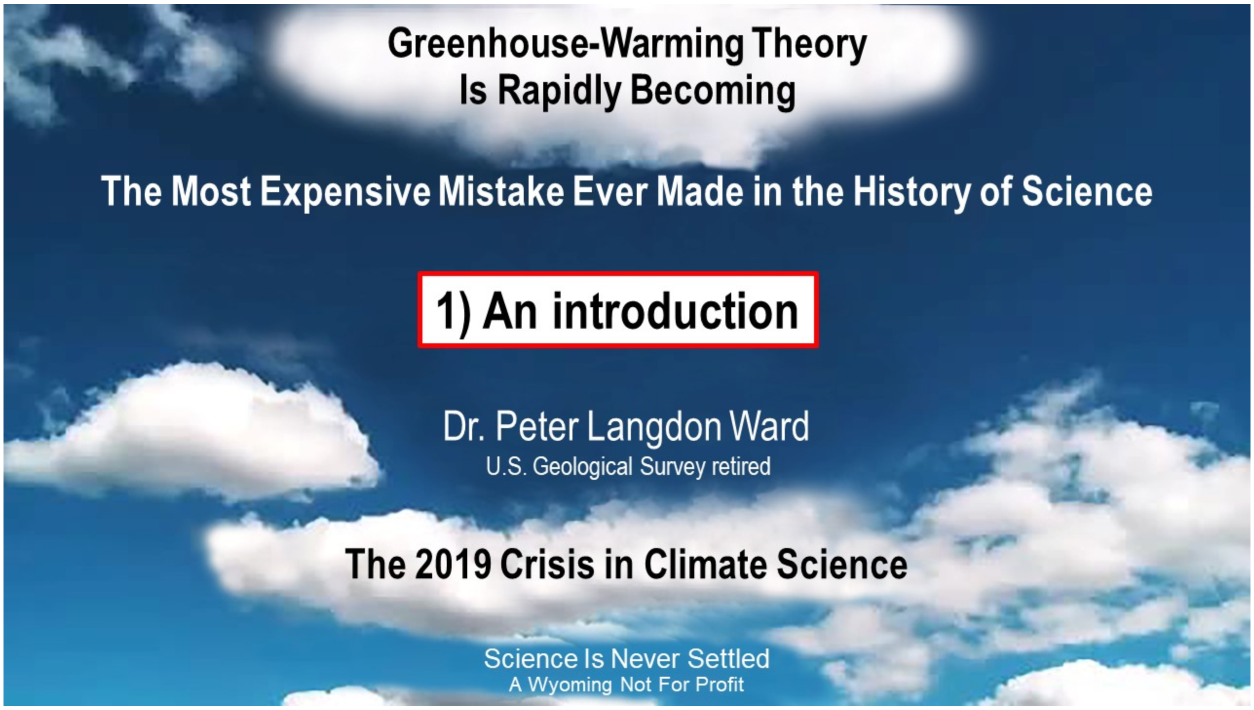


Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 1: An introduction.

Earth has warmed approximately one degree Celsius, nearly two degrees Fahrenheit, since 1975. Most of this warming was caused by humans. New data and improved scientific understanding, however, show unequivocally that increases in emissions of greenhouse gases cannot physically explain observed global warming.

This is a most inconvenient reality for the vast majority of climate scientists who have worked earnestly for decades to demonstrate consensus behind greenhouse-warming theory in order to convince political leaders to spend the major funds required to reduce greenhouse-gas emissions. This strategy paid off with the Paris Agreement of 12 December 2015 when leaders of nearly all countries in the world agreed to work together to reduce greenhouse-gas emissions. But as leaders seek to define the "rulebook" for

The Paris Agreement: "To keep global temperature rise this century to well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius."

future action, fatal cracks are opening in the foundation of greenhouse-warming theory.

I believe climate science is facing a major crisis in 2019. Most climate scientists are so convinced greenhouse gases are the cause of global warming, they simply refuse to even consider the possibility that greenhouse-warming theory could be mistaken in any way. They summarily dismiss as spam any questioning of greenhouse-warming theory—refusing to examine the remarkably clear evidence of a serious problem.

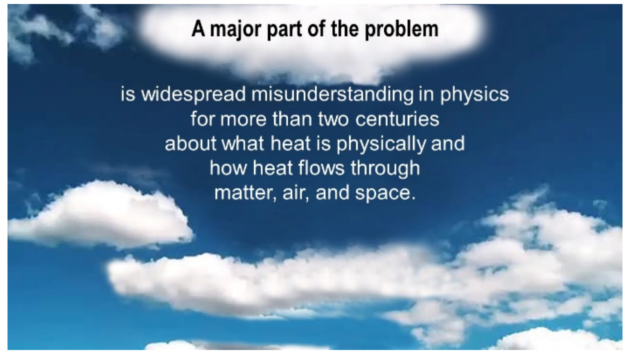
Ignoring new, inconvenient observations is not good science, but it is human nature. We need to bring genuine debate back to climate science. Healthy science is never settled. Ignoring reality will not make the problem go away, it will only delay taking action that will reduce global warming. Ignoring reality will increase the already astronomic economic and political costs of greenhouse-warming theory, which is rapidly becoming the most expensive mistake ever made in the history of Science.

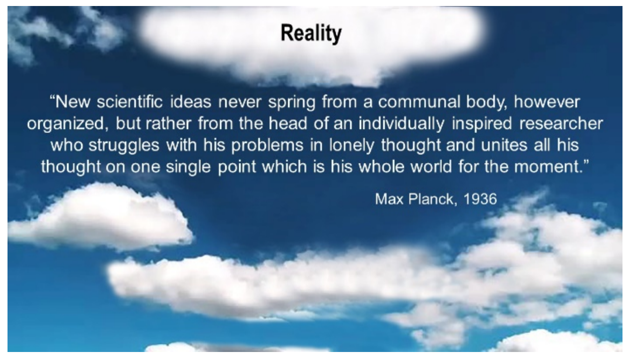
While most climate scientists and scientific organizations are absolutely certain that greenhouse-warming theory is correct, why should you listen to me? Because the closest things to truth, the closest things to reality in science, are direct observations of how things work in Nature—direct observations that do not rely on assumptions, theory, or mathematical equations written long ago that everyone takes for granted as being correct. Everything I am about to explain is based on direct observation.

Ten years ago, I too was convinced that greenhouse-warming theory explained why the world was getting warmer. I too was deeply concerned about the world we were leaving for my four children and my six grandchildren.

But several things just did not make sense. As I began to wonder why, I found that several assumptions believed by most climate scientists to be fact, just do not stand up to close scrutiny. To my amazement, I found that I was the first person trained in physics in 119 years to question in detail the physics of greenhouse warming theory. It is hard to believe that a theory this important to humanity is based on assumptions made long ago that are clearly mistaken.

A major part of the problem is widespread misunderstanding in physics and in climate science for more than two centuries about what heat is physically and how heat flows through matter, air, and space.





It is not that I am particularly smart. It is just that I have spent many years objectively questioning widely held assumptions concerning the physics of heat and the physics of greenhouse-warming theory that, as you will come to see, just do not stand up to scrutiny.

Max Planck was one of the fathers of modern physics and the one scientist who almost got the physics of heat right in 1900. In 1936, he explained: "New scientific ideas never spring from a communal body, however organized, but rather from the head of an individually inspired researcher who struggles with his problems in lonely thought and unites all his thought on one single point which is his whole world for the moment."

The details of the 2019 Crisis in Climate Science are described in the following sixteen 5 to 10-minute videos that can be viewed in any order. The observations that I describe are quite straight-forward and quite clear. You do not need special training in science to understand. Many scientists want me to show that they are wrong by using their equations and their computer models. I am showing, however, that their equations and their computer models predicting major warming within decades are based on mistaken equations that are based on mistaken assumptions.

Videos 2 through 6 describe evidence for global warming and for the role of humans and of volcanic eruptions in causing observed climate change. Videos 7 through 10 explain what is mistaken concerning greenhouse-warming theory and why this theory is physically impossible. Videos 11 through 16 discuss issues related to setting informed public policy concerning climate change.

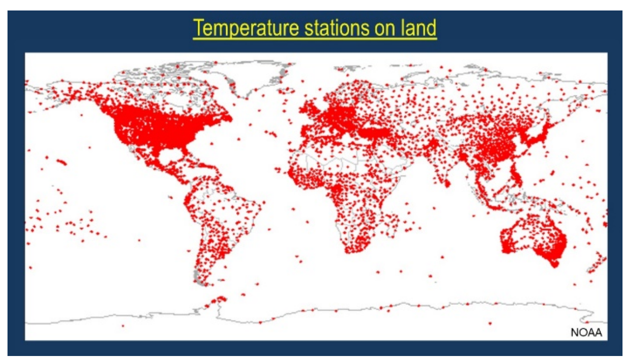
Science evolves. Science is self-correcting. I hope these videos encourage you to think more deeply about the science of climate change and how we should adapt. I sincerely hope that you enjoy this quest for new scientific understanding as much as I do.

CLICK ON THE LINK BELOW TO SKIP TO ANY VIDEO

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

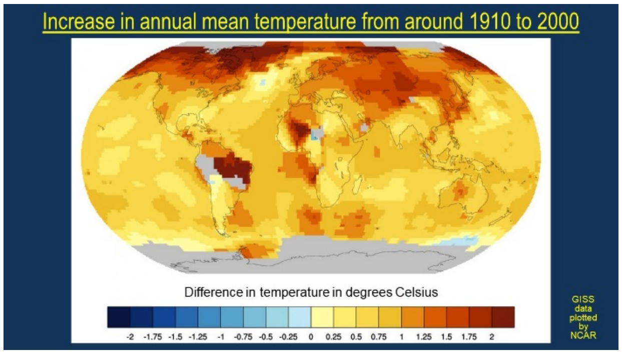
Video 2. The globe has warmed one degree Celsius since 1975.

Most people agree that the world around them, on average, feels warmer now than it did several decades ago, that glaciers are melting, and that sea-level is rising.



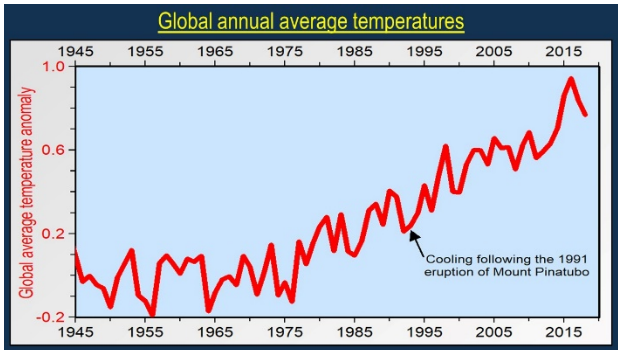
Scientists from three government agencies (NASA, NOAA, and the United Kingdom Met Office) have analyzed all available air temperature data measured worldwide from just above the land surface and from just above or below the sea surface. They calculate changes in monthly and annual average global temperatures. Each group used slightly different techniques for filtering and averaging data collected at numerous stations in some areas and very few stations in most areas.

This map shows the regional increases in temperatures from around 1910 to 2000. Warming was primarily greatest in northern regions.

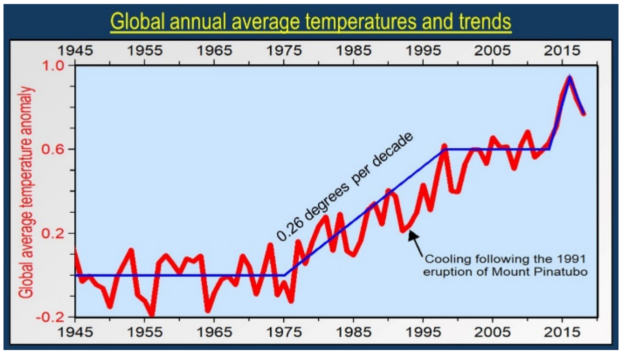


A fourth group of scientists at Berkeley Earth was skeptical of these three analyses and developed yet another method for analyzing and summarizing more than 1.6 billion temperature measurements from 39,000 temperature stations worldwide.

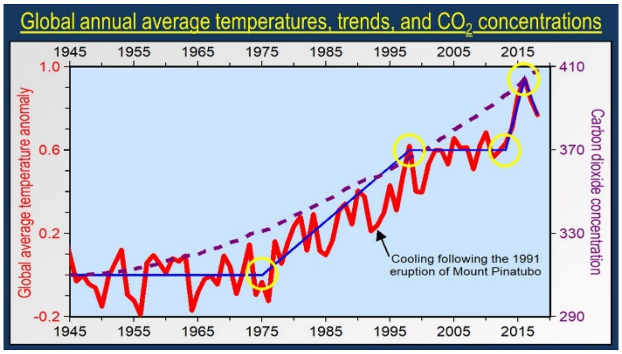
This graph shows the average of the annual average values for these four analyses from 1945 through 2018.



All four groups, despite using different methods, agree quite precisely that annual average global temperature changed very little from 1945 to 1975, warmed approximately 0.6 degrees Celsius from 1975 to 1998, changed very little from 2001 through 2013, and then suddenly warmed an additional 0.3 degrees from 2013 to 2016, making 2016 the hottest year on record, followed by cooling of nearly 0.2 degrees Celsius by 2018.

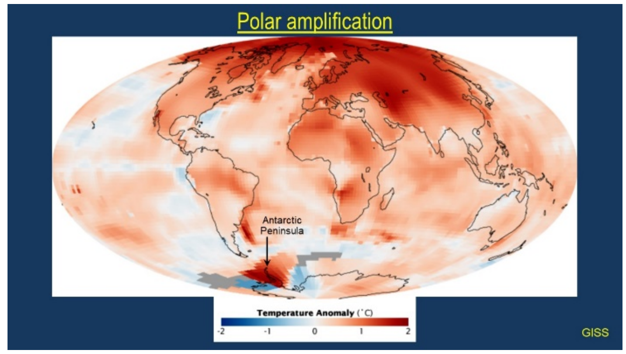


The rate of warming from 1975 to 1998 was about 0.26 degrees per decade and the temperatures reached by 1998 have continued. The rate of warming from 2014 through 2016 was more than three-times faster, but the higher temperatures have only lasted for a few years.



Meanwhile, concentrations of carbon dioxide, shown by the purple dashed line, and other greenhouse gases in the atmosphere continue to rise at ever increasing rates, showing no direct relationship to the sudden changes in temperature trends clearly observed around 1975, 1998, and 2014 and to decreasing temperatures since 2016.

Furthermore, greenhouse gases are typically well mixed throughout the atmosphere so that their effects are expected to be similar at all latitudes and during all seasons. Normally, the greatest heating of Earth's surface is observed to be in the tropics. This heat is thought to be convected poleward year-round in air currents, ocean currents, and storm systems.



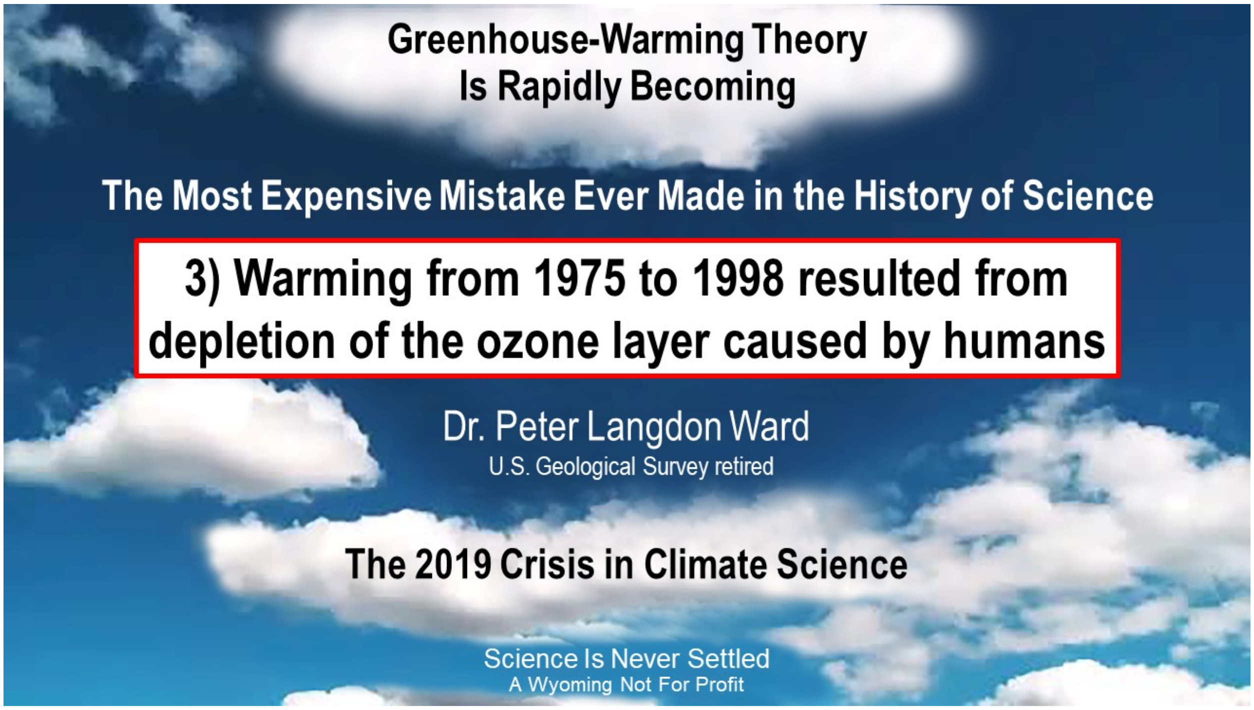
The greatest increases in global temperatures, however, are clearly observed to occur in polar regions during winter/spring, a phenomenon known as polar amplification.

Minimum temperatures on the Antarctic Peninsula, near 65 degrees south, rose 6.7 degrees Celsius from 1951 to 2003, more than ten times world-average warming. Based on ice-core data, this was the greatest warming known in this region in more than 1800 years. Maximum temperatures on the Antarctic Peninsula during summer months, on the other hand, changed very little during the same years since 1951.

Similarly, annual mean land-surface temperatures in the Arctic north of 60 degrees increased 1.5 degrees Celsius between 1966 and 2003, more than twice mean global warming. This was the greatest warming observed in Arctic regions for at least the past 600 years.

Greenhouse-warming theory cannot explain directly why warming is observed to be greatest in polar regions during winter/spring. Explanations, with considerable arm waving, tend to invoke the complexity of climate systems and a variety of postulated climate feedback mechanisms.

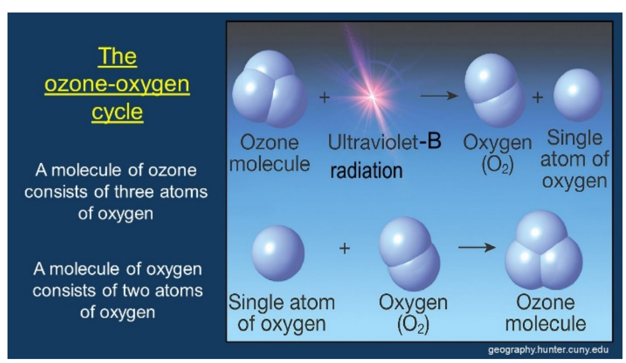
The most direct, straightforward explanation for polar amplification is depletion of the ozone layer, to be described in the next video.



Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 3. Warming from 1975 to 1998 resulted from depletion of the ozone layer caused by humans.

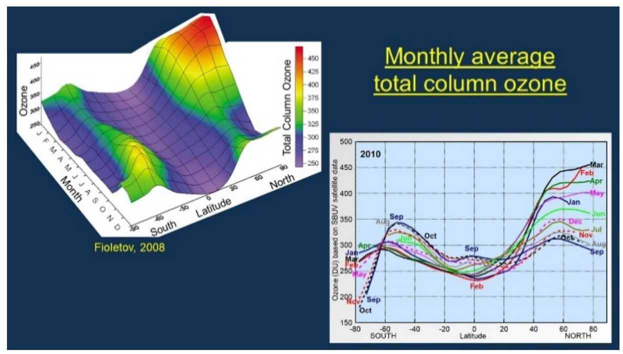
Ozone is a trace gas in Earth's atmosphere that is found primarily in the ozone layer extending from 9 to 22 miles above Earth. There are only about ten molecules of ozone for every million molecules of other gases in the ozone layer. But tiny amounts of ozone are extremely important in atmospheric chemistry because these molecules, consisting of three atoms of oxygen, are continually being formed and destroyed in an endless ozone-oxygen cycle.



When a molecule of ozone absorbs solar ultraviolet-B radiation, the molecule is dissociated into a molecule of oxygen and an atom of oxygen, releasing heat. A typical molecule of ozone lasts only about eight days on average. Thus, where there is ozone in the lower stratosphere, there is a higher than normal air temperature—the higher the concentration of ozone, the higher the surrounding air temperature.

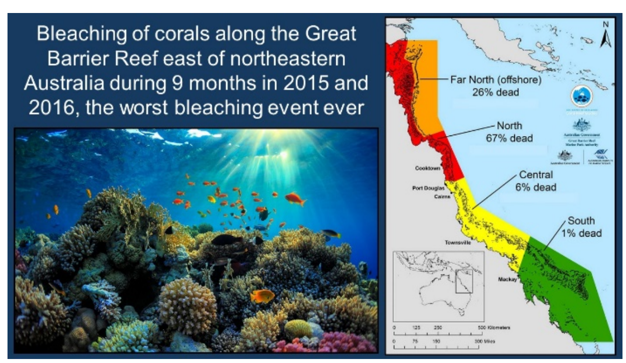
The ozone layer protects life on Earth from the highest energy solar radiation normally reaching the lower atmosphere. At Earth's surface, this very energetic ultraviolet-B radiation is observed to cause sunburn, cataracts, depression of the immune system, and genetic damage that can lead to skin cancer and mutations.

The total amount of ozone contained in a vertical column up through the atmosphere varies by the month and by latitude as shown with colors in these surface and cross-section plots. Note that total column ozone concentrations are lowest in the tropics and during summers and highest at mid to high latitudes, especially during winter and spring. These polar locations are the same locations and times when ozone depletion is greatest compared to values before 1970.

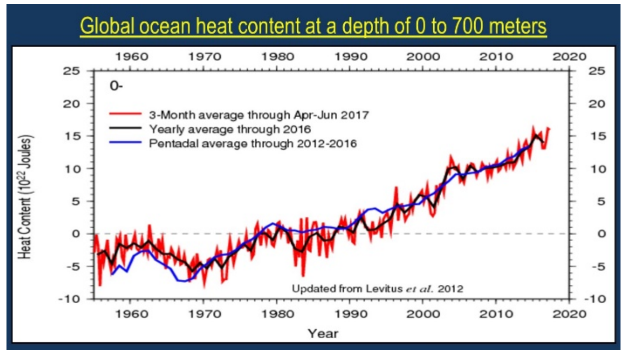


The higher the concentration of ozone, the more ultraviolet-B radiation is absorbed in the ozone layer, the higher the temperature of the ozone layer, and the lower the air temperature just above Earth's surface. When the ozone layer is depleted, more ultraviolet-B radiation than normal is observed to reach Earth, cooling the ozone layer and warming Earth.

Ultraviolet-B radiation has enough energy to penetrate oceans to hundreds of feet so that it sunburns life-forms such as those that make up plankton and those that inhabit coral reefs. Bleaching of coral reefs is more likely due to sunburn than to changes in water temperature because temperature of water changes very slowly.

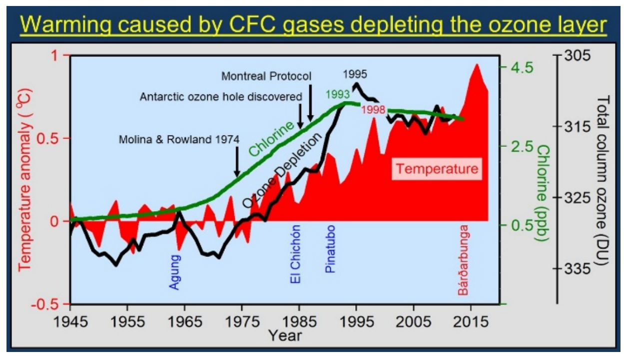


Because ultraviolet energy penetrates oceans so deeply, increases in ultraviolet radiation warm oceans very efficiently, raising ocean heat content, as is clearly observed.



In the 1960s, chemical engineers developed chlorofluorocarbon gases, CFCs for short, that became widely used as refrigerants, spray-can propellants, solvents, and foam-blowing agents. CFCs became very popular because they do not react chemically with most other materials or gases and are, therefore, much safer and cheaper to use. Many CFCs have atmospheric lifetimes of more than fifty years.

This graph summarizes the increased production of CFCs shown in green, related to increases in ozone depletion shown in black, and increases of temperature shown in red.



In 1974, Molina and Rowland discovered that CFCs move slowly, over 3 to 5 years, up into the stratosphere, where they are broken down by ultraviolet radiation to release atoms of chlorine, especially in very cold environments.

Under the right circumstances, one atom of chlorine can lead to the destruction of more than 100,000 molecules of ozone, creating the Achilles heel of Earth's climate.

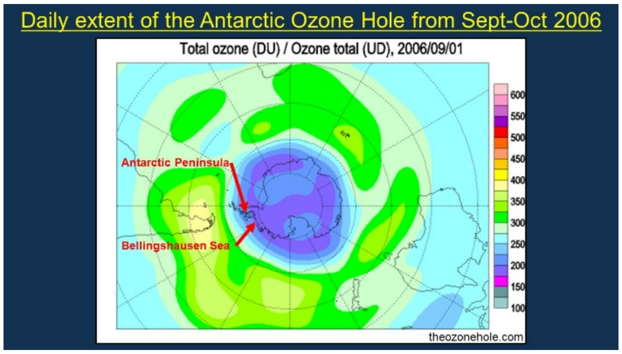
In 1985, scientists discovered widespread depletion of the ozone layer over Antarctica during winter, forming what became known as the Antarctic Ozone Hole, where ozone concentrations were reduced by 50 to 70 percent compared to levels observed before 1970.

By 1987, scientists had helped political leaders at the United Nations frame the Montreal Protocol On Substances that Deplete the Ozone Layer mandating cutback in CFC production beginning in January 1989. Sure enough, the increases in concentrations of CFC gases in the atmosphere stopped in 1993; the increases in ozone depletion stopped in 1995; and the increases in global temperatures stopped in 1998.

Humans had caused global warming beginning around 1975 by manufacturing large amounts of CFC gases. Humans had stopped the increase in global warming by 1998 by substantially reducing the amounts of CFC gases being manufactured.

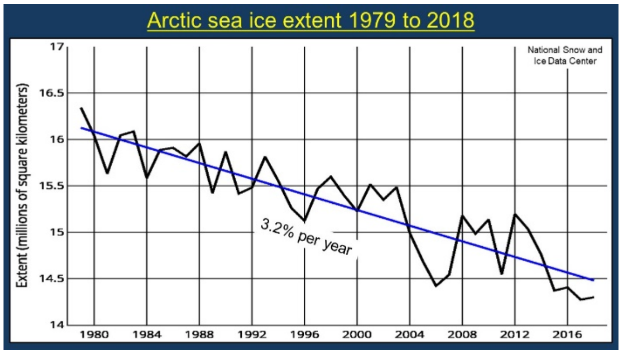
Depletion of the ozone layer caused by CFC gases explains why ozone depletion and surface temperatures began increasing around 1975 and stopped increasing around 1998, why the temperature of the ozone layer decreased during this same period, and why global warming was primarily of minimum temperatures during the winter when ozone depletion is greatest.

Total column ozone is constantly changing at every location. This animation shows daily average ozone in most of the southern hemisphere for each day from September first through October 31, 2006. Note that the Antarctic Ozone Hole changes daily, but typically covers most regions at latitudes greater than fifty-five degrees south.

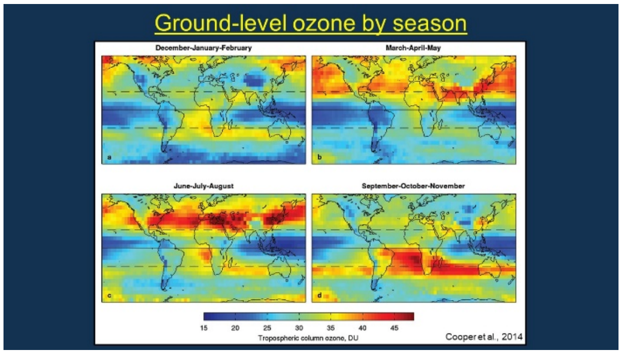


The extent of the Antarctic Ozone Hole explains why warming was greatest on the Antarctic Peninsula, why southern oceans surrounding Antarctica showed major warming, and why the Bellingshausen Sea warmed one degree Celsius.

Ozone depletion in the Arctic region explains why ice covering the Arctic Sea has been decreasing at a rate of 3.2% per year since 1979. All of these observations cannot be explained as directly using greenhouse-warming theory.



Ozone in the ozone layer is known as good ozone because it absorbs highly energetic solar ultraviolet-B radiation, protecting life on Earth. But ozone can also be formed just above the ground-level by chemical reactions between nitrogen oxides and volatile organic compounds. Ground-level ozone is

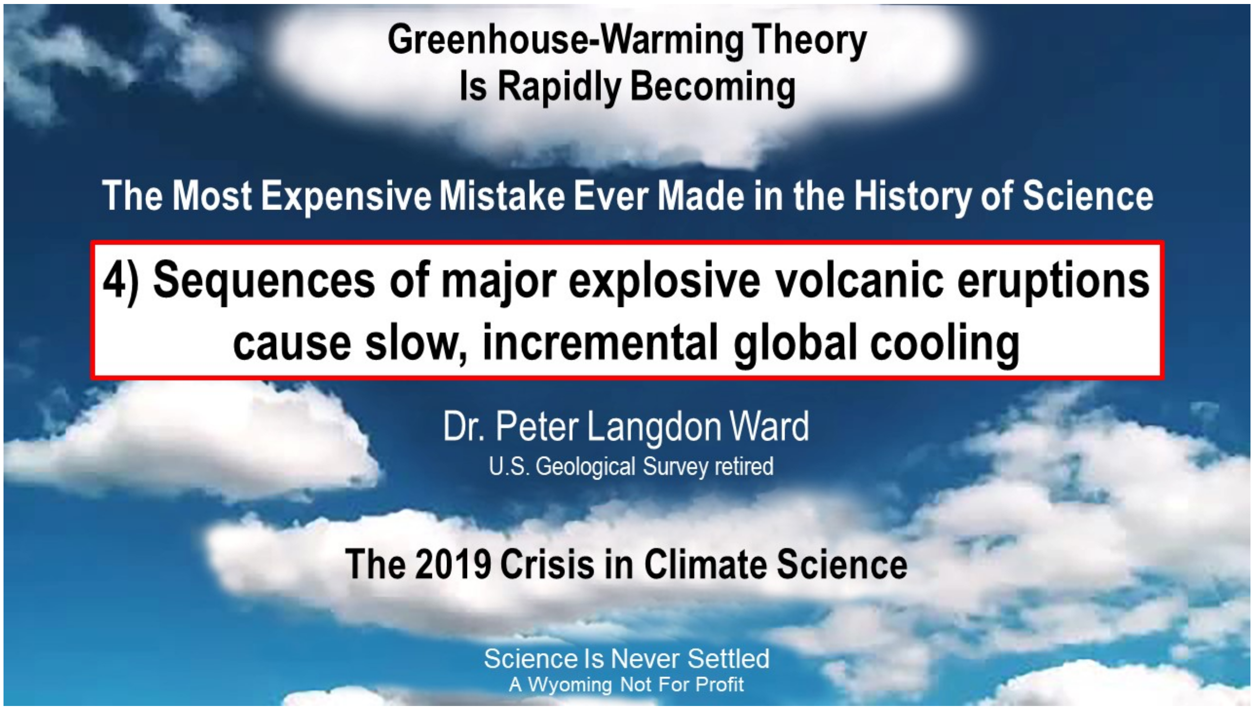


formed when pollutants are emitted, for example, by cars, power plants, industrial boilers, refineries, and chemical plants and that these react chemically in the presence of sunlight. Ground-level ozone is known as bad ozone because it is highly toxic to people and to the environment. Bad ozone is the primary ingredient in "smog."

Ground-level ozone is created as a result of pollution in heavily populated, industrialized regions. When more ultraviolet-B radiation reaches Earth's surface, it dissociates more ground-level ozone, warming the air. This explains why global warming was observed to be greatest in heavily industrialized regions and why global warming was twice as great in the northern hemisphere containing 89 percent of world population.

The dissociation of ground level ozone by ultraviolet-B radiation provides a direct explanation for the urban heat island

Ozone is also depleted by volcanic eruptions described in the next video.



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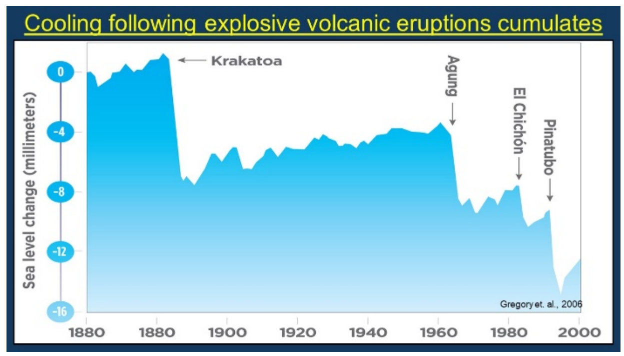
Video 4. Sequences of major explosive volcanic eruptions cause slow, incremental global cooling.

On June 15, 1991, [Mount Pinatubo](), in the Philippines, erupted 2.4 cubic miles of debris as high up as 22 miles into the stratosphere within 9 hours. This was the largest volcanic eruption since 1912.

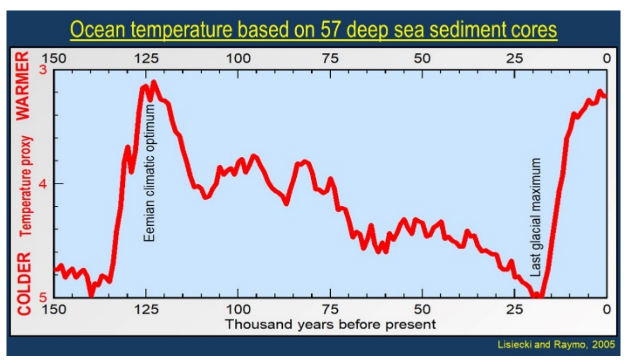
Water vapor and sulfur dioxide ejected into the lower stratosphere formed a [sulfuric-acid aerosol]() or mist that was observed from satellites to spread around the world in the tropics within 21 days and to spread poleward within a year. The droplets within the aerosols were observed to grow large enough within months to reflect and disperse sunlight, causing global cooling of about half a degree Celsius for three years.

All major explosive volcanic eruptions observed throughout written history have been followed by similar global cooling. The 1815 eruption of Mt. Tambora in Indonesia, the largest volcanic eruption since 1257, was followed by average global cooling of up to 0.7 degrees Celsius. The next year, 1816, was known as the "Year Without Summer" when average temperatures in Europe dropped several degrees and hundreds of thousands of people perished due to crop failures.

Since 1800, there have been six eruptions as large as the Pinatubo eruption and 14 smaller eruptions that were large enough to form aerosols that cooled Earth for at least two years.

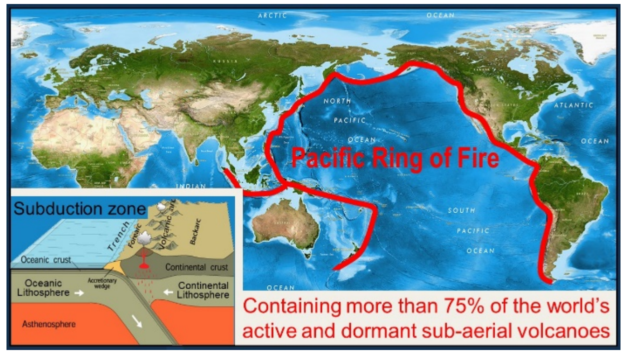


Nearly all heat in the ocean-atmosphere system is stored in the ocean, which covers 71% of Earth's surface. Modelling of ocean temperatures and modelling of mean sea-level show that when the ocean surface is cooled by half a degree for a few years, the effects of this cooling can still be observed in ocean temperatures one hundred years later. Thus, sequences of explosive eruptions can cause slow incremental cooling of the ocean modelled as a small decrease in sea-level in this plot. The more numerous the eruptions, the faster the cooling.



In deep-sea sediment cores, the temperature of the ocean at the time a tiny animal forms its shell can be estimated by measuring the ratio of oxygen isotopes in that shell. This figure shows how these temperatures document in detail a much longer period of slow incremental cooling from the last interglacial period known as the Eemian climatic optimum, 120,000 years before present, to the last glacial maximum around 20,000 years before present.

Nearly all major explosive volcanoes are found today in the so-called Ring of Fire surrounding the Pacific Ocean where ocean lithosphere, shown in the lower left, is being subducted down under continental lithosphere. Subduction-related volcanoes are most active when the rates of subduction are highest.

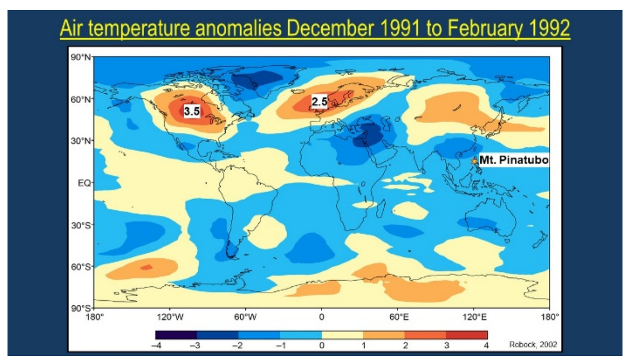


The most recent ice age, the Pleistocene, appears to have been caused by major increases in the rates of subduction of lithospheric plates under continents around the Pacific Ocean beginning 2.6 million years before present. Rapid onset of glaciation in Antarctica, 34 million years before present, is contemporaneous with rapid increases in the rates of subduction all around the Pacific Ocean. Worldwide glaciation approximately 650 million years before present, referred to as snowball earth, was contemporaneous with subduction along the edges of nearly all continents.

Thus, each major explosive volcanic eruption is observed to cause short-term global cooling of about 0.5 degrees Celsius, for a few years. Several such events per century are shown by modelling to cause slow, incremental, long-term cooling of the ocean. When such rates of explosive volcanic activity continue for millennia, they cool global oceans down into ice-age conditions.

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

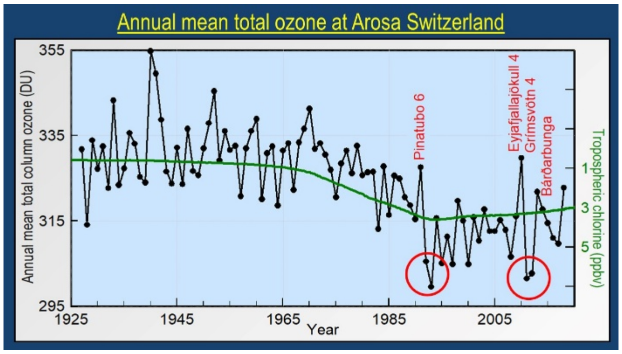
Video 5. Extensive, non-explosive, basaltic lava flows cause sudden global warming.



The orange contours on this global map show that air temperatures in many of the most populated areas of North America and Europe were as much as [3.5 degrees Celsius](#) warmer than usual during the first winter following the eruption of Mt. Pinatubo in the Philippines in June 1991.

Yet, as explained in video 4, there was net global cooling of approximately one-half degree Celsius for three years following this major explosive eruption. This period, December through February, is precisely the months when ozone depletion is greatest in the Northern Hemisphere. What's going on?

The Pinatubo eruption exploded approximately 10 megatons of chlorine into the lower stratosphere. Remember, as discussed in Video 3, that one atom of chlorine in the lower stratosphere, under winter temperatures, can catalyze destruction of more than 100,000 molecules of ozone.



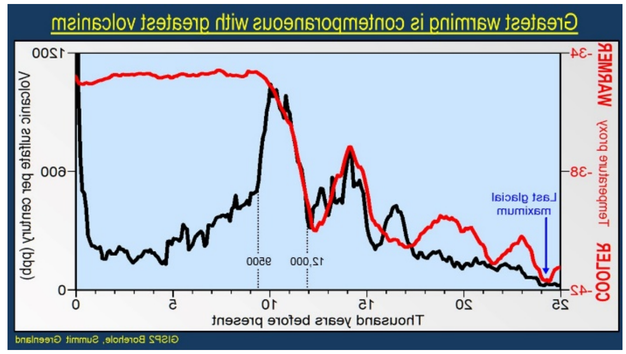
The first routine measurements of total column ozone in the atmosphere began in 1927 by pointing a new type of instrument, the Dobson spectrophotometer, up into the sky above Arosa Switzerland at 47 degrees north latitude. Total column ozone varies with every measurement, but long-term averages of the data document systematic changes. The black line in this graph shows the average, annual mean ozone above Arosa. Note that values remained relatively constant, on average, from 1927 to 1975.

By early 1991, ozone had become depleted by about 5% compared to average levels from 1927 to 1975. As discussed in video 3, this depletion was contemporaneous with increases in manufactured CFCs shown in green, increasing downward.

In 1992 and 1993, however, ozone above Arosa had become depleted by an additional 5% following the eruption of Mt. Pinatubo. Less ozone in the ozone layer allowed more ultraviolet-B solar radiation to reach Earth where it dissociated bad ozone pollution in industrial areas as discussed in Video 3, causing warming of air. By late winter 1992, however, the particle sizes of the sulfuric-acid aerosols had grown large enough and spread widely enough around the world to cause net global cooling that lasted three years. This 5% depletion had recovered within a decade or so, but then there was a second 5% depletion in 2011 following the hundred-times smaller explosive eruptions of Eyjafjallajökull and Grímsvötn in Iceland in 2010.

Thus, explosive volcanic eruptions are causing substantial ozone depletion and associated warming, but they are also forming aerosols in the lower stratosphere that reflect and scatter sunlight, causing a NET global cooling.

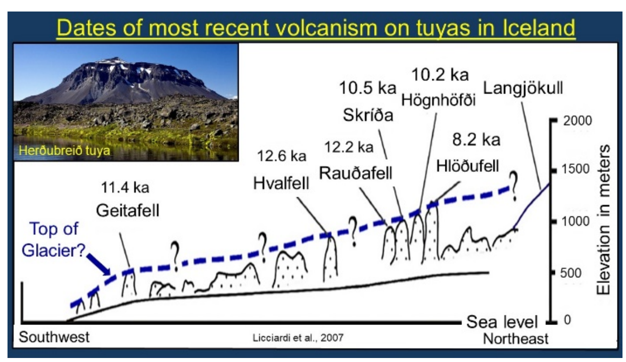
In 2006, I discovered published data from ice cores drilled under Summit Greenland that clearly show the greatest amounts of volcanism recorded in Greenland ice, shown in black, occurred from 12,000 to 9500 years before present, precisely when the world warmed out of the last ice age shown by air-temperature in red. This contemporaneity suggests the warming may have been caused by the volcanism.



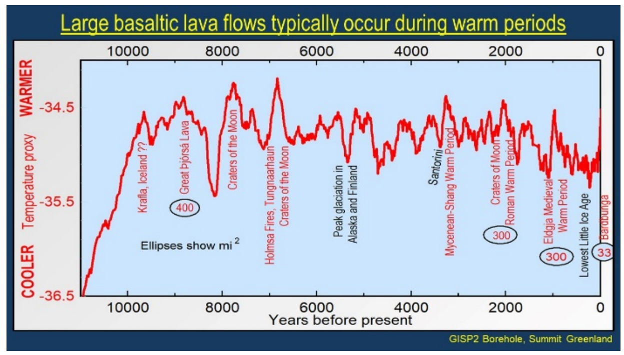
But this just didn’t make sense. As described above, major explosive volcanic eruptions are clearly observed to cause sudden global cooling of about one-half degree Celsius for a few years. How could volcanic eruptions cause both cooling and warming? This was an enigma that piqued my curiosity. I climbed my first active volcano at age nineteen and have studied volcanoes for more than fifty-five years. This is the enigma that got me started on the thirteen years of research discussed in these videos.

Being retired, I was able to put aside most other things in my life to concentrate full-time trying to figure out what in the world was happening.

This volcanism that ended the ice age can be traced primarily to well-dated basaltic volcanic centers in Iceland. Basalts erupting under ice build vertically, forming these distinctive flat-topped mountains known as tuya. The top of the glacier shown by the blue dashed line was up to 1000 meters above the land.

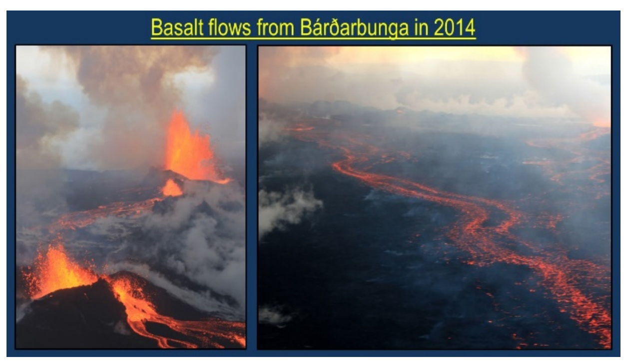


Basalts are primitive magmas that come directly from Earth’s upper mantle. They are much hotter than magmas ejected by major explosive volcanos and contain ten-times more chlorine. They typically flow out over the land without much explosive activity as observed in the relatively small eruptions in Hawaii. Basaltic eruptions are rarely explosive, so they do not form major aerosols in the lower stratosphere.



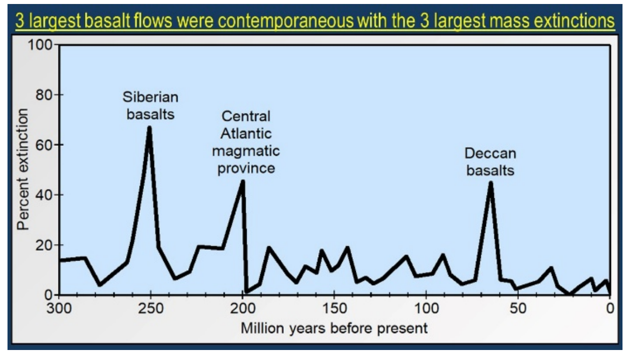
Since the end of the last ice age, temperatures have peaked every thousand years or so. Nearly all of these peaks were contemporaneous with extrusion of at least three hundred square miles of basaltic lava flows. For example: the eruption of Eldgjá in Iceland in 939 AD, was contemporaneous with the onset of the Medieval Warm Period. The eruption of basaltic lavas in Craters of the Moon National Monument in south-central Idaho, 2200 years before present, was contemporaneous with the Roman Warm Period.

There is still a lot of work needed to map and date major basaltic lava flows, but available data support the contemporaneity of major basalt flows and major periods of warming every thousand years or so since the last ice age.



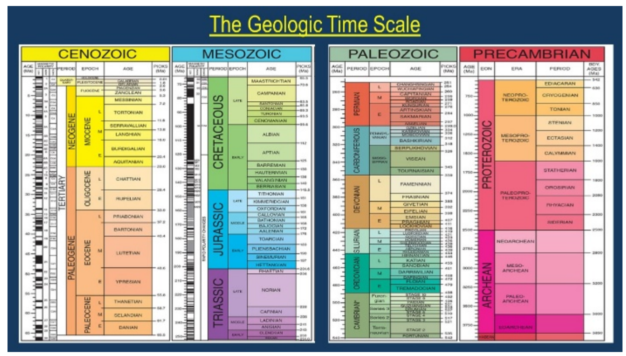
One of the largest known basalt flows formed in Siberia, 251 million years before present, covering an area of three million square miles, almost as large as the United States. Just imagine black, basaltic lava fields covering all the land from New York City to San Francisco, from Seattle to Miami. Oceans warmed to hot-tub temperatures. Basalts emit large volumes of sulfur dioxide gas that combines with water vapor to form sulfuric acid. The oceans became very hot and highly acidic, causing 96% of all ocean species to go extinct.

The largest known basalt field, covering more than four million square miles, formed 201 million years before present as Africa and North America began to rift apart forming the central Atlantic Ocean. As long as this volcanism was subaerial, there was major warming and major mass extinctions.

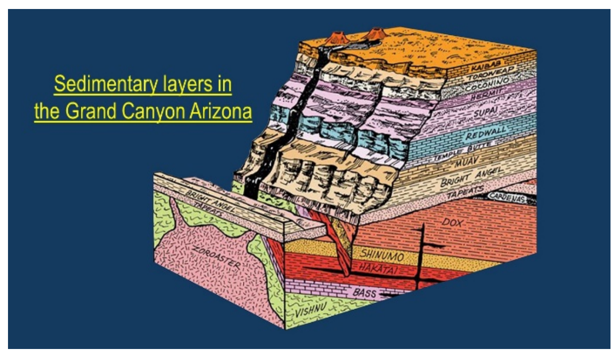


The third largest mass extinction was 66 million years before present when the Deccan basalts covered 200,000 square miles of India, causing major global warming. The dinosaurs were already in severe decline by the time a major asteroid formed a crater nearly 100 miles in diameter in Mexico.

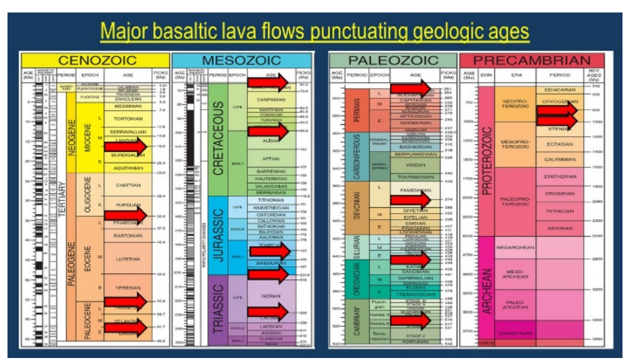
Over the past 200 years, geoscientists have pieced together a geologic time scale, based on meticulous studies of sediments, fossils, and radiometric age-determinations. This figure shows the geologic Eons, Eras, Periods, Epochs, and Ages for the past four billion years.



Geoscientists have found that sedimentary layers, such as those observed in the Grand Canyon, formed in the same climate over millions to tens of millions of years. Then there is often a sudden change in climate causing a sudden change in sediment and fossils types, marking the beginning of a new geologic period, epoch, or age.



Many of these sudden changes are contemporaneous with major basaltic lava flows—the larger the flow, the greater the climate change. More than 200 major basalt flows have been mapped on Earth. The largest are shown by red arrows in this figure. Most formed at the end of geologic periods when there



was sudden changes in climate, sedimentation types, and fossils. Most were formed in rift zones where continents were breaking apart.

Eighty percent of volcanic eruptions take place under water. It is only those eruptions on land that have major effects on climate.

Lava field from Bárðarbunga volcano August 2014 to February 2015

In August 2014, a basaltic volcano named Bárðarbunga began extruding lava over the ground in central Iceland, in the rift zone just north of the Vatnajökull ice cap. Within six months, the lava covered an area of 33 square miles, the size of Manhattan, the largest basaltic eruption since 1783. In 2014, 15, and 16, average global temperatures rose 0.3 degrees at a rate that was more than three-times faster than the warming from 1975 to 1998 caused by humans manufacturing CFC gases.

While basalts contain more than ten times the amount of chlorine and bromine found in explosive magmas, it is not clear how these water-soluble gases get lofted into the lower stratosphere. Air convecting off the very hot lava flows must play a major role. Ozone was not depleted as much during these lava flows as during explosive eruptions, so we still have much to learn about the chemical mechanism for the observed warming.

Clearly, however, large basaltic eruptions, covering hundreds to millions of square miles of Earth, are widely observed to be contemporaneous with global warming throughout Earth history. Ozone depletion is the only mechanism that I can find that can explain the added heat coming from Sun.

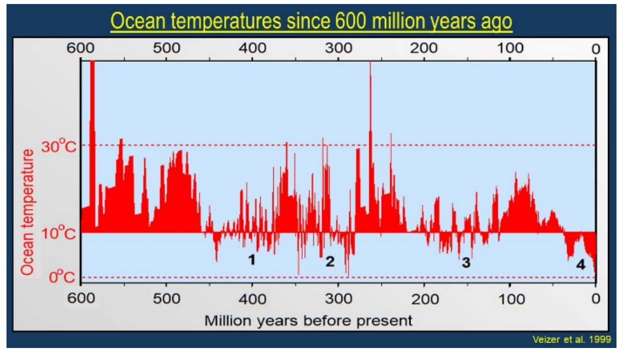
Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 6. Global temperatures have typically risen within years and cooled over millennia.

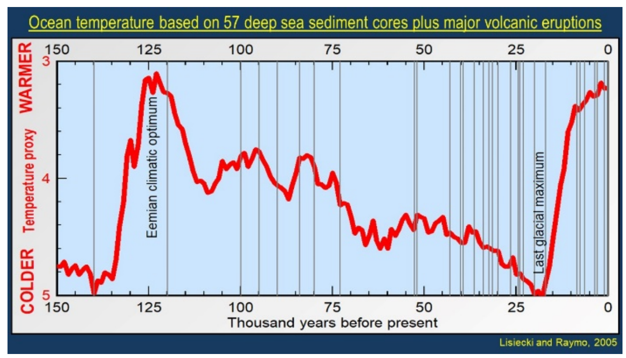
The geologic record contains extensive evidence for how climate has changed throughout Earth history: when the temperature changed, by how much, how suddenly, how frequently, and how cyclically.

The most widely used method to estimate former ocean temperatures involves measuring the ratio of heavy isotopes of oxygen to light isotopes of oxygen in the shells of tiny little animals. Foraminifera, which are typically less than one millimeter in diameter, are a good example. Water containing the heavier isotope of oxygen is hard to vaporize and easier to condense, making this isotopic ratio proportional to the temperature of the water at the time each animal was growing its shell. Geologists have devised ways to determine the ages of those shells based on their species and based on their position in sedimentary layers that are referenced to the geologic time scale.

When you take seventeen thousand of these measurements and average the temperature data for each million-year interval, you get a quick overview of climate change throughout the past 600 million years shown in red in this figure.



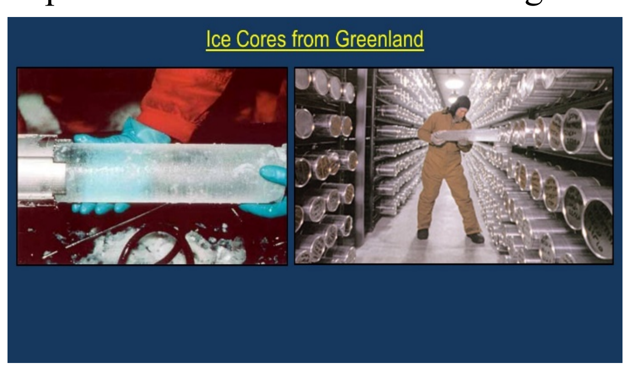
Note that ocean temperatures are changing all the time and that there is no obvious cyclicity. The numbers label the four periods of time when glaciers were widespread. These are the only times when extensive evidence of glaciation is found in the rocks and sediments. There are longer periods when much warmer temperatures were common.

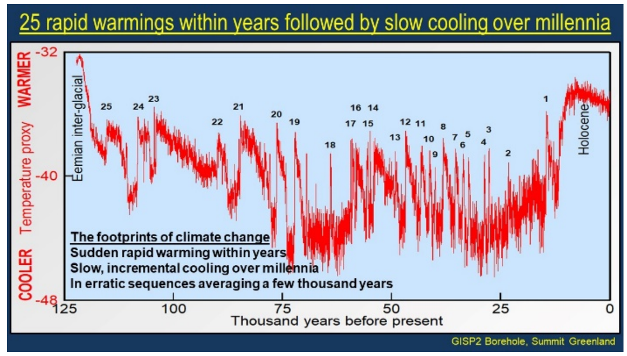


This figure shows ocean temperatures in red over the past 150,000 years based on a combination of oxygen isotope data from fifty-seven globally distributed deep-ocean cores.

Note how ocean temperatures cool slowly and incrementally from the Eemian climatic optimum on the left around 125,000 years before present to the last glacial maximum on the right around 20,000 years before present. Vertical black lines show times of all known major explosive volcanic eruptions. Evidence for these eruptions gets harder to see for older periods of time but note the high rate of eruptions from 40,000 to 20,000 years before present, just before the last glacial maximum.

Geochemists also can measure oxygen isotopes in air bubbles contained in glacial ice to estimate changes in air temperature at the time the ice was formed. Since ice layers can be dated to within years to decades, these studies provide the most detailed evidence available for changes in air temperatures, especially in Greenland where snow falls at a much higher rate than in Antarctica.





Twenty-five times in the last 120,000 years, there was rapid warming of air within years followed by slow cooling over millennia. These sequences average every few thousand years in length, but they are clearly erratic—they are not cyclic.

Throughout the geologic record, whenever we observe finely layered ocean or lake sediments with time resolutions better than a few thousand years, we find evidence of climate changing from cold to hot within years and then cooling slowly, incrementally, over millennia, in sequences that average several thousand years in length but are highly erratic—these sequences are clearly not cyclic. These sequences can be explained most directly by major effusive, basaltic eruptions causing sudden warming and a series of major explosive eruptions causing slow, incremental cooling.

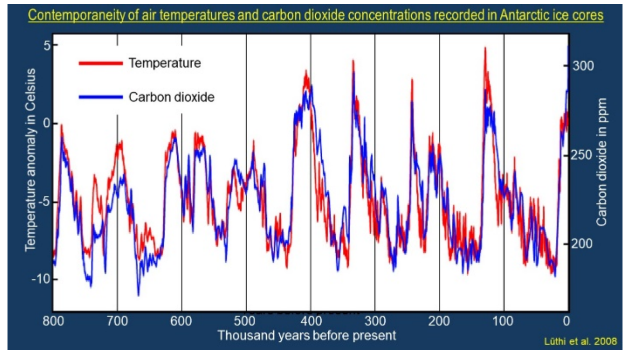
Basaltic eruptions are most common in areas of continental rifting and ocean-floor rifting. Explosive volcanoes, on the other hand, are most common in regions of plate convergence and subduction.

Volcanoes appear to rule climate change. Global temperatures appear to be a delicate balance between the volume of basaltic lavas being formed in areas of continental rifting and the frequency of major explosive eruptions per century occurring in subduction zones. These well-observed erratic sequences in climate cannot be explained by cyclic causes such as cyclic changes in Earth's orbit, cyclic changes in solar radiation, or cyclic changes in sunspots. Furthermore, it is hard to envision how changes in atmospheric concentrations for greenhouse gases could cause such major erratic changes in climate.

The only known way to suddenly increase greenhouse gases is with major volcanic eruptions. While Mt. Pinatubo is thought to have ejected as much as 200 megatons of carbon dioxide up into the atmosphere, concentrations of carbon dioxide in the atmosphere measured on Mauna Loa, in Hawaii, stopped increasing for the next three years apparently caused by aerosols cooling the oceans, which then absorbed more carbon dioxide.

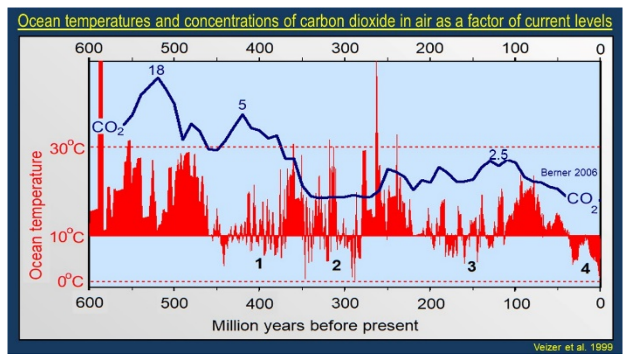
This figure shows a temporal correlation between temperatures and concentrations of carbon dioxide in air bubbles from ice cores in Antarctica over the past 800,000 years.

Most detailed studies of this correlation suggest that carbon dioxide concentrations increase up to 400 years after temperatures rise. This suggests that atmospheric concentrations of carbon dioxide increase as oceans warm and decrease as oceans cool due to the well-known solubility of carbon dioxide in water plotted in video 10.



You observe this phenomenon when bubbles of carbon dioxide rise into the atmosphere as your beer or soda warms.

Returning to the figure showing ocean temperatures over the past 600 million years, I have added the [best evidence for concentrations of carbon dioxide] shown in blue. Note that glaciation was common during times when carbon dioxide concentrations in the atmosphere were 2.5 and 5 times greater than current concentrations. There does not appear to be any clear correlation between climate change and concentrations of carbon dioxide in the atmosphere.



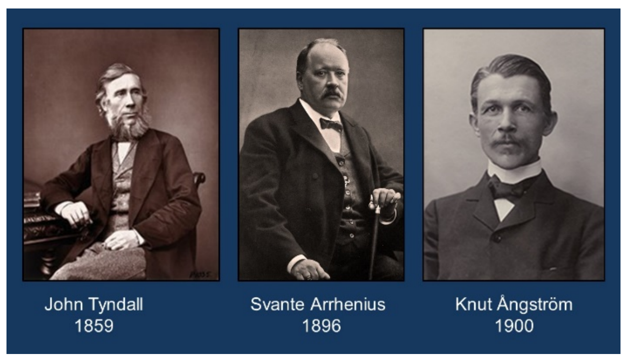
Thus, extensive observations of climate change throughout Earth history show that climate has been dominated by erratic sequences of rapid warming within days to years followed by slow, incremental cooling over millennia and that these sequences can often be as frequent as every few thousand years in length.

Climate has been changing at rates far higher than most climate scientists currently imagine.

There is no evidence of similar rapid changes in atmospheric concentrations of greenhouse gases.

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 7. Greenhouse-warming theory has never been verified by experiment.



In 1859, John Tyndall, a prominent Irish physicist, demonstrated in the laboratory that carbon dioxide gas absorbs some infrared energy radiated by Earth. Tyndall, and most physicists and climate scientists since, have assumed that if a gas absorbs thermal radiation, it must get hotter. This fundamental assumption forms the foundation upon which greenhouse-warming theory is built. While it sounds rather obvious, this assumption has never been verified by experiment, a cornerstone of the scientific method, and does not appear to be correct.

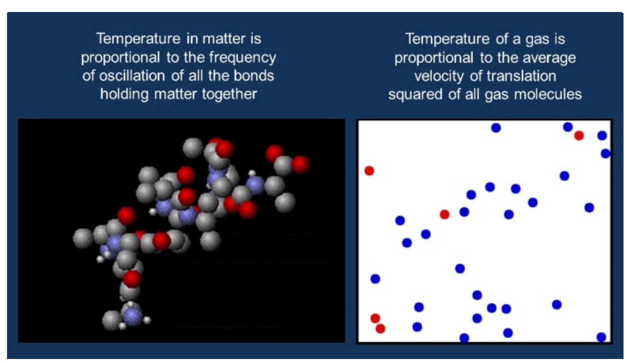
In 1895, Svante Arrhenius set out to determine if Earth's surface temperatures could be "influenced by the presence of heat-absorbing gases in the atmosphere."

After hearing several talks and engaging in heated discussions about the possible causes of ice ages and about geologic estimates of the carbon cycle, he wondered whether halving the concentration of carbon dioxide in air might explain cooling of approximately five degrees Celsius during ice ages.

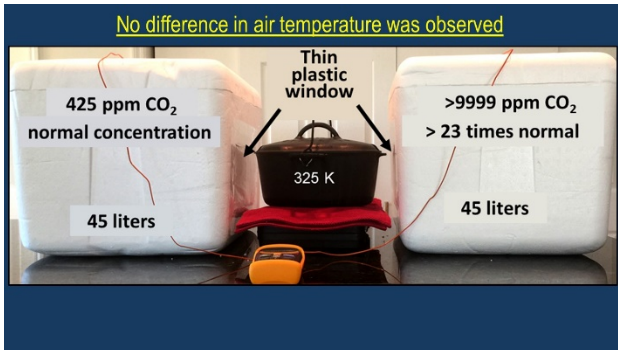
Arrhenius acknowledged that "one should, strictly speaking, arrange experiments" to measure the effect, but concluded that such experiments "would require very expensive apparatus beyond that at his disposal." While such equipment would not have been all that expensive, the real issue was that Arrhenius was a physical chemist who relied on the laboratory work of spectral physicists. So, he embarked on what became a year of very intense effort, trying to devise a rational way mathematically to calculate how halving carbon dioxide concentrations could lower world temperatures 4 to 5 degrees. The empirical basis for his model was limited, so that he had to make a whole lot of seemingly reasonable assumptions in order to have the numbers work out to the values that he wanted to calculate. Arrhenius published his estimates in 1896. That paper forms the foundation of greenhouse-warming theory.

Arrhenius relied, in part, on measurements by Knut Ångström, a spectral physicist who participated in most of the same discussions of carbon dioxide and ice ages. In 1900, Ångström published two experiments concluding that "no more than about 16 percent of earth's radiation can be absorbed by atmospheric carbon dioxide, and secondly, that the total absorption is very little dependent on the changes in the atmospheric carbon dioxide content, as long as it is not smaller than two tenths of the existing value."

Ångström convinced most physicists in 1900 that greenhouse-warming theory was not correct. Yet his work has been summarily dismissed ever since by climate scientists. Ångström was the last physicist that I can find in the literature to seriously question the basic physical assumptions underlying greenhouse-warming theory.



We now understand, in considerable detail, that a molecule of carbon dioxide absorbs less than 16 percent of the frequencies that make up infrared energy radiated by Earth. The frequencies and amplitudes radiated by Earth are shown by green in this Figure. The few frequencies absorbed by a molecule of carbon dioxide are shown as black vertical lines. If these limited number of frequencies were re-radiated perfectly and absorbed by another body of matter, they could not warm that body even to the temperature of Earth. These frequencies are only the resonant frequencies of the bonds holding the molecule together. Thus, the thermal energy is absorbed into the bonds, increasing the bond energy that holds molecules together and this does not increase the temperature of a gas. The temperature of a gas is well-known to be proportional to the kinetic energy of the gas, which is proportional to the square of average velocity that all gas molecules are traveling.



In 2017, I carried out an experiment showing that air containing more than 23-times the normal concentration of carbon dioxide was not heated any more than air with the normal concentration of carbon dioxide. In both cases, each volume of air was absorbing infrared radiation from a black cast-iron pot full of water with a temperature slightly warmer than Earth.

Since 2015, I have been offering to pay $10,000 from my children's inheritance to the first person who can demonstrate by experiment that warming observed since 1970 could be physically explained by the observed increase in carbon dioxide. No one has shown any interest.

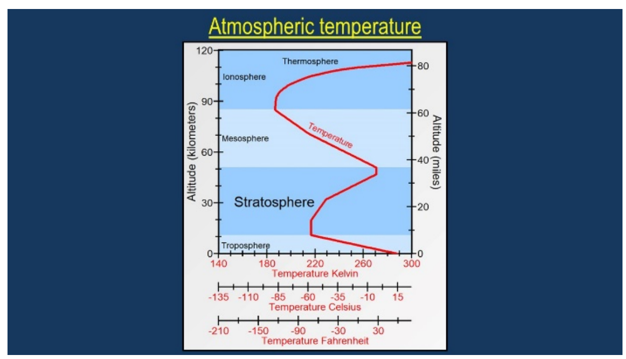
Many experiments described on YouTube claim to show heating associated with increasing concentrations of carbon dioxide gas such as this one by Bill Nye, The Science Guy. These experiments typically use heat lamps that are approximately ten times hotter than Earth. From Planck's law we can see that these heat lamps are radiating frequencies and amplitudes of oscillation that are much higher than anything radiated by Earth. These experiments are simply not relevant to greenhouse-warming theory.

To this very day, no one has ever shown by experiment that greenhouse-warming theory is physically possible.

There are numerous studies that have inferred that doubling the concentration of carbon dioxide would cause a warming of air by [1.5 to 4.5 degrees Celsius](). These studies, however, assume that all observed global warming was caused by observed changes in carbon dioxide concentrations. I showed in video 3 that ozone depletion appears to be the major cause of warming from 1975 to 1998.

Major warming of air is clearly observed in the stratosphere, 5 to 30 miles above Earth, where oxygen molecules absorbing ultraviolet-C radiation from Sun are dissociated, breaking the bond apart that holds two atoms of oxygen together into one molecule of oxygen. Dissociation causes the two atoms of oxygen to fly apart at high velocities, instantaneously converting all bond energy to kinetic energy that increases air temperature. Infrared radiation, on the other hand, does not have enough energy to cause dissociation.

It is this dissociation of carbon dioxide molecules by solar ultraviolet radiation that appears to cause the atmosphere of Venus, containing 96% carbon dioxide, to have a very hot temperature of 467 degrees Celsius.



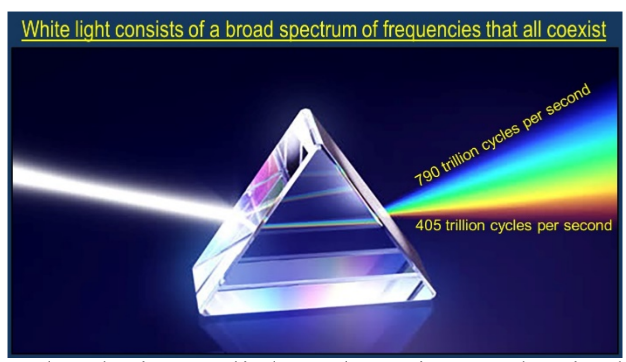
It is the stratosphere of Earth that keeps Earth more than 33 degrees warmer than expected, not carbon dioxide as proposed by Arrhenius in 1908.

There is now considerable evidence that greenhouse-warming theory is not even physically possible as explained in detail at Physically-Impossible.com and in video 10. In brief, no body of matter can be warmed by absorbing its own radiation. If that were possible, bodies, under the right conditions, could spontaneously heat up. We all know that spontaneous heating cannot physically happen. Second, placing a blanket over a body of matter slows the rate of cooling, but cannot physically cause the body to get a higher temperature. Thirdly, the temperature of a body of matter is determined by the temperature of the source of the radiation being absorbed, not by the rate of loss of heat by the matter. This is a little harder to understand but is explained in detail at Physically-Impossible.com and in less detail in the next video.

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

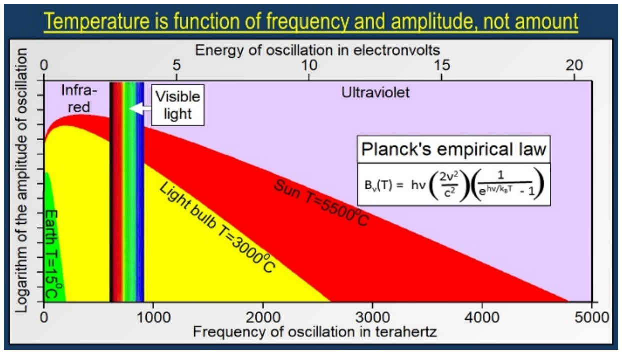
Video 8. Global temperatures can only be increased by absorbing radiation from a hotter body.

Solar radiation heats our world and makes it visible.



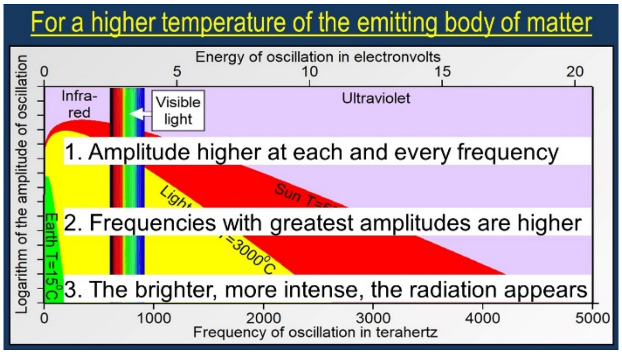
When solar radiation is passed through a prism, we observe that white sunlight contains a rainbow of colors. Scientists measure each shade of visible color as a unique frequency of oscillation ranging from deep red at 405 terahertz to violet at 790 terahertz. Terahertz means one trillion cycles per second. All of these frequencies are observed to coexist independently in sunlight. There is no physical way for these frequencies of oscillations of the bonds in matter that are emitting the radiation to interact with each other in air and in space.

Extensive laboratory studies of radiation in the latter part of the 19^{th} century extended the measured spectrum down into infrared frequencies, meaning below red, that are not visible and make us feel warm, and up into ultraviolet frequencies, meaning extreme violet, that are also not visible but are so energetic, so hot, that they cause sunburn, cataracts, depression of the immune system, and genetic damage that can lead to skin cancer and mutations.

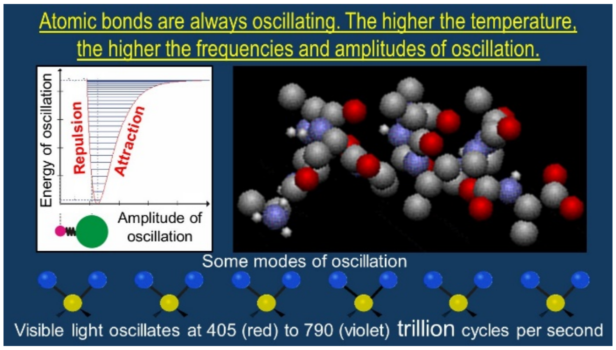


In 1900, Max Planck, one of the fathers of modern physics, was able to devise an equation, by trial and error, now known as Planck's law. Planck's law, shown here, calculates the observed amplitude of oscillation at each and every frequency of oscillation as a function of the temperature of the radiating body shown in this plot. We perceive amplitude of oscillation as the brightness or intensity at each frequency coexisting in this broad spectrum of radiation.

Note that Earth is observed to emit only the frequencies at the amplitudes shown in green and, as we all know, does not emit any visible light. A typical incandescent light bulb, on the other hand, emits only the frequencies at the amplitudes shown in green and yellow. While Sun emits all the frequencies at the amplitudes shown in green, yellow, and red.

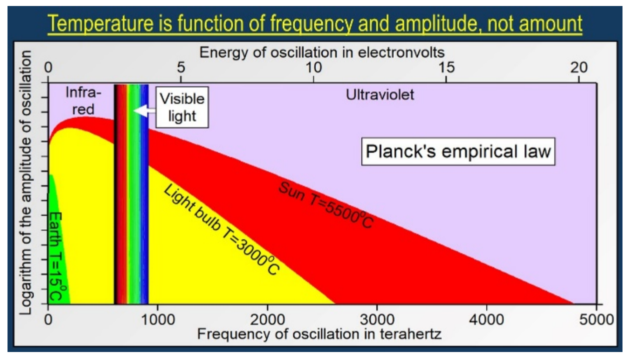


The most important observations from this plot are that for a higher temperature of the body, first the amplitude of oscillation radiated at each and every frequency of oscillation is higher, second the frequencies with the greatest amplitudes of oscillation are higher, and third the brighter or more intense the radiation appears.



But what is oscillating? All the bonds that hold the atoms of matter together are observed not to be rigid. These bonds are observed to oscillate between electrodynamic forces of attraction and of repulsion, very rapidly changing their tiny lengths. Each molecule-scale, frictionless oscillator on the surface of a body of matter, transmits, through motion of charge, its single frequency of oscillation.

This is precisely the way a radio antenna transmits its station's assigned frequency. This myriad of oscillators transmits a broad spectrum of frequencies of oscillation, all of which independently coexist and do not interact with each other in air and space in any way except when in the immediate presence of matter.

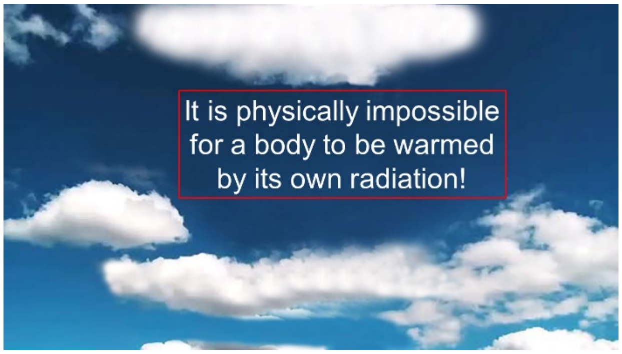


Planck's law, therefore, not only shows us all the frequencies at their amplitudes of oscillation contained within radiation from a body of matter at a given temperature, but also, all the frequencies at their amplitudes of oscillation occurring on the surface and within the radiating body of matter. In this way, Planck's law shows us the broad spectrum of frequencies and their amplitudes of oscillation that must be physically happening within a body of matter for that body of matter to possess a given temperature.

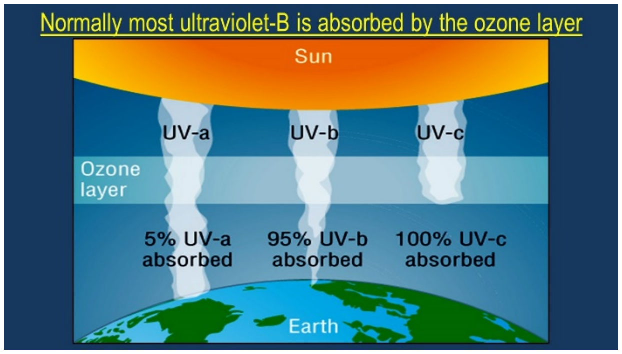
What is extremely important here is that Planck's law, which simply describes extensive observations of Nature, shows us that the only physical way to increase the temperature of a body of matter absorbing radiation is if that radiation is emitted by a hotter body that contains higher amplitudes of oscillation at each and every frequency of oscillation.

The temperature of matter is not raised by absorbing an increased amount of radiation as widely assumed. The temperature of a body of matter is raised only by absorbing radiation from a hotter body. The greater the temperature difference, the greater the flux of heat, the greater the warming. Greenhouse-warming theory, however, assumes that temperature is increased by increasing the amount of radiation absorbed. There is no amount of radiation from Earth that can make any absorbing body warmer than Earth. Earth can only be warmed by absorbing radiation from a nearby body that is hotter than Earth, which in our solar system is limited to Sun.

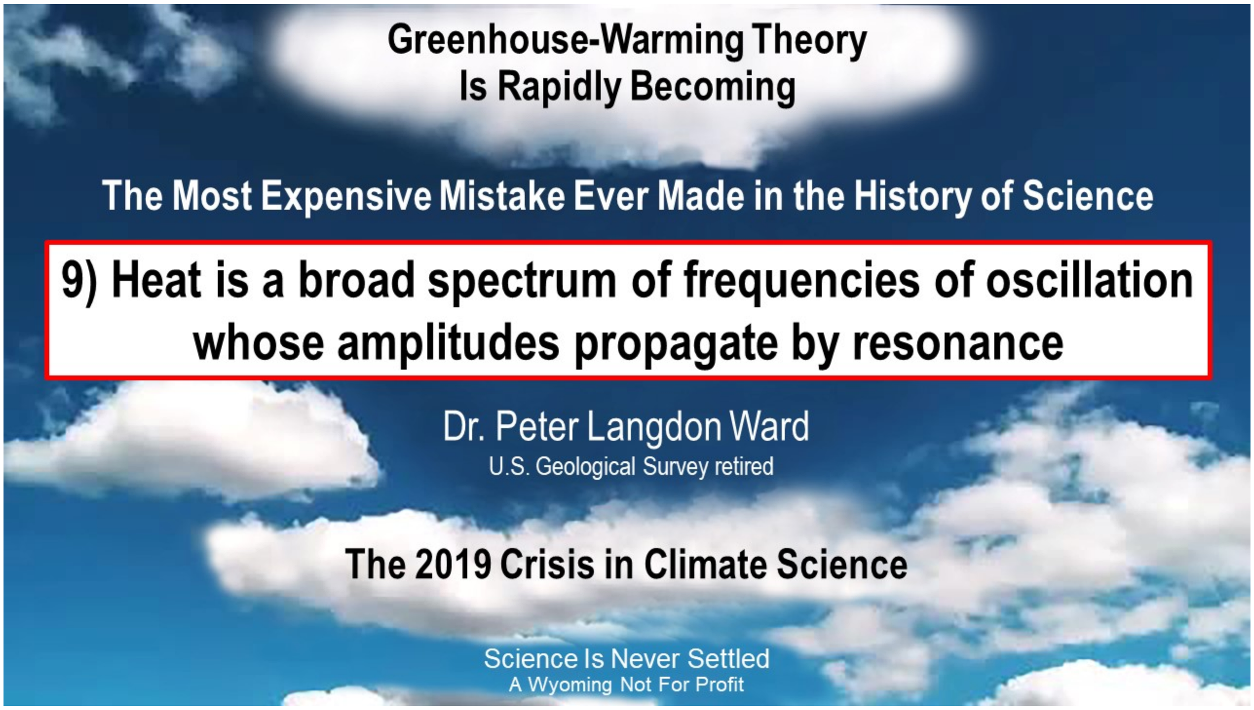
Planck's law shows us unambiguously that Earth can only be warmed physically by increases in the amplitudes of some or all of the solar frequencies of radiation reaching Earth. Greenhouse gases absorbing radiation from Earth cannot, in any way, make Earth warmer.



It is physically impossible for a body to be warmed by its own radiation.

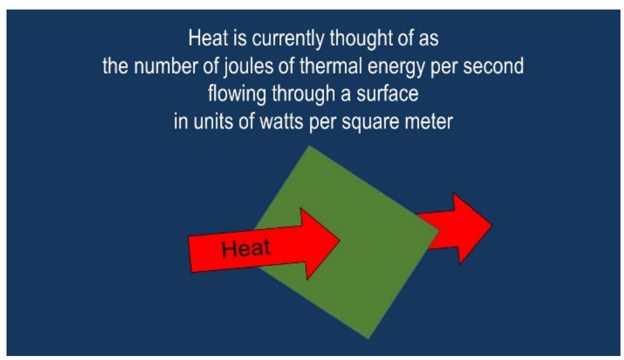


There is a way in which solar radiation reaching Earth is observed to be increased. Most solar ultraviolet-B radiation is observed to be absorbed by ozone in the ozone layer, warming the ozone layer. When there is less ozone in the ozone layer, in other words when ozone is depleted, the greater amplitudes of oscillation of ultraviolet-B radiation are observed to reach Earth, causing warming at Earth's surface and cooling of the ozone layer.



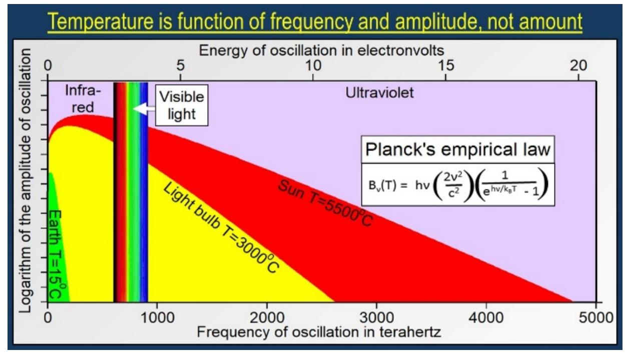
Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 9. Heat is a broad spectrum of frequencies of oscillation whose amplitudes propagate via resonance.



For at least two hundred years, physicists have considered heat to be a single number that quantifies the amount of thermal energy being transferred per second. Specifically, heat is assumed to be the number of joules of thermal energy flowing per second through some surface with units of watts per square meter. This thinking of heat as a flux in watts forms the foundation of greenhouse-warming theory, which assumes that Earth gets warmer when the amount of heat flowing from Earth back into space is less than the amount of heat flowing from Sun to Earth.

Global warming of nearly one degree Celsius, observed since 1970, is thought to have been caused by increasing amounts of greenhouse gases absorbing more and more amounts of radiation from Earth, decreasing, in one way or another, the amount of heat flowing back into space by somewhere between 0.6 to 0.9 watts per square meter. This net balance of heat flowing was described by Joseph Fourier in 1822. It seems quite logical if you think temperature of matter is a function of the net amount of heat absorbed. However, as shown in the last video, Planck's empirical law shows that temperature in matter is not a function of amount of heat. Temperature in matter is observed to be a function of a broad spectrum of frequencies and amplitudes of oscillation shown in this diagram.

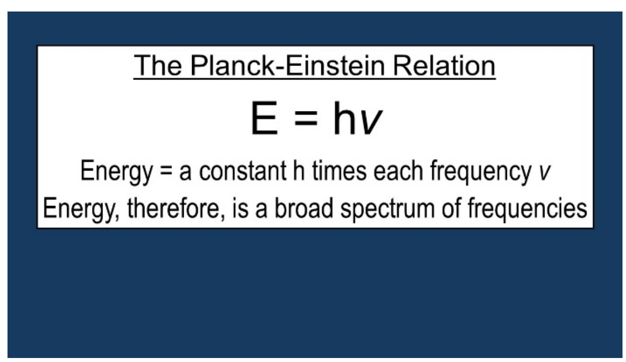


What is most surprising about the current definition of heat as simply a flow of thermal energy is that it totally sidesteps the issue of what thermal energy actually is physically, and why, physically, temperatures remain constant when there is no heat flowing.

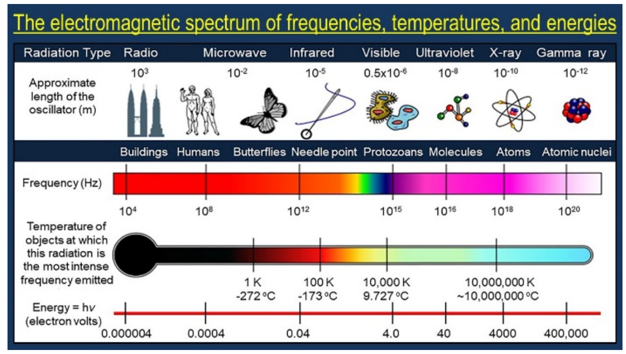
The most basic definition of heat is as follows: Heat is what a body of matter must absorb to be raised to a higher temperature and must lose to be cooled to a lower temperature. For example, the heat that Earth must absorb to become as hot as the tungsten filament of a lightbulb is shaded yellow in this plot of Planck's law. Planck's law shows clearly that heat, just like temperature, is a function of a broad spectrum of frequencies of oscillation, each with an amplitude of oscillation that is determined both by the temperature and by the difference in temperature.

Physics is about what is physically happening in Nature. How is it physically that a flow of heat causes the temperature of a body of matter to change?

When Planck worked out his law in 1900, he found it useful to postulate that thermal radiant energy E is equal to a constant h times frequency *v*, the Greek letter nu. This simple equation, E=h*v*, says that the energy of oscillation for a frictionless oscillator is equal to some scaling constant h, known as the Planck constant, multiplied by a frequency of oscillation. Thus, frequency of oscillation, physically, is the same thing as energy of oscillation. Energy of oscillation, physically, is the same thing as frequency of oscillation.

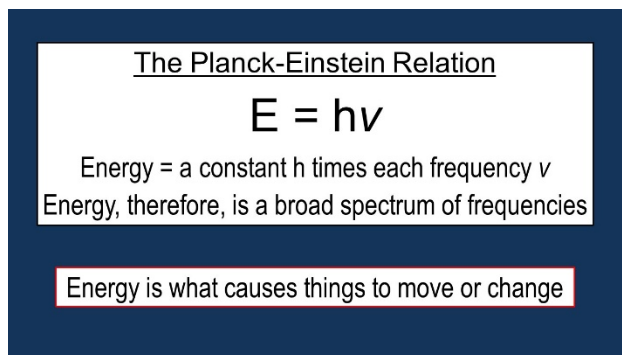


This simple equation is now known as the Planck-Einstein relation and is the universally accepted way to calculate the energy of oscillation at each frequency of oscillation throughout the whole electromagnetic spectrum ranging over twenty orders of magnitude from radio signals at cycles per second, through infrared, visible, and ultraviolet frequencies, to X-rays and to gamma rays at one hundred million, million, million cycles per second.

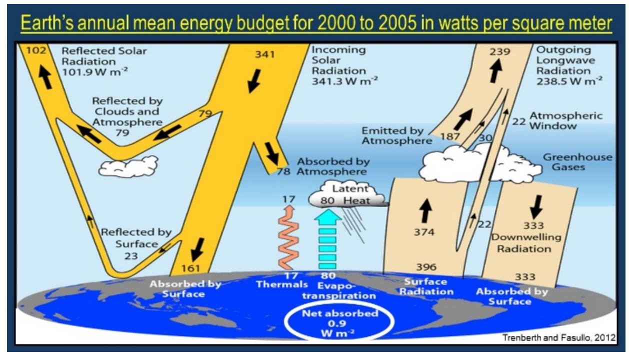


Note the smaller the oscillator, the higher the frequencies of oscillation with the greatest intensity, the higher the energies of oscillation, and the higher the temperatures associated with these oscillations. Visible light has enough energy to cause oscillation of biological cells in our eyes. Ultraviolet radiation has enough energy to break the bonds holding molecules together. X-rays have enough energy to break the bonds holding atoms together. Gamma rays have enough energy to break the bonds holding atomic nuclei together.

The concept of energy in physics has a long history and is still not crystal clear. Energy is what causes things to move or to change. Planck's law shows us that absorbing or emitting a broad spectrum of thermal energy causes temperature of matter to change. This change in temperature is proportional to the change in amplitude of oscillation at each and every frequency of oscillation.

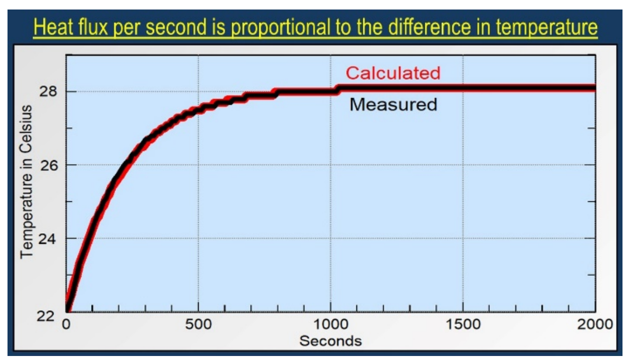


Absorbing an individual frequency of energy, E=hν, on the other hand, typically causes change in the amplitude of oscillation of certain bonds. If this individual frequency of energy is high enough, it is observed to cause chemical changes ranging from the photoelectric effect to a change in the configuration or even the destruction of certain chemical bonds holding matter together.



[This figure](#) shows Earth's annual energy budget calculated using the wide-spread assumption that heat is additive. Incoming and outgoing heat are added together to determine that the net heat absorbed is 0.9 watts per square meter shown in the white ellipse at the bottom center of this figure. This net heat absorbed is assumed to be the cause of observed global warming.

Temperature, which is the result of the flow of heat, however, is not additive. If you take two bodies of matter that are identical in every way except in temperature and connect them together so that heat can flow, the final temperature, assuming no other losses, will be the average of the two initial temperatures, not the sum. Temperatures are not additive, they are **averative**, a word I coined to specify the averaging that is observed to be physically happening in Nature.



Furthermore, heat flows in a manner that is averative. The black line in [this graph](#) shows the increase in temperature measured every ten seconds for a small piece of black metal three feet away from a light bulb after the light bulb has been turned on.

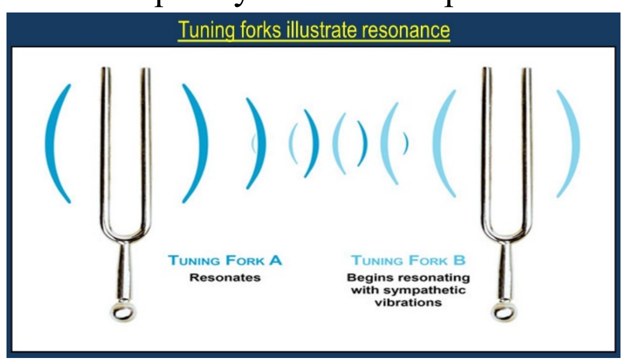
The red line shows the temperature calculated by adding 4.6% times the ending temperature of 28 degrees Celsius minus the existing temperature at each 10-second interval. The two curves are identical. The 4.6% is a function of the conductivity of both surfaces and the rate heat is being lost by the piece of metal.

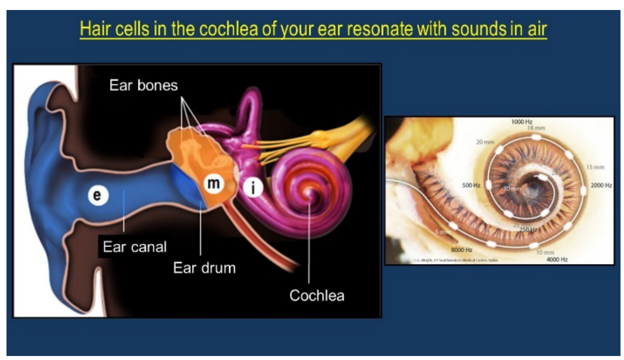
All curves of warming and of cooling have this distinctive asymptotic shape where the flux, the change in heat per second, the change in temperature per second, decreases with the difference in temperature in an averative way. How does averaging occur in Nature? How does the rate of warming or cooling "know" the final temperature of 28 degrees in this case?

The answer is [resonance](#), also known as sympathetic vibration. Resonance is a fundamental physical property of oscillating systems that is widely observed throughout Nature. When two oscillators are oscillating at the same frequency, the oscillator with the lower amplitude of oscillation is observed to gain amplitude of oscillation while the oscillator with the higher amplitude of oscillation is observed to lose amplitude of oscillation. In an ideal case, both oscillators end up with identical amplitudes of oscillation, which is the average of the two initial amplitudes of oscillation. In this way, amplitude of oscillation flows spontaneously from higher amplitude of oscillation to lower amplitude of oscillation.

Furthermore, every oscillator has certain natural frequencies of oscillation based on its size, mass, and configuration that are called resonant frequencies. When an oscillator is caused to oscillate at one of its resonant frequencies, the amplitude of oscillation can become very large, especially when the oscillator has very little or no friction, as is typical for the oscillation of all the bonds that hold matter together.

Resonance occurs when two oscillators are physically touching in some way. The simplest example is when you push a child on a swing. If you push at the same frequency as the frequency that the swing is swinging, the amplitude of oscillation of the swing will increase. Push at any other frequency and the amplitude will decrease.

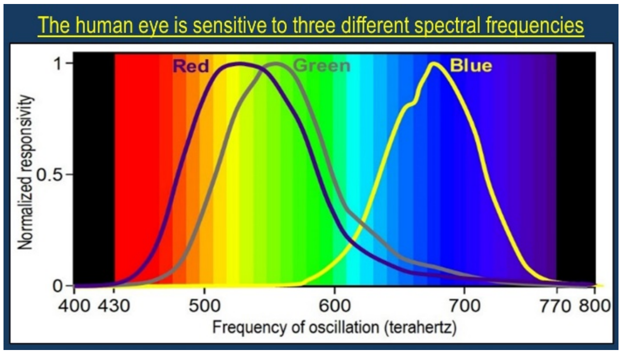




Another example of resonance is when you take two tuning forks and strike one, so it rings. The other will start ringing. They are interconnected by the sounds causing changes in air pressure. This is the same way that certain hair cells in the cochlea of your ear resonate to sounds that you hear, allowing your brain to distinguish different frequencies of oscillation.

Resonance is also observed to occur across air or space via line of sight by what we think of as being electro-magnetic radiation. Electric currents on the surface of the antenna of your favorite radio station are caused by the transmitter to oscillate at the frequency assigned by the government to that radio station. You tune your radio receiver to resonate at that specific frequency, causing your receiver to receive that specific station with much greater amplitude of oscillation than all the other radio signals that are occurring simultaneously. In the same way, thermal energy is transferred by simultaneous resonance as each and every frequency of oscillation.

Resonance is observed to happen at any distance in direct line of sight, but the density of cells on the surface that can resonate decreases with the square of the distance, making the radiation appear fainter. Fewer cells resonating means they have to share their amplitudes of oscillation with other cells on the surface.



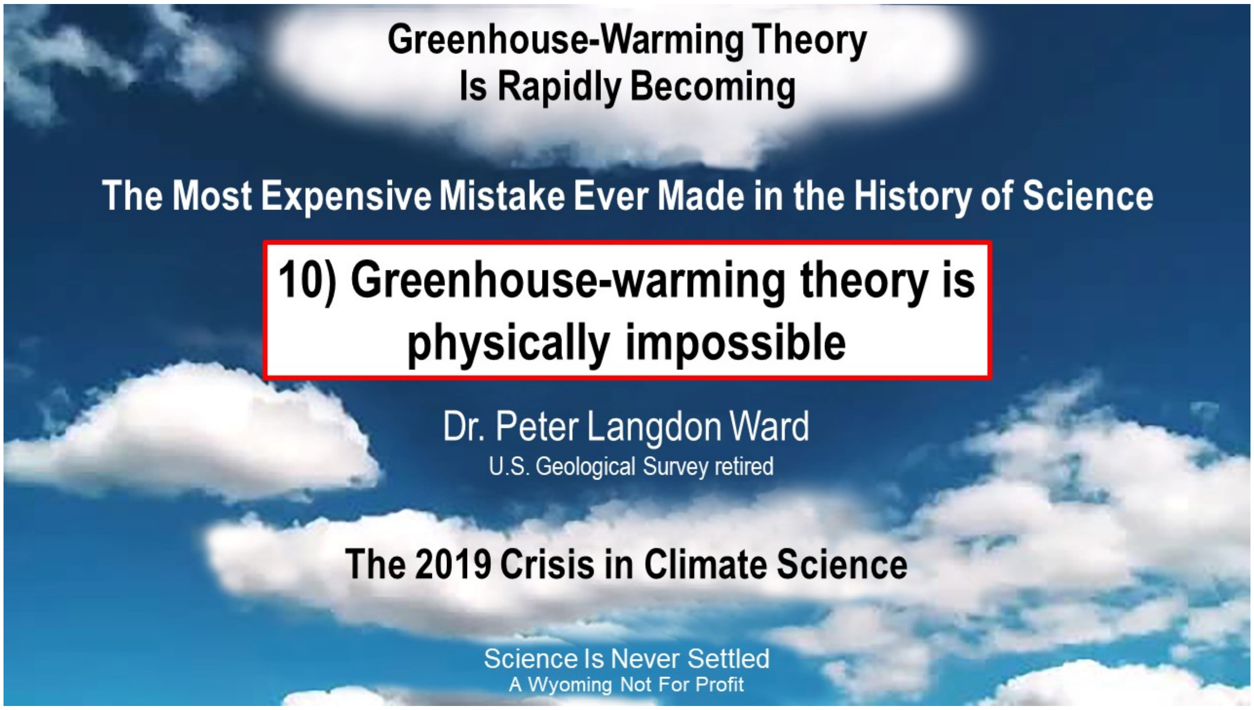
You see via resonance. Visible light has very high frequencies that are close to the natural resonant frequencies of three types of color-sensing cones in each of your eyes. Each type of cone is most sensitive to a particular part of the spectrum that, for simplicity, we will call red, green, and blue. Each of these cells resonates with different amplitudes of oscillation in response to a particular incoming color. The three amplitudes are sent as signals to our brain, which combines these three signals to distinguish approximately ten million different colors.

The RGB monitor of your computer does something similar, combining three different shades of red, green, and blue digital signals sent by the computer to allow each pixel to display one of nearly 17 million different colors. Each color has an intensity or brightness, which physically is the amplitude of oscillation of the oscillator producing that specific color.

Thermal energy is the simultaneous resonance at all frequencies of oscillation in the infrared, visible, and ultraviolet spectra, transferring amplitude of oscillation in an averative way, warming the absorbing body and cooling the emitting body.

Current concepts of heat, radiation, and radiative forcing are additive, but we observe that in Nature they are averative, which can only happen in Nature via resonance.

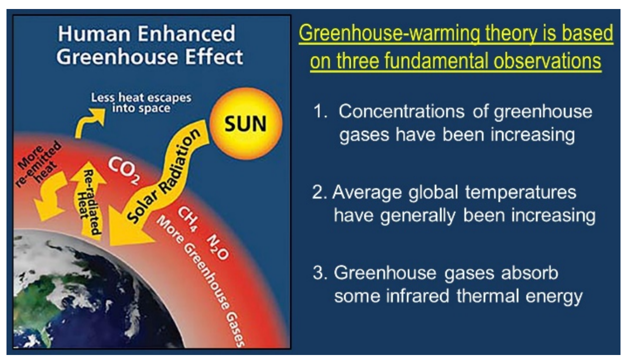
Heat, physically, is not a single number of watts per square meter as assumed today in climate science, and in physics. Heat is observed to be a broad spectrum of frequencies of oscillation whose amplitudes of oscillation propagate via resonance.



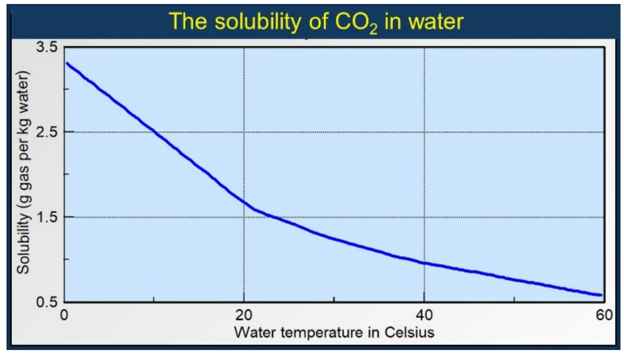
Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 10. Greenhouse-warming theory is physically impossible.

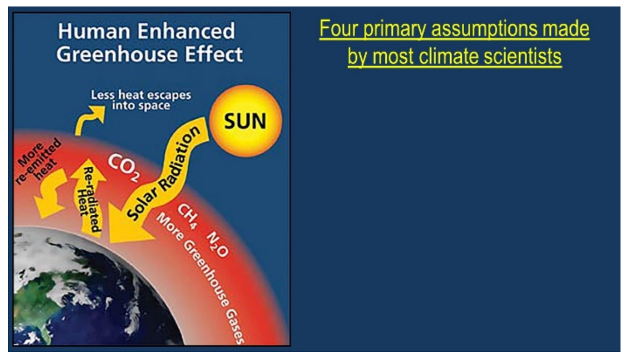
It is now clear to people with open minds that greenhouse-warming theory is not only mistaken, it is not even physically possible. Greenhouse-warming theory is based on three fundamental observations. First, atmospheric concentrations of greenhouse gases have been increasing at an ever-increasing rate since the beginning of the industrial revolution around 1750. This increase tracks known increases in the burning of fossil fuels. Second, average global temperatures have generally been increasing over the same period, although the rate of increase in temperature has been much more irregular as described in video 2. And third, greenhouse gases absorb some infrared thermal energy radiated by Earth as first observed in the laboratory by John Tyndall in 1859.

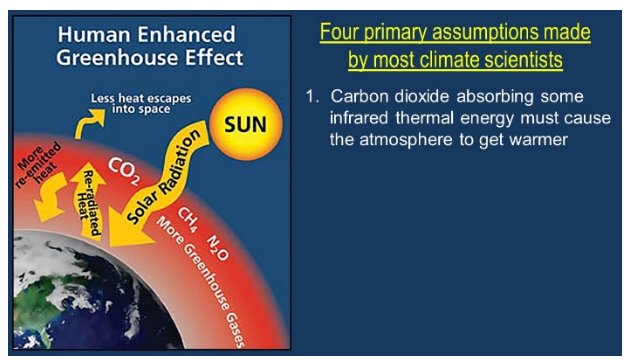


The observation that increases in greenhouse gases and increases in global temperatures are more or less contemporaneous is not proof of causation. Detailed studies in Antarctica, for example, suggest that concentrations of carbon dioxide sometimes increase as much as 400 years after increases in temperature. This suggests that a warming ocean absorbs less carbon dioxide, releasing more carbon dioxide into the atmosphere. Such release is predicted by the well-known curves of solubility of carbon dioxide in water shown by the blue line. We all observe this relationship when our beer or soda drink loses its carbon dioxide fizz as it gets warmer.

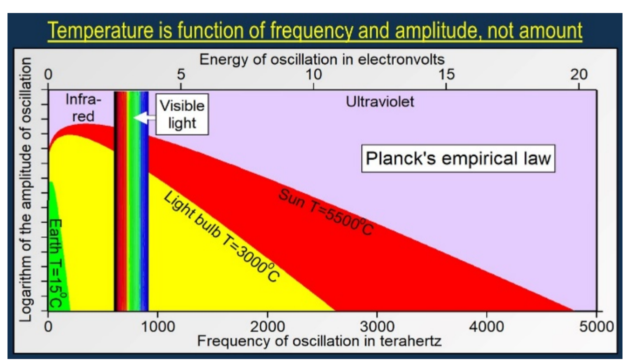


Beyond these observations, there are four primary assumptions made by most climate scientists that lead them to conclude that greenhouse-warming theory must explain reality. The first assumption is that carbon dioxide, absorbing some infrared thermal energy radiated by Earth, must cause the atmosphere to get warmer. This key assumption has never been verified by experiment as explained in video 7. In fact, in 1900, Knut Ångström, a well-known radiation physicist, showed in the laboratory and in the field that changes in concentrations of carbon dioxide do not seem to have any effect on air temperature above some minimum concentration. Furthermore, Ångström measured that carbon dioxide absorbed less than 16% of the frequencies of oscillation radiated by Earth.

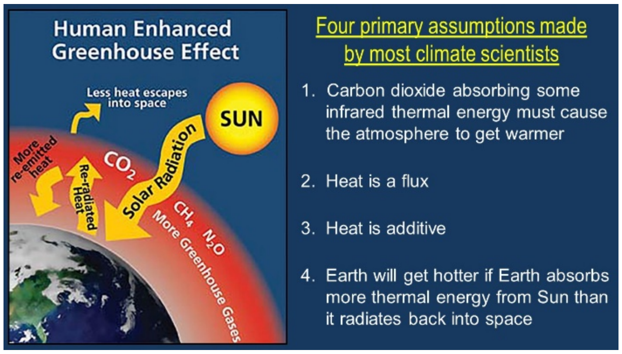




Planck's empirical law shows that a body of matter must absorb 100% of the frequencies of oscillation radiated by Earth at the amplitudes of oscillation radiated by Earth to become as warm as Earth.



We now know that carbon dioxide absorbs the infrared thermal energy into the bonds holding the molecules together. Temperature in air, on the other hand, is well-known to be proportional to the average velocity of motion of all gas molecules squared, something very different. Converting bond energy to translational motion has never been observed to be an efficient process. Furthermore, the energy absorbed by each molecule of carbon dioxide must be shared with 2500 molecules of the other gases making up air.

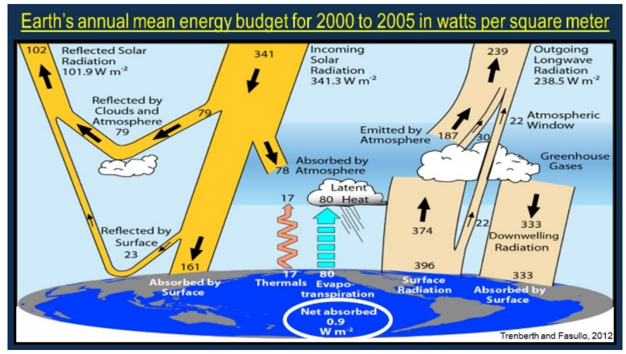


The second assumption is that heat is a flux—an amount of thermal energy that flows each second across a surface measured in units of watts per square meter. This assumption is still made today by most physicists and climate scientists even though Planck showed in 1900 that heat is a broad spectrum of frequencies of oscillation and that thermal energy at each frequency is equal to the frequency times the Planck constant. Thus, heat is a broad spectrum of energies that cannot be described accurately by a single number of watts per square meter.

The third assumption is that heat is additive—the more heat flowing into a body, the hotter the body will become. Yet the hottest a body can become is the temperature of the source of the radiation. Absorbing an infinite amount of infrared energy radiated by Earth cannot make you warmer than Earth. Yet absorbing a small amount of ultraviolet energy radiated by Sun causes sunburn. Energy is a function of frequency, not amount.

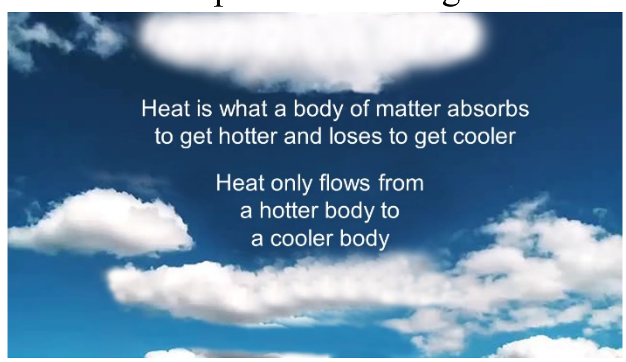
The fourth assumption is that Earth will get hotter if Earth absorbs more thermal energy from Sun than it radiates back into space. This assumption was clearly stated by Joseph Fourier in 1822 and is central to greenhouse-warming theory today as shown in this figure which implies that the global warming today is caused by a net absorption of 0.9 watts per square meter. Yet Planck's law again shows quite clearly that Earth can only get hotter by absorbing radiation from a hotter body, Sun, which contains higher amplitudes of oscillation at all frequencies of oscillation. Temperature is about the physical properties of the radiation absorbed, not the amount of some generic thing called radiation.

Note in this figure on the right, that downwelling radiation from greenhouse gases at 333 watts per square meter is more than twice the incoming solar radiation reaching Earth at 161 watts per square meter on the left.



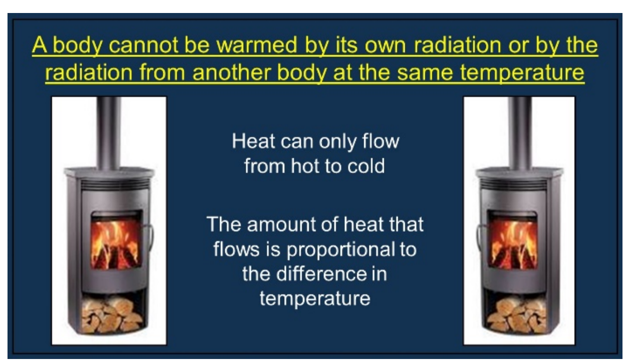
Come on folks! That just does not make physical sense. We all know that air in the lower atmosphere is heated primarily by solar radiation heating Earth's surface. That is why temperatures are hotter during the day when the sun shines than at night when infrared radiation rising from Earth is dominant.

These assumptions are all down in the details, though. If we simply step back and look at the overall flow of heat, we see several serious problems with greenhouse-warming theory. Heat is what a body of matter absorbs to get hotter and loses to get colder.



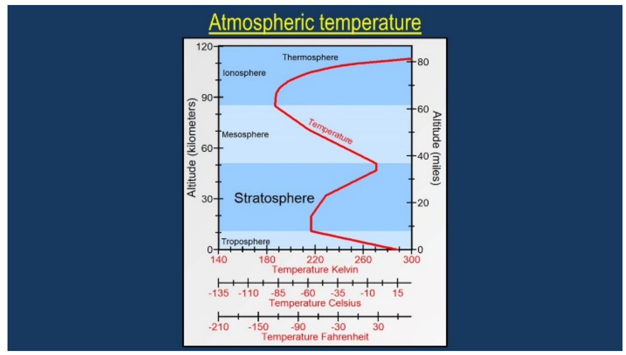
First, heat is well-observed only to flow from higher temperature to lower temperature, a reality enshrined in physics as the second law of thermo-dynamics. No exception is known. Temperature of air decreases with increasing elevation. This means that heat cannot flow from up in the atmosphere back to Earth as shown in this diagram. You cannot get warm standing next to a cold stove.

Secondly, greenhouse-warming theory assumes that radiation from Earth, absorbed by greenhouse gases, in one way or another, warms Earth. But a body cannot be warmed by its own radiation. Heat cannot flow as radiation from one body to another body at the same temperature because the amount of heat that flows is clearly observed to be proportional to the difference in temperature. Think of two wood stoves at the same temperature. Radiation from one cannot make the other hotter.

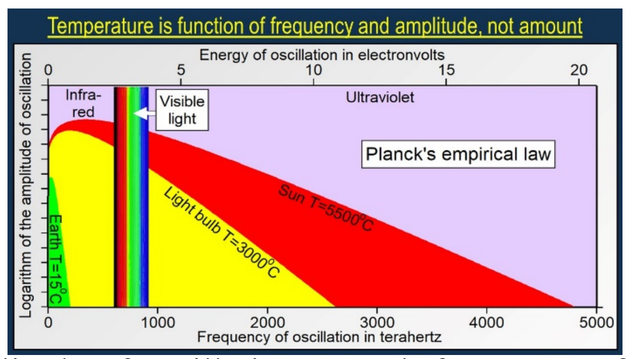


Thirdly, many climate scientists assume that greenhouse gases form a blanket around Earth that causes Earth to get warmer. Blankets are well known to slow cooling, but they cannot cause heating unless they are electric, bringing thermal energy from elsewhere.

The stratosphere acts as an electric blanket around Earth because it is heated by solar ultraviolet-C radiation dissociating oxygen and other air molecules, converting bond energy directly into velocity, which means temperature. The top of the stratosphere is observed to be approximately 36 degrees Celsius warmer than the bottom of the stratosphere.



Fourthly, most climate scientists and most physicists assume that temperature is a function of amount of radiation absorbed measured in watts per square meter. But again, Planck's empirical law shows clearly that temperature is the result of a very broad spectrum of frequencies of oscillation where the amplitude of oscillation at each frequency of oscillation increases with temperature.

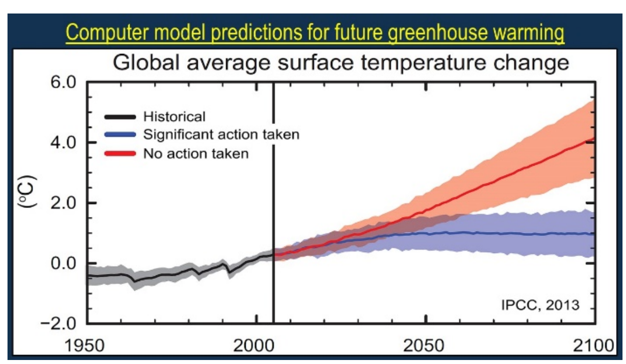


Greenhouse-warming theory is based on numerous assumptions that turn out not to be correct. Greenhouse-warming theory is not only mistaken, it is not even physically possible.

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

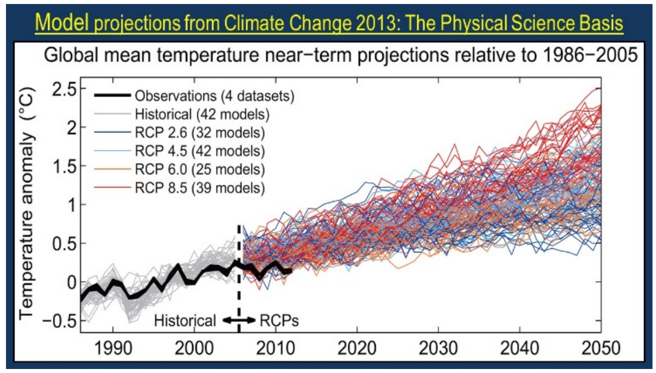
Video 11. We can burn fossil fuels safely without overheating Earth.

Average, annual global temperatures rose approximately 0.6 degrees Celsius from 1950 to 2013. Glaciers are shrinking, sea level is rising, less sea ice is forming, ice on rivers and lakes is breaking up earlier than usual, trees are flowering sooner, plant and animal ranges have shifted uphill and towards the poles, and heat waves, droughts, floods, and major storms seem to be more frequent and more severe. These changes in climate are especially severe in some areas but beneficial in other areas. The net cost of adapting to these changes in climate, however, appears to be manageable.



The reason climate scientists are saying there is a climate crisis that requires immediate attention is not because of observed warming. It is because their computer models based on greenhouse-warming theory are predicting warming of more than four degrees by 2100, just 81 years from now, within the lifetime of some of our grandchildren.

Anticipated warming is nearly seven times greater than the warming we have observed, and the warming in polar regions could be ten degrees or much more. If the models are right, the effects of global warming on life on Earth could be profound.

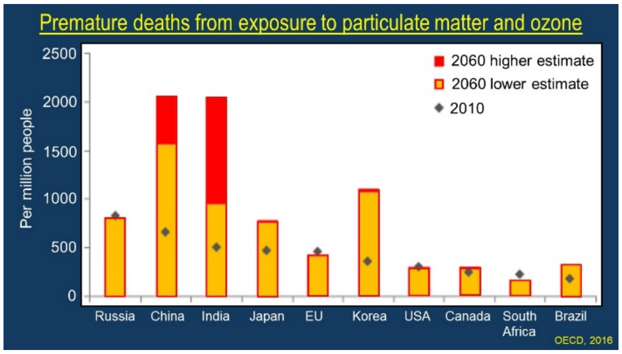


These computer models are quite sophisticated. They take hours to days of super-computer time to run. More than a dozen major global climate models have been developed by different groups of climate scientists. Each model tries to deal with most major known issues. These models have each been run through thousands of scenarios with results compared closely to available data. There have been major studies comparing the different models. Hundreds of climate scientists who have run these models and published their results admit that these are only mathematical models of a very complex system, but they genuinely believe that climate modelers are on the right track and they genuinely fear for the future of humanity.

These models, however, are all based on greenhouse warming theory. They all assume heat is quantified in watts per square meter. They calculate radiative forcings for each of the possible physical and chemical processes that could affect global temperatures. They add all these forcings together. As I have shown in these videos, it is now clear that greenhouse-warming theory is mistaken and does not even appear to be physically possible. It is now clear that heat is quantified as a broad spectrum of frequencies of oscillation. It is now clear that heat and temperature are not additive—they are averative. This all means that the climate models are based on mistaken theory and mistaken assumptions.

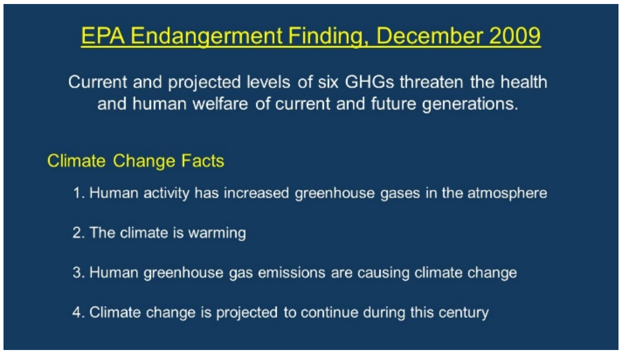
There is no scientific basis for predicting future global warming based on increasing emissions of greenhouse-gases. We may burn fossil fuels without overheating Earth.

There is no scientific reason to predict that increased burning of fossil fuels will be detrimental to humanity in any way provided we are aggressive about controlling pollution. The World Health Organization estimates that 4.2 million people die prematurely each year due to ambient air pollution which is worst in China, India, southeast Asia, and Africa.



As explained in video 3, global warming from 1975 to 1998 appears caused by depletion of the ozone layer due to manufactured CFC gases. These gases are broken down in the stratosphere to release atoms of chlorine that cause depletion of the ozone layer, allowing more solar ultraviolet-B radiation than usual to reach Earth. It will take many decades before the concentrations of anthropogenic CFC gases return to 1970 levels. During these decades, the ocean will continue to warm, glaciers will continue to melt, and sea levels will continue to rise, but the yearly effects will be smaller than what we've already observed. The long-term effect of manufacturing CFC gases will be a small increase in ocean temperature of much less than a fraction of one degree.

World temperatures rose from 1975 to 1998 due to ozone depletion caused by CFC gases and from 2014 to 2016 due to the largest basaltic eruption observed since 1783. Future warming is not anticipated unless a major new basaltic eruption occurs.



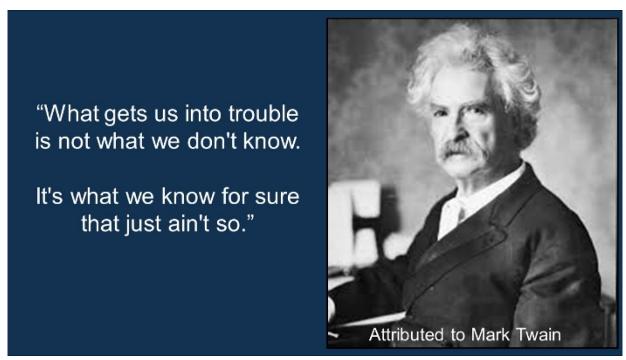
In 2009, the Environmental Protection Agency passed the Endangerment Finding under the Clean Air Act declaring that "Current and projected levels of six greenhouse gases threaten the health and human welfare of current and future generations." The finding authorizes the EPA to regulate greenhouse-gas emissions. The Finding was based on four so-called "Climate Change Facts" shown here. I have shown in these videos that facts 3 and 4 are not correct. It is physically impossible for greenhouse-gas emissions to cause global warming. There is now no scientific basis or need for EPA to regulate greenhouse-gas emissions.

We can burn fossil fuels safely without overheating Earth provided we are aggressive about reducing air pollution.

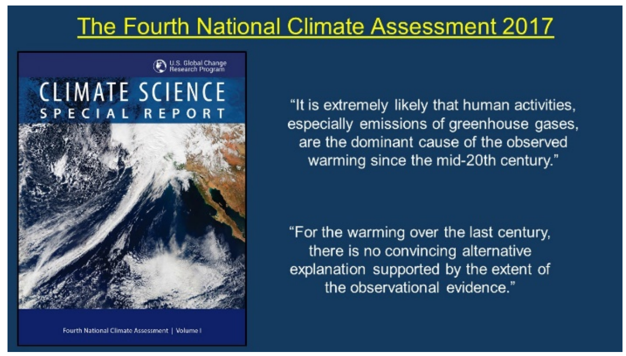
Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 12. Climate scientists refuse to face the reality that greenhouse-warming theory is mistaken.

Al Gore claims that [Mark Twain quipped] "What gets us into trouble is not what we don't know. It's what we know for sure that just ain't so." These immortal words explain precisely the 2019 Crisis in Climate Science. Climate scientists "know for sure" that increases in greenhouse-gas emissions are the primary cause of observed global warming. Meanwhile, new observations and new insights show that greenhouse-warming theory is physically impossible as explained cogently at [Physically-Impossible.com] and in video 10.



Climate scientists, being so convinced that they "know for sure", refuse to even consider the slightest possibility that there could be the slightest mistake with greenhouse-warming theory. Meanwhile governments worldwide are preparing to spend tens of trillions of dollars to reduce greenhouse-gas emissions. These efforts will almost certainly be a monumental waste of money. And they are highly likely to disrupt the availability and increase the cost of the energy that we all depend on to drive our economies and our quality of life.



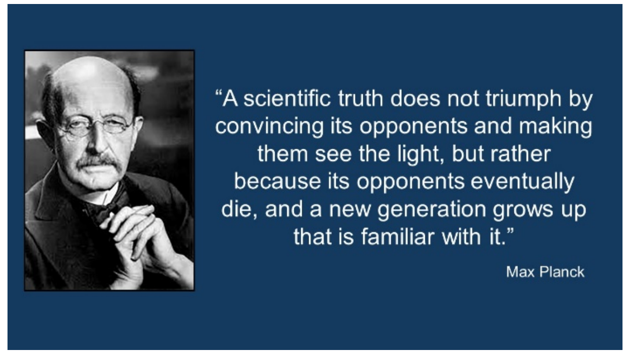
The Fourth National Climate Assessment, released by the United States Global Change Research Program in late 2017, concludes: "it is extremely likely that human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century." A second conclusion is that "for the warming over the last century, there is no convincing alternative explanation supported by the extent of the observational evidence."

I have interacted with two of the three Coordinating Lead Authors of this assessment for many years. I wrote all three, when this report was in draft form, to explain that both conclusions are demonstrably mistaken. It is physically impossible for greenhouse gases to cause significant warming as explained cogently at Physically-Impossible.com. Secondly, ozone-depletion theory explains the details of warming since the mid-20^{th} century and throughout geologic history far more directly, far more precisely than greenhouse-warming theory.

Climate scientists have underestimated the thermal effects of ozone depletion because of a fundamental misunderstanding of the physics of radiant energy. I have explained these conclusions to them and to many other leading climate scientists since 2015 in my book, in many papers, in numerous talks, and on detailed websites. No climate scientist has provided any cogent criticism of my scientific conclusions. The sad reality is that nearly all climate scientists are simply not interested in considering the possibility that there could be any problem with greenhouse-warming theory. They know for sure that greenhouse-warming theory is greenhouse-warming fact.

The even sadder reality is that peer review is broken regarding any scientific paper that questions greenhouse-warming theory. Scientists refuse to give private review. Journal editors refuse to send such papers out for review. They do not consider the possibility worth their time. As one of the lead authors explained to me "Peter, there is no way that you could be correct and all the rest of us are wrong." I responded, "Can you give me a scientific reason?" He could not.

It is only human to defend the consensus that thousands of scientists have worked hard for decades to develop. Max Planck, one of the fathers of modern physics, put it this way: "A scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." With climate, however, we do not have the time to wait. World leaders, convinced by the broad consensus of scientists, are preparing to waste trillions of dollars trying to reduce greenhouse-gas emissions.



On April 18th, 2016, I sent personal emails to more than one thousand climate journalists and more than two thousand top climate scientists who contributed to the 2013 Physical Science Basis Report issued by the Intergovernmental Panel on Climate Change. I asked them to click on a thirteen minute video where I plead with scientists to recognize that there appears to be a significant problem with greenhouse-warming theory and that we scientists have a responsibility to society to be sure that the most up-to-date science is available to those setting public policy. No response. To date, that video, readily available on YouTube, has only been watched by 2100 people.

On November 12th, 2015, I sent emails to a similar large list of reporters and scientists offering $10,000 from my children's inheritance, to the first person who can demonstrate by experiment that warming observed since 1970 could be physically explained by the observed increase in carbon dioxide. No one has shown any interest, and no one has yet demonstrated by experiment that greenhouse-warming theory is even physically possible. My offer still stands.

Over the past five years, I have written to the leaders of numerous scientific organizations arguing that we need to bring back genuine scientific debate to climate science. None have responded seriously.

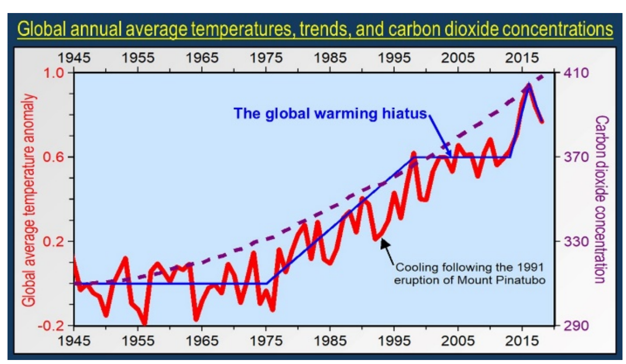
I am the only scientist I know who has rented a booth in the exhibit hall of major national science conferences to discuss science. I have now interacted with more than 7000 scientists in this way over four years at four annual meetings of the Geologic Society of America, four annual meetings of the American Geophysical Union, four annual meetings of the American Meteorological Society, and two annual meetings of the American Association of Petroleum Geologists. This effort has led to some very interesting discussions.

I have done more than 140 radio shows discussing climate change.

One major problem is that climate scientists are tired of arguing with a very vocal minority of climate skeptics who claim that there has been no warming or claim that observed warming is natural and certainly has not been caused by humans. Most climate scientists do not think these arguments by skeptics are based on sound science. Many of these skeptics have strong conservative and even libertarian political views against any type of government regulation. Some are funded by energy companies who also wish to limit government regulation. Climate scientists have thus come to assume that anyone questioning greenhouse-warming theory must be one of those damned skeptics and should be ignored.

Some scientists have even tried to penalize any skeptic or any journalist who described the arguments from any skeptic not agreeing with "the consensus." They blame the skeptics for warping the public mind as documented in polls showing only 26% of Republicans believe Earth is warming mostly due to human activity as opposed to 75% of all Democrats.

The essence of human beings is not their ability to reason but their ability to rationalize. From 1998 to 2013, temperatures did not rise very much while concentrations of carbon dioxide kept increasing, suggesting that greenhouse-warming theory may not be correct. This period became known as "the global warming hiatus." Hundreds of climate scientists have written peer reviewed papers arguing that this 15-year hiatus was statistically normal, that the



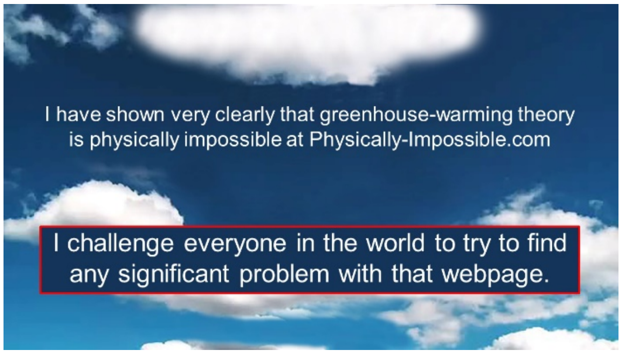
climate system is complex, that there are many feedbacks that make it more complex, that the long-term trend is still upward, and that warming will "return with a vengeance". These arguments are all grasping at straws.

The primary reason climate scientists are reluctant to consider what I am describing and documenting is because it involves a fundamental revolution in physics. This revolution could be the greatest revolution in the history of science, measured by its economic and political effects. I am showing, based on very straightforward observations of nature, that light, electromagnetic radiation, and heat are each a broad spectrum of frequencies of oscillation that travel through space via resonance, not as waves, not as photons.

Max Planck in 1900 came very close to describing these conclusions, but he, along with all other physicists at the time, confused brightness or intensity of radiation with energy of radiation. Even though Planck postulated that energy equals a constant times frequency, he saw this as a mathematical convenience and did not think about what was physically happening.

It may take years for physicists to come to agree with what I have shown about radiation because it has huge negative implications for quantum mechanics and particle physics. But again, my conclusions are based on very straightforward observations of nature that you and anyone else can make for yourself.

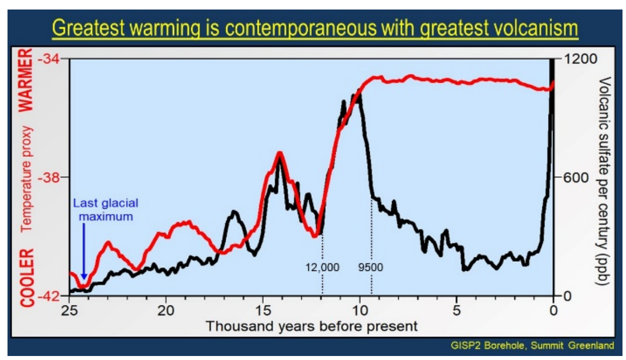
A very large consensus of scientists is currently urging political leaders to spend trillions of dollars right now to reduce greenhouse-gas emissions. I have shown very clearly that greenhouse-warming theory is physically impossible. I challenge anyone in the world to try to find any significant problem with the webpage Physically-Impossible.com.



This is not the time for scientists to stick their heads in the sands of consensus. It is time for them to debate the science, which in hindsight, is remarkably clear. Ignoring reality is no longer scientifically, economically, or politically acceptable.

Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

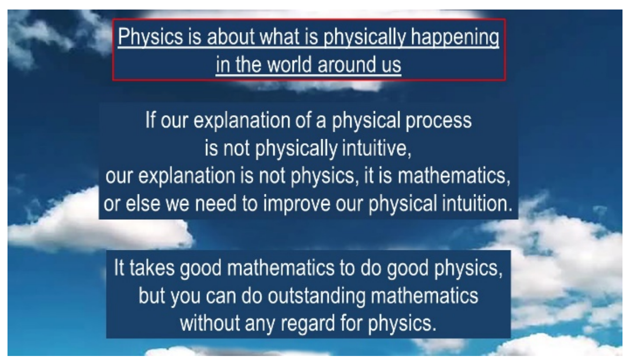
Video 13. Where did this revolution in science come from?



In 2006, as explained in video 5, I stumbled on detailed data on Internet from ice cores [drilled under Summit Greenland](), showing that the greatest volcanism recorded in Greenland ice was contemporaneous with the greatest warming at the end of the last ice age. This did not make sense. Large, explosive volcanic eruptions are well-known to cause cooling. How could volcanic eruptions also cause warming?

Having studied volcanoes all my life, I became fascinated and ultimately consumed by the quest for new understanding. I had a clear instinct that figuring this enigma out could be very important. Being retired and self-funded, I was able to follow the data wherever they led without concern for time, funding, promotions, office dynamics, committee meetings, writing proposals, or the need to defend any existing theories concerning climate change. My only concern was to satisfy my own curiosity, doing the best science I could—just trying to understand what is happening physically in the world around us.

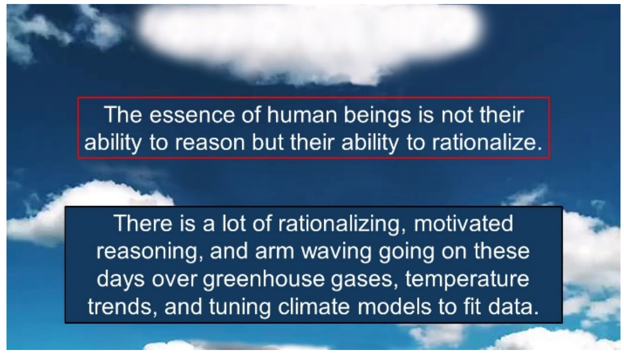
I soon put aside nearly everything else in my life, concentrating full time on many different disciplines including climate science, atmospheric chemistry, radiation physics, volcanology, and paleoclimatology, consulting more than ten thousand papers, shelves of books, and hundreds of websites over thirteen years. Perhaps most valuable, I could just let things simmer, becoming comfortable with a whole lot of unknowns. There was no need to jump to conclusions because there were no deadlines. I had the chance to explore conflicting views and to regularly question my own emerging views especially as they began to diverge from majority views.



I am a rather pragmatic, field geophysicist who believes firmly that physics is about what is physically happening in the world around us. If our explanation of a physical process is not physically intuitive, our explanation is not physics, it is mathematics, or else we need to improve our physical intuition. It takes good mathematics to do good physics, but you can do outstanding mathematics without any regard for physics. I understand clearly the value of mathematical equations, but I see them as tools, not as conclusions. Most equations are built on a suite of simplifying assumptions that must always be remembered. We often must make assumptions in science in order to move forward. The trick is to remember what is an assumption and what is a direct observation.

In science, we typically make observations of something that has happened or is happening and then try to determine the cause. There are typically many possible causes that can be described by many different systems of mathematical equations. The problem is to determine the actual cause, which may or may not be included in the causes we are considering. I have also come to realize, like many other scientists, that the more complicated the explanation, the less chance it describes accurately what is actually happening physically in Nature.

If there is a lot of arm waving going on, be suspicious. The essence of human beings is not their ability to reason but their ability to rationalize. There is a lot of rationalizing, motivated reasoning, and arm waving going on these days over greenhouse gases, temperature trends, and tuning climate models to fit data.



As I dug deeper, things started to unravel. Over the years I have asked myself many fundamental questions. What holds matter together? Are these bonds rigid? What is thermal energy in matter? What is temperature in matter? What is temperature in air? What is temperature in space? How does thermal energy radiate spontaneously? What is thermal radiation? How does radiation travel? Radiation cannot physically travel in space as waves, because waves are the deformation of matter, and there is no matter in space. Electromagnetic radiation is well-observed to be a continuum of frequencies of oscillation covering more than 20 orders of magnitude from radio signals to gamma rays. How could a continuum travel as photons? Is there a different photon for every decimal place? What happens physically when a photon of light interacts with a molecule of gas? How and why are spectral lines of absorption formed? What physically are an electric field, a magnetic field, and an electromagnetic field? What physically is resonance? How does resonance work? How do life forms sense and interact with the world around them? How do we see, hear, taste, smell? How does solar energy interact with Earth's atmosphere? What warms the stratosphere? What forms the ionosphere? What forms the ozone layer? What frequencies of solar radiation are absorbed in the upper atmosphere and why? How do ozone concentrations vary through time, latitude, and region?

There were new questions every day. Some of them took years to answer. Others still have not yet been answered adequately. I was impressed how many of these fundamental questions had not been addressed adequately in the scientific literature. Many were described by mathematical equations that many times just did not feel right to me.

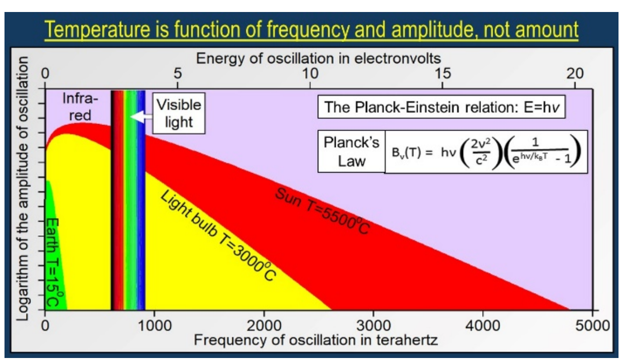
The confusion over waves and wavelengths was and still is widespread. We cannot see radiation. Why do we insist in explaining something we cannot see in terms of things we can see, or at least visualize, such as waves and particles? Wave frequency equals the velocity of light divided by wavelength. But frequency of oscillation is something very different from wave frequency.

Greenhouse-warming theory is built on the assumption that greenhouse gases absorbing infrared thermal energy get warmer or somehow warm Earth. But less than 16% of the frequencies making up terrestrial energy are absorbed into the bonds of the trace amounts of greenhouse-gas molecules, which has essentially zero effect on the temperature of a gas. Ångström showed this in 1900. This assumption of greenhouse warming has never been validated by experiment, a cornerstone of the scientific method. I did an experiment in 2017, as explained in video 7, that measured no difference in the temperature of air containing more than 23 times normal concentrations of carbon dioxide.

Climate scientists and climate models calculate that there is a greater amount of infrared energy than ultraviolet-B radiation. This led me to realize that heat is not about amount, it is about the difference in temperature between the source and the absorber. Furthermore, we know that ultraviolet-B radiation has about 50 times the energy of infrared radiation absorbed most strongly by carbon dioxide no matter the amount. Radiant energy is a function of a broad spectrum of frequencies, not a single amount of watts per square meter.

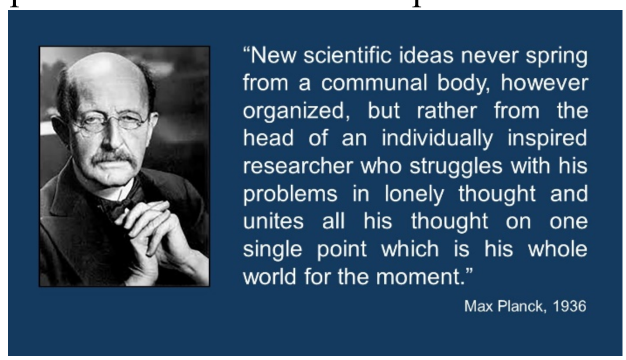
Current ways of calculating heat work reasonably well for systems with similar temperatures, but they fail catastrophically in climate calculations where Sun is twenty-times hotter than Earth.

Physicists in the late 19th century and still today think of the brightness or intensity of radiation as the energy. Therefore, Planck's law, as originally formulated, plots energy as a function of wavelength. Yet Planck postulated, when writing out his law, that radiant energy is equal to frequency times the Planck constant. He saw this as a neat mathematical trick and never thought about the fact that if energy is a function of frequency, energy must be plotted on the x-axis, the same axis as frequency or wavelength.



Planck's law stood out as an experimental triumph relating temperature to a broad spectrum of frequencies, but Planck and experimental physicists in the late 19th century were confused between energy and intensity or amplitude of oscillation. Physicists thought they were measuring energy when they were actually measuring amplitude of oscillation, which we perceive as brightness or intensity. In many ways, my primary contribution to physics is to bring improved understanding to the Planck-Einstein relation and to Planck's law. This has major implications for climate change, for quantum physics, for particle physics, and for identifying a theory of everything.

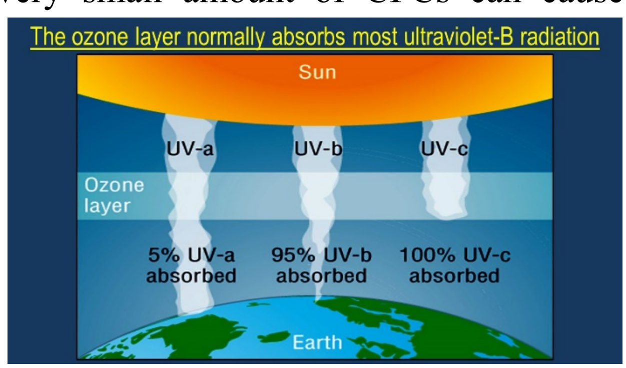
These thirteen years have been incredibly stimulating as I worked systematically through many, many issues, just trying to explain observations of Nature. I was surprised to find that very few physicists have actually thought critically about the physics of greenhouse-warming theory. Having the time and the space to wonder and having an insatiable curiosity has helped me understand and experience what Planck said in 1936: "New scientific ideas never spring from a communal body, however organized, but rather from the head of an individually inspired researcher who struggles with his problems in lonely thought and unites all his thought on one single point which is his whole world for the moment."



Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science

Video 14. What actions should we take now to reduce global warming?

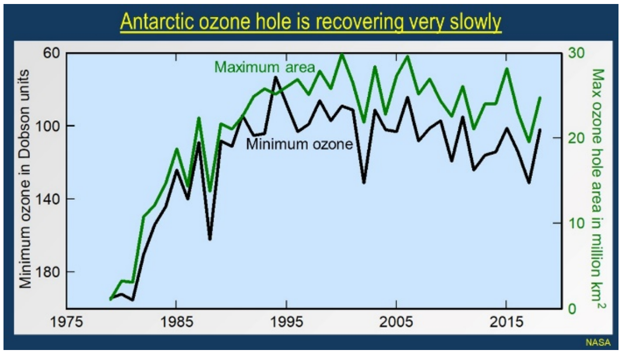
We need to improve enforcement of the Montreal Protocol on Substances that Deplete the Ozone Layer especially for chlorofluorocarbon gases known as CFCs. CFCs became very popular in the 1960s because they were cheaper, more effective, and safer to use than alternatives for spray-can propellants, refrigerants, solvents, and foam blowing agents. CFCs are very stable gases that do not interact with most other gases or materials until they are broken down in the stratosphere by very energetic, solar, ultraviolet radiation, releasing atoms of chlorine. What makes CFCs so damaging for climate is that only one atom of chlorine, under very cold conditions in the stratosphere typical in winter months, can lead to the destruction of more than 100,000 molecules of ozone. Thus, a very small amount of CFCs can cause significant depletion of the ozone layer—the Achilles heel of climate change.



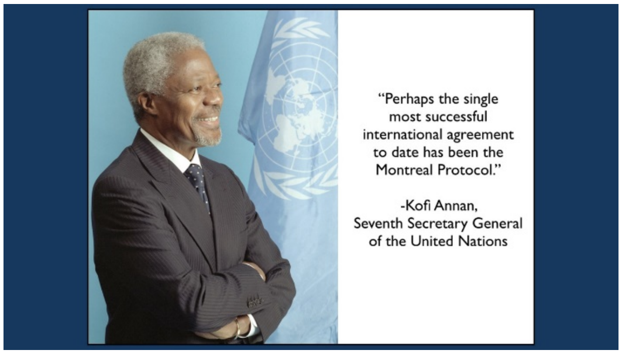
The ozone layer normally absorbs most ultraviolet-B radiation from Sun, protecting life on Earth from this very hot radiation. When ultraviolet-B radiation reaches Earth, it causes global warming, crop damage, and increasing risk of sunburn, cataracts, depression of the immune system, and genetic damage that can lead to skin cancer and mutations.

Major increases in production of CFCs in the 1970s and 1980s led to depletion of the ozone layer and global warming of about 0.6 degrees Celsius. As long as CFC production was increasing, ozone depletion and average global temperatures were increasing. When CFC production was severely curtailed as a result of the Montreal Protocol, ozone depletion and global temperatures stopped increasing, but both have remained high.

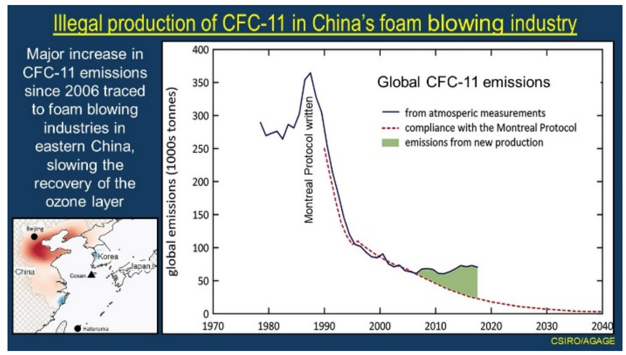
Ultraviolet-B penetrates oceans hundreds of feet and thus continues to increase ocean heat content very efficiently. Ultraviolet-B sunburns plankton and coral reefs. Ultraviolet-B also sublimes snow and melts glaciers. As a result, sea level continues to rise.



The other problem with CFCs is that they last in the atmosphere for many decades. Since 2000, stratospheric ozone has been recovering at a very slow rate of one to three percent per decade. The Antarctic ozone hole is recovering very slowly. Total column ozone over Antarctica is not anticipated to return to 1980 levels for at least another forty years. However, this recovery could be delayed. The longer it takes for the ozone layer to recover, the hotter the oceans will become, which means the hotter Earth will become. But the rate of warming the ocean is very slow compared to the rates predicted for greenhouse-warming of air because of the huge heat content of oceans.



The Montreal Protocol is one of the greatest success stories of international environmental diplomacy, stopping the increases in ozone depletion and global temperatures within a decade after it took effect in 1989. While there were alternative gases that did not deplete ozone, converting existing air conditioners, refrigerators, and freezers to use these gases cost hundreds of dollars for each home-sized unit and for each automobile. A major feature of the Montreal Protocol was to phase out CFCs faster in developed countries. This led to a thriving black market for CFCs legally manufactured in developing countries but illegally diverted to developed countries for maintenance of existing equipment. By the mid-1990s, CFCs were the second largest illegal import via Miami, second only to cocaine. Illicit trade in ozone-depleting substances has been a significant problem, slowing recovery of the ozone layer. Continued vigilance is required.



In 2010, production of CFCs became illegal in China. In 2018, however, scientists measured atmospheric concentrations of CFC-11 in eastern China that suggested a major increase since 2012. The Environmental Investigation Agency traced the source to at least 18 factories producing polyol blend rigid foam used widely for insulation of buildings. The manufacturers admitted that they knew CFC use was illegal, but it was cost effective and it was utilized by all their competitors. After this illegal manufacturing attracted international attention, the Chinese government has improved enforcement of the Montreal Protocol.

Shorter lived ozone-depleting substances such as chloroform and dichloromethane had not been included in the Montreal Protocol because their effects did not appear to be that important. But production levels have now increased such that they are delaying recovery of the ozone layer by at least a few years.

There is considerable research needed to fully understand the precise chemical path and how chlorine and bromine atoms are carried up into the stratosphere both from man-made sources and especially from effusive, basaltic volcanic sources. There is still much to learn about the details of ozone depletion and of atmospheric mixing at different latitudes and different seasons of the year. Can we discover ways to speed recovery of the ozone layer?

When ozone is depleted, more solar, ultraviolet-B radiation reaches Earth where it dissociates ground-level ozone pollution, warming air in highly populated and industrialized regions. As the ozone layer recovers, less ultraviolet-B radiation will reach Earth, destroying less ground-level ozone. This this very toxic, ground-level ozone pollution could become a greater problem.

The greatest problem for humanity, though, from burning fossil fuels, is air pollution. Currently, at least [4.8 million premature deaths] occur every year as a result of exposure to air pollution. Pollution is greatest in China, India, much of southeast Asia, and Africa. Currently, 91% of the world's population lives in places where air quality exceeds limits recommended by the World Health Organization. Ground-level ozone pollution is currently destroying [21% of India's wheat crop and 6% of its rice].

Since the 1970s, we have reduced ground-level ozone and other pollution in the United States, but many cities are not currently meeting EPA guidelines. [This newspaper story] in the Los Angeles Times on July 1, 2019, documents how air quality in Los Angeles is slipping once again.


The war on Southern California smog is slipping.
Fixing it is a $14-billion problem

By Tony Barbosa and Rahul Mukherjee

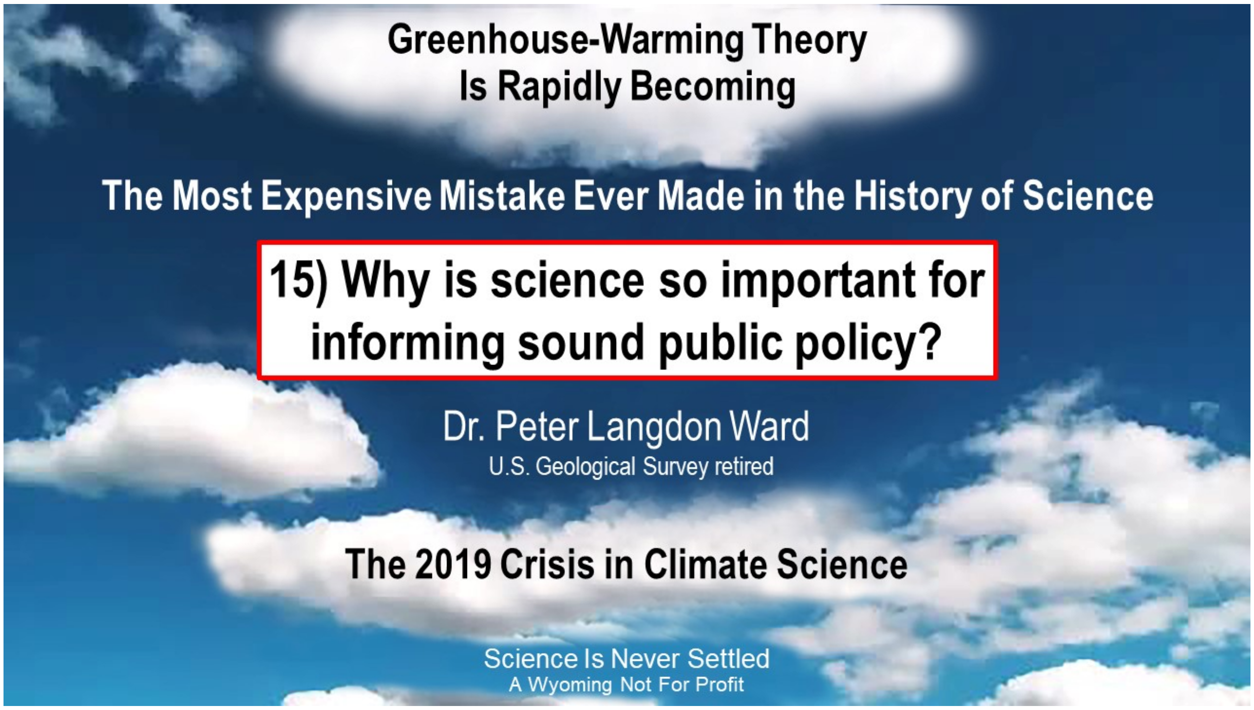
Los Angeles Times July 1, 2019

The war on smog has been called one of America's greatest environ-mental successes. Decades of emissions-cutting regulations under a bipartisan law — the 1970 Clean Air Act — have eased the choking pollution that once shrouded U.S. cities. Cleaner air has saved lives and strengthened the lungs of Los Angeles children.

But now, air quality is slipping once again.

Air quality has slipped in recent years, and regulators are falling far short of raising billions they say is needed to clean ozone pollution in time to avoid tough economic sanctions. Here, smog hangs over downtown Los Angeles in 2018. (Wally Skalij / Los Angeles Times)

We have the technology to reduce these losses substantially and the cost is far less than trying to reduce greenhouse-gas emissions.



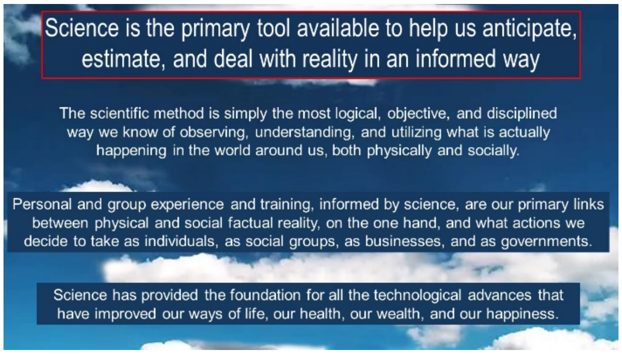
Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

Video 15. Why is science so important for informing sound public policy?

Your survival and especially your quality of life are dependent on how well you turn lemons into lemonade. How well you anticipate, adapt to, and succeed in dealing with physical and social reality.

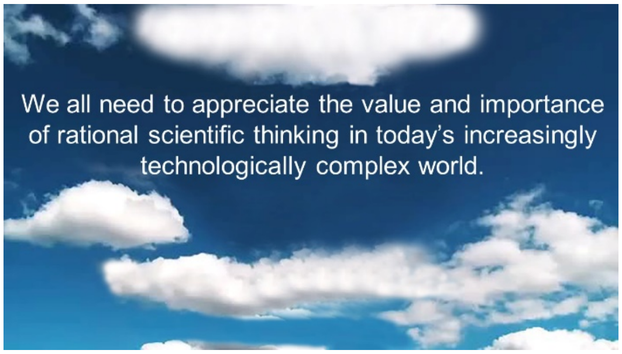
Reality is what actually happens in life whether we like it or not. Reality for a farmer is the number of bushels of grain sold, times the price per bushel paid, minus all the costs of growing the grain. Reality for a regulation limiting air pollution is by how much the health and quality of life for those affected is actually improved and by the number of premature deaths prevented each year. Reality in climate change is when, where, and by how much climate has changed throughout Earth history and how it actually changes in the future. Reality for a politician is the number of votes received. The ultimate reality for lovers is a baby.

Science is the primary tool available to help us anticipate, estimate, and deal with reality in an informed way. The scientific method is simply the most logical, objective, and disciplined way we know of observing, understanding, and utilizing what is actually happening in the world around us both physically and socially. The scientific method is also the most effective way for groups of people to work together in search of ultimate truth.



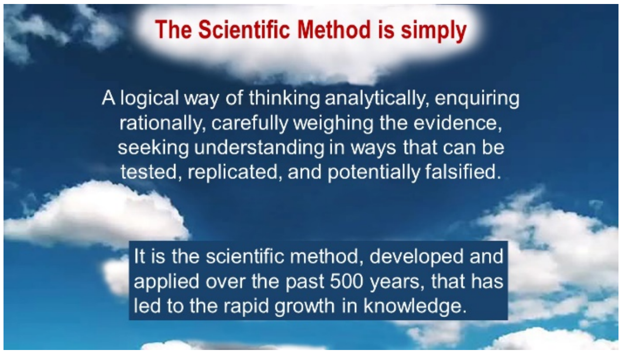
Personal and group experience and training, informed by science, are our primary links between physical and social reality, on the one hand, and what actions we decide to take as individuals, as social groups, as businesses, and as governments. Science has provided the foundation for all the technological advances that have improved our ways of life, our health, our wealth, and our happiness. As technology plays a larger and larger role in all aspects of our daily lives, we are becoming more and more dependent on science for informing our actions so that we can respond in the most effective ways.

Unfortunately, a majority of people do not understand science, are intimidated by it, are fearful of it, or would just rather believe what they want to believe. Some are turned off by the mathematics. Artists are better at art because they have had extensive training and spend hours every day practicing their art. Similarly, musicians are better at music, lawyers are better at law, and scientists are better at science. But we all need to appreciate the value and importance of rational scientific thinking in today's increasingly technologically complex world.



Scientists have a passionate desire to get it right—to separate fact from fiction—to separate reality from belief—to understand the reality of how things actually work in Nature. The closest thing to truth in science is a clear observation of what is happening in Nature—a clear observation of reality that does not require assumptions or theories to understand and replicate.

Scientists are fallible humans. Some do their job better than others. Some are more curious than others. Most excel in detail; some have a broader overview. Each has their own personal worldview. Each has their own political leaning. Each has their own religiosity. Each has their own prejudices. But what unites all scientists is the scientific method, which is simply the most logical way of thinking analytically, enquiring rationally, carefully weighing the evidence, seeking understanding in ways that can be tested, replicated, and potentially falsified.



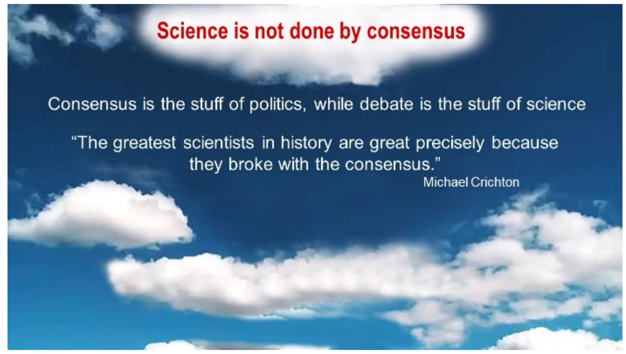
Most scientists are highly curious and as persistent as their work environment will allow. It is the scientific method developed and applied over the past 500 years that has led to the rapid growth in knowledge. This knowledge has allowed world population to increase by more than a factor of thirteen while constantly improving food supply, quality of life, health, and robust global economies.

Scientists try to determine cause by observing effects. They try to build upon current understanding by making detailed observations, hypothesizing causes, and proposing theories. As Carl Sagan, famous astronomer and science educator said: "There are many hypotheses in science which are wrong. That's perfectly all right; they're the aperture to finding out what's right. Science is a self-correcting process. To be accepted, new ideas must survive the most rigorous standards of evidence and scrutiny."

Scientists are acutely aware of uncertainty as they build understanding on what is already known. They know, for example, that we have working models for light, heat, electrons, atoms, DNA, gravity, to name a few, that appear to explain most observations. They also know that these working models may be improved in the future by utilizing new observations and new insights. But all scientists know there is little in reality that is 100% certain except for death and taxes.

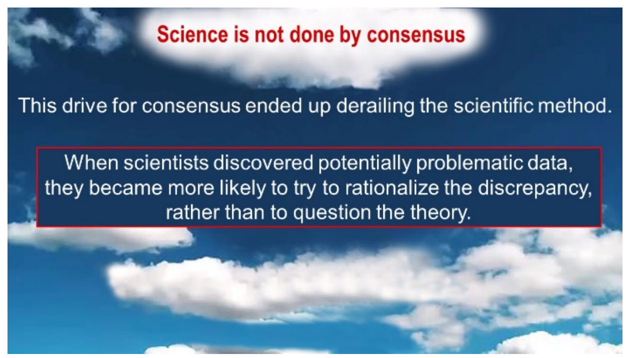
Conservative commentators like to emphasize uncertainty—that scientists are not sure about this or that. This shows a fundamental misunderstanding of the scientific method. Scientists seek perfection but can only approach it step by step. Scientists, therefore, try hard to estimate their uncertainty, which allows users of scientific information to estimate how important a given conclusion is likely to be for them and to react accordingly. A good example is a weather forecast: there is a 30% chance that it will rain in your neighborhood tomorrow and the temperature high tomorrow will most likely be seventy degrees.

Science is becoming more and more of a team effort—large groups of scientists working together with expensive equipment. New ideas, however, can easily be suffocated by groupthink. The digital revolution is making it easier for individuals to examine group data without group pressure. Remember it was the instant availability of ice core data on the Internet that got me started on the research and the revolution described in these videos.



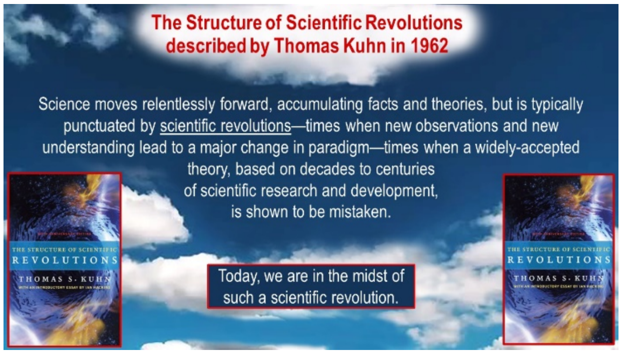
Science is not done by popular vote. Science is not done by consensus. Consensus is the stuff of politics while debate is the stuff of science. Consensus among scientists is thought by many to reduce the estimated uncertainty, but it does not prove the conclusion is correct. As Michael Crichton put it: "The greatest scientists in history are great precisely because they broke with the consensus."

If greenhouse-warming theory had turned out to be physically correct, this drive for consensus in order to spur political action would have been judged heroic by history. But this drive for consensus ended up derailing the scientific method. When scientists discovered potentially problematic data, they became more likely to try to rationalize the discrepancy, rather than to question the theory. Debate is the stuff of science even when there is a very broad consensus that Earth is flat, or Sun revolves around Earth.



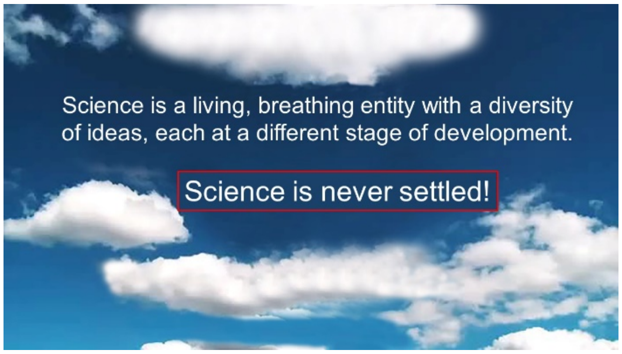
Scientists typically describe their observations, assumptions, theories and conclusions in scientific papers that they usually send to their friends for review. Many employers require internal scientific review. Then scientists submit these papers to scientific journals whose editors send them out for review. Most scientists crave peer review to help them produce quality results and to be sure they have explained their work as clearly as they can. Peer review works especially well for detailed studies where there are a handful of other scientists working in the same detailed field.

Most scientists are specialists, and when reading papers outside of their specialty, like to know that at least some specialists in the paper's science have provided peer review. Unfortunately, peer review breaks down for broad papers that bring together information from several specialties. Most reviewers do not feel competent to review all the specialties involved. Even more problematic, peer review often breaks down for truly novel papers, especially when editors reject high-quality but controversial papers without sending them out for review.

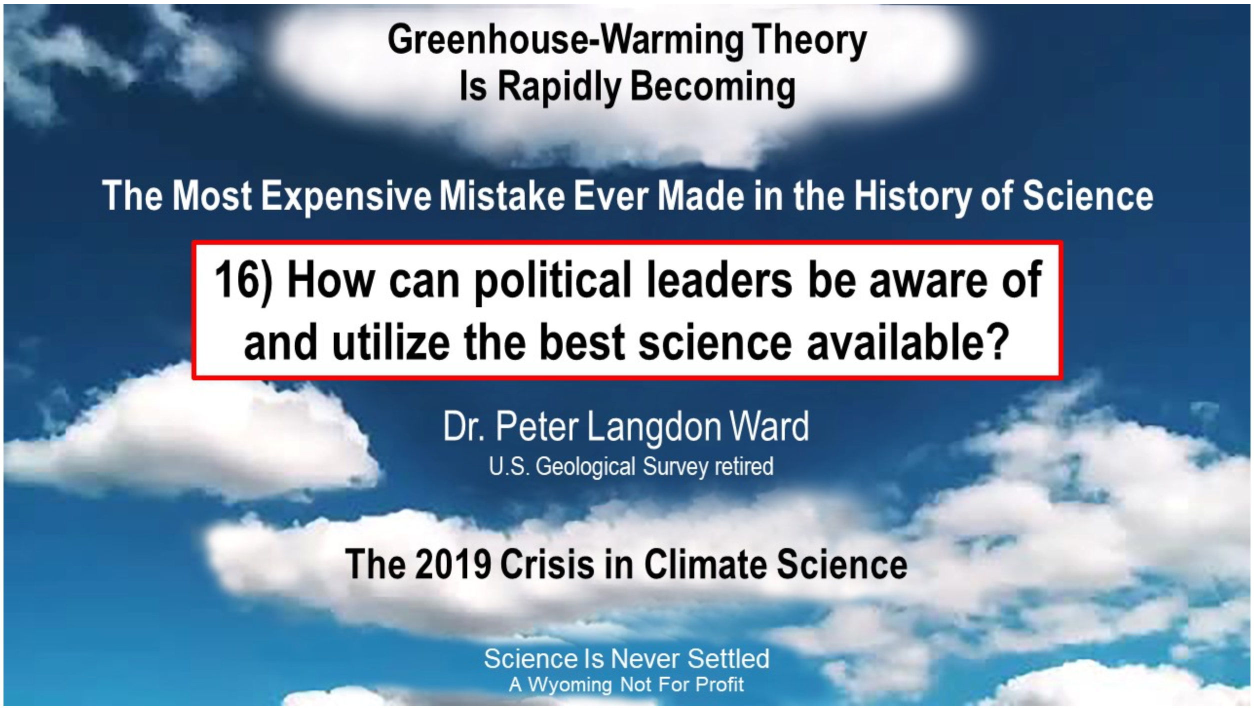


Science moves relentlessly forward, accumulating facts and theories, but, as explained by Thomas Kuhn, science is typically punctuated by scientific revolutions—times when new observations and new understanding lead to a major change in paradigm—times when a widely-accepted theory, based on decades to centuries of scientific research and development, is shown to be mistaken. Today, we are in the midst of such a scientific revolution. Most scientists are not even aware of this revolution yet, as they cling defensively to "well-established" ideas. Yet this may be the greatest scientific revolution ever in world history when measured in terms of economic and political consequences.

As explained in these videos, we have come to realize that our models of temperature in matter, heat, light and electromagnetic radiation are not quite right. They do not properly address the reality that all are the result of a broad spectrum or continuum of frequencies of oscillation of the bonds holding matter together. As a result, we now recognize that greenhouse-warming theory is not only mistaken, it is physically impossible. We also now recognize that the photon, which is central to quantum mechanics and particle physics, appears to be a mathematical convenience, not a physical reality.



Widespread acceptance by scientists of these major changes in paradigms could take years to many decades, but in this case, time is of the essence. We do not have time to wait. World leaders are preparing to spend tens of trillions of dollars to reduce greenhouse emissions, an action we can now understand is likely to be a monumental waste of money. It is no longer clear that increases in greenhouse-gas emissions have any significant effect on observed global warming. Plus, the global climate wars over greenhouse-warming theory are ripping our political systems apart. Science is a living, breathing entity with a diversity of ideas, each at a different stage of development. Science is never settled.



Greenhouse-warming theory is rapidly becoming the most expensive mistake ever made in the history of science.

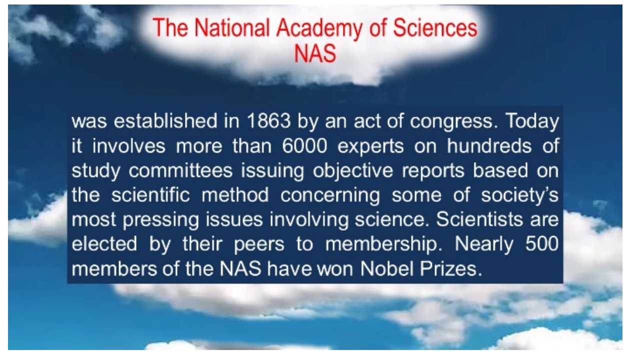
Video 16. How can political leaders be aware of and utilize the best science available?

Scientists do not and should not make public policy, but their advice is critical for rational decision making based on our best scientific estimates of reality.

In the United States, as in most developed countries, there is an extensive advisory system linking scientists with policy makers. A Science Advisor to the President was first appointed in 1941, who leads the Office of Science and Technology Policy, created by Congress in 1976, and the President's Council of Advisors on Science and Technology or its predecessors utilized heavily, especially for national defense, by all presidents except Nixon, Reagan, George W. Bush, and Trump.

There are a wide variety of standing and ad hoc government advisory committees regulated under the 1972 Federal Advisory Committee Act. In organizations such as the Environmental Protection Agency, charged with the responsibility to issue and enforce regulations, there are formal procedures for integrating scientific advice into regulatory decisions.

The Congressional Research Service provides non-partisan evaluation of scientific and other issues requested by members of Congress, their committees, and staff.



The National Academy of Sciences was established in 1863 by an act of congress. Today it involves more than 6000 experts on hundreds of study committees issuing objective reports based on the scientific method concerning some of society's most pressing issues involving science. Scientists are elected by their peers to membership. Nearly 500 members of the NAS have won Nobel Prizes. Most NAS reports are requested and paid for by government agencies.

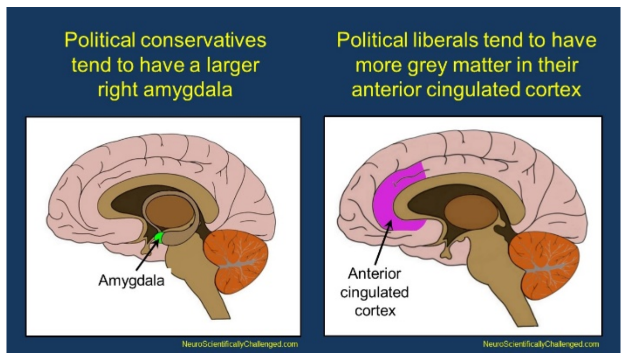
Numerous scientific professional societies issue position statements on main issues such as climate change. They also issue fact sheets and encourage their members to communicate with their political representatives.

Since 1945, hundreds of organizations known as [think tanks](#) have been created to develop and distribute reports on critical policy issues. Most of these organizations work hard to be engaged effectively in Washington politics. Each tends to have an ideological or political agenda.

These political agendas have led to what many call "The War on Science" described in several excellent books. [Social scientists have observed](#) that most people have an approach to life and to politics that falls on a broad spectrum from conservative to liberal.

Conservatives tend to resist change. They support political and social stability. They tend to have a deep human desire to manage uncertainty and fear. They tend to be uncomfortable with ambiguity and uncertainty. They tend to be more closed, fixed and certain in their views. They tend to err toward the black-and-white worldview. They value firm beliefs. They often don't value compromise and are typically unwilling to bend. They often rationalize inequity as being okay. They may be resistant to equality because they distrust people not like themselves. They tend to have a strong sense of loyalty and willingness to sacrifice for a group. They tend to be obedient and respectful of authority. In difficult times, conservatives value authoritarian leadership. They tend to value structure in their lives. They often have a sense of needing to preserve purity and sanctity. They preach fiscal responsibility and the free market.

Liberals, on the other hand, often see a need for change, for fairness, for inclusiveness, for understanding, for equity of opportunity. They tend to be more open, flexible, curious, nuanced. They tend to value compromise and are willing to bend. They tend to have much less need for closure than conservatives. They tend to err toward the shades-of-grey worldview. Liberals often have more need for cognition. They typically feel more need to provide care and to protect from harm. They tend to have a strong sense of what is just and fair. They tend to value being experimental, taking risks in one's way of living, and one's choices, and wanting to sample variety across the range of life's experiences.



What is surprising is that a number of studies are beginning to link political orientation with the biology of the brain. On average, political conservatives have a larger right amygdala, a key part of the more primitive core of our brain that plays the primary role in our emotional responses to threats and stimuli that evoke fear. Political liberals, on the other hand, tend to have more grey matter in their anterior cingulated cortex, a part of the frontal lobe involved in conflict monitoring, detecting mistakes and errors.

Arch conservatives and arch liberals are two very different kinds of people who approach life in very different ways. Scientists estimate that at least 50% of our tendency to be liberal or conservative is based on our genes. We are born with it!

Liberals tend to value objective, well-reasoned, scientific input, while conservatives often want to disparage scientific input, especially if it does not agree with their political position. Conservatives tend to be Republican. Liberals tend to be Democrats. Both approaches to life provide certain benefits and have certain drawbacks. Government tends to work best when these approaches work together from the center. Unfortunately, over the past few decades, Republican leadership has moved far to the right, to the arch conservative point of view.

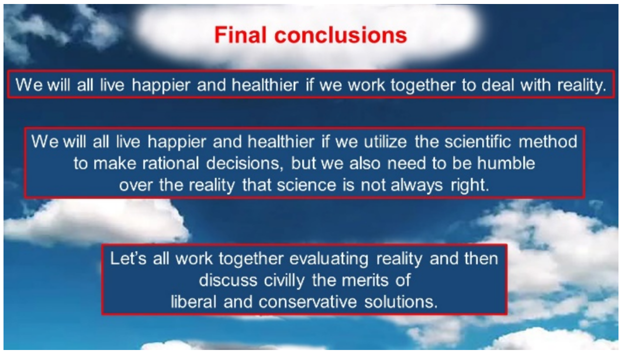
Unfortunately, at the same time, and perhaps because of the rapid growth in communications and the number of media channels, there has been a major increase in the use of propaganda and fake news, in deliberate attempts to influence an audience to believe false realities in order to push a particular political agenda. This is where science becomes especially important. We need to base political decisions on an objective evaluation of reality. The scientific method provides the most objective way to estimate reality objectively.

At the same time, science is not perfect, and scientists need some humility in recognizing that even when they have extensive consensus, they may not have it right.

Jeffersonian democracy is founded on the assumption that voters will be informed about the issues. Deliberate misinformation is a major threat to democracy as we know it. Today, political campaigns are more about getting your political base to go out and vote than they are about specific issues. The future of democracy depends on how much value we put on truth, on objective efforts to comprehend and react to reality. First, we need to come together to agree on objective evaluations of reality. Then we can debate the conservative and liberal approaches to deciding how to best deal with our mutually perceived reality.

Many conservative commentators like to postulate conspiracy theories—how scientists are trying to take over government, economies, and such. Many scientists point out that many of these commentators are receiving money from industries that benefit from ignoring science or rich people who want to promote their own opinions. Ad hominem attacks simply raise the heat of battle, making it more difficult to work together.

We have one world with a marvelous diversity of human beings. We all have much to learn in our rapidly evolving world. We will all live happier and healthier if we work together to deal with reality. We will all live happier and healthier if we utilize the scientific method to make rational decisions, but we also need to be humble over the reality that science is not always right.



Let's all work together evaluating reality and then discuss civilly the merits of liberal and conservative solutions.

Thank you very much for listening.