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 In Climate Debate,  
 The 'Hockey Stick'  
 Leads to a Face-Off**

**Nonscientist Assails a Graph  
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 And He Gets a Hearing**

**Defenders Call Attack Political**

**By ANTONIO REGALADO**  
 Staff Reporter of THE WALL STREET JOURNAL  
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One of the pillars of the case for man-made global warming is a graph nicknamed the hockey stick. It's a reconstruction of temperatures over the past 1,000 years based on records captured in tree rings, corals and other markers. The stick's shaft shows temperatures oscillating slightly over the ages. Then comes the blade: The mercury swings sharply upward in the 20th century.

The eye-catching image has had a big impact. Since it was published four years ago in a United Nations report, hundreds of environmentalists, scientists and policy makers have used the hockey stick in presentations and brochures to make the case that human activity in the industrial era is causing dangerous global warming.

But is the hockey stick true?


According to a semiretired Toronto minerals consultant, it's not. After spending two years and about \$5,000 of his own money trying to double-check the influential graphic, Stephen McIntyre says he has found significant oversights and errors. He claims its lead author, climatologist Michael Mann of the University of Virginia, and colleagues used flawed methods that yield meaningless results.



Dr. Mann vigorously disagrees. On a Web site launched with the help of an environmental group ([www.realclimate.org](http://www.realclimate.org)<sup>1</sup>), he has sought to debunk the debunking, and counter what he calls a campaign by fossil-fuel interests to discredit his work. "It's a battle of truth versus disinformation," he says.

But some other scientists are now paying attention to Mr. McIntyre. Although a scientific outsider, the 57-year-old has forced Dr. Mann to publish a minor correction. Now a critique by Mr. McIntyre and an ally is being published in a respected scientific journal. Some mainstream

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scientists who harbored doubts about the hockey stick say its comeuppance is overdue.

The clash has grown into an all-out battle involving dueling Web logs ([www.climateaudit.org](http://www.climateaudit.org)<sup>2</sup>), a powerful senator and a score of other scientists. Mr. McIntyre's new paper is circulating inside energy companies and government agencies. Canada's environment ministry has ordered a review.

Mr. McIntyre's critique isn't going to settle the broader global-warming debate. Indeed, he takes no strong position on whether fossil-fuel use is heating the planet or, if so, how to cope. He just says he has found a flaw in a main leg supporting the global-warming consensus, the consensus that led to an international initiative taking effect this week: Kyoto.

The Kyoto protocol obligates the 35 industrialized nations that ratified it -- which don't include the U.S. -- to reduce emissions of six gases 5% below 1990 levels by 2012. The thinking behind it is straightforward: Human activity, especially the burning of fossil fuels, generates carbon dioxide, methane and other gases that accumulate in the atmosphere; there they trap the sun's heat the way a greenhouse does; to reduce the heat, reduce the gases.

But that will mean far-reaching industrial changes. Mr. McIntyre's complaint is that supporters of Kyoto pushed for it by wielding a graph, the hockey stick, whose validity they'd never fully scrutinized. "Give me a break -- we are making billion-dollar decisions," he says, noting that businesses, by contrast, must carefully audit their financial statements and projections.

Many skeptics contend that liberal environmental agendas are behind alarming global-warming headlines, though often skeptics bring policy agendas of their own. Think tanks backed with funding from the energy industry have waged a wide campaign to cast doubt on key scientific results. "Climate science today is fully politicized," says Roger Pielke Jr., head of the University of Colorado's Center for Science and Technology Policy Research. Mr. McIntyre says he hasn't received any industry funding.

The hockey stick was a highlight of a 2001 report by the U.N.'s Intergovernmental Panel on Climate Change. That is an advisory body through which the world's scientists try to reach consensus on man-made climate change and provide advice on how to limit it. Because the graph showed only minor temperature changes before the industrial age and then an upward slant -- the hockey-stick shape -- it became an oft-cited argument that human activity was raising temperatures.

The problem, says Mr. McIntyre, is that Dr. Mann's mathematical technique in drawing the graph is prone to generating hockey-stick shapes even when applied to random data. Therefore, he argues, it proves nothing.



**Michael Mann**

Statistician Francis Zwiers of Environment Canada, a government agency, says he now agrees that Dr. Mann's statistical method "preferentially produces hockey sticks when there are none in the data." Dr. Zwiers, chief of the Canadian agency's Center for Climate Modeling and Analysis, says he hasn't had time to study Dr. Mann's rebuttals in detail and can't say who is right.

Dr. Mann, while agreeing that his mathematical method tends to find hockey-stick shapes, says this doesn't mean its results in this case are wrong. Indeed, Dr. Mann says he can create the same

shape from the climate data using completely different math techniques.

The dispute turns on esoteric math concepts like principal components analysis, detrended standard deviations and autoregressions. "It's a very difficult technical question, one that not even most people in climate research would understand," says Eduardo Zorita, a climate scientist at the GKSS Research Centre in Germany. He, too, now agrees that Mr. McIntyre has identified a statistical snafu in the hockey-stick math. What he says isn't yet clear is whether it could invalidate Dr. Mann's final result.

Some scientists believe the debate has little bearing on the broad case for man-made warming. That's because, they say, other studies of past temperatures also indicate that the late 20th century was unusually warm. Recent temperature increases also square with the known effects of greenhouse gases. "The main punch line still appears in many other studies," says Jonathan Overpeck, a climate specialist at the University of Arizona. He shares some other scientists' concern that critics have unfairly singled out Dr. Mann's work. A variety of critics appear to be "on some kind of witch hunt," Dr. Overpeck says.

Mr. McIntyre first became interested in the hockey stick in late 2002 after seeing the graph in materials distributed by the Canadian government. "What struck me is that it looked very promotional," he says, "and I wanted to see how they made it." As a financial consultant to small minerals-exploration companies, he was mindful of how wrong estimates of the size of Borneo gold deposits lay behind the 1997 Bre-X Minerals scandal. Mr. McIntyre, who won math contests in high school and a math scholarship to the University of Toronto, says he'd always been disappointed in not having any academic accomplishments "despite having a good mind."

Mr. McIntyre e-mailed Dr. Mann requesting the raw data used to build the hockey stick. After initially providing some information, Dr. Mann cut him off.

Dr. Mann says his busy schedule didn't permit him to respond to "every frivolous note" from nonscientists. The climate-statistics expert, now 39, gained a big career boost from initial publication of the graph in 1998 and 1999. Although others had sought clues to past temperatures, his team was among the first to stitch many disparate records together to span hundreds of years across the entire Northern Hemisphere.

Scientists already knew that average global temperatures had risen about one degree Fahrenheit since 1900. Now the hockey stick, showing only smaller fluctuations in earlier centuries, was seen as a breakthrough. The IPCC used it to back a striking conclusion: The 1990s were probably the warmest decade in 1,000 years. This conclusion helped shut down skeptics' claim that the 20th century's greater warmth might be due to natural factors such as changes in solar intensity.

Some scientists had doubts, however. The graph gave little emphasis to what's known as the "medieval warm period," the years around 1000 A.D. when the Norse colonized Greenland. It also seemed to smooth over a cold epoch starting in the 15th century called "the little ice age." Others worried that it relied too heavily on growth rings from a small number of ancient trees, such as California bristlecone pines that can live thousands of years clinging to mountainsides.

Some also disliked Dr. Mann's self-confident persuasive style, among them Wallace Broecker of Columbia University's Lamont-Doherty Earth Observatory. Yet because the graph so neatly strengthened the case for man-made warming, Dr. Broecker says, "a lot of people grabbed that hockey stick."

From the outset, the graph was a target of numerous lobbyists and skeptics. When Mr. McIntyre became interested in it, he quickly teamed up with Ross McKittrick, an economist at Canada's University of Guelph who'd written a book questioning global warming. (The two met on an Internet chat group for climate skeptics.) In October 2003, *Energy & Environment*, a British social-science journal known for contrarian views, published an initial critique by the pair.

The two were invited to Washington as a vote neared on a bill to cap fossil-fuel emissions. They met with Sen. James Inhofe, who heads the environment committee and has called the threat of catastrophic global warming the "greatest hoax ever perpetrated on the American people." The Oklahoma Republican relied on doubts raised by a variety of skeptics in leading successful opposition to the bill in 2003. Mr. McKittrick says he was paid \$1,000 by the Competitive Enterprise Institute, a free-market research and lobbying group, and had his travel costs picked up by another lobby group. Mr. McIntyre, who briefed lobbyists with the National Association of Manufacturers, says he has taken no payment.

Dr. Mann and scientists close to him viewed this as a political attack, not science. Dr. Mann offered a strong rebuttal of the Canadians' 2003 journal article, explaining that it didn't correctly apply his techniques. In doing so, however, he revealed details of his data and mathematical methods that hadn't appeared in his original paper.

When Messrs. McIntyre and McKittrick pointed this out to *Nature*, the journal that first published the hockey-stick graph, Dr. Mann and his two co-authors had to publish a partial correction. In it, they acknowledged one wrong date and the use of some tree-ring data that hadn't been cited in the original paper, and they offered some new details of the statistical methods. The correction, however, stated that "none of these errors affect our previously published results."

Mr. McIntyre thinks there are more errors but says his audit is limited because he still doesn't know the exact computer code Dr. Mann used to generate the graph. Dr. Mann refuses to release it. "Giving them the algorithm would be giving in to the intimidation tactics that these people are engaged in," he says.

Mainstream scientists have also been scrutinizing the hockey stick. One, Hans von Storch of Germany's GKSS center, has presented theoretical findings arguing that Dr. Mann's technique could sharply underestimate past temperature swings. Indeed, new research from Stockholm University on historical temperatures suggests past fluctuations were nearly twice as great as the hockey stick shows. That could mean the 20th-century jump isn't quite so anomalous.

Dr. von Storch says he faced pressure from colleagues who feared that skeptics could misuse his results. He complains of a tendency in climate science to "use filters and make only comments that are politically correct."

Reports such as his helped to reopen the debate, even to outsiders. And last month, a peer-reviewed journal, *Geophysical Research Letters*, accepted a paper by Messrs. McIntyre and McKittrick.

The editor, Steve Mackwell, says Dr. Mann contacted him to argue that the Canadians' work was deeply flawed. Dr. Mann then put a critique on his blog, "Realclimate.org," calling the Canadians' new paper "demonstrably specious." He said the intense criticism of his work struck him as odd because he had always "emphasized...the uncertainties."

Now the IPCC is preparing a new global warming report, due in 2007, and charges of exaggeration are again flying. A U.S. hurricane researcher, Chris Landsea, quit the U.N. body last month after an IPCC senior author, Kevin Trenberth, said storms could get worse because of global warming. Dr. Landsea called that idea unsupported by data and said the IPCC was "motivated by pre-conceived agendas." Dr. Trenberth, defending his analysis, said his critic is the one "politicizing" the science.

As the IPCC revisits the warming issue -- and the hockey stick -- it is taking account of all views, including Mr. McIntyre's, say the group's leaders.

Mr. McIntyre says he intends to continue his audit of climate science and has demanded that other researchers send him details of their work. He isn't satisfied with the responses so far. "When I ask them for additional data, you can imagine how cooperative they are," he says.

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