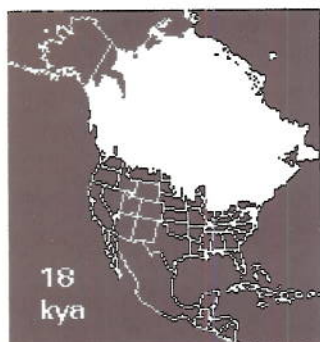


Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)

Ice Ages



When most people hear the words **Ice Age**, they think of glaciers covering much of North America and Eurasia, animals like mammoths and saber-toothed cats, and Cro-Magnon people painting cave walls. These things come to mind because the words "Ice Age" often refer to the last time that glaciers extended over a large portion of the Earth's surface. The ISM online exhibit [The Midwestern U.S. 16,000 Years Ago](#) provides more information on this glaciation in the Midwestern United States.

The amount of ice on the Earth's surface has varied greatly through time. For example, the [extent of ice](#) in North America has changed dramatically since the height of the last glacial advance 20,000 years ago.

During most of the last 1 billion years the earth had no permanent ice. However, sometimes large areas of the globe were covered with vast ice sheets. These times are known as ice ages. Illinois has experienced changes in rocks and fauna during these times. This Web module tells how some of these changes happened. Knowledge of the changes and their causes helps increase understanding about ancient rock formations and animals remains found in Illinois sites as evidenced in the Museum's specimen collections and site reports.

For example, the Online Exhibit The Midwest 16,000 Years Ago presents evidence that snowshoe hares are found today in the northern part of the midwest, yet 16,000 year old remains were found in Kentucky and Missouri, much farther south. If a type of animal lives in a certain type of climate now, we may infer that its ancestors lived in that type of climate, too. Does that mean that Kentucky and Missouri were once as cold as Wisconsin is today? What other evidence can we study to find out?

To begin to understand ice ages we must answer the following questions:

- [What](#) are Ice Ages?
- [When](#) did Ice Ages occur?
- [Why](#) do Ice Ages occur?

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[Search](#)

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)

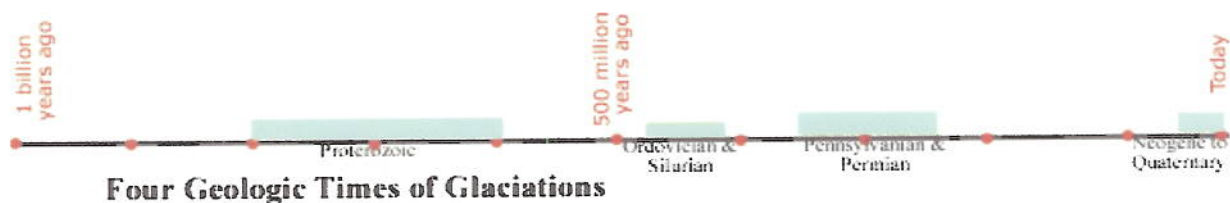
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Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

When have Ice Ages occurred?

Many glacial advances and retreats have occurred during the last billion years of Earth history. These glaciations are not randomly distributed in time. Instead, they are concentrated into four time intervals. Large, important glaciations occurred during the late Proterozoic (between about 800 and 600 million years ago), during the Pennsylvanian and Permian (between about 350 and 250 million years ago), and the late Neogene to Quaternary (the last 4 million years). Somewhat less extensive glaciations occurred during portions of the Ordovician and Silurian (between about 460 and 430 million years ago).



During each of these intervals, many glacial advances and retreats occurred. For example, over 60 glacial advances and retreats have occurred during the last 2 million years.

If "ice age" is used to refer to long, generally cool, intervals during which glaciers advance and retreat, we are still in one today. Our modern climate represents a very short, warm period between glacial advances.

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[Search](#)

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

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Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

Why were there four long, generally cool periods during which continent-sized glaciers advanced and retreated?

Although scientists cannot answer this question with certainty, they know that a number of factors interact to produce conditions favoring the formation of ice sheets. Some of these factors include

1. [changing continental positions](#)
2. [uplift of continental blocks](#)
3. [reduction of CO₂ in the atmosphere](#)
4. [changes in the Earth's orbit](#)

Long ice age intervals did not just suddenly occur. Instead, they seem to have been the culmination of even longer periods of worldwide climatic cooling. This cooling took place for tens of millions of years before the beginning of glaciation.

Once ice sheets start to grow, they probably contribute to their own further development. This positive feedback occurs because ice sheets reflect more sunlight back into space than does ground not covered by ice. The reflected sunlight would otherwise warm the Earth's surface. Consequently, the presence of ice sheets may lead to more cooling and continued development of ice sheets.

Changing continental positions

Plate tectonics is an important process influencing when ice ages occur, and the position of the continents is probably one of the most important factors controlling long periods of multiple glaciations. The presence of large land masses at high latitudes appears to be a prerequisite for the development of extensive ice sheets, because the large accumulations of ice associated with ice sheets cannot form over the ocean.

During the current ice age, which began slightly less than 3 million years ago, several large land masses have been at high latitudes. These include Antarctica, much of North America and much of Eurasia. This continental configuration led to extensive glaciation of both North America and Eurasia.

During the ice age that occurred in the Pennsylvanian and Permian, the southern portion of the supercontinent Pangea was at the south pole. The result was extensive glaciation of what is now Africa, South America, India, Antarctica, Australia, and the Arabian peninsula.

The position of the continents during the Late Proterozoic glaciation (around 700 million years ago) is not well-known. Evidence of glaciers exists from North America, Australia, and Africa.

Uplift of continental blocks

Plate tectonics probably contributes to the development of long periods with many glaciations in another, more subtle way. Plate movements sometimes cause uplift of large continental blocks. Major uplift can cause profound changes in the global oceanic and atmospheric circulation patterns. Changing circulation patterns cause climate change. Some scientists hypothesize that climatic changes caused by uplift are critical to the development of ice ages.

Over the past 15 million years, the continents have risen about 600 meters (2000 feet) on average. The uplift of the Himalayas and the Tibetan Plateau probably contributed to the initiation of the current cool period.

Similar tectonic uplift appears to have been involved in the three other long, ice age intervals.

Reduction of CO2 in the atmosphere

A general reduction in the amount of carbon dioxide (CO2) in the atmosphere may contribute to the development of ice ages. Carbon dioxide is an important greenhouse gas. Decreases in the amount of CO2 in the atmosphere may lead to global cooling.

Many processes can cause a long-term decrease in the amount of CO2 in the atmosphere. These processes include many complex interactions among organisms, ocean currents, erosion, and volcanism. Important relationships exist between ice ages and the composition of the atmosphere; however, many scientists are unsure whether the changes in atmosphere cause cool periods or whether cool periods cause atmospheric changes. Also, many scientists are not sure the magnitude of past CO2 changes was large enough to initiate ice ages.

Changes in the Earth's orbit

The Earth's orbit varies through time. Important parameters that vary include the eccentricity of the orbit around the sun, the tilt of the Earth's axis, and the direction the north pole points. Variation in these three factors changes the amount and distribution of incoming solar radiation. Variations in the distribution of solar radiation affect and initiate glaciations. The next section of this exhibit describes and illustrates these three factors.

However, the variation of the orbital parameters seems to be on too short a time scale to explain the timing of the long, cool intervals with many glaciations. Variations in orbital factors are probably more important in controlling [the advance and retreat of large glaciers during the four long, cool periods](#) than they are for controlling the larger-scale patterns.

[Illinois State Museum](#)

[State of Illinois](#)

[IDNR](#)

[Search](#)

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

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Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

What controls the advance and retreat of these large glaciers during the four long, cool periods?

Scientists understand more about why glaciers advance during cool periods than they do about why large scale cool periods occur, because they have gathered large quantities of data about the current cool period.

Variation in the Earth's orbit through time causes changes in the amount and distribution of sunlight (and other solar radiation) reaching the Earth's surface. These changes are thought to affect the development of ice sheets.

Although the idea that variation in the Earth's orbit causes glacial-interglacial cycles originated in the mid 1800s, Milutin Milankovitch first popularized it in about 1920. Although Milankovitch's hypothesis was not widely accepted initially; data collected during the 1970's have generated broad support for it.

Three orbital parameters are especially important in causing ice sheet waxing and waning:

1. Changes in the [eccentricity](#) of the Earth's orbit
2. Changes in the [tilt](#) of the Earth's axis
3. The [precession of the equinoxes](#)

In combination these factors influence the amount and distribution of solar radiation reaching the Earth. Changes vary with both latitude and season. Because of the different periodicities of variation for the three factors, the [composite variations in solar radiation](#) are very complex.

Although the connections are not obvious and direct, changes in the amount of solar radiation are thought to drive the growth and melting of major ice sheets. Over the last 750,000 years ice sheets have expanded into the midwestern United States at least [8 major times](#). The timing of the earlier of these advances is not well known.

The last glaciation of the midwestern United States had its maximum extent approximately 20,000 years ago. The animals and plants discussed in this exhibit are the ones that were living in the midwestern U.S. during and just following that glaciation.

Eccentricity

The Earth's orbit around the sun is not a circle, but rather it is an ellipse. The shape of the elliptical orbit, which is measured by its eccentricity, varies from between one and five percent through time.

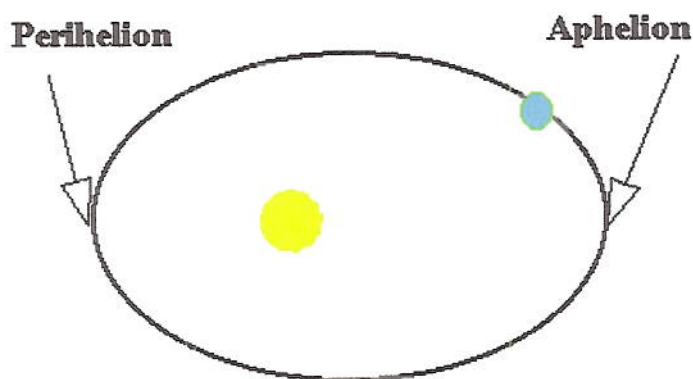
The eccentricity affects the difference in the amounts of radiation the Earth's surface receives at [aphelion](#) and at [perihelion](#). The effect of the radiation variation is to change the seasonal contrast in the northern and southern hemispheres. For example, when the orbit is highly elliptical, one hemisphere will have hot summers and cold winters; the other hemisphere will have warm summers and cool winters. When the orbit is nearly circular, both hemispheres will have similar seasonal contrasts in temperature.

Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

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Aphelion and Perihelion



Aphelion -- the point on its orbit when the Earth is farthest from the sun

Perihelion -- the point on its orbit when the Earth is closest to the sun

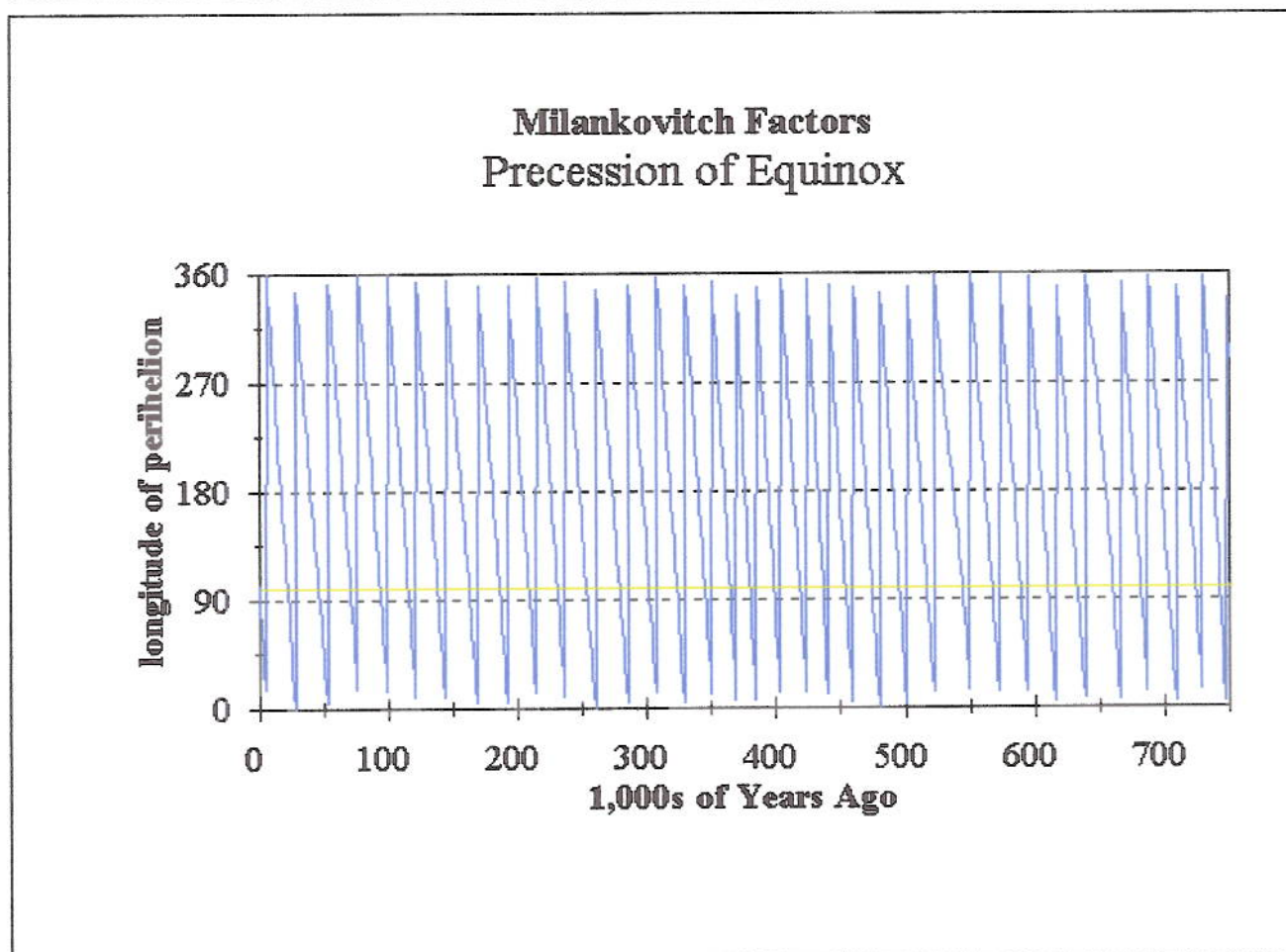
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[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>http://www.museum.state.il.us/exhibits/ice_ages/aph_peri.html, Last modified August 30th 2007, 02:59PM.

Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

Graph of the precession of the equinox



This graph shows the precession of the equinox over the last 750,000 years. The precession is expressed as the longitude of the perihelion from the vernal equinox. The blue line traces the precession; the orange line shows today's value for comparison. The data are from [Berger and Loutre \(1991\)](#).

[Illinois State Museum](#)[State of Illinois](#)[IDNR](#)[Search](#)[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

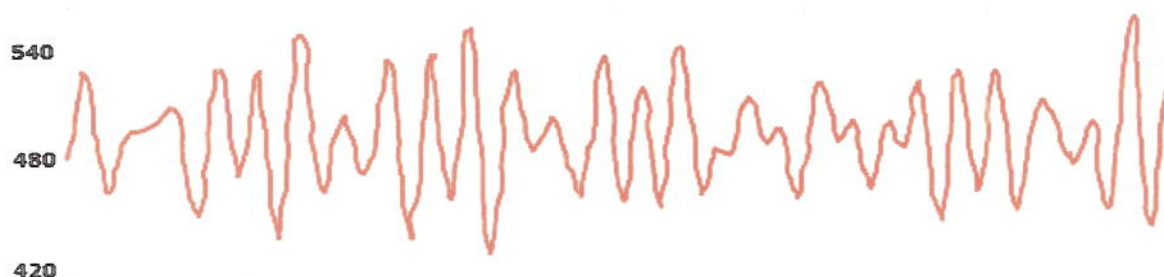
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Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

Graph of insolation

June Insolation at 65 degrees North (after Berger, 1978)



This graph shows the incoming solar radiation over the last 600,000 years for summer at 65 degrees north latitude. Note the complex changes that occur in the curve. The curve was derived using the changing values of the eccentricity of the orbit, tilt of the axis and precession of the equinoxes. The data are from [Berger and Loutre \(1991\)](#).

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[State of Illinois](#)

[IDNR](#)

[Search](#)

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

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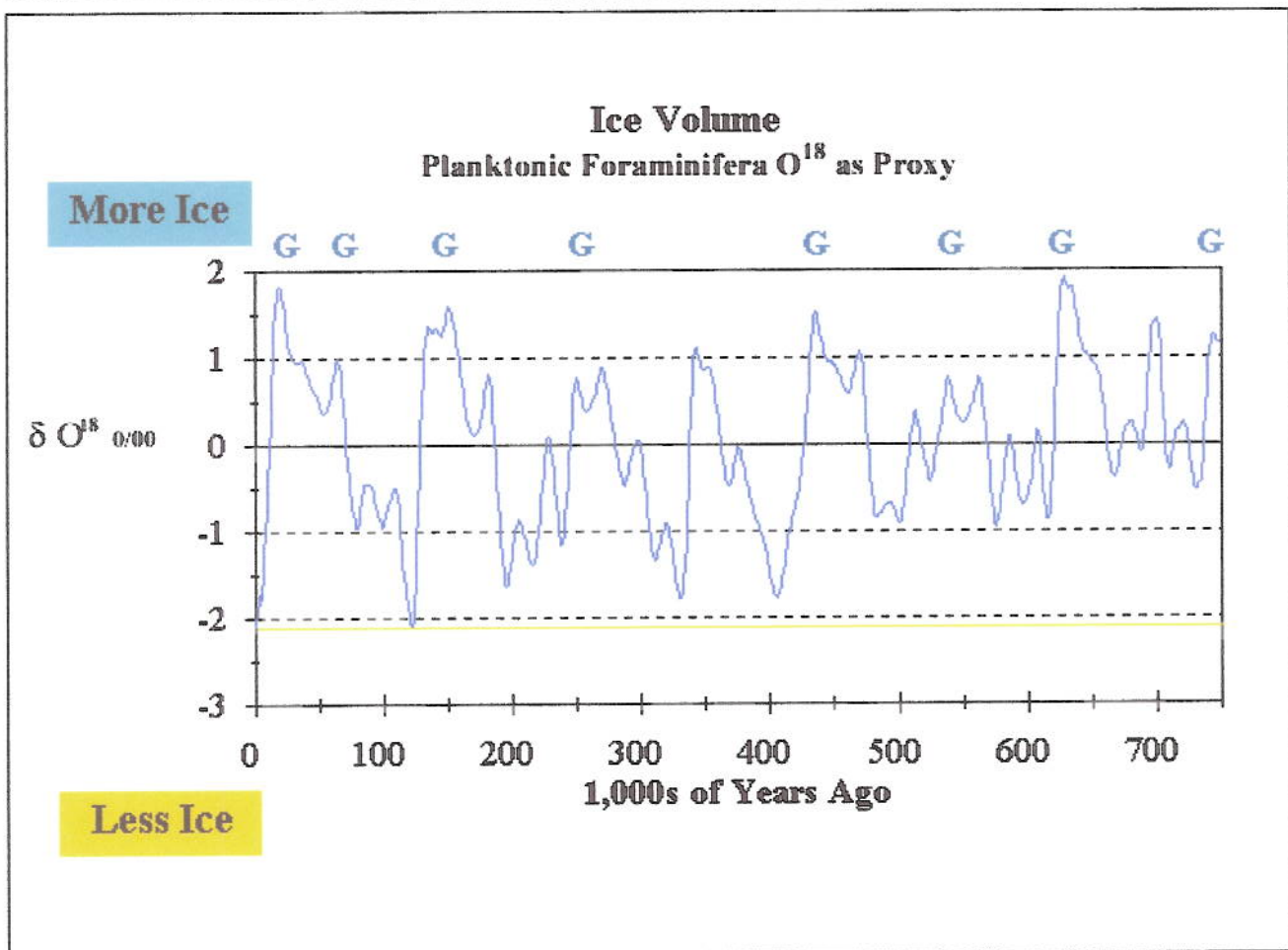
[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

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Ice Ages

[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>

Graph of Ice Volume on the Earth



This graph shows the general trend of changing ice volume on the Earth over the past 750,000 years. The extent of ice is estimated using changes in the amount of different isotopes of oxygen found in the calcium carbonate shells of planktonic sea creatures (foraminifera). These data are from [Imbrie and others \(1984\)](#). The portions of the curve marked with "G"s are times when glaciers may have reached into the midwestern U.S. The timing of midwestern U.S. glacial advances prior to 40,000 years ago are not well known. The advances indicated on this graph are taken from [Richmond and Fullerton \(1986\)](#).

[Illinois State Museum](#)[State of Illinois](#)[IDNR](#)[Search](#)[ISM Home](#) > [Exhibits](#) > [Ice Ages](#)>http://www.museum.state.il.us/exhibits/ice_ages/specmap_graph.html, Last modified August 30th 2007, 02:59PM.

The Australian

Sorry to ruin the fun, but an ice age cometh

- Phil Chapman
- From: The Australian
- April 23, 2008 12:00AM

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THE scariest photo I have seen on the internet is www.spaceweather.com, where you will find a real-time image of the sun from the Solar and Heliospheric Observatory, located in deep space at the equilibrium point between solar and terrestrial gravity.

What is scary about the picture is that there is only one tiny sunspot.

Disconcerting as it may be to true believers in global warming, the average temperature on Earth has remained steady or slowly declined during the past decade, despite the continued increase in the atmospheric concentration of carbon dioxide, and now the global temperature is falling precipitously.

All four agencies that track Earth's temperature (the Hadley Climate Research Unit in Britain, the NASA Goddard Institute for Space Studies in New York, the Christy group at the University of Alabama, and Remote Sensing Systems Inc in California) report that it cooled by about 0.7C in 2007. This is the fastest temperature change in the instrumental record and it puts us back where we were in 1930. If the temperature does not soon recover, we will have to conclude that global warming is over.

There is also plenty of anecdotal evidence that 2007 was exceptionally cold. It snowed in Baghdad for the first time in centuries, the winter in China was simply terrible and the extent of Antarctic sea ice in the austral winter was the greatest on record since James Cook discovered the place in 1770.

It is generally not possible to draw conclusions about climatic trends from events in a single year, so I would normally dismiss this cold snap as transient, pending what happens in the next few years.

This is where SOHO comes in. The sunspot number follows a cycle of somewhat variable length, averaging 11 years. The most recent minimum was in March last year. The new cycle, No.24, was supposed to start soon after that, with a gradual build-up in sunspot numbers.

It didn't happen. The first sunspot appeared in January this year and lasted only two days. A tiny spot appeared last Monday but vanished within 24 hours. Another little spot appeared this Monday. Pray that there will be many more, and soon.

The reason this matters is that there is a close correlation between variations in the sunspot cycle and Earth's climate. The previous time a cycle was delayed like this was in the Dalton Minimum, an especially cold period that lasted several decades from 1790.

Northern winters became ferocious: in particular, the rout of Napoleon's Grand Army during the retreat from Moscow in 1812 was at least partly due to the lack of sunspots.

That the rapid temperature decline in 2007 coincided with the failure of cycle No.24 to begin on schedule is not proof of a causal connection but it is cause for concern.

It is time to put aside the global warming dogma, at least to begin contingency planning about what to do if we are moving into another little ice age, similar to the one that lasted from 1100 to 1850.

There is no doubt that the next little ice age would be much worse than the previous one and much more harmful than anything warming may do. There are many more people now and we have become dependent on a few temperate agricultural areas, especially in the US and Canada. Global warming would increase agricultural output, but global cooling will decrease it.

Millions will starve if we do nothing to prepare for it (such as planning changes in agriculture to compensate), and millions more will die from cold-related diseases.

There is also another possibility, remote but much more serious. The Greenland and Antarctic ice cores and other evidence show that for the past several million years, severe glaciation has almost always afflicted our planet.

The bleak truth is that, under normal conditions, most of North America and Europe are buried under about 1.5km of ice. This bitterly frigid climate is interrupted occasionally by brief warm interglacials, typically lasting less than 10,000 years.

The interglacial we have enjoyed throughout recorded human history, called the Holocene, began 11,000 years ago, so the ice is overdue. We also know that glaciation can occur quickly: the required decline in global temperature is about 12C and it can happen in 20 years.

The next descent into an ice age is inevitable but may not happen for another 1000 years. On the other hand, it must be noted that the cooling in 2007 was even faster than in typical glacial transitions. If it continued for 20 years, the temperature would be 14C cooler in 2027.

By then, most of the advanced nations would have ceased to exist, vanishing under the ice, and the rest of the world would be faced with a catastrophe beyond imagining.

Australia may escape total annihilation but would surely be overrun by millions of refugees. Once the glaciation starts, it will last 1000 centuries, an incomprehensible stretch of time.

If the ice age is coming, there is a small chance that we could prevent or at least delay the transition, if we are prepared to take action soon enough and on a large enough scale.

For example: We could gather all the bulldozers in the world and use them to dirty the snow in Canada and Siberia in the hope of reducing the reflectance so as to absorb more warmth from the sun.

We also may be able to release enormous floods of methane (a potent greenhouse gas) from the hydrates under the Arctic permafrost and on the continental shelves, perhaps using nuclear weapons to destabilise the deposits.

We cannot really know, but my guess is that the odds are at least 50-50 that we will see significant cooling rather than warming in coming decades.

The probability that we are witnessing the onset of a real ice age is much less, perhaps one in 500, but not totally negligible.

All those urging action to curb global warming need to take off the blinkers and give some thought to what we should do if we are facing global cooling instead.

It will be difficult for people to face the truth when their reputations, careers, government grants or hopes for social change depend on global warming, but the fate of civilisation may be at stake.

In the famous words of Oliver Cromwell, "I beseech you, in the bowels of Christ, think it possible you may be mistaken."

Phil Chapman is a geophysicist and aeronautical engineer who lives in San Francisco. He was the first Australian to become a NASA astronaut.

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Global Warming: A Chilling Perspective

- A Brief History of Ice Ages and Warming
- Causes of Global Climate Change
- Playing with Numbers
- A Matter of Opinion
- Unraveling the Earth's Temperature Record
- Stopping Climate Change

A Brief History of Ice Ages and Warming

Global warming started long before the "Industrial Revolution" and the invention of the internal combustion engine. Global warming began 18,000 years ago as the earth started warming its way out of the **Pleistocene Ice Age**-- a time when much of North America, Europe, and Asia lay buried beneath great sheets of glacial ice.

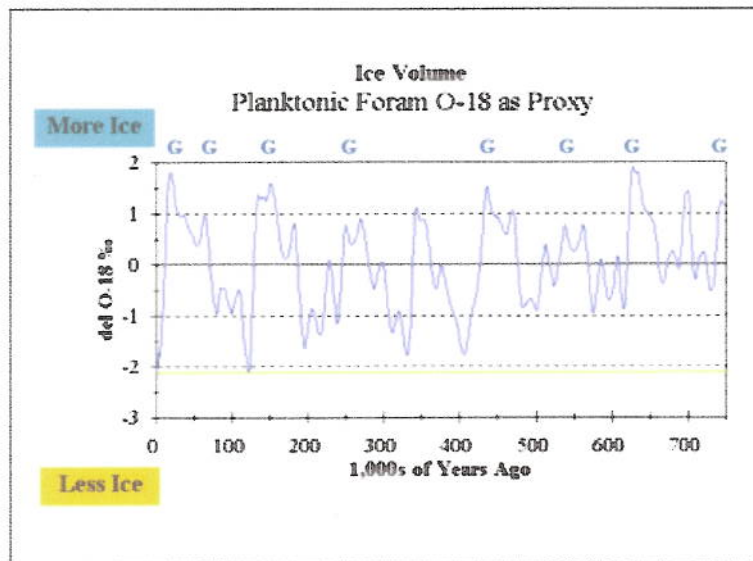
Earth's climate and the biosphere have been in constant flux, dominated by **ice ages and glaciers** for the past several million years. We are currently enjoying a temporary reprieve from the deep freeze.

Approximately every 100,000 years Earth's climate warms up temporarily. These warm periods, called **interglacial periods**, appear to last approximately 15,000 to 20,000 years before regressing back to a cold ice age climate. At year 18,000 and counting our current interglacial vacation from the Ice Age is much nearer its end than its beginning.

Global warming during Earth's current **interglacial warm period** has greatly altered our environment and the distribution and diversity of all life. For example:

- Approximately 15,000 years ago the earth had warmed sufficiently to halt the advance of glaciers, and sea levels worldwide began to rise.
- By 8,000 years ago the land bridge across the Bering Strait was drowned, cutting off the migration of men and animals to North America.
- Since the end of the Ice Age, Earth's temperature has risen approximately 16 degrees F and [sea levels have risen a total of 300 feet!](#) Forests have returned where once there

was only ice.



Over the past 750,000 years of Earth's history, Ice Ages have occurred at regular intervals, of approximately 100,000 years each.



Courtesy of [Illinois State Museum](#)

During ice ages our planet is cold, dry, and inhospitable-- supporting few forests but plenty of glaciers and deserts. Like a spread of colossal bulldozers, glaciers have scraped and pulverized vast stretches of Earth's surface and completely destroyed entire regional ecosystems not once, but several times. During Ice Ages winters were longer and more severe and ice sheets grew to tremendous size, accumulating to thicknesses of up to 8,000 feet!. They moved slowly from higher elevations to lower-- driven by gravity and their tremendous weight. They left in their wake altered river courses, flattened landscapes, and along the margins of their farthest advance, great piles of glacial debris.

During the last 3 million years glaciers have at one time or another covered about 29% of Earth's land surface or about 17.14 million square miles ([44.38 million sq. km.](#)) . What did not lay beneath ice was a largely cold and desolate desert landscape, due in large part to the colder, less-humid atmospheric conditions that prevailed.

During the Ice Age summers were short and winters were brutal. Animal life and especially plant life had a very tough time of it. Thanks to global warming, that has all now changed, at least temporarily.



 <p>(view full size map)</p>	<p>Before "global warming" started 18,000 years ago most of the earth was a frozen and arid wasteland. Over half of earth 's surface was covered by glaciers or extreme desert. Forests were rare.</p> <p>Not a very fun place to live.</p>
 <p>(view full size map)</p>	<p style="text-align: center;">Our Present World</p> <p>"Global warming" over the last 15,000 years has changed our world from an <i>ice box</i> to a <i>garden</i>. Today extreme deserts and glaciers have largely given way to grasslands, woodlands, and forests.</p> <p>Wish it could last forever, but . . .</p>


In the 1970s concerned environmentalists like Stephen Schneider of the National Center for Atmospheric Research in Boulder, Colorado feared a return to another **ice age** due to manmade **atmospheric pollution blocking out the sun**.

Since about 1940 the global climate did in fact appear to be cooling. Then a funny thing happened--sometime in the late 1970s temperature declines slowed to a halt and ground-based recording stations during the 1980s and 1990s began reading small but steady increases in near-surface temperatures. Fears of "**global cooling**" then changed suddenly to "**global warming**,"-- the cited cause:

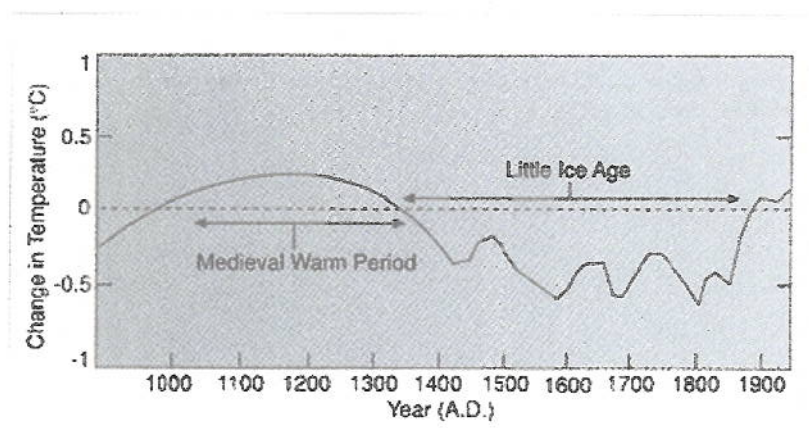
manmade **atmospheric pollution causing a runaway greenhouse effect**.

What does geologic history have to offer in sorting through the confusion?

Quite a bit, actually.

 "If 'ice age' is used to refer to long, generally cool, intervals during which glaciers advance and retreat, we are still in one today. Our modern climate represents a very short, warm period between glacial advances." [Illinois State Museum](#)

Periods of Earth warming and cooling occur in cycles. This is well understood, as is the fact that small-scale cycles of about 40 years exist within larger-scale cycles of 400 years, which in turn exist inside still larger scale cycles of 20,000 years, and so on.



Example of regional variations in surface air temperature for the last 1000 years, estimated from a variety of sources, including temperature-sensitive tree growth indices and written records of various kinds, largely from western Europe and eastern North America. Shown are changes in regional temperature in ° C, from the baseline value for 1900. Compiled by R. S. Bradley and J. A. Eddy based on J. T. Houghton et al., *Climate Change: The IPCC Assessment*, Cambridge University Press, Cambridge, 1990 and published in *EarthQuest*, vol 5, no 1, 1991. Courtesy of Thomas Crowley, [Remembrance of Things Past: Greenhouse Lessons from the Geologic Record](#)

Earth's climate was in a cool period from A.D. 1400 to about A.D. 1860, dubbed the "Little Ice Age." This period was characterized by harsh winters, shorter growing seasons, and a drier climate. The decline in global temperatures was a modest $1/2^{\circ}\text{C}$, but the effects of this global cooling cycle were more pronounced in the higher latitudes. The Little Ice Age has been blamed for a host of human suffering including crop failures like the "Irish Potato Famine" and the demise of the [medieval Viking colonies in Greenland](#).

Today we enjoy global temperatures which have warmed back to levels of the so called "Medieval Warm Period," which existed from approximately A.D. 1000 to A.D. 1350.

🔍 "...the Earth was evidently coming out of a relatively cold period in the 1800s so that warming in the past century may be part of this natural recovery."

[Dr. John R. Christy](#)

(leading climate and atmospheric science expert- U. of Alabama in Huntsville) (5)



Global warming alarmists maintain that global temperatures have increased since about A.D. 1860 to the present as the result of the so-called "**Industrial Revolution**,"-- caused by releases of large amounts of **greenhouse gases (principally carbon dioxide)** from manmade sources into the atmosphere causing a runaway "**Greenhouse Effect**."

Was man really responsible for pulling the Earth out of the Little Ice Age with his industrial pollution? If so, this may be one of the greatest unheralded achievements of the Industrial Age!

Unfortunately, we tend to overestimate our actual impact on the planet. In this case the magnitude

of the gas emissions involved, even by the most aggressive estimates of atmospheric warming by greenhouse gases, is inadequate to account for the magnitude of temperature increases. So what causes the up and down cycles of global climate change?




Causes of Global Climate Change

Climate change is controlled primarily by cyclical eccentricities in Earth's rotation and orbit, as well as variations in the sun's energy output.

"Greenhouse gases" in Earth's atmosphere also influence Earth's temperature, but in a much smaller way. Human additions to total greenhouse gases play a still smaller role, contributing about 0.2% - 0.3% to Earth's greenhouse effect.

Major Causes of Global Temperature Shifts

(1) Astronomical Causes

- 11 year and 206  year cycles: Cycles of solar variability (sunspot activity )
- 21,000 year cycle: Earth's combined tilt and elliptical orbit around the Sun (precession of the equinoxes)
- 41,000 year cycle: Cycle of the +/- 1.5° wobble in Earth's orbit (tilt)
- 100,000 year cycle: Variations in the shape of Earth's elliptical orbit (cycle of eccentricity )

(2) Atmospheric Causes

- Heat retention: Due to atmospheric gases, mostly gaseous water vapor (not droplets), also carbon dioxide, methane, and a few other miscellaneous gases-- the "greenhouse effect"
- Solar reflectivity: Due to white clouds, volcanic dust, polar ice caps

(3) Tectonic Causes

- Landmass distribution: Shifting continents (continental drift) causing changes in circulatory patterns of ocean currents. It seems that whenever there is a large land mass at one of the Earth's poles, either the north pole or south pole, there are ice ages.
- Undersea ridge activity: "Sea floor spreading" (associated with continental drift) causing variations in ocean displacement.

For more details see:

<http://www.ngdc.noaa.gov/paleo/milankovitch.html>

http://www.abc.net.au/science/news/enviro/EnviroRepublish_233658.htm

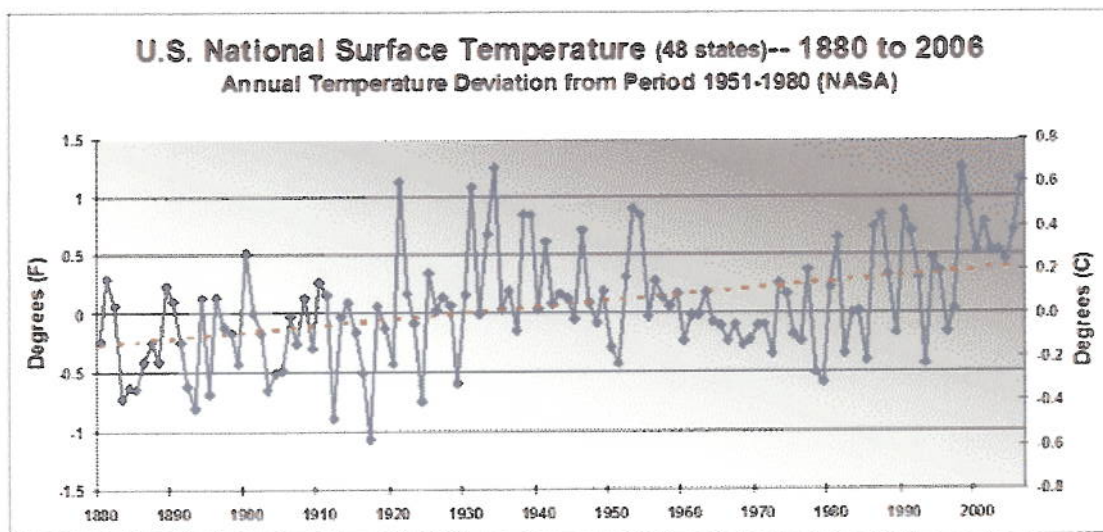


Playing with Numbers

Global climate and temperature cycles are the result of a complex interplay between a variety of causes. Because these cycles and events overlap, sometimes compounding one another, sometimes canceling one another out, it is inaccurate to imply a statistically significant trend in climate or temperature patterns from just a few years or a few decades of data.

Unfortunately, a lot of disinformation about where Earth's climate is heading is being propagated by "scientists" who use improper statistical methods, short-term temperature trends, or faulty computer models to make analytical and anecdotal projections about the significance of man-made influences to Earth's climate.

During the last 100 years there have been two general cycles of warming and cooling recorded in the U.S. We are currently in the second warming cycle. Overall, U.S. temperatures show **no significant warming trend over the last 100 years (1)**. This has been well - established but not well - publicized.



Each year Government press releases declare the previous year to be the "hottest year on record." [The UN's executive summary on climate change, issued in January 2001](#), insists that the 20th century was the warmest in the last millennium. The news media distribute these stories and people generally believed them to be true. However, as most climatologists know, these reports generally are founded on ground-based temperature readings, which are misleading. **The more meaningful and precise orbiting satellite data for the same period (which are generally not cited by the press) have year after year showed little or no warming.**

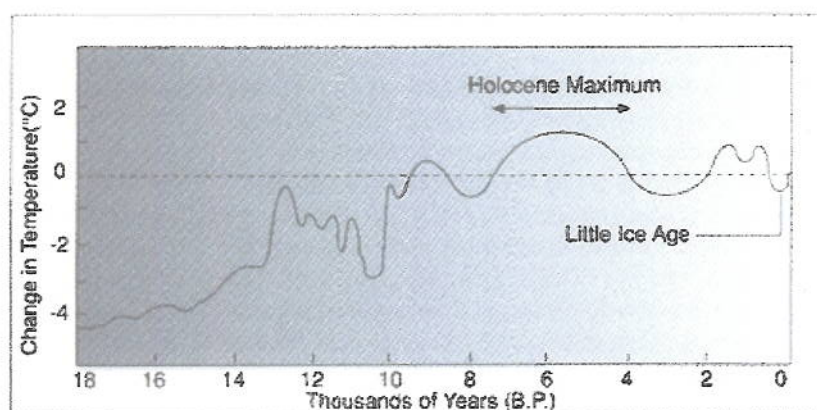
Dr. Patrick Michaels has demonstrated this effect is a common problem with ground- based recording stations, many of which originally were located in predominantly rural areas, but over time have suffered background bias due to urban sprawl and the encroachment of concrete and asphalt (the ["urban heat island effect"](#)). The result has been an upward distortion of increases in

ground temperature over time(2). Satellite measurements are not limited in this way, and are accurate to within 0.1° C. They are widely recognized by scientists as the most accurate data available. Significantly, global temperature readings from orbiting satellites show no significant warming in the 18 years they have been continuously recording and returning data (1).

A Matter of Opinion

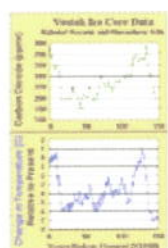
Has manmade pollution in the form of carbon dioxide (CO₂) and other gases caused a runaway Greenhouse Effect and Global Warming?

Before joining the mantra, consider the following:



1. The idea that man-made pollution is responsible for global warming is not supported by historical fact. The period known as the **Holocene Maximum** is a good example-- so-named because it was the hottest period in human history. The interesting thing is this period occurred approximately 7500 to 4000 years B.P. (before present)-- long before humans invented industrial pollution.

Compiled by R.S. Bradley and J.A. Eddy based on J.T. Houghton et al., *Climate Change: The IPCC Assessment*, Cambridge University Press, Cambridge, 1990 and published in *EarthQuest*, vo. 1, 1991. Courtesy of Thomas Crowley, [Remembrance of Things Past: Greenhouse Lessons from the Geologic Record](#)



([view full-size image](#))

Figure 1

2. CO₂ in our atmosphere has been increasing steadily for the last 18,000 years-- long before humans invented smokestacks (**Figure 1**). Unless you count campfires and intestinal gas, man played no role in the pre-industrial increases.

As illustrated in this chart of **Ice Core data from the Soviet Station Vostok in Antarctica**, CO₂ concentrations in earth's atmosphere move with temperature. Both temperatures and CO₂ have been on the increase for 18,000 years. Interestingly, CO₂ lags an average of about 800 years *behind* the temperature changes-- confirming that CO₂ is not a primary driver of the temperature changes (9).

Incidentally, earth's temperature and CO₂ levels today have reached levels similar to a previous interglacial cycle of 120,000 - 140,000 years ago. From beginning to end this cycle lasted about 20,000 years. This is known

as the **Eemian Interglacial Period** and the earth returned to a full-fledged ice age immediately afterward.

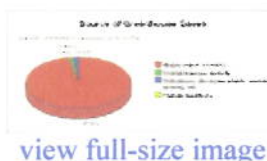


Figure 2

3. Total human contributions to greenhouse gases account for only about 0.28% of the "greenhouse effect" (Figure 2). Anthropogenic (man-made) carbon dioxide (CO2) comprises about 0.117% of this total, and man-made sources of other gases (methane, nitrous oxide (NOX), other misc. gases) contributes another 0.163% .

Approximately 99.72% of the "greenhouse effect" is due to natural causes -- mostly water vapor and traces of other gases, which we can do nothing at all about. Eliminating human activity altogether would have little impact on climate change.

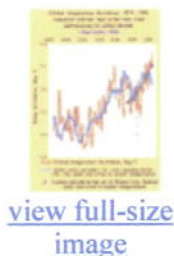


Figure 3

4. If global warming is caused by CO2 in the atmosphere then does CO2 also cause increased sun activity too?

This chart adapted after *Nigel Calder (6)* illustrates that variations in sun activity are generally proportional to both variations in atmospheric CO2 and atmospheric temperature (Figure 3).

Put another way, rising Earth temperatures and increasing CO2 may be "effects" and our own sun the "cause".

FuN FACTS about CARBON DIOXIDE

● Of the 186 billion tons of carbon from CO2 that enter earth's atmosphere each year from all sources, only 6 billion tons are from human activity. Approximately 90 billion tons come from biologic activity in earth's oceans and another 90 billion tons from such sources as volcanoes and decaying land plants.

● At 380 parts per million CO2 is a minor constituent of earth's atmosphere-- less than 4/100ths of 1% of all gases present. Compared to former geologic times, earth's current atmosphere is CO2- impoverished.

● CO2 is odorless, colorless, and tasteless. Plants absorb CO2 and emit oxygen as a waste product. Humans and animals breathe oxygen and emit CO2 as a waste product. Carbon dioxide is a nutrient, not a pollutant, and all life-- plants and animals alike-- benefit from more of it. All life on earth is carbon-based and CO2 is an essential ingredient. When plant-growers want to stimulate plant growth, they introduce more carbon dioxide.

● CO2 that goes into the atmosphere does not stay there but is continually recycled by

terrestrial plant life and earth's oceans-- the great retirement home for most terrestrial carbon dioxide.

● If we are in a global warming crisis today, even the most aggressive and costly proposals for limiting industrial carbon dioxide emissions would have a negligible effect on global climate!

The case for a "greenhouse problem" is made by environmentalists, news anchormen , and special interests who make inaccurate and misleading statements about global warming and climate change. Even though people may be skeptical of such rhetoric initially, after awhile people start believing it must be true because we hear it so often.

👉 "We have to offer up scary scenarios, make simplified, dramatic statements, and make little mention of any doubts we may have. Each of us has to decide what the right balance is between being effective and being honest."

Stephen Schneider (leading advocate of the global warming theory)
 (in interview for *Discover* magazine, Oct 1989)

👉 "In the United States...we have to first convince the American People and the Congress that the climate problem is real."

[former President Bill Clinton](#) in a 1997 address to the United Nations

👉 Nobody is interested in solutions if they don't think there's a problem. Given that starting point, I believe it is appropriate to have an over-representation of factual presentations on how dangerous (global warming) is, as a predicate for opening up the audience to listen to what the solutions are...

former Vice President Al Gore
 (now, chairman and co-founder of *Generation Investment Management*--
 a London-based business that sells carbon credits)

(in interview with [Grist Magazine](#) 📅 May 9, 2006, concerning his book, *An Inconvenient Truth*)

👉 "In the long run, the replacement of the precise and disciplined language of science by the misleading language of litigation and advocacy may be one of the more important sources of damage to society incurred in the current debate over global warming."

Dr. Richard S. Lindzen

(leading climate and atmospheric science expert- MIT) (3)

👉 "Researchers pound the global-warming drum because they know there is politics and, therefore, money behind it. . . I've been critical of global warming and am *persona non grata*."

Dr. William Gray

(Professor of Atmospheric Sciences at Colorado State University, Fort Collins, Colorado and leading expert of hurricane prediction)

(in an interview for the *Denver Rocky Mountain News*, November 28, 1999)

👉 "Scientists who want to attract attention to themselves, who want to attract great funding to themselves, have to (find a) way to scare the public . . . and this you can achieve only by making things bigger and more dangerous than they really are."

Petr Chylek

(Professor of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia)

Commenting on reports by other researchers that Greenland's glaciers are melting.

(*Halifax Chronicle-Herald*, August 22, 2001) (8)

👉 "Even if the theory of global warming is wrong, we will be doing the right thing -- in terms of economic policy and environmental policy."

Tim Wirth , while U.S. Senator, Colorado.

After a short stint as **United Nations Under-Secretary for Global Affairs** (4)

he now serves as **President, U.N. Foundation**, created by **Ted Turner** and his \$1 billion "gift"


👉 "No matter if the science is all phony, there are collateral environmental benefits.... Climate change [provides] the greatest chance to bring about justice and equality in the world."

Christine Stewart, former Minister of the Environment of Canada
quote from the *Calgary Herald*, 1999

Unraveling the Earth's Temperature Record

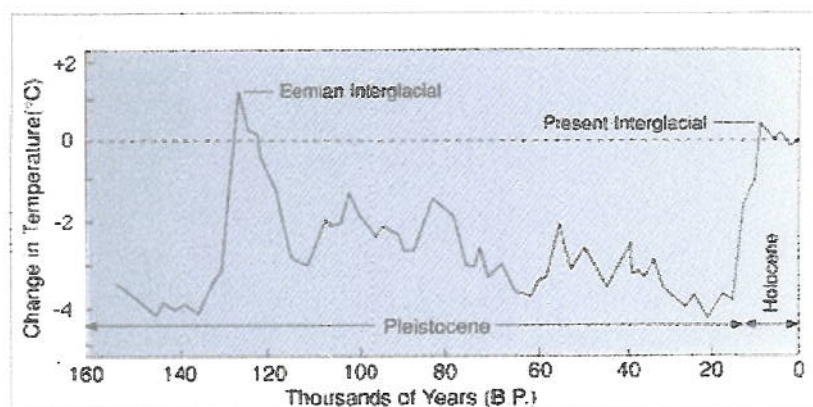


Because accumulating layers of glacial ice display annual bands which can be dated, similar to annual rings of a tree, the age of ice core samples can be determined. Continuous ice cores from borings as much as two miles long have been extracted from permanent glaciers in Greenland, Antarctica, and Siberia. Bubbles of entrapped air in the ice cores can be analyzed to determine not only carbon dioxide and methane concentrations, but also atmospheric temperatures can be determined from analysis of entrapped hydrogen and oxygen.

ice core photo by: Vin Morgan 
[Palaeo Environment \(Ice Cores\) Field Work](#)

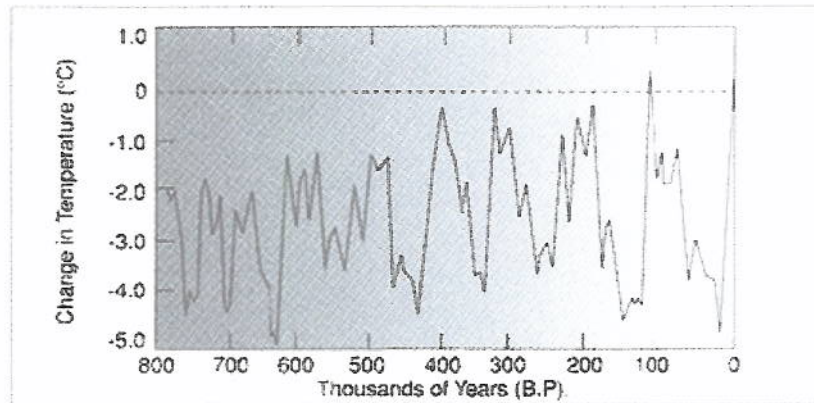
Based on historical air temperatures inferred from ice core analyses from the Antarctic Vostok station in 1987, relative to the average global temperature in 1900 it has been determined that from 160,000 years ago until about 18,000 years ago Earth temperatures were on average about 3° C cooler than today.

Except for two relatively brief interglacial episodes, one peaking about 125,000 years ago (Eemian Interglacial), and the other beginning about 18,000 years ago (Present Interglacial), the Earth has been under siege of ice for the last 160,000 years.



Compiled by R.S. Bradley and J.A. Eddy based on J. Jouzel et al., *Nature* vol. 329, pp. 403-408, 1987 and published in *EarthQuest*, vol. 5, no. 1, 1991. Courtesy of Thomas Crowley, [Remembrance of Things Past: Greenhouse Lessons from the Geologic Record](#)

As illustrated in this final graph, over the past 800,000 years the Earth has undergone major swings in warming and cooling at approximately 100,000 year intervals, interrupted by minor warming cycles at shorter intervals. This represents periods of glacial expansion, separated by distinct but relatively short-lived periods of glacial retreat.



Temperature data inferred from measurements of the ratio of oxygen isotope ratios in fossil plankton that settled to the sea floor, and assumes that changes in global temperature approximately tracks changes in the global ice volume. Based on data from J. Imbrie, J.D. Hays, D.G. Martinson, A. McIntyre, A.C. Mix, J.J. Morley, N.G. Pisias, W.L. Prell, and N.J. Shackleton, in A. Berger, J. Imbrie, J. Hays, G. Kukla, and B. Saltzman, eds., *Milankovitch and Climate*, Dordrecht, Reidel, pp. 269-305, 1984. Courtesy of Thomas Crowley, [Remembrance of Things Past: Greenhouse Lessons from the Geologic Record](#)

The Polar Ice Cap Effect



As long as the continent of Antarctica exists at the southern pole of our planet we probably will be repeatedly [pulled back into glacial ice ages](#). This occurs because ice caps, which cannot attain great thickness over open ocean, can and do achieve great thickness over a polar continent-- like Antarctica. Antarctica used to be located near the equator, but over geologic time has moved by [continental drift](#) to its present location at the south pole. Once established, continental polar ice caps act like huge cold sinks, taking over the climate and growing bigger during periods of reduced solar output. Part of the problem with shaking off the effects of an ice age is once ice caps are established, they cause solar radiation to be reflected back into space, which acts to perpetuate global cooling. This increases the size of ice caps which results in reflection of even more radiation, resulting in more cooling, and so on.

Continental polar ice caps seem to play a particularly important role in ice ages when the arrangement of continental land masses restrict the free global circulation of equatorial ocean currents. This is the case with the continents today, as it was during the [Carboniferous Ice Age](#) when the supercontinent *Pangea* stretched from pole to pole 300 million years ago.

Stopping Climate Change

Putting things in perspective, geologists tell us our present warm climate is a mere blip in the history of an otherwise cold Earth. Frigid Ice Age temperatures have been the rule, not the exception, for the last couple of million years. This kind of world is not totally inhospitable, but not a very fun place to live, unless you are a polar bear.

Some say we are "[nearing the end of our minor interglacial period](#)", and may in fact be on the brink of another Ice Age. If this is true, the last thing we should be doing is limiting carbon dioxide emissions into the atmosphere, just in case they may have a positive effect in sustaining present temperatures. The smart money, however, is betting that there is some momentum left in our present warming cycle. Environmental advocates agree: resulting in a shift of tactics from the "global cooling" scare of the 1970s to the "global warming" threat of the 1980s and 1990s.

Now, as we begin the 21st century the terminology is morphing toward "**climate change**," whereby no matter the direction of temperature trends-- up or down-- the headlines can universally blame humans while avoiding the necessity of switching buzz-words with the periodicity of solar cycles. Such tactics may, however, backfire as peoples' common sensibilities are at last pushed over the brink.

Global climate cycles of warming and cooling have been a natural phenomena for hundreds of thousands of years, and it is unlikely that these cycles of dramatic climate change will stop anytime soon. We currently enjoy a warm Earth. Can we count on a warm Earth forever? The answer is most likely... no.

Since the climate has always been changing and will likely continue of its own accord to change in the future, instead of crippling the U.S. economy in order to achieve small reductions in global warming effects due to manmade additions to atmospheric carbon dioxide, our resources may be better spent making preparations to adapt to global cooling and global warming, and the inevitable consequences of fluctuating ocean levels, temperatures, and precipitation that accompany climatic change.

Supporting this view is British scientist [Jane Francis](#), who maintains:

" What we are seeing really is just another interglacial phase within our big icehouse climate." Dismissing political calls for a global effort to reverse climate change, she said, " It's really farcical because the climate has been changing constantly... What we should do is be more aware of the fact that it is changing and that we should be ready to adapt to the change."

THIS PAGE BY:

Monte Hieb

This site last updated October 5, 2007



Previous



Table of Contents



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- (2) [The Effects of Proposals for Greenhouse Gas Emission Reduction](#); Testimony of Dr. Patrick J. Michaels, Professor of Environmental Sciences, University of Virginia, before the Subcommittee on Energy and Environment of the Committee on Science, United States House of Representatives
- (3) [Statement Concerning Global Warming](#)-- Presented to the Senate Committee on Environmental and Public Works, June 10, 1997, by Dr. Richard S. Lindzen, Massachusetts Institute of Technology
- (4) Excerpts from, "[Our Global Future: Climate Change](#)", Remarks by Under Secretary for Global affairs, T. Wirth, 15 September 1997. Site maintained by [The Globe - Climate Change Campaign](#)
- (5) [Testimony of John R. Christy](#) to the Committee on Environmental and Public Works, Department of Atmospheric Science and Earth System Science Laboratory, University of Alabama in Huntsville, July 10, 1997.
- (6) *The Carbon Dioxide Thermometer and the Cause of Global Warming*; Nigel Calder,-- Presented at a seminar SPRU (Science and Technology Policy Research), University of Sussex, Brighton, England, October 6, 1998.
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- (9) Ice Core Studies Prove CO₂ Is Not the Powerful Climate Driver Climate Alarmists Make It Out to Be; *CO₂ Science*;
Volume 6, Number 26: 25 June 2003; <http://www.co2science.org/articles/V6/N26/EDIT.php> 

Additional Reading

[Understanding Common Climate Claims](#): Dr. Richard S. Lindzen; Draft paper to appear in the Proceedings of the 2005 Erice Meeting of the World Federation of Scientists on Global Emergencies.

[Geological Constraints on Global Climate Variability](#): Dr. Lee C. Gerhard-- A variety of natural climate drivers constantly change our climate. A slide format presentation. 8.5 MB.

[Thoughts of Global Warming](#): "The bottom line is that climatic change is a given. It is inescapable, it happens. There is no reason to be very concerned about it or spend bazillions of dollars to try and

even things out.

[NOAA Paleoclimatology](#): An educational trip through earth's distant and recent past. Also contains useful information and illustrations relating to the causes of climate change.

[Cracking the Ice Age](#): From the PBS website-- NOVA online presents a brief tour of the causes of global warming.

[Little Ice Age \(Solar Influence - Temperature\)](#): From the online magazine, "CO2 Science."

[Solar Variability and Climate Change](#): by Willie Soon, January 10, 2000

[Earth's Fidgeting Climate](#): NASA Science News "It may surprise many people that science cannot deliver an unqualified, unanimous answer about something as important as climate change"

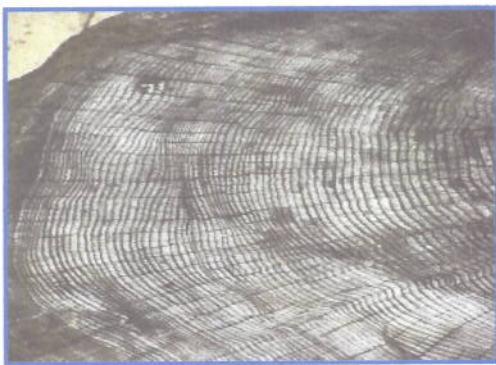
[NoTricksZone](#)

Not here to worship what is known, but to question it. Free commentary from Germany on climate science and energy policy - by P Gosselin

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New Esper Study Confirms Warm Periods Lead To Prosperity, Cold Periods To Death And Misery – Climate Extremes Were Greater In the Past

By [P Gosselin](#) on 14. Januar 2011



2500 years of tree rings.

This newest tree ring study **completely** refutes Mann's bogus hockey stick. That question is now forever resolved. There were warm and cold periods – with plenty of extremes. But that's nothing new for many of us.

[Der Spiegel](#) reports on [a new study put out by Science](#) where scientists gathered data from a large set of tree rings from the Alps and used them to reconstruct 2500 years of climate in fine detail. The scientists were able to reconstruct past climate with unprecedented precision and found some significant results.

The press here is acting like these results are new. But to skeptics, it only confirms what they've been saying all along.

It turns out that Hannibal indeed most likely did cross the Alps with elephants way back in the year 218 BC, at a time when Europe was in a warm optimum. The study shows that weather and climate events triggered human and cultural shifts and events like wars, famine, disease – or prosperity and growth, depending on whether it was warm or cold.

Der Spiegel writes:

From 9000 pieces of wood from old post and beam homes and trees, scientists Ulf Büntgen of the Swiss WSL Environmental Research Institute and Jan Esper of the University of Mainz read off the climate story – a unique global historical archive was created.”

Der Spiegel presents the most important results, which I myself think are **not** a surprise. The bulk of the Der Spiegel piece focuses on the hunger and misery precipitated by the climatic cold periods throughout the 2500-year period. One really gets a sense of how temperatures in Europe by no means followed the hockey stick shape proposed by Mann, and went from cold to warm, and vice versa. Numerous other proxies show the same applies globally.

Disease, war, famine and societal collapse in cool, raw times



Witches were burned for bad weather. (Photo source: <http://www.suppressedhistories.net/>)

2500 years ago Europe was gripped by a cold period and temperatures were 2°C below today's levels. Wars raged and societies collapsed. In the 4th century AD, after the Roman Warm Period, the climate again went downhill. It got cold and dry in central and southern Europe. The Huns invaded, and the Roman Empire collapsed. The temperature continued to drop through the 6th, 7th and 8th centuries - and with catastrophic consequences. Der Spiegel writes:

In the famine year of 784, one third of Europe's population died. 'It was a cool summer', says Büntgen's sober diagnosis, looking at the data. 'With the worsening climate, not only did harvests in Europe go bad, but livestock also shriveled away', reports historian Berninger.”

These cool times continued into the 10th century. Crops continued to fail, famine, unrest, war, disease and misery spread – all because of the cold climate.

Finally, by the 11th century, the climate turned the corner and warm times started up again (all naturally, without man-made CO₂). Europe prospered again, cathedrals were built and society advanced until the 14th century.

In the early 14th century, climate-related hunger and famine began to spread again. From 1346 to 1352, half of Europe's population was killed off by the Black Plague. As the temperature dropped, starvation and misery continued, all blamed on witches, who were burned. Sound familiar?

Europe had plunged into madness. The 30-year war raged across Germany from 1618 to 1648. At this point Europe was in the middle of the Little Ice Age. Der Spiegel writes:

In 1709 the weather in Europe rendered one of the worst natural catastrophes Europe: In the grisly cold of 1709, rivers in Portugal froze, palm trees were buried in snow. All over Europe rivers had frozen fish, livestock froze in the stables."

Prosperity and the emergence of empires in warm periods

Heydays, the Roman Empire and the German Empire coincided with warm times. For example, by 300 BC, the climate again got warmer, and with rains. It got so warm in fact, that the Alps became passable. The Roman Empire emerged – all helped along by the climate. Harvests were bountiful, and England had vineyards and made wine. The MWP was similarly warm, read above. There's ample evidence showing that the Roman Period and the MWP were warmer than today.

Weather extremes were greater in the past than today

Büntgen and Esper's ring studies also show that rainfall amounts in Central Europe fluctuated much more year-to-year in ancient times and in the Dark Ages than in recent times, and also weather extremes were greater. In the year 1135, very little rain fell and the Danube River almost dried up. Regensburg used the opportunity to build its landmark Steinernen bridge. The historical records also show a number of great floods, storms and periods of drought during Europe's history.

That was climate and it was all natural. It was not caused by witches and bad behaviour. This study clearly shows that warm times are good, cold times are bad, and that the past had more extremes than today. Not only is it more nails for the hockey stick's coffin, but also nails for the AGW theory.