First results from a new interdisciplinary robotic vehicle for under-ice research

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

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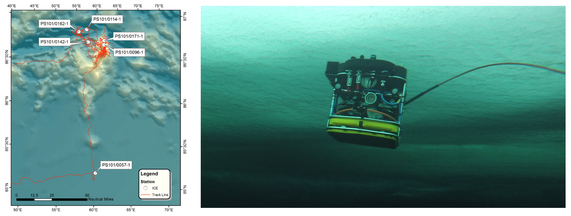
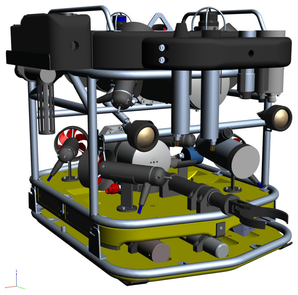
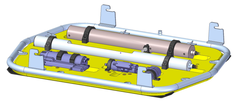
ROV „Beast“ for sea-ice research

To increase the capabilities for spatially extensive under-ice investigations, the Helmholtz Infrastructure Initiative FRAM (FRontiers in Arctic marine Monitoring) enabled the Alfred-Wegener-Institute to commission a ROV system for sea ice studies.
The system is composed of two redundant vehicle platforms with an extensive interdisciplinary sensor suite. It was built by Ocean Modules (Åtvidaberg, Sweden) in 2016 and immediately after acceptance tests taken on expedition to the Central Arctic. During the expedition PS101 of the german research icebreaker Polarstern, the vehicle was deployed during six sea-ice stations achieving a total of 10 different dives with over 22 hours of diving time, travelling a total horizontal distance of 11.5 km.



Design Challenges





Specifications:

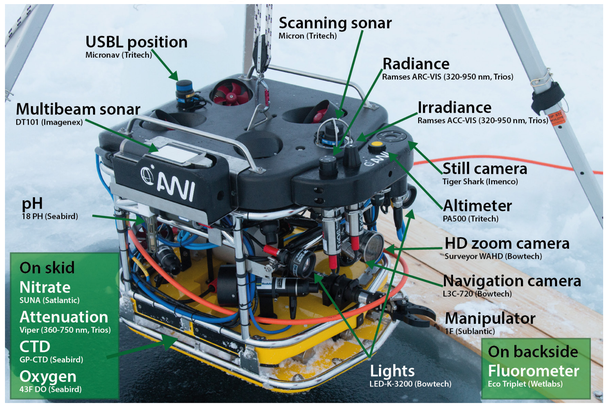
Manufacturer:	Ocean Modules
Model:	M500
Depth rating:	500m
Horiz. range:	300m
Weight:	125 kg
Size:	90x60x90 cm
Thrusters:	8 vectored, 150V

The design goal was to commission a lightweight but multifunctional ROV platform. It needs to be robust and is handled with ease by three persons under polar conditions in the sea-ice environment. The exceptionally large payload capacity relative to its size poses a challenge, as most sensors are to be pointed upward against the ice. The Ocean Modules M500 with its six degrees of freedom in maneuverability provides thus a platform superior to stable ROVs of the same size class. Water column sensors are located in a sensor skid underneath the main system, while ice-viewing sensors are mounted through the upper buoyancy block.

Next steps

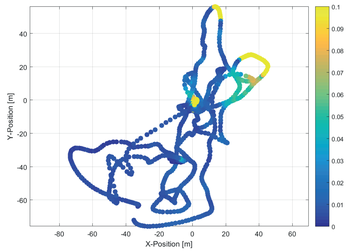
The Manufacturer will address some minor issues that could not be fixed before delivery due to the tight time schedule. The vehicle will be ready and all sensors fully functional for its next deployment during Polarstern cruise PS106 to the Arctic in May-July 2017.
The system comprises additional data and power connections, so that it can be used as versatile sensor platform and extend its capabilities to water sampling, zooplankton observations as well as many other needs of under-ice research.

Interdisciplinary sensor suite

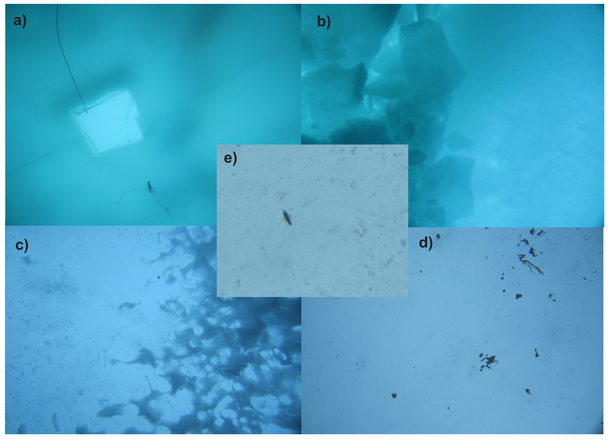


Light transmittance

This map shows light-transmittance of sea-ice as measured by the RAMSES radiometers during ice station PS101-0171. Both, the area of open water, as well as an area of thin newly formed ice are easily discernible.

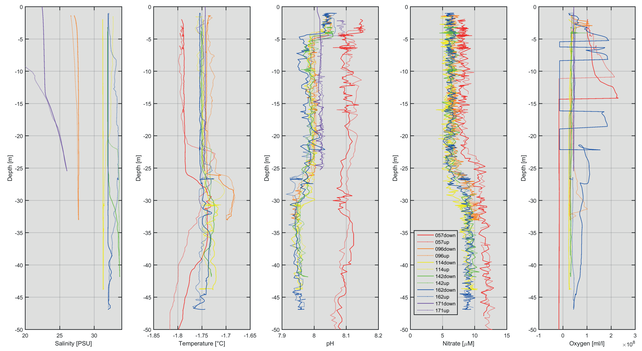


Upward looking images



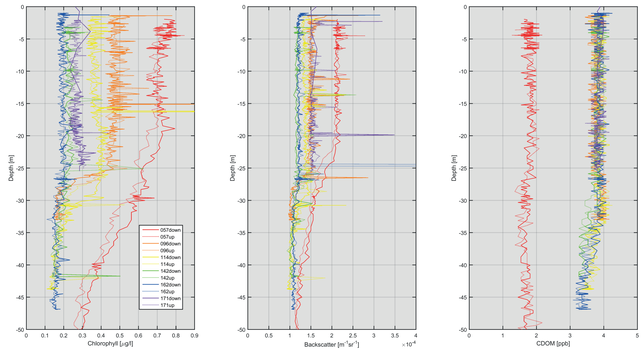
Images from the upward looking still camera: a) A Ctenophore floating below the deployment hole. b) Rafted pieces of new sheet ice. c) Melt structures of rotten sea ice. d) Last strands of *Melosira Arctica* hanging under the ice. e) Closeup of an Amphipod hanging at the ice-water interface.

Watercolumn profiles



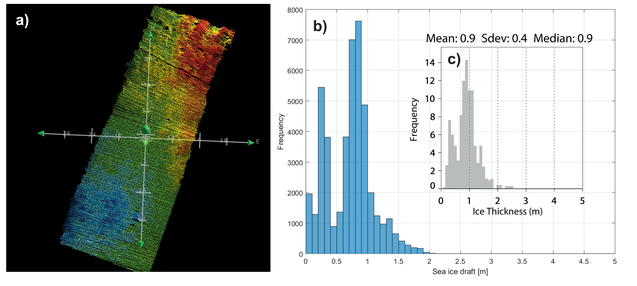
Vertical profiles measured onboard the ROV. CTD and Oxygen data seem to have some issues due to problems with the pumping system.

Autumn under-ice bloom !?



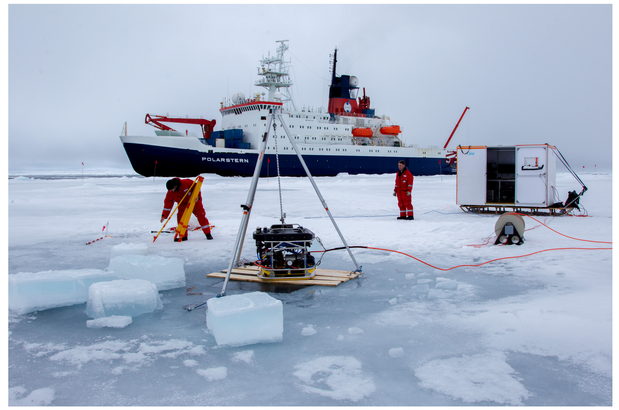
Data from the Triplet Fluorometer suggest, that chlorophyll content in the upper water layer was significantly decreasing over time. This might indicate either a decaying autumn bloom, or the very late stages of a summer bloom far into the ice covered area, likely caused by the exceptionally low ice concentration in the area.

Ice Thickness surveys



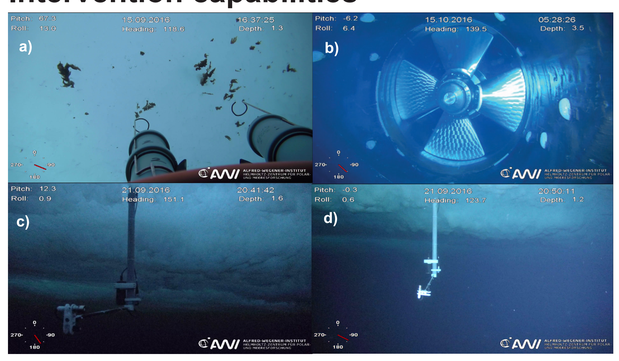
Sea ice thickness was measured by different methods: Multibeam sonar data (a) await further processing, while altimeter derived sea-ice draft (b) on station PS101-0171 compares well to EM ice thickness surveys (c).

Deployment



The ROV system is deployed directly from the ice through an access hole using a lifting tripod. All control electronics is located in the white control stand which can be put in place on sledges or by helicopter.

Intervention capabilities



Apart from passive sensing, the new system was used for active manipulation tasks such as suction sampling of algae (a), the inspection of possible damage on the ship‘s thrusters (b) as well as correction of a buoy sensor placement that was twisted during deployment (c & d).

Summary

- The ROV system was successfully deployed for the first time during Polarstern cruise PS101
- All scientific sensors acquired reasonable data under Arctic sea-ice
- Smaller issues with the sensor systems will be adressed before the next deployment on PS106 (spring 2017)
- Two Master students will work on the data

References
Katlein, C., et al. (2015), Influence of ice thickness and surface properties on light transmission through Arctic sea ice, J. Geophys. Res. Oceans, 120, 5932–5944, doi:10.1002/2015JC010914.
Katlein, C., Perovic, D.K., Nicolaus,M. (under review), Geometric effects of an inhomogeneous sea ice cover on the under ice light field, Frontiers in Earth Science: Cryospheric Sciences

Acknowledgements
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