The Influence of Platelet Ice and Snow on Antarctic Landfast Sea Ice

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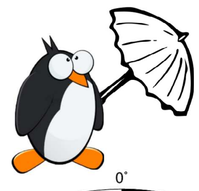
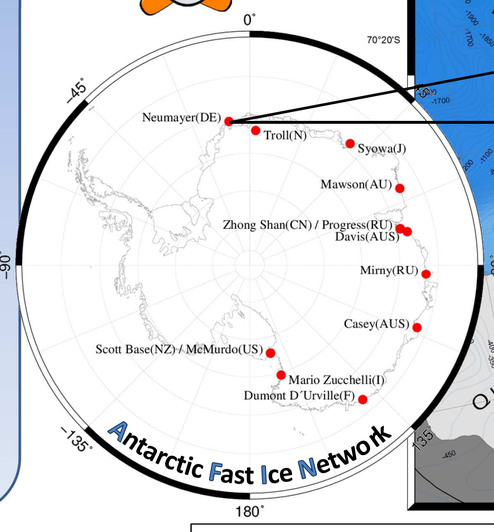
Introduction

Sea ice fastened to coasts, icebergs and ice shelves is of crucial importance for **climate- and ecosystems**. Near Antarctic ice shelves, this landfast sea ice exhibits two unique characteristics that distinguish it from most other sea ice:

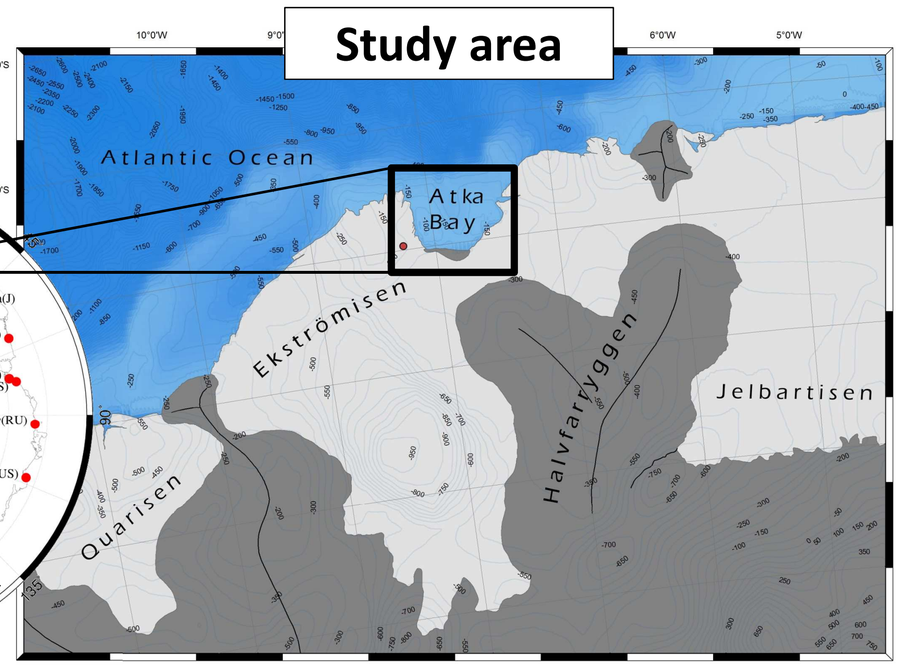
1. Ice **Platelets** form and grow in super-cooled water, which originates from ice shelf cavities. These crystals accumulate beneath the solid sea-ice cover and are incorporated into the sea-ice fabric as **platelet**. This **ice** special type of sea ice contributes significantly to the total mass of Antarctic landfast sea ice.
2. A thick and partly multi-year **snow cover** accumulates on the fast ice, altering the sea-ice surface and affecting the **sea-ice energy and mass balance**.

In order to investigate the role of platelet ice and snow for the mass balance of Antarctic fast ice, we perform **regular field measurements** on the landfast sea ice of Atka Bay as part of the international Antarctic Fast Ice Network (AFIN). Here we present the results of our observations in 2010 and 2011.



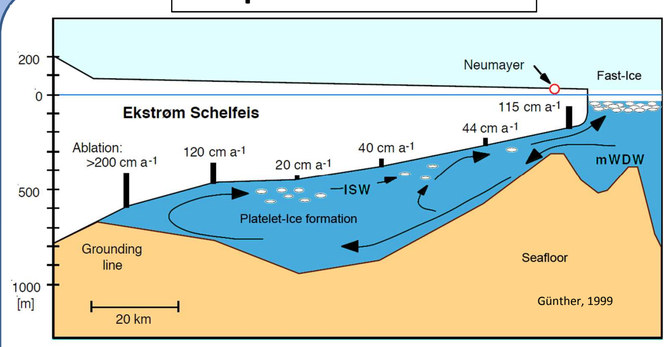


Study area



A platelet puᶻzle in Antarctica

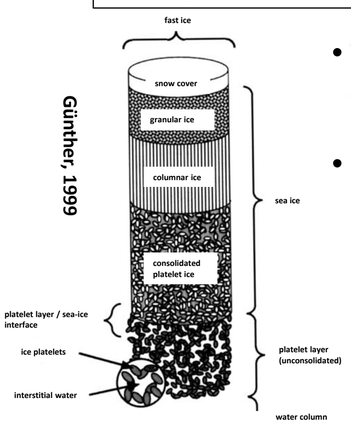
Ice platelet formation



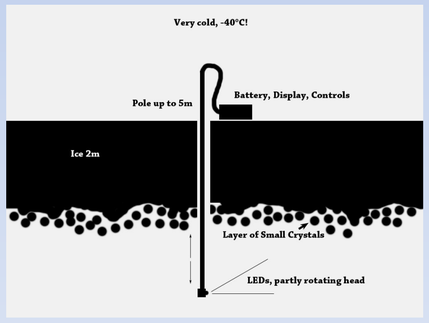
Interaction of ocean with base of ice shelf leads to **supercooled water masses**, where ice platelets form, rise and accumulate below landfast ice.

How to measure?

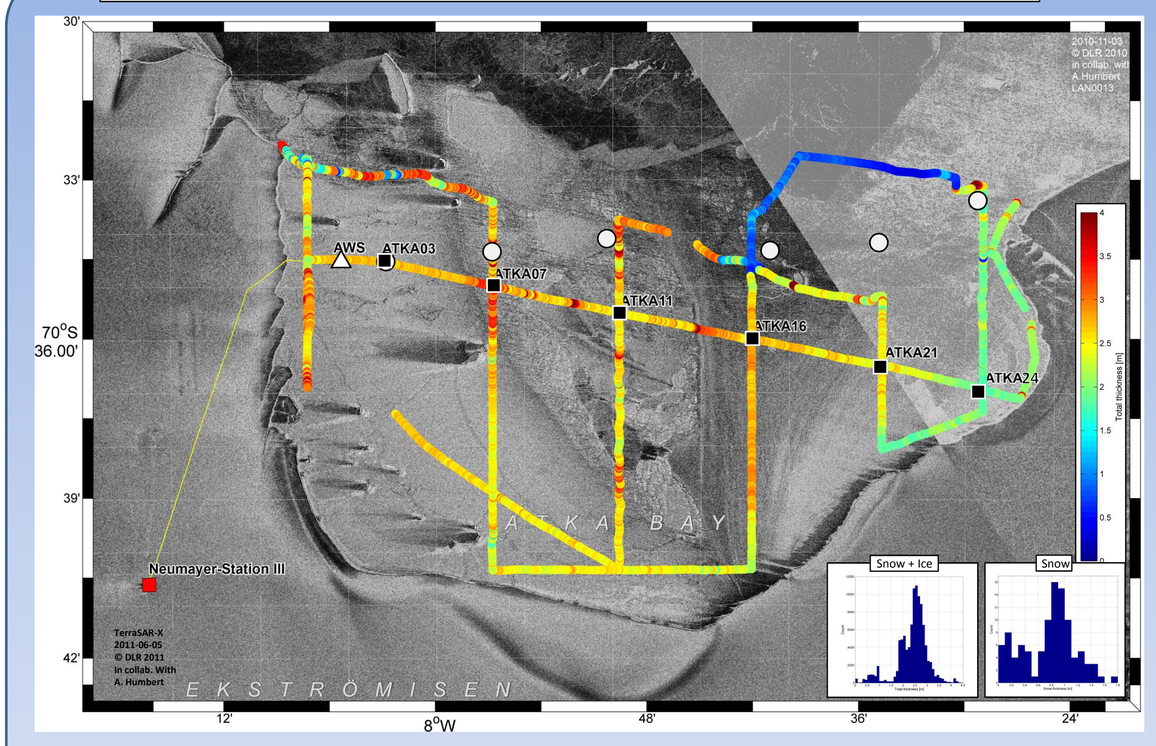
Sample ice core from Atka Bay



- Platelet ice accounts for more than 60 % of total sea-ice mass
- Two different layers: consolidated platelet ice (frozen into the structure) and unconsolidated platelet layer below the solid sea ice

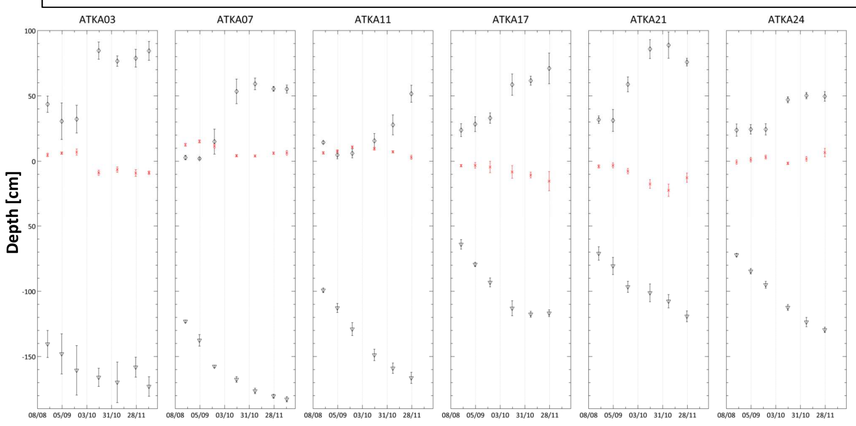


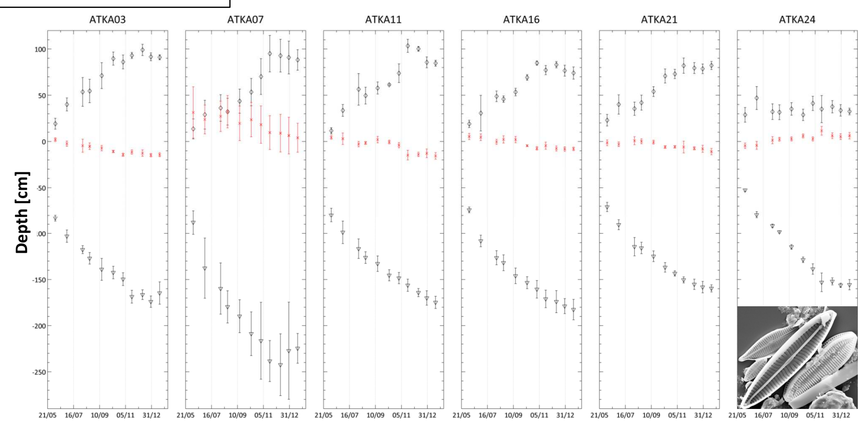
Atka Bay landfast sea ice & snow cover



Top: TerraSAR-X image of Atka Bay with stations in 2010 (white) and 2011 (black), where regular **manual thickness measurements** took place. Station names (e.g. ATKA03) refer to the distance to the western ice-shelf edge. The profile was relocated in 2011 in order to reduce the likeliness of an early ice break-up at ATKA07 as in 2010.
In 2011, an automatic **weather station** and a **thermistor chain** were deployed between ATKA03 and the ice-shelf edge. The colored circles show **electromagnetic thickness measurements** in Nov/Dec 2011. Snow thickness was measured manually in parallel. The histograms depict snow and snow+sea-ice thickness distributions.

Results of manual drillings in 2010 and 2011



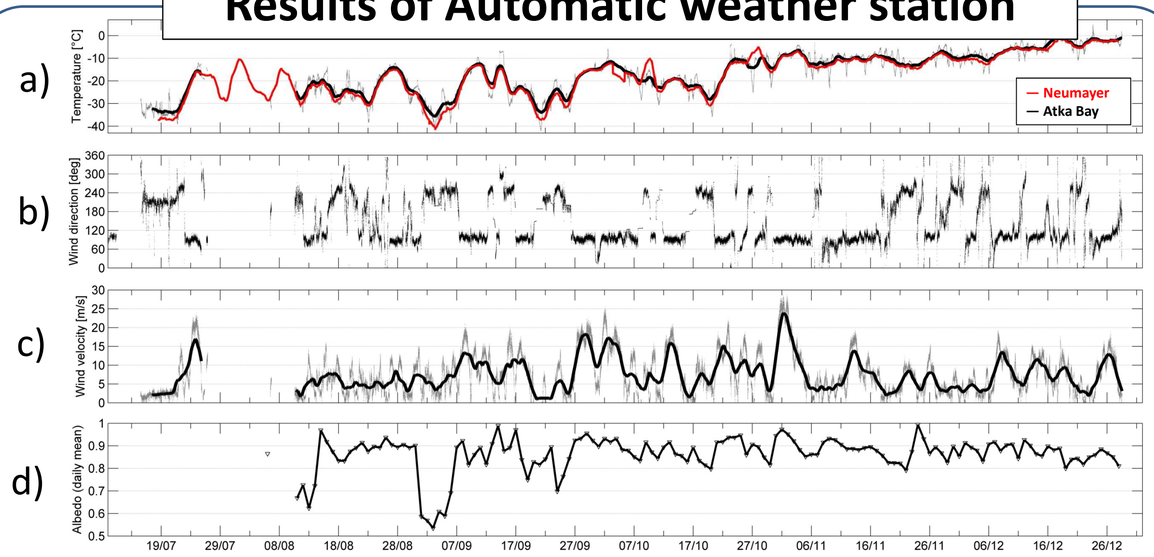


- Sea ice in the western part is generally thicker than in the East.
- Local variability is very high in the West
- Snow cover and Freeboard are heterogeneous
- Ice platelets are often observed in boreholes
- Diatom bloom at ATKA24

Possible explanations:

1. Differences in snow accumulation due to prevailing winds from the East
2. Differences in ocean currents (temperature, transport/formation of ice platelets)

Results of Automatic weather station



a) **Daily running mean of temperature in 2m** is on average 1.2°C higher on Atka Bay than at Neumayer
b) **Wind direction** measured on sea-ice gives evidence to frequent occurence of easterly winds (90°)
c) **Wind velocity** shows that winds from East are stronger than from other directions
d) **Daily mean of Albedo** varies between 0.5 and 1, while lower values occur earlier in the season

Summary and Perspective

- Ice platelets are often observed under Atka Bay fast ice
- The high variability of ice platelets strongly influences the fast-ice mass balance
- Platelet ice contributes significantly to sea-ice formation and processes
- Strong easterly winds lead to thicker sea ice and snow depth in the West
- Snow cover is very heterogeneous throughout the entire Bay
- Negative freeboard leads to extensive surface flooding
- Freezing model supports the observations and results from previous studies

- In 2012, additional autonomous observations of radiation and sea-ice mass balance will be added
- Extension of observational program through ice-thickness transects by EM methods and ice coring for texture analysis
- We will perform an additional field campaign in Nov/Dec 2012, including visual inspection of platelet layer, extensive snow transects (thickness & properties), and CTD profiles

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References: **[1] Hoppmann, M., Nicolaus, M., and Schmithüsen, H.:** doi:10.1594/PANGAEA.762681, 2011 **[2] Heil, P., Gerland, S., and Granskog, M. A.:** The Cryosphere Discuss., doi:10.5194/tcd-5-2437-2011 **[3] Günther , S., and Dieckmann , G.S.:** *Antarctic Science 11 (3): 305-315, 1999*