Young and thin instead of old and bulky: Researchers report on changes in Arctic sea ice

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In the central Arctic the proportion of old, thick sea ice has declined significantly. Instead, the ice cover now largely consists of thin, one-year-old floes. This is one of the results that scientists of the Alfred Wegener Institute for Polar and Marine Research in the Helmholtz Association brought back from the 26th Arctic expedition of the research vessel Polarstern.

The ship arrived at its home port of Bremerhaven at about 7 o'clock this morning. Prior to that it had covered more than 11,800 nautical miles on its 16-week research voyage and accommodated around 130 scientists from six countries on the three legs. The last stage took them through the central Arctic Ocean and the Polarstern also reached the North Pole. One of the most important research questions was: Did sea ice melt to a greater extent this summer, making it thinner than in past years?

To answer it, the sea ice physicists headed by Dr. Marcel Nicolaus and Dr. Stefan Hendricks employed a measuring instrument called "EM Bird". This nearly four-metre-long, torpedo-shaped probe is flown over the ice with a helicopter and meas-ures the ice thickness by means of an electromagnetic induction method. In this way the sea ice physicists created an ice thickness profile of the central Arctic over a total distance of more than 2,500 flown kilometres. Their conclusion is: at sites where the sea ice was mainly composed of old, thicker ice floes in the past decades there is now primarily one-year-old ice with an average

thickness of 90 centimetres. Only in the Canadian Basin and near the Severnaya Zemlya island group in northern Siberia did the sea ice physicists encounter significant amounts of several-year-old ice. As a rule, this old ice is between two and five metres thick.

Compared to their measurements from 2007, when the extent of the sea ice had di-minished to a record minimum of 4.3 million square kilometres, the researchers have not yet found any differences, however. "The ice has not recovered. This summer it appears to have melted to exactly the same degree as in 2007. Yes, it is exactly as thin as in the record year," says Hendricks.

The researchers detected significant differences in places where ice was lacking this summer – in the Laptev Sea, for example. "On our expedition in 2007 we encount-ered thin, newly formed ice in the Laptev Sea in September. This time, however, there was no sign of ice formation anywhere. The water temperature at a depth of ten metres was three degrees Celsius – that is how much the sun had heated the ice-free water surface," says Prof. Dr. Ursula Schauer, scientific head of the leg through the central Arctic. However, this warming is restricted only to the top layers. In the depths of the Arctic Ocean colder water from the Atlantic currently provides for falling water temperatures.

The sea ice physicists also made major advances in connection with the question of how much sunlight penetrates through the ice. For this purpose they utilised for the first time an underwater vehicle with remote control via cable. The so-called ROV (Remotely Operated Vehicle) dived to a depth of 100 metres below the ice and made large-scale recordings of the distribution of sunlight under the ice using a spectral radiometer. "Our measurements have shown that the quantity of light under the ice depends to a considerable extent on the type of ice. Several-year-old ice lets the least amount of light through because it has few melt ponds and a thick layer of weathered ice on its surface," says

Nicolaus. One-year-old ice, by contrast, is more pervious to light, especially in areas with many melt ponds. The researchers measured the greatest amounts of light under new ice. "From these results we can conclude that the observed change from a several-year-old ice cover to a seasonal Arctic ice cover will lead to an increase in light in the Arctic Ocean, particularly in summer and autumn," states Nicolaus.

Changes in sea ice thickness and extent also have direct consequences for the eco-system of the Arctic Ocean. The reason is that the marginal ice zone is sort of like a "Garden of the Arctic Ocean". Due to the melting of sea ice, algae are released from the ice into the sea. In addition, the freshwater in the ice mixes with the seawater. Since the former has a lower density than seawater, a stable stratification of the surface water occurs. As a result, the algae remain in the topmost, light-flooded water layer and start to grow. So-called algal bloom results. These algae, in turn, form the beginning of the Arctic food webs. Currently it is scientifically controversial, however, whether the Arctic Ocean will become "more productive" because of the decline in ice and the related increase in light.

Scientists like Dr. Ilka Peeken therefore investigated the biology of the algae not only in the sea ice, but also in the melt ponds and in the water column under the ice. The initial results point to regional differences: in the Atlantic part of the central Arctic the algae biomass and carbon intake, both in the ice and in the melt ponds and water column, were significantly higher than in the Pacific section.

This applies similarly to the climate-relevant trace gas methane, which may form during algal bloom. Measurements by the biogeochemists headed by Dr. Ellen Damm showed that the formation and release of the greenhouse gas are influenced by which region of the Arctic Ocean is seasonally ice-free. In addition, the researchers succeeded for the first time in verifying how much methane is oxidised to carbon dioxide in the

ice.

The scientists now want to compare these and many other snapshots of the situation in summer 2011 with their results from 2007 as well as with data from the two Arctic long-term observatories of the Alfred Wegener Institute in the Fram Strait. The so-called "mooring" and the deep-sea observatory HAUSGARTEN were the destinations of the first two expedition legs. Their various measuring devices have to be replaced at regular intervals, the data must be read out on board the Polarstern and the sensors have to be recalibrated. Only in this way is it possible to record environmental changes in detail.

The Polarstern is currently at the Lloyd shipyard for routine maintenance work and is expected to set off on the next expedition to the Antarctic on 28 October 2011.

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