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## Into the cold?

### Slowing ocean circulation could presage dramatic – and chilly – climate change

By Robert C. Cowen | Special to The Christian Science Monitor

Call it global warming's dirty little secret. Those much-publicized scenarios of how carbon-dioxide (CO<sub>2</sub>) pollution may gradually heat up the earth don't tell you another key fact: that climate has sometimes changed without warning. It can go from warm to cold – or cold to warm – in less than decade, and stay that way for centuries.

Water-circulation data from the North Atlantic now suggest the climate system may be approaching that kind of threshold. If man-made warming or natural causes push it over the edge, the system will chill down many temperate parts of North America and Europe, even while the planet as a whole continues to warm.

Terrence Joyce, chairman of the physical-oceanography department at Woods Hole Oceanographic Institution in Massachusetts, is one of a handful of scientists trying to raise awareness about this possibility. He says he is "not predicting an imminent climate change – only that once it started (and it is getting more likely) it could occur within 10 years."

Mr. Joyce explains that many of the computer simulations of climate change "never predict any abrupt transition." But, he says, such an event could occur. "Abrupt climate change has been a part of our history," he says.

That's what happened when the so-called Little Ice Age cut in about 500 years ago. Take a look at Bruegel's famous paintings of skaters on frozen Dutch canals to get an idea of what would be in store for regions that haven't known such harsh winters since we emerged from the Little Ice Age during the last century.

There is as yet no conclusive evidence that the Dutch should stock pile ice skates. But Woods Hole director Robert Gagosian feels an urgency to settle the question. He sees enough disturbing information in the North Atlantic data, which oceanographers from Woods Hole and other institutions have gathered, to call it "strong evidence that we may be approaching a dangerous threshold." He says we need to know whether we are blindly walking toward the edge of a cliff.

North Atlantic water circulation raises this level of concern because it is a key factor in the climate system. Broadly speaking, that system redistributes solar heat from the tropics around the planet. The atmosphere carries heat north and south in the form of warm air and water vapor. The latter releases its heat when it condenses into droplets. That's about half the distribution; ocean currents carry the rest.

Winds move heat around quickly. Ocean currents can take centuries. Oceanographers call their stately flow the Great Ocean Conveyor. Warm surface currents distribute tropical heat. Deep currents carry cold water back toward the equator. Together, these currents form an interconnected system that circulates through the North and South Atlantic into the Indian Ocean and the Pacific.

The "pump" that drives the conveyor is in the northern part of the North Atlantic. There, the Gulf Stream brings in warm, relatively salty water. This cools as it gives up heat to the winds that warm Britain and Europe. Cold, salty water is relatively heavy. Mingling with Arctic outflows, the Gulf Stream water sinks to great depths and flows southward. More Gulf Stream water flows in to replace it.

This circulation – sucking in Gulf Stream water at the top and forcing it down and out at the bottom – propels the North Atlantic branch of the conveyor. Shut down that pump, and you could have what Dr. Gagosian calls "dramatic" climate change. He explains in a posting to the Woods Hole website that "average winter temperatures could drop by 5 degrees Fahrenheit over much of the United States, and by 10 degrees in the northeastern United States and in Europe."

The way to shut down the pump is to dilute the inflow water to the point where it is no longer salty enough to sink deeply and flow southward near the bottom. That seems to be happening now. Last April, Robert Dickson of Britain's Centre for Environment, Fisheries, and Agricultural Science, together with colleagues from Canada, Germany, and Scotland reported in Nature magazine that fresh water has been diluting the North Atlantic for the past four decades. Research by other groups confirms this trend.

Joyce says the evidence "strongly suggests" the North Atlantic pump is "threatened by fresh-water dilution." The cause is unclear. It could be a subtle effect of global warming. Changes in air circulation have altered the freezing and melting patterns of Arctic ice generally. Ice in the Arctic Ocean, in particular, has thinned. Also, the Arctic has warmed to the point where melting permafrost now is a major concern. But there is no clear causal pattern to the North Atlantic fresh-water dilution.

The urgent need, Joyce says, is for "specific research to clarify what is going on." That includes more upper-ocean salinity

measurements and monitoring of the North Atlantic conveyor circulation.

Last December, the National Academy of Sciences released a report urging research to understand abrupt climate change generally. Richard Alley of Pennsylvania State University at University College, chairman of the Academy committee, warned at that time that "it will be a long time, if at all, before we are really good at predicting climate change...." He added, "Any reality may be very different from the predictions, and we need to anticipate changes and surprises."

Right now, those climate simulations don't deal with the nasty surprises Gagosian anticipates if the North Atlantic circulation pump shuts down, as it has done in some past climate changes. Instead of half a century or more to adapt to global warming, the next 10 to 20 years might bring a climate change that would change the world and the world economy. In Gagosian's words, it could "freeze rivers and harbors and bind North Atlantic shipping lanes in ice ... disrupt the operation of ground and air transportation ... cause energy needs to soar exponentially ... force wholesale changes in agricultural practices and fisheries." Efforts to curb CO2 emissions to slow global warming would become a secondary issue as people tried to cope with more immediate challenges.

Dr. Alley says there's no reason yet for alarm, although there is a case to be made for more intensive research to find out what's happening to North Atlantic circulation. He also sees a larger challenge. If drastic climate change were imminent, there is little we could do to stop it. The best strategy, he says, is to work harder now to build resiliency into agriculture, housing, energy use, and into economies generally. That's essentially the conclusion a US Department of Energy climate-change study group reached 25 years ago.

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