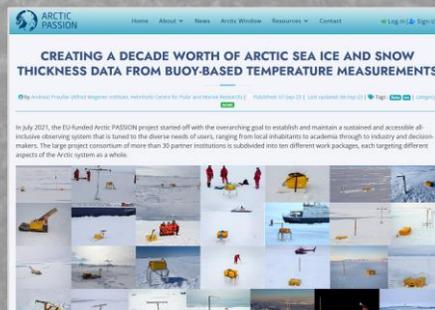
“Enhancing instrumentation & data analysis”

Main goals:

Develop a **uniform processing scheme for SIMBA** to minimize methodological ambiguities in the derivation of **snow-ice-ocean interfaces**

Create a **SIMBA data set with added value** in terms of **characterizing the sea ice mass balance**

Assess the **interannual variability** of SIMBA measurements through **analyzing decadal changes & linkages to large-scale observations**



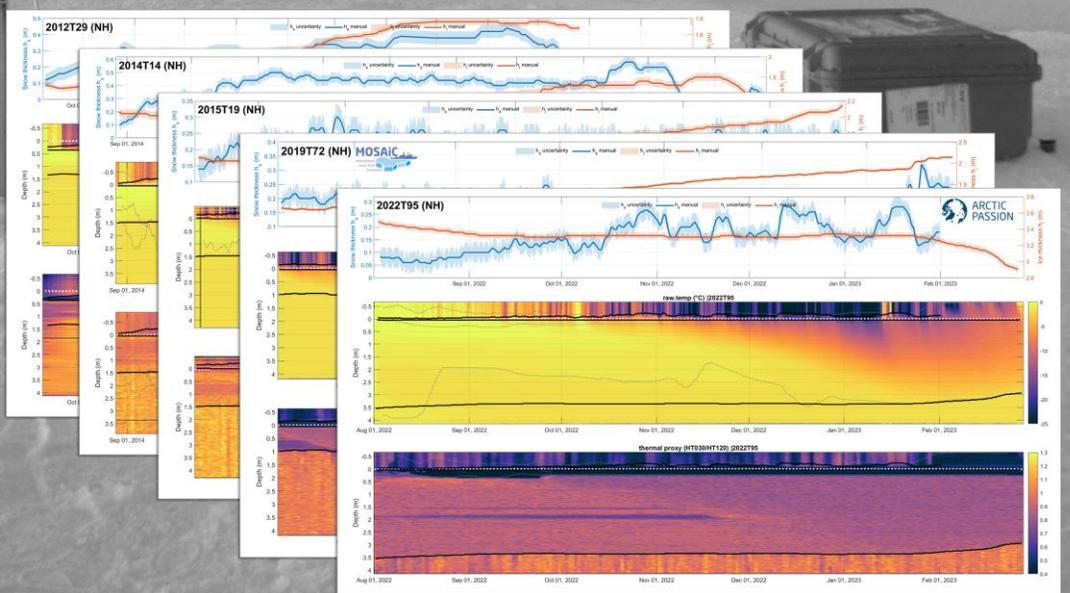
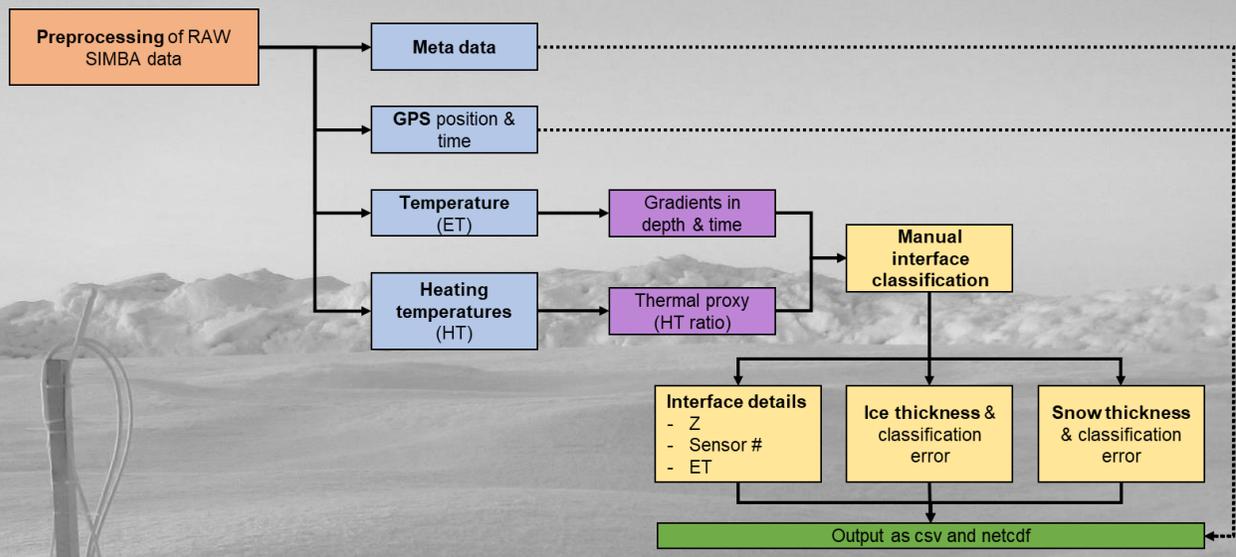
www.arcticpassion.eu
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ARCTIC PASSION

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SIMBA processing & status of dataset



78 buoys processed for NH & SH
(deployments up to 2022)

Timeseries of ice & snow thickness, interface positions & temperatures
(+ supplementary drift & buoy parameters)

Interface detection most challenging & critical point

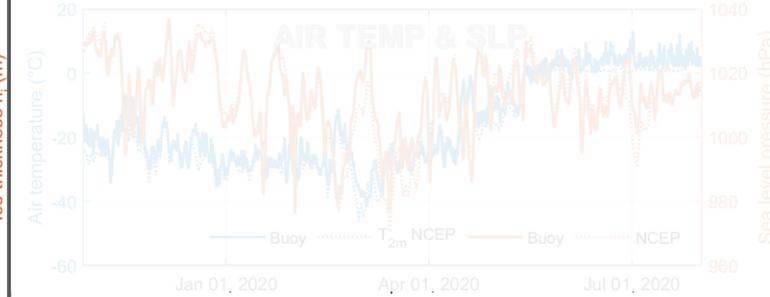
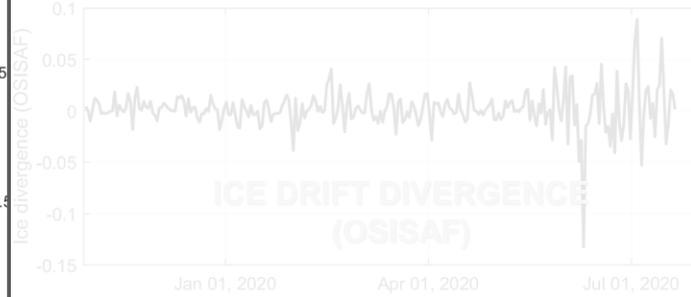
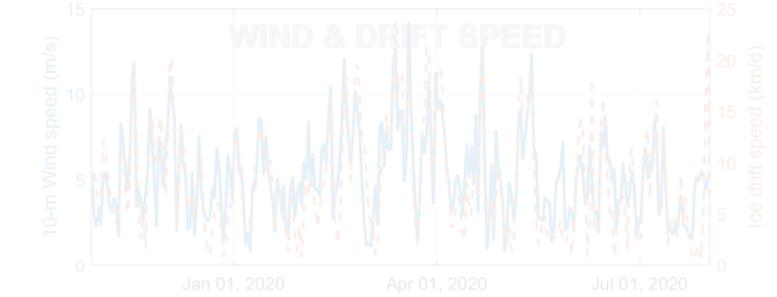
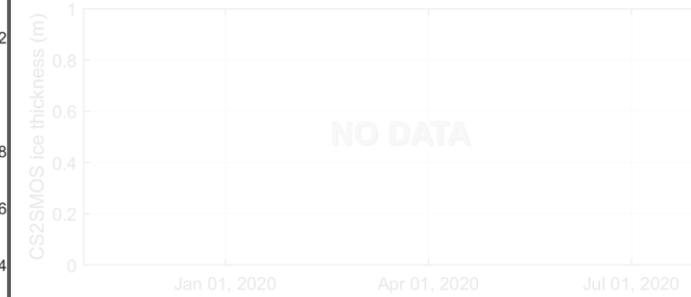
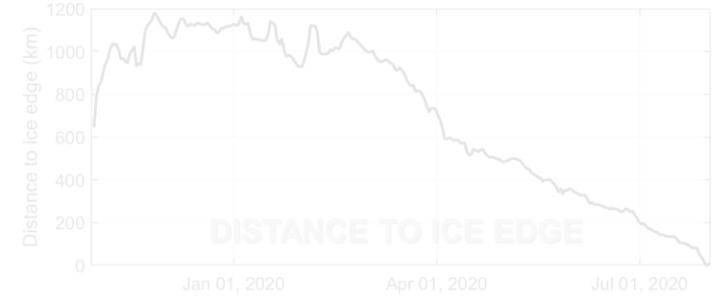
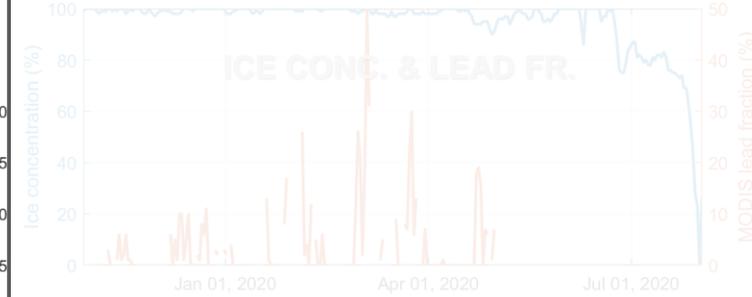
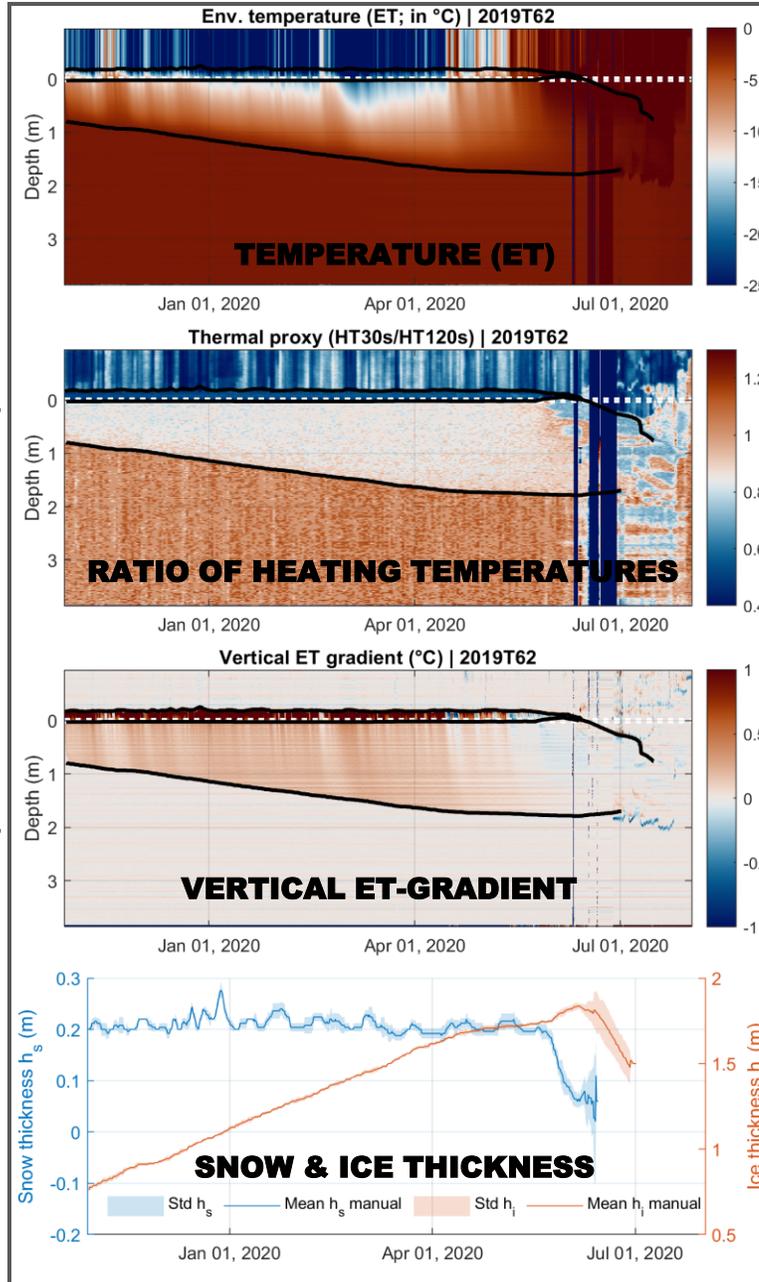
(classification error between 2-8 cm for chain with 2 cm sensor spacing)

Submission to Pangaea underway



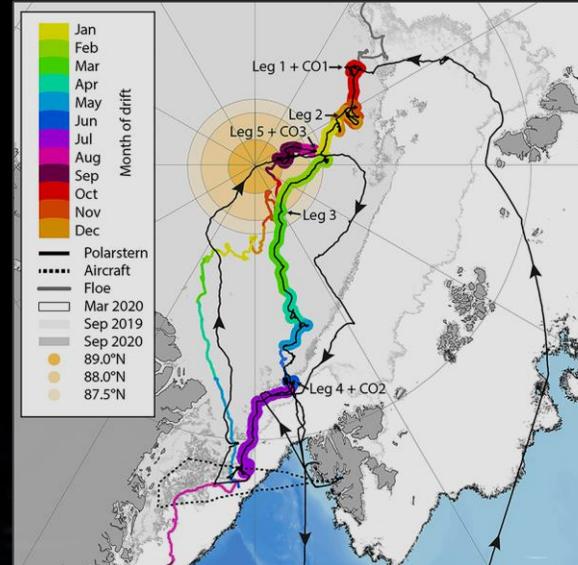
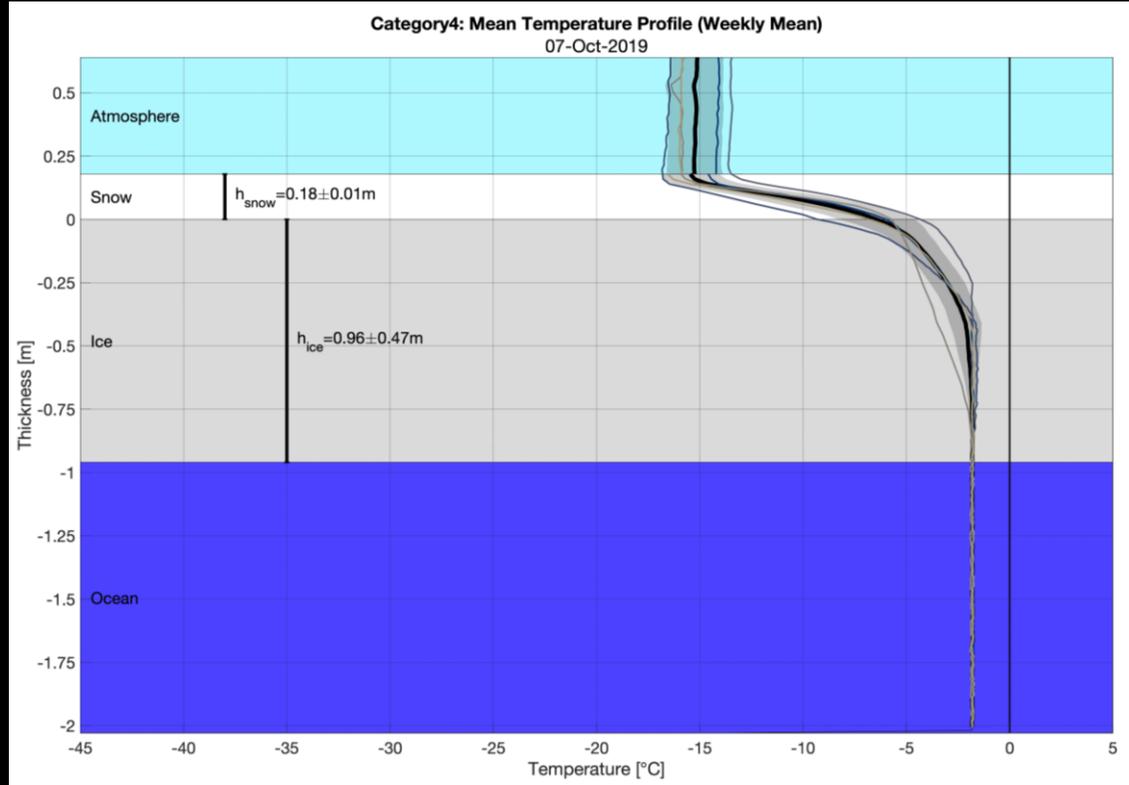
Derived thickness estimates & auxiliary drift parameters

SIMBA BUOY (here: 2019T62)



Seasonal thickness & temperature evolution during MOSAic

Array of SIMBA buoys drifting between Autumn 2019 and Spring 2021



Nicolaus et al. (2022) – DOI: 10.1525/elementa.2021.000046

Annual cycle of **vertical temperature gradients** well captured (nearly continuous)

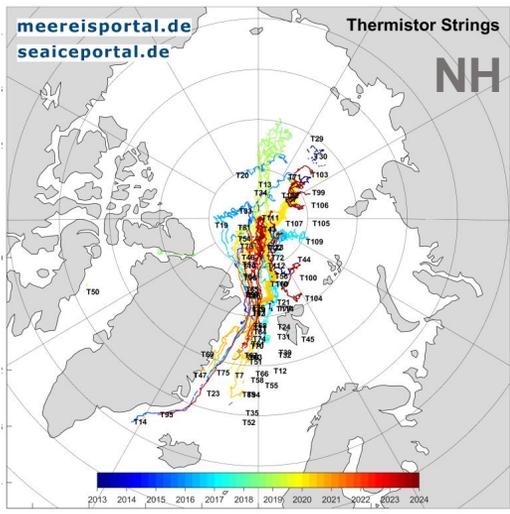
Gradients evolve in concert with **snow & ice thickness variations**



Mass balance variability from SIMBA buoys

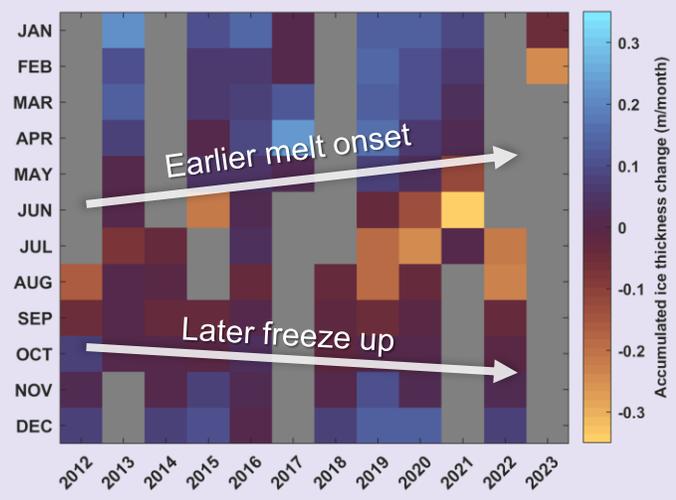
2012-2023

Transpolar drift



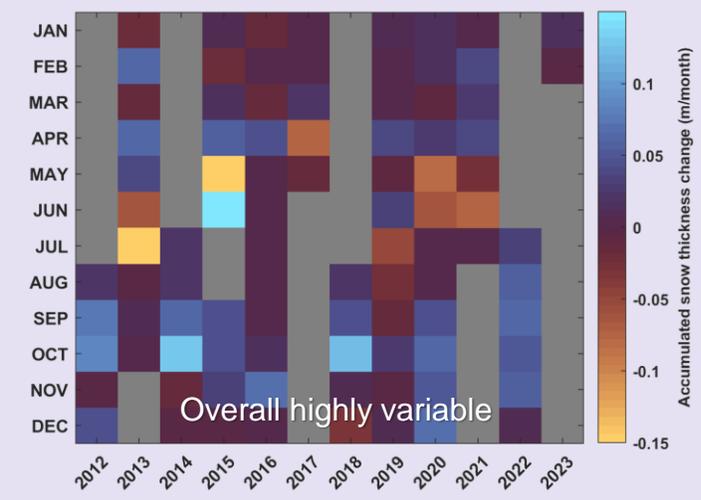
Total change of ice / snow thickness

Ice thickness change (m/month)

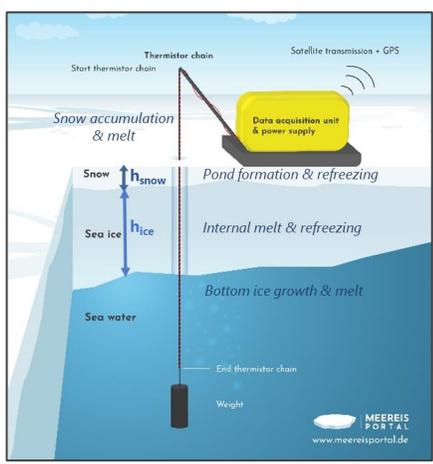


[all drifting NH buoys; N = 59]

Snow thickness change (m/month)

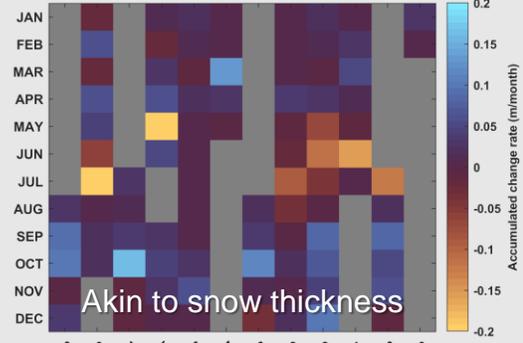


[all drifting NH buoys; N = 59]

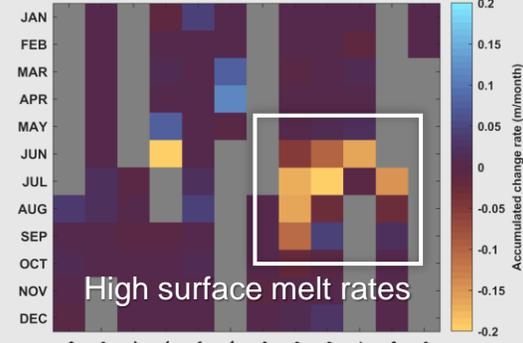


Change of interface heights

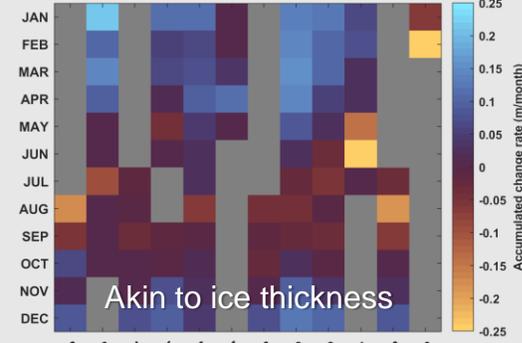
Atm-Snow IF change (m/month)



Snow-Ice IF change (m/month)



Ice-Ocean IF change (m/month)

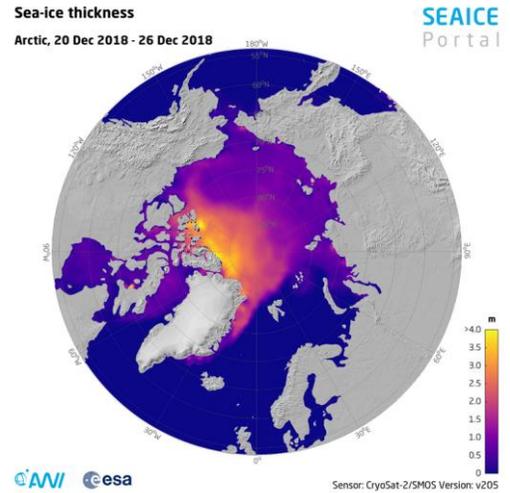


Surface (snow/ice) growth or melt

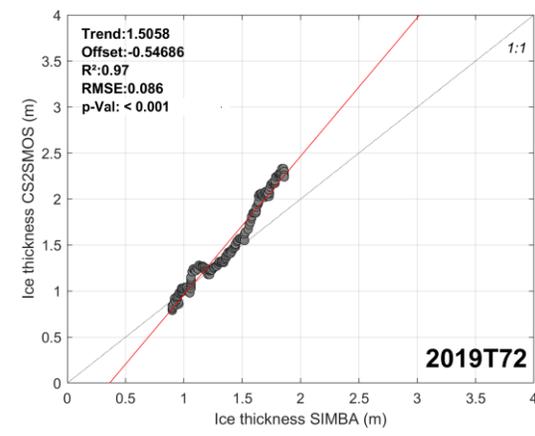
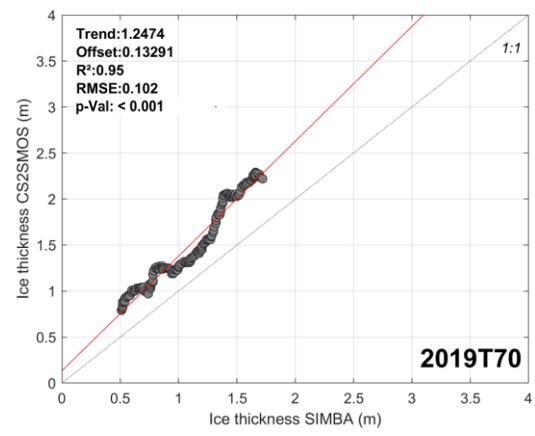
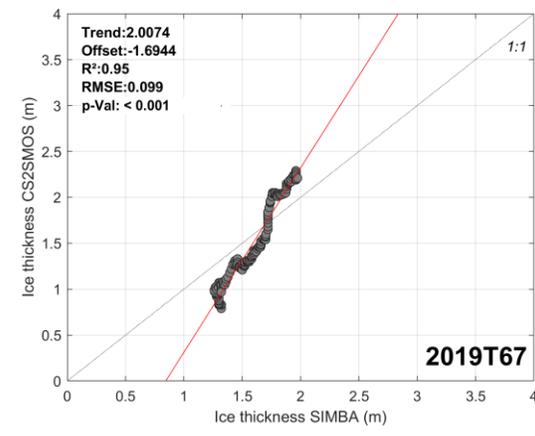
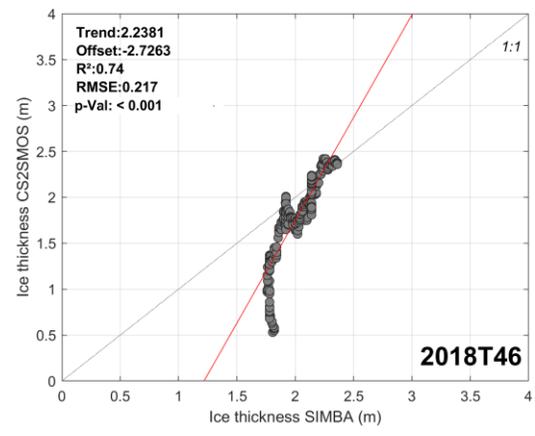
Bottom ice growth or melt

→ Bottom growth & melt *usually* dominating ice thickness evolution

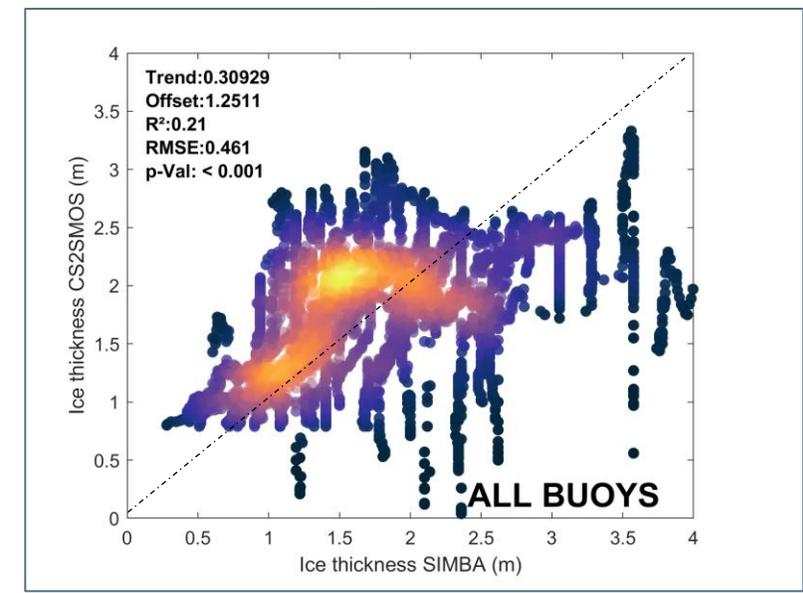
Satellite perspective - SIMBA vs. CS2SMOS



Single buoys



All SIMBA buoys (NH; 2012 - 2023)



→ Even more rigorous artefact-screening could lead to further improvement

Note: point measurements vs. areal integral (25 x 25 km²)

→ Question of representativeness remains challenging, but in that regard many well chosen deployment sites

Summary & look-ahead



SIMBA ice & snow thickness

- **New thickness data set** spanning > 10 years of buoy data
- Retrieved information allows for **long-term analysis of the local sea ice mass balance**
- **Satellite comparisons** point to a number of **representative deployment sites**
- **Interface positions & temperatures** useful to **support validation exercises** for remote sensing & modelling

Upcoming

- **Short IMB workshop** at the 3rd MOSAiC Science Conference 2024 in Potsdam, Germany
- **AWI sea ice portal**: addition of extended buoy-related information planned



Thank you for listening! Any questions?



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