Seasonality of snow depth on Weddell sea Sea ice from observations and simulations

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Introduction

Snow on Antarctic sea ice has tremendous impacts on Albedo, light transmission and sea ice mass balance. Snow Buoys (Nicolaus et al., 2021) measure snow accumulation over time with four ultra sonic sensors. Here we present 14 Snow Buoys which were deployed in the Weddell Sea since 2013. These snow surface height measurements are coupled with the 1D SNOWPACK Sea ice version model (Wever et al. 2020) in order to retreave snow pack processes, which are not detactable from the surface.

Snow ice formation is a major process on Antarctic sea ice is, when the snow pack is flooded by sea water and refreezes. This changes the snow and sea ice mass balance. Here we present the effect on snow cover depth depending on season.

Method

The SNOWPACK model is forced by the Snow Buoy (available from www.meereisportal.de, Grosfeld et al., 2016) snow surface height measurements. The atmospheric foricing (along the Snow buoy trajectoires, see figure 1) is provided by the ERA5 reanalysis product from the European Centre for Medium-Range Weather Forecasts.

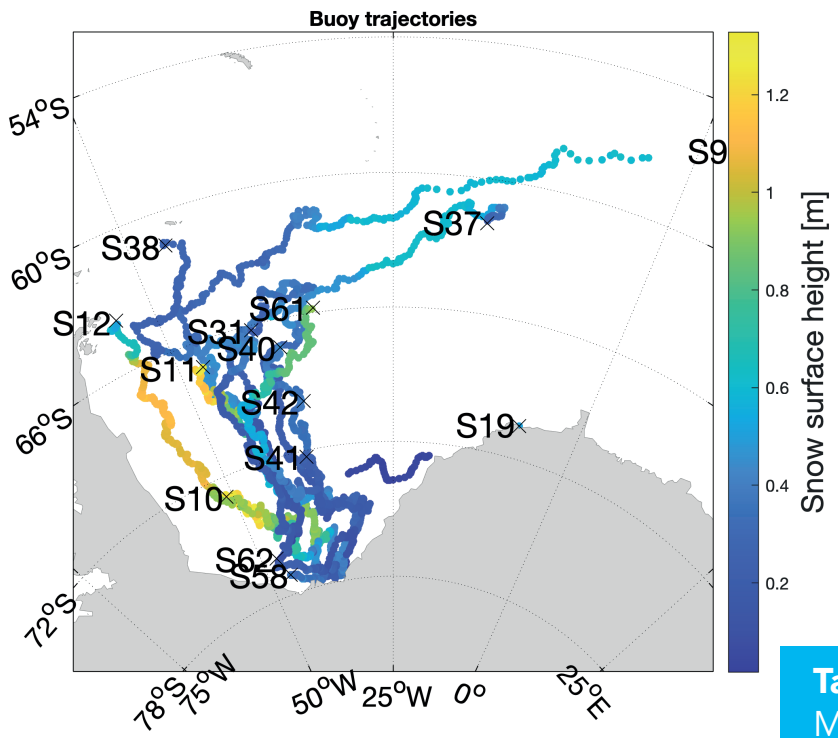
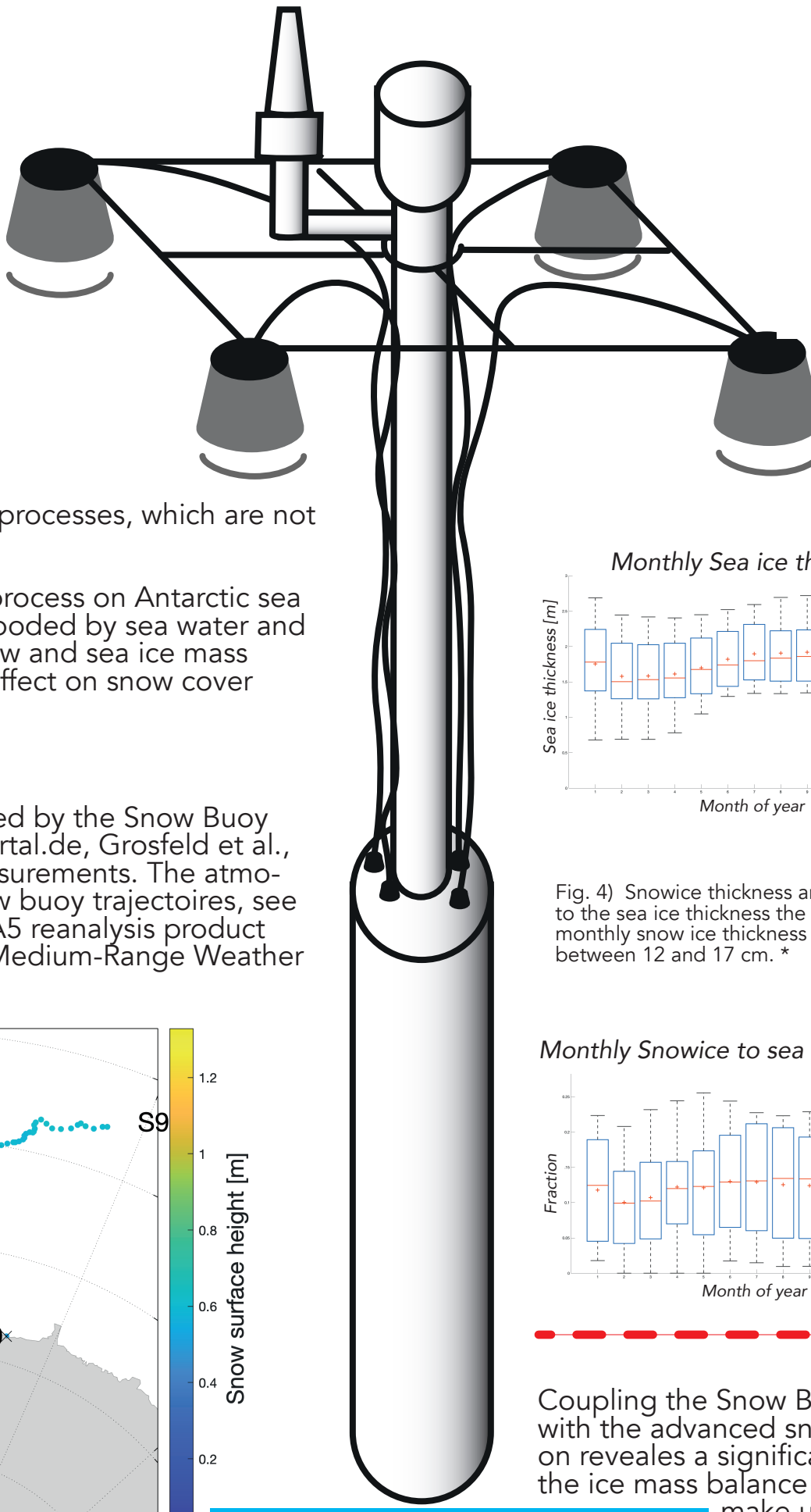


Figure 1. Snow Buoy trajectories. The SXX number is the abbrivation of the Snow Buoys name (e.g. 2014S12 shown as S12) at the corresponding end point. The color coding reflects the snow surface height measurement from the Buoy.



Results

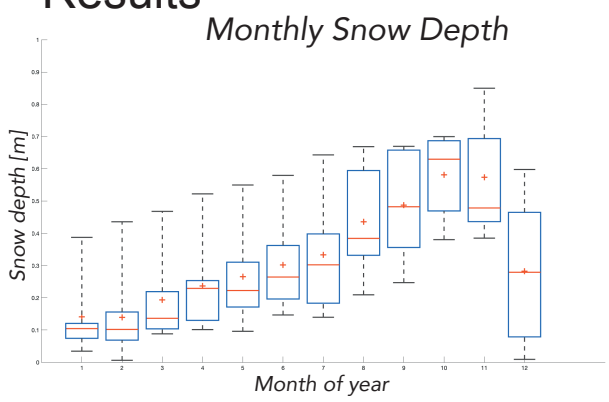


Fig. 2) Snow depth variation derived from 14 Snow Buoys arranged by months for an ocean heat flux of 4 Wm^{-2}.* The monthly snow depth distribution shows highest values are during Oct – Nov. The snow depth does not exceed 80 cm for extrem and 40 cm as mean value.
*The red cross and line represent the mean and median snow depth (respectively). Within the blue box are the 25th and 75th percentiles.

Fig. 3) Monthly sea ice thickness shows a thickness between 1.5 and 1.75 m.* This includes ice from the ocean as well as meteoric ice formation (either via snowice formation or melted and refrozen snow)

Fig. 4) Snowice thickness are similar to the sea ice thickness the mean monthly snow ice thickness lies between 12 and 17 cm. *

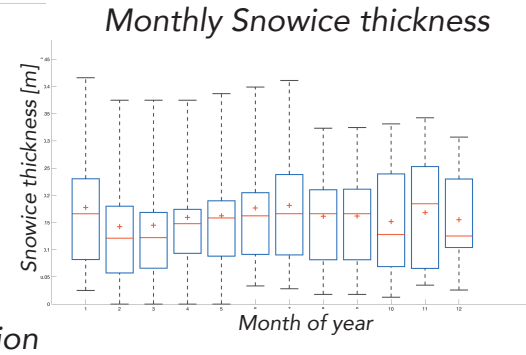


Fig. 5) The mean fraction between snowice to sea ice varies around 10% with maximum values up to 25%. There is a constant snow ice layer on Antarctic sea ice due to the sufficient snow load on the sea ice floes.*

Conclusion

Coupling the Snow Buoy surface height measurements with the advanced snow model SNOWPACK Sea ice version reveales a significant contribution of the snow cover to the ice mass balance via snow ice formation. This can make up to 25% of the sea ice mass. The model reveales mean snow depth does not exceed 40 +/- 10 cm during the year. Snow ice formation counter acts basal ice melt and restricts the maximum snow depth.

Take home message:
Mean Snow depth on Antarctic sea ice does not exceed 40 +/-10 cm. All further snow load is converted into snowice.

Reference
Grosfeld et al. (2016) Online sea-ice knowledge and data platform <www.meereisportal.de>, Polarforschung, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research & German Society of Polar Research, 85 (2), 143-155, doi:10.2312/polfor.2016.011
Nicolaus et al.(2021) Snow Depth and Air Temperature Seasonality on Sea Ice Derived From Snow Buoy Measurements.Frontiers in Marine Science, doi:10.3389/fmars.2021.655446
Wever et al.(2020) Version 1 of a sea ice module for the physics-based, detailed, multi-layer SNOWPACK model.Geoscientific Model Development. doi:10.5194/gmd-13-99-2020

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