Antarctic research from RV Polarstern, Neumayer III, and autonomous observatories

Marcel Nicolaus
with many co-workers

Alfred-Wegener-Institut
Bremerhaven, Germany

Foto: M. Hoppmann

The Alfred Wegener Institute

- contributes significantly with climate and coastal research to understand the changeability of the global environment and the Earth System
- provides the scientific basis for political decisions
- coordinates Polar research in Germany and provides both the necessary equipment and the essential logistic back up for polar expeditions

Tools: Observation- Modeling- Application

1980: Establishment of the institute in Bremerhaven as a foundation under public law

As of 2012:

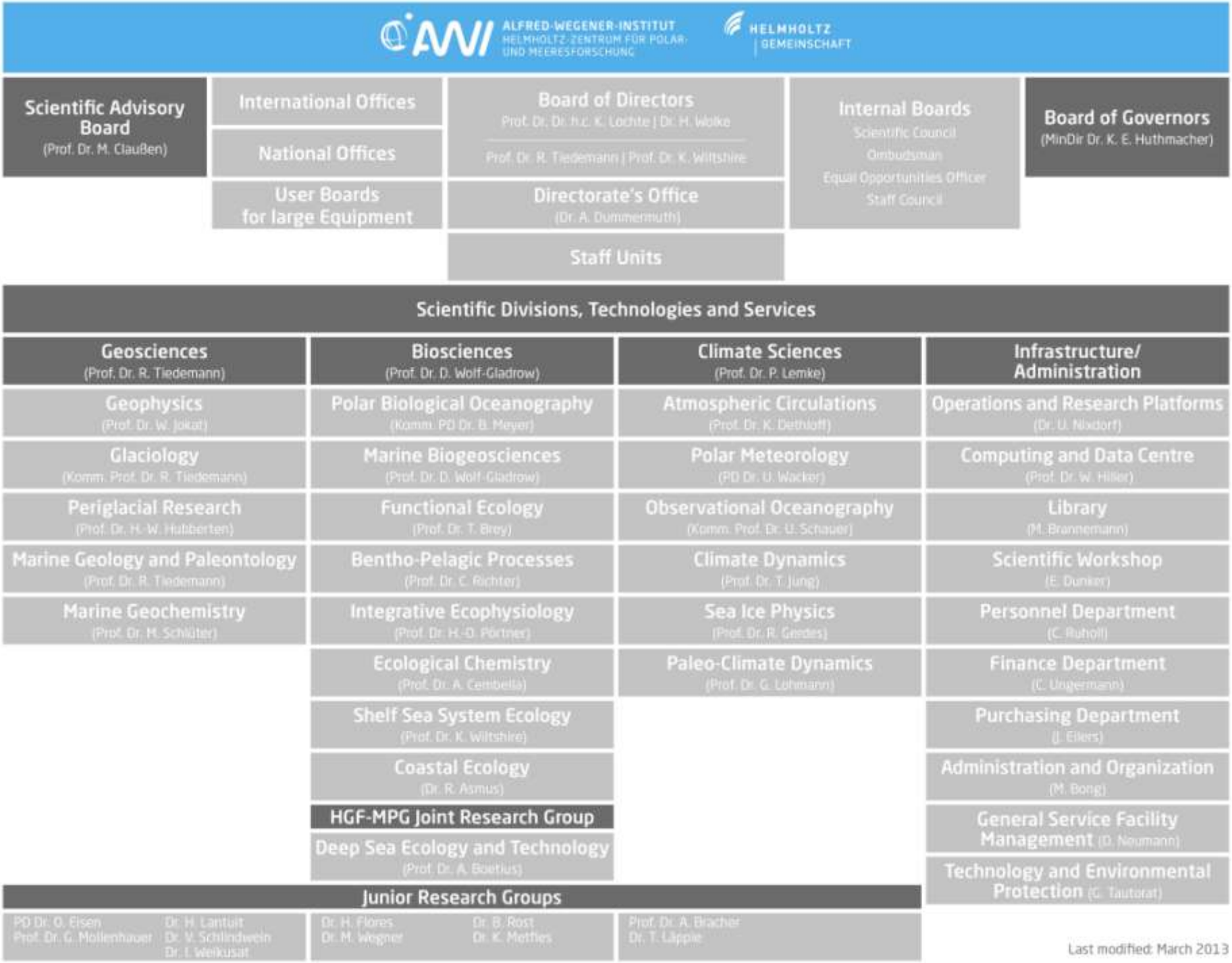
- Budget: **113 Mill. Euro**
- > 1000 Employees

Funding:

90% Federal Ministry of Education and Research (BMBF)
8% Land Bremen
1% each Federal States Brandenburg and Schleswig-Holstein

external funds (ca. 20 Mill. Euro p.a)

Member of the Helmholtz Association



Last modified: March 2013

Research facilities around the globe

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HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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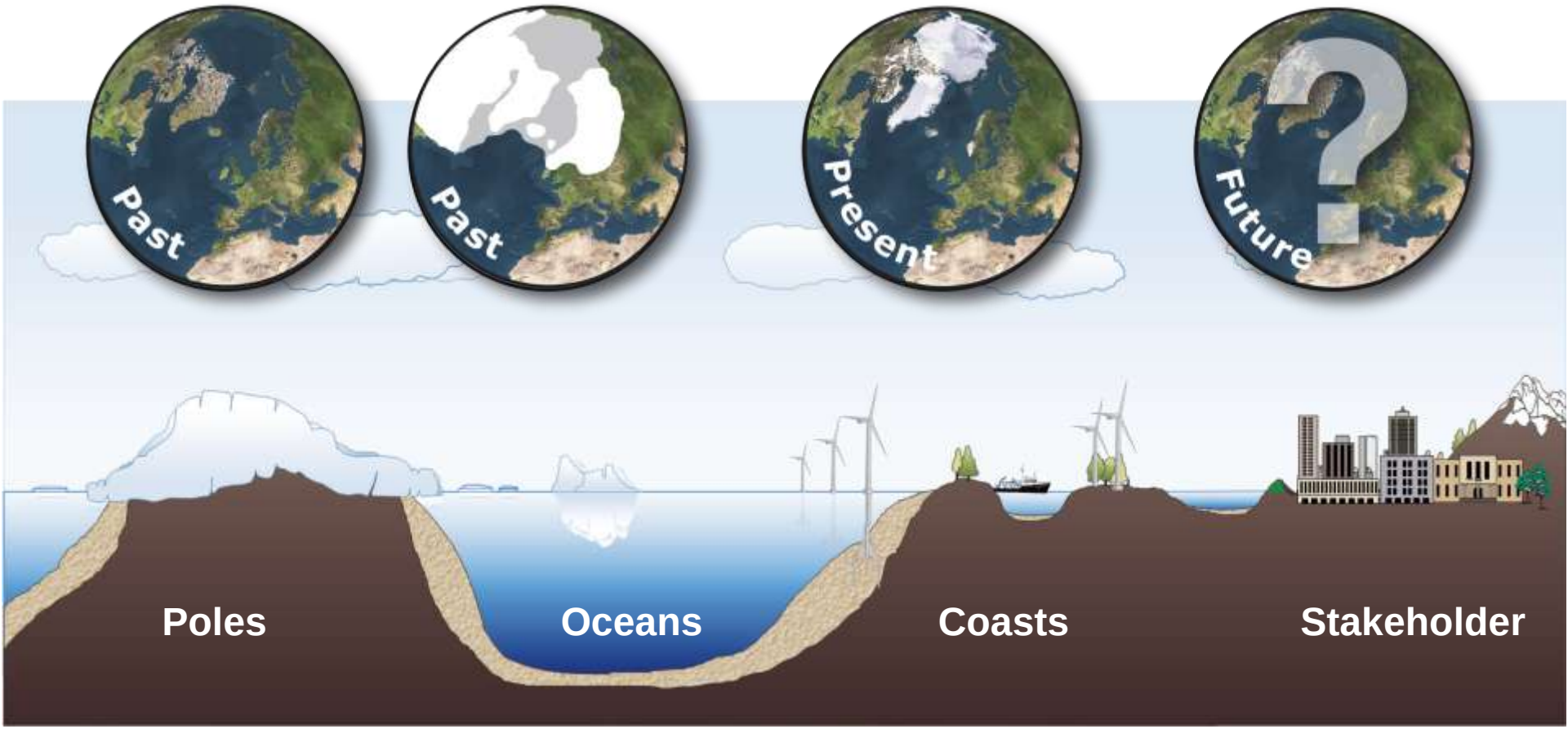
PACES II - Polar regions And Coasts in the changing Earth System



HELMHOLTZ GEMEINSCHAFT

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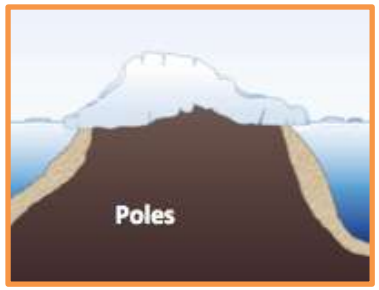


Topic 1

Changes and regional feedbacks in Arctic and Antarctic

Coordinators: U. Schauer and P. Lemke

Quantification of contemporary changes in atmosphere, cryosphere and ocean in both Polar Regions

Develop (? Improve) understanding of the underlying processes

HELMHOLTZ GEMEINSCHAFT

Topic 1: Arctic and Antarctic

Research organized in six interdisciplinary work packages and two networking themes:

WP1: The polar atmosphere and feedbacks to sea-ice, ocean and frozen land

WP2: Ice sheet dynamics and mass balance

WP3: Degrading permafrost landscapes; carbon, energy and water fluxes

WP4: Arctic sea ice and its interaction with ocean and ecosystems

WP5: Southern Ocean physics, biodiversity, and biogeochemical fluxes in a changing climate

WP6: Large scale variability and change in polar benthic biota and ecosystem functions

Networking Themes:

- Methane in the Arctic - Sources, Sinks and Pathways in the ecosystems
- Sea level rise

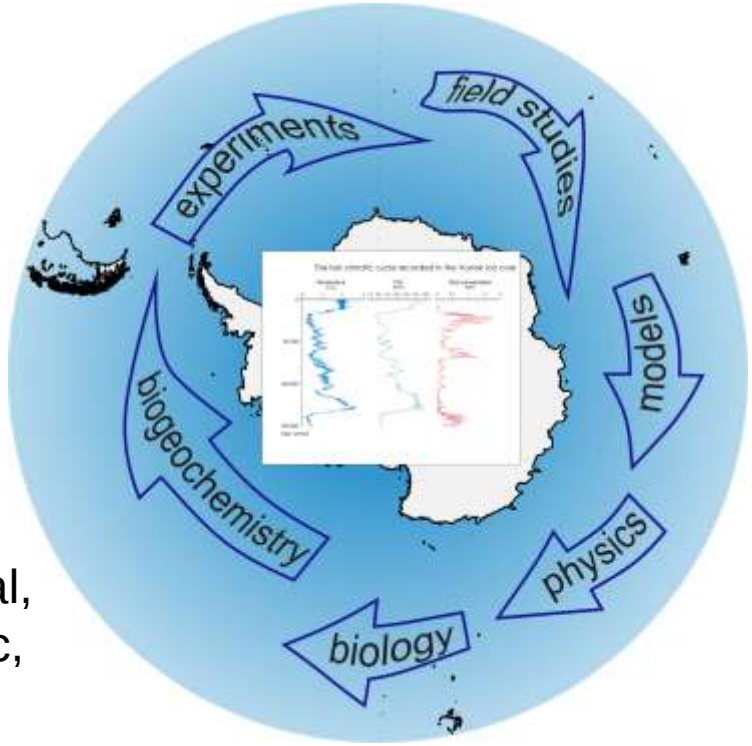
WP5: Southern Ocean physics, biodiversity and biogeochemical fluxes in a changing climate

- How does the Southern Ocean change?
- What are the processes that link physics, chemistry and ecology?
- What processes determine the feedbacks to the global climate system?

Research Strategy

Combining

- Experiments (laboratory and in situ)
- Observations (long-term and process-oriented studies, remote and in situ)
- and Models (theoretical and numerical, diagnostic and prognostic, regional to global)



Integrating

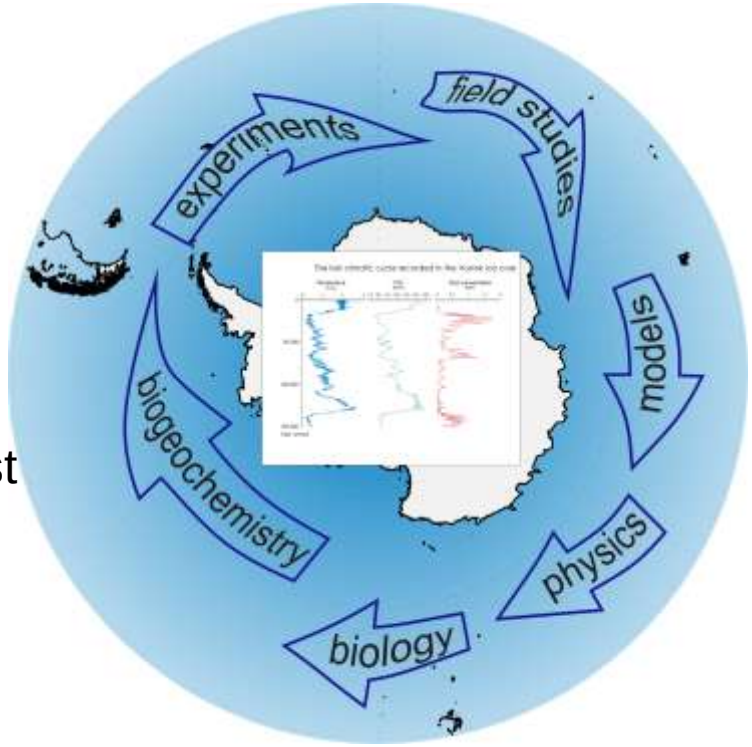
- Physics (sea-surface forcing, turbulent micro-scale to basin-scale dynamics)
- Chemistry (carbon and macro/micro nutrients, particulate and dissolved substances, tracers?)
- Biology (phytoplankton to mammals, food-web fluxes)

WP5: Southern Ocean physics, biodiversity and biogeochemical fluxes in a changing climate

Expected Results

- Assessment of variations and trends (physics, chemistry, bio-diversity)

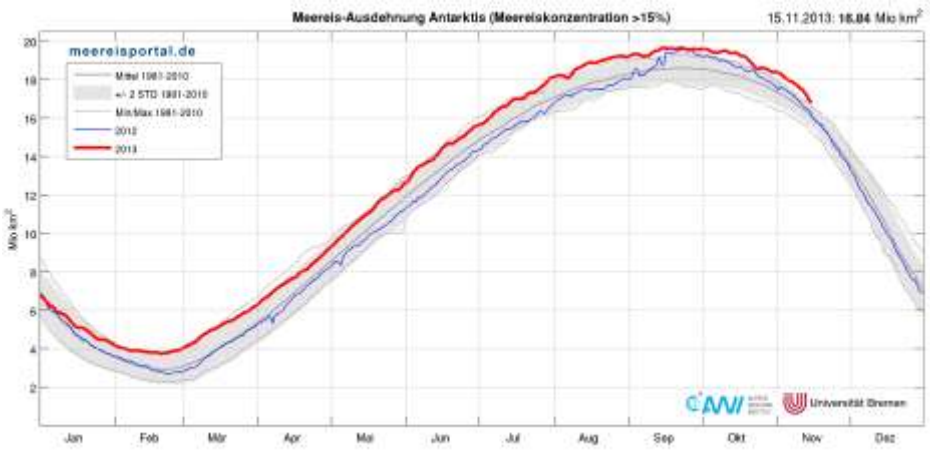
- Identification of the most important physical-chemical processes that affect the ecosystems and associated biogeo-chemical fluxes

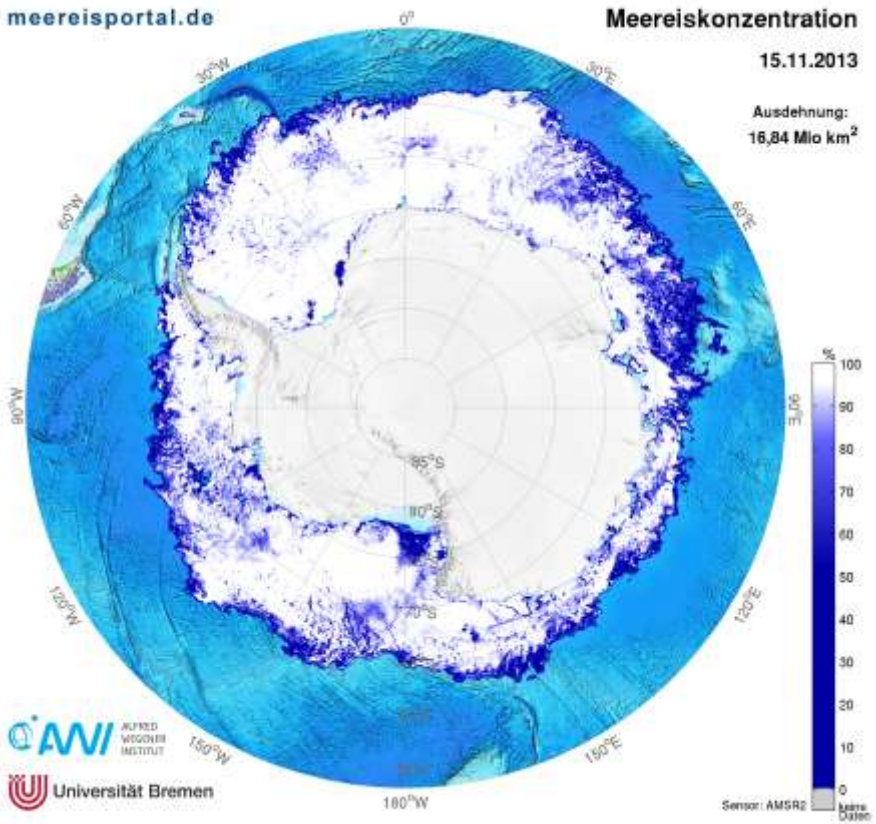


- Confirmation/rejection of hypotheses (correlation of atmos-pheric temperature and carbon dioxide on paleo-timescales)

- Improved ability to predict the consequen-ces of future climatic changes for the balance of the biological and physical carbon pumps

Antarctic Sea Ice Today





Annual cycle

February: 3 to 4 Mio km^2

September: almost 20 Mio km^2

$\Rightarrow$ **Factor 5 to 6**

Strong regional variability

Quantifying sea ice mass and energy balance in the Weddell Sea: Impacts on the ecosystem and the thermo-haline circulation

Sea ice mass balance
- Thickness measurements
- Dynamics (drift)

Snow on sea ice
- Metamorphism => Remote sensing signatures
- Mass balance
- Light / Energy balance

Ice-shelf and ocean interaction
- Platelett ice

Research Icebreaker „POLARSTERN“

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Technical Data	
Construction	Howaldtswerke/ Deutsche Werft, Kiel
	Werft Nobiskrug, Rendsburg
Ice breaking Concept	Hamburgische Schiffbau-Versuchsanstalt
Length overall	118 m
Beam moulded	25 m
Depth (main deck)	13.6 m
Draught	max. 11.2 m
Deadweight	5,480 t
Lightweight	11,820 t
Engine	ca. 14000 kW (20000 PS)
Max speed	14 kn

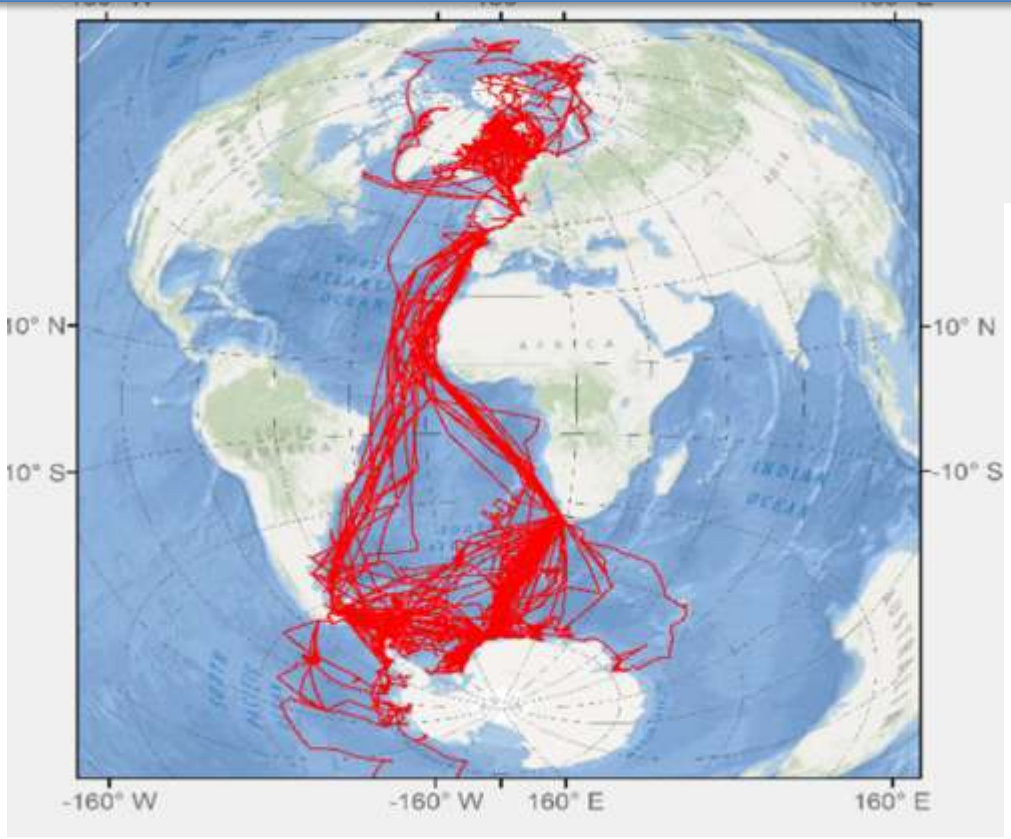
HELMHOLTZ GEMEINSCHAFT

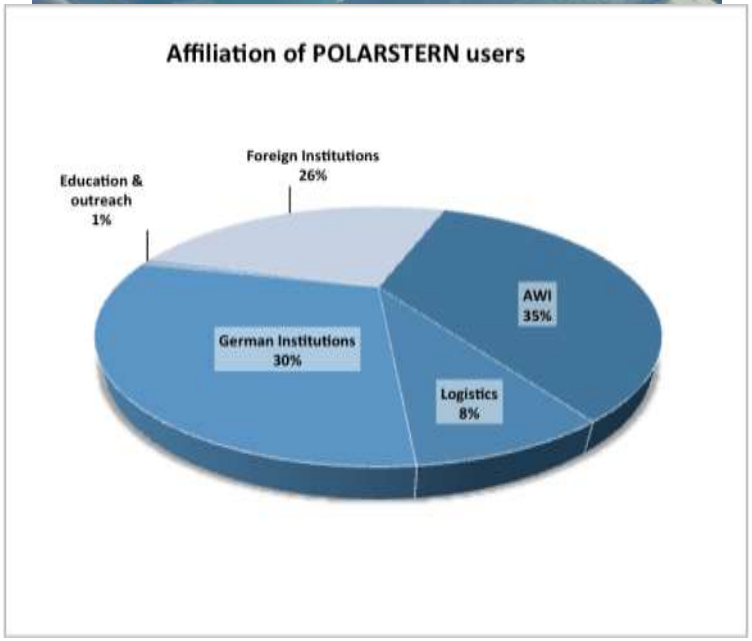
1982 – 2012: 30 years of service for research and supply – Total distance made until 31 Dec 2012: 1 487 123 nm

9456 users

27 Arctic expeditions — 29 Antarctic expeditions

310 days/year at sea — 45 users/cruise leg





POLARSTERN – the supply vessel

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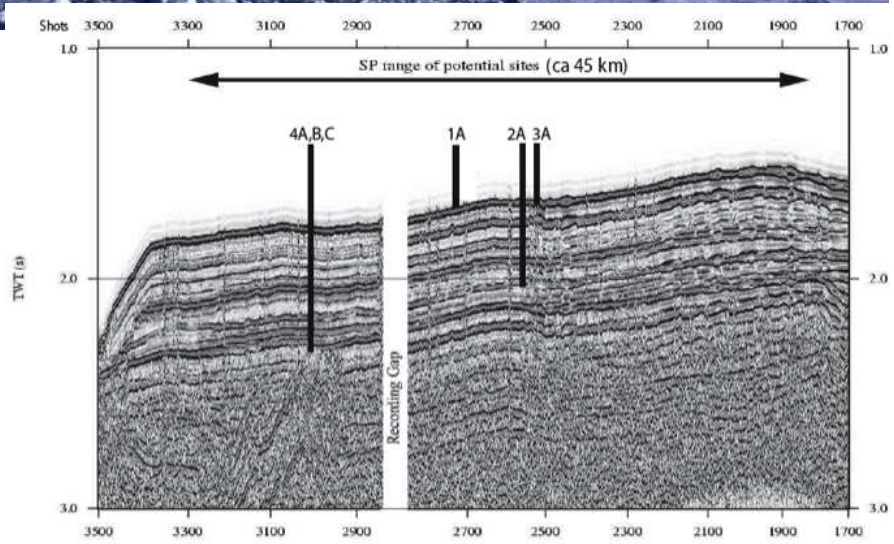
SAR

Support of inland activities

POLARSTERN - capabilities



- Biogeochemistry
  - Nutrients
  - DMS, CO_2, total gas
  - Organic matter
- Biology
  - Krill
  - Copepods
  - Phyto- and zooplakton
- Atmospheric chemistry
  - Aerosols
  - Frost flowers
  - Trace gases
- Oceanography
  - Water mass formation
  - Shelf processes

Ice Thickness Transects

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EM-Bird Technology

- Physical properties
  - Thermal
  - Optical
- Surface characteristics
  - Melt ponds
  - Satellite signatures
- Mass balance
  - Snow depth
  - Snow density / mass
- Fresh water

Sea Ice Sampling (Ice Coring)

Sea Ice Sampling

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Along Track Observations (Aspect)

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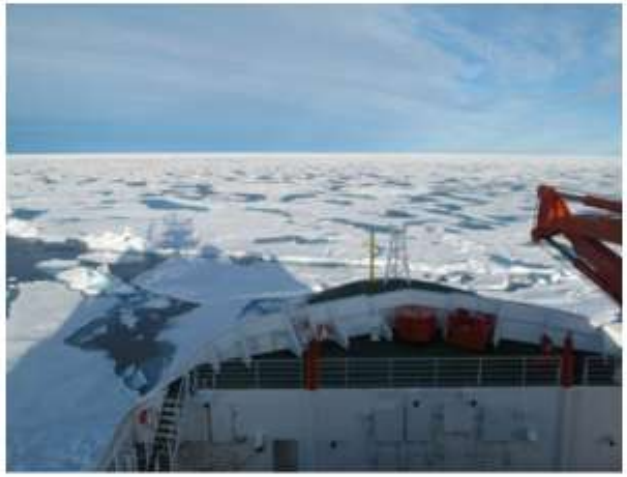

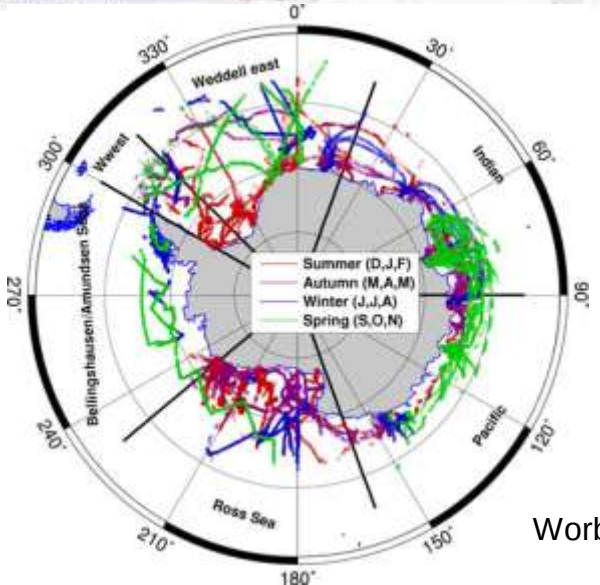

Worby et al. (2008)

70° 40‘ S
08° 16‘ W

- Operation year round
- Research focus in meteorology, geophysics, air chemistry
- Operation of several long term observatories
- Base for supply of Kohnen Station and land expeditions
- Opening 20th February 2009

NEUMAYER III – the hub

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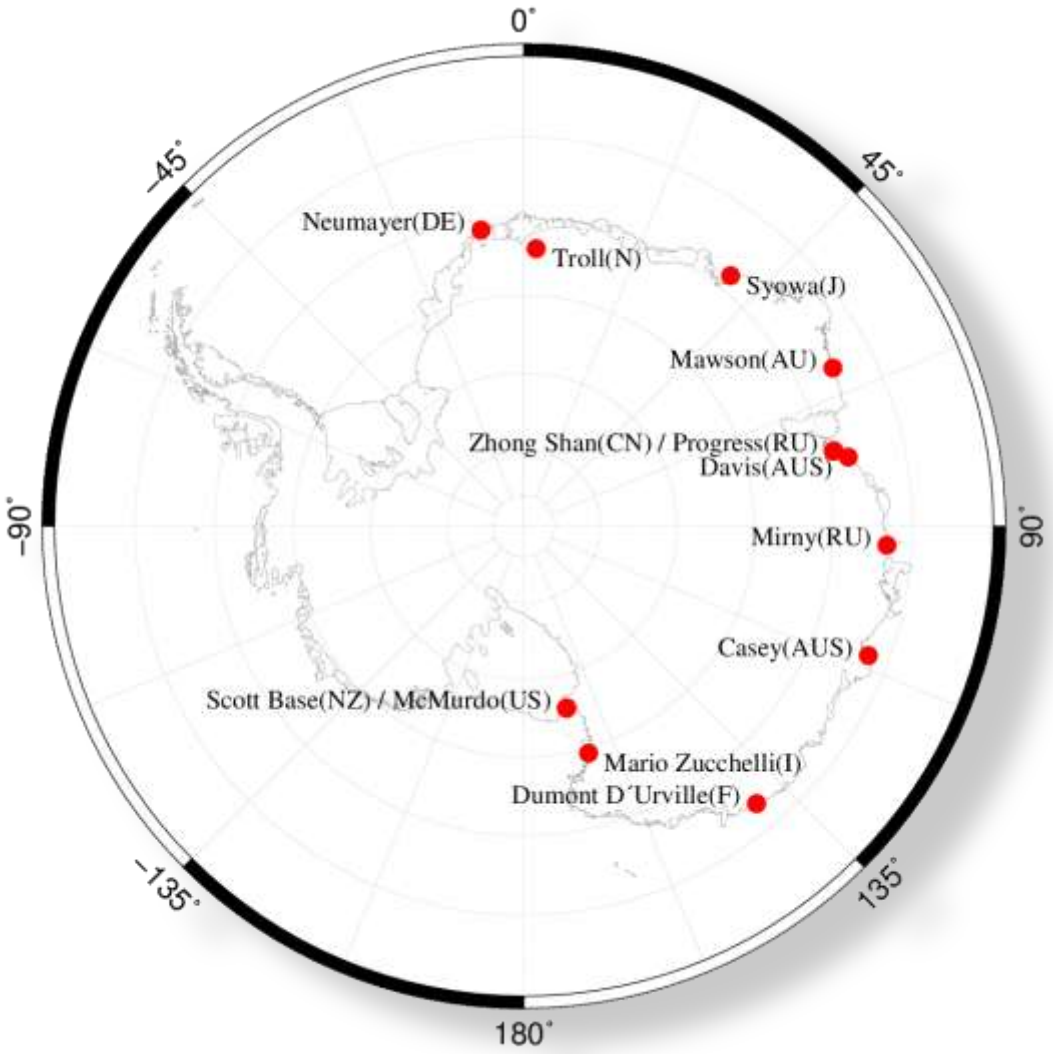
Georg von Neumayer Station	1981-1992	Logistic base for deep field operations
Neumayer Station	1992-2009	Supply base for Kohnen Station (800 km)
Neumayer III	2009-2039 ?	DROMLAN hub

Antarctic Fast Ice Network (AFIN)



Neumayer III since 2010

- Sea-ice Thickness
- Snow depth
- Snow and ice properties
- Ice-Shelf interaction
- Atmospheric conditions
- Autonomous stations (development)

Atka Bay

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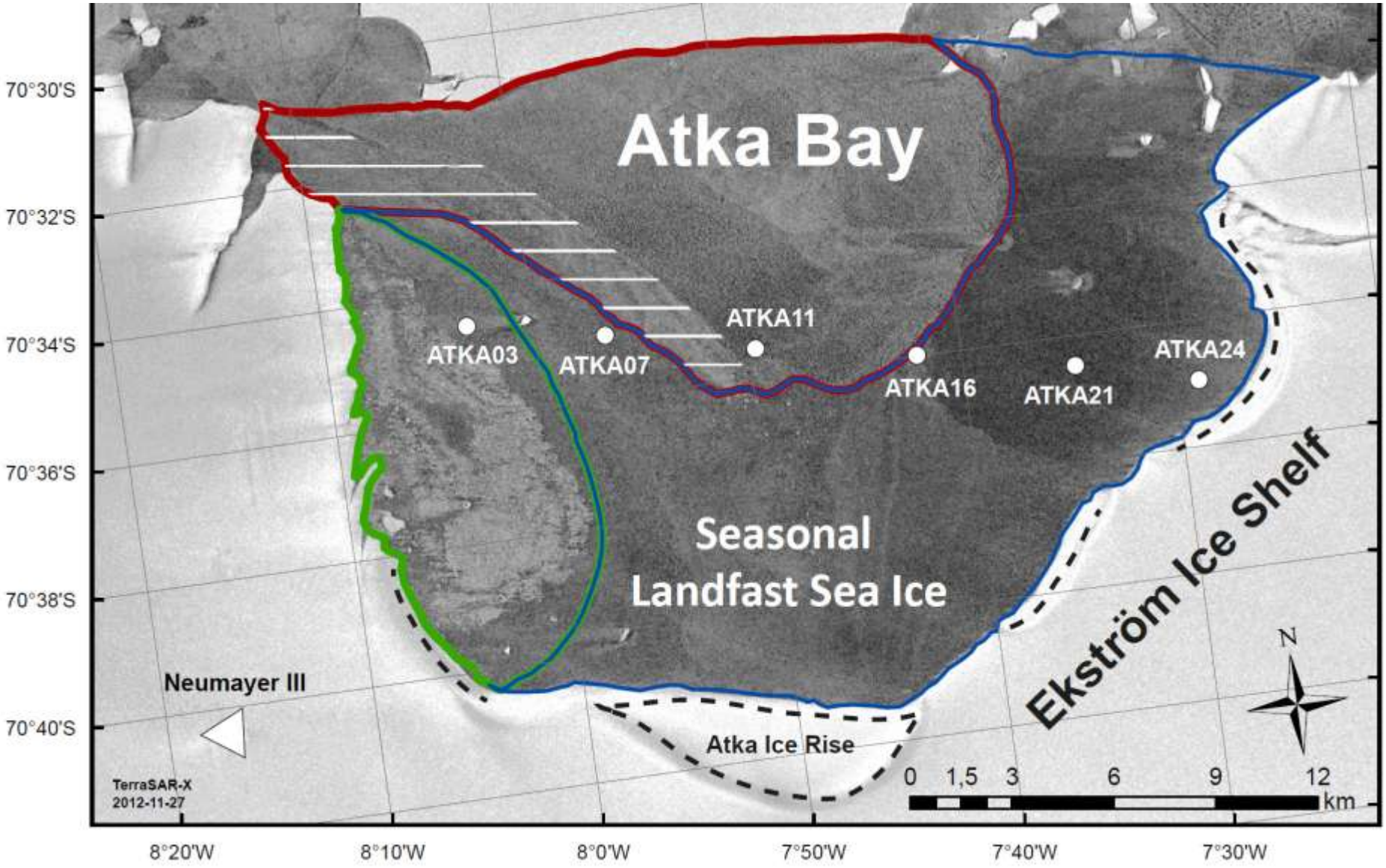

Thickness Drillings (impressions)

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Ice Thickness Transects (EM 31)

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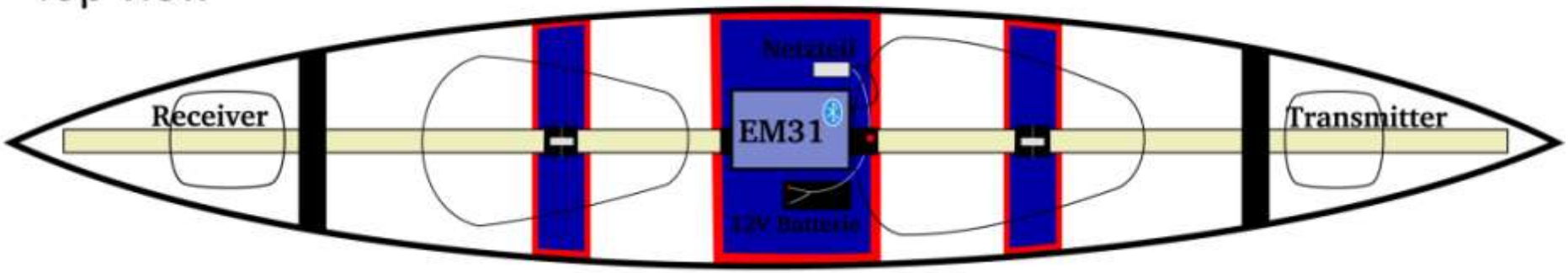
Top view



Weather and Radiation Station

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Spectral radiometers

Autonomous Measurements (Buoys)

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AWI
Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft

WCRP/SCAR International Programme for Antarctic Buoys

Home | Data | Deployment Plans | Meetings & Publications | Participants & Buoy types | Contact

IPAB: International Programme for Antarctic Buoys

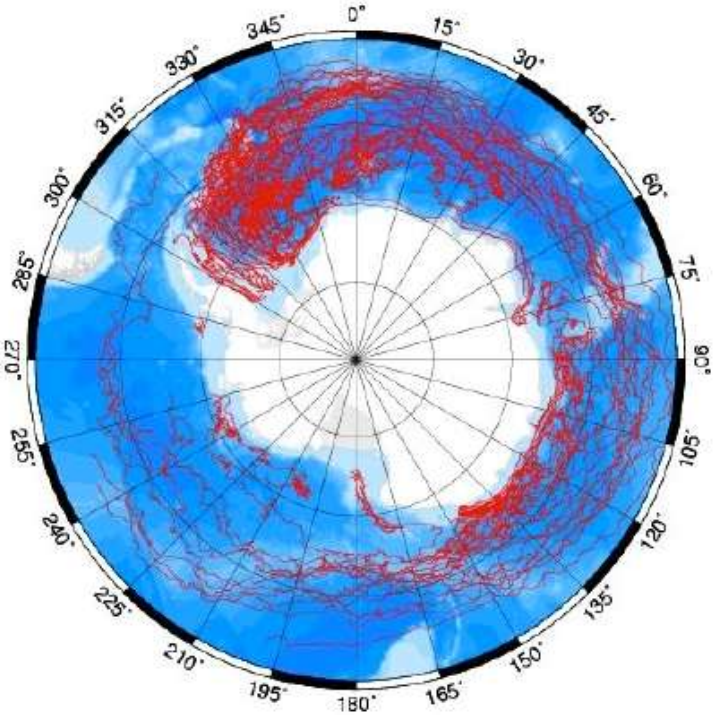
The Participants of the WCRP/SCAR International Programme for Antarctic Buoys (IPAB) work together to maintain a network of drifting buoys in the Southern Ocean, in particular over sea ice, to provide meteorological and oceanographic data for real-time operational requirements and research purposes.

IPAB data are used for many purposes, for example:
1. Research in Antarctic climate and climate change
2. Forecasting weather and ice conditions
3. Validation of satellite measurements
4. Forcing, validation and assimilation into numerical climate models
5. Tracking the source and fate of samples taken from the ice

IPAB is coordinated by Christian Haas from the University of Alberta (Canada) and chaired by Shuki Ushio from the National Institute of Polar Research (Japan). The website is hosted by the Alfred Wegener Institute for Polar and Marine Research (Germany). IPAB is a sister program of the International Arctic Buoy Program IABP.

NEW NEW NEW NEW

6th IPAB Participants Meeting, June 4&5, 2012, Geneva, Switzerland



Sea Ice Mass Balance

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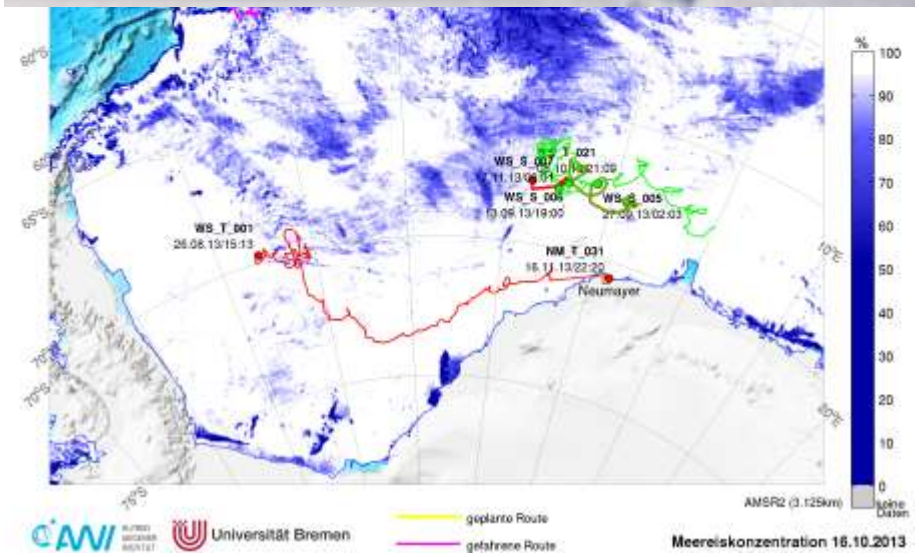
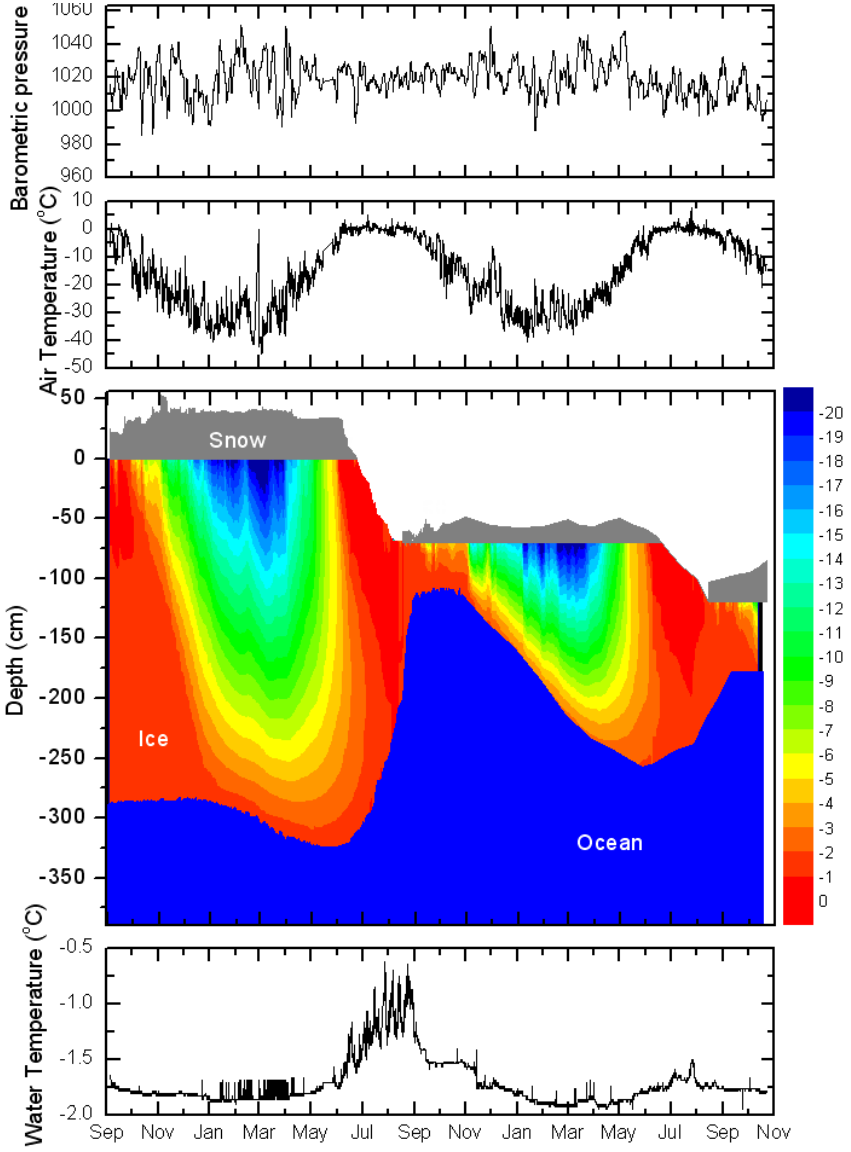
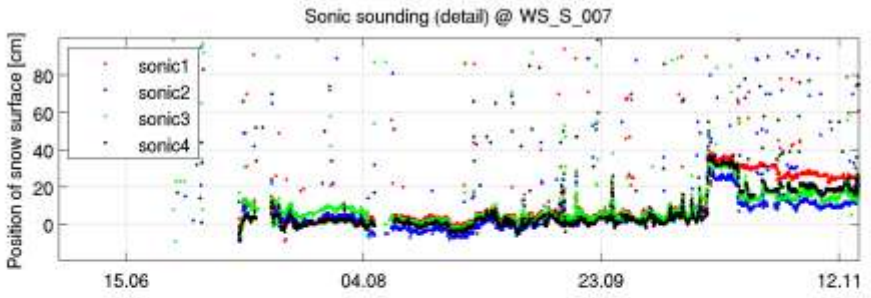
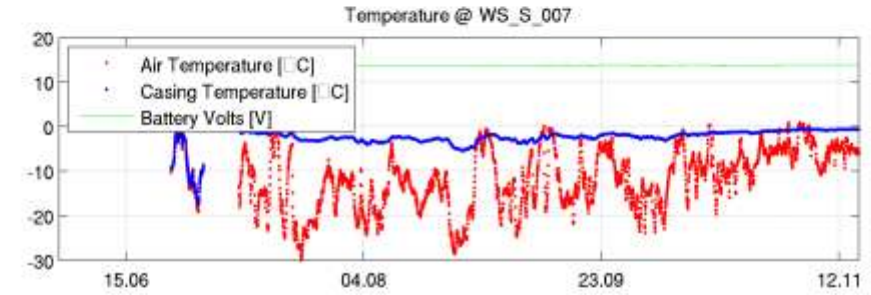
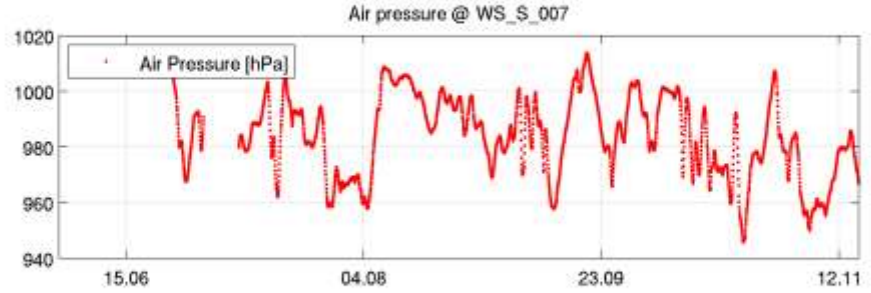




Snow Depth


Sonic sounding (detail) @ WS_S_007
Position of snow surface [cm]
sonic1
sonic2
sonic3
sonic4
80
60
40
20
0
15.06
04.08
23.09
12.11


Temperature @ WS_S_007
Air Temperature [°C]
Casing Temperature [°C]
Battery Volts [V]
20
10
0
-10
-20
-30
15.06
04.08
23.09
12.11


Air pressure @ WS_S_007
Air Pressure [hPa]
1020
1000
980
960
940
15.06
04.08
23.09
12.11

Radiation and Weather Station

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Upward-looking Sonars (Sea Ice Thickness)

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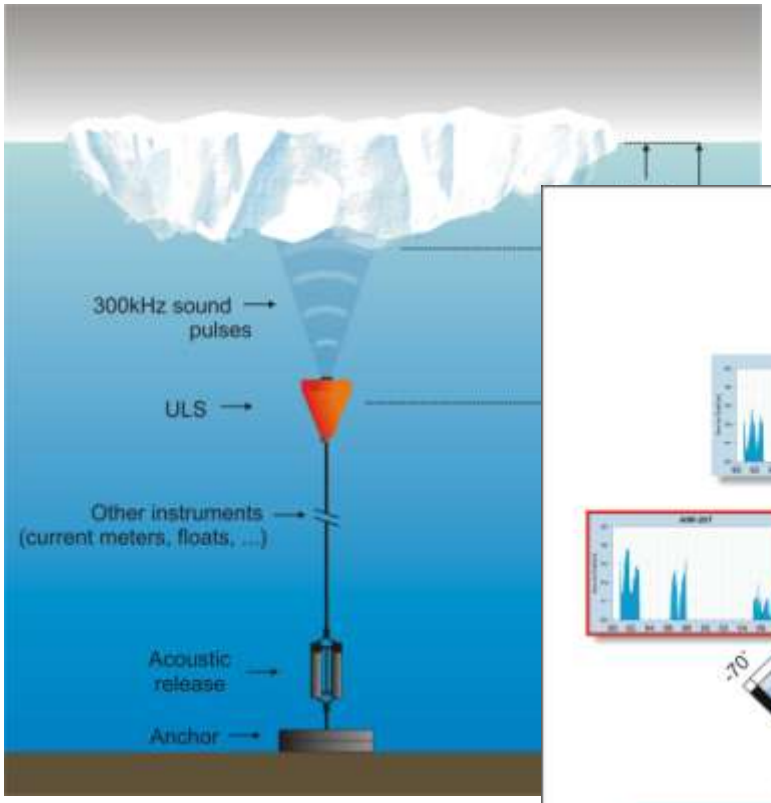
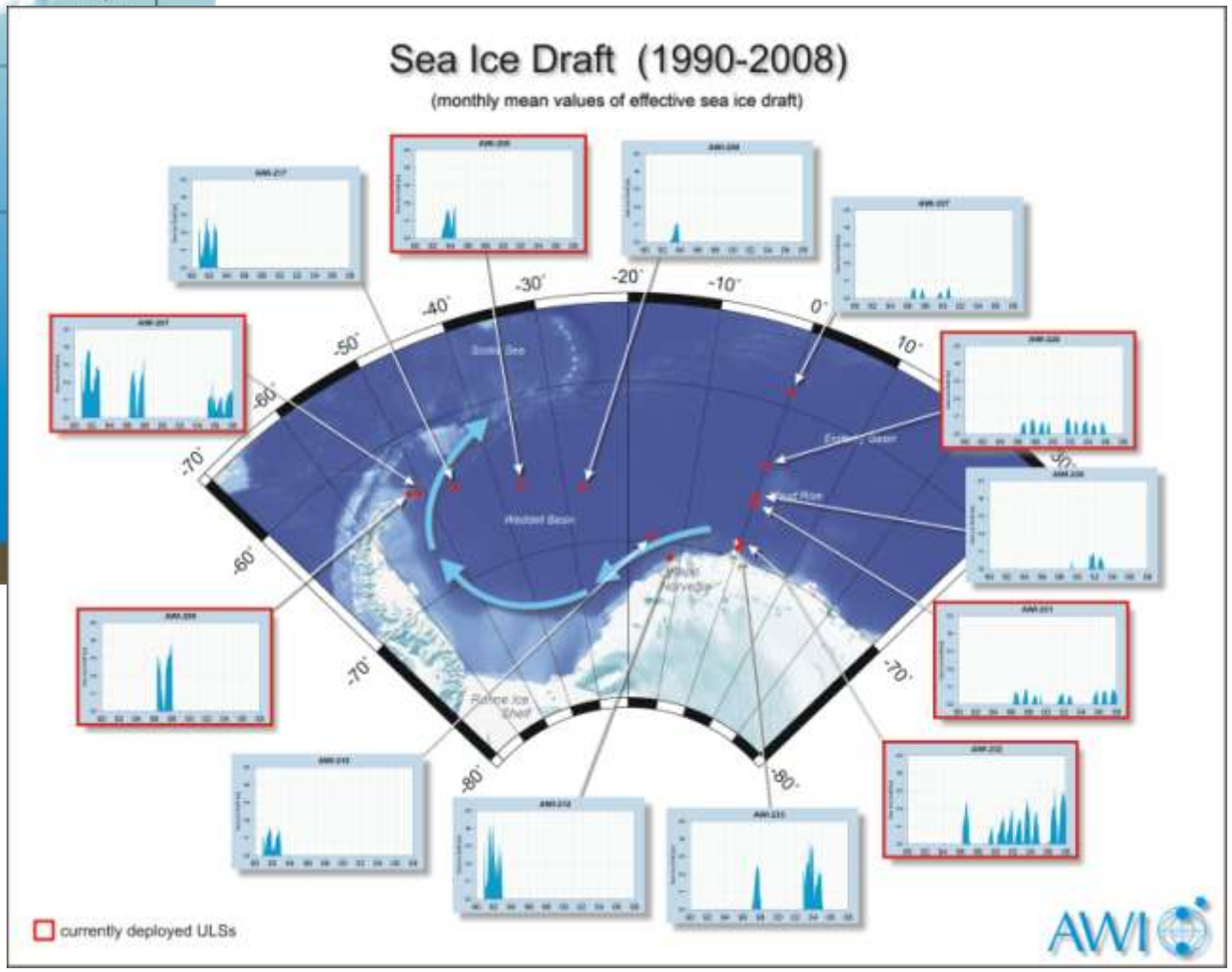




PANGAEA®

Data Publisher for Earth & Environmental Science

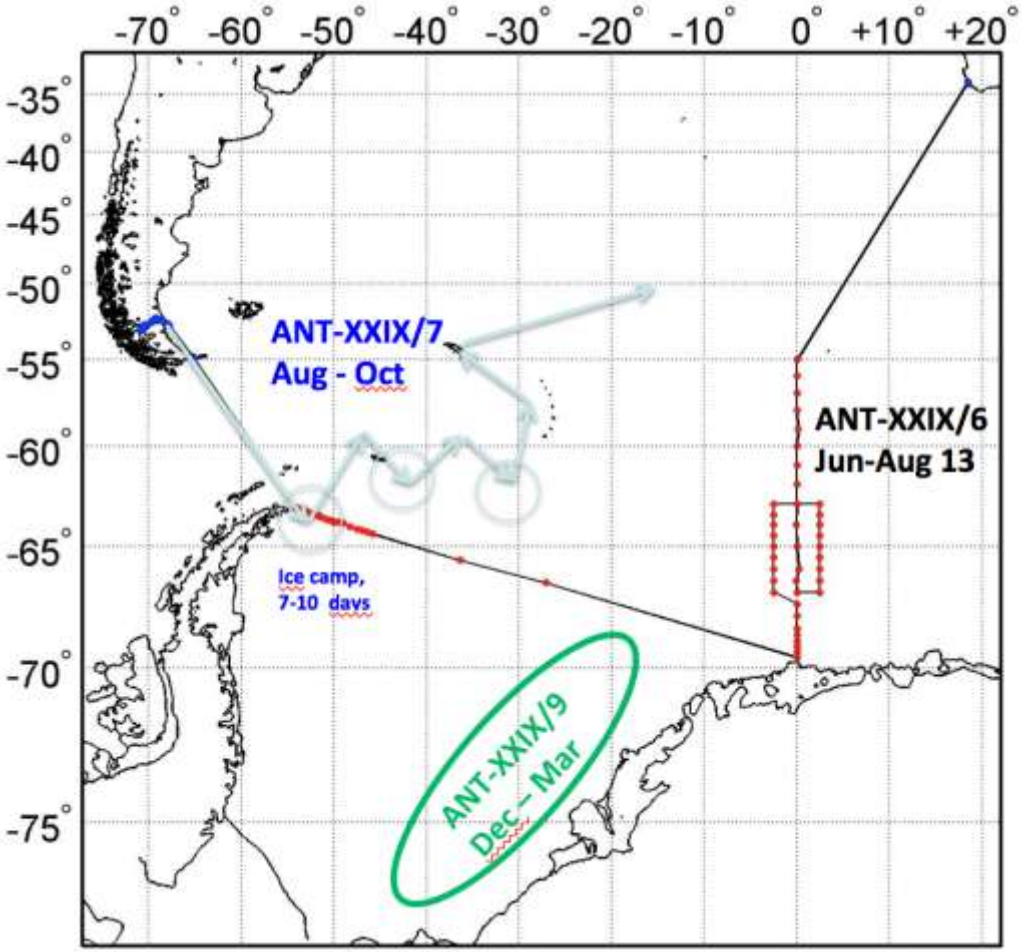
www.meereisportal.de

- All expedition data (work in progress)

- Sea-ice Thickness
- Snow depth
- Buoy tracks and data

Contact: Marcel Nicolaus
Marcel.Nicolaus@awi.de

Foto: M. Hoppmann



- Sea Ice Observations
  - Thickness
  - Physical properties
- Snow Observations
  - Depth & Redistribution
  - Properties
  - Optics & Energy budget
- Autonomous Measurements
  - Buoys
  - Moorings
- Along Track Observations
  - Aspect protocol

Neumayer III inside

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HELMHOLTZ GEMEINSCHAFT

Neumayer III underneath

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