EUROPEAN CLIMATE

Mild Winters Mostly Hot Air, Not Gulf Stream

The Gulf Stream does little to moderate European winters, it turns out, and the atmosphere plays a bigger role in climate change than once thought

The idea that the Gulf Stream warms Europe goes back at least to pioneering U.S. oceanographer Matthew Maury, who waxed eloquently in 1855 about how it "makes Erin the 'Emerald Isle of the Sea,' and clothes the shores of Albion in evergreen robes; while in the same latitude, on this side, the coasts of Labrador are fast bound in fetters of ice." Not so, says a group of climate researchers in next month's *Quarterly Journal of the Royal Meteorological Society*.

Maury's contention that the Gulf Stream's warmth alone moderates Europe's winters might linger in the popular imagination and even in some scientific circles, but the reality is quite different, the group says. The heat carried into the North Atlantic by the great current is not what plays the dominant role in moderating Europe's winters, the researchers say. Instead, it's atmospheric circulation, tweaked by the Rocky Mountains, that counters intuitive expectations of high-latitude cold. The summer's warmth lingering in the North Atlantic also plays a role.

The new study doesn't propose anything climatically new under the sun. Everyone has long agreed that three factors make Europe's winters milder than those of eastern North America at the same latitude. Winds blowing toward Europe from the west pick up heat from the waters of the North Atlantic, which retain far more summer heat than the interior of the North American continent. Those balmy winds give Europe a milder, maritime climate relative to North America's more extreme, continental climate. The Gulf Stream—the tail end of a great "conveyor belt" of currents carrying warm waters from the Southern Hemisphere—also contributes heat to the westerly winds and thus to Europe. And those westerly winds tend not to blow straight out of the west. They arrive over eastern North America from more out of the frigid north, intensifying the continentality of eastern North America's climate. In contrast, Atlantic winds tend to blow more from the warmer climes of the south before reaching Europe.

Together, these moderating mechanisms work to make British winters 15°C warmer than Labrador's, but "no one had bothered to quantify the relative importance of the three effects," says climate researcher Richard Seager of Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, who with David Battisti of the University of Washington, Seattle, headed up the *Quarterly Journal* study. The lack of quantification, says Seager, left the impression in many quarters that the Gulf Stream's "ocean heat transport is the dominant mechanism making Western European winters mild."

Image not available for online use.

No British warming. Scandinavia benefits far more from the warming (blue) due to heat delivered by ocean currents than does the rest of Western Europe.

Seager and his colleagues began by using meteorological observations made over the past half-century to calculate how the world's winds—which carry five times more heat out of the tropics than do ocean currents—distributed heat over the globe. Indeed, frigid northwest winds did chill central and eastern North America, whereas more southwesterly winds across the Atlantic warmed Europe. And analysis of marine observations showed that 80% of the heat that cross-Atlantic winds picked up was summer heat briefly stored in the ocean rather than heat carried in by the Gulf Stream.

Seager and colleagues confirmed a minor role for the Gulf Stream by running two climate models with fairly complete climate systems, then removing all ocean heat transport from both models and comparing the results to the complete versions. The ocean heat transport of the Gulf Stream was crucial to warming Scandinavia and keeping the far northern North Atlantic free of ice. It also warmed latitudes south of Scandinavia by 3°C on both sides of the Atlantic. But the wintertime temperature contrast between Europe south of Scandinavia and eastern North America was still about 15°C.

About half of that contrast is due to the huge wiggles induced in the prevailing westerlies as the winds pass over the Rocky Mountains and the rest of the high ground of the North American cordillera, the researchers found. Instead of blowing straight from west to east, the westerlies alternately snake more from the north and then turn more from the south and back to more northerly, like the wiggles in a rope shaken at one end. The researchers removed a model's cordillera, reducing the wiggles in the westerlies streaming toward Europe. That warmed eastern North America by as much as 6°C and cooled Europe by 3°C.

Seager and his colleagues seem to be making headway in their argument that the Gulf Stream plays less of a role than the winds in creating the wintertime east-west contrast. "It's an excellent paper," says meteorologist Rowan Sutton of the University of Reading, U.K. "The importance of the Gulf Stream in European climate is often overstated."

The analysis will also no doubt stoke the debate over the relative roles of the Gulf Stream and the tropics in climate change (*Science*, 27 April 2001, p. 660). Geochemist Wallace Broecker of Lamont has long invoked a sudden shutdown of the Gulf Stream and its larger conveyor belt to explain abrupt climate shifts during the last ice age. In his scheme, the loss of Gulf Stream heat simply cooled everything down, including large parts of the Southern Hemisphere. "Broecker's simple [conveyor] diagram captured people's imaginations, but it's a bit simplistic," says Sutton.

Broecker now agrees. "I apologize for my previous sins," he has said. Still, he remains convinced that the trigger of abrupt climate change, although not necessarily the sole driving force, lies in the North Atlantic.

Whether or not he's right, the case of mild European winters only encourages Sutton and others to explore the more climatically sensitive atmosphere as well as the ocean. "There's been too much emphasis on mid- and high latitudes," Sutton says. The tropics and its atmosphere deserve their due.

–RICHARD A. KERR

SOURCE: SEAGER *ET AL./QUART. J. ROY. MET. SOC.* **128** (2002)