Weather

IS GLOBAL WARMING

Some scientists believe that an extreme cooling episode, potentially a mini–ice age, is imminent. Others think that it may already be under way.

–background photo, BLOOMimage/Getty Images

OVER THE PAST CENTURY, CLIMATIC CONDITIONS HAVE RUN FROM cool (1900s) to warm (1930s) to cool (1960s) to warm (1980s) **(see Figure 1 opposite and the time line below),** and many of us during the past 50 to 75 years have come to believe that mankind has been responsible for the swings. Scientists have blamed us for generating warming greenhouse gases, then polluting the air with sun-blocking particulates, then raising temperatures through urbanization, deforestation, and greenhouse gases.

There is another possible explanation for—or, at least, influence on—the warming. This involves natural factors, most notably the Sun and Earth's oceans. We at the Almanac are among those who believe that sunspot cycles and their effects on oceans correlate with climate changes. Studying these and other factors suggests that a cold, not warm, climate may be in our future.

HOW SOLAR GOES POLAR

Our Sun is a dependable but variable star. Its most notable variables are brightness, or irradiance; eruptive activity, including solar flares and geomagnetic storms; and the degree of diffusion of low-cloud-producing cosmic rays. These variables manifest in cycles of 11, 22, 88, 106, 213, 429, and more years.

A CENTURY OF CYCLES: DO YOU SEE A PATTERN HERE?

1895

"Geologists think that the world may be frozen up again."

–The New York Times

1912

"The human race will have to fight for its existence against cold."

–Los Angeles Times

The *Titanic* strikes an iceberg and sinks. "An ice age is encroaching."

–The New York Times

Weather

ON THE WANE?

by Joseph D'Aleo

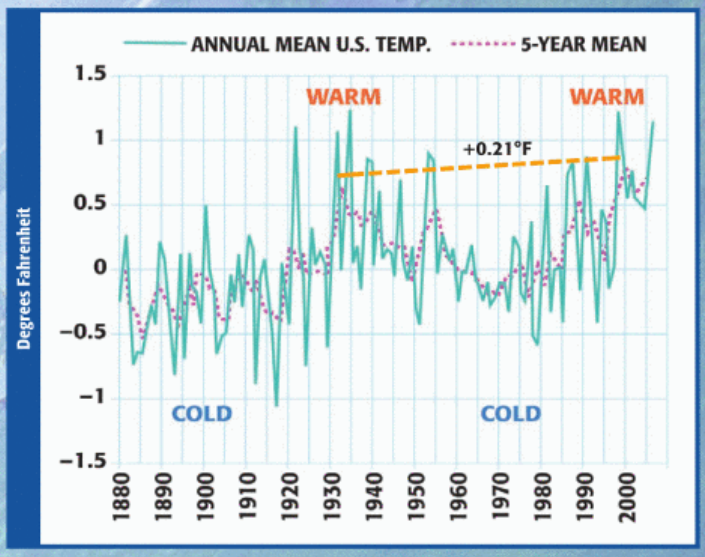

FIGURE 1. Annual mean and 5-year running mean surface air temperature anomalies for the 48 contiguous United States, based on data from 1,221 climate stations, 1880–2007, and relative to the 1951–80 average, or normal. Only a small (0.21°F) change has been observed since 1930, well within the margin of error.

Source: Goddard Institute for Space Studies (GISS), National Aeronautics and Space Administration (NASA)

At the low point of a cycle, called the solar minimum, both irradiance and eruptive activity on the Sun tend to decrease, resulting in a decrease in solar warming. Changes in visible light brightness are small but measurable (about 0.1 percent during an 11-year cycle), while decreases in ultraviolet, or UV, radiation are greater (6 to 8 percent during the same period).

We know that when UV rays combine

1923

"The Ice Age is Coming Here"
–The Washington Post

"Scientist Says Arctic Ice Will Wipe Out Canada and parts of Europe and Asia, and Switzerland Would be Entirely Obliterated"
–Chicago Tribune

1930s

Searing heat and drought turn the nation's midsection into a "Dust Bowl."

1933

"America is in longest warm spell since 1776, with temperatures in a 25-year rise."
–The New York Times

1939

"... weathermen have no doubt that the world, at least for the time being, is growing warmer."
–TIME

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with oxygen to produce ozone, heat is generated. Fewer UV rays (typical in the minimum phase of a solar cycle) means less ozone—and thus less heat—is produced.

Through observational measurements over the past 50 years and in replications using NASA models, a reduction in UV radiation has been shown to result in cooling, especially in Earth's tropics and midlatitudes. (Models suggest—and many scientists believe—that these conditions led to the mini–ice age in the 1600s known as the Maunder Minimum.)

It is also notable that when eruptive activity on the Sun decreases, solar winds weaken; fewer solar flares occur; and fewer geomagnetic storms reach Earth's atmosphere. Danish scientists and others have shown that decreased solar activity leads to an increase in cosmic rays reaching Earth's lower atmosphere.

Cosmic rays have a cloud-enhancing property; they increase low cloudiness. Low clouds reflect solar radiation, so an increase in cosmic rays leads to cooling. (Conversely, a decrease in cosmic rays, the norm during active solar cycles, means fewer low clouds and thus more sunshine and warmer surface temperatures.)

The direct changes in solar brightness, combined with the indirect cycles of UV and cosmic rays, help to bring about temperature oscillations, or cycles, on Earth. Studies have shown that long-term cycles of solar activity correlate with weather station–based annual mean temperatures very well **(see Figure 2, page 72).**

HOW OCEANS CHILL THE AIR

Ocean temperatures are not constant. They vary from predominantly warm to predominantly cold over large areas in multidecadal cycles, or oscillations. Two oscillations among many that influence North America's climate are the Pacific Decadal Oscillation (PDO) in the North Pacific and the Atlantic Multidecadal Oscillation (AMO) in the North Atlantic.

When warm water dominates the eastern tropical Pacific, heat is carried both northward and southward along the coastline of the Americas. The prevailing winds that carry this warmth east into North America cause increased warming

Early to mid-1950s

North America experiences above-normal temperatures, droughts, and, on the East Coast, devastating hurricanes.

1952

Melting glaciers are the trump card of global warming.

–The New York Times

1960s

Brutal cold prevails worldwide.

1970s

The chill continues. *TIME* and *Newsweek* magazines report on the coming ice age.

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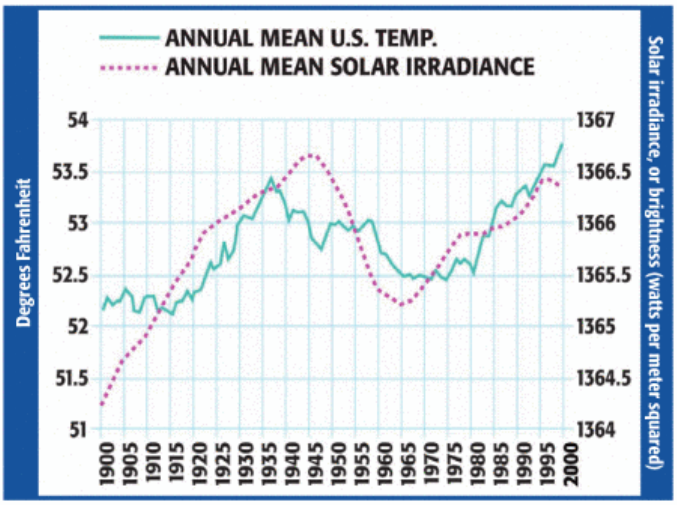

FIGURE 2. **Annual mean U.S. temperatures vs. 11-year running mean total solar irradiance (from scientists Douglas V. Hoyt and Kenneth H. Schatten), 1900–2000.** Source: Joseph D'Aleo

along the West Coast. (This describes El Niño, an oscillation within the PDO.)

Conversely, when cool water dominates the eastern tropical Pacific, cool air is carried both northward and southward along the coastline, and then east by the prevailing winds. In North America, this results in cooling along the West Coast. (This phenomenon describes La Niña, El Niño's opposite.)

In the Atlantic Ocean, the AMO experiences similar warm and cool periods, or oscillations. When waters of the north Atlantic are warm, the East Coast is at risk of more hurricanes, more strong hurricanes, and more hurricanes that make landfall. In addition, warm temperatures may develop in the ocean and coastal areas of Greenland, Iceland, Scandinavia, and other parts of the Arctic, however slightly.

The AMO is in a warm phase that began in 1995 and could last several decades. The PDO was in a warm phase from 1978 to, at least, the late 1990s. In 2007, the PDO reentered its cold phase (on schedule, many believe), and the National Oceanic and Atmospheric Admin-

1976–79

The United States and many other parts of the Western Hemisphere experience the coldest contiguous winters on record.

1979

"Plan for the Study of Dome Over Town Is Approved" [Winooski, Vermont; to protect the city from cold]

–The New York Times

–John Anderson

1980

A brutal summer heat wave occurs in much of the United States. (Residents of Winooski realize that they would have fried to death under a dome.)

1980–2000

Temperatures rise globally, interrupted only by the cooling effects of major volcanic eruptions: El Chichón in Mexico (1982) and Pinatubo in the Philippines (1991).

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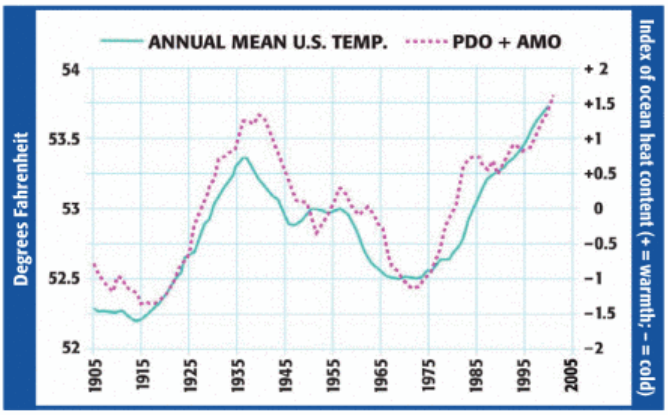

FIGURE 3. Annual mean U.S. temperatures vs. 11-year annual mean Pacific Decadal Oscillation (PDO) plus Atlantic Multidecadal Oscillation (AMO) temperatures, 1905–2000. Source: Joseph D'Aleo

istration (NOAA), among other sources, announced the presence of a La Niña.

When the AMO and PDO are considered together, they can be used as an ocean-warming index. A strong correlation exists between this index and annual mean U.S. temperatures **(see Figure 3)**—one that is roughly two to four times stronger than the correlation of carbon dioxide with the annual U.S. temperatures.

The high correlations of temperatures with both solar cycles **(see Figure 2)** and ocean cycles **(see Figure 3)** suggest that the Sun and oceans are themselves correlated. It is possible that the increased heat produced during active solar periods and felt most intensely in the tropics where the Sun is highest in the sky induces the oceans to enter their warm phases. Conversely, a less active Sun can result in less heat and thus cooler ocean waters.

Weather and climate are driven by imbalances. The atmosphere and the oceans compensate for the variability of solar activity (and the resulting variability in heat energy) by moving any tropical heat received during active solar periods to higher latitudes through warm water currents, more hurricanes, and strong winter storms (as occurred in eastern North America earlier in this decade).

1988

Record heat and drought in eastern and central United States cause over $40 billion in crop losses.

1991

–StockTrek/Photodisc/Getty Images

"Volcano's Eruption in Philippines May Counteract Global Warming"

–The New York Times

1997–98

A super El Niño results in the warmest temperatures on record worldwide.

1998

"Earth Temperature in 1998 Is Reported at Record High"

–The New York Times

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These events reduce some of the imbalance in temperature, or heat energy, and produce warming in higher latitudes.

THE CASE FOR A COOL CLIMATE

The science of forecasting solar cycles is nascent, burgeoning, and inexact. For example, predictions of the transition from cycle 23 to 24 ranged from the autumn of 2006 to March 2008; the event occurred in January 2008. (It was, as always, marked by the occurrence of a sunspot that has opposite magnetic polarity from any sunspots of the previous cycle.)

Predictions of a cycle's intensity are based on numerous formulas and methodologies. Expectations of cycle 24's intensity vary from big and intense to quiet. After lengthy study, NOAA's official prediction panel is split, while other forecasters see a decline in eruptive activity, citing a 25 percent decline in cycle 23's activity, the late start of cycle 24, and comparative studies of the 88-year (and longer) cycles.

Doug Hathaway, a solar physicist at NASA, believes that solar activity has diminished and will continue to do so for decades. In 2006, he predicted, based on observations of the slowing of the plasma flow on the Sun, that cycle 25 could be the quietest—thus, the coolest—in centuries. Also in that year, Khabibullo Abdusamatov, head of research for the Russian Academy of Sciences, issued an imminent mini–ice age warning based on expectations of a quieter Sun over the next 50 years. Our long-range forecast (p. 81) also points toward cooling conditions.

These factors—the cooling Pacific, the yet-to-cool Atlantic, and the historical reduction in recent solar activity—suggest that a staggered cooling period could continue.

Absent from most headlines about global warming is a discussion of measures suggesting that the warming has ceased and a cooling may have begun. For example, deep-ocean heat content has not increased during the past five years. Looking at just one year, from January 2007 to January 2008, we find that satellite-derived atmospheric temperatures indicate

2007

"First Major Snow in Buenos Aires Since 1918"
–International Herald Tribune

Australia records its coldest June ever and Chile experiences its toughest winter in 50 years. Johannesburg, South Africa, gets its first significant snow in a half-century. Despite the bitter cold throughout much of the Southern Hemisphere, NASA's James Hansen declares 2007 the second-warmest year on record.

2008

"Snow Day in Baghdad"
–International Herald Tribune

The coldest weather since 1964 hits the Middle East, while China experiences unusually heavy snow and freezing temperatures.

–Eugene Hoshiko/AP Images

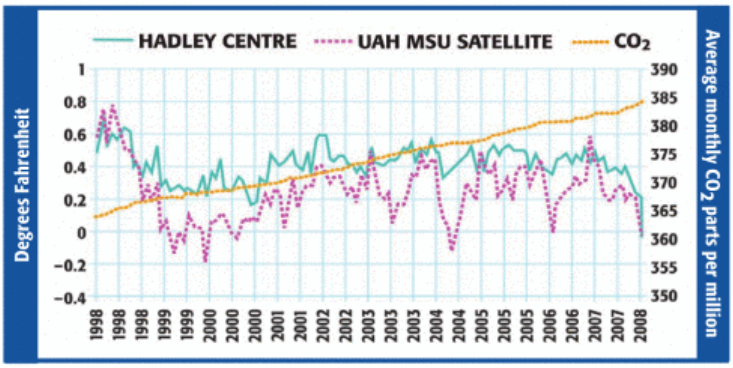

FIGURE 4. Monthly global temperature anomalies (labeled at 5-month intervals) compared with CO_2 in the atmosphere, 1998–2008.

Sources: Hadley Centre for Climate Prediction and Research, Exeter, England; University of Alabama–Huntsville Microwave Sounding Unit (UAH MSU) satellite; Joseph D'Aleo

that Earth was about one degree Fahrenheit cooler at the beginning of 2008 than it was at the beginning of 2007. The United Kingdom's Hadley Centre ocean and land temperature records show cooling in the last seven to ten years.

During the past 100 years, while temperatures have risen and fallen and risen yet again, carbon dioxide has been on a steady climb **(see Figure 4)**—and, for that, mankind does bear some responsibility. However, we would be wise to also consider the cycles and synchronicity of the Sun and oceans in any discussion of the causes of climate change.

Meteorologist and climatologist **Joseph D'Aleo** was a cofounder of The Weather Channel. Today, he is a principal in a commodity investment fund that utilizes climate forecasting for trading in energy and agriculture. He is also executive director of Icecap, an organization and Web site devoted to climate change issues.

THE WEATHER WHERE YOU ARE

Have you noticed changes in vegetation, animals—and even utility bills—that indicate climate change in your area? What do you think causes climate change? What are you doing about it? Share your thoughts at **Almanac.com/blogs** and find links to many of the sources used in this article.

SOLAR UPS AND DOWNS

Scientists have been counting solar cycles since 1755. Each sunspot cycle begins at a minimum, or period of low activity, and lasts 11 years, on average. The peak, or maximum, spans 2 to 3 years, but variations can occur. Cycle intensity is measured by the number of sunspots; the average ranges from 75 to 155 per cycle. Cycle 19 was the largest cycle in recorded history with 201 sunspots, on average. Here are dates of cycles during the past 118 years:

March 1890:	Cycle 13 begins.	April 1954:	Cycle 19 begins.
February 1902:	Cycle 14 begins.	October 1964:	Cycle 20 begins.
August 1913:	Cycle 15 begins.	June 1976:	Cycle 21 begins.
August 1923:	Cycle 16 begins.	September 1986:	Cycle 22 begins.
September 1933:	Cycle 17 begins.	May 1996:	Cycle 23 begins.
February 1944:	Cycle 18 begins.	January 2008:	Cycle 24 begins.