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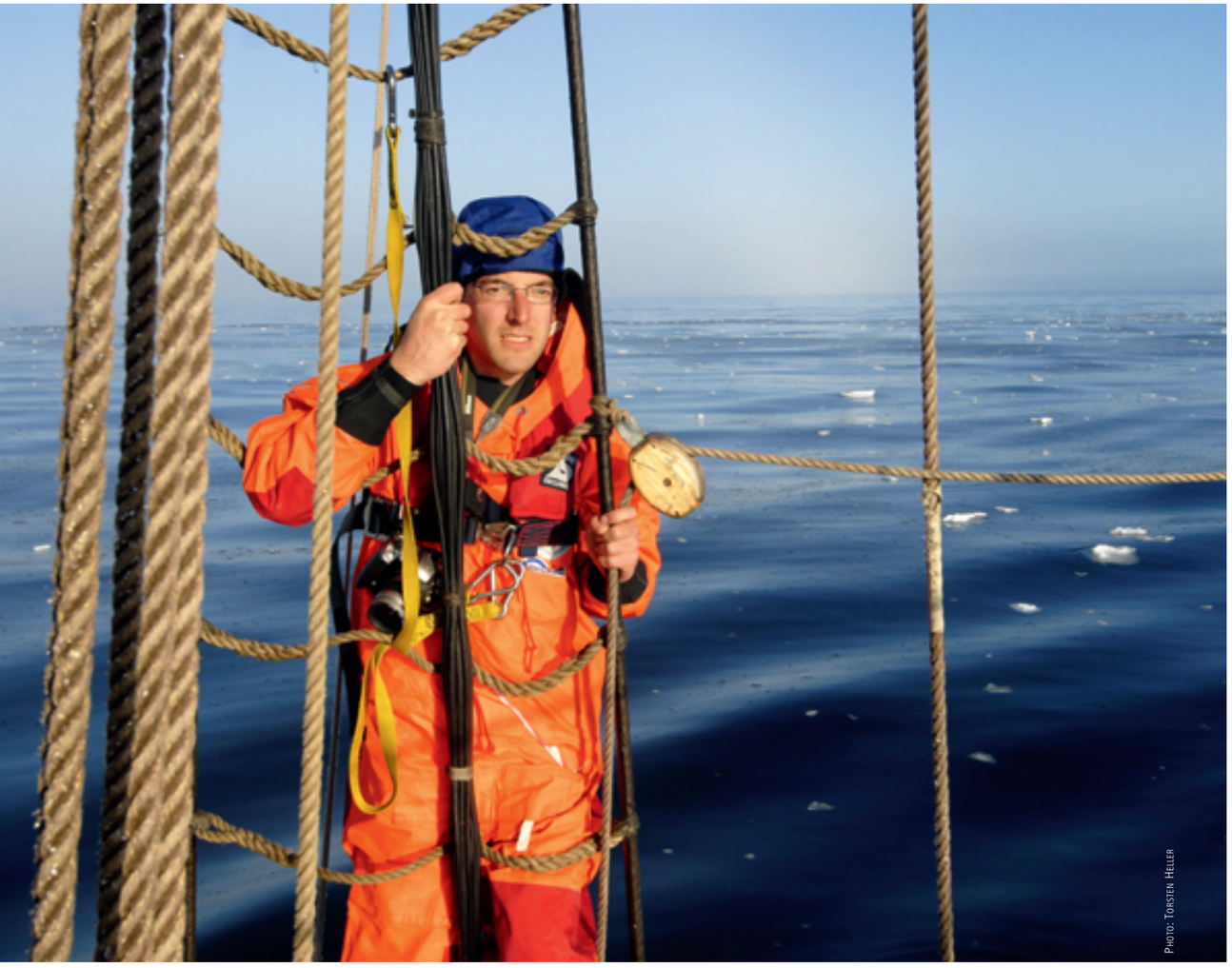


Photo: Torsten Heller

There are many reasons why **Dirk Notz**, *who was recently appointed head of a research group at the* **Max Planck Institute for Meteorology** *in Hamburg, loves all questions relating to climate – one of them being the nature experience he gains on his adventure-packed expeditions to the Arctic.*

The photo is an eye-catcher. The shimmering bright blue icebergs in the image hanging next to the computer in Dirk Notz's office are a reminder of one voyage to the Arctic. He is always joining expeditions there. This is due to the nature of his research: he wants to find out what role sea ice plays in the climate system. At the Max Planck Institute for Meteorology, he was recently appointed head of a research group dedicated to just this goal.

In the northern polar region, Dirk Notz collects not only data, but also impressions of a landscape of cold beauty – as well as the occasional tale of adventure. Like this one, from the winter of 2004: Notz and four other researchers had just moved into an isolated hut on a fjord on Spitsbergen, where they were to live for two weeks. "When our oldest team member, Jamie Morison, stepped outside to brush his teeth the first day, he found himself face to face with a mama polar bear and her cub," recounts Dirk Notz. But the bears were apparently just as surprised as the sleepy researcher, and turned on their heels and galloped away.

The next day continued in the same vein – as if the participants in the expedition didn't already have enough respect for the risks of their undertaking. "When we returned to the hut in the evening after taking our measurements, a polar bear had completely demolished the toilet door," says Notz, with a trace of grim humor in his voice. However, the door to the adjacent hut, where their frozen provisions were stored, and the door to the main hut, where the bears would have found even more edibles, remained untouched. "We were just lucky that no one was sitting on the toilet right then."

Such impudence on the part of the furry visitors could almost be called ungrateful. After all, Dirk Notz and his colleagues are trying to preserve the polar bears' habitat. A first step toward this goal is a better understanding of how quickly the Arctic sea ice is melting in the ever-warming greenhouse that is the Earth, and how its disappearance may further intensify climate change.

Measurements taken from submarines show that the ice has become an average of 40 percent thinner since the middle of the last century – and that doesn't even take the heavy melting of recent summers into account. And satellite images show that the area that is covered by sea ice in summer has shrunk by nearly four million square kilometers since the 1970s. That is a decrease of more than ten times the surface area of Germany. Moreover, the dark sea that peeks out from beneath the dwindling ice stores the heat of the Sun's rays much better than the light ice, which reflects most of these rays. This speeds up the warming, and even more ice melts. "The Arctic Ocean may even be largely ice-free in summer as early as mid-century," says Dirk Notz.

Oceanic Thermal Cover in Danger

If the atmosphere heats up so much that the ice starts receding even in winter, then the ocean will also lose its insulation layer: "Currently, the sea ice still functions like a lid on a pan of hot water," explains Dirk Notz. Without sea ice, the ocean would release massive amounts of heat into the atmosphere. "This is because, in winter, the temperature of the salty ocean water hovers around freezing, while the temperature of the air above the sea ice frequently drops below minus 30 degrees Celsius," says the researcher. The meteorologist is working on new models to predict this development more accurately and reliably. They are expected to account better for the physics of the sea ice than is currently possible with future-climate simulations. The tools of his trade: mathematics. "Mathematics is a wonderful language," says Notz, smiling. "Reducing the complexity of the world to highly precise formulas simply fascinates me."

As a meteorologist, Notz can employ mathematics in the service of the sense of responsibility he feels for the world. This attitude is also a product of his connection with nature. Dirk Notz grew up with his three sisters in a single-family house in Hamburg-Harburg, not far from a nature preserve. He often wandered through the forests there with his friends. "Sometimes we also just spent a week in a hut in the forest and smoked salmon there."

His penchant for research was also clearly noticeable in his youth, and was likely inspired by his parents. The son of a teacher and a physicist, he already had a great interest in the natural sciences at school, and discussed physical phenomena with his father. "I enjoyed school," says Dirk Notz.

Today, the meteorologist can live out both his interest in the natural sciences and his love for nature on his research trips to the North Polar Sea: "Icebergs in the morning light. Snowstorms in which you can't even remain standing. Hot cocoa at lunchtime. Hoar frost that pours off your sleeping bag onto your face." Those are fantastic experiences, he finds. And the animal encounters are particularly impressive. With beluga whales in a glacier-enclosed lagoon, for example. "There were seabirds everywhere, and in front of this backdrop, the whales spouted jets of water into the air." Just as moving

Photos: Torsten Heller (2)

Expedition on ice: Dirk Notz bores into an ice floe to determine its thickness.

for him was the sight of a mama polar bear teaching her two playful cubs how they might be able to catch some lunch by jumping up and down on a seal cave.

Dirk Notz enthusiastically recalls his experiences: "In their inimitable way, penguins stand on the ice and watch with curiosity as the research ship passes by." When he also vividly describes the pastel colors on the horizon hours before the Sun rises over the Polar Sea, the polar regions are very present on this summer day in Hamburg.

His first encounter with the Arctic was in 1999, when he spent a year studying Arctic oceanography and Arctic meteorology on Spitsbergen. He was almost finished with his studies in meteorology at the University of Hamburg. He originally undertook the detour to Spitsbergen purely out of curiosity, as he has also done on a few other occasions. "My parents have always supported me in my endeavors, and trusted my judgment," says Notz. "They encouraged my interest, even if it didn't lead to a concrete goal at that time."

He benefits from that today, and his study abroad program likely played a role in steering his interest toward sea ice as a climate factor. That his interest might turn into a research project became evident just a short time later. A few short months after he returned from Spitsbergen, he began writing his thesis on "processes of sea ice development in the Arctic during summer." One of his thesis advisors was Miles McPhee from the University of Washington in Seattle. Notz had met McPhee during his stay on Spitsbergen, and their collaboration continues to this day.

Brine Affects Water Circulation

During his stay in Seattle, Notz also met his future Ph.D. advisor, Grae Worster, from the University of Cambridge. What began as a chance encounter in Seattle likewise turned into an extended collaboration that culminated in Dirk Notz transferring to Cambridge after completing his undergrad degree, and writing his Ph.D. dissertation there from 2002 to 2005. This time, his work basically focused on thermodynamic and hydrodynamic processes in sea ice, and especially on the salt in the ice.

Unlike ice in a freshwater lake, sea ice does not form a compact block. Rather, millimeter-thin sheets form, between which brine collects. The more water freezes, the higher the salt concentration in the brine. This salt content is a key determinant of the properties of the sea ice. For example, it determines how well the ice insulates the heat of the sea.

But what is even more important for the Earth's climate system is that a large portion of the brine that is stored between the ice sheets flows into the ocean over time. Due in no small part to this flow of highly concentrated brine, seawater in the polar regions can become so heavy that it sinks to the ocean floor. From there, it spreads throughout the world's oceans and sets their water masses in motion. Cold water flows into warm regions, where it takes up heat, transports it to cooler areas and creates milder temperatures there. To describe this cycle and predict how it will develop under different climate conditions, climate researchers must thus calculate the salt content in the sea ice correctly.

To this end, while working on his doctorate in Cambridge, Dirk Notz created a model, together with Grae Worster. According to this model, the ice directly at the interface to the ocean ought to contain just as much salt as the seawater. However, previous measurements had always painted a different picture: they showed there was considerably less salt in the ice than in the water.

"Normally in such a case, a quote from Richard Feynman would apply," says Dirk Notz. The American physicist once coolly remarked: "It doesn't matter how beautiful your theory is. It doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong." According to that, Notz and Worster actually should have buried their theory, but they didn't want to. And for good reason: The theory they used to describe the ice and saltwater system is based on principles that hold quite well in similar mixtures.

"After we thoroughly reviewed our model again for errors, we looked at the common method for measuring the salt content of the ice," says Dirk Notz. In doing so, they realized that their self-assurance was justified. Previously, oceanographers had determined the salt concentration in the melt water from cores they drilled out of the ice. "When the cores are removed from the ice, some of the saltwater flows out of them," explains Dirk Notz: "Similar to water dripping out of a sponge when it is taken out of a bucket." This was known, but it was always disregarded.

And in fact, the losses were not that great when the ice was still thick, before climate change had begun. But now that the sea ice has started growing ever thinner, and the warm sea ice contains more and more brine, that has changed. Notz and Worster thus developed an instrument with which they can determine the salt content directly in newly formed sea ice: they measure the resistance between two wires spaced five millimeters apart in the ice. These measurements then indicate the salt content. In practical terms, this means that the researchers hang a sort of ladder composed of such wire pairs in the freezing water in winter. In this way, they can determine the salt content of the ice at any desired depth as soon as the water is frozen.

Thought-Provoking Measurements

"At minus 30 degrees Celsius, we laid cables in the frozen desert, connected them to generators, and typed away on our laptops with clammy fingers, all the while regularly looking up from our work to scan the horizon for approaching polar bears," recounts Dirk Notz. Their efforts under these hostile conditions paid off. The measurements now matched the theoretical predictions very well.

Nevertheless, the researchers were only mildly excited. The results indicate that, in the future, the sea ice may melt even faster than previously predicted. But Notz is still cautious about issuing any ardent pleas: "The most important task of science is to deliver sound findings. Citizens and politicians must decide how to counter climate change." But it seems that many are not yet ready for that: "Society is still in the target-definition phase."

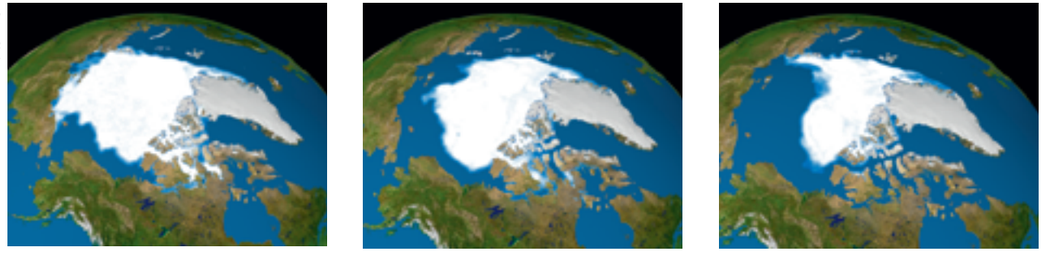
At least the EU has already defined a benchmark: "Limiting warming through the end of the century to an average of two degrees is a compromise between what may still be achievable and the attempt to avert uncontrollable consequences, such as the melting of Greenland's inland ice."

To achieve this goal, Notz does ultimately demand political action: merely continually pointing out that such countries as the US and China also need to do their part in reducing global greenhouse gas emissions will achieve nothing. "The Earth doesn't care where the methane or carbon dioxide comes from," says Notz, and stresses: "Every little bit each individual can save helps."

It is clear that he finds it difficult to completely disengage from any political impetus. And why should he? After all, he wants his not-quite-one-year-old daughter to be able to grow old on an Earth that is worth living on. Indeed, Notz doesn't just limit himself to producing scientifically sound findings behind the scenes of the political processes. It is very important to him to also communicate his findings to the public. "I'm not a proponent of convoluted scientific formulations," he says, and this attitude has already won him multiple prizes for understandable science, such as the Klaus Tschira Award in physics last year.

But for Dirk Notz, that alone is not enough in the way of PR work for climate change. He would like to start informing young people about the phenomenon. That is why, together with expedition leader Arved Fuchs, who became known through

Photos: NASA



Arctic vanishing act: Satellite photos from September 1979, 2005 and 2007 show how the ice is receding.

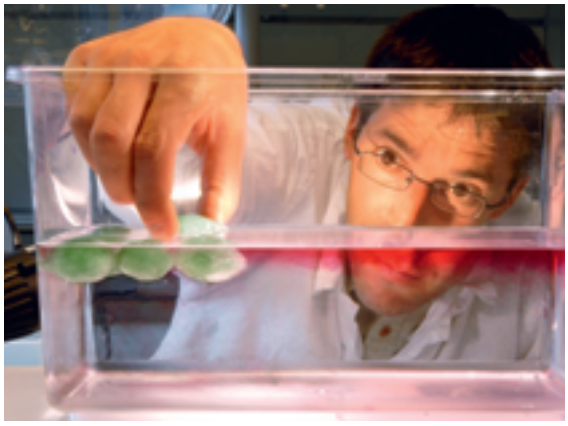


PHOTO: TORSTEN HELLER

Polar research in the lab: Dirk Notz examines how quickly saltwater from the green ice cubes sinks in the warmer red water.

his films and books about his polar adventures, he is organizing international youth camps that deal with climate change in the Arctic. Estonia, Israel, Colombia and South Africa are just a few of the countries from which this year's participants hail. A competition, organized by Fuchs, determines who gets to go. "We are also targeting schools in Hamburg to invite them to participate in the competition," says Notz.

There's no doubt that climate research and climate change are more than just a research field that Dirk Notz simply chanced to stumble upon. Nevertheless, he can also imagine himself in an entirely different profession. For example, his eyes begin to light up when he considers the possibility of becoming a science journalist. He recently proved, with an article on his research that appeared in the German science magazine BILD DER WISSENSCHAFT, that he has the requisite talent. He has already amassed enough anecdotes for articles on his polar research. In one, he can report how he and his colleagues wanted to drive the moisture out of their clothes after a snowstorm. A nice, roaring fire was to help. "Unfortunately, in the process, we also dried the ceiling of the wooden hut so well that an oil lamp on the wall set it on fire," recounts Dirk Notz, laughing. "With an outside temperature of minus 30 degrees Celsius, that actually did generate a bit of chaos. But quick, prudent action helped us avert any overly dramatic consequences. I hope the same is possible with respect to climate change."

PETER HERGERSBERG/ANJA KUNZMANN