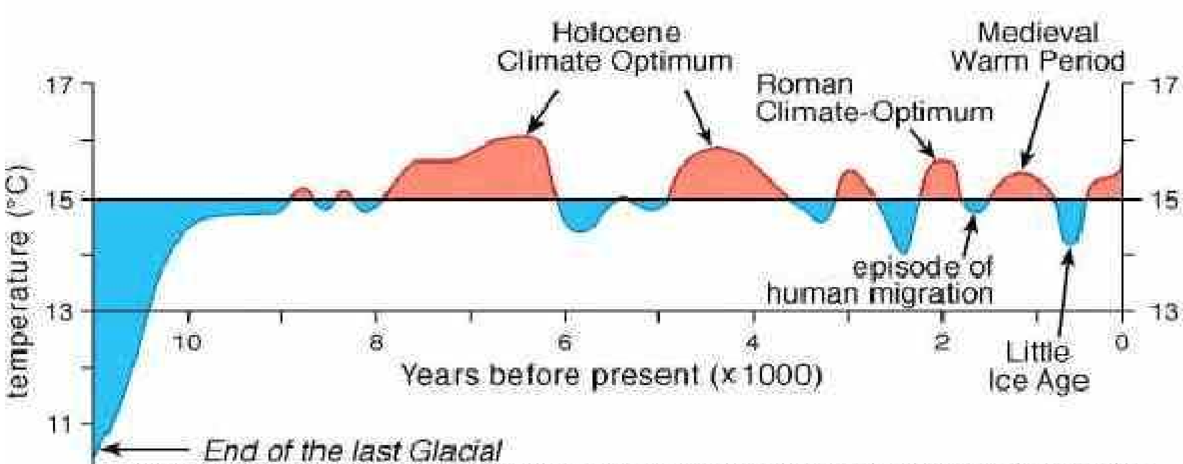
Climate Change in Perspective

by Jonathan DuHamel

The information in this essay is gleaned from the scientific literature. The data show that the current warming is not unusual, but part of a natural cycle; that greenhouse gases are not significant drivers of climate; that human emissions of carbon dioxide are insignificant when compared to natural emissions of greenhouse gases; and that many predictions by climate modelers and hyped by the media are simply wrong. There is no physical evidence showing that human carbon dioxide emissions have a significant effect on global temperature. Carbon dioxide is vital to life on earth and current atmospheric levels are dangerously low. Therefore, political policy to cut greenhouse gases will have no measurable effect on temperature but will greatly harm the economy by controlling energy use and production. The greatest danger posed by climate change is that politicians think they can stop it.

1) The current warm period is not unusual:

The graph below, based on reconstruction from the geologic and historical records, shows that there have been several warm/cold cycles since the end of the last glacial epoch. The temperature during the **Holocene Climate Optimum** was 3ºF to 10ºF warmer than today in many areas. This is warmer than the extreme scenarios of the IPCC.



Average near-surface temperatures of the northern hemisphere during the past 11,000 years (after Dansgaard et al. 1969, and Schonwiese, 1995)

Sources:

Schönwiese, Christian (1995): Klimaänderungenaten, Analysen, Prognosen.-224 S., 58 illus., Softcover, ISBN: 978-3-540-59096-5.

W. Dansgaard, S. J. Johnsen, J. Møller, and C. C. Langway Jr. (1969) One Thousand Centuries of Climatic Record from Camp Century on the Greenland Ice Sheet Science 17 Vol. 166. no. 3903, pp. 377 - 380 DOI: 10.1126/science.166.3903.377.

The graph below shows the last 2000 years in more detail.

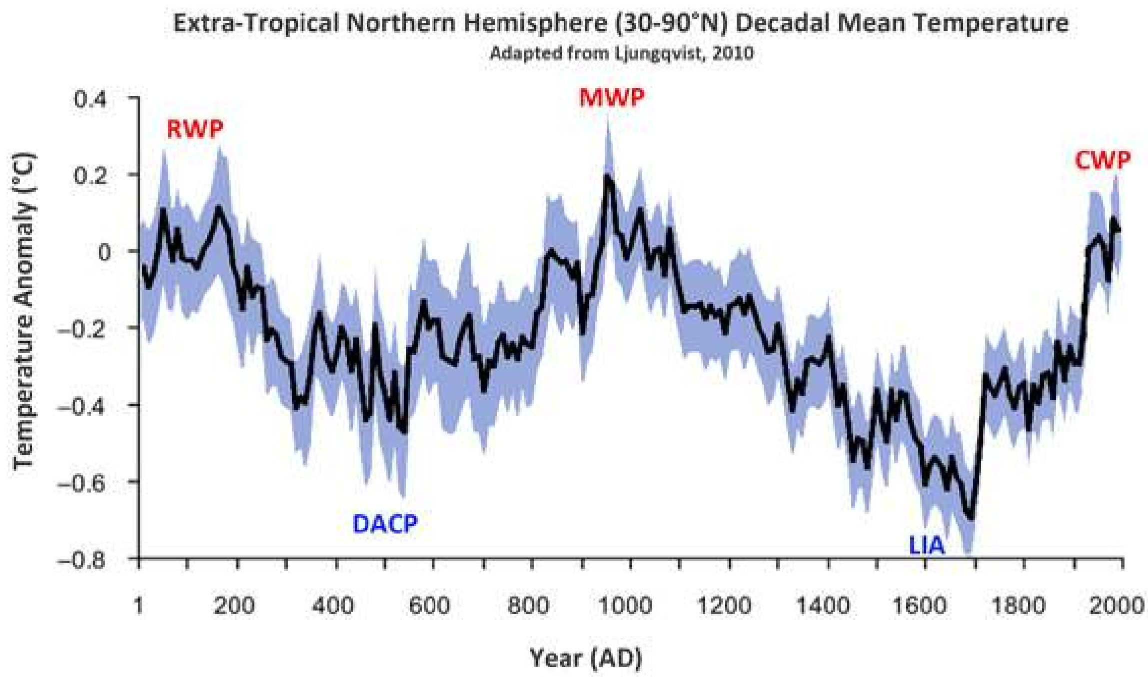
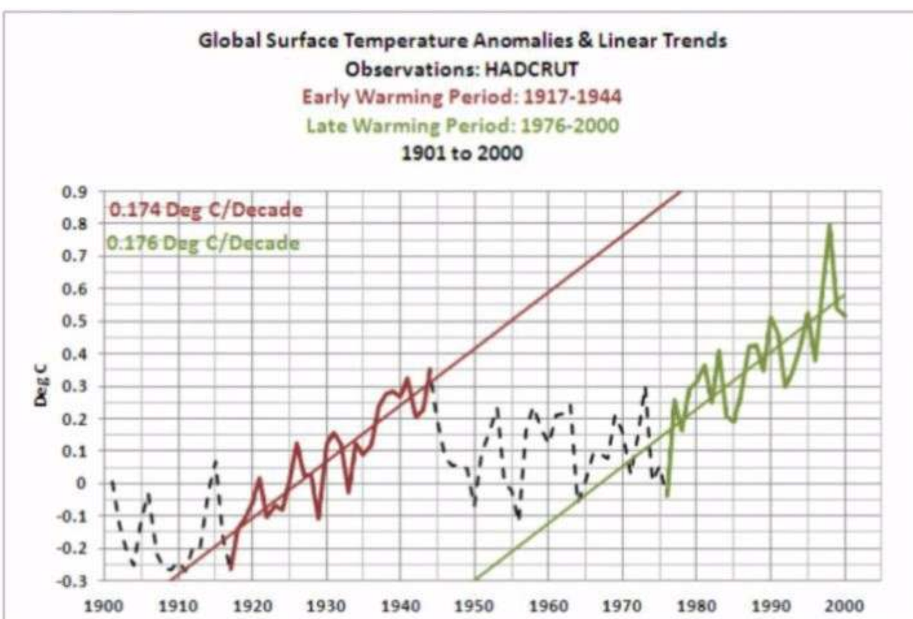


Figure 1. Reconstructed extra-tropical (30-90°N) mean decadal temperature variations relative to the 1961-1990 mean of the variance-adjusted 30-90°N CRUTEM3+HadSST2 instrumental temperature data of Brohan et al.(2006) and Rayner et al. (2006). Adapted from Ljungqvist (2010). Source: http://www.co2science.org/articles/V13/N50/C2.php

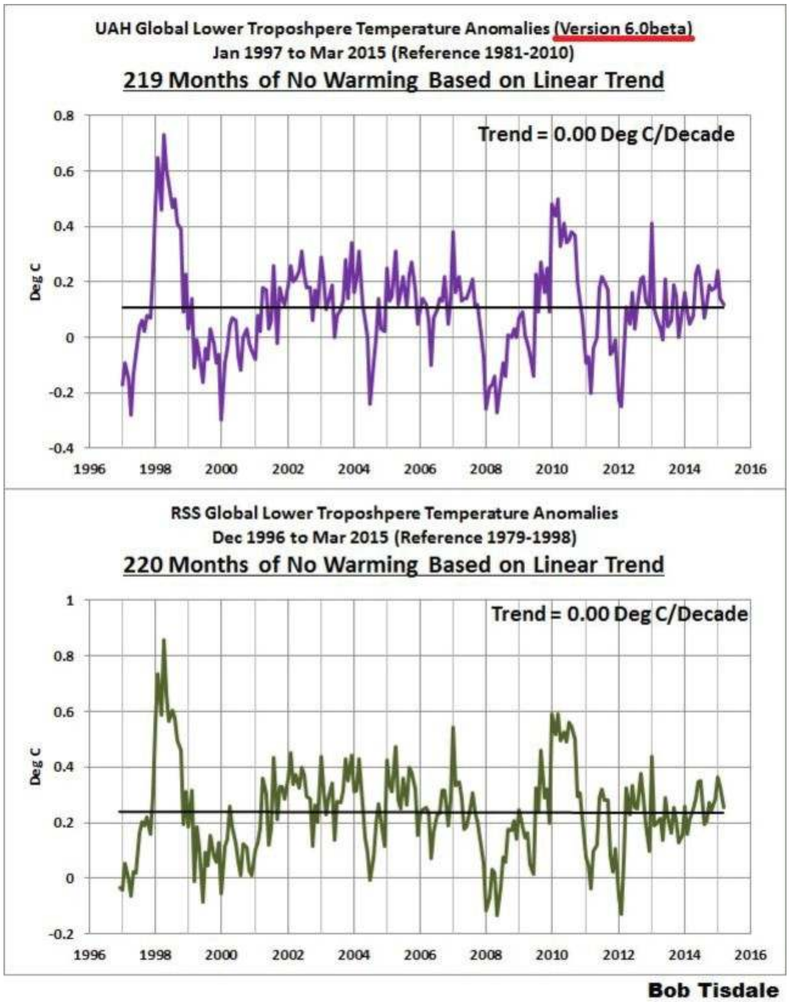
Clearly, current temperatures are neither unprecedented nor unusually warm.

It has been claimed that the rate of warming in the late 20th Century (1980-2000) is unprecedented, but that rate is the same as that which occurred in the 1930s.



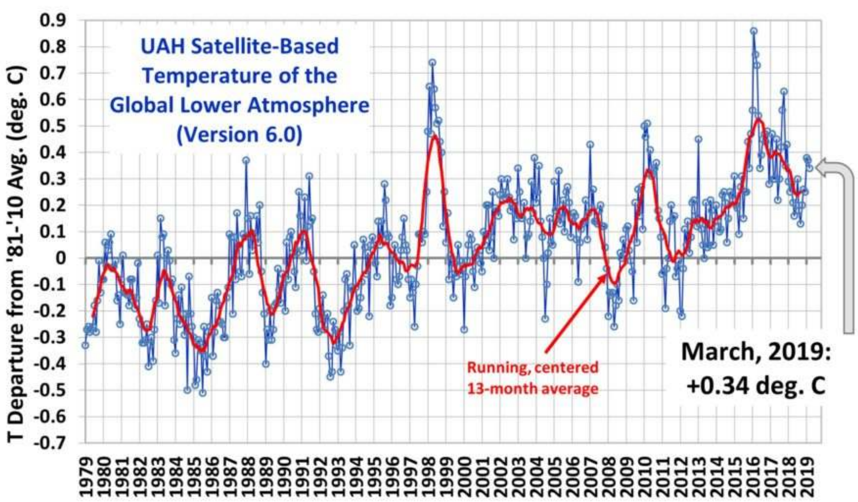
http://wattsupwiththat.com/2013/03/25/dispelling-myths-about-global-warming/

Since the "super El Nino" of 1997-1998, there has been no net warming of the atmosphere even though carbon dioxide emissions have continued to rise. This statement is based on measurements by two independent satellite systems and supported by balloon-borne radiosonde measurements.



http://wattsupwiththat.com/2015/04/29/new-uah-lower-troposphere-temperature-data-show-no-global-warming-for-more-than-18-years/

Update showing the strong El Nino of 2016 from UAH satellite data:



Source: http://www.drroyspencer.com/2019/04/uah-global-temperature-update-for-march-2019-0-34-deg-c/

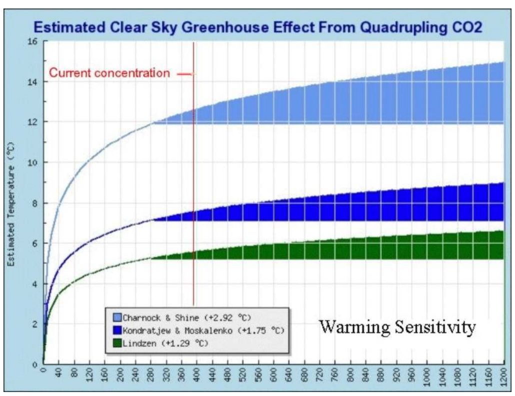
2) Carbon Dioxide and the Greenhouse Effect

We begin with a very simplified review of what the greenhouse effect is. Solar radiation, mostly short-wave radiation, passes through the atmosphere and warms the surface. In turn, the heated surface re-radiates energy as long-wave infrared radiation back to the atmosphere and eventually, back to space.

Greenhouse gases in the atmosphere intercept some of the long-wave infrared radiation and transfer some of the energy to excite (warm) other molecules in the atmosphere, some of the radiation goes back to the surface (this is called down-welling infrared radiation), and some of the radiation is radiated into space (this is called out-going long-wave radiation).

The term "greenhouse effect" with respect to the atmosphere is an unfortunate analogy because it is misleading. The interior of a real greenhouse (or your automobile parked with windows closed and left in the sun) heats up because there is a physical barrier to convective heat loss. There is no such physical barrier in the atmosphere. The greenhouse hypothesis deals only with heat transfer by radiation and completely ignores convective heat transfer.

Carbon dioxide is a "greenhouse" gas, so let's examine its theoretical and actual effect on temperature.



Even the IPCC agrees that the hypothetical capacity of carbon dioxide to change temperature is given by the formula: $\triangle T_c = \alpha \ln(C_2/C_1)$, where $\triangle T_c$ is the change in temperature in degrees Centigrade and the term $\ln(C_2/C_1)$ is the natural logarithm of the CO_2 concentration at time two divided by the concentration at time one. The constant α (alpha) is sometimes called the sensitivity and its value is subject to debate. This relationship was proposed by Svante August Arrhenius, a physicist and chemist, around 1896. This logarithmic formula produces a graph in the form shown at the left. This shows that as the concentration of carbon dioxide increases, its effects have less and less influence. This graph is the pure theoretical capacity of carbon dioxide to warm the atmosphere in absence of any confounding feedbacks. The different curves represent different values of alpha.

The reason it works this way is because carbon dioxide can absorb only a few specific wavelengths of thermal radiation, most of which are also absorbed by water vapor. The current concentration of carbon dioxide has absorbed almost all available radiation in those wavelengths so there is little left for additional carbon dioxide to absorb.

3) Predictions of the greenhouse hypothesis versus reality

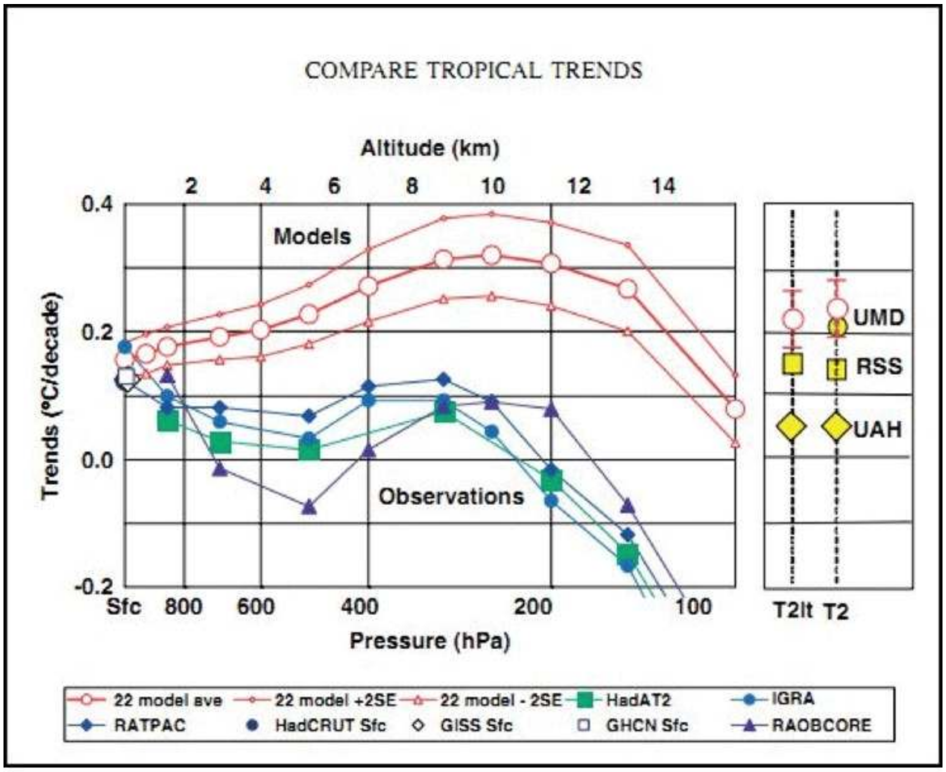
The carbon dioxide driven greenhouse hypothesis makes several predictions about what we should see if indeed our carbon dioxide emissions are "intensifying" the greenhouse effect.

Prediction 1: With an "intensified" greenhouse effect, we should see a decrease in out-going long-wave infrared radiation into space.

Reality: According to satellite data compiled by NOAA, out-going long-wave radiation into space has not been decreasing but, in fact, slightly increasing (source).

Prediction 2: The rate of warming should increase by 200-300% with altitude in the tropics, peaking at around 10 kilometers. We should see a "hot spot" over the tropics – a characteristic "fingerprint" for greenhouse warming.

Reality: Balloon-borne radiosondes and two separate satellite systems measure the temperature of the troposphere. None of these systems detect the model-predicted warming spot in the troposphere. [Source: Douglass, D.H. et al. 2007, A comparison of tropical temperature trends with model predictions, International Journal of Climatology DOI:10.1002/joc.1651]. See graph below.



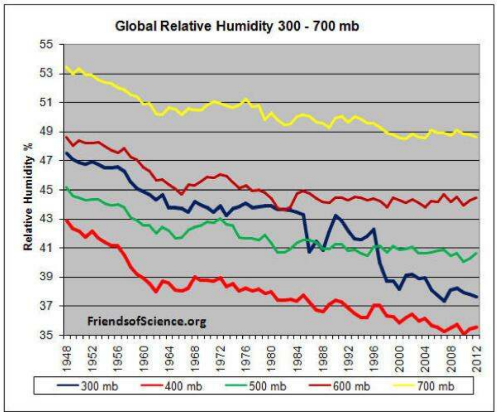
http://www.scribd.com/doc/904914/A-comparison-of-tropical-temperature-trends-with-model-predictions

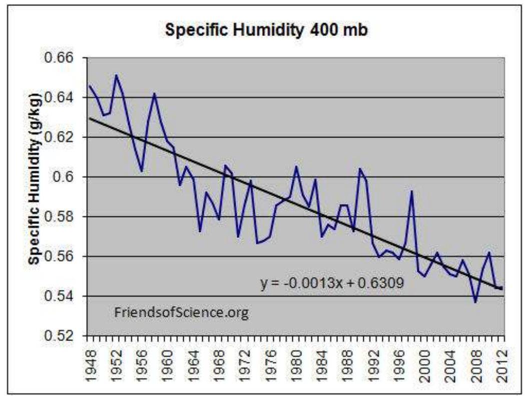
Prediction 3: There should be an increase in down-welling infrared radiation reflected from the stronger greenhouse gas "blanket."

Reality: An independent study, published in the Journal of Climate, based on 800,000 observations, finds there has been a significant decrease in down-welling, long-wave infrared radiation from increasing greenhouse gases over the 14 year period 1996-2010 in the US Great Plains. CO2 levels increased about 7% over this period and according to AGW theory, down-welling long-wave infra-red radiation should have increased over this period with buildup of carbon dioxide. (http://journals.ametsoc.org/doi/abs/10.1175/2011JCLI4210.1)

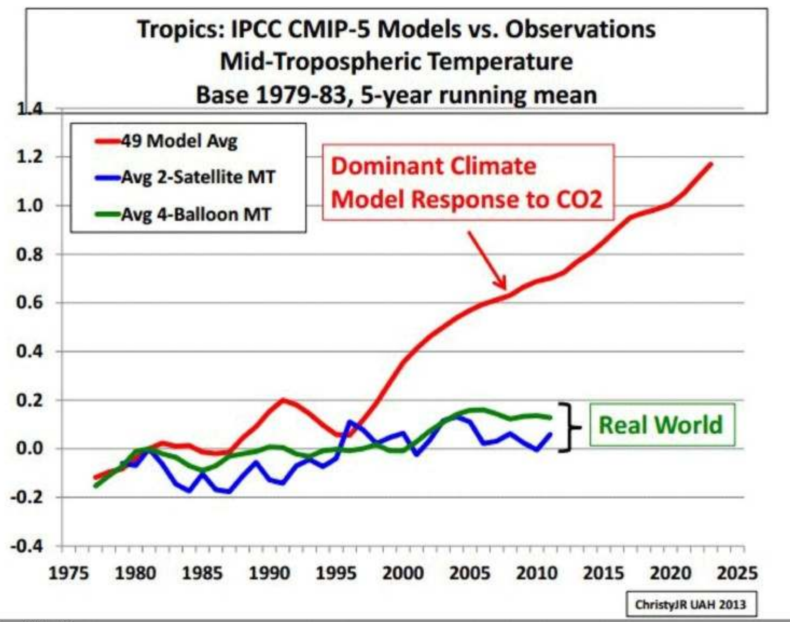
Prediction 4: Carbon dioxide is supposed to start warming which will put more water vapor into the atmosphere. Water vapor is a strong greenhouse gas and should produce more warming.

Reality: Satellite measurements show global humidity is not increasing.





Most climate models used by the IPCC assume that carbon dioxide is the major climate driver. They also ignore most natural climate drivers. As a result, the output from the models diverges from observations. The graph below, prepared by Dr. John Christy, shows the divergence between observed temperatures as measured by satellites and the output of models. (Source: http://www.drroyspencer.com/2013/04/global-warming-slowdown-the-view-from-space/):



Simplified from
http://www.drroyspencer.com/2013/06/still-epic-fail-73-climate-models-vs-measurements-running-5-year-means/

Empirical data show that the AGW hypothesis fails on four major predictions. This indicates that our carbon dioxide emissions have little to no effect on global temperature nor the intensity of the "greenhouse effect" possibly because the AGW hypothesis ignores convective heat transfer (weather) and other natural cycles that control the complex climate system.

"*It doesn't matter how beautiful your theory is; it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.*" – Richard Feynmann

4) What keeps Earth warm - the greenhouse effect or something else?

Planet Earth is 33 degrees C warmer than a theoretical planet without an atmosphere would be. Climate alarmists attribute this warmth to the radiative effects of greenhouse gases in the atmosphere. But there is another, more basic mechanism which accounts for the surface temperature: gravity and atmospheric density.

Scottish physicist James Clerk Maxwell proposed in his 1871 book "*Theory of Heat*" that the temperature of a planet depends only on gravity, mass of the atmosphere, and heat capacity of the atmosphere. Greenhouse gases have nothing to do with it. Many publications since, have expounded on Maxwell's theory and have shown that it applies regardless of atmospheric composition.

Most papers on this subject are written in calculus and difficult to follow. A more readable explanation is given by a post at the HockeySchtick here. Another readable explanation is given by Hans Jelbring in his 2003 paper "The 'Greenhouse Effect' as a Function of Atmospheric Mass."

Putting aside all the theoretical and dense reading required by the thermodynamic explanations, it occurs to me that we may have a practical demonstration of this alternate mechanism right here in Arizona.

Consider the Grand Canyon. The river level is 4,900 feet below the South Rim and 5,900 feet below the North Rim. Does the extra weight of the atmosphere at the bottom of the Canyon make the bottom warmer than the rim? Even though cold air sinks, the bottom of the Canyon is always warmer than the rim, at any time of the year, as shown by temperature measurements in the table below. Notice also that the higher North Rim is almost always cooler than the South Rim. This is a demonstration of the "lapse rate." Atmospheric pressure decreases with altitude. This is because as you go higher up there is less air above you, and therefore less downward force due to the weight of this air. As pressure decreases, air expands and cools.

Annual Grand Canyon Weather Conditions

South Rim http://www.grandcanyon123.com/grand-canyon-weather.html

(Average Elevation 7000 ft / 2133 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High (°F)	40°	45°	51°	60°	70°	81°	84°	81°	76°	65°	52°	43°
Average Low (°F)	18°	21°	25°	32°	39°	47°	54°	53°	47°	36°	27°	20°
Average Precipitation (inches)	1.45	1.60	1.25	0.86	0.61	0.42	1.95	2.23	1.54	1.15	0.92	1.54

North Rim

(Average Elevation 8000 ft / 2438 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High (°F)	37°	39°	44°	53°	62°	73°	77°	75°	69°	59°	46°	40°
Average Low (°F)	16°	18°	21°	29°	34°	40°	46°	45°	39°	31°	24°	20°
Average Precipitation (inches)	3.21	3.27	2.63	1.71	1.23	0.81	1.89	2.80	2.01	1.39	1.51	2.83

Inner Canyon - River Level

(Average Elevation 2100 ft / 640 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High (°F)	56°	63°	71°	83°	91°	102°	107°	103°	98°	86°	68°	57°
Average Low (°F)	36°	40°	46°	55°	62°	71°	77°	74°	68°	58°	45°	36°
Average Precipitation (inches)	0.61	0.73	0.80	0.43	0.34	0.33	0.80	1.55	0.83	0.65	0.37	0.69

And just to make things interesting, a 2013 paper in Nature Geoscience explains why "A minimum atmospheric temperature, or tropopause, [separating stratosphere from troposphere] occurs at a pressure of around 0.1 bar in the atmospheres of Earth, Titan, Jupiter, Saturn, Uranus, and Neptune, despite great differences in atmospheric composition, gravity, internal heat and sunlight." This shows that temperature is controlled by pressure, not greenhouse gases. By the way, in the troposphere, heat transfer is mainly by convection, i.e., weather, whereas in the stratosphere heat transfer is mainly by conduction/radiation.

What happens on other planets:

Venus has a surface temperature of about 900°F and an atmosphere composed of 96% carbon dioxide. The temperature is the same from equator to poles, from day to night (Venus rotates on its axis in 2,802 hours rather than 24 hours). Venus is often touted as the extreme example of run-away greenhouse warming. But, there is almost no greenhouse warming on Venus because little, if any, direct sunlight gets to the surface. The atmosphere is too thick. In 1975, the Russian Venus lander Venera 9 measured clouds that were 30–40 km thick with bases at 30–35 km altitude. The surface air pressure on Venus is about 92 times greater than that on Earth. The high pressure alone can explain most of the high surface temperature. Although Venus gets almost twice the solar irradiation of Earth, Venus' high albedo reflects back 65% of the sunlight.

Venus has almost no water vapor in the atmosphere (about 0.002%), and therefore lacks the major greenhouse gas that Earth has.

Mars has an atmosphere composed of 95% carbon dioxide and only a trace of water. Its atmosphere is very thin. Its surface pressure is about 2% that of Earth. The temperatures on the two Viking landers, measured at 1.5 meters above the surface, range from + 1° F, (-17.2° C) to -178° F (-107° C). However, the temperature of the surface at the winter polar caps drop to -225° F, (-143° C) while the warmest soil occasionally reaches +81° F (27° C) as estimated from Viking Orbiter Infrared Thermal Mapper (NASA data). Again, no water vapor, no greenhouse effect.

Maxwell's hypothesis (see above) explains both Venus and Mars without resorting to a "greenhouse" effect.

The greenhouse model is a simplified story that helps explain how our atmosphere works. However, the real world is very complicated and still not fully understood. Even global warming alarmist James Hansen of NASA's Goddard Institute for Space Studies, had this to say: "The forcings that drive long-term climate change are not known with an accuracy sufficient to define future climate change." -- James Hansen, "Climate forcings in the Industrial era", PNAS, Vol. 95, Issue 22, 12753-12758, October 27, 1998.

And even the IPCC once admitted, "In climate research and modeling, we should recognize that we are dealing with a coupled non-linear chaotic system, and therefore that the prediction of a specific future climate state is not possible." -- Final chapter, Draft TAR 2000 (Third Assessment Report), IPCC.

5) Human contribution to greenhouse gases is insignificant:

Carbon dioxide is continually being emitted into the atmosphere and absorbed by the oceans, plants, formation of limestone, etc. According to the U.S. Department of Energy annual emission reports, humans are responsible for about 3% of total CO_2 emissions; the rest is from natural sources. Carbon dioxide constitutes about 3% to 4% of total greenhouse gases by volume; therefore anthropogenic CO_2 represents just over one-tenth of one percent (0.12%) of total greenhouse gases emitted into the atmosphere each year. Water vapor is the major greenhouse gas, about 25 times more abundant than carbon dioxide, yet you rarely hear about it from media reports, and many computer climate models fail to take it into account.

We have all heard scary stories about global warming and, therefore, propose to limit our carbon dioxide emissions, assuming that they are responsible for the warming. So, the central question is: How much carbon dioxide does it take to theoretically raise global temperatures by 1°C ? That number can be estimated from global emissions reports and IPCC scenarios.

Based on data from the Carbon Dioxide Information Analysis Center (DOE), it takes about 15,700 million metric tonnes (mmt) of CO_2 to raise atmospheric concentration by 1 part per million by volume (ppmv). In 2000, mean atmospheric CO_2 concentration was 368 ppmv (NOAA global index). The "let's do nothing" scenario (A2) of the IPCC Fourth Assessment Report (2007) predicts CO_2 concentration will rise to 836 ppmv by 2100– a 468 ppmv rise. In the same scenario, the IPCC predicts a temperature rise of 3.4°C. Therefore, under that assumption, to get a 1°C temperature rise requires a 140 ppmv rise in atmospheric CO_2 concentration (468/3.4 ≈ 140). And, simple arithmetic shows that to get a 1°C temperature rise requires carbon dioxide emissions of 2,198,000 mmt. (15,700 mmt/ppmv x 140 ppmv/°C = 2,198,000 mmt of CO_2). That's 2 million, million tonnes of CO_2.

According to the EPA, total human CO_2 emissions in the U.S., from all sources, including power plants, industry, automobiles etc. were 6,103 million metric tonnes in 2007. **If we stopped all U.S. emissions it could theoretically prevent a temperature rise of 0.003°C**. (6,103/2,000,000 = 0.003°C.) If every country totally stopped human emissions, we might forestall 0.01°C of warming.

The calculation above ignores the fact that 98.5% of all carbon dioxide emissions are reabsorbed. http://www.eia.doe.gov/oiaf/1605/archive/gg04rpt/pdf/tbl3.pdf So that actual emissions would have to be 146 million million tonnes to get a 1°C temperature rise, i.e., if we stopped all U.S. emissions it would really prevent a temperature rise of just 0.00004°C. But it will take even more than that because the effect of CO_2 concentration is logarithmic, not linear as assumed above. The calculations above also assume that all the warming is produced by carbon dioxide with no natural component. If natural cycles were included, then the effect of carbon dioxide would be much less.

Climate alarmists maintain that human emissions of carbon dioxide will accumulate to dangerous levels because they say that CO_2 stays in the atmosphere for 50- to 200 years. However, based on 35 studies of isotopic analysis, the actual residence time is less than ten years.
(See Segalstad paper from Bate, R. (Ed.): "Global Warming: The Continuing Debate", European Science and Environment Forum (ESEF), Cambridge, England (ISBN 0-9527734-2-2), pages 184-219, 1998. http://folk.uio.no/tomvs/esef/ESEF3VO2.htm and Carbon Dioxide: The Houdini of Gases http://ilovemycarbondioxide.com/pdf/Carbon_Dioxide_The_Houdini_of_Gases.pdf)

6) Humans and the Carbon Cycle

Some people must think that humans are not part of nature because they claim that human carbon dioxide emissions upset "the balance of nature." This belief reflects a misunderstanding of what "balance" really is. Nature is never really "in balance" or static, it is always seeking equilibrium between forces that upset the status quo.

There are actually two carbon cycles. The geologic carbon cycle stores carbon in limestone, dolomite, petroleum, and coal deposits. Carbon dioxide from the atmosphere is used up during the weathering of silicate rocks, a process that speeds up with increasing temperature or increasing carbon dioxide, thereby forming a negative feedback or thermostat. It takes millions of years, usually, for this carbon to cycle back into the biosphere. Volcanoes recycle carbonate rocks and emit 200 million metric tons of carbon dioxide per year according to the U.S. Geological Survey. There are also carbon dioxide gas seeps. Carbon dioxide is also produced from metamorphism of carbonate rocks and from the spontaneous combustion of coal in natural seams.

The biologic carbon cycle is exchange of carbon dioxide between the atmosphere, biosphere, and ocean. The biologic process involves photosynthesis, respiration, ocean absorption, and biological use of carbonates to form shells and other structures. Human emissions are part of these natural cycles.

The ocean is also the connection between the geologic carbon cycle and the biologic carbon cycle. The oceans contain about 10 times more carbon than exists in fossil fuel deposits. As the amount of carbon dioxide in the atmosphere increases, ocean uptake also increases. The carbon dioxide is stored not only as dissolved gas, but also as carbonate ions which are sequestered by marine life and the production of limestone and dolomite deposits.

There is another complication. Some carbon is missing. When calculating the carbon flux, i.e., the emissions from known sources versus carbon sequestration by known sinks, there should be more carbon dioxide in the atmosphere than there is. So, either there is an unknown process taking up carbon dioxide or a known process is working faster than we thought (seeking equilibrium).

There is some observational evidence for that last process. We see that terrestrial plant life has increased its net primary productivity by growing more robustly and by making better use of nitrogen in the soil. (Source) There are also new studies showing that small marine creatures, such as Thaliacea, are depositing more carbon into the geologic sink than previously realized. Perhaps we still don't know as much about the carbon cycle as we thought.

7) The Lack of Correlation Between Temperature and Atmospheric CO2 Content at Various Time Scales

In this section, we will examine the Earth's temperature and the carbon dioxide (CO2) content of the atmosphere at several time scales to see if there is any relationship. I stipulate that the greenhouse effect does exist. I maintain, however, that the ability of CO2 emissions to cause global warming is tiny and overwhelmed by natural forces. The main effect of our "greenhouse" is to slow cooling.

There is an axiom in science which says: "correlation does not prove causation." Correlation, however, is very suggestive of a relationship. Conversely, lack of correlation proves that there is no cause-and-effect relationship.

Note this section is the subject of a stand-alone Wryheat post: https://wryheat.wordpress.com/2017/05/09/an-examination-of-the-relationship-between-temperature-and-carbon-dioxide/

Here are the highlights:

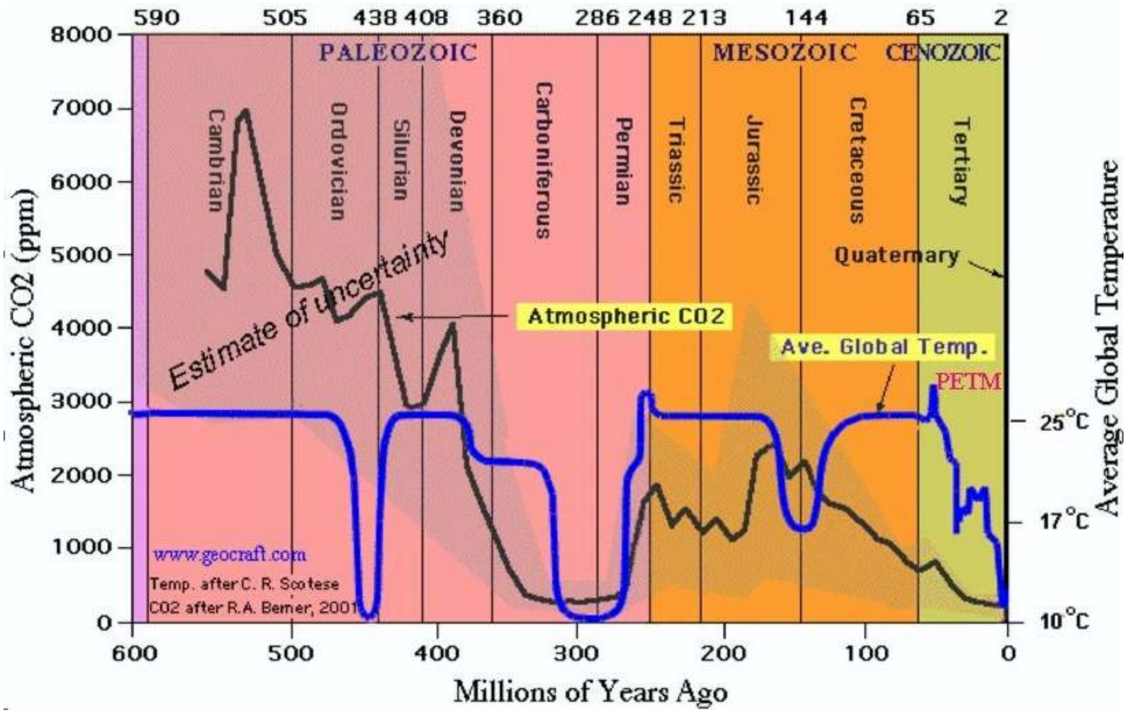
Phanerozoic time – the past 500 million years:

Here is the big picture.

Estimates of global temperature and atmospheric CO2 content based on geological and isotope evidence show little correlation between the two. Earth experienced a major ice age in the Ordovician Period when atmospheric CO2 was 4,000ppm, 10 times higher than now. Temperatures during the Cretaceous Period were rising and steamy, but atmospheric CO2 was declining.

Notice also, that for most of the time, Earth's temperature was much warmer than now and life flourished.

There were some major extinction periods, all associated with ice ages.

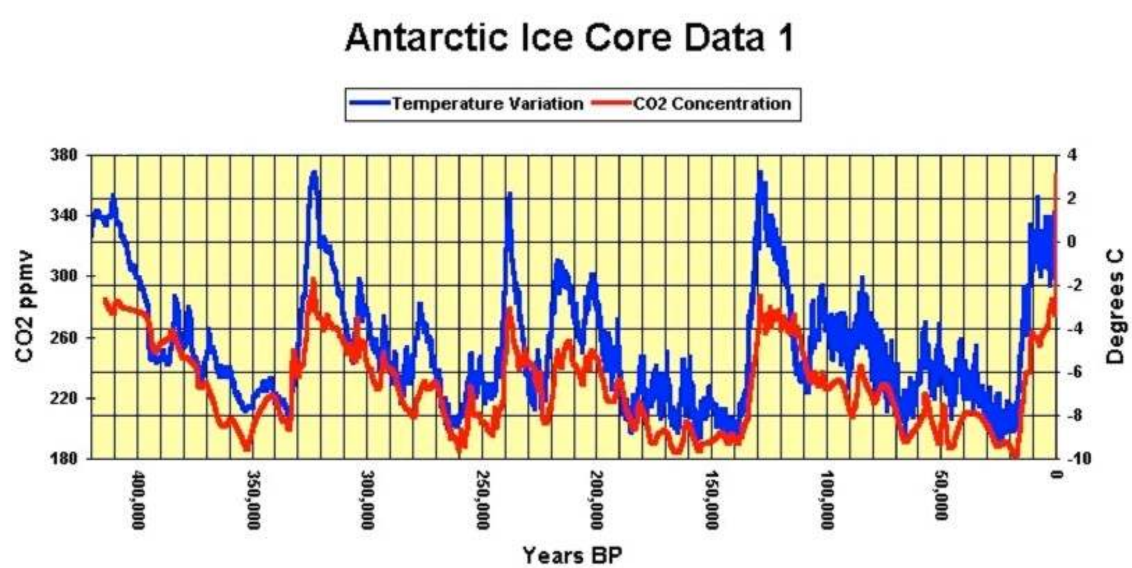


Sources:

Berner, R.A. and Kothavala, Z, 2001, GEOCARB III: A Revised Model of Atmospheric CO2 over Phanerozoic Time, American Journal of Science, Vol. 301, February, 2001, P. 182–204

Scotese, C.R., http://www.geocraft.com/WVFossils/Carboniferous_climate.html

Our current ice age – the past 420,000 years:



The scientists working on the Vostok core noticed that temperature changes PRECEDED changes in CO_2 concentration by about 800 years. Again, we see that CO_2 doesn't have much influence on temperature, but temperature has great influence on CO_2 concentration because temperature controls CO_2 solubility in the ocean.

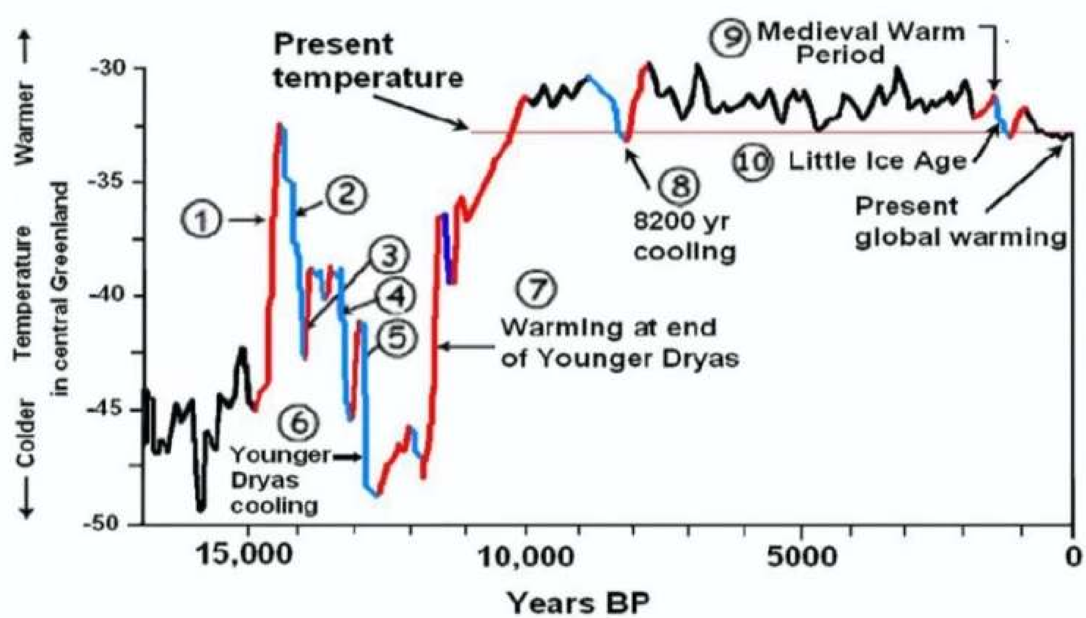
Sources for Vostok graph above:

Petit, J.R., et al., 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. Nature 399: 429-436.

Mudelsee, M, 2001. The phase relations among atmospheric CO2 content, temperature and global ice volume over the past 420 ka, Quaternary Science Reviews 20:583-589.

Siegenthaler, U. Et al., 2005. Stable carbon cycle-climate relationship during the late Pleistocene. Science 310: 1313-1317.

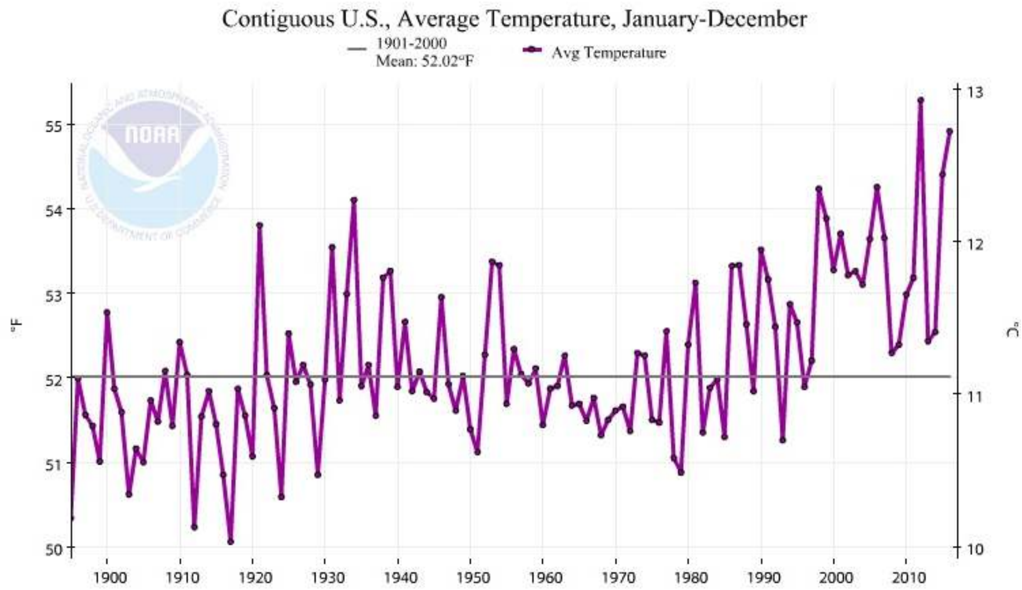
The Holocene – the past 10,000 years:



Cuffey, K.M. and G.D. Clow, 1997, Temperature, accumulation and ice sheet elevation in central Greenland through the last deglacial transition: Journal of Geophysical Research, vol. 102, p.26383-396.

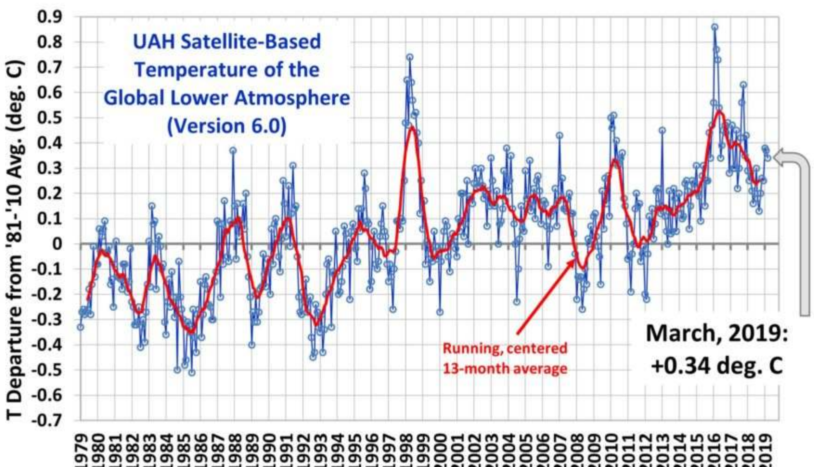
The Holocene represents the current interglacial period. For most of the past 10,000 years, temperature was higher than now. CO_2 was fairly steady below 300ppm (vs over 400ppm now). There were cycles of warm and cool periods at a periodicity of 1200 to 1500 years. This periodicity correlates with the interplay of the several solar cycles. The sun itself goes through cycles of solar intensity and magnetic flux. When the cycles are in a strong phase, the amount of cosmic rays entering the atmosphere is reduced, there are fewer clouds to block the sun, so it is warmer. When solar cycles wane, as is beginning to happen now, more cosmic rays enter the atmosphere and produce more clouds which block the sun, so it becomes cooler. The number of sunspots (hence magnetic flux) varies on an average cycle of 11 years. There are also 87-year (Gliessberg) and 210-year (DeVriess-Suess) cycles in the amplitude of the 11-year sunspot cycle which combine to form an approximately 1,500-year cycle of warming and cooling.

The 20th Century:



The first part of the 20th Century experienced warming in the 1920s and 1930s comparable to current temperatures. According to NASA, atmospheric CO2 rose from 295ppm in 1900 to 311ppm in 1940. Major emissions from burning fossil fuels, however, commenced after WWII in the mid 1940s. The period 1940-1970 saw a CO2 rise of 311ppm to 325ppm. That period also showed global cooling to such an extent that climate scientists were predicting a return to glacial conditions. From about 1980 to 2000, CO2 rose from 339ppm to 370ppm and we had warming during that period until the super El Nino of 1997/1998. Some of this data has been "corrected" by NOAA.

The 21st Century so far:



Between the El Nino of 1997 and that of 2016, there have been temperature fluctuations but no net warming. Atmospheric CO2 rose from 363ppm to 407ppm today. It seems that there is no correlation between global temperature and CO2.

8) The real climate drivers

The real drivers of climate are the sun's insolation (light and heat), and magnetic flux. The luminosity and magnetic flux vary with solar cycles, and the amount of heat and light reaching the Earth also varies depending on the relative position of the Earth to the sun. The sun's magnetic flux controls the amount of cosmic rays impinging on the atmosphere which influences cloudiness. Geologic factors are also in play because the position of the continents control how ocean currents can distribute heat.

There are three main positional variations of the Earth and Sun, called Milankovitch cycles (after Serbian geophysicist Milutin Milanković who first calculated the cycles): Orbital Eccentricity, Axial Obliquity (tilt), and Precession of the Equinoxes. All these cycles affect the amount and location of sunlight impinging on the earth. The following explanation of the cycles are summarized from *The Resilient Earth* (Hoffman, D.L. and Simmons, A., 2008.

Orbital Eccentricity: Earth's orbit around the sun cycles from nearly circular to elliptical with an eccentricity of about 9%. This cycle takes 100,000 years. When the orbit is highly elliptical the seasonal variation is greater, about 30%. Also an elliptical orbit changes the length of seasons. Earth's current orbital eccentricity is 0.0167, which is relatively circular. Currently, Earth's distance from the Sun at perihelion, on January 3rd, is 91 million miles. Earth's distance from the Sun at aphelion, on July 4th, is 95 million miles. This difference between the aphelion and perihelion causes Earth to receive 7% more solar radiation in January than in July. Besides the 100,000 year cycle, there is also a weak variation in the cycle of 413,000 years.

Obliquity or Tilt of the Axis: The second Milankovitch cycle involves changes in obliquity, or tilt, of Earth's axis which varies on a 41,000 year cycle from 22.1° to 24.5°. The smaller the tilt, the less seasonal variation there is between summer and winter at middle and high latitudes. For small tilt angles, the winters tend to be milder and the summers cooler. Cool summer temperatures are thought more important than cold winters, for the growth of continental ice sheets. This implies that smaller tilt angles lead to more glaciation. Currently, axial tilt is approximately 23.45 degrees, reduced from 24.50 degrees just a thousand years ago.

Precession cycle of 23,000- 25,800 years: The third cycle is due to precession of the spin axis. As a result of a wobble in Earth's spin, the orientation of Earth in relation to its orbital position changes. This occurs because Earth, as it spins, bulges slightly at its equator. The equator is not in the same plane as the orbit of Earth and other objects in the solar system. The gravitational attraction of the Sun and the Moon on Earth's equatorial bulge tries to pull Earth's spin axis into perpendicular alignment with Earth's orbital plane. Earth's rotation is counterclockwise [viewed from above the north pole]; gravitational forces make Earth's spin axis move clockwise in a circle around its orbital axis. This phenomenon is called precession of the equinoxes because, over time, this backward rotation causes the seasons to shift.

The full cycle of equinox precession takes 25,800 years to complete. Due to the eccentricity cycle, Earth is closest to the Sun in January and farther away in July, but the northern hemisphere is tilted away. Due to precession, the reverse will be true 12,900 years from now. The Northern Hemisphere will experience summer in December and winter in June. The North Star will no longer be Polaris because the axis of Earth's rotation will be pointing at the star Vega instead. Individually, each of the three cycles affect insolation patterns. When taken together, they can partially cancel or reinforce each other in complicated ways.

Glacial epochs can be triggered when tilt is small, eccentricity is large, and perihelion, when Earth is closest to Sun, occurs during the Northern Hemisphere's winter. Perihelion during the Northern Hemisphere winter results in milder winters but cooler summers, conditions that keep snow from melting over the summer. Deglaciation is triggered when perihelion occurs in Northern Hemisphere summer and Earth's tilt is near its maximum. There are other factors which act to enhance the forcing effects of the cycles. These include various feedback mechanisms such as snow and ice increasing Earth's albedo, changes in ocean circulation and enhanced greenhouse heating due to increased CO2 and water vapor concentrations.

The Sun's Internal Cycles: The sun itself goes through cycles of solar intensity and magnetic flux. When the cycles are in a strong phase, the amount of cosmic rays entering the atmosphere is reduced, there are fewer clouds to block the sun, so it is warmer. When solar cycles wane, as is beginning to happen now, more cosmic rays enter the atmosphere and produce more clouds which block the sun, so it becomes cooler. The number of sunspots (hence magnetic flux) varies on an average cycle of 11 years. There are also 87-year (Gliessberg) and 210-year (DeVriess-Suess) cycles in the amplitude of the 11-year sunspot cycle which combine to form an approximately 1,500-year cycle of warming and cooling.

Recent research confirms the relationship between magnetic flux, cosmic rays, and cloudiness. In essence, cosmic rays ionize the upper atmosphere and produce nuclei that become the seeds for water droplets and hence clouds which block sunlight.
See:
http://www.sciencebits.com/CosmicRays_Climate_TheMissingLink
https://www.nature.com/articles/s41467-017-02082-2

In addition, "Two mechanisms, the top-down stratospheric response of ozone to fluctuations of shortwave solar forcing and the bottom-up coupled ocean-atmosphere surface response...act together to enhance the climatological off-equatorial tropical precipitation maxima in the Pacific, lower the eastern equatorial Pacific sea surface temperatures during peaks in the 11-year solar cycle, and reduce low-latitude clouds to amplify the solar forcing at the surface."

Source: Meehl, G.A., et al., 2009, Amplifying the Pacific Climate System Response to a Small 11-Year Solar Cycle Forcing, Science 28 August 2009: Vol. 325. no. 5944, pp. 1114 - 1118.

The gravitational effect of Jupiter and Saturn on the sun is correlated with climate oscillations:
"...large climate oscillations with peak-to-trough amplitude of about 0.1 and 0.25°C, and periods of about 20 and 60 years, respectively, are synchronized to the orbital periods of Jupiter and Saturn. Schwabe and Hale solar cycles are also visible in the temperature records. A 9.1-year cycle is synchronized to the Moon's orbital cycles. A phenomenological model based on these astronomical cycles can be used to well reconstruct the temperature oscillations since 1850 and to make partial forecasts for the 21st century. It is found that at least 60% of the global warming observed since 1970 has been induced by the combined effect of the above natural climate oscillations."
Source: ***Scafetta,N., Empirical evidence for a celestial origin of the climate oscillations and its implications .*** *Journal of Atmospheric and Solar-Terrestrial Physics (2010),doi:10.1016*
www.fel.duke.edu/~scafetta/pdf/scafetta-JSTP2.pdf

And, according to NASA: "Other important forcings of Earth's climate system include such "variables" as clouds, airborne particulate matter, and surface brightness. **Each of these varying features of Earth's environment has the capacity to exceed the warming influence of greenhouse gases and cause our world to cool**. For example, increased cloudiness would give more shade to the surface while reflecting more sunlight back to space. Increased airborne particles (or "aerosols") would scatter and reflect more sunlight back to space, thereby cooling the surface. Major volcanic eruptions (such as that of Mt. Pinatubo in 1992) can inject so much aerosol into the atmosphere that, as it spreads around the globe, it reduces sunlight and causes Earth to cool. Likewise, increasing the surface area of highly reflective surface types, such as ice sheets, reflects greater amounts of sunlight back to space and causes Earth to cool."

You may have heard climate alarmists say something like this: "There is more carbon dioxide in the atmosphere today than at any time during at least the past 650,000 years, based on analyses of the chemical composition of air bubbles entrapped in Antarctic ice over that time." The assumption is that entrapped bubbles are an accurate measure of the ancient atmosphere, but there is no proof of that. In fact, there is good evidence that, with increasing pressure and time, the bubbles undergo chemical and physical changes that deplete CO_2, so it is unlikely that they contain true ancient atmospheric compositions. Furthermore, the ice core composition data disagree with other proxies.

[Sources: Hurd, B., 2006, Analyses of CO_2 and other atmospheric gases, AIG News, No. 86. And, Jaworowski,Z.,Segalstad,T.V.andHisdal,V.,1992, Atmospheric CO_2 and global warming: A critical review., Meddelelser 119, Norsk Ploarinstitutt, Oslo.]

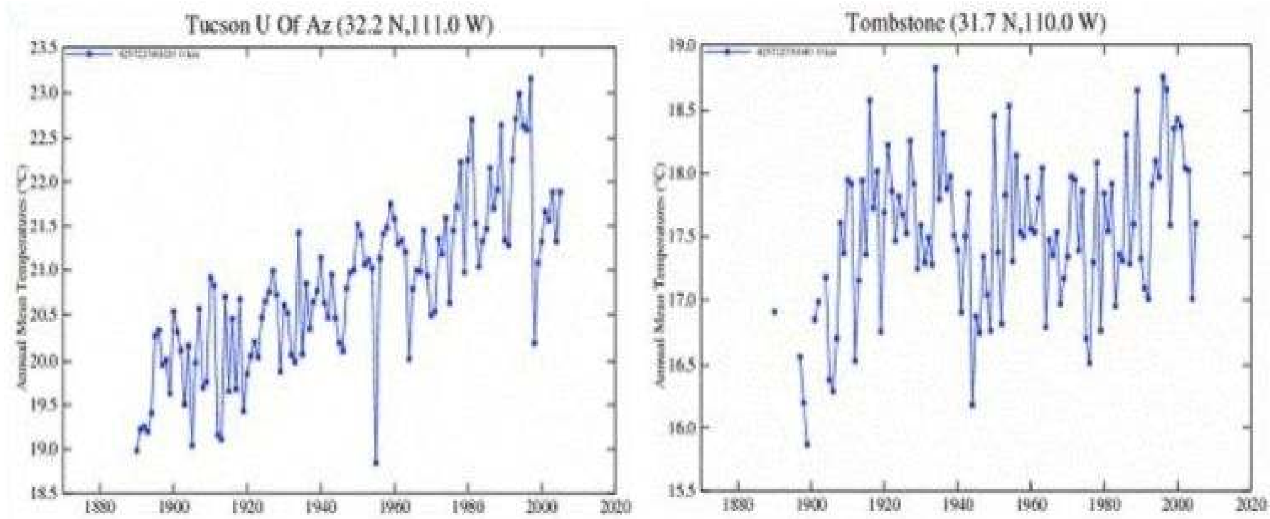
9) But it was the warmest year, month, decade since.....

Climate alarmists and the media cherry-pick data to produce scary headlines. Official surface temperature records have been corrupted by deliberate manipulation which tend to make the past cooler and the present warmer, by siting deficiencies, and by ignoring inconvenient data. See:

Is the Western Climate Establishment Corrupt?
Surface Temperature Records: Policy Driven

Problems with official surface temperature readings were discovered by meteorologist Anthony Watts [see Surfacestations.org]. He found that many official weather stations were sited so as to produce a warming bias. Bad siting includes being near asphalt parking lots, next to buildings, being near air conditioning exhaust vents, and encroaching urbanization. Compare the station at the University of Arizona in 1923 vs. 2007. In 1923, the station was in an open area near lawns and dirt roads, but now, the station is next to an asphalt parking lot between buildings. This change in site conditions has produced a warming bias.

To demonstrate the Urban Heat Island effect, we compare the temperature record of Tucson to rural Tombstone. It appears that "global warming" is not global.

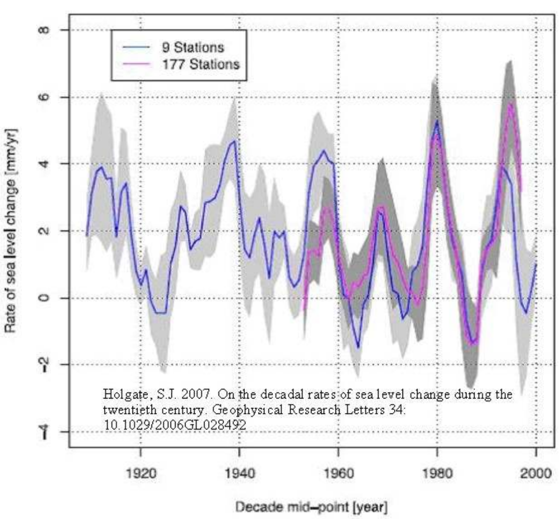


http://www.appinsys.com/GlobalWarming/GW_Part3_UrbanHeat.htm

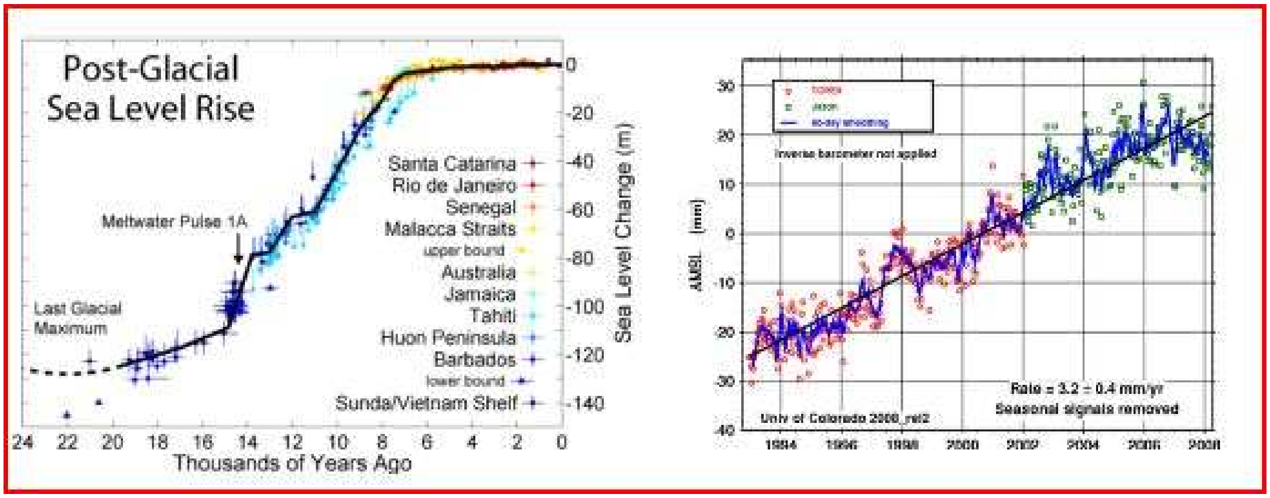
10) Should we be concerned with sea level rise?

Climate alarmists put forth scary scenarios saying that global warming is causing unprecedented sea level rise and the rise is accelerating. Well, don't sell your beach-front property yet. Since the end of the last glacial epoch 12,000 years ago, sea level has risen 120 meters, about one meter per century. [NOAA puts normal rise at 1 to 3mm per year, about the thickness of a penny.] A recent paper in *Journal of Coastal Research* (22: 788-800) studied the rate of sea level rise for the past 6,000 years, based on geologic evidence and the historic record. The researchers found that there has been no acceleration of sea level rise in response to increased temperature or CO_2 levels.

In another study, Holgate, S.J. 2007. *On the decadal rates of sea level change during the twentieth century*. Geophysical Research Letters 34: 10.1029/2006GL028492, data from worldwide coastal tidal gauge records shows that the rate of sea level rise is decreasing. Specifically, the mean rate of global sea level rise was "larger in the early part of the last century (2.03 ± 0.35 mm/yr 1904-1953), in comparison with the latter part (1.45 ± 0.34 mm/yr 1954-2003)." [CO2Science.org]. Note that the rate of sea level change is cyclical.



Kolker, A.S. and Hameed, S. (2007. *Meteorologically driven trends in sea level rise*. Geophysical Research Letters 34: 10.1029/2007GL031814) report "a major fraction of the variability and the trend in mean sea level at key sites along the Atlantic Ocean are driven by shifts in the position and intensity of the major atmospheric pressure centers that reside over the Atlantic Ocean, the Azores High and the Icelandic Low," which they refer to as atmospheric centers of action. Apparent sea level is also affected by variability of storms, winds, floods, waves, shifts in major ocean currents, volcanically-induced ocean heat content variations, the El Niño Southern Oscillation, subsidence, uplift, tectonics, and freshwater fluxes.



The graph on the left above is a reconstruction of sea level rise since the end of the last glacial epoch. The graph on the right above shows satellite measurements of sea level. Notice there has been no acceleration of rise. However, the rate of rise is 3.2±0.4 mm/yr. This rate is higher than Holgate's 1.45 mm/yr and thus gives the impression that the rate is increasing. But, it depends where you start looking. Holgate's study shows that the rate of sea level rise is cyclical. It just so happens that the satellite measurements started at the bottom of a cycle, thereby giving the false impression that the rate was accelerating. Notice that although the cycles have greater amplitude, the general trend of the rate of sea level rise has been decreasing since the 1950s.

11) Sea Ice in the Arctic/Antarctic

News media made much of the fact that during the summer of 2007, Northern Hemisphere sea ice area was at a historic minimum (2.92 million sq. km) representing a 27% drop in sea ice coverage compared to the previous (2005) record Northern Hemisphere ice minimum.

What they did not report, however, was that in 2007, Southern Hemisphere sea ice extent broke the previous **maximum** record of 16.03 million sq. km and reached 16.26 million sq. km. (August, 2007). This represents an increase of about 1.4% above the previous Southern Hemisphere ice area record high. *[Source: The Cryosphere Today, a publication of The Polar Research Group, University of Illinois]*
In 2014, Antarctic sea ice extent exceeded 20 million sq. km., the highest ever recorded.

In 2009, researchers from the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven flew a research aircraft over the Arctic. During the flight, scientists were measuring the ice thickness in regions that have never been overflown before. The result: the sea ice is apparently thicker than scientists suspected. Under normal conditions, the ice is formed within two years and ends up being slightly above 2 meters thick, but researchers found ice thickness as high as four meters.

To put things in further perspective, consider these historical reports:

"A considerable change of climate inexplicable at present to us must have taken place in the Circumpolar Regions, by which the severity of the cold that has for centuries past enclosed the seas in the high northern latitudes in an impenetrable barrier of ice has been, during the last two years, greatly abated."

"2000 square leagues [approximately 14,000 square miles or 36,000 square kilometers] of ice with which the Greenland Seas between the latitudes of 74° and 80°N have been hitherto covered, has in the last two years entirely disappeared."

These paragraphs, however, are not the latest scare story from the greenhouse industry, but extracts from a letter by the President of the Royal Society addressed to the British Admiralty, written in 1817 (Royal Society, London. Nov. 20, 1817. Minutes of Council, Vol. 8. pp.149-153).

When this report was written, the planet was in the midst of the Little Ice Age. How could the ice disappear in a Little Ice Age?

There is also the following story:

Arctic Ocean Getting Warm; Seals Vanish And Icebergs Melt

The Arctic ocean is warming up, icebergs are growing scarcer and in some places the seals are finding the waters too hot, according to a report to the Commerce Department yesterday from Consul Ifft, at Bergen , Norway .

Reports from fishermen, seal hunters and explorers, he declared, all point to a radical change in climatic conditions and hitherto unheard-of temperatures in the Arctic zone. Exploration expeditions report that scarcely any ice has been met with as far north as 81 degrees 29 minutes. Soundings to a depth of 3,100 meters showed the gulf stream still very warm.

Great masses of ice have been replaced by moraines of earth and stones, the report continued, while at many points well known glaciers have entirely disappeared. Very few seals and no white fish are being found in the eastern Arctic, while vast shoals of herring and smelts, which have never before ventured so far north, are being encountered in the old seal fishing grounds.

This is from an AP story which appeared in the Washington Post, November 2, 1922.

Could it be that carbon dioxide and global warming have nothing to do with it? Well, yes.

A new NASA-led study conducted by NASA's Jet Propulsion Laboratory, says unusual winds caused the 2007 Arctic minimum. Their press release says:

"Unusual atmospheric conditions set up wind patterns that compressed the sea ice, loaded it into the Transpolar Drift Stream and then sped its flow out of the Arctic. When that sea ice reached lower latitudes, it rapidly melted in the warmer waters."

"The winds causing this trend in ice reduction were set up by an unusual pattern of atmospheric pressure that began at the beginning of this century."

The fact that a 192-year-old report on Arctic ice is very similar to one today lends credence to the contention that changes in ice cover are natural cyclic phenomena and not due to the increase in atmospheric carbon dioxide. AccuWeather says the changes in wind may be due to changes in the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) which are large atmospheric circulations that have major impacts on the weather in certain parts of the world.

Polar bears, which the US Fish & Wildlife Service added to the Endangered Species list because of all the global warming hype, survived these cyclic disappearances of the ice just fine, and there is no reason to believe they can't adapt to the current, temporary shortage of ice.

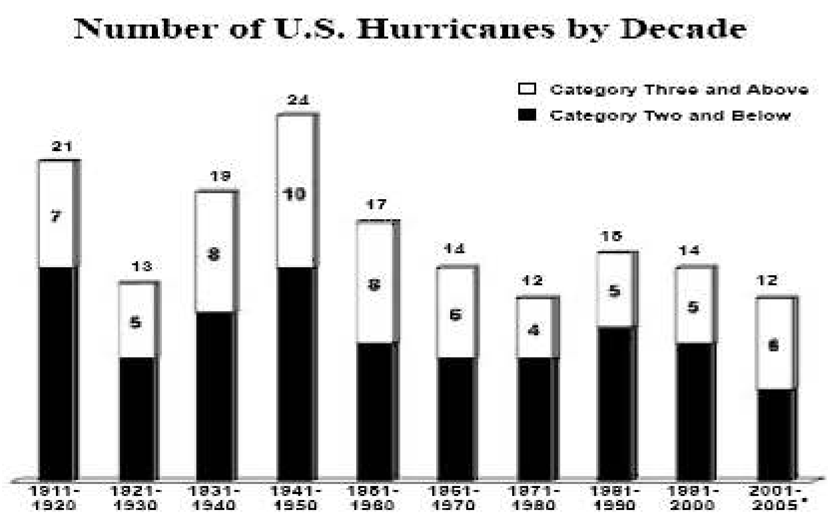
Alaskan warming is put in perspective by the following report. A study based upon "multiproxy geochemical analyses of a sediment core" in Alaska, found that it was as warm as the present at AD 0-300 [during the Roman Warm Period], after which temperature decreased steadily by ~3.5°C to reach a minimum at AD 600 [during the depths of the Dark Ages Cold Period]. Then temperature increased by ~3.0°C during the period AD 600-850 and then [during the Medieval Warm Period] exhibited fluctuations of 0.5-1.0°C until AD 1200. Between AD 1200-1700,temperature decreased gradually by 1.25°C [as the world descended into the depths of the Little Ice Age], and from AD 1700 to the present, increased by 1.75°C," the latter portion of which warming initiated the Modern Warm Period. Alaskan temperatures seem to follow natural cycles with no influence from human-produced CO_2. The study also says, "these data agree with tree-ring evidence from Fennoscandia, indicating that the recent warmth is not atypical of the past 1000 years." *[Source: Hu, F.S., Ito, E., Brown, T.A., Curry, B.B. and Engstrom, D.R. 2001. Pronounced climatic variations in Alaska during the last two millennia. Proceedings of the National Academy of Sciences, USA 98: 10,552-10,556]*

12) Hurricane frequency and intensity

Climate alarmists say that hurricane frequency and intensity will increase as the world warms. But actual data from NOAA National Hurricane Center (see graph) show that in each decade since 1950 both the number of hurricanes making landfall in the U.S. and the number of intense storms have been steadily decreasing.

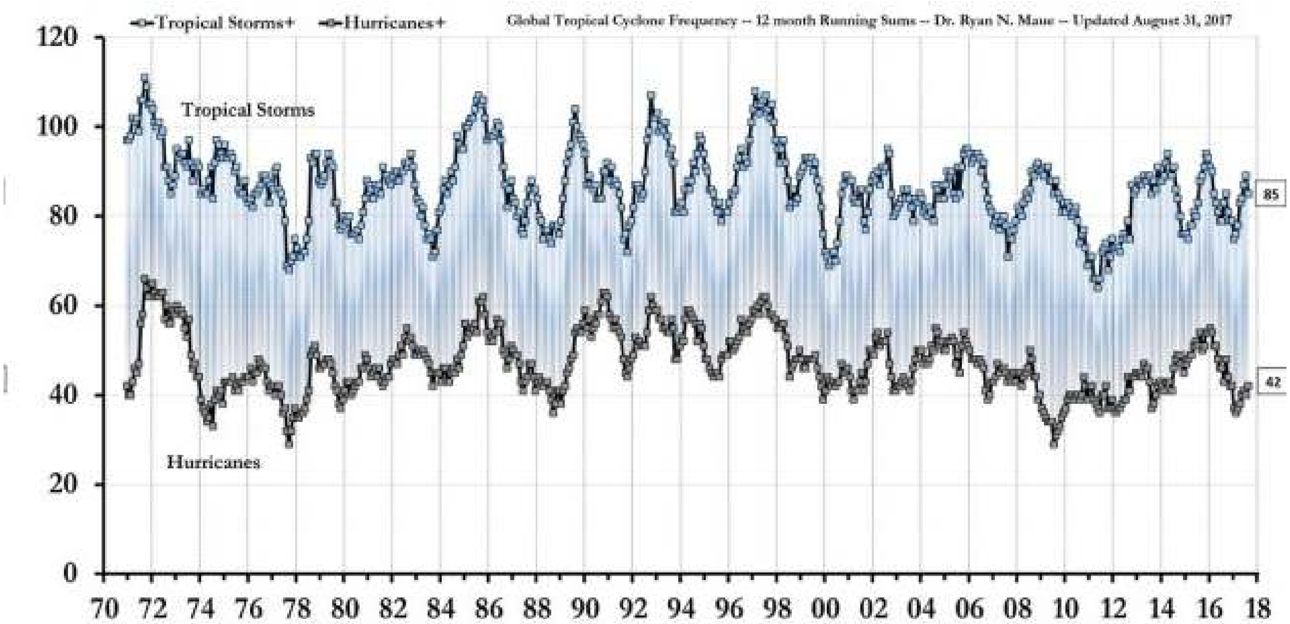
The story is the same in Asia. A study of land-falling hurricanes for the period 1945-2004 found no significant linear trend "**which suggests that global warming has not led to a higher frequency of landfalling tropical cyclones or typhoons in any of the regions in Asia."** *[Source: Chan, C.L. and Ming Xu, 2008, Inter-annual and inter-decadal variations of landfalling tropical cyclones in East Asia, International Journal of climatology DOI: 10.1002/joc.1782, 2008 Royal Meteorological Society]*

FIGURE III

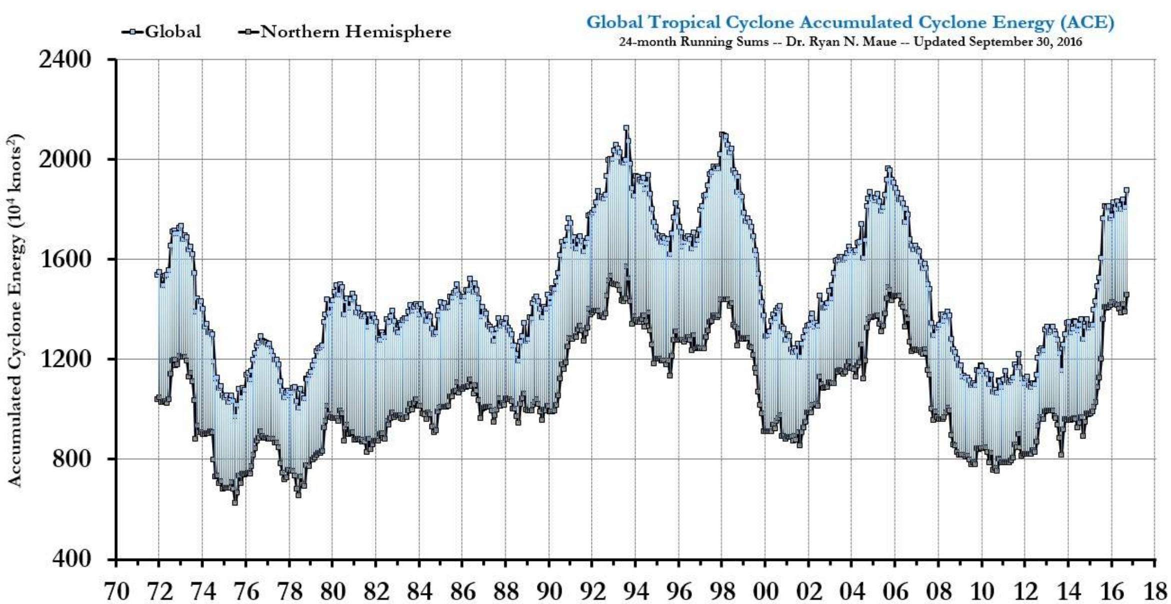


* For first half of the decade.
Note: The number on top of each bar is the total of all categories of hurricanes.
Source: National Hurricane Center.

More recent data show that the frequency of hurricanes is decreasing:



There is also no overall trend in cyclone intensity:



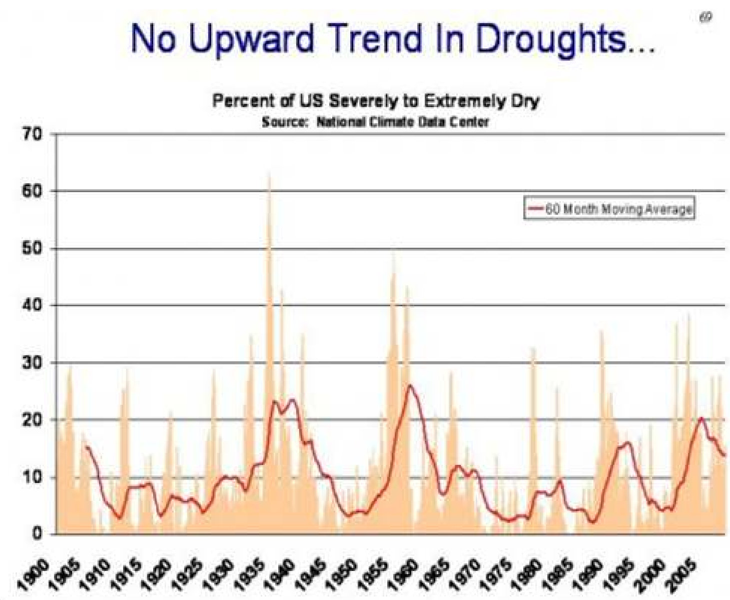
Six recent research papers claim that storm frequency and intensity will decrease in a warming world, see: http://notrickszone.com/2017/12/26/media-silence-flurry-of-recent-papers-show-warming-likely-will-lead-to-less-storm-activity/#sthash.I2speTXR.x06kiC85.dpbs

13) Droughts

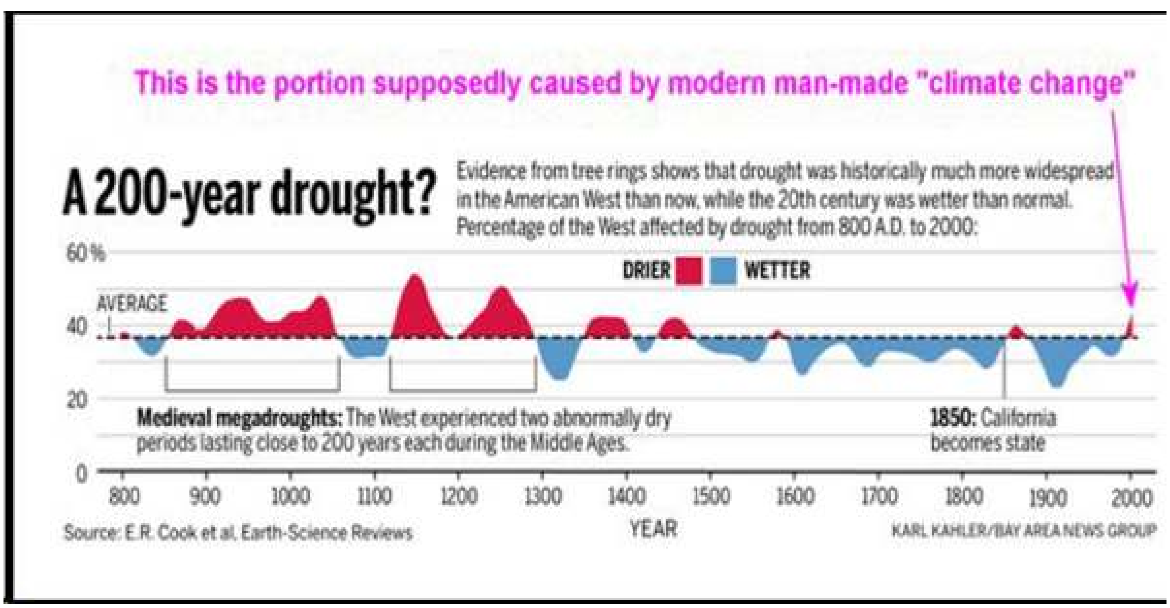
The geologic record and other proxies show that in North America, droughts equal or greater in magnitude to those of the Dust Bowl period were a common occurrence during the last 2000 years. Hence, the real-world data demonstrate that, if anything, the modest warming that released the planet from the global chill of the Little Ice Age may have initiated a period of less frequent and severe droughts. Studies in other parts of the world show no evidence that warming increases the frequency or severity of droughts. [Source: papers from www.CO_2Science.org subject index for "drought"] Droughts in the U.S. southwest, however, are greatly influenced by La Nina cycles.

For further perspective see http://www.co2science.org/articles/V13/N43/EDIT.php

U.S. drought since 1900:



The next graph shows a longer perspective of drought in the western U.S.



14) Wildfires

Alarmist Prediction: Warming will cause more wildfires.

Reality: For several areas of the world, such as Eurasia and western North America, there were indeed significant upward trends in land area burned. These increases in burned area, however, were offset by equivalent decreases in burned area in tropical southeast Asia and Central America. Although one can identify parts of the world that experienced increases in land area burned over the last two decades of the 20th century, for the globe as a whole there was absolutely no relationship between global warming and total area burned over this period. *[Source: Riano, D., Moreno Ruiz, J.A., Isidoro, D. and Ustin, S.L. 2007. Global spatial patterns and temporal trends of burned area between 1981 and 2000 using NOAA-NASA Pathfinder. Global Change Biology 13: 40-50].* *[Note: USFS estimates that annually, 30,000 to 40,000 forest fires in the U.S. are caused by arson.]*

See a table from the National Interagency Fire Center showing fire frequency and acres burned in the U.S. from 1960 to 2016: https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html
The annual number of fires from 1960 to 1982 are an order of magnitude higher than the annual fire numbers from 1983 to 2016. Climate alarmists cherry-pick these data and mention only that the number of fires rose from 1983 to 2016 and blame it on global warming.

15) Vector borne diseases and global warming

The contention that global warming will increase the incidence of vector borne diseases is complex.

A historical analysis of malaria reveals that this disease was an important cause of illness and death in England during the Little Ice Age, when temperatures in Europe were much colder than at present. Its transmission began to decline only in the 19th century and "cannot be attributed to climate change, for [the decline] occurred during a warming phase, when temperatures were already much higher than in the Little Ice Age." *[Source: Reiter, P. 2000. From Shakespeare to Defoe: Malaria in England in the Little Ice Age. Emerging Infectious Diseases 6: 1-11.]*

Gage et al. note that "temperature, precipitation, humidity, and other climatic factors are known to affect the reproduction, development, behavior, and population dynamics of the arthropod vectors of these diseases," which suggests that the subject is extremely complex. They conclude that "the precise impacts" of the various climatic changes that are typically claimed to occur in response to rising atmospheric CO_2 concentrations "are difficult to predict." Indeed, they say that "in some areas, climate change could increase outbreaks and the spread of some vector-borne diseases while having quite the opposite effect on other vector-borne diseases."

They write that "the mere establishment of suitable vectors for a particular agent does not necessarily mean that spread to humans will commonly occur, as indicated by the limited transmission of dengue and malaria in the southern U.S.," because,"in these instances, competent vectors are present and infected individuals or vectors occasionally enter this region, but local transmission has been limited by factors unrelated to the climatic suitability of the areas for the relevant vector species." And they add that "in instances where a vector-borne disease is also zoonotic, the situation is even more complex, because not only must the vector and pathogen be present but a competent vertebrate reservoir host other than humans must also be present."

Some of the non-climatic factors that impact the spread of vector-borne diseases of humans include "many other global changes concurrently transforming the world, including increased economic globalization, the high speed of international travel and transport of commercial goods, increased population growth, urbanization, civil unrest, displaced refugee populations, water availability and management, and deforestation and other land-use changes," as well, we would add, as the many different ways in which these phenomena are dealt with by different societies.

[Source: Gage, K.L., Burkot, T.R., Eisen, R.J. and Hayes, E.B. 2008. Climate and vector borne diseases. American Journal of Preventive Medicine 35: 436-450]'

16) Effects of Temperature on Human Health

From chapter 7 of *Climate Change Reconsidered II: Biological Impacts* published by the Heartland Institute. See links to the entire publication at:
http://climatechangereconsidered.org/climate-change-reconsidered-ii-biological-impacts/

Here are the key findings based on extensive review of the scientific literature:

• Warmer temperatures lead to a net decrease in temperature-related mortality, including deaths associated with cardiovascular disease, respiratory disease, and strokes. The evidence of this benefit comes from research conducted in every major country of the world.

• In the United States the average person who died because of cold temperature exposure lost in excess of 10 years of potential life, whereas the average person who died because of hot temperature exposure likely lost no more than a few days or weeks of life.

• Some 4,600 deaths are delayed each year as people in the U.S. move from cold northeastern states to warm southwestern states. Between 3 and 7% of the gains in longevity experienced by the U.S. population over the past three decades is due simply to people moving to warmer states.

• Cold-related deaths are far more numerous than heat-related deaths in the United States, Europe, and almost all countries outside the tropics. Coronary and cerebral thrombosis account for about half of all cold-related mortality.

• Global warming is reducing the incidence of cardiovascular diseases related to low temperatures and wintry weather by a much greater degree than it increases the incidence of cardiovascular diseases associated with high temperatures and summer heat waves.

• The adverse health impacts of cold temperatures, especially with respect to respiratory health, are more significant than those of high temperatures in many parts of the world, including Spain, Canada, Shanghai, and Taiwan. In the subtropical island of Taiwan, for example, researchers found low minimum temperatures were the strongest risk factor associated with outpatient visits for respiratory diseases.

• A vast body of scientific examination and research contradict the claim that malaria will expand across the globe and intensify as a result of CO_2-induced warming.

• Concerns over large increases in vector-borne diseases such as dengue as a result of rising temperatures are unfounded and unsupported by the scientific literature, as climatic indices are poor predictors for dengue disease.

• While climatic factors largely determine the geographical distribution of ticks, temperature and climate change are not among the significant factors determining the incidence of tick-borne diseases.

• The ongoing rise in the air's CO2 content is not only raising the productivity of Earth's common food plants but also significantly increasing the quantity and potency of the many health-promoting substances found in their tissues, which are the ultimate sources of sustenance for essentially all animals and humans.

• Atmospheric CO2 enrichment positively impacts the production of numerous health-promoting substances found in medicinal or "health food" plants, and this phenomenon may have contributed to the increase in human life span that has occurred over the past century or so.

• There appears to be little reason to expect any significant CO2-induced increases in human health-harming substances produced by plants as the atmosphere's CO2 concentration continues to rise.

17) Why we will never have runaway warming:

Earth is a water-rich world. 'Runaway' global warming is not possible here for that reason. Latent heat (temporarily bound in evaporating water) and sensible heat (warmth you can feel) are transported aloft by convective towers where the water vapor condenses (releasing latent heat). These towers need only transport 'spare' heat a mere 5,500 meters (18,000 feet -- about half the altitude flown by commercial airliners) to bypass half the total mass of the Earth's atmosphere and hence half of all possible greenhouse absorbers. This is how Earth remains so cool despite almost complete absorption of surface emission spectra by greenhouse gases in the lower atmosphere.

Moreover, any warming which increases evaporation increases the volume of water vapor carried aloft by convective towers, increases condensation with altitude (clouding), and increases Earth's albedo (reflection of incoming solar radiation). Thus water increases both heat transport from the surface and reduces heat transport to the surface, preventing 'runaway' warming.

Finally, Earth has had sufficient greenhouse gases in its atmosphere to absorb much more outgoing long-wave radiation than it currently does. The reason it does not absorb more is that each gas absorbs specific frequencies of electromagnetic radiation. Current concentrations of carbon dioxide and water vapor completely absorb their specific frequencies so that nothing is left to absorb by additional carbon dioxide or water vapor. This means that additional atmospheric carbon dioxide will have no effect.

18) Ocean Acidification

We often hear that increasing carbon dioxide in the atmosphere will make the oceans too acidic and dissolve or otherwise harm carbonate-shelled marine fauna. These writers or reporters seem ignorant of the fact that marine fauna evolved when the atmospheric CO_2 concentration was more than 10 times higher than the current level.

Two factors control the amount of carbon dioxide in the ocean: ocean temperature and amount of carbon dioxide in the atmosphere, i.e., its partial pressure. Cooler oceans and higher atmospheric CO_2 should result in more carbon dioxide in the oceans.

Henry's law states that the concentration of a gas in a liquid is proportional to the partial pressure of the gas in equilibrium above the liquid. It stands to reason that more CO_2 in the atmosphere would translate to more in the ocean. However, Henry's law assumes constant temperature. If the temperature changes, then the absorption changes. If the oceans warm, CO_2 will leave the ocean and return to the atmosphere. Cold liquids can hold more dissolved gas than warm liquids. Just think of what happens to a carbonated beverage left to warm to room temperature.

It has been estimated that current ocean pH is 0.1 pH unit less alkaline than it was in recent pre-industrial time, and some climate models predict a further decrease of 0.7 pH units by 2300. However, proxy reconstructions of ocean acidity, based on fossil and modern corals, show that ocean pH has oscillated between pH of 7.91 and 8.29 during the past seven thousand years. That cyclic variation is nearly four times larger than the 0.1 decrease alarmists are whining about, and even if the model predicted decrease of 0.7 units occurs, the water will still be alkaline.

An independent reconstruction, again based on corals, shows that between 1708 and 1988, there was a clear interdecadal oscillation of pH, (between 7.9 and 8.2 pH units) which is synchronous with the Interdecadal Pacific Oscillation of water temperature. During this time, atmospheric CO_2 concentration increased by about 100 parts per million. If more CO_2 is dissolved in the ocean, the added carbonate (to build the calcium carbonate shells) will more than offset the decreasing alkalinity. The effect of increased CO_2 seems benign to other small sea creatures, including corals.

Can the oceans ever become very acidic? There is no evidence that the oceans were ever acidic during the past 500 million years, even when atmospheric concentration of carbon dioxide was more than 10 times current levels. This implies that besides temperature and partial-pressure, there is a third controlling factor. That factor is the buffering effect of carbonic acid reaction with the basaltic oceanic crustal rocks. This process uses up excess carbon dioxide.

The specter of acidification seems irrelevant to carbonate-shelled animals. What of fish and fish larvae? A study found "CO_2 acidification had no detectable effect on embryonic duration, egg survival and size at hatching." As for adult fish, they found that "most shallow-water fish tested to date appear to compensate fully their acid-base balance within several days of exposure to mild hypercapnia [a deleterious condition produced by having more than the normal level of carbon dioxide in the blood due to exposure to elevated CO2 concentrations]."
See www.CO2Science.org database for numerous references.

19) CO_2 and Corals

Climate alarmists claim that increased CO_2 and rising temperatures bleach coral reefs and will cause death of the corals. The issue is complicated; here is what research says.

Coral bleaching is caused by high sea temperatures, high solar irradiance, by anomalously low sea temperatures, and by sudden drops in temperature that accompany intense upwelling episodes, thermocline shoaling or seasonal cold-air outbreaks.

Many coral species have endured three periods of global warming, from the Pliocene optimum (4.3-3.3 million years ago) through the Eemian interglacial (125,000 years ago) and the mid-Holocene Optimum (6000-5000 years ago), when atmospheric CO_2 concentrations and sea temperatures often exceeded those of today. Data show that an increase in sea warming of less than 2°C would result in a greatly increased diversity of corals in certain high latitude locations.

Some coral bleaching may be due to marine pathogens, i.e., diseases. Coral polyps depend on symbionts such as zooxanthellae (algal symbionts). These symbionts vary seasonally and with environmental stress. Some symbionts are highly adaptable, and some corals can change their symbionts to better suit conditions. Some coral bleaching appears to be synchronous with El Nino events which raise water temperature.

Although corals may endure bleaching, they are resilient. For instance, scleractinian corals, which are the major builders of the reefs of today, first appeared during mid-Triassic time 210 million years ago, when the earth was considerably warmer. They endured the Cretaceous Period, when temperatures were as much as 10-15°C higher than now. And they survived the warm and cold cycle of Pleistocene ice ages.

One of the reasons coral are resilient and able to withstand a wide range of temperature, salinity, and CO_2 variations is that they shuffle symbionts. For instance, "as the community structure of coral reefs shift in response to global climate change and water quality impacts, opportunistic corals harboring symbionts that enable maximum rates of growth may similarly gain a competitive advantage." The corals themselves also have several mechanisms to deal with and deflect thermal stress, including dynamic photoprotective mechanisms, and the expression of heat-shock proteins.

On the issue of coral calcification, real observation finds that the combination of increased CO_2 (which provides more carbonate) and the shuffling of symbionts, makes the corals able to withstand the variations of temperature, disease, and solar irradiation.

Real world observations trump the scare stories derived from theoretical models.

While human CO_2 emissions have little effect on coral health, we are significantly affecting corals in other ways: "runoff, sedimentation, and nutrient enrichment; coastal construction leading to smothering of habitat and creation of high turbidity around coasts; over-fishing and destructive fishing." See www.CO2Science.org database for numerous references.
Update: Reef Corals Responding to Extremes in a Natural Environment
http://www.co2science.org/articles/V20/oct/a10.php It appears that corals are well equipped to deal with future changes in their environment, be they naturally or anthropogenically induced.

20) Benefits of Carbon Dioxide

Most news media report stories about the imagined perils of carbon dioxide, but few report the real beneficial effects of more carbon dioxide in the atmosphere. But a revolution is taking place: the planet is becoming much greener. The increasing concentration of CO_2 in the atmosphere is making plants more robust, more drought tolerant, and better able to withstand higher temperatures.

Terrestrial plants evolved in the Paleozoic Era, beginning about 500 million years ago, when atmospheric CO_2 was more than 4000 ppmv (parts per million by volume), more than 10 times what it is now. CO_2 dropped to almost current levels during an ice age in the Carboniferous Period, 350 million years ago, because carbon was removed from the atmosphere to form the major coal deposits of the planet. Following the ice age, rising temperatures drove CO_2 up to about 2000 ppmv and triggered the evolution of flowering plants during the Triassic Period, 250 million years ago.

The so-called pre-industrial concentration of CO_2 in the atmosphere (about 180 to 270 ppmv) was the lowest in the geological history of the planet since the Carboniferous. Plants have been literally starving for sustenance because of the extraordinarily low CO_2 in the atmosphere. But with the recent increase in CO_2, plant-life is rebounding.

Laboratory experiments show that doubling the current CO_2 concentration (380 ppmv) causes plants to produce 25% to 90% more biomass which overcomes warming-induced loss of carbon, and greatly increases carbon sequestration. In fact, the aerial fertilization effect is more pronounced at higher temperatures, especially for important food plants.

Outside the laboratory, satellite-derived observations over the last two decades of the 20th century indicate that the planet's terrestrial vegetation significantly increased its productivity. This CO_2-induced increase in the rate of photosynthesis is very important because plants are the ultimate food source for nearly all of the biosphere.

Development of agriculture was aided by the natural increase in CO_2 after the last glaciation. According to reviews of many scientific papers by CO2Science.org: early agriculture was characterized by sets of primary domesticates or "founder crops" that were adopted in several independent centers of origin, all at about the same time; and that this synchronicity suggests the involvement of a global trigger. Researchers saw a causal link between this development and the rise in atmospheric CO_2 concentration that followed deglaciation (a jump from about 180 to 270 ppmv), and hypothesized that the aerial fertilization effect caused by the rise in CO_2, combined with its transpiration-reducing effect, led to a large increase in the water use efficiencies of the world's major founder crops. This development was the global trigger that launched agriculture and civilization.

A continued rise in atmospheric CO_2 will make food production for our ever-increasing population more efficient, and allow us to forego using more wild land to grow crops, especially if we allow atmospheric CO_2 to double. For that reason alone, we can see the folly of trying to limit CO_2 emissions, and the foolishness of schemes to bury carbon dioxide emitted in the course of energy production. We should not be put off by the phantom menace of CO_2-induced global warming, for which there is absolutely no hard evidence. Geologic history shows that the planet is more verdant and productive at higher CO_2 levels.

21) Conclusion

The basic conclusion is that carbon dioxide has little effect on climate and all attempts to control carbon dioxide will be a futile exercise in climate control. All the dire predictions are based on flawed computer models. Carbon dioxide is a phantom menace.

Neither researchers nor the IPCC have presented any physical or observational evidence that CO_2 is a significant driver of temperature.

Climate models are complex mathematical constructs, not physical evidence. But the atmosphere is even more complex, so modelers must ignore many variables such as Sun-Earth relationships and clouds, in favor of a few basic parameters. The fundamental assumption of climate models is that changes in CO_2 concentration drive temperature change, but evidence from geology and astronomy show that the relationship is just the opposite.

Climate modelers also assume that the pre-industrial concentration of CO_2 was below about 280 ppmv and that the current value of about 400 ppmv is unprecedented. But that assumption is shown to be wrong by several lines of evidence including direct measurements made since the early 1800s. CO_2 concentration has fluctuated widely during the last 10,000 years and has often exceeded current levels. *[Sources: Beck, E., 2007, 180 Years of Atmospheric CO_2 Gas Analysis By Chemical Methods, Energy & Environment Volume 18 No. 2 and Kurschner et al., 1996, Oak leaves as biosensors of late Neogene and early Pleistocene paleoatmospheric CO_2 concentrations, Marine Micropalaeontology, 27:299-312.].*

Models, when tested by running in hindsight from the present, cannot reproduce the Medieval Warm Period nor the glacial epochs. The U.N. IPCC claims that the surface temperature rise in the last 130 years has been 0.6°C ± 0.2°C. That is a 33% margin of error in each direction. The standard for statistically significant scientific findings is 5% in each direction. The large margin of error reflects the uncertainty of the basic measurements from weather stations and the methods of averaging the data.

Climate modelers make some outlandish predictions, but occasionally there is a glimmer of honesty:

"The forcings that drive long-term climate change are not known with an accuracy sufficient to define future climate change." -- James Hansen, "Climate forcings in the Industrial era", PNAS, Vol. 95, Issue 22, 12753-12758, October 27, 1998.

"In climate research and modeling, we should recognize that we are dealing with a coupled non-linear chaotic system, and therefore that the prediction of a specific future climate state is not possible." -- Final chapter, Draft TAR 2000 (Third Assessment Report), IPCC.

While controlling CO_2 emissions from burning fossil fuels my have some beneficial effects on air quality, it will have no measurable effect on climate, but great detrimental effects on the economy and our standard of living. The greatest danger of climate change is that politicians think they can stop it. But the climate has always been in a state of flux. In my opinion, the debate over global warming is truly a scam designed to control (and tax) production and use of energy from fossil fuels.

“The whole aim of practical politics is to keep the populace alarmed (and hence clamorous to be led to safety) by menacing it with an endless series of hobgoblins, all of them imaginary.” - H. L. Mencken

Jonathan DuHamel is a registered professional geologist, residing in Tucson, AZ. Contact: jedtaz@cox.net

Additional Reading:

Climate Change Reconsidered II: Physical Science
Idso, Carter, and Singer, Lead Authors/Editors, 2013
https://www.heartland.org/media-library/pdfs/CCR-II/CCR-II-Full.pdf
Summary: http://www.nipccreport.org/reports/ccr2a/pdf/Summary-for-Policymakers.pdf

Climate Change Reconsidered II: Biological Impacts
Idso, Idso, Carter, and Singer, Lead Authors/Editors, 2014
http://www.nipccreport.org/reports/ccr2b/pdf/Full-Report.pdf
Summary: https://www.heartland.org/media-library/pdfs/CCR-IIb/Summary-for-Policymakers.pdf
A 2000-year global temperature reconstruction based on non-treering proxies (PDF)
(Energy & Environment, Volume 18, Numbers 7-8, pp. 1049-1058, December 2007)
- Craig Loehle

A comparison of tropical temperature trends with model predictions (PDF)
(International Journal of Climatology, Volume 28, Issue 13, pp. 1693-1701, December 2007)
- David H. Douglass, John R. Christy, Benjamin D. Pearson, S. Fred Singer

An empirical evaluation of earth's surface air temperature response to radiative forcing, including feedback, as applied to the CO_2-climate problem
(Meteorology and Atmospheric Physics, Volume 34, Numbers 1-2, pp. 1-19, March, 1984)
- Sherwood B. Idso

Are observed changes in the concentration of carbon dioxide in the atmosphere really dangerous? (PDF)
(Bulletin of Canadian Petroleum Geology, Volume 50, Number 2, pp. 297-327, June 2002)
- C. R. de Freitas

Atmospheric CO_2 and global warming: a critical review (PDF)
(Norwegian Polar Institute Letters, Volume 119, May 1992)
- Zbigniew Jaworowski, Tom V. Segalstad, V. Hisdal

Can increasing carbon dioxide cause climate change? (PDF)
(Proceedings of the National Academy of Sciences, Volume 94, pp. 8335-8342, August 1997)
- Richard S. Lindzen

CO_2 and Climate: a Geologist's View (PDF)
(Space Science Reviews, Volume 81, Numbers 1-2, pp. 173-198, July 1997)
- Harry N.A. Priem

Do glaciers tell a true atmospheric CO_2 story? (PDF)
(Science of the Total Environment, Volume 114, pp. 227-284, August 1992)
- Zbigniew Jaworowski, Tom V. Segalstad, N. Ono

Environmental Effects of Increased Atmospheric Carbon Dioxide (PDF)
(Journal of American Physicians and Surgeons, Volume 12, Number 3, pp. 79-90, Fall 2007)
- Arthur B. Robinson, Noah E. Robinson, Willie H. Soon

Limits on CO_2 Climate Forcing from Recent Temperature Data of Earth (PDF)
(Energy & Environment, Volume 20, Numbers 1-2, pp. 177-189, January 2009)
- David H. Douglass, John R. Christy

Does the Earth Have an Adaptive Infrared Iris? (PDF)
(Bulletin of the American Meteorological Society, Volume 82, Issue 3, pp. 417-432, March 2001)
- Richard S. Lindzen, Ming-Dah Chou, Arthur Y. Hou

Carbon Dioxide and the Earth's Future, Pursuing the Prudent Path (PDF)
Center for Study of Carbon Dioxide and Global Change

A Multidisciplinary, Science-Based Approach to the Economics of Climate Change
http://www.mdpi.com/1660-4601/8/4/985/pdf