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

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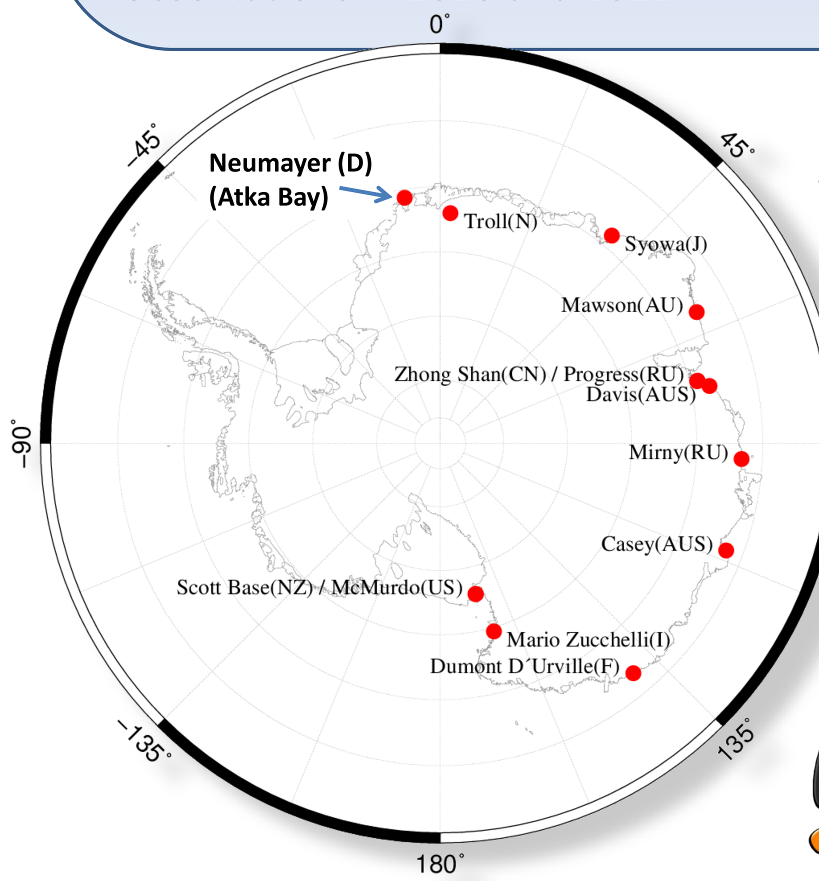
Introduction

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. The crystals accumulate beneath the solid sea-ice cover and are incorporated into the sea-ice fabric, contributing between 10 and 60% to the mass of the land-fast sea ice around Antarctica.
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 and the spatial and temporal variability of platelet ice and snow for Antarctic fast ice, we perform **regular field measurements** on the land-fast 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.



Antarctic Fast Ice Network

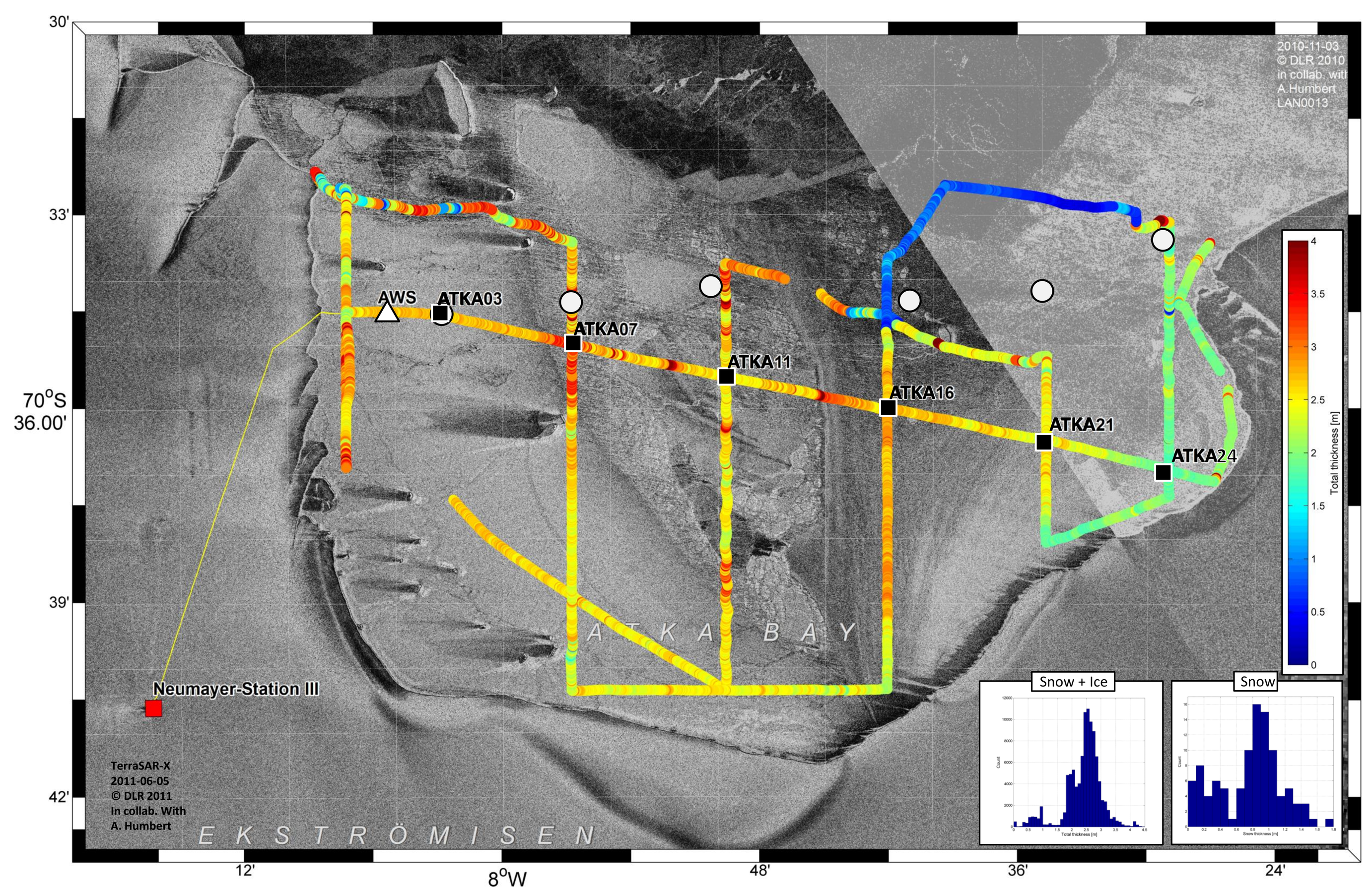
- **International network** of fast-ice monitoring stations around the Antarctic coastline, established in 2007 [Heil et al. 2011]
- Measurements include ice and snow thicknesses, freeboard, dates of fast-ice formation and (intermittent and final) breakout, as well as meteorological and oceanic parameters

Summary and Perspective

- Ice platelets are often observed under Atka Bay fast ice
- Platelet ice contributes significantly to sea-ice formation and processes
- The high variability of ice platelets strongly influences the spatial and temporal variability of fast-ice mass balance in Atka Bay
- Strong easterly winds lead to thicker sea ice and snow cover in the West with high local variability
- 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

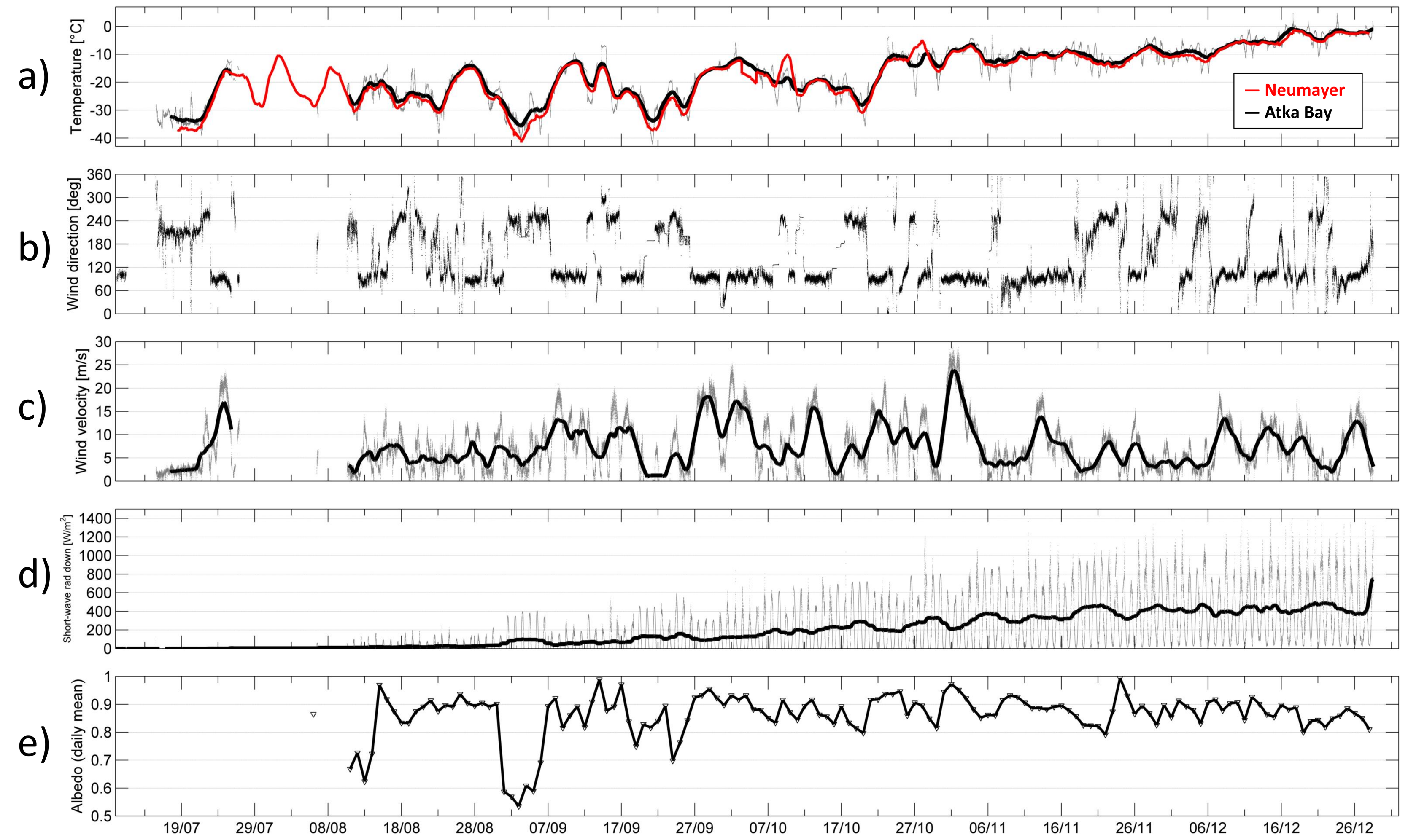
- In 2012, additional autonomous observations of radiation and sea-ice mass balance will be added
- Extension of observational program through ice-thickness transects by EM methods and ice coring for texture analysis
- We will perform an additional field campaign in Nov/Dec 2012, including visual inspection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

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.

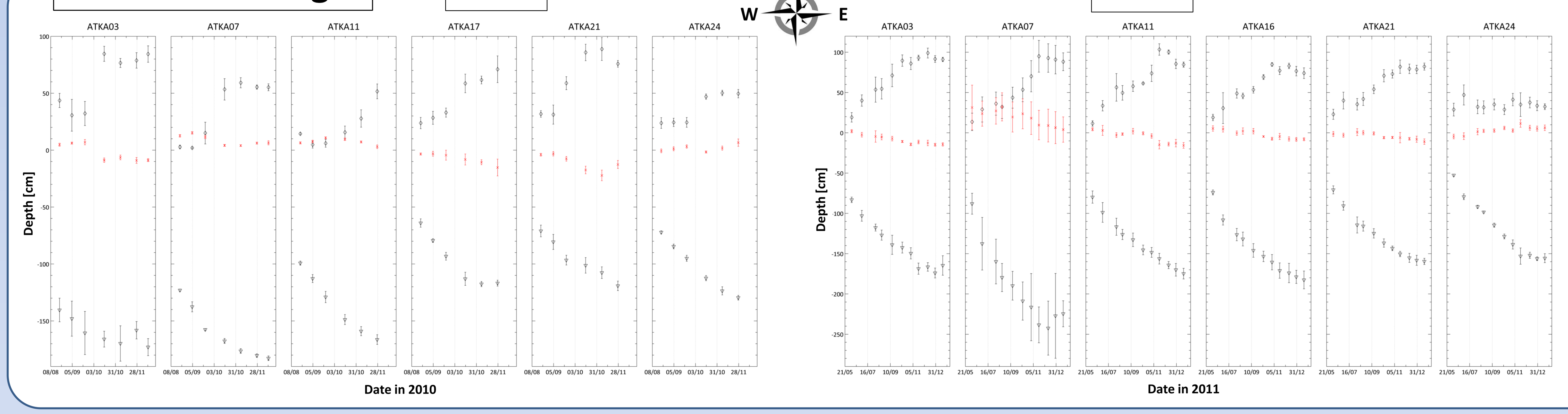
Automatic weather station



Top: data collected from automatic weather station on Atka Bay landfast sea ice

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

Manual drillings



Left: time series of drillings at the different stations

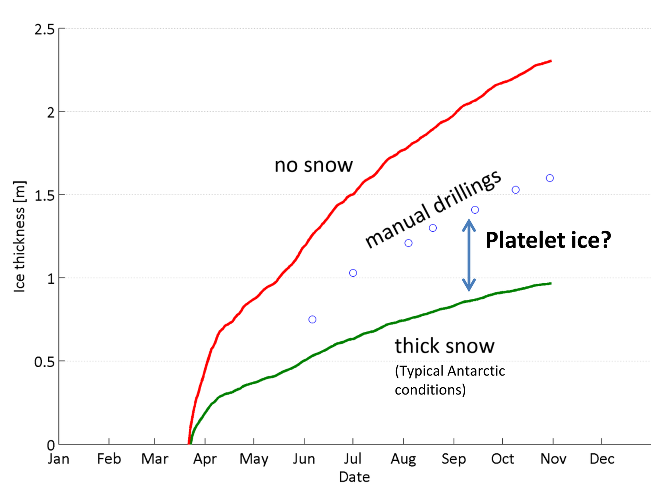
Observations:

- 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

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)

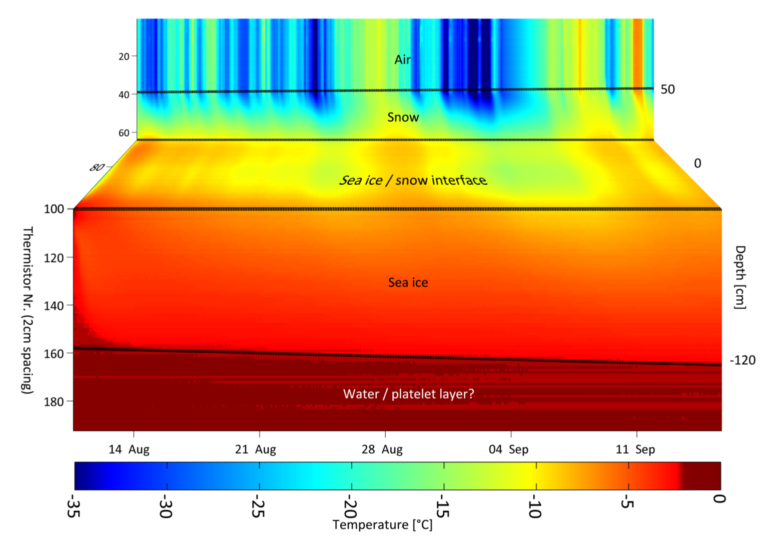
Thermodynamic growth model



A simple Freezing-Degree-Day model was applied to compare sea-ice thickness as it would result from pure thermodynamic growth with thickness measured in the field (including platelet ice contribution) in 2011.

The model clearly shows the big influence of snow on ice growth and gives a first estimate of consolidated platelet-ice thickness.

Thermistor chain data



Temperatures measured by a thermistor chain deployed between ATKA03 and the ice-shelf edge. Due to technical problems, data is only available for 3 weeks in 2011. Air/snow, snow/sea-ice and sea-ice/water interfaces are visible around 50 cm, 0 cm and -120 cm. Below the solid sea ice, a layer of ice platelets might be recognizable.

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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