Sea-Ice Mass Balance Influenced by Ice Shelves

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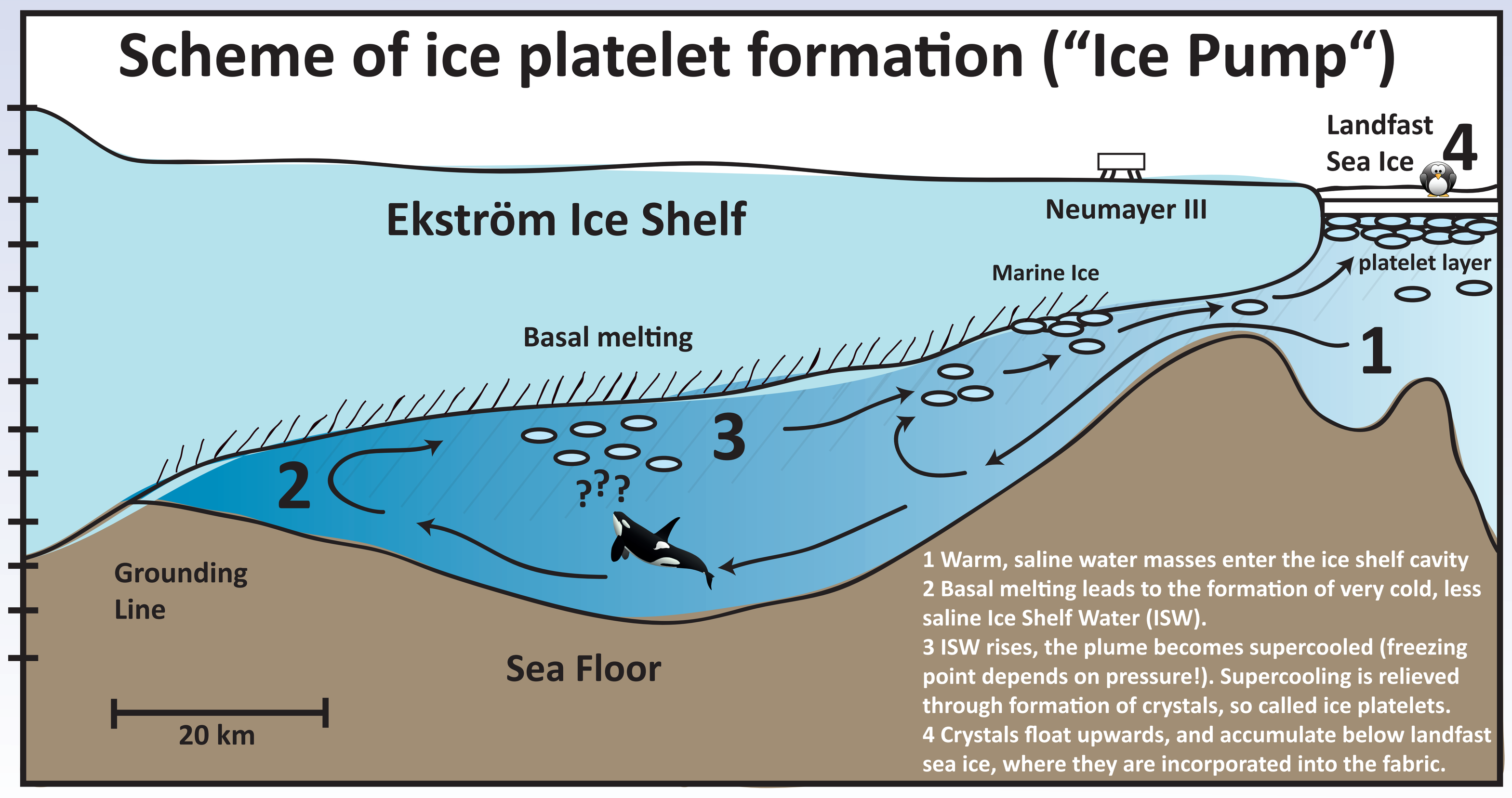
Background

Sea ice fastened to coasts, icebergs and ice shelves is of crucial importance for climate- and ecosystems. At the same time, it is not represented in climate models and many processes affecting its energy- and mass balance are currently only poorly understood. Near Antarctic ice shelves, which fringe about 44 % of the coastline, this **landfast sea ice** exhibits two unique characteristics that distinguish it from most other sea ice:

1. **Ice platelets** form and grow in supercooled water masses, which originate from cavities below the **ice shelves**. These crystals rise to the surface, where they accumulate beneath the solid sea-ice cover. Through freezing of interstitial water they are incorporated into the sea-ice fabric as **platelet ice**.
2. A thick and partly multi-year **snow cover** accumulates on the fast ice, altering the response of the surface to remote sensing and affecting sea-ice **energy- and mass balance**.

In order to improve our understanding of these processes, we perform a continuous measurement program on the landfast sea ice of Atka Bay, Antarctica, contributing to the international Antarctic Fast Ice Network (AFIN). In addition, we will intensify our measurements during two field campaigns. Here we present our major research questions, introduce our methods and present first results.

Scheme of ice platelet formation (“Ice Pump“)



Research Questions

1. Which are the most important formation processes of Atka Bay landfast sea-ice, and to what extent do nearby ice shelves influence sea-ice growth?

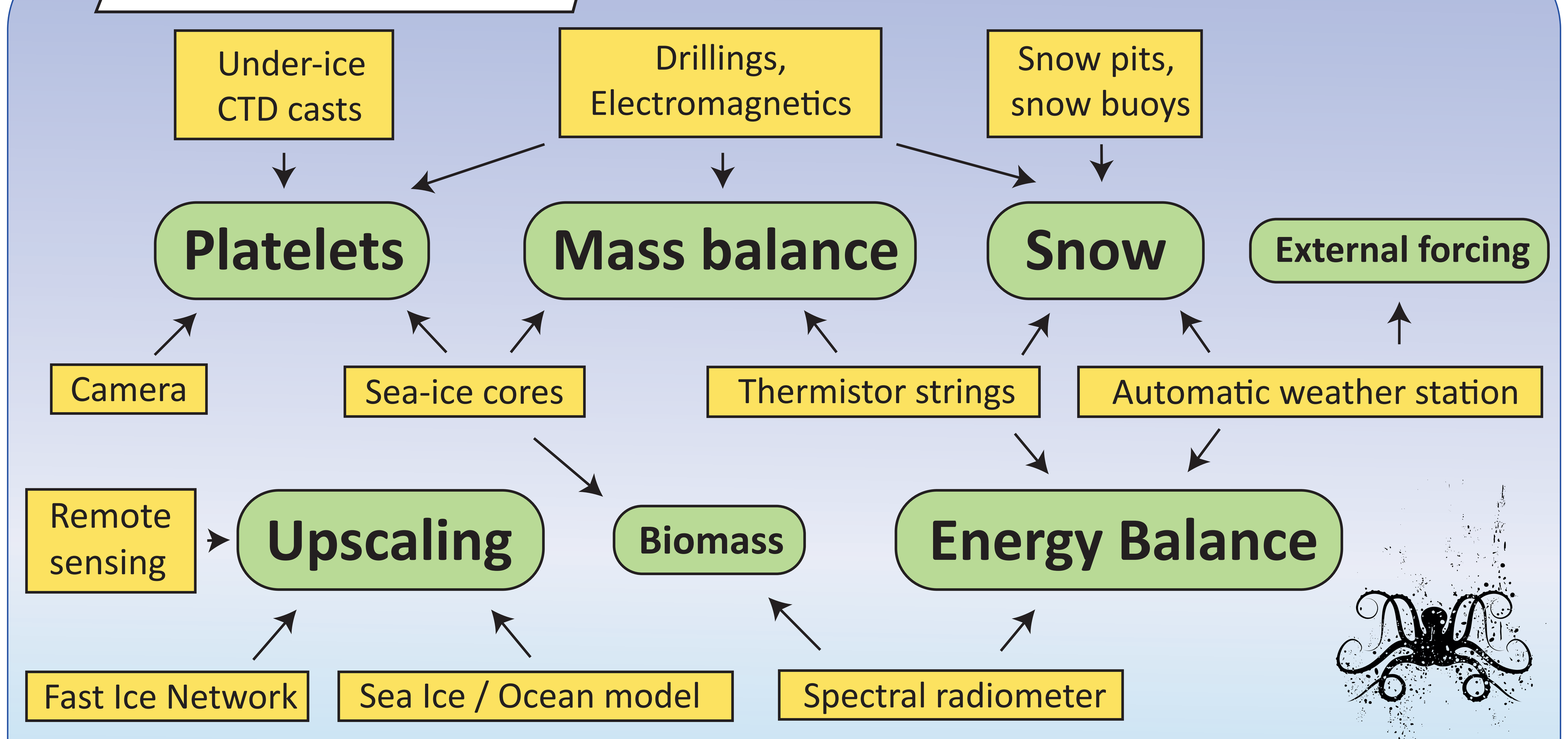
2. How does the snow cover influence landfast sea-ice mass balance and energy budget?

3. What is the seasonality of surface energy budget and particularly, light transfer through snow and sea ice?

4. Which are the most important sea-ice and snow processes affecting the backscatter of visible, thermal and microwave parts of the electromagnetic spectrum with regard to satellite observations?

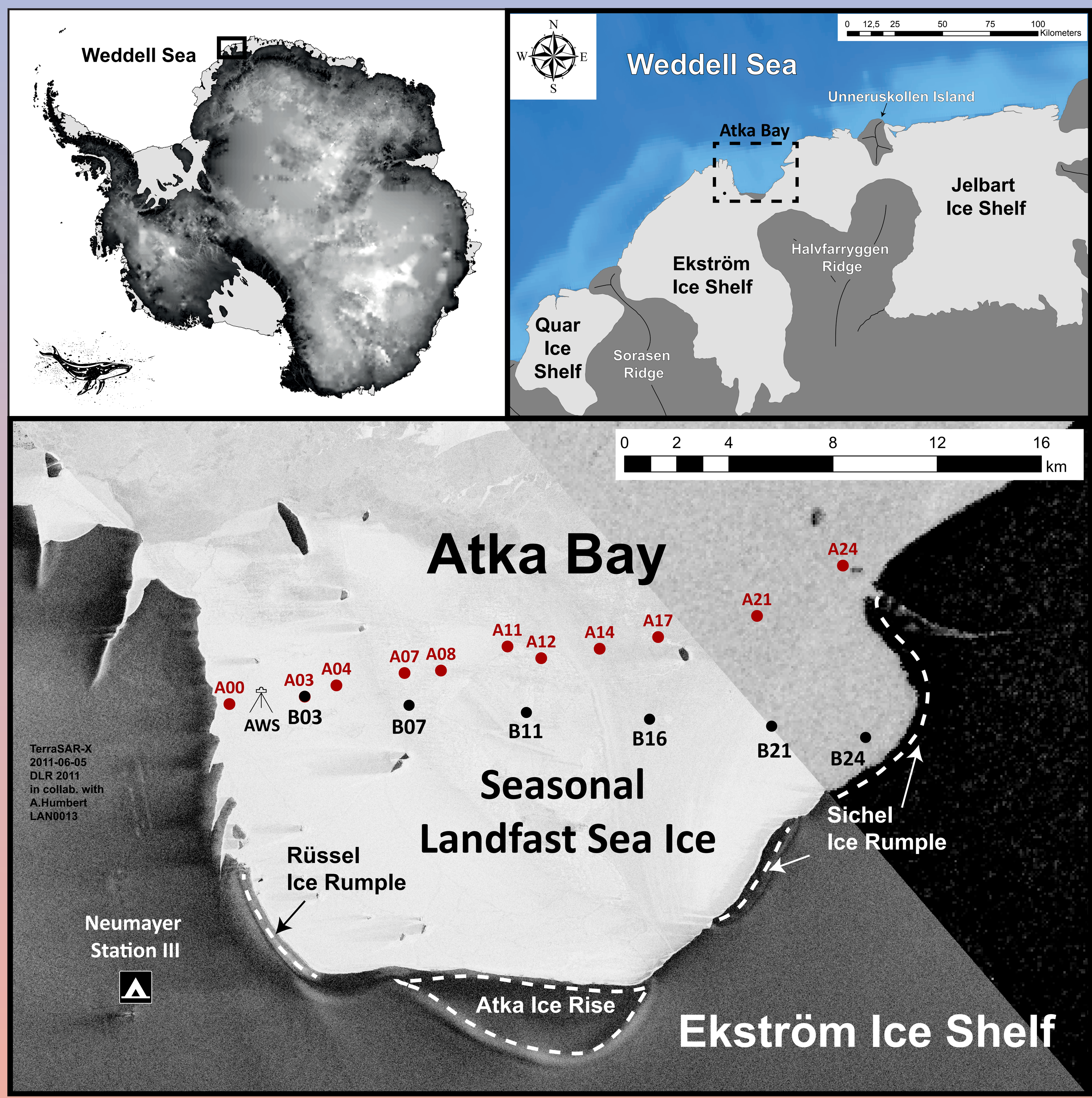
5. How representative is the fast ice cover of Atka Bay, compared to other fast ice regions around the coastline?

Methods



We use a variety of methods to investigate the research questions outlined above. The interdisciplinary nature of this project combines methods of **Geophysics, Meteorology, Oceanography, Biology, Optics and traditional Sea Ice Physics** with **numerical simulations and remote sensing**. Pioneering methods include **multifrequency EM**, a mobile **under-ice camera** and a special configuration of **spectral radiation** measurements.

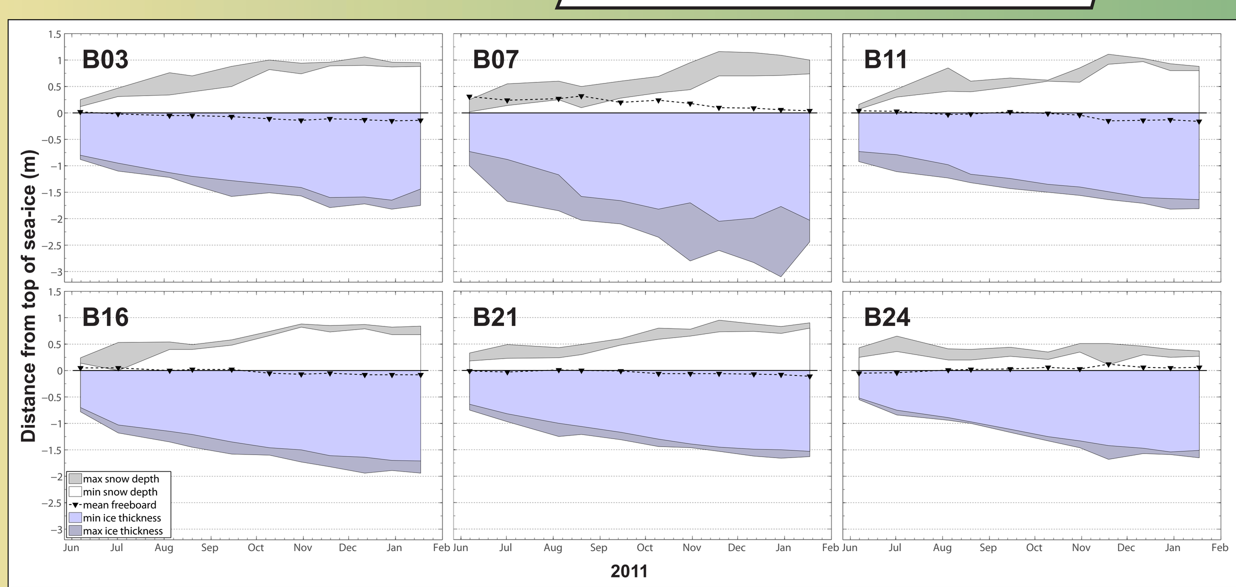
Study area



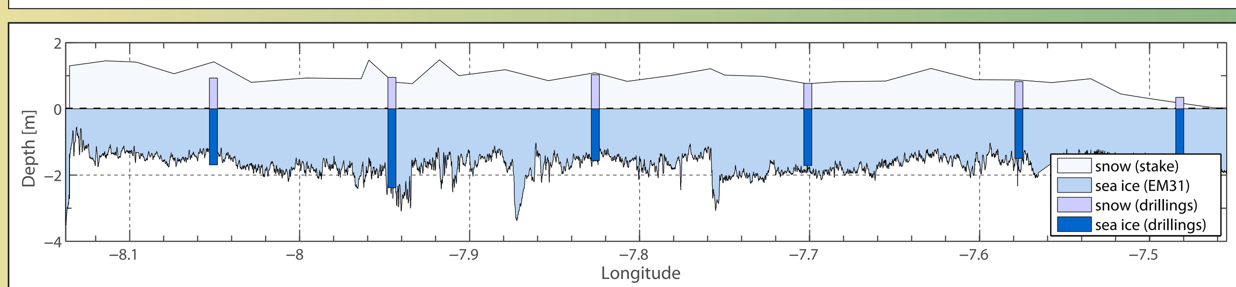
Top: Our study area of **Atka Bay** is located near the **Ekström Ice Shelf** in the southeastern part of the **Weddell Sea, Antarctica**. Floating ice shelves are light grey, grounded ice and land are dark grey. **Bottom:** TerraSAR-X image from June 2010 showing our **drilling** sites in 2010 (red), 2011 (black) and the site of **autonomous measurements** in 2011 (AWS).

Some Results

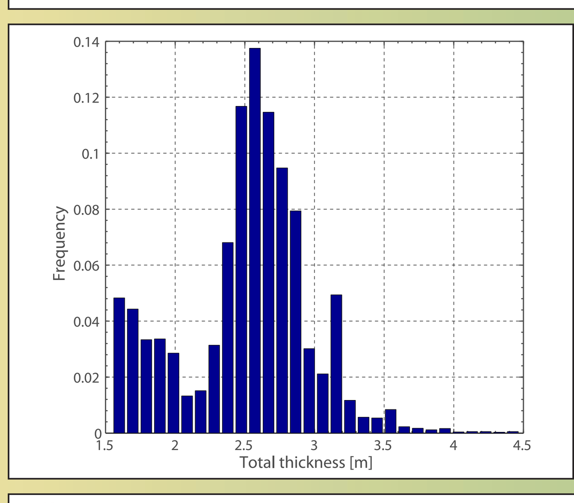
Sea-ice thickness, snow depth and freeboard at drilling sites on Atka Bay landfast sea ice in 2011. Each measurement comprised five drillings.
Ice platelets were observed in half of the boreholes.
Sea-ice in the West is influenced by pressure ridging, as opposed to the thermodynamically grown East. Snow depth is higher in the West, due to redistribution by easterly winds.



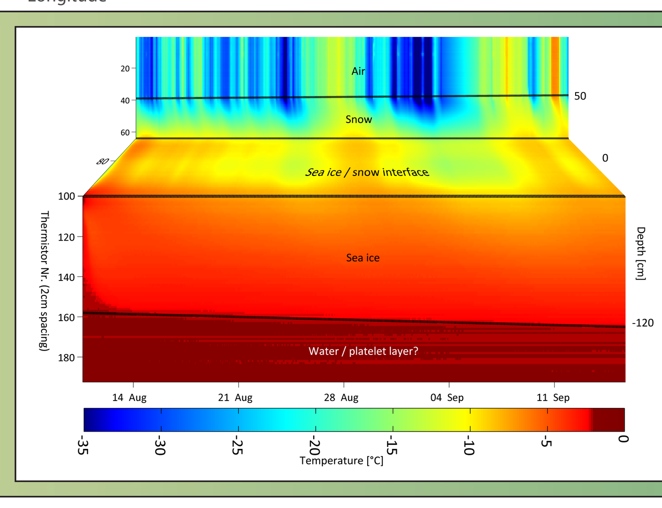
Electromagnetic thickness survey and manual **snow measurements** on 18 November 2011. Results agree well with manual drillings.



Left: total thickness distribution (sea-ice+snow) from above EM survey. Modal thickness is 2.6 m.



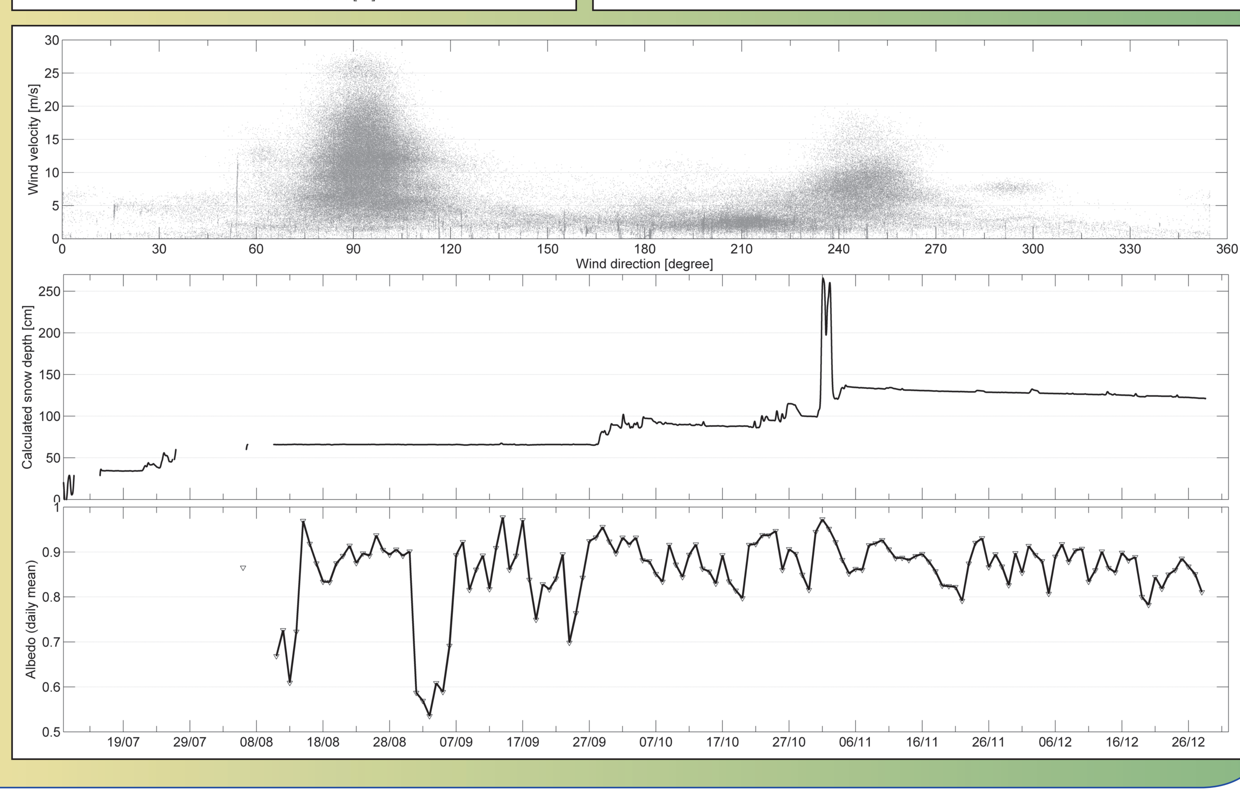
Right: Temperatures of air, snow, sea ice and ocean in August and September 2011 measured by **thermistor string.** Evolution of sea-ice interfaces and thermodynamic properties can be derived.



Top: wind forcing between August and December 2011: persistent easterly winds are strongest, and force sea-ice towards West.

Middle: snow depth measured by ultrasonic pinger; accumulation is highest in July, October and November.

Bottom: daily mean surface Albedo varies between 0.53 and 0.98, and stays around 0.85 later in the season.



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