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New Technologies for Arctic Research

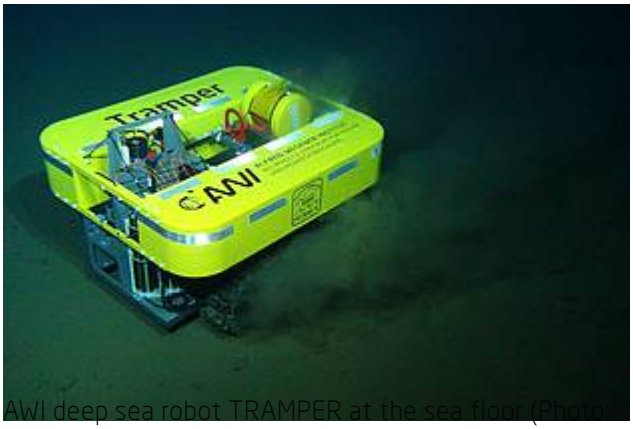
Underwater robot scheduled to surface after a year exploring the Arctic depths

The Helmholtz Alliance ROBEX tests innovative technologies during a Polarstern expedition

[18. August 2017] **On Tuesday, 22 August the research icebreaker Polarstern will depart the Norwegian port of Tromsø for a unique expedition to the Arctic: the autonomous underwater robot TRAMPER is scheduled to resurface, after a full year of deep-sea exploration in the Arctic. It and other robotic systems jointly designed by deep-sea and aerospace researchers in the context of the Helmholtz Alliance ROBEX will now undergo nearly three weeks of testing under real-world operating conditions. The purpose of ROBEX is to develop new technologies for exploring remote regions characterised by extreme environmental conditions.**



As Dr Frank Wenzhöfer from the Alfred-Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) confidently proclaims, "TRAMPER will surface to greet us." The biogeochemist designed the deep-sea crawler together with AWI engineers and subsequently deployed it on 11 July 2016, during a previous Polarstern expedition to the Arctic Ocean. In the event that the scientists can't get the TRAMPER to surface and return to the Polarstern, they still have an ace up their sleeve: the ROV Kiel 6000, supplied by the GEOMAR Helmholtz Centre for Ocean Research Kiel. The remote-controlled underwater vehicle can, if need be, mechanically release the TRAMPER's ballast, which will automatically make it rise to the surface. Once there, it can be located using GPS and its VHF homing beacon, and the Polarstern can come retrieve it.



AWI deep sea robot TRAMPER at the sea floor (Photo: ROV-Team GEOMAR)

Wenzhöfer's thoughts are above all on the treasure trove of information he hopes to find: "I'm very curious to see whether the TRAMPER carried out all of its pre-programmed tests as planned," says

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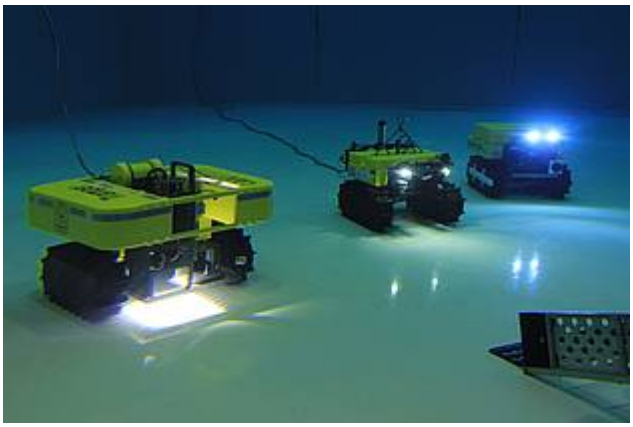
the scientific leader of the Polarstern expedition and biogeochemist in the Helmholtz-Max-Planck Joint Research Group for Deep-Sea Ecology and Technology. “Needless to say, when it came to calculating the power needs, we in the ROBEX Alliance took into account the fact that the robot would be working for an entire year, without any external contact, at a depth of roughly 2,500 metres and extreme temperatures of roughly 0.8 °C below zero. But, since no-one before us has ever ventured such an undertaking in the Arctic, there’s always a chance that things didn’t go quite as planned.”

TRAMPER was designed for the continuous measurement of oxygen consumption on the seafloor. Every Monday, the robot traverses 15 metres of the ocean floor to find an untouched area; then an image-detecting camera scans the surface. If it recognises stones or other obstacles, TRAMPER moves a metre farther. Once it finds a suitable spot, it takes high-resolution images of the sampling area before the actual measurement begins. Here, sensors are extended into the sediment in increments of only 0.1 millimetres, measuring the oxygen distribution in the topmost ten centimetres of the seafloor. Once this procedure is complete, the TRAMPER goes on standby for a week – the only way to ensure it has sufficient energy for the 52-week testing cycle. The real questions behind the oxygen measurements are how the carbon cycle works in the ocean, how organisms on the ocean floor find sustenance, and what changes can be observed in the wake of climate change [further information in this press release from 18.07.2016]. The researchers plan to upload the data gathered, supply the TRAMPER with fresh sensors and batteries, and send it on another one-year trek in the AWI’s long-term observatory “Hausgarten”.


Family photo of the ROBEX crawlers (Photo: Lars Grübner)

“The expedition will be especially exciting for the aerospace researchers, some of whom have never worked on a ship before,” explains ROBEX coordinator Martina Wilde (ROBEX stands for Robotic Exploration under EXtreme conditions). Working in close collaboration with the deep-sea researchers, they are currently investigating further innovative technologies. As such, TRAMPER’s two “big brothers” are already slated for their first missions in the Arctic depths: the NOMAD, which was also designed at the AWI, and the autonomous crawler VIATOR, which was designed and tested under the auspices of the GEOMAR, together with Airbus and the German Research Center for Artificial Intelligence (DFKI). Starting from its base station (MANSIO), VIATOR will perform scientific surveying; then, once its work is done, it will use navigation software and markers borrowed from the aerospace industry to find its way back to its “garage”.

Further, the University of Bremen’s MARUM (Centre for Marine Environmental Sciences), Airbus and the University of Würzburg have jointly developed a new underwater glider – a task that posed new challenges regarding how to provide the flying-wing glider with a design and steering systems that would allow it to sweep through the ocean’s upper layers, recording what it sees in high resolution. In turn, advanced unmanned aircraft designed by the AWI and the University of Würzburg are intended to help the AWI’s autonomous underwater vehicle PAUL navigate in hard-to-reach, ice-covered regions.

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The Institute

The Alfred Wegener Institute pursues research in the polar regions and the oceans of mid and high latitudes. As one of the 19 centres of the Helmholtz Association it coordinates polar research in Germany and provides ships like the research icebreaker Polarstern and stations for the international scientific community.

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Lastly, the "lab on a chip" will be tested – a miniaturised, high-density integrated analysis device for gathering chemical readings that can be employed not only in various underwater technologies, but also future aerospace systems. In turn, all of these innovative vehicles and devices will be monitored and supported by the GEOMAR's ROV Kiel 6000, a remote-controlled underwater vehicle with advanced video and camera systems.

In the course of this Polarstern expedition, many of the technologies the aerospace and deep-sea researchers are testing are the first of their kind. "The collaboration in the Alliance is exhilarating for both sides, because there's so much we can learn from each other," reports Martina Wilde. "Even though space and the ocean depths may seem very different at first blush, they're both extreme habitats that can only be explored with the help of new technologies." Accordingly, the ROBEX coordinator hopes this deep-sea demonstration mission will be just as successful as the tests for aerospace technologies conducted on Mount Etna in June 2017.

You can follow then expedition on the Polarstern-Blog.

Video: TRAMPER in the deep sea

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