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], Petra Heil[3]

# Monitoring land-fast sea ice in the Weddell Sea

## – A contribution to the Antarctic Fast Ice Network –

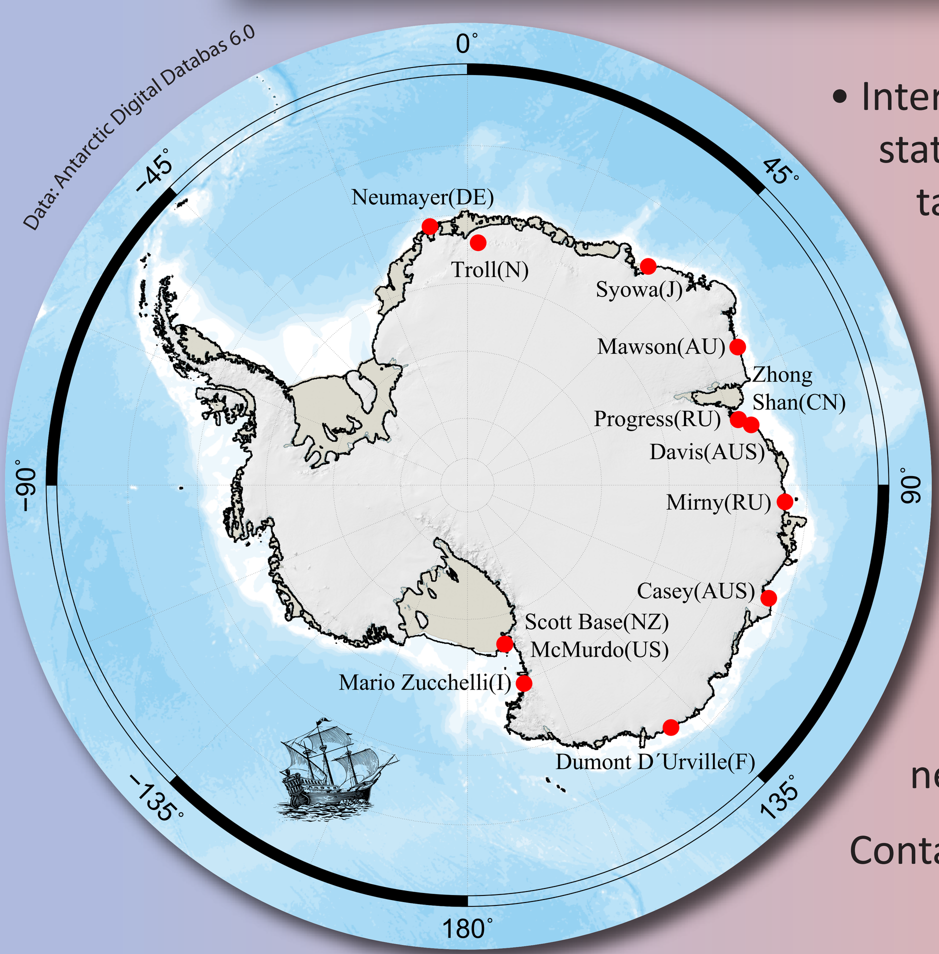
[1] Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meersforschung, Bremerhaven, Germany;
[2] Department of Environmental Meteorology, University of Trier, 54296 Trier, Germany;
[3] Australian Antarctic Division & ACE CRC, University of Tasmania, Hobart, Australia

## Background

Continuous observations of sea-ice and its snow cover are crucial to understand key processes and predict changes in the polar regions. In the pack-ice zone of the Southern Ocean, gathering these data is most challenging due to logistical constraints. In contrast, immobile sea ice fastened to the coast and ice shelves around Antarctica is relatively easy to probe from nearby coastal stations. During IPY 2007/08, several international partners grouped together in the **Antarctic Fast Ice Network (AFIN)** to provide the scientific community with continuous observations of fast-ice areas around the Antarctic coastline.

Since 2010/11, we contribute to AFIN with a suite of measurements on the **seasonal fast ice of Atka Bay**, in the eastern Weddell Sea. Through its geographical location near the Ekström Ice Shelf, the fast ice is influenced by **ocean-ice shelf interaction** and is generally covered with a thick and highly variable snow cover. Here we present the concept and selected results of our ongoing **monitoring program**, where we combine traditional sea-ice measurements (drillings, coring, snow pits) with automated stations/buoys and remote sensing by satellites (MODIS, SAR).

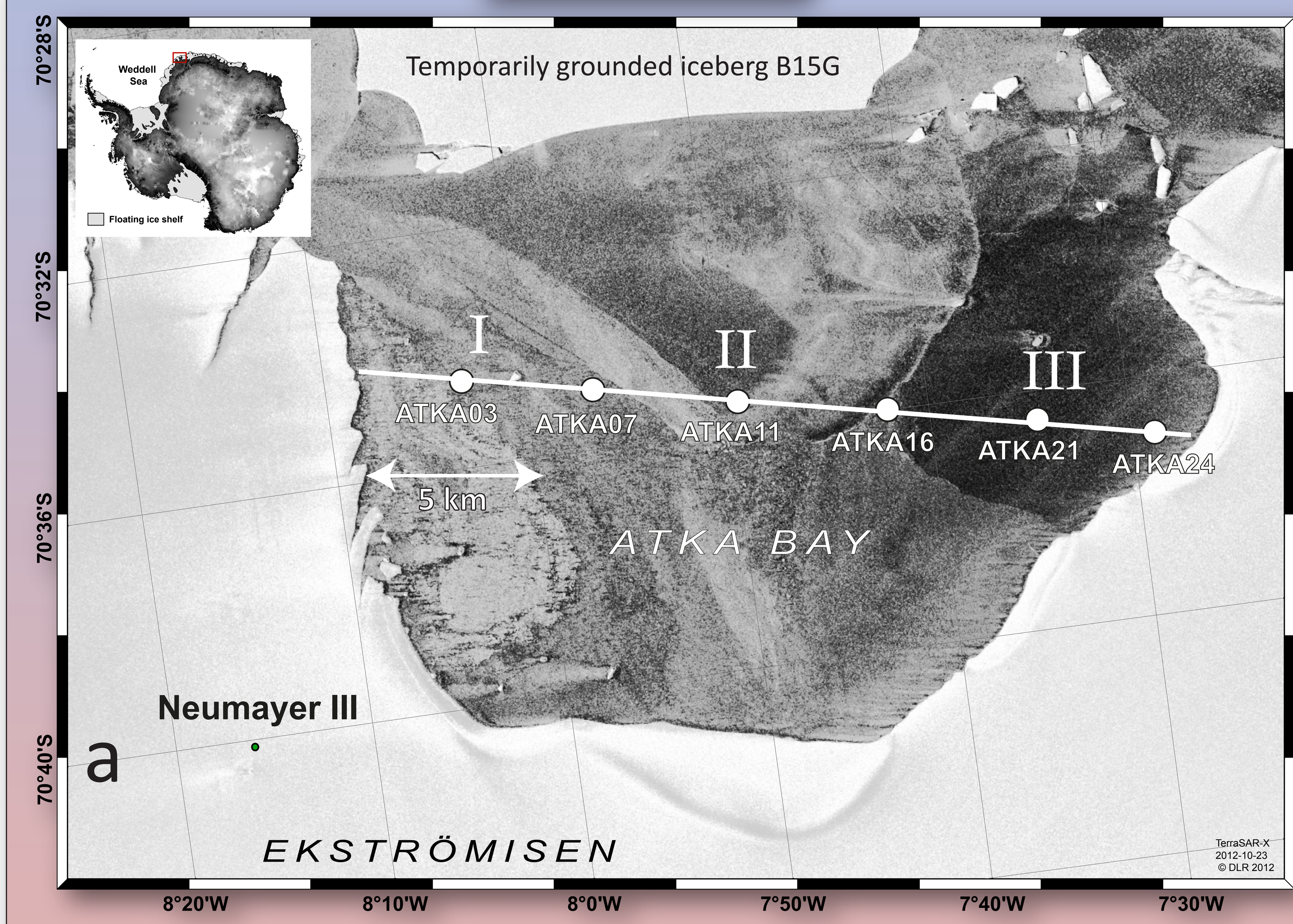
## The Antarctic Fast Ice Network

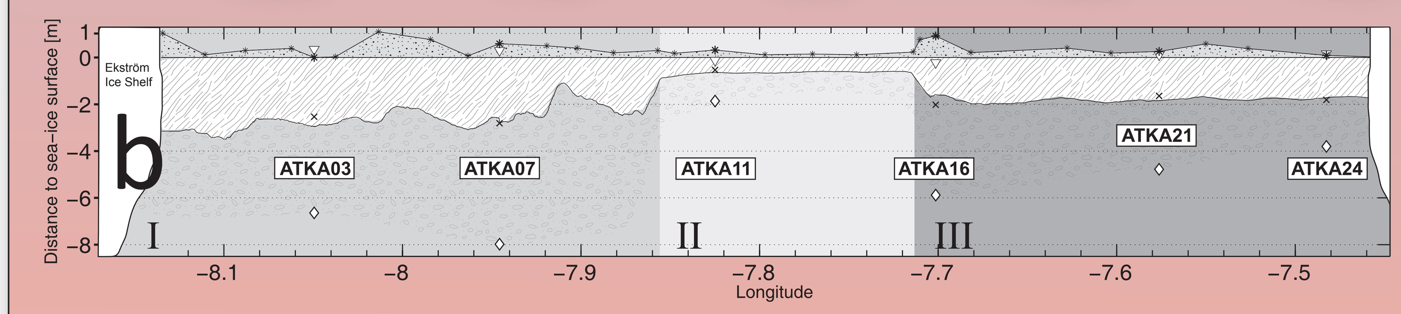


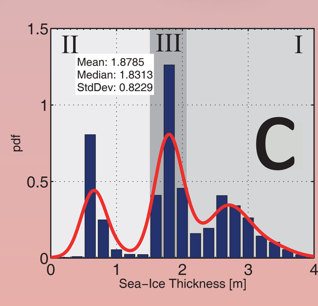

- International network of fast-ice monitoring stations around the Antarctic coastline, established in IPY 2007 (Heil et al., 2011).
  - Current members: Australia, China, France, Germany, Japan, Malaysia, New Zealand, Norway, Russia.
    - Measurements include sea-ice thickness, snow depth, freeboard, dates of formation/breakout, meteorological and oceanic parameters.
  - Development and in-situ testing of new observation technologies.

Contact: Petra.Heil@utas.edu.au

## Study area




**a)** Map of our study area. Six regularly visited sampling sites are located on a 25-km long west-east transect. The sample radar image gives an impression of the sea-ice conditions in October 2012. Areas I, II and III denote different sea-ice regimes as observed in 2012 (pressure-ridged sea ice, new sea ice and level sea ice).

**b)** EM31-based sea-ice thickness profile (November 2012) along the transect indicated in a. The symbols indicate bore-hole measurements of sea-ice thickness, snow depth, freeboard and platelet-layer thickness. The different sea-ice regimes are also apparent from the data.

**c)** Sea-ice thickness distribution for data in b, with highlighted sea-ice regimes according to a and b.

## Sea-Ice Observations

**The overwinterers at the German Antarctic station Neumayer III perform a regular sea-ice field-work programme each year between June and January since 2010.**


**a)** Aerial view of Neumayer III, the base for our field work.

**b)** EM31/GEM-2 electromagnetic thickness transect. The instrument is mounted in a kayak and pulled behind a snowmobile. A typical transect is 50 km long.

**c)** Every time a sampling site is visited, five bore holes are drilled in order to measure **sea-ice thickness, freeboard, snow depth and platelet-layer thickness**.

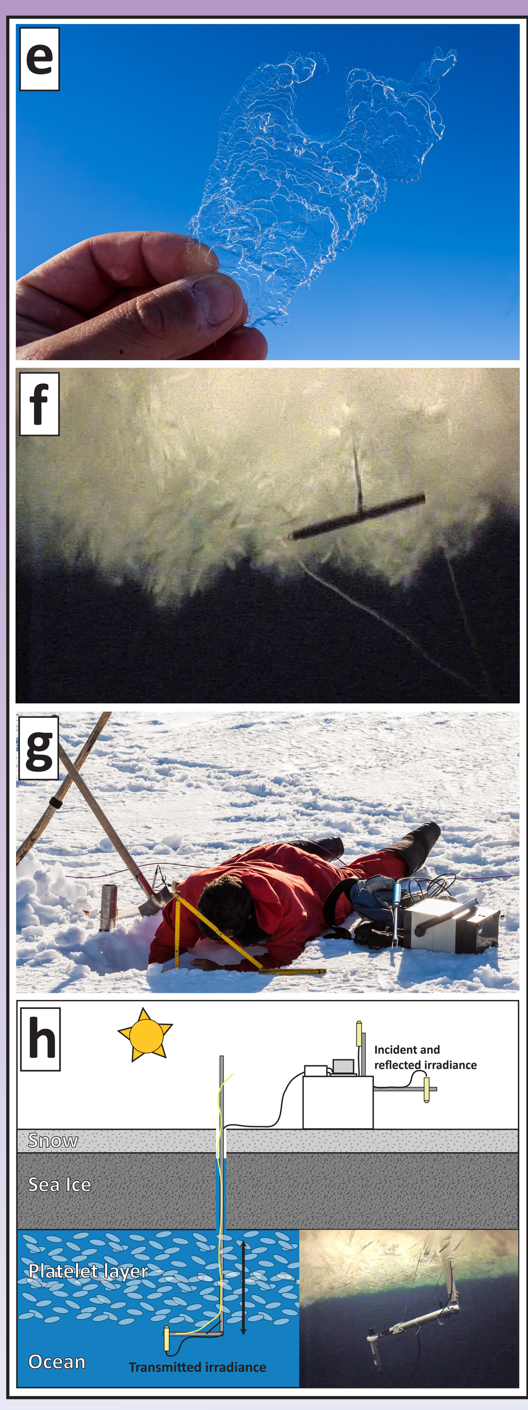
**d)** **Sea-ice cores** are retrieved in summer to investigate the sea-ice physical properties and growth history.

**e)** **Accumulations of ice platelets** of several cm in diameter and <1 mm thickness are commonly found below the solid sea ice.

**f)** The platelet-layer thickness below the solid fast ice is determined with a heavy metal bar attached to a thickness gauge. This is necessary to penetrate the porous matrix of ice platelets.

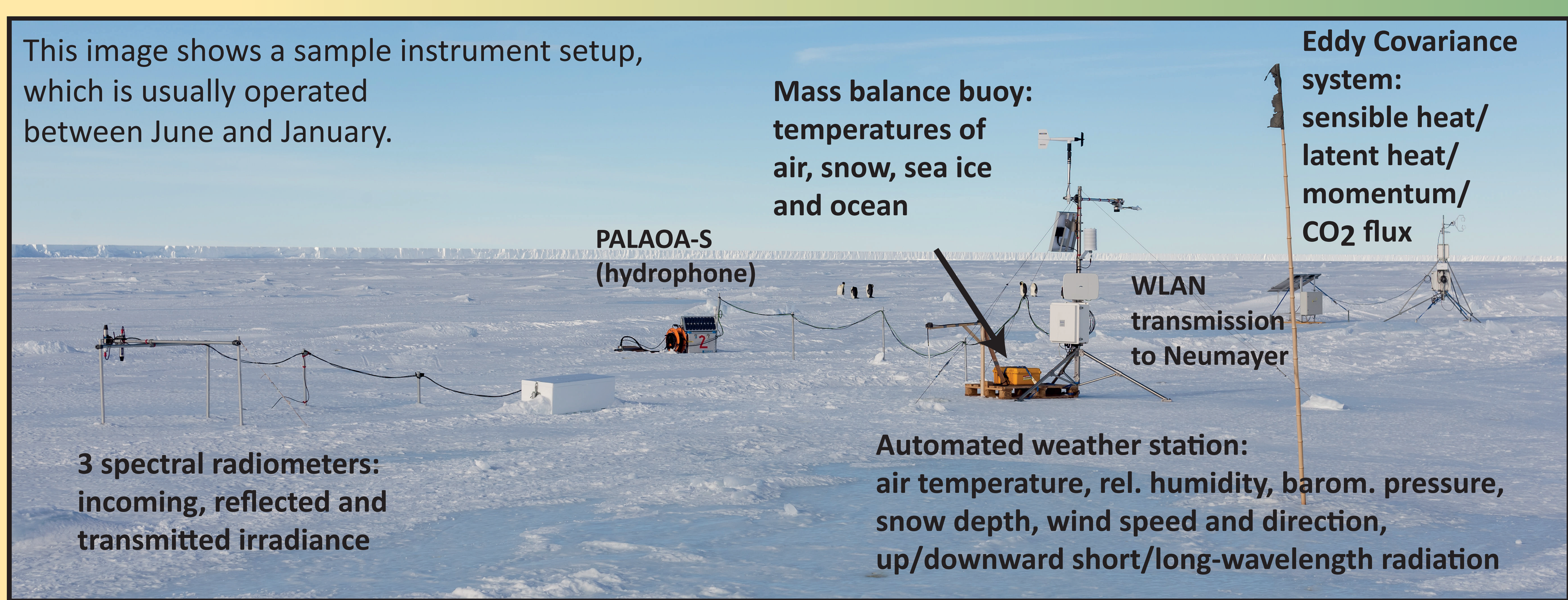
**g)** During a dedicated field campaign, **snow properties** were linked to **satellite-based radar backscatter** signals.

**h)** Measurement of the **light field** within the platelet layer, which is a **unique habitat** for myriads of organisms.




## Autonomous measurements

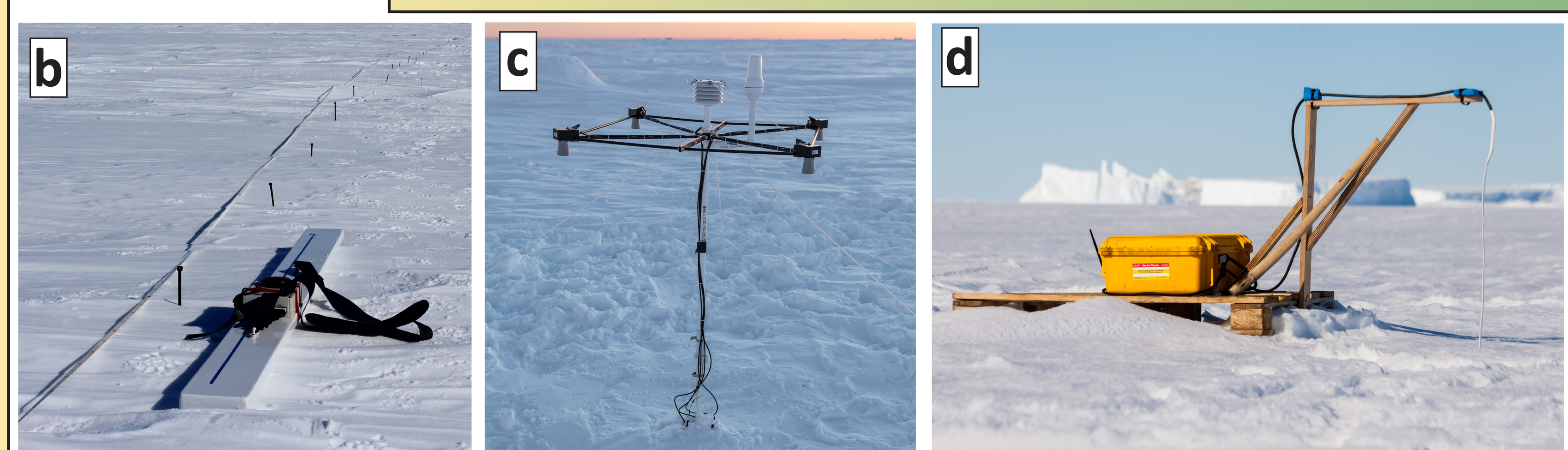
**The traditional sea-ice field work is complemented by different types of automated measurements, like autonomous weather and radiation stations and mass balance buoys.**




## New technologies

**In addition to its scientific relevance, the fast ice of Atka Bay is an ideal testing ground for new technologies and innovative methods.**


a) Bore-hole camera, especially suitable for environments dominated by ice platelets.
b) GEM-2 multifrequency-EM device, provides more information about sea-ice and platelet-layer properties than commonly used monofrequent instruments.
c) Affordable snow-depth buoy with four ultrasonic pingers and sensors for temperature and barometric pressure (Nicolaus et al., Poster 69A695).
d) SAMS thermistor-string sea-ice mass balance buoy (Jackson et al., 2013).




## Take-home Messages

- **Land-fast sea ice is a valuable indicator of climate (change).**
- **Compared to the pack ice, it is easily accessible from nearby stations.**
- **Near an ice shelf, it reflects ocean-ice shelf interactions.**
- **Antarctic Fast Ice Network was established in 2007.**
- **Monitoring program at Atka Bay (eastern Weddell Sea) since 2010.**

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