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HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

AWI-Hausgarten

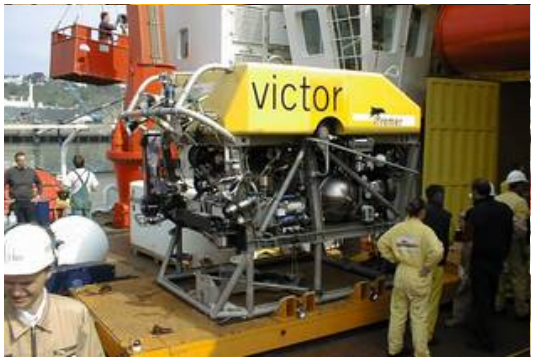
Anniversary in the far north

20 years of long-term ecological research in the deep Arctic Ocean

[29. August 2019] **20 years ago, scientists from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) laid the "foundation stone" for a unique long-term observatory in the partly ice-covered Fram Strait between Greenland and Svalbard, which they call their HAUSGARTEN. The deep-sea observatory is the first, and still the only one of its kind for year-round physical, chemical and biological observations in a polar region. Here researchers investigate how a polar marine ecosystem alters in a period of global change.**



As a result of climate change, the Arctic is changing at a rapid pace. However, observation programmes that provide information on changes in the Arctic marine ecosystem are rare, since the polar regions are largely only accessible with the help of modern and expensive infrastructures and equipment. The HAUSGARTEN stations are spread over an area of roughly 30,000 km^2 between 78° and 80° North and between 6° West and 11° East. In this area, deep-sea researchers regularly carry out investigations at a network of 21 stations at depths ranging from 250 to 5500 metres. Using a multidisciplinary approach, they study all parts of the marine ecosystem, from the surface down to the deep seafloor, in order to determine the effects of climate change on the biodiversity of the marine Arctic. Samples and measurements are taken in the water column and at the seafloor every year during regular summer expeditions. In addition, instruments anchored to the sea floor continually take samples and measurements; more recently, mobile autonomous devices have been in operation all year round.



ROV Victor6000 (Photo: Michael Klages)

"In summer 1999, we used the French Remotely Operated Vehicle Victor6000 for the first large-scale mapping of the seafloor in the HAUSGARTEN area," reminisces one of the founders, Dr Thomas Soltwedel, a biologist at the Alfred Wegener Institute. "Actually, at that time we had a different overarching question: what causes / allows the high biodiversity in the deep sea? We then decided to always carry out our investigations into this question at the same location, in order to gain an idea of the natural fluctuations in the environmental conditions in the research area over time – and so the time series was created." In times of global climate change, the central question is now how a polar marine ecosystem alters with the global changes.

Since it was founded, the HAUSGARTEN Observatory in the eastern Fram Strait has also served as an experimental area for unique long-term biological investigations on the Arctic deep seafloor. For example, in the past year, samples were successfully taken from an 18-year colonisation experiment, allowing us to demonstrate that the colonisation of free areas at the deep

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Contact

Science

Thomas Soltwedel
+49(471)4831-1775
Thomas.Soltwedel@awi.de

Press Office

Folke Mehrtens
+49(471)4831-2007
Folke.Mehrtens@awi.de

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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

seafloor by sessile organisms like sponges and sea lilies is an extremely slow process. This shows that human interventions at the deep seafloor, e.g. the planned mining to extract mineral sludge and manganese nodules, could cause lasting damage to the deep-sea ecosystem. Other long-term experiments simulate various scenarios for the altered environmental conditions that are likely based on the current global changes. Feeding experiments investigate how organisms at the seafloor respond to quantitative and qualitative changes in the food supply. Further, as part of the EU-funded INTAROS (Integrated Arctic Observing System) project, a highly technically complex experimental approach will be used to investigate, for the first time, how bottom-dwelling deep-sea organisms respond to the continuing acidification of the oceans.


Deployment of the AUV during a Polarstern expedition (Photo: Michael Ginzburg)

The continuous ecological studies at the HAUSGARTEN have already demonstrated a number of interesting trends. The widespread idea that deep-sea ecosystems only respond very slowly, if at all, to environmental changes in the surface water needs to be revised. For instance, between 2005 and 2008, an episodic and marked increase in the water temperature in the Fram Strait of roughly 2 °C led to profound changes in the phytoplankton communities in the light-flooded surface water. The smaller organisms that live at and in the deep seafloor responded rapidly, since these organisms feed exclusively on dead plankton that sink to the seabed. The number and species composition of larger bottom dwellers reacted more slowly, with a delay of roughly a year.

The intermittent warm water influxes between 2005 and 2008 caused changes in the marine ecosystem in the Fram Strait, which among others led to the migration of sub-polar and boreal species of zooplankton from farther south, offer a first glimpse of the ecological conditions that can be expected in a warmer and increasingly ice-free Arctic Ocean. Since then, the water temperatures in the Fram Strait have fluctuated relatively little, but a look back at the temperature development over the last 20 years confirms the global trend of continually rising water temperatures. A similar trend, although with a less steep gradient, was found even at depths of 2500 m in the HAUSGARTEN area.

“Even after 20 years of intensive observations at the HAUSGARTEN observatory, we still can’t say with complete certainty whether the changes detected are a reflection of the natural variations in a marine polar ecosystem, or whether the trends seen are the result of anthropogenic climate change, and so possibly permanent,” says Thomas Soltwedel. Using a modelling approach, a recent scientific study demonstrated that time series for roughly 30 years are needed in order to differentiate between climate-change driven changes in the marine ecosystem and natural variability, and to develop robust prediction models. At HAUSGARTEN, roughly two thirds of this time span has already been covered. Currently, the long-term observations are continuing during the ongoing Polarstern expedition PS121.

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