Contact:
Mario.Hoppmann@awi.de

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Mario Hoppmann[1], Marcel Nicolaus[1], Priska Hunkeler[1], Stephan Paul[2], Olaf Boebel[1]

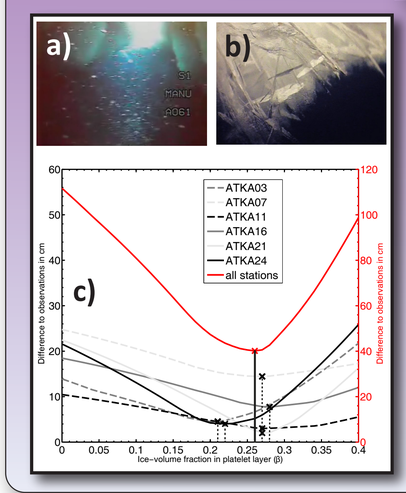
Ice shelf - Sea Ice Interaction: A Case Study

[1] Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meersforschung, Bremerhaven, Germany;
[2] Department of Environmental Meteorology, University of Trier, 54296 Trier, Germany;

Summary

- Here we present results from our investigation on the influence of the **Ekström Ice Shelf** on the **land-fast sea ice of Atka Bay**, eastern Weddell Sea.
- **Ice platelets** emerge from the cavity and interact with the fast-ice of Atka Bay as early as June. **Episodic accumulations** throughout the winter lead to an average **platelet-layer thickness of 4 m** in December, with local extrema of 10 m.
- **Additional buoyancy** prevents surface flooding and snow-ice formation despite thick -now cover.
- The seasonal cycle shows a **maximum thickness in December**, and a subsequent thinning, which is associated with an inflow of warm water masses.
- The combination of model studies with observed fast-ice thickness reveals an average **ice-volume fraction of the platelet layer of 0.26.**
- Half of the combined solid sea-ice and ice-platelet volume in this area is generated by **heat loss to the ocean** rather than to the atmosphere, equivalent to more than **one fifth of the annual basal melt volume** under the Ekström Ice Shelf.

Platelet layer



a) Ice platelets rise up from depth to accumulate below the fast-ice cover. Episodic events of high platelet fluxes overlay a low continuous flux.

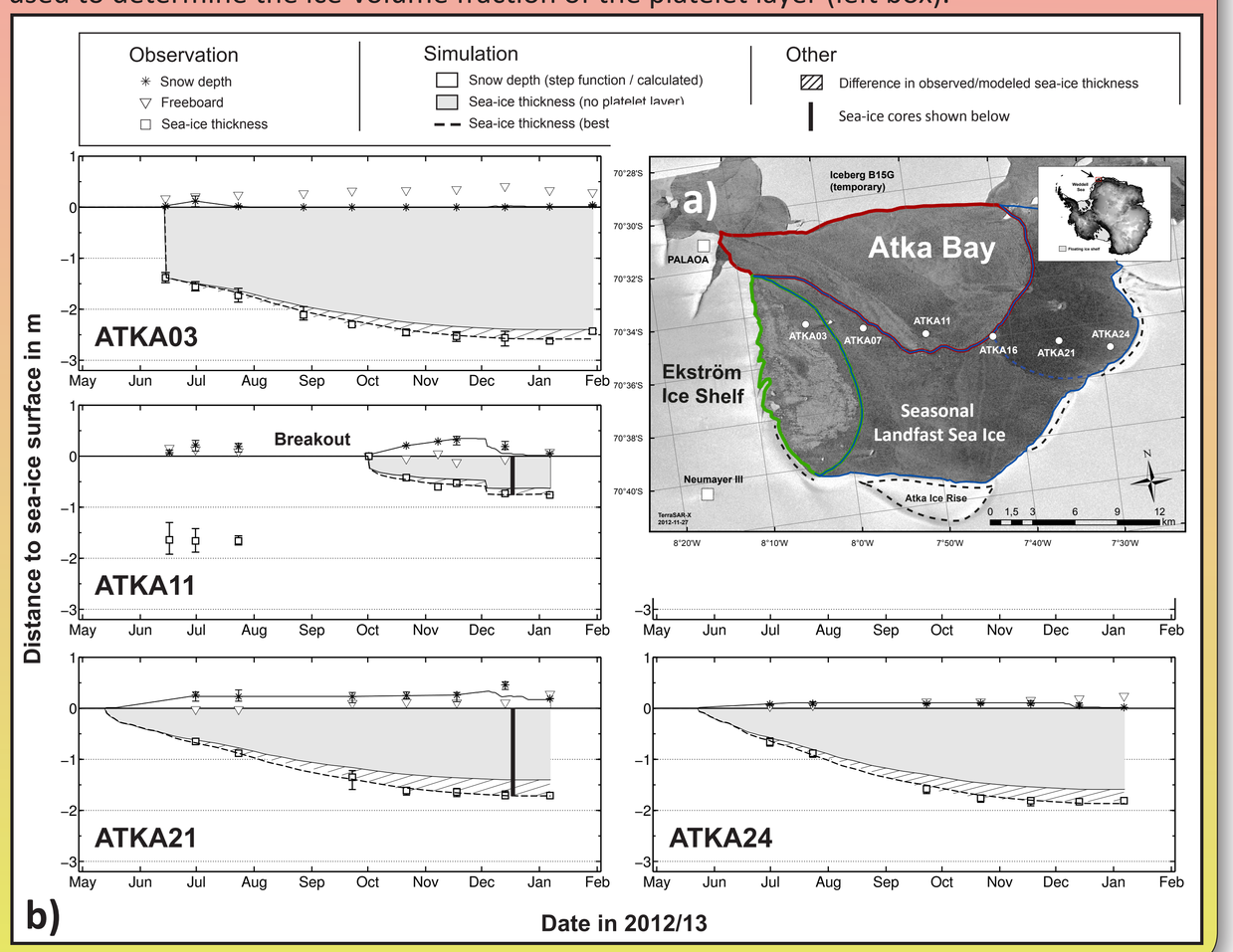
b) Crystals of variable sizes are intertwined in a porous matrix (platelet layer).

c) The ice-volume fraction of the platelet layer (β) is important for the energy and mass balance, and influences the sea-ice thickness retrieval by remote sensing methods. Comparison between model simulations and observations at Atka Bay yielded β = 0.26 (0.21 to 0.28).

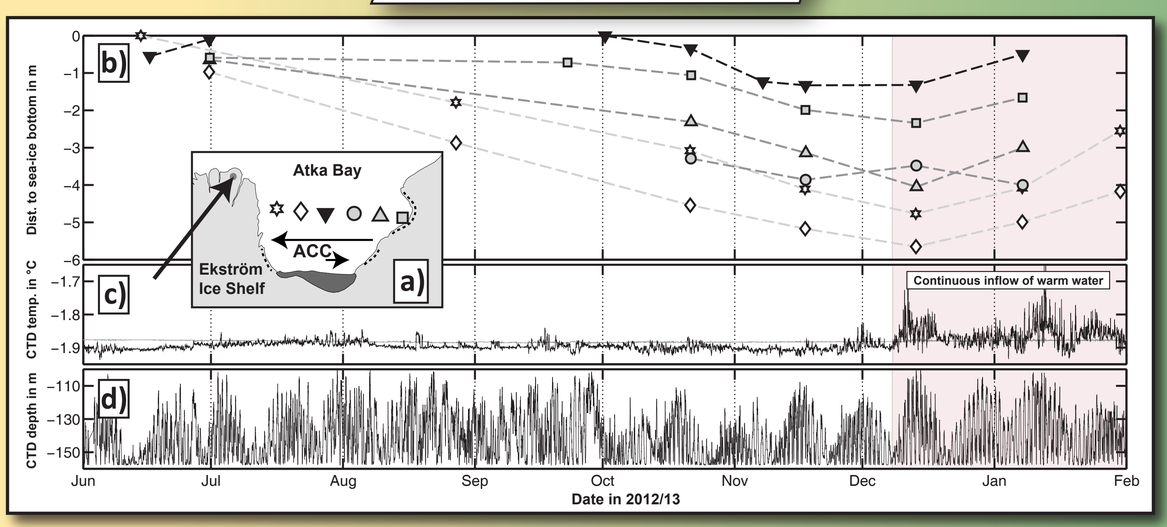
Sea-ice growth

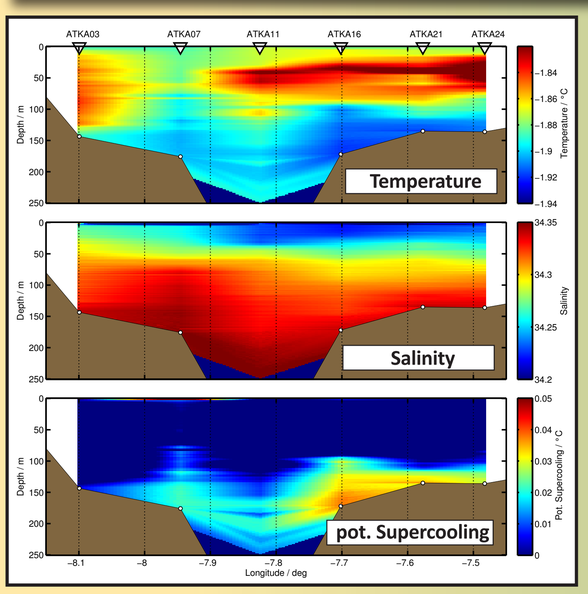
a) TerraSAR-X image of the **study area**. Seasonal sea ice (grey) is fastened to the Ekström Ice Shelf (white). Colors indicate different sea-ice types observed in 2012 (green: uneven first/second year ice, red: new ice, blue: level first-year ice).

b) Annual cycle of measured sea-ice properties at Atka Bay in 2012/13 (symbols). Growth simulations driven by meteorological data from the nearby Neumayer station (filled areas) are used to determine the ice-volume fraction of the platelet layer (left box).



Oceanography

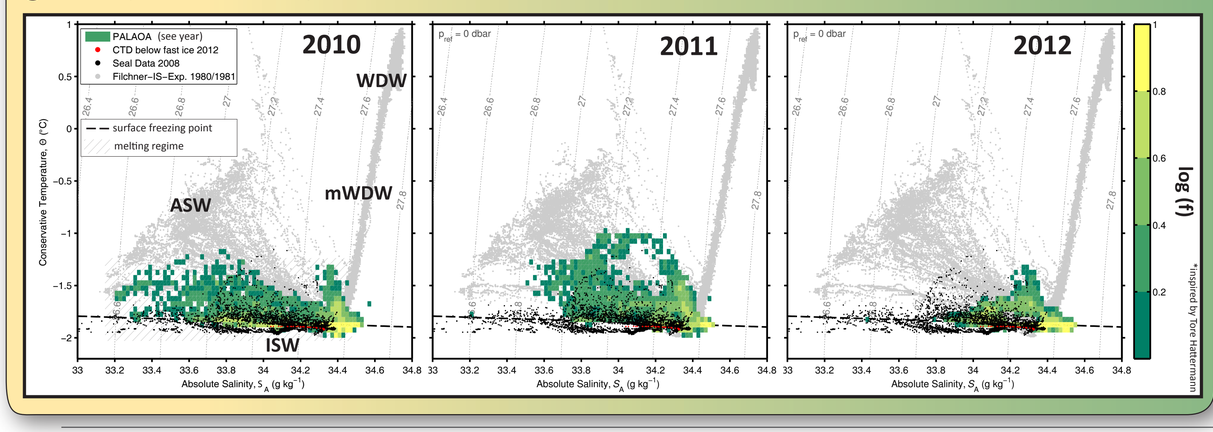




Top: Annual cycle of platelet-layer thicknesses (b) at sites indicated on the map (a). Water temperatures (c) recorded by a CTD under the Ekström Ice Shelf at depth (d) reveal that warmer water penetrates the cavity and also leads to a thinning of the platelet layer below the fast ice.

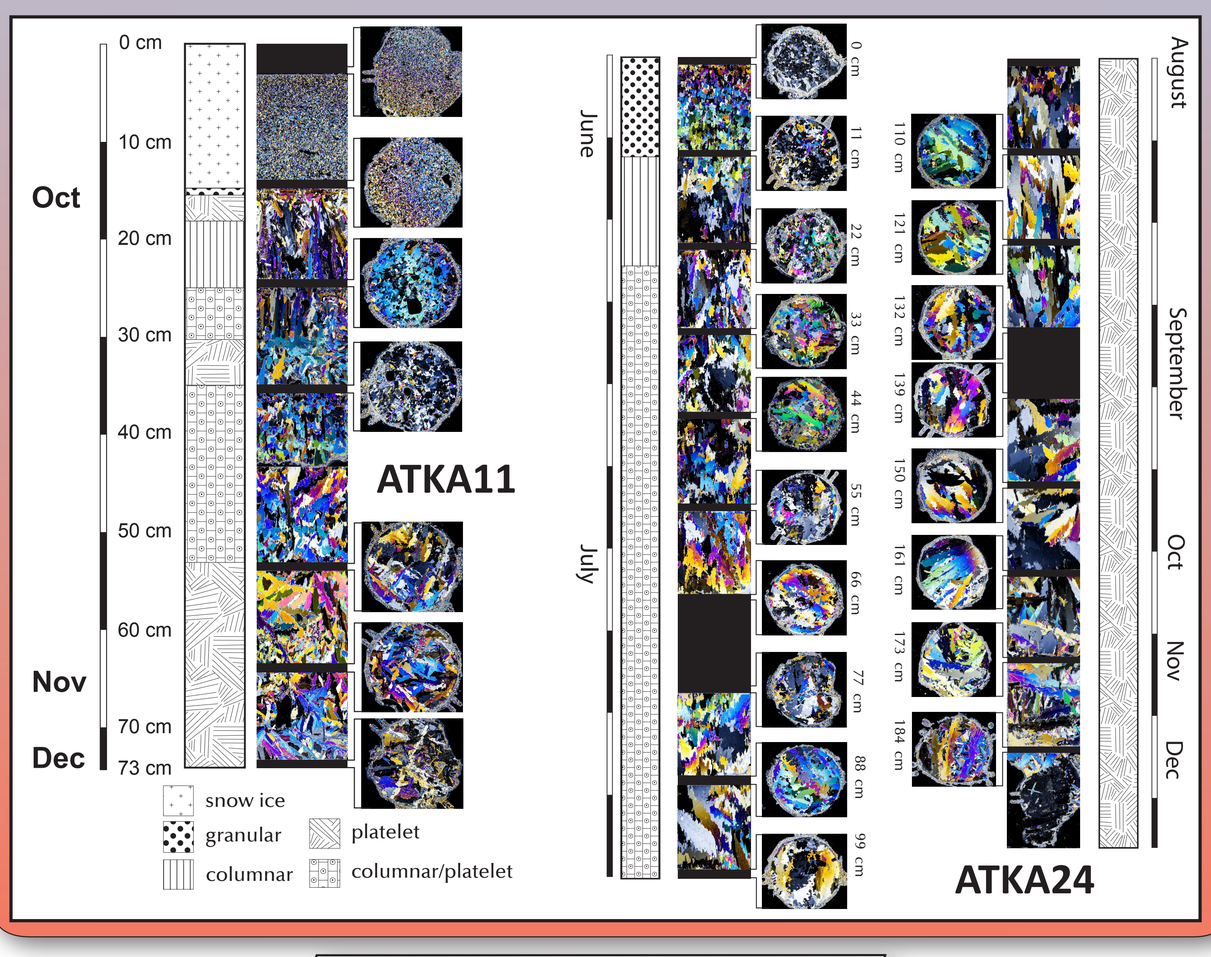
Left: Cross section of Atka Bay with data from 6 CTD profiles (19 December 2012). A plume of warm Antarctic surface water is penetrating Atka Bay from the east, which leads to melting of sea ice.

Bottom: T-S diagrams of sub-ice-shelf water masses recorded by a CTD between 2006 and 2012 (colored). Typical water masses in the eastern Weddell Sea are plotted in the background (WDW: Weddell Deep Water, mWDW: modified WDW, ASW: Antarctic Surface Water, ISW: Ice-Shelf Water).



Sea-ice structure

Thin sections between crossed polarizers reveal the **sea-ice structure and growth history**. The cores shown below were retrieved on 19 Dec 2012 at two study sites at Atka Bay. Nearly the entire growth history was at least partly influenced by larger ice platelets. The **incorporated, blade-shaped crystals** are best visible in the lower parts of the cores.



Conclusions & Outlook

- **Fast-ice mass balance and structure in the eastern Weddell sea is heavily influenced by ice shelves.**
- **At the same time, fast ice provides a valuable source of information about sub ice-shelf processes.**
- **More information about oceanographic conditions is needed to understand the seasonality and spatial variability of ice-platelet occurence in the eastern Weddell Sea. This work is ongoing.**
- **More efficient methods are needed to determine platelet-layer properties on a larger scale. A promising approach using use a multifrequency EM instrument is presented by Hunkeler et al., submitted.**

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References
Hunkeler, P. A., S. Hendricks, M. Hoppmann, S. Paul (submitted), „Towards an improved estimation of sea-ice thickness with multi-frequency induction sounding", Annals of Glaciology