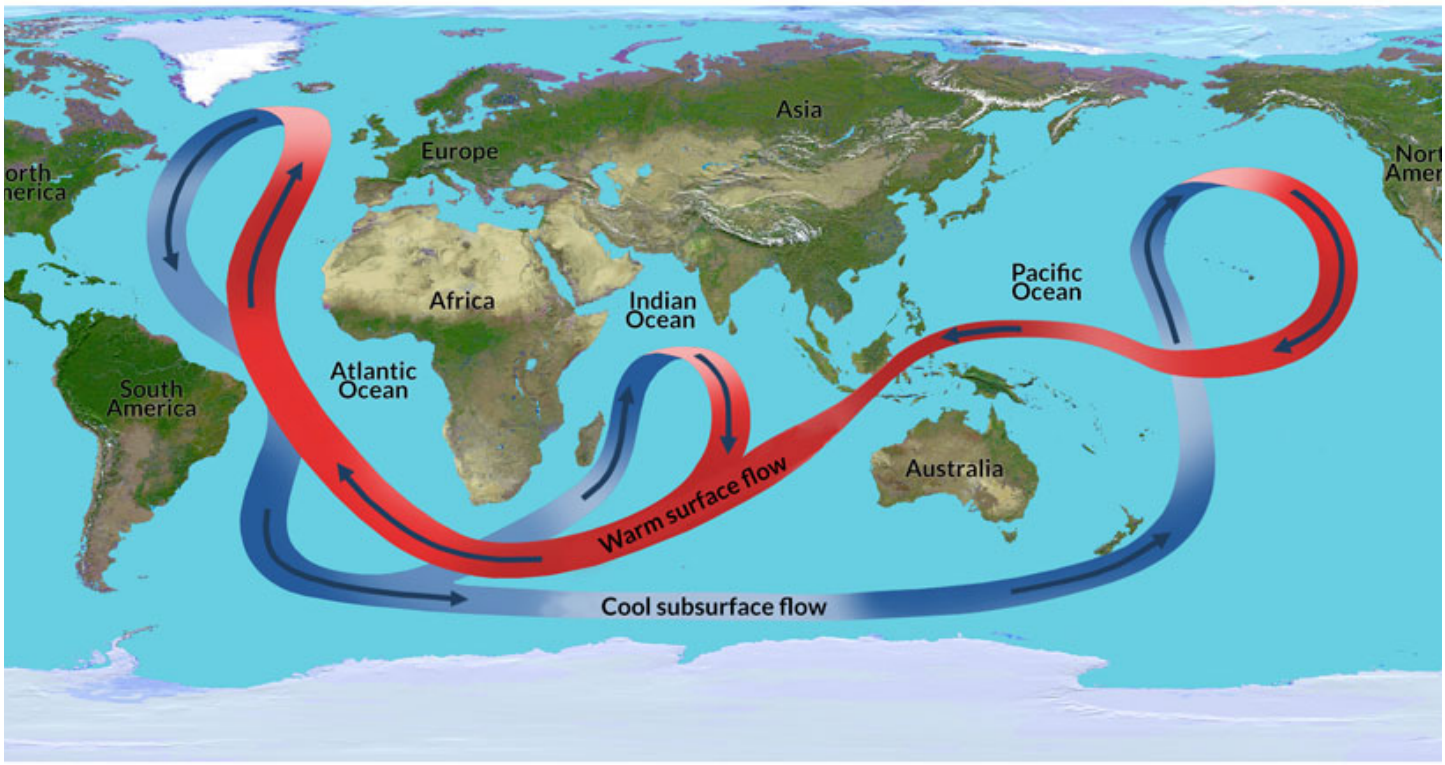
OCEANS

Climate change could stall Atlantic ocean current

Global conveyor belt could shut down — and cool Europe's climate



Ocean currents ferry warm and cool water around the globe. The Atlantic Ocean current boosts temperatures in northwestern Europe. But rising levels of carbon dioxide in the atmosphere could shut these warming currents down.

JPL-CALTECH/NASA

By **Thomas Sumner**

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Rising concentrations of *carbon dioxide* — or CO_2 — in the atmosphere tend to boost temperatures at Earth's surface. But CO_2 increases could eventually shut down the flow of a major *ocean current*, a new climate study concludes. Without this moving water, wintertime temperatures could plummet in parts of Europe by 7 degrees Celsius (13 degrees Fahrenheit). A stalling of this ocean current also could change rainfall patterns across the globe.

This is similar to the scenario that played out in the 2004 disaster movie, *The Day After Tomorrow*. Fortunately, it's not nearly as extreme as the dire freezing that the movie's characters

had to live through.

The current in the Atlantic ferries warm water northward from the *Southern Hemisphere*. These waters keep winter temperatures mild in Northern Europe and affect rainfall. Previously, *computer models* of climate didn't predict that a shutdown in this current would occur.

They do now.

Explainer: What is a computer model?

Wei Liu is a climate scientist at Yale University in New Haven, Conn. He and his colleagues noticed a problem in climate models. *Freshwater* is important for understanding climate change. But in the old models, freshwater was moving the wrong way between the Atlantic Ocean and the Southern Ocean (located around Antarctica). It flowed in the opposite direction from what scientists see in nature. Liu and his colleagues fixed this problem.

Then they set up an extreme test. They examined how growing CO_2 levels might affect the North Atlantic current. For these tests, they had a computer double CO_2 levels in the atmosphere. Within 300 years, the computer predicted, the Atlantic current would shut down.

Such an extremely fast rise in carbon dioxide is unrealistic. But it is an important test, the scientists say. The ocean current isn't stable after all, they concluded January 4 in *Science Advances*. Liu says they now need a more realistic test "to predict what the future will look like."

Predicting the behavior of the current is hard. Good predictions depend on having long-term data on actual Atlantic currents. In fact, notes Gerald Meehl, only some 20 years of such data exist for the Atlantic current. A climate scientist, Meehl works at the National Center for Atmospheric Research in Boulder, Colo.

A global conveyor belt

This Atlantic current is also called the *Atlantic Meridional Overturning Circulation*, or AMOC. It works like a colossal conveyor belt. It carries warm water along the Atlantic Ocean surface,

moving from south to north. Near Greenland, the current makes a U-turn. Then the cold water sinks and flows south again. These two halves form a loop. This loop keeps northwestern Europe warm. The current also drives rainfall across the tropical Atlantic.

Climate change has been warming waters in the North Atlantic. Those waters now are less dense than they used to be. They are therefore less likely to sink. And that could threaten to slow the AMOC down.

Explainer: How scientists know Earth is warming

The ocean's saltiness also plays an important role in the operation of this conveyor belt. In earlier computer models, freshwater flowed from the Southern Ocean into the Atlantic Ocean. As Earth's climate warmed, the flow of that freshwater slowed and the Atlantic became saltier. This salt-laden water is denser, like cold water, and should speed the AMOC back up.

But ocean observations show that freshwater flows differently. It flows into the Southern Ocean from the Atlantic Ocean, not the other way around. For his team's new study, Liu corrected the direction of the flow of freshwater here.

Then the researchers doubled the carbon dioxide in the atmosphere compared to what levels had been back in 1990. Now the computer predicted that the North Atlantic would warm and the AMOC would slow. Less warm water moved northward. And as the AMOC slowed, less freshwater flowed from the Atlantic into the Southern Ocean. This left the Atlantic less salty. Over time, the AMOC slowed and weakened. Eventually, that conveyor belt of water just stopped moving.

That was a prediction by the computer. If that also happened in real life, countries such as England and Iceland would become colder. Earth's growing levels of carbon dioxide normally would warm the atmosphere. But the cooling from a stalled current would overwhelm that effect. It would cancel *greenhouse warming*.

The researchers also tried the simulation without correcting for the true direction of the freshwater flow. Now the current wasn't disrupted any longer.

Shutting down the conveyor belt over a 300-year period wasn't even the worst that might happen, the researchers note. A warming climate has been melting ice in Greenland. That also can boost freshwater flow into the Atlantic Ocean, helping to slow down the AMOC. But in their new study, Liu's team didn't study this factor.

CITATIONS

Journal: W. Liu et al. Overlooked possibility of a collapsed Atlantic Meridional Overturning Circulation in warming climate. *Science Advances*. Published online January 4, 2017. doi: 10.1126/sciadv.1601666.