FRAM
FRontiers in Arctic marine Monitoring

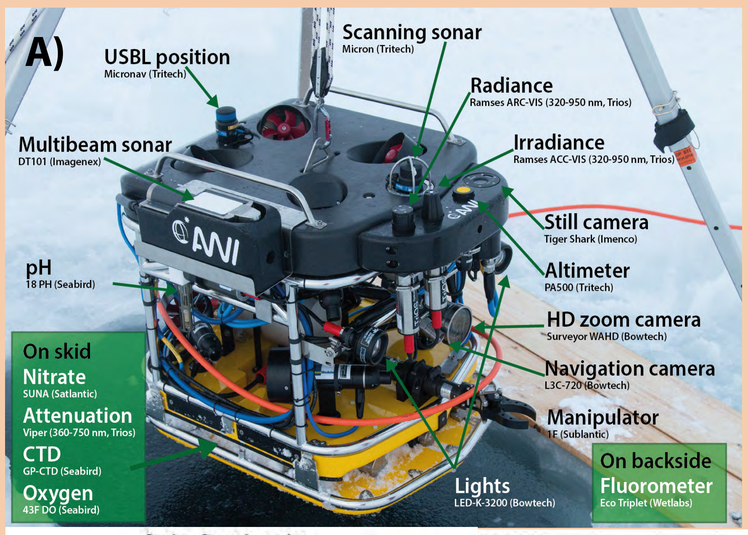
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

[1]Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany

Advancing interdisciplinary sea ice research with a new under-ice remotely operated vehicle and autonomous observatories.

Christian Katlein[1], Marcel Nicolaus[1], Mario Hoppmann[1], Frank Wenzhöfer[1], Ben Rabe[1]

Spatial variability: remotely operated vehicle (ROV)



A new under-ice ROV

Weight:	~120 kg
Size:	0.9 x 0.6 x 0.8 m
Range:	300 m
Depth rating:	500 m
Speed:	2 kN
People:	2-3 operators
Deployment:	on ice-station
Total weight:	700 kg

V8 M500 (Ocean Modules) with comprehensive sensor suite combining physical, oceanographic and biooptical sensors.

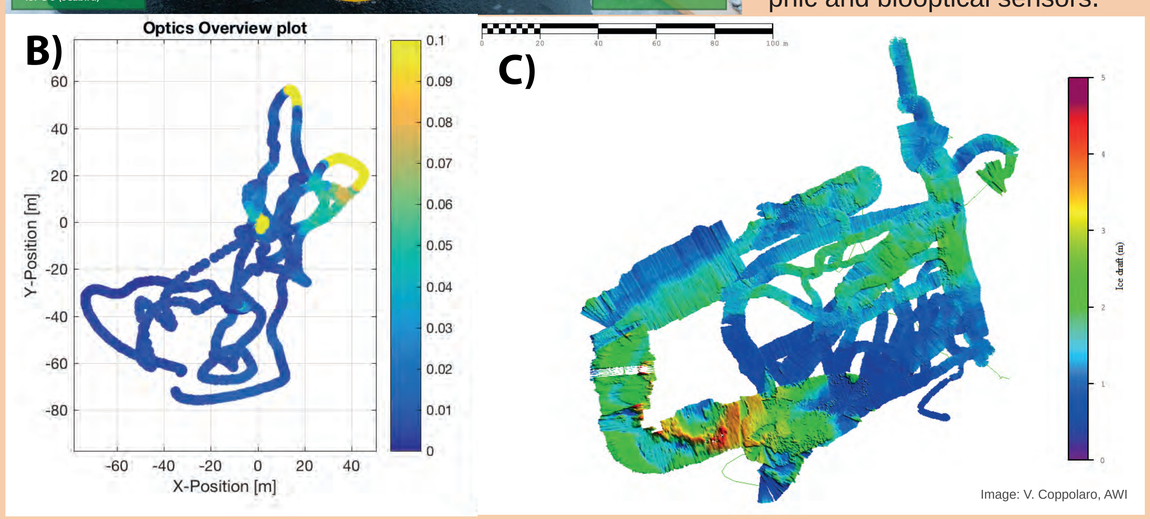


Image: V. Coppolaro, AWI

To observe the spatial variability of sea ice and its associated ecosystem, we equipped a new ROV for interdisciplinary sea ice research (A). Due to its unique payload to weight ratio it provides a capable sensor platform comparable to much larger vehicles. The vehicle's lightweight and modular design allows efficient operation by a small science team. All data are logged and timestamped synchronously using special recording software. First exemplary data of light transmittance during freeze up conditions (B) and sea ice draft mapped with upward looking multibeam sonar (C) are shown above.

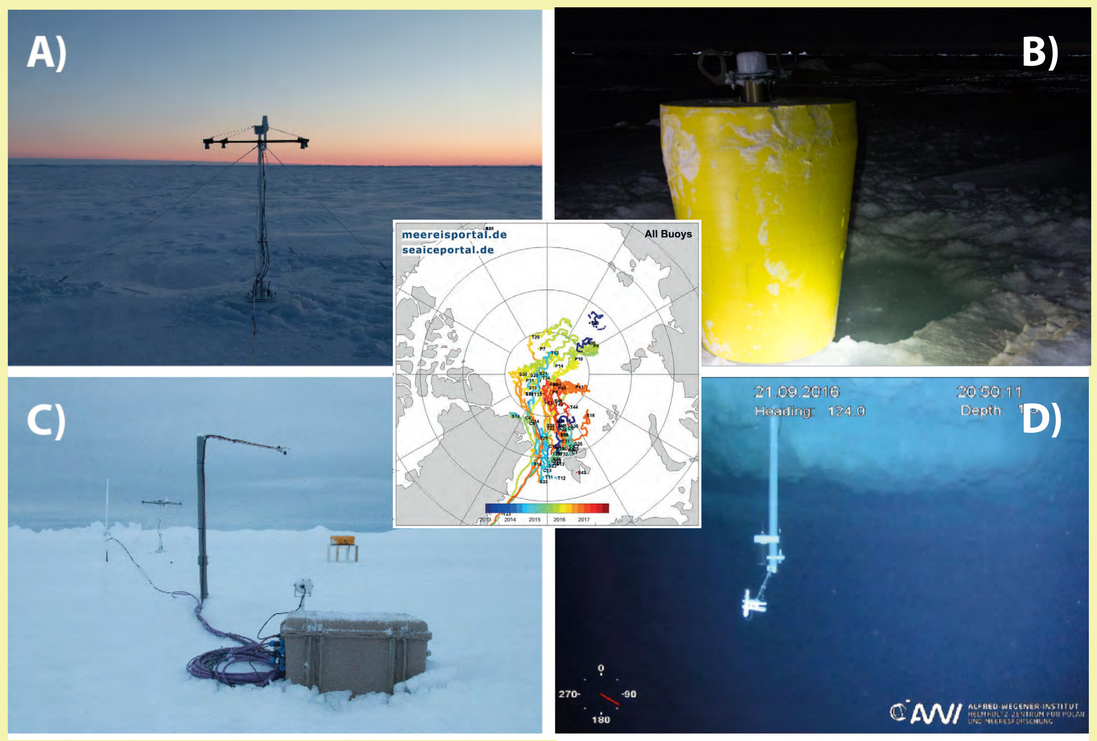
The ROV builds on five years of experience in polar ROV operations and was successfully deployed during RV Polarstern cruise PS101 in October/September 2016 in the central Arctic. The vehicle is currently being upgraded and prepared for its next Arctic mission during PS106 observing the spring transition in June and July north of Spitsbergen.

Upcoming additions:

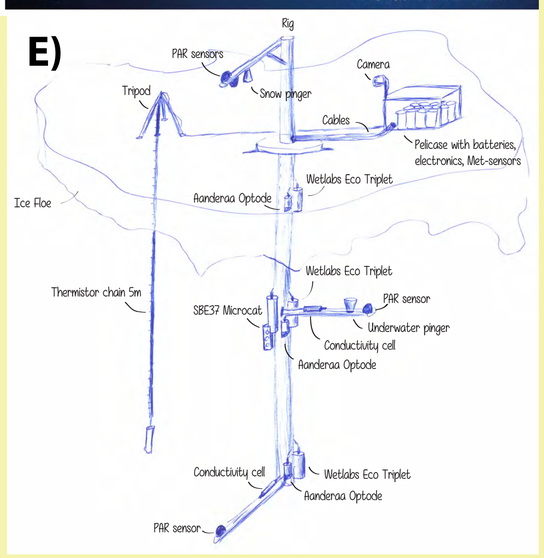
- water sampling (bottle / slurp sampler)
- current profiling (ADCP)
- zooplancton camera (ROV-LOKI)
- zooplankton net (ROV-SUIT)
- long baseline positioning (LBL)

During **MOSAiC**, the vehicle will be deployed weekly during the entire year of the drift observing the four dimensional evolution of the physical properties of sea ice and the associated ecosystem.

Temporal variability: drifting buoys



To extend observations beyond the direct presence of researchers, we use various autonomous sensor platforms. Snow Buoys (A) provide snow thickness and atmospheric observations. We deployed an ITP (B) upgraded with bio-optical sensors and are involved in implementing and testing bio-optical sensors for the IAOOS profiler buoy.
Extending the capabilities of traditional ice-mass-balance buoys (C), we developed the ITBOB (Ice Tethered Bio Optical Buoy, C,D,E), with chlorophyll and CDOM fluorometers, oxygen optodes, CTD packages and light sensors in the ice, directly under and 5m below the ice. We deployed a prototype in 2016 (C,D) and deploy two units in 2017 in the transpolar drift.



The FRAM concept

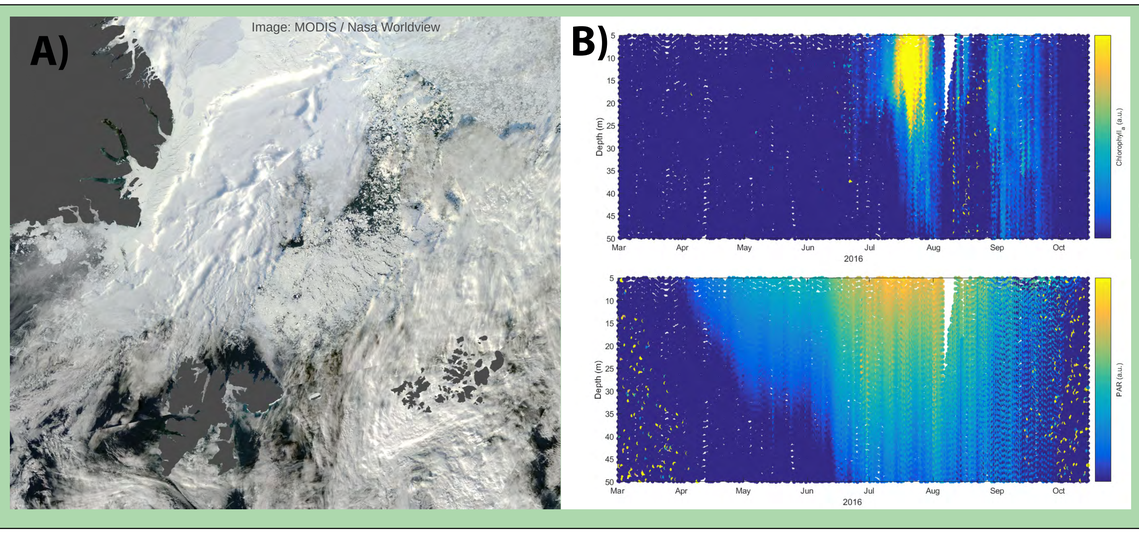
- **Improve observation coverage in the Arctic**
- **Extend existing technologies with interdisciplinary sensors**
- **Same sensors on ROV and buoy platforms**
- **From point measurements to a spatial picture and time series observations**
- **Lateral, vertical and temporal variability of ice properties and the associated ecosystem**
- **Interdisciplinary Arctic buoy deployment programme (MIDO)**

Under-Ice Autumn blooms !?

- exceptionally low sea ice concentration at 86°N. (A)
- decreasing chlorophyll$_a$ signal in the mixed layer (C)
- stunning abundances of zooplankton (ROV's video)

These observations might indicate a late season autumn bloom deep in the Central Arctic pack ice.

A significant increase of chlorophyll concentration in autumn clearly separated from the spring/summer bloom was also recorded by the FRAM ITP93 in a similar region of the transpolar drift (B).



Acknowledgements
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HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
HELMHOLTZ GEMEINSCHAFT

CHRISTIAN KATLEIN

Bussestraße 27
27570 Bremerhaven
Telefon 0471 4831-0
www.awi.de