Sea-Ice Mass Balance Influenced by Ice Shelves

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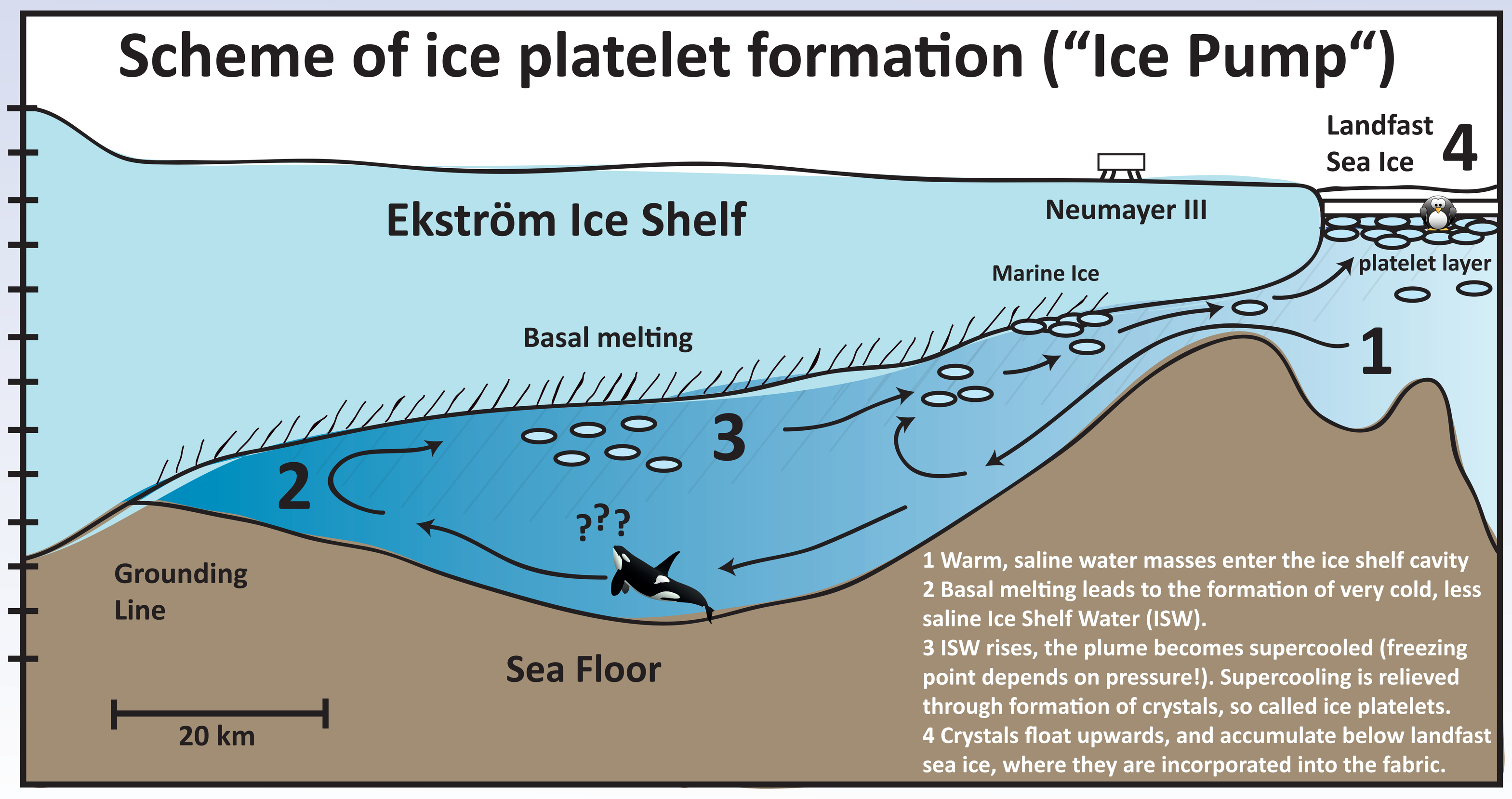
Background

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 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 highly stratified **snow cover** accumulates on the fast ice, altering the response of the surface to **remote sensing** and affecting sea-ice **energy- and mass balance**.

Combining a variety of methods from different disciplines, we aim to improve our understanding of Antarctic sea-ice, its interaction with ice shelves and its role in the climate system. Here we present our major research questions, introduce our methods and present some exemplary results.



Research Questions

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

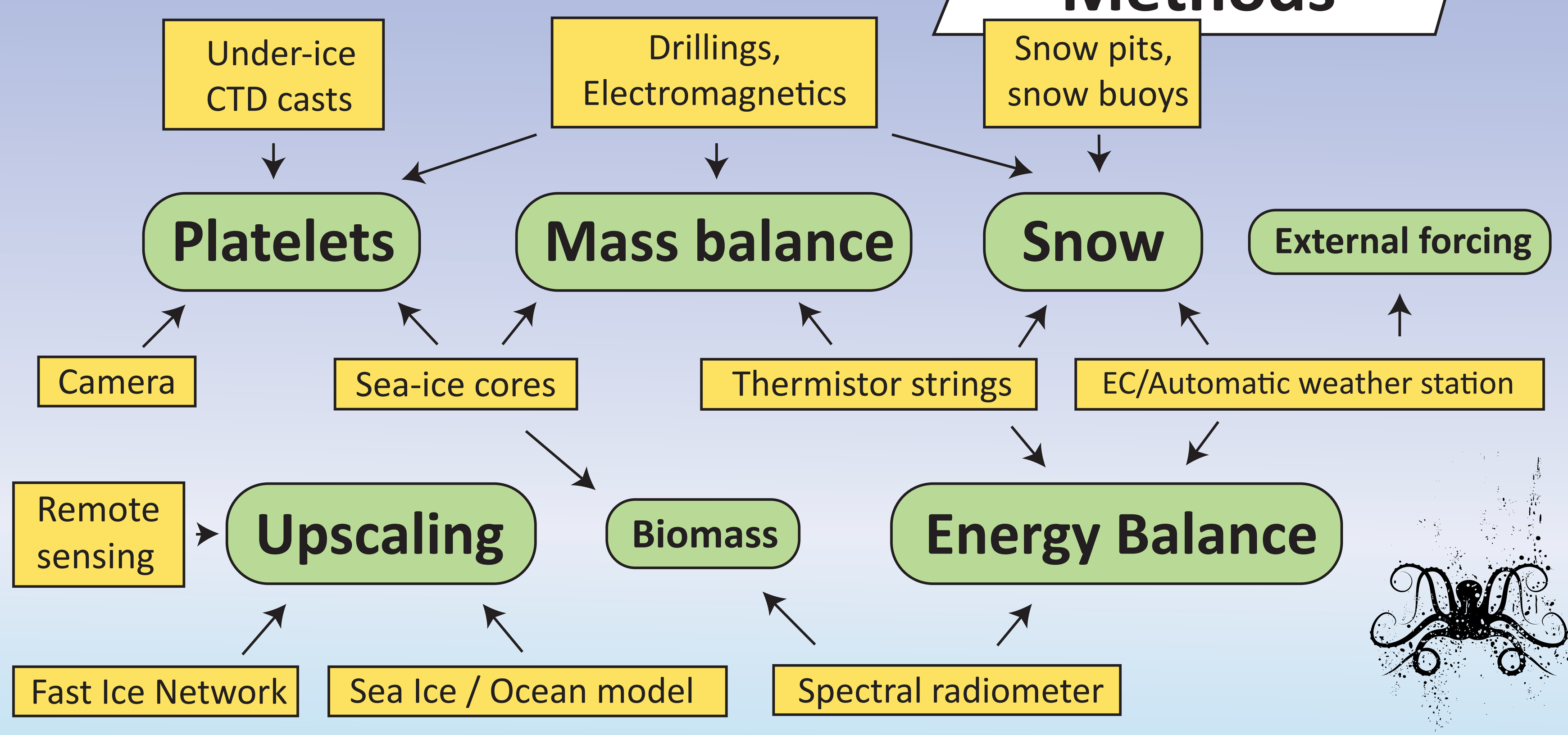
2. How does the snow cover influence landfast sea-ice mass balance and energy budget?

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 electro magnetic spectrum with regard to satellite observations?

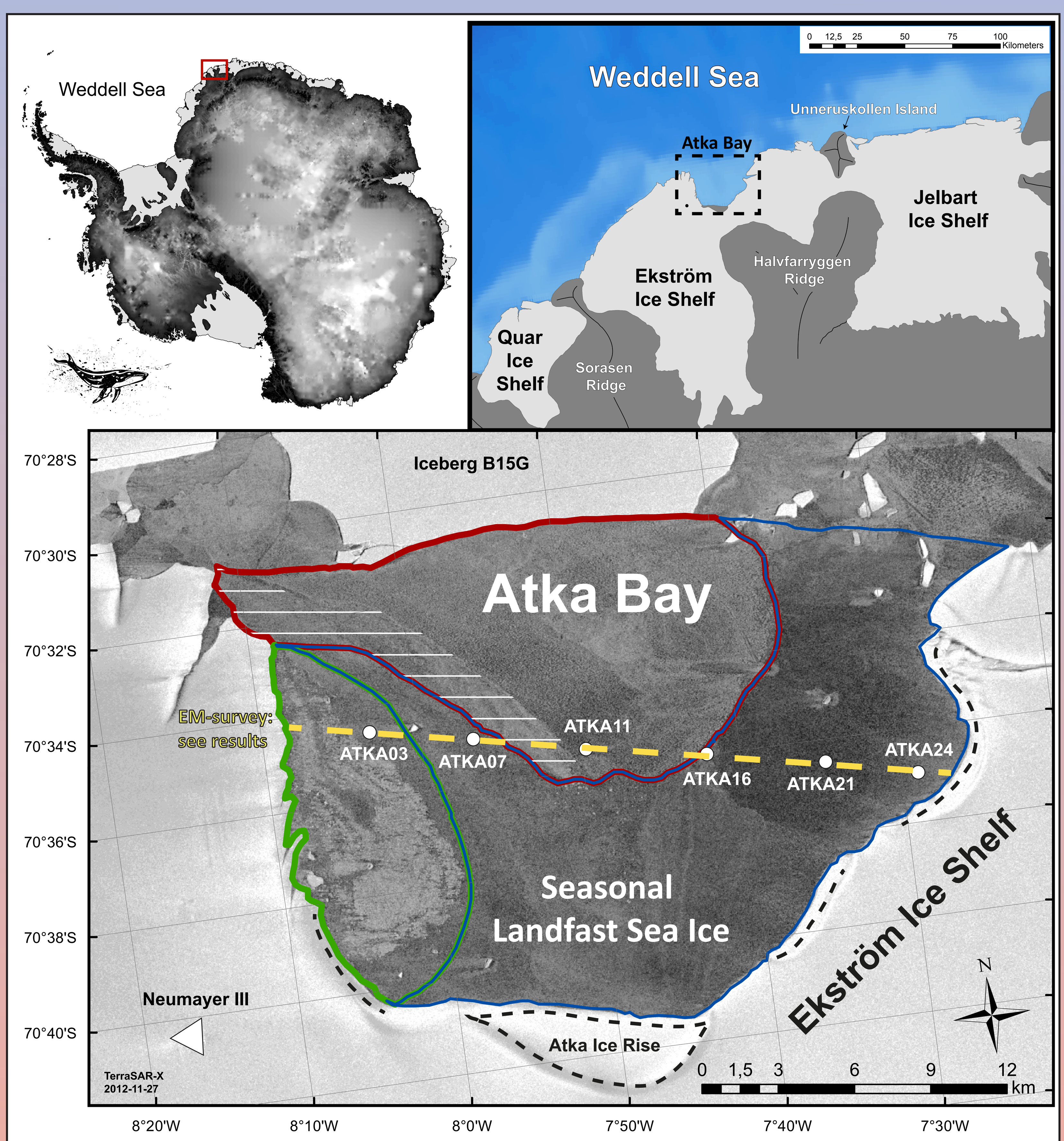
5. How representative is the fast ice cover of Atka Bay, compared to other fast ice regions around the coastline?

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.

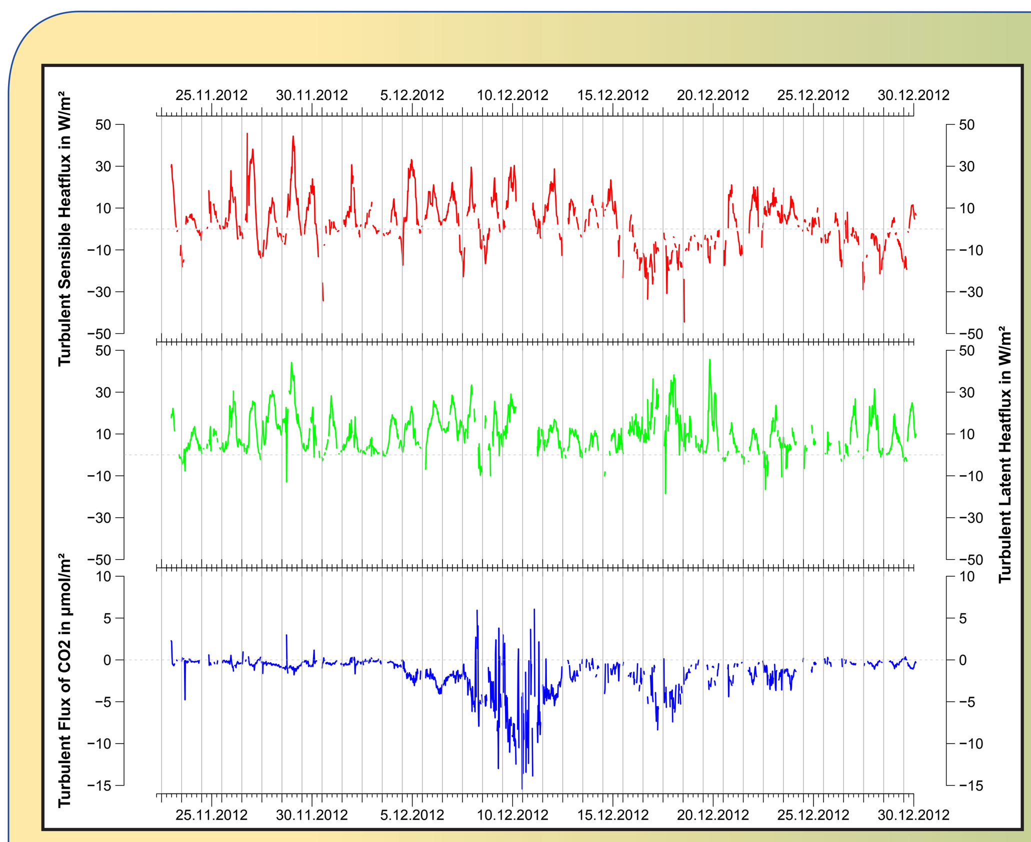
Study area



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 November 2012 showing our **sampling** sites on the fast ice in 2012 (white circles). The colored borders indicate **different sea-ice regimes**; Green: deformed second-year ice; blue: first year ice; red: new ice (September)

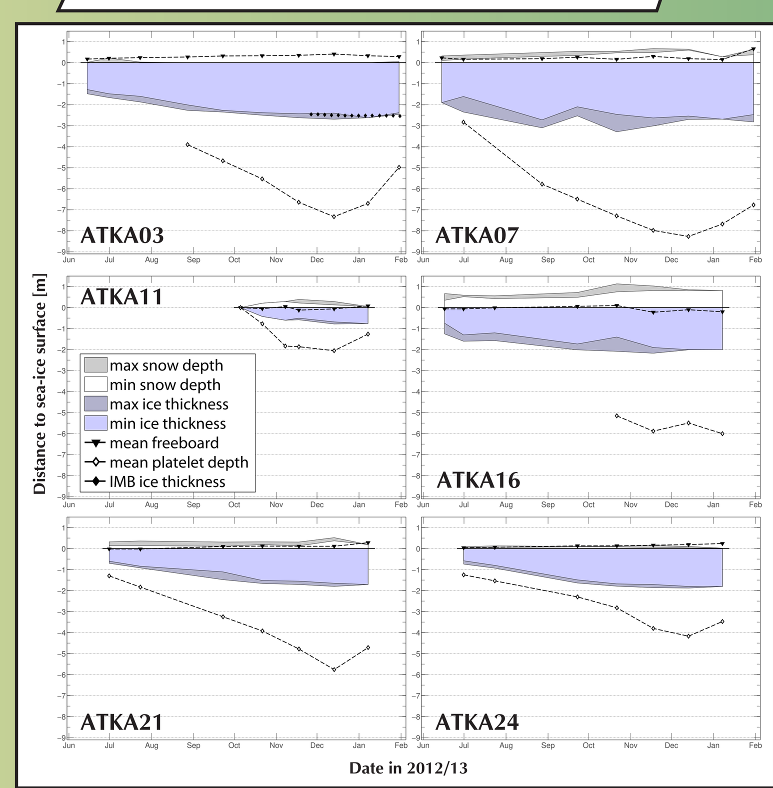
Questions? Don't hesitate to ask

Selected Results

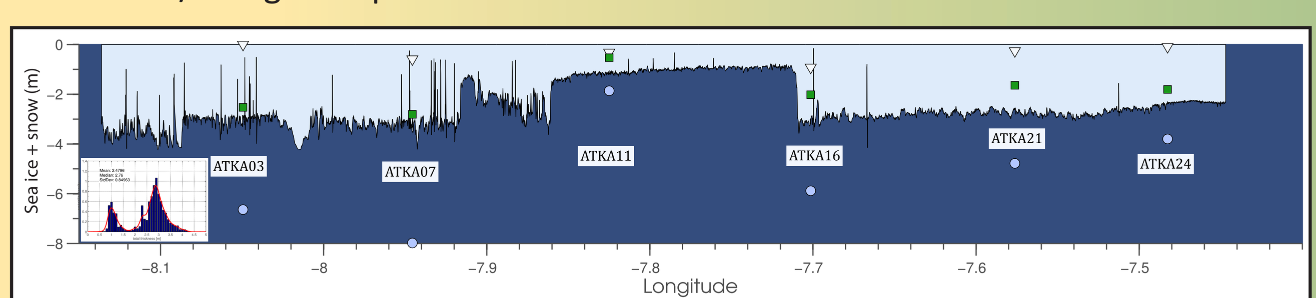


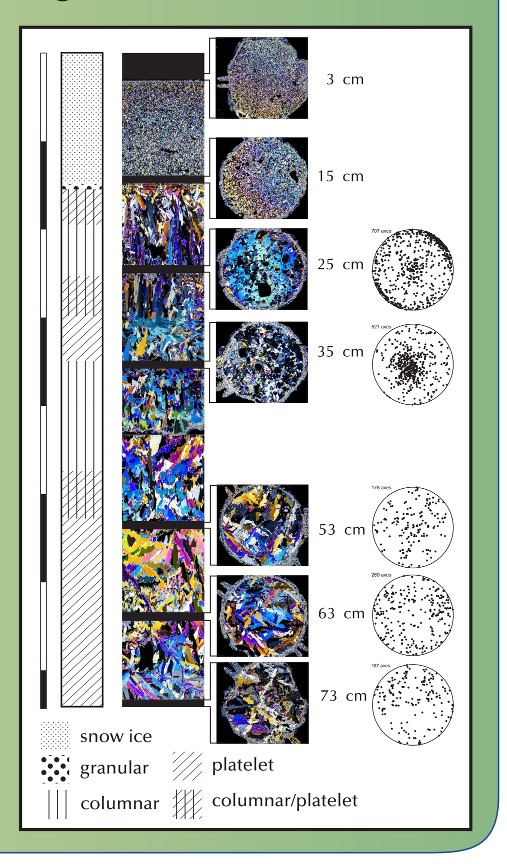
Top left: Sensible and latent heat fluxes measured by an Eddy Covariance station at ATKA03 in Nov/Dec 2012.

- On average, sensible and latent heat fluxes are directed from surface to atmosphere (3 W/m² and 10 W/m² respectively).
- Sea ice emerged as a CO_2 sink (-2 μmol/m²).
- Large fluctuations (-15 to +6 μmol/m²) correspond to storm events and/or high temperatures.



Top right: Sea-ice thickness, snow depth, freeboard and **sub-ice platelet layer thickness** at drilling sites on Atka Bay landfast sea ice in 2012. The large sea-ice thickness is mostly a result of incorporation of accumulated platelets. A thick snow cover insulates the sea ice and is responsible for surface flooding.





Top: Electromagnetic thickness survey in November 2012. The filled area (bright blue) represents EM31 total thickness (sea ice + snow) ; the triangles indicate simultaneously measured snow depths; the green squares are sea-ice thicknesses from regular drillings; the blue circles represent platelet layer depths.

Right: Sea-ice crystal structure from a core retrieved at ATKA11 in December 2012. Sea ice started to grow in September, when platelets were already present at the surface. Short periods of columnar growth are interrupted by a platelet-dominated fabric. The top 15 cm show a characteristic snow-ice texture as a consequence of flooding under heavy snow load. Mixed columnar/platelet and pure platelet texture account for more than 50 % of the total core length. Crystal alignments are shown in Schmidt diagrams on the right. Similar results were obtained for ATKA24 (181 cm).

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