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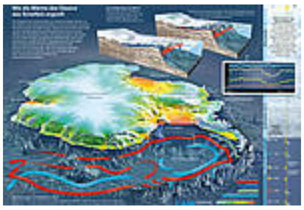
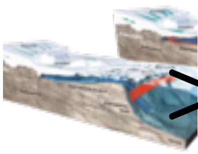
Antarctic

Irreversible ocean warming threatens the Filchner-Ronne Ice Shelf

AWI climate researchers have deciphered the processes driving an irreversible inflow of warm wa-ter under the ice shelf, which could begin within the next few decades

[11. May 2017] **By the second half of this century, rising air temperatures above the Weddell Sea could set off a self-amplifying meltwater feedback cycle under the Filchner-Ronne Ice Shelf, ultimately causing the second-largest ice shelf in the Antarctic to shrink dramatically. Climate researchers at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) recently made this prediction in a new study, which can be found in the latest issue of the Journal of Climate, released today. In the study, the researchers use an ice-ocean model created in Bremerhaven to decode the oceanographic and physical processes that could lead to an irreversible inflow of warm water under the ice shelf - a development that has already been observed in the Amundsen Sea.**

When it comes to the fate of the great Antarctic ice shelves, the sea ice surrounding them is of central importance. For example, in the southern Weddell Sea so much sea ice forms during the autumn and winter months that the amount of salt released in the process turns the water around and below the 450,000 km^2 Filchner-Ronne Ice Shelf into a massive protective sheath. So far, this barrier of extremely salty water, with an average temperature of ca. minus 2 degrees Celsius, has protected the shelf from the inflow of water masses that are 0.8 degrees warm, which the Weddell Gyre transports along the edge of the continental shelf (see graphic).

New simulations from climate researchers at the AWI now indicate that this cold-water barrier could be permanently lost in the course of the next few decades. The reason: rising air temperatures over the Weddell Sea, which could cause less sea ice to form. "We can already see the first signs of this trend today. First of all, less sea ice is forming in the region, and secondly, oceanographic recordings from the continental shelf break confirm that the warm water masses are already moving closer and closer to the ice shelf in pulses," says Dr Hartmut Hellmer, an oceanographer at the AWI and first author of the study.

These comparatively small-scale changes may mark the beginning of a fundamental and irrevocable transformation in the southern Weddell Sea. The researchers expect the effects to become noticeable by 2070. "Our simulations show that there will be no turning back once the warm water masses find their way under the ice shelf, since their heat will accelerate the

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melting at its base. In turn, the resulting meltwater will produce an intensified overturning, which will suck even more warm water from the Weddell Gyre under the ice. As such, according to our calculations, the hope that the ocean would someday run out of heat won't pan out in the long run," Hellmer explains.

As a result of the dramatic melting on its underside, the shelf's grounding line will shift further south and the ice will gradually lose direct contact with the seafloor. To date, frictional contact with the seafloor has helped to slow down the ice flow. Once this natural brake is gone, the draining of ice from the Antarctic Ice Sheet will quicken. "The meltwater feedback cycle under the ice shelf will only slow down once the shelf has collapsed, or no more glacial ice flows in from inland to take its place. So we're talking about processes that will continue over several centuries," says co-author and AWI model designer Dr Ralph Timmermann.

The researchers' forecasts are based on the AWI's BRIOS (Bremerhaven Regional Ice-Ocean Simulations) model, a coupled ice-ocean model that the team forced with atmospheric data from the SRES-A1B climate scenario, created at Britain's Met Office Hadley Centre in Exeter. The dataset includes e.g. information on the future development of winds and temperatures in the Antarctic, and is based on the assumption that the carbon dioxide concentration in the atmosphere will reach 700 parts per million by the year 2100. "Accordingly, our model used climate data that is similar to the IPCC's (Intergovernmental Panel on Climate Change) current business-as-usual scenario. The results clearly show that even limiting global warming to two degrees Celsius won't be enough to save the Filchner-Ronne Ice Shelf," says co-author and AWI researcher Dr Frank Kauker.

In addition, the authors believe the predicted changes in the Weddell Sea offer a new perspective on current developments in the Amundsen Sea. As Hartmut Hellmer explains, "When it comes to the Amundsen Sea, where warm water has already reached the continental shelf and even the grounding line of some ice shelves, we can safely say that this inflow of heat cannot be stopped; the climate regime change has already taken place. In other words, the losses of mass of the West Antarctic Ice Sheet will intensify – just like the models predict."

To measure the forecasted inflow of warm water under the Filchner-Ronne Ice Shelf, in the past two Antarctic summers scientists from the Alfred Wegener Institute and the British Antarctic Survey drilled through the ice at seven sites to deploy oceanographic recording devices below it. Thanks to their efforts, every night fresh data on the water temperature, salinity, flow speed and flow direction is transmitted to the AWI facilities in Bremerhaven via satellite. "However, it will take a few years before we can use this latest data to reliably document the changes," says Hellmer.

Original publication

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