A Newfound Cog in the Ocean Conveyor

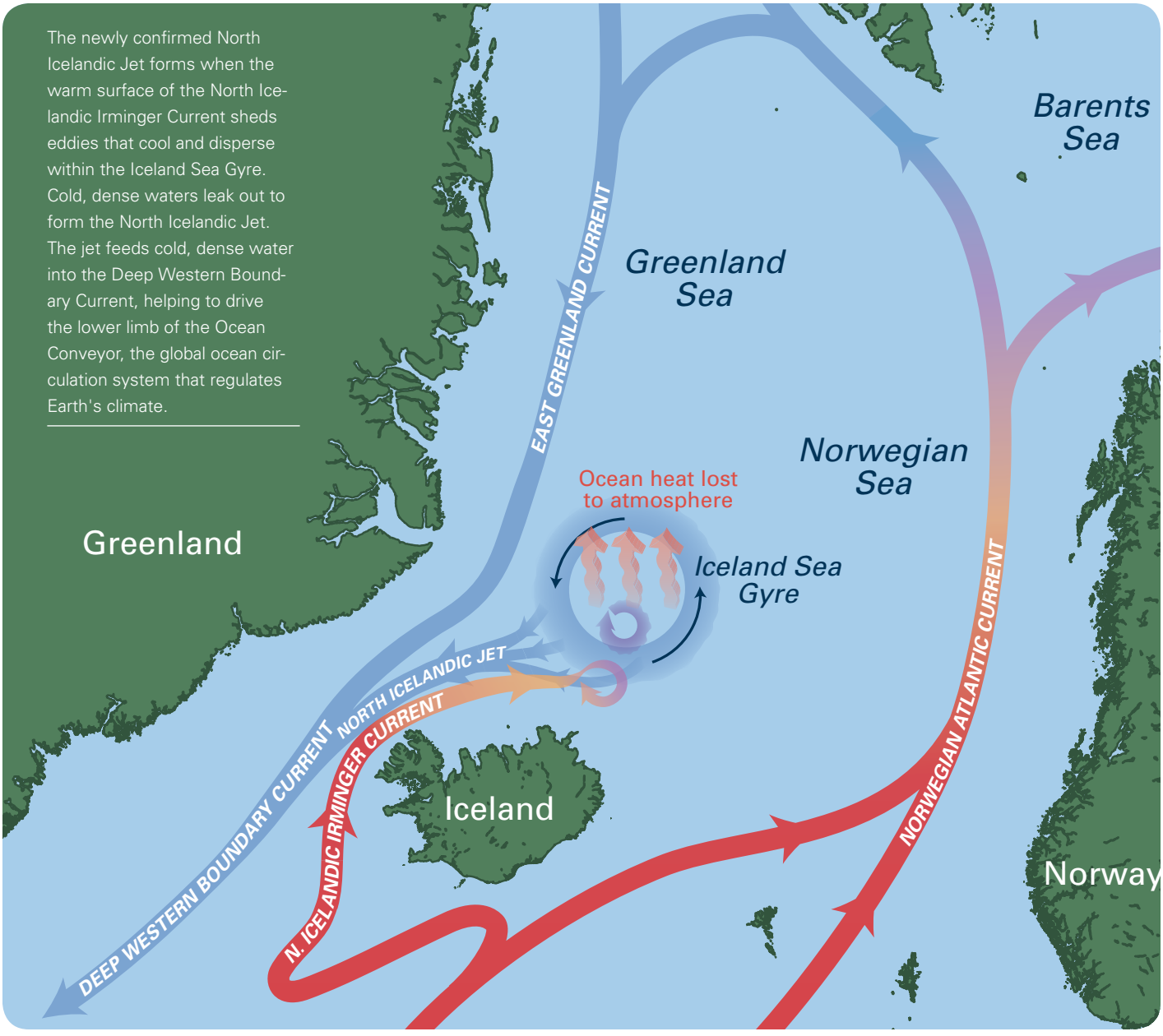
A decade into the 21st century, scientists have confirmed the existence of a previously unknown and apparently crucial ocean current. International teams led by Woods Hole Oceanographic Institution (WHOI) oceanographer Bob Pickart verified the current near Iceland in 2008 and returned in 2010 to determine how it is formed.

The current, called the North Icelandic Jet, is not merely a curiosity. Though relatively narrow, it is an important cog in the global oceanic conveyor of currents that transports equatorial heat to the North Atlantic and tempers the region's climate. Learning how the current operates offers insights into potential monkey wrenches that could clog ocean circulation and cause disruptive climate changes.

Initial evidence for the newfound current came in 1999 when Héðinn Valdimarsson and Steingrímur Jónsson from the Icelandic Marine Research Institute (MRI) used instruments measuring water velocity to detect a flow of dense water north of Iceland. But confirmation had to wait until 2008, when Pickart led a research cruise to the region aboard the WHOI research vessel *Knorr*. Taking detailed measurements of water properties and velocities, Pickart and colleagues from WHOI, MRI, and the University of Bergen in Norway confirmed the North Icelandic Jet, publishing their findings in Nature *Geoscience* in 2010.

But *why* was it there?

Pickart consulted WHOI colleague Michael Spall, who specializes in using numerical models of ocean circulation. Incorporating known data and the laws of physics, Spall's model painted a picture that could explain the North Icelandic Jet. In a sense, the jet is a tail-end tributary of a great river of water in the ocean, the Gulf Stream.



Jack Cook, WHOI

The Gulf Stream conveys huge amounts of warm, salty water from the tropics to the North Atlantic, where it meets cold air in winter, releases its heat to the atmosphere, and warms the region. As the water becomes colder, it becomes denser; it sinks toward the seafloor and flows back southward, driving the lower limb of a big loop, often called the global Ocean Conveyor. Waters in the conveyor then flow around the entire planet, eventually rise, and circle back into the Gulf Stream. Like a planetary plumbing system, the conveyor pumps water and heat around the globe and regulates Earth's climate.

In the North Atlantic, the Gulf Stream diverges: The Norwegian Atlantic Current bends east to warm the United Kingdom and Scandinavia, and the smaller North Icelandic Irminger Current veers around the west of Iceland. The latter current was thought to diminish north of Iceland with little or no impact. But Spall's model indicated that the North Icelandic Irminger Current sheds eddies that cool and dissipate within the Iceland Sea Gyre north of the island.

Spall, Pickart, and Kjetil Våge, Pickart's former graduate student at WHOI, now at the University of Bergen, proposed that the newly formed cold, dense water subsequently leaks out of the gyre, coalesces, and sinks to form the deep North Icelandic Jet. This constitutes a local overturning loop in which warm surface water flowing north—the North Icelandic Irminger Current—is transformed into the deep, cold southward flow of the North Icelandic Jet.

To test this hypothesis, Pickart returned to the region aboard *Knorr* in 2011 with a team of researchers from WHOI, Iceland, Norway, and the Netherlands. Covering 3,812 nautical miles, they measured current velocities and water temperatures and salinities, precisely mapping the bounds of the North Icelandic Jet. They proved that it indeed forms north of Iceland and flows south to join the East Greenland Current. The combined currents supply the cold, dense water that drives the lower limb of the Ocean Conveyor.

Rachel Fletcher

Crew members aboard the *Knorr* lower an instrument to measure ocean temperature and salinity near Iceland.

Until now, the accepted theory was that only one current, the East Greenland Current, fed the lower limb of the conveyor in this region. Pickart and colleagues have now established that the North Icelandic Jet is a distinct current that supplies about half of the total water, as well as the densest water, that flows southward through the Denmark Strait and into the Ocean Conveyor.

As such, the North Icelandic Jet is part of a previously unknown regional loop in the larger loop that regulates Earth's climate. As scientists strive to predict how rising global temperatures could disrupt the balance of this oceanic machinery and have impacts on climate, it's crucial to know where all the integral parts are and how they work.

—Lonny Lippsett

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What Corals Say About Sea Level Rise

Stony and silent, fossil corals can tell tales—if coaxed skillfully by a geochronologist like Bill Thompson at Woods Hole Oceanographic Institution. He and colleagues sampled fossil reefs like this one on Great Inagua Island in the Bahamas. A younger coral reef sprouted directly atop the remains of an older reef some 120,000 years ago, a time when Earth's climate was as warm as today, ice sheets melted, and sea levels were higher.

Thompson used an improved technique to calculate ages of the corals with a precision that was previously unattainable. Working with H. Allen Curran and Brian White of Smith College and Mark A. Wilson of the College of Wooster, he reported that sea levels were considerably less stable than earlier thought: They oscillated up and down by 13 to 20 feet over a few thousand years about 120,000 years ago during the Last Interglacial, a warm period when the climate resembled today's. The new evidence raises the possibility of a similar scenario if the planet continues its recent warming trend. The findings were published in September 2011 in *Nature Geoscience.*

H. A. Curran, Smith College

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