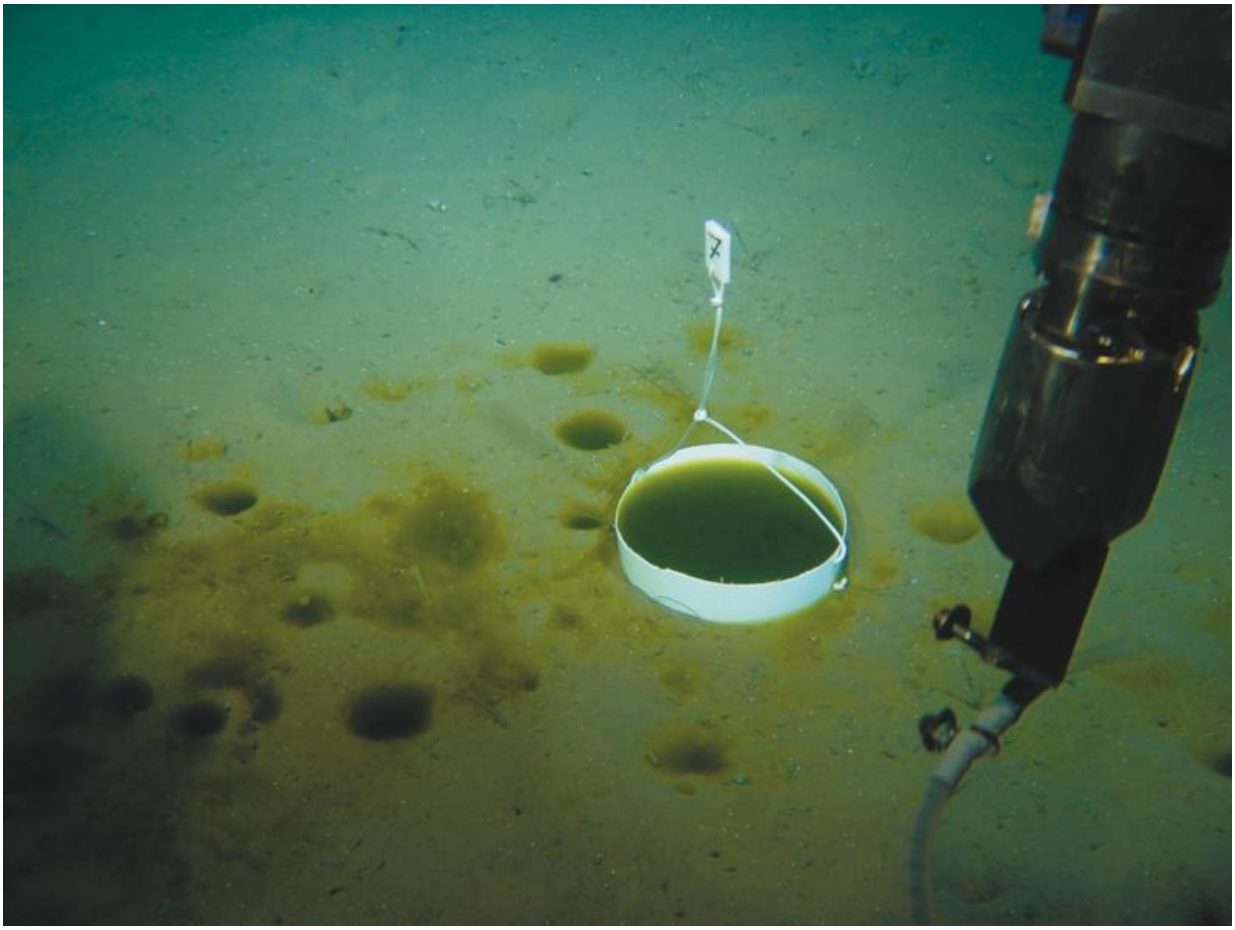
Climate change: Warm water is mixing up life in the Arctic

November 20 2015



Experiments at AWI longterm observatory HAUSGARTEN. Selective enrichment of the seafloor with organic matter. Credit: Alfred-Wegener-Institut/Michael Klages

The warming of arctic waters in the wake of climate change is likely to produce radical changes in the marine habitats of the High North. This is indicated by data from long-term observations in the Fram Strait, which researchers from the Alfred Wegener Institute (AWI) have now analysed. Their most important finding: even a short-term influx of warm water into the Arctic Ocean would suffice to fundamentally impact the local symbiotic communities, from the water's surface down to the deep seas. As the authors recently reported in the journal *Ecological Indicators*, that's precisely what happened between 2005 and 2008.

The Arctic is a remote and extreme habitat. Yet, despite its isolation, the anthropogenically accelerated climate change will massively transform this region in the years to come. We've known for some time now that, thanks to the greenhouse effect, the sea-ice cover in the Arctic is shrinking and the world's oceans are gradually warming. But it was unclear just how polar marine organisms were responding.

Scientists at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) have now used an unprecedented set of long-term observations to show that arctic marine habitats could radically change if subjected to a sustained rise in temperature. As the AWI researchers detail in the journal "*Ecological Indicators*", the most surprising finding is that the thermally induced changes at the ocean surface can rapidly spread to affect life in the deep seas.

In order to investigate the changes in the ecosystems of arctic waters, for the past 15 years the AWI has operated the deep-sea observatory "HAUSGARTEN" in the Fram Strait, the sea lane between Greenland and Svalbard. HAUSGARTEN is a network of 21 individual research stations, which AWI staff seek out every summer to collect water and soil samples. Some of the stations feature anchored systems that operate year-round, recording the water temperature and tides, collecting water

and soil samples at regular intervals, and capturing the sediments that drift down to the seafloor from the upper water layers.

"This is the only observatory of its kind in the world. There's no other project in which readings from the surface down to the ocean floor were taken in fixed positions over such a long time - let alone in the polar regions," says AWI biologist Thomas Soltwedel.

For the current publication, the AWI researcher and his team analysed the first 15 years of the HAUSGARTEN dataset. The Fram Strait is especially interesting for Soltwedel and his colleagues because it represents the only deep juncture in the Arctic Ocean, allowing water masses from the Atlantic to flow into the Arctic to the west of Svalbard. In turn, water and ice floes find their way back out of the Arctic Ocean on the strait's Greenland side.

Normally the water near the surface, which flows north out of the Atlantic through the Fram Strait, has an average temperature of three degrees Celsius. Yet with the help of their observatory, the AWI researchers were able to determine that from 2005 to 2008 the average temperature of the inflowing water was one to two degrees higher: "In that time, large quantities of warmer water poured into the Arctic Ocean. Since polar organisms have adapted to living in constant cold, this extra heat input hit them like a temperature shock," explains Soltwedel.

The reactions in the ecosystem were correspondingly extreme: "We were able to identify serious changes in various symbiotic communities, from microorganisms and algae to zooplankton. One major change was the increase in free-swimming conchs and amphipods, which are normally found in the more temperate and subpolar regions of the Atlantic. In contrast, the number of conchs and amphipods in the Arctic dropped significantly," reports Soltwedel.

Another remarkable aspect: the decline in small, hard-shelled diatoms. Prior to the unexpected influx of warm water, they made up roughly 70 per cent of the vegetable plankton in the Fram Strait. But during the warm phase, the foam algae Phaeocystis took their place. A change with consequences: "Unlike diatoms, foam algae tend to clump and sink to the ocean floor, where they become a food source. But the sudden rise in available food led to major changes in deep-sea life, including a noticeable increase in the settlement density of benthic organisms," explains the AWI biologist.

Soltwedel can't yet say exactly how all these changes will affect the overall arctic food web in the future: "Above all, we're troubled by the simple fact that the changes have been so rapid, and so far-reaching."

Since the flow of warm water has subsided, the water temperature in the Fram Strait has stabilised - though it is still slightly above the average value from before 2005. Yet the changes in the ecosystem have partly become lasting realities. For example, the number of diatoms remains very small. And the conchs from the lower latitudes seem to have made a home for themselves in the Fram Strait.

"At the moment we can't say whether the warm-water influx we've monitored is due to climate change, as there are also natural climate fluctuations that, for instance, occur every ten years. They overlap with the anthropogenically caused effects of climate change, as a result of which, after 15 years, we still don't exactly know whether this flow of warm water was the result of strictly natural causes," says Soltwedel.

That being said, the results of the ecological long-term studies clearly show that even short-term changes in ocean temperature can drastically impact life in the Arctic. As the AWI researcher aptly puts it: "You could say the episodic warm-water influx offered us a glimpse of the future."

Without the observations made over the years at HAUSGARTEN, which are supplemented by regular shipborne measurements, that glimpse would have never been possible. According to Soltwedel: "This shows how important long-term observations at the same location are to identifying lasting changes and making forecasts on future developments."

The research efforts at HAUSGARTEN will be continued. "We'll only be able to say for sure whether changes are natural or manmade once we have data covering several decades," says Thomas Soltwedel. The first 15 years already collected offer an excellent basis.

More information: Thomas Soltwedel et al. Natural variability or anthropogenically-induced variation? Insights from 15 years of multidisciplinary observations at the arctic marine LTER site HAUSGARTEN, *Ecological Indicators* (2015). DOI: 10.1016/j.ecolind.2015.10.001

Provided by Alfred Wegener Institute