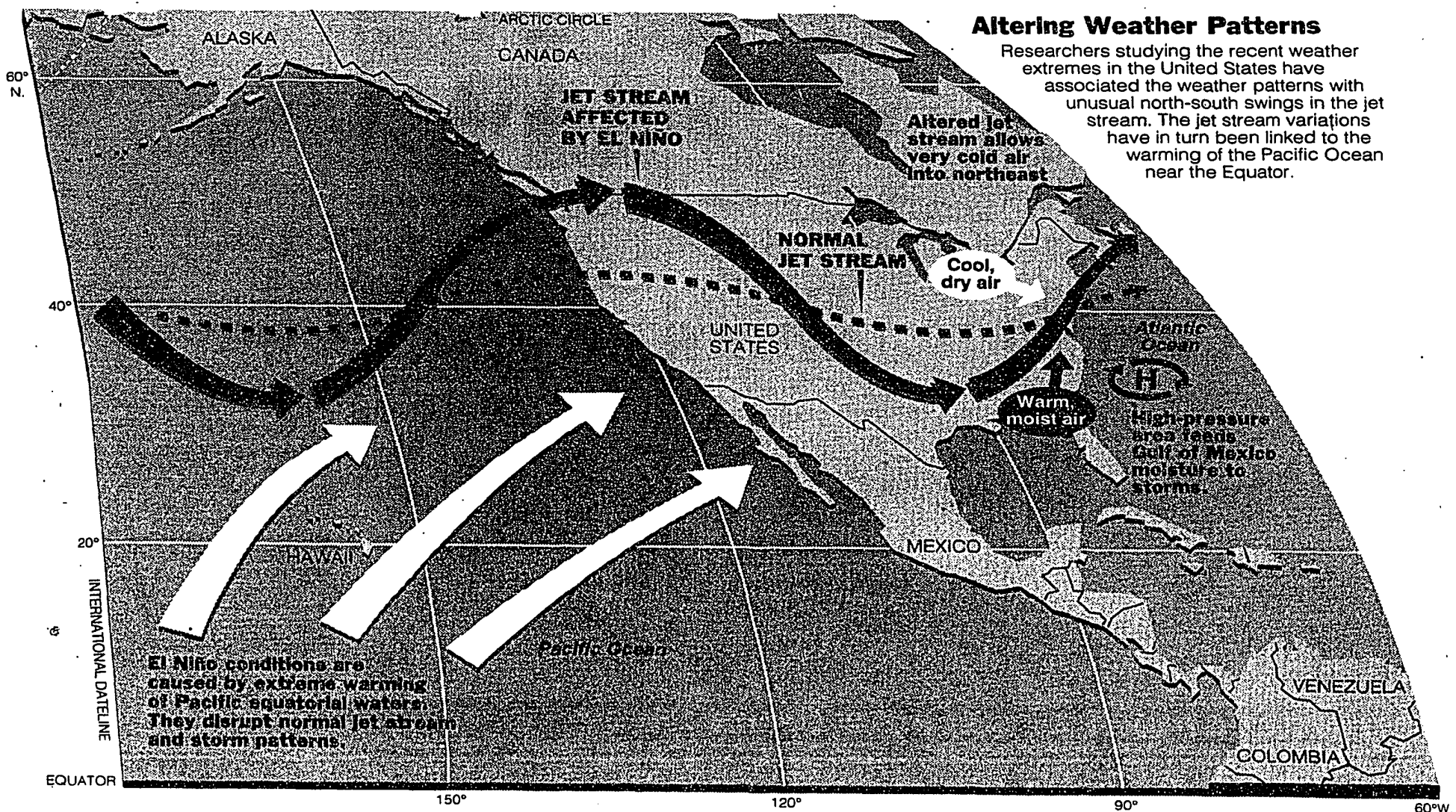


# Violent Weather Battering Globe In Last 2 Years Baffles Experts: ...

By WILLIAM K. STEVENS

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## Altering Weather Patterns

Researchers studying the recent weather extremes in the United States have associated the weather patterns with unusual north-south swings in the jet stream. The jet stream variations have in turn been linked to the warming of the Pacific Ocean near the Equator.

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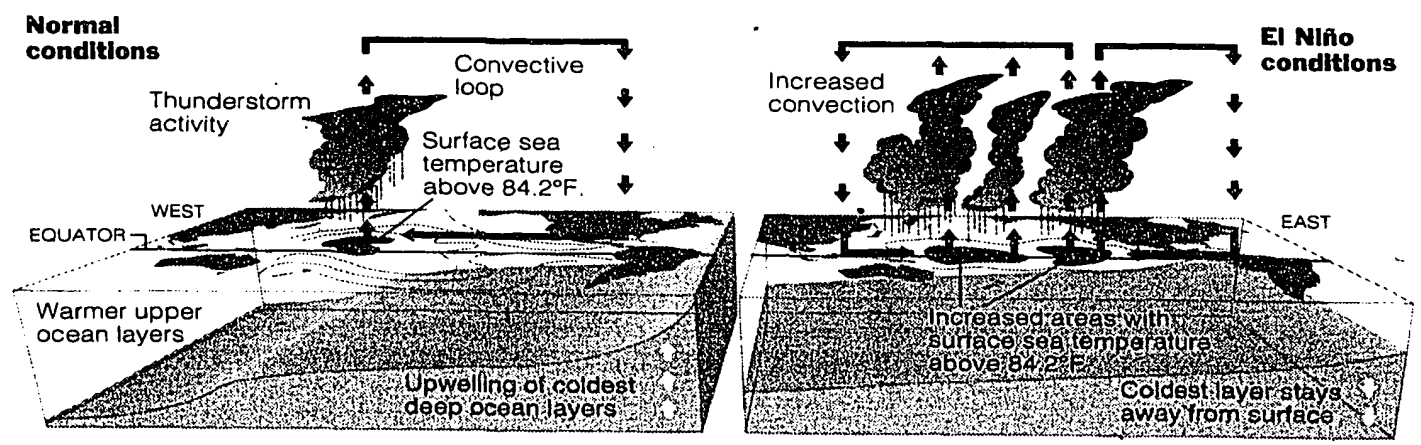
By WILLIAM K. STEVENS

**T**HE extreme weather of the last two years in North America is part of a worldwide pattern, scientists say, and they are searching hard for an explanation. The United States has suffered through the extra-cold summer that chilled the Northeast in 1992; Hurricane Andrew in August 1992, the most destructive American hurricane ever; the East Coast "storm of the century" in March 1993; the devastating flooding in the upper Midwest last summer; and the seemingly unending snows of early 1994 in the Northeast, accompanied by record warmth in the West. All are part of a global pattern of sharper climatic swings over about the last decade, say climatologists. Around the world, the 1980's and early 1990's were remarkable for the "frequency and intensity of extremes of weather and climate," Dr. John Houghton, a co-chairman of an international

The extremes may be due to natural climate variation or may signal the start of global warming.

## The Birth of El Niño

Warmer sea surface temperatures in the central Pacific create movement in the atmosphere, promoting clusters of thunderstorms. The storm clusters generate heat in the mid-atmosphere, and this heating causes a repositioning of the jet stream over North America.



The New York Times. Illustration by John Papastian

group of scientists advising the United Nations on climate change, says in a new book, "Global Warming: The Complete Briefing" (Lion Publishing, Oxford, England).

One tempting explanation for the extreme weather would be to ascribe it to the start of global warming, the feared climate change that could be brought about by emissions of heat-trapping industrial waste gases. Computer models of global climate predict more violent weather as the atmosphere heats up. But most climatologists say the small amount of warming seen so far could well lie within the normal limits of the climate's variability. And whatever the cause of the warming, it may or may not be responsible for the recent climatic extremes, says Dr. Houghton: "We have no means of knowing, actually."

If global warming cannot be blamed for the recent blast of violent weather, scientists must turn to the usual suspects, such as the circulation of air currents, the positioning of storm systems and the distribution of heat and moisture. These are the factors that determine weather on a local and regional scale, and the puzzle is to see if there is some new interconnec-

Continued on Page C4

# Violent Weather Battering Globe in Last 2 Years Baffles Experts

Continued From Page C1

tion that has driven them to their recent round of assaults.

While scientists have no definitive answers, some clues have come their way. They have found, for instance, that some large-scale patterns of air circulation may come and go in a rough kind of cycle. The average winter course of the North American jet stream, along which storms develop, has recently shifted from a relatively straight west-to-east path across the continent to a curvier one that dips south from the Pacific Northwest into the central part of the country and then turns upward through the Middle Atlantic states.

This curvier pattern allows colder, wetter weather to plunge down into the Northeast and warmer, drier weather to thrust upward into the West. The jet stream broke sharply from a flatter pattern in the late 1950's and the curvy pattern has predominated ever since, according to studies by Dr. Daniel J. Leathers of the University of Delaware and Dr. Michael A. Palecki of the State University of New York at Buffalo. Variations on the pattern are believed partly responsible both for last winter's many snowstorms in the Northeast and for a period of more intense northeasters in the Middle Atlantic states.

The pattern is itself linked to sea-surface temperatures in the Pacific Ocean, and especially to the behavior of one of the globe's most powerful weather makers: the cycle featuring, El Niño, a quasi-periodic oscillation in which temperatures in the tropical Pacific rise above average, then fall below it over irregular periods of two to seven years. The changes in ocean temperature touch off long-distance atmospheric chain reactions that alter patterns of air circulation and often bring drought or excessive rains to various parts of the world. El Niño, the warming phase of the cycle, is believed to have been a factor in causing last year's Midwestern floods.

## Snippet of Understanding

El Niño events have become relatively more frequent in the last 15 to 20 years, and Dr. Leathers and Dr. Palecki found that the curvy North American jet stream comes and goes in an approximate rhythm with them and other changes in Pacific sea surface temperatures.

Similar processes may be at work in other parts of the globe. But all of this amounts to a snippet of understanding, given the vast complexity of the climate system. What seems clearer is that the system has been serving up more extremes and greater variability over the last decade or so.

Dr. Houghton cites insurance-industry figures that show that the

number of catastrophic windstorms worldwide in the 1980's was 29 — more than double the 14 of the 1970's, which had in turn increased from the 8 of the 1960's. Insured losses from these storms have increased tenfold since the 1960's. Some of the increase is related to more people living in the storm-struck areas, but much of it "seems to have arisen from the increased storminess in the late 1980's and early 1990's," Dr. Houghton says. Moreover, floods and droughts have been going to extremes as well, he says.

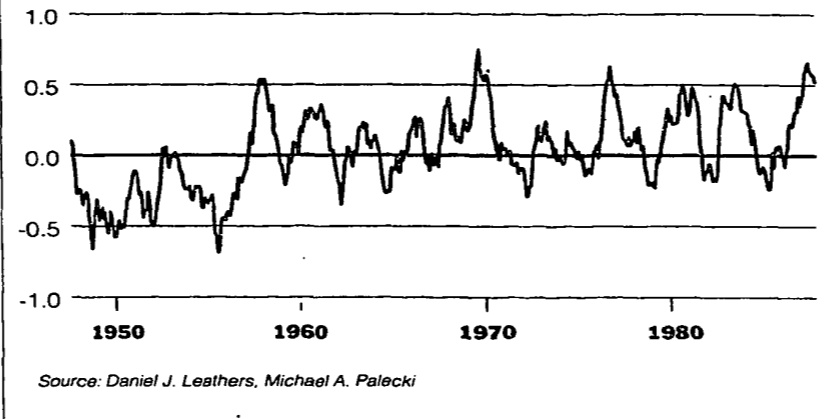
Some of the extreme weather may be linked to El Niño, Dr. Houghton, chief executive of the Meteorological Office of Britain until his retirement in 1991, and other climatologists say. A 1982-83 El Niño event was one of the strongest on record and caused climatic devastation from California to South America to Australia. An unusually cold turn of the cycle, the opposite side of the coin that has been named La Niña, has been tied, though inconclusively, to both the Bangladesh floods and the Midwestern drought of 1988. And an especially protracted El Niño, lasting for three years and ending only in the last few months, has been implicated, at least partly, in some of the more recent climatic behavior.

One obstacle to further understanding of weather cycles is that good records go back only to the 1940's, said Anthony Barnston, a senior analyst at the National Weather Service Climate Analysis Center at Camp Springs, Md. It could be, he said, that "it's run of the mill that we have these decade-to-decade changes in

## Measuring Climatic Shifts

Using a measurement of jet stream variations called the Pacific/North American teleconnection pattern, scientists have linked the stream's changes to extreme weather patterns in the United States.

In the chart below, numbers above 0 indicate sharper than usual north-south dips and ridges in the jet stream, meaning more severe weather over the United States; the numbers below 0 indicate a more even, or east-west, jet stream.



Source: Daniel J. Leathers, Michael A. Palecki

The New York Times

variability," but there is no good way to tell.

Some parts of the climate system, like the El Niño-La Niña cycle, vary on less than a decade's scale and are easier to analyze. Scientists have pinned down pretty well how the cy-

cle affects weather in various parts of the globe through "teleconnections," or chains of cause and effect that ripple through the atmosphere as a result of tropical ocean warming or cooling. But they can only approximate when the cycle will turn, and

sometimes, as with everyday weather predictions, they are wrong.

The chief reason is chaos, the inherent unpredictability of weather systems that thwarts attempts at long-range forecasts. Forecasters are attempting to deal with the chaos in the El Niño cycle by running many different computer simulations that predict a range of outcomes. If many of the outcomes are in a narrow cluster suggesting that an El Niño event is on the way, then that "tilts the roulette table" in favor of such a prediction, said Dr. Mark Cane of Columbia University's Lamont-Doherty Earth Observatory, a pioneer in El Niño forecasting.

"If we had the tools we have now, we might have been able to say months or a year ahead that there was a better than even chance" of a strong El Niño in 1982 and 83, he said.

Mr. Barnston said a slight majority of forecasters at the Climate Analysis Center believes that the tropical Pacific, after three years of warm El Niño conditions, is moving into a mild cold period characteristic of La Niña. That phase is usually associated with warm winters in the Southeastern United States, colder than normal winters from the Great Lakes to the Pacific Northwest, unsettled winters in the Northeast and Middle Atlantic states and, maybe, summer drought in the country's midsection.

By changing the distribution of storms over the ocean, El Niño creates warmer conditions in the Western United States and cooler ones in the Northeast — the exact pattern of last winter. This effect has tended to

be more prevalent since about 1976, when a period of relatively more frequent El Niño events began, said Dr. Kevin Trenberth, a climate researcher at the Center for Atmospheric Research in Boulder, Colo. "What happened this past winter in some sense was another example that fits into that particular phase," he said.

Climatologists are only beginning to try to understand how all the factors influencing climate fit together. Many are sure, however, that global greenhouse warming, if and when it happens, will alter atmospheric circulation by creating heat imbalances on the planet's surface: the ocean warms more slowly than the land.

It cools more slowly, too, as when Mount Pinatubo in the Philippines erupted in 1991, cooling the earth by casting aloft sulfate droplets that reflected sunlight. Some climate researchers believe this imbalance affected weather patterns by altering atmospheric circulation, but they have not yet pinned this down.

Many climatologists believe further that a warmer world will increase the evaporation of ocean water and thereby the number and intensity of storms. Floods, droughts and storms, in other words, would be the likely signature of global warming. And that violent regime could be triggered, some fear, by just a small warming of global climate.

But for now, climatologists are in a dense fog as to whether the current phase of violent weather is a harbinger of a warming planet or just a normal fluctuation of the global climate.