



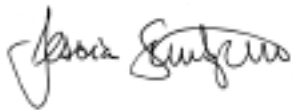
# ARM YOURSELF

HOW TO TALK TO A CLIMATE SKEPTIC:  
TOP 30 FREQUENTLY USED ARGUMENTS & REBUTTALS



You hold in your hands a nifty manual designed to overcome any argumentative global warming nay-sayer who comes your way. Filled with 30+ frequently used arguments to back you up when you need them most, this booklet features the most popular climate-skeptic comebacks from the online series written by Coby Beck for Grist. Designed as a portable booklet for quick and easy access, you will now have a pocket-ready rebuttal for any climate ostrich in the room.

This is our gift to you.



Jessica Switzer & Tim Gnatek  
Founding Partners/Blue Practice

Blue Practice is a marketing and PR group that speaks out for green-minded companies and organizations. Devoted to making an impact on awareness and behavior change with specialized campaigns for a cleaner, greener future, the company can be contacted via its website at [www.bluepractice.com](http://www.bluepractice.com).

FORWARD

We would like to thank the Grist folks, especially CEO Kendra Howe who helped make this booklet possible. If you aren't one of the 750 thousand readers who have been activated to the boiling point on behalf of an environmental cause by reading Grist ([www.grist.org](http://www.grist.org)), you are missing out. Big shout out to Coby Beck, the creator and author. Thank god there are people like you studying intelligence.

If you've read through all of this and you've still got some fight left in you, you can find more arguments and quick comebacks at [www.gristmill.org/skeptics](http://www.gristmill.org/skeptics) or [www.bluepractice.com](http://www.bluepractice.com).



### **DEDICATION**

To Ava, Henry, Elena, Molly, Matt, Ben, Jake, Rowie, Zachary, Hallie, Lexi, Wyatt, Ava Mae, Nico and Tomas

We dedicate this booklet to these and all kids in the coming generation who are inheriting this problem. It's up to you little guys to really fix this mess, but we're waking up now and we'll do what we can to help you.

## FREQUENTLY USED ARGUMENTS

### STAGES OF DENIAL

1. One record year is not enough.
2. Glaciers have always grown and receded.
3. Warming is due to the Urban Heat Island Effect.
4. Global warming is a hoax.
5. We can't even predict the weather next week.
6. Current global warming is just part of a natural cycle.
7. Mars and Pluto are warming too.
8. Historically, CO<sup>2</sup> never caused temperature change.
9. Why should the U.S. join Kyoto when China and India haven't?
10. Observations show climate sensitivity is not that high.

### SCIENCE SCHMIENCE

11. The temperature record is simply unreliable.
12. It's cold today in Wagga Wagga.
13. Hansen has been wrong before.
14. Sea leveling: the Arctic is falling.

15. It's the sun, stupid.
16. CO<sup>2</sup> in the air comes mostly from volcanoes.
17. What about mid-century cooling?
18. Greenland used to be green.
19. The scientists aren't even sure.
20. Climate scientists dodge the subject of water vapor.

#### **UNINFORMED, MISINFORMED & CRACKPOTTERY**

21. Kyoto is a big effort for almost nothing.
22. What's wrong with warmer weather?
23. Climate change mitigation could lead to disaster.
24. It was warmer during the Holocene Climate Optimum.
25. We cannot trust unproven computer models.
26. Antarctic ice is growing.
27. The satellites show cooling.
28. Natural emissions dwarf human emissions.
29. The models don't have clouds.
30. Climate is always changing.

## OBJECTION

So 2005 was a record year. Records are set all the time. One really warm year is not global warming.

## ANSWER

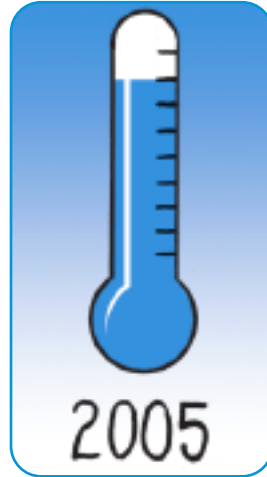
This is actually not an unreasonable point — single years taken by themselves can not establish or refute a trend. So 2005 being the hottest globally averaged temperature on record is not convincing. Then how about:

- the 20 hottest years on record occurred in the last 25
- every year since 1917 has been warmer than 1917

The five-year mean global temperature in 1910 was .8 degrees Celsius lower than the five year mean in 2002. This, and all of the above, comes from the temperature analysis by NASA GISS.

There is an interesting quote from the NASA GISS website:

*Record warmth in 2005 is notable, because global temperature has not received any boost from a tropical El Niño this year.*



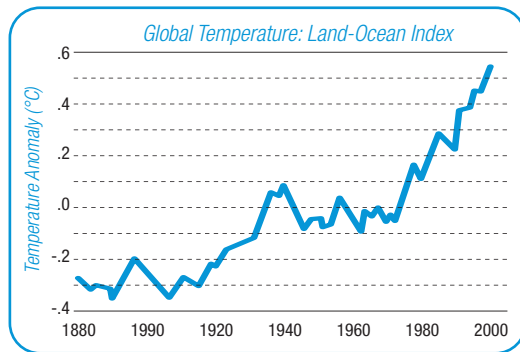
# #1

STAGES OF DENIAL

“ONE RECORD YEAR  
IS NOT ENOUGH.”

*The prior record year, 1998, on the contrary, was lifted 0.2°C above the trend line by the strongest El Niño of the past century.*

So, yes it is true that one record year does not make a long term trend, but that is clearly not the whole story.





## OBJECTION

A few glaciers receding today is not proof of global warming. Glaciers have grown and receded differently in many times and places.

## ANSWER

Firstly, it is more than “a few glaciers” that are receding; it is a pervasive, sustained, and accelerating global trend. The National Snow and Ice Data Centre (NSIDC) maintains a chart of global glacier mass balance, and for as far back as their data allows us to look, all but a few years have shown a loss in ice volume of subpolar and mountain glaciers. Further, annual losses are increasing.

But no one claims that melting glaciers are proof of global warming. Proof is a mathematical concept. In climate science one needs to look at the balance of evidence. The above data is just one piece of evidence that is consistent with global warming.

So what do we find if we look to the other aspects of the cryosphere? It turns out what we find



# #2

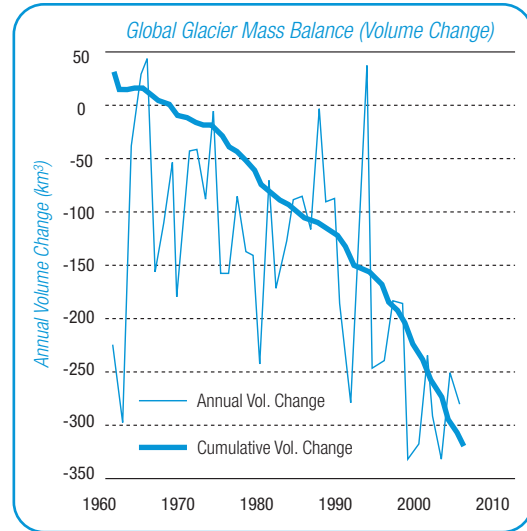
STAGES OF DENIAL

“GLACIERS HAVE ALWAYS  
GROWN AND RECEDED.”

is lots more evidence indicative of world-wide and sustained temperature increases:

- Sea ice in the arctic is reaching new record declines as the year 2006 continues the pattern of sharply decreasing Arctic sea ice.
- Measurements by NASA have found that Greenland's massive ice sheet has been losing nearly 100 gigatons of ice annually in recent years.
- Glaciers in Greenland are receding and calving at record rates.
- Ancient permafrost is also thawing (which represents its own dangers).

And of course, this is all consistent with all the other evidence of warming out there. Clearly we are dealing with much more than a few receding glaciers.



## OBJECTION

The apparent rise of global average temperatures is actually an illusion due to the urbanization of land around weather stations, the Urban Heat Island Effect.

## ANSWER

Urban Heat Island Effect has been examined quite thoroughly and found to have a negligible effect on temperature trends. RealClimate ([www.realclimate.org](http://www.realclimate.org)) has a detailed discussion of this. What's more, NASA GISS takes explicit steps in their analysis to remove any such spurious signal by normalizing urban station data trends to the surrounding rural stations. It is a real phenomenon, but it is one climate scientists are well aware of and have taken any required steps to remove its influence from the raw data.

But heavy duty data analysis and statistical processing aside, a little common sense and a couple of pertinent images should put this idea to bed. On the next page is an image, taken from Astronomy Picture of the Day (a wonderful site, by the way), of the surface of the earth. It is a composite of hundreds of satellite images all taken at night.

Aside from being very beautiful, it is a perfect indicator of urbanization on earth. As you can see,



# #3

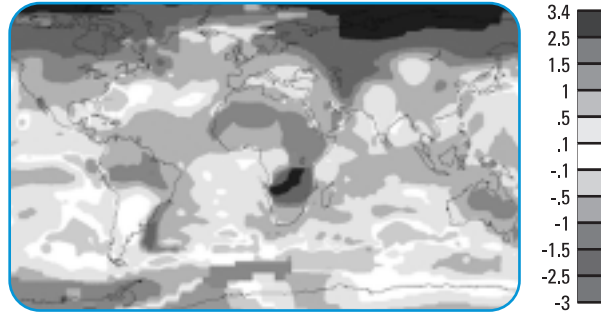
STAGES OF DENIAL

“WARMING IS DUE TO THE  
URBAN HEAT ISLAND EFFECT.”

the greatest urbanization is over the continental United States, Europe, India, Japan, Eastern China, and generally coastal South America. The next image was taken from NASA GISS. It is a global surface temperature anomaly map which shows warming (and infrequently, cooling) by region.

Look at North America, Europe, Asia, Australia, Africa and the Poles and compare them to the urbanization in the first image. There is quite simply no way to discern any correlation whatsoever between urbanization and warming. If the Urban Heat Island Effect were the cause of warming in the globally averaged record, we would see it in this map.

The claim that global warming is an artifact of the Urban Heat Island Effect is simply an artifact of the Urban Myth Effect.



## OBJECTION

Global warming is a hoax perpetrated by environmental extremists and liberals who want an excuse for more big government (and/or world government via the U.N.)

This is a common line, regardless of how ridiculous it is, so it should not go unanswered.

## ANSWER

Here is a list of organizations that accept anthropogenic global warming as real and scientifically well-supported:

- NASA's Goddard Institute of Space Studies (GISS)
- National Oceanic and Atmospheric Administration (NOAA):
- Intergovernmental Panel on Climate Change (IPCC):
- National Academy of Sciences (NAS):
- State of the Canadian Cryosphere (SOCC)
- Environmental Protection Agency (EPA):
- The Royal Society of the UK (RS)
- American Geophysical Union (AGU):
- American Meteorological Society (AMS):
- American Institute of Physics (AIP):



[www.giss.nasa.gov](http://www.giss.nasa.gov)  
[www.ncdc.noaa.gov](http://www.ncdc.noaa.gov)  
[www.grida.no](http://www.grida.no)  
[books.nap.edu](http://books.nap.edu)  
[www.socc.ca](http://www.socc.ca)  
[www.epa.gov](http://www.epa.gov)  
[www.royalsoc.ac.uk](http://www.royalsoc.ac.uk)  
[www.agu.org](http://www.agu.org)  
[www.ametsoc.org](http://www.ametsoc.org)  
[www.aip.org](http://www.aip.org)

# #4

STAGES OF DENIAL

"GLOBAL WARMING IS A HOAX."

- National Center for Atmospheric Research (NCAR): [eo.ucar.edu](http://eo.ucar.edu)
- American Meteorological Society (AMS): [www.ametsoc.org](http://www.ametsoc.org)
- Canadian Meteorological and Oceanographic Society (CMOS): [www.cmos.ca](http://www.cmos.ca)

Every major scientific institution dealing with climate, ocean, and/or atmosphere agrees that the climate is warming rapidly and the primary cause is human CO<sup>2</sup> emissions. In addition to that list, a joint statement that specifically and unequivocally endorses the work and conclusions of the IPCC Third Assessment report, was issued by:

- Academia Brasileira de Ciencias (Brazil)
- Chinese Academy of Sciences
- Deutsche Akademie der Naturforscher Leopoldina (Germany)
- Accademia dei Lincei (Italy)
- Russian Academy of Sciences
- National Academy of Sciences (United States of America)
- Royal Society of Canada
- Academie des Sciences (France)
- Indian National Science Academy
- Science Council of Japan
- Royal Society (United Kingdom)

But if scientists are too liberal and politicians too unreliable, perhaps you find the opinion of key industry representatives more convincing.

BP, the largest oil company in the UK and one of the largest in the world, has this opinion:

*There is an increasing consensus that climate change is linked to the consumption of carbon based fuels and that action is required now to avoid further increases in carbon emissions as the global demand for energy increases.*

## OBJECTION

Scientists can't even predict the weather next week, so why should we believe what some climate model tells us about 100 years from now?

## ANSWER

Climate and weather are very different things, and the level of predictability is comparably different.

Climate is defined as weather averaged over a period of time — generally around 30 years. This averaging smooths out the random and unpredictable behavior of weather. Think of it as the difference between trying to predict the height of the fifth wave from now versus predicting the height of tomorrow's high tide. The former is a challenge — to which your salty, wet sneakers will bear witness — but the latter is routine and reliable.

This is not to say it's easy to predict climate changes. But seizing on meteorologists' failures to cast doubt on a climate model's 100-year projection is an argument of ignorance.



# #5

STAGES OF DENIAL

"WE CAN'T EVEN PREDICT  
THE WEATHER NEXT WEEK."

## TREES, PLEASE!

*Trees in New York City removed an estimated 1,821 metric tons of air pollution in 1994. In an area with 100 percent tree cover (such as contiguous forest stands within parks), trees can remove from the air as much as 15 percent of the ozone, 14 percent of the sulfur dioxide, 13 percent of the particulate matter, 8 percent of the nitrogen dioxide, and 0.05 percent of the carbon monoxide.*

*Source: The Benefits of Parks, © The Trust for Public Land [www.tpl.org](http://www.tpl.org)*



## OBJECTION

Current warming is just part of a natural cycle.

## ANSWER

While it is undoubtedly true that there are natural cycles and variations in global climate, those who insist that current warming is purely natural — or even mostly natural — have two challenges.

First, they need to identify the mechanism behind this alleged natural cycle. Absent a forcing of some sort, there will be no change in global energy balance. The balance is changing, so natural or otherwise, we need to find this mysterious cause.

Second, they need to come up with an explanation for why a 35% increase in the second most important greenhouse gas does not affect the global temperature. Theory predicts temperature will rise given an enhanced greenhouse effect, so how or why is it not happening?

The mainstream climate science community has provided a well-developed, internally consistent theory that accounts for the effects we are now observing. It provides explanations and makes predictions. Where is the skeptic community's model or theory whereby CO<sup>2</sup> does not affect the temperature? Where is the evidence of some other natural forcing, like the Milankovich cycles that controlled the ice ages (a fine historical example of a dramatic and regular climate cycle that can be read in the ice core records taken both in Greenland and in the Antarctic)?



# #6

STAGES OF DENIAL

“CURRENT GLOBAL WARMING IS  
JUST PART OF A NATURAL CYCLE.”

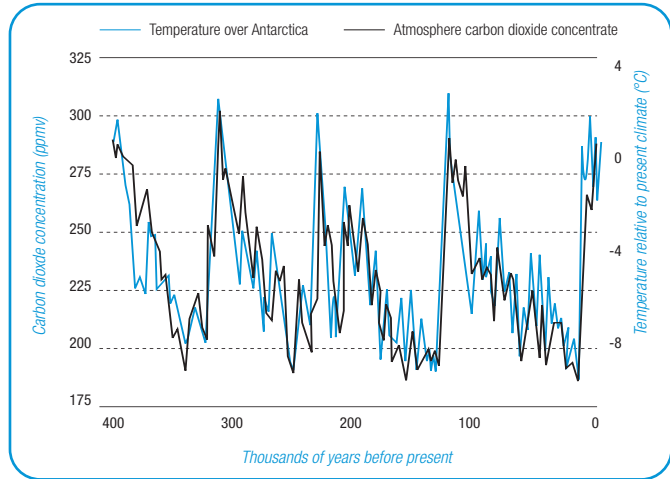
Is this graph a candidate for explaining today's warming? A naive reading of this cycle indicates we should be experiencing a cooling trend now — and indeed we were gradually cooling over the length of the pre-industrial Holocene, around  $.5^{\circ}\text{C}$  averaged over 8,000 years.

Not only is the direction of the change wrong, but compare the speed of those fluctuations to today's changes. Leaving aside the descents into glaciation, which were much more gradual, the sudden (geologically speaking) jumps up in temperature every  $\sim 100,000$  years represent a rate of change roughly ten times slower what we are currently witnessing.

So could current changes be part of a natural cycle?

Well, no natural cause has been identified. There is no climatological theory in which  $\text{CO}_2$  does not drive temperature. And natural cycle precedents do not exhibit the same extreme changes we're now witnessing.

In short: No.



## OBJECTION

Global warming is happening on Mars and Pluto as well. Since there are no SUVs on Mars, CO<sup>2</sup> can't be causing global warming.

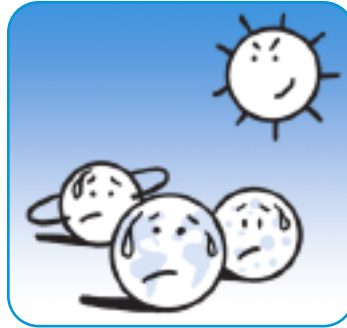
## ANSWER

Warming on another planet would be an interesting coincidence, but it would not necessarily be driven by the same causes.

The only relevant factor Earth and Mars share is the sun, so if the warming were real and related, that would be the logical place to look. As it happens, the sun is being watched and measured carefully back here on Earth, and it is not the primary cause of current climate change.

As for the alleged extraterrestrial warming, there is extremely little evidence of a global climate change on Mars. The only piece I'm aware of is a series of photographs of a single icy region in the southern hemisphere that shows melting over a six year period (about three Martian years).

Here on Earth we have direct measurements from all over the globe, widespread glacial retreat, reduction of sea ice, and satellite measurements of the lower troposphere up to the



# #7

STAGES OF DENIAL #7

“MARS AND PLUTO  
ARE WARMING TOO.”

stratosphere. To compare this mountain of data to a few photographs of a single region on another planet strains credulity. And in fact, the relevant scientists believe the observation described above is the result of a regional change caused by Mars' own orbital cycles, like what happened during the earth's glacial cycles. See "Global Warming on Mars?" from RealClimate for much more detail about this issue.

Turning to the outer reaches of the solar system: in the icy cold and lonely Kuiper Belt, scientists observed a difference in Pluto's atmospheric thickness, inferred from two occultation observations 14 years apart. But a cursory glance at Pluto's orbit and atmosphere reveals how ridiculous it is to draw any conclusions about climate, much less climate change, from observations spanning less than even a single season, let alone enough years to even establish the climate's normal state.

Anyone trying to draw conclusions about what is happening here on Earth from all this might as well be from another planet.

Back to Earth for a quick summary: we have poles melting, surface temperature rising, tropospheric temperatures rising, permafrost melting, glaciers worldwide melting, CO<sup>2</sup> concentrations increasing, borehole analysis showing warming, sea ice receding, proxy reconstructions showing warming, sea level rising, sea surface temperatures rising, energy imbalance, ice sheets melting, and stratospheric cooling, all of which leads us to believe the Earth is undergoing global warming driven by an enhanced greenhouse effect.

On Mars we have one spot melting, which leads us to believe that ... one spot is melting.

Forgive me for not being reassured.

## OBJECTION

In the geological record, it is clear that CO<sup>2</sup> does not trigger climate changes. Why should it be any different now?

## ANSWER

Given the fact that human industrialization is unique in the history of planet Earth, do we really need historical precedent for CO<sup>2</sup>-triggered climate change before we accept what we observe today? Surely it is not far-fetched that unprecedented consequences would follow from unprecedented events.

But putting this crucial point aside, history does indeed provide some relevant insights and dire warnings.

During the glacial/interglacial cycles, temperatures and CO<sup>2</sup> concentrations showed remarkable correlation. Closer examination reveals that CO<sup>2</sup> does not lead the temperature changes, but lags by many centuries. Even so, the full extent of the warming can not be explained without the effects of CO<sup>2</sup>. Though these cycles do not demonstrate that greenhouse gas initiated warming, they do lend credence to the importance of CO<sup>2</sup> and CH<sup>4</sup> in setting the planetary thermostat.



# #8

STAGES OF DENIAL

“HISTORICALLY, CO<sup>2</sup> NEVER  
CAUSED TEMPERATURE CHANGE.”

There are also events in geological history when sharp rises in temperature were initiated and driven by large spikes in greenhouse gases — not unlike the fossil-fuel-emissions spike today. The Paleocene Eocene Thermal Maximum is such a case. Roughly 55 million years ago, ocean pH levels dropped drastically and global temperatures rapidly rose over 5°C. The resolution of available proxy records indicates that this occurred in a period of time no longer than 5,000 years; it's not possible to know if it happened even faster. The likely cause was massive releases of methane from the ocean floors, perhaps due to some smaller warming or changes in sea level. It took over 100,000 years for the ocean, atmosphere, and temperatures to return to their previous state. The result was a mass extinction event that took millions of years to recover from.

We can also look at the formation of the Deccan Traps. In this case, a massive and sustained volcanic action altered atmospheric chemistry and caused a drastic climate change, one that led to the extinction of the dinosaurs. And Snowball Earth theories involve the build-up of greenhouse gases as the mechanism by which the earth eventually escaped its frozen state.

In short, it is simply untrue that history lacks precedent for greenhouse-gas-driven warming. The precedents are there, as are the dire warnings.

## OBJECTION

Why should the U.S. join Kyoto while India and China haven't?

## ANSWER

The U.S. puts out more CO<sup>2</sup> than any other nation on earth, including China and India, by a large margin. Considering the relative populations (a billion-plus each for China and India versus 300 million in the U.S.), per capita emissions in the U.S. are many times larger. This has been true for the past 100 plus years of CO<sup>2</sup> pollution.

For the U.S. to refuse to take any steps until India and China do the same is like the fattest man at the table, upon realizing the food is running out, demanding that the hungry people who just sat down cut back just as much as him, at the same time.

There is no morally sane assessment of the global warming problem that does not place a greater burden on the U.S., the worst polluter. Perhaps we should divide global emissions by global population and allocate carbon credits according to census data. Or, using a Kyoto 1990-levels approach, perhaps we should demand that all nations target the per-capita levels of the U.S. in the 1990s. If you live anywhere but inside U.S. borders, these proposals do not sound preposterous.

All that aside, it is simply untrue that China and India have not joined the Kyoto treaty. They have. They were simply not required to return to the third-world level of emissions they produced

# #9

STAGES OF DENIAL

“WHY SHOULD THE US JOIN KYOTO  
WHEN CHINA AND INDIA HAVEN'T?”

in 1990. What comes next for them has yet to be negotiated. Further, this framework of differing responsibilities and the acknowledgement of differing social needs was explicitly accepted in the UNFCCC treaty — which was ratified by the U.S.

The U.S. has already agreed that China and India should be held to different standards!

Paragraph 3:

*Noting that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs ...*

Paragraph 6:

*Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions ...*

Clearly, the notion that it's unfair to expect the largest historical polluters to make the greatest reductions is not only wrong, but it is a violation of an already signed and ratified treaty on the issue of global warming.

But now that the world's biggest polluter has refused to make any sacrifices, what do you think China will have to say when renegotiations come around in 2012?



## OBJECTION

Taking into account the logarithmic effect of CO<sup>2</sup> on temperature, the 35 percent increase we have already seen in CO<sup>2</sup> concentrations represents about three-quarters of the total forcing to be expected from a CO<sup>2</sup> doubling. Since we have warmed about 0.7 degrees Celsius so far, we should only expect about 0.3 degrees more for a doubling from pre-industrial levels, so about 1 degree total, not 3 degrees as the scientists predict. Clearly the climate model sensitivity to CO<sup>2</sup> is much too high.

## ANSWER

Even without addressing the numbers in this argument, there is a fundamental flaw in its reasoning.

We don't yet know exactly how much the climate will warm from the CO<sup>2</sup> already in the air. There is a delay of several decades between forcing and final response. Until an equilibrium temperature is reached, present day observations will not tell us the exact value of the climate's sensitivity to CO<sup>2</sup>.

The reason for this is primarily the large heat capacity of the oceans. The enhanced greenhouse effect from higher CO<sup>2</sup> levels is indeed trapping energy in the climate system according to expectations, but the enormous quantity of water on earth is



# #10

STAGES OF DENIAL

“OBSERVATIONS SHOW CLIMATE SENSITIVITY IS NOT THAT HIGH.”

absorbing most of the resulting heat. Due to water's high heat capacity, this absorbed energy shows up as only a modest ocean warming, which in turn dampens the temperature change on land and lowers the global average trend.

This is commonly referred to as the climate system's thermal inertia. According to model experiments and consistent with data from past climate changes, this inertia results in a lag of several decades between the imposition of a radiative forcing and a final equilibrium temperature.

Now let's look at a couple of further details. CO<sup>2</sup> is not the only factor affecting global temperature. There is a phenomenon called "global dimming" counteracting greenhouse gas warming. Global dimming refers to the blocking of incoming sunlight by particulate pollution in the troposphere and airplane contrails in the stratosphere. It is not a well quantified effect, but it may well be masking a great deal more warming; it is definitely masking some.

## OBJECTION

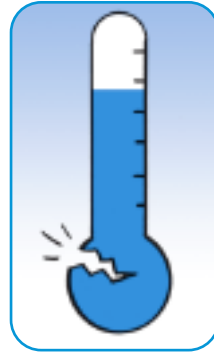
The surface temperature record is full of assumptions, corrections, differing equipment and station settings, changing technology, varying altitudes, and more. It is not possible to claim we know what the “global average temperature” is, much less determine any trend. The IPCC graphs only say what the scientists want them to say.

## ANSWER

There is actually some truth to the part about the difficulties; scientists have overcome many of them in turning the hundreds of thousands of measurements taken in many different ways and over a span of more than a dozen decades into a single globally averaged trend.

But this is the nature of science — no one said it was easy. It’s taken the scientific community a long time to finally come out and say that what we have been observing for 100 years is in fact exactly what it looks like. All other possible explanations (for example, the Urban Heat Island Effect) have been investigated, the data has been examined and re-examined, reviewed and re-reviewed, and the conclusion has become unassailable.

And while it is true that differing weather station locations, from proximity to lakes or rivers or elevation above sea level, probably make it impossible to arrive at a meaningful figure for global average surface temperature, that is not what we are really interested in. The investigation is



# #11

SCIENCE SCHMIENCE

“THE TEMPERATURE RECORD  
IS SIMPLY UNRELIABLE.”

focused on trends, not the absolute level. Often, as in this case, it is easier to determine how much a given property is changing than what its exact value is. If one station is near an airport at three feet above sea level and another is in a park at 3000 feet, it doesn't really matter — they both show rising temperature, and that is the critical information.

So how do we finally know when all the reasoning is reasonable and the corrections correct? One good way is to cross check your conclusion against other completely unrelated data sets. In this case, all the other available indicators of global temperature trends unanimously agree. Go ahead, put aside the direct surface temperature measurements — global warming is also indicated by:

- Satellite measurements of the upper and lower troposphere
- Weather balloons show very similar warming
- Borehole analysis
- Glacial melt observations
- Declining Arctic sea ice
- Sea level rise
- Proxy reconstructions
- Rising ocean temperature

All of these completely independent analyses of widely varied aspects of the climate system lead to the same conclusion: the earth is undergoing a rapid and substantial warming trend. Looks like the folks at NASA and CRU know what they are doing after all.

## OBJECTION

It was way colder than normal today in Wagga Wagga, proof that there is no global warming.

Does this even deserve an answer? If we must ...

## ANSWER

The chaotic nature of weather means that no conclusion about climate can ever be drawn from a single data point, hot or cold. The temperature of one place at one time is just weather, and says nothing about climate, much less climate change, much less global climate change.



# #12

SCIENCE SCHMIENCE

"IT'S COLD TODAY  
IN WAGGA WAGGA."

TECHNOLOGY GOT US INTO THIS MESS,  
AND TECHNOLOGY CAN HELP GET US OUT OF IT.

*"There's more smart money than ever before focused on alternative and renewable energy investments. Solar and wind power, biofuels, zero emission vehicles, sustainable manufacturing processes, alternative building compounds and other environmentally-conscious startups are target investments. In fact, clean tech is the fastest growing segment of VC investments in the U.S. exceeding \$1 billion and expected to grow to \$17 billion by 2009. Nearly all of the Silicon Valley blue chip venture capital firms have increased their clean tech allocations. Some have funds devoted exclusively to clean tech, and we salute your leadership."*

*Jessica Switzer, partner, Blue Practice*

## OBJECTION

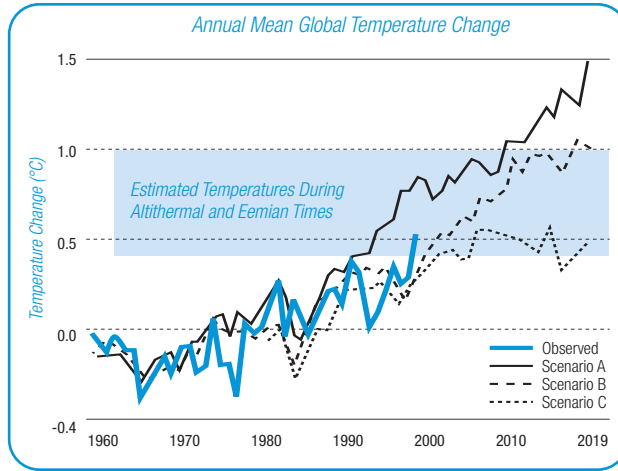
In 1988, Hansen predicted dire warming over the next decade — and he was off by 300%. Why in the world should we listen to the same doom and gloom from him today?

## ANSWER

While in some instances it is ignorant repetition of misinformation, at its source this story is a plain lie.

In 1988, James Hansen testified before the U.S. Senate on the danger of anthropogenic global warming. During that testimony he presented a graph — part of a paper published soon after. This graph had three lines on it, representing three scenarios based on three projections of future emissions and volcanism.

Line A was a temperature trend prediction based on rapid emissions growth and no large volcanic event; it was a steep climb through the year 2000 and beyond.



# #13

SCIENCE SCHMIENCE

"HANSEN HAS BEEN  
WRONG BEFORE."

Line B was based on modest emissions growth and one large volcanic eruption in the mid 1990s.

Line C began along the same trajectory as Line B, and included the same volcanic eruption, but showed reductions in the growth of CO<sup>2</sup> emission by the turn of the century — the result of hypothetical government controls.

As it happens, since Hansen's testimony, emissions have grown at a modest rate and Mt. Pinatubo did in fact erupt, though in the early 1990s, not the middle. In other words, the Line B forcings scenario came remarkably close to predicting what actually came to pass.

Not coincidentally, the observed temperature trend has tracked closely with the Line B prediction as well.

Hansen was right on the money and the models he used proved successful.

Unfortunately, when Patrick Michaels made his testimony before Congress in 1998, ten years later, he saw fit to erase the two lower lines, B and C, and show the Senators only Line A. He did so to make his testimony that Hansen's predictions had been off by 300% believable. He lied by omission. This lie was picked up by Michael Crichton in his novel *State of Fear* (one of many omissions, confusions, and falsehood in that book).

To my knowledge, Patrick Michaels has never owned up to his deception, either with an apology and retraction or with an explanation, and consequently the urban myth lives on to this day.



## OBJECTION

According to the latest state-of-the-art satellite measurements from over the Arctic, sea levels are falling! Guess all that ice isn't melting after all.

## ANSWER

Yes, a new study using Europe's Space Agency's ERS-2 satellite has determined that over the last 10 years, sea level in the Arctic Ocean has been falling at an average rate of about 2 mm/year. This is very new and very interesting news, though it is preliminary and not published in any peer-reviewed journals yet. But even if these results hold up to time and scrutiny, it is not evidence that globally sea levels are not rising, because they are.

Sea level and sea level change is not uniform around the globe.

Local sea levels are subject to many influences including: wind and ocean currents that can "pile up" the ocean water locally, temperature anomalies like El Niño, local gravity wells of ice sheets and land masses, and regional salinity levels that alter the water's density. Measurement of these levels is further complicated by changes in land height as the earth's crust moves up or



# #14

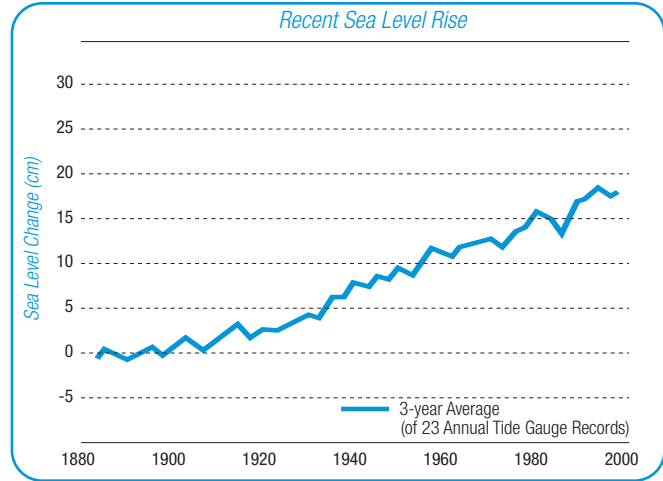
SCIENCE SCHMIENCE

"SEA LEVELING:  
THE ARCTIC IS FALLING."

down from tectonic motion and rebounds after long and recently ended glaciation, although these complications are avoided by using satellite measurements.

So in short, this is undoubtedly of interest to specialists in several fields, but it does not in any way alter the global climate change picture.

*Chart courtesy of Global Warming Art*



## OBJECTION

The sun is the source of warmth on earth. Any increase in temperature is likely due to changes in solar radiation.

## ANSWER

It's true that the earth is warmed, for all practical purposes, entirely by solar radiation, so if the temperature is going up or down, the sun is a reasonable place to seek the cause.

Turns out it's more complicated than one might think to detect and measure changes in the amount or type of sunshine reaching the earth. Detectors on the ground are susceptible to all kinds of interference from the atmosphere — after all, one cloud passing overhead can cause a shiver on an otherwise warm day, but not because the sun itself changed. The best way to detect changes in the output of the sun — versus changes in the radiation reaching the earth's surface through clouds, smoke, dust, or pollution — is by taking readings from space.

This is a job for satellites. According to PMOD at the World Radiation Center there has been no increase in solar irradiance since at least 1978, when satellite observations began. This means



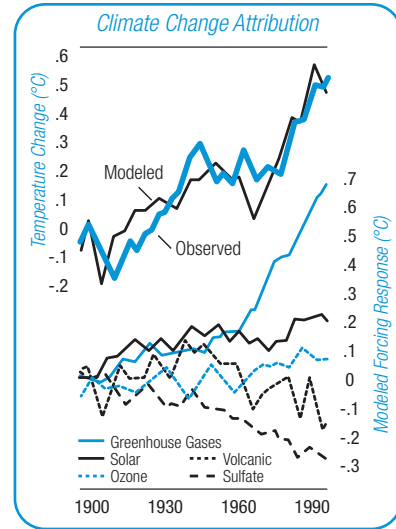
# #15

SCIENCE SCHMIENCE

“IT’S THE SUN, STUPID.”

that for the last thirty years, while the temperature has been rising fastest, the sun has not changed.

There has been work done reconstructing the solar irradiance record over the last century, before satellites were available. According to the Max Planck Institute, where this work is being done, there has been no increase in solar irradiance since around 1940. This reconstruction does show an increase in the first part of the 20th century, which coincides with the warming from around 1900 until the 1940s. It's not enough to explain all the warming from those years, but it is responsible for a large portion. See this chart of observed temperature, modeled temperature, and variations in the major forcings that contributed to 20th century climate.



## OBJECTION

One decent-sized volcanic eruption puts more CO<sup>2</sup> in the atmosphere than a decade of human emissions. It's ridiculous to think reducing human CO<sup>2</sup> emissions will have any effect.

## ANSWER

Not only is this false, it couldn't possibly be true given the CO<sup>2</sup> record from any of the dozens of sampling stations around the globe. If it were true that individual volcanic eruptions dominated human emissions and were causing the rise in CO<sup>2</sup> concentrations, then these CO<sup>2</sup> records would be full of spikes — one for each eruption. Instead, such records show a smooth and regular trend.

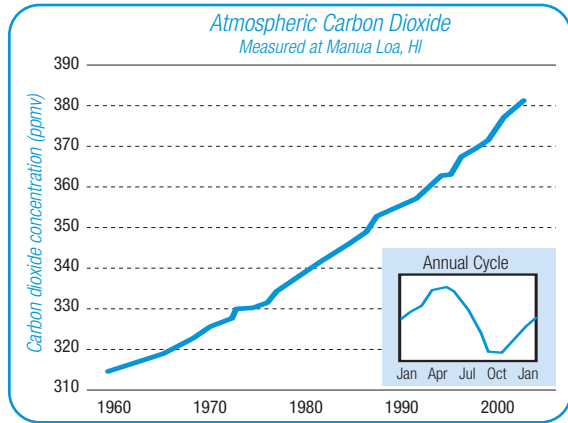
The fact of the matter is, the sum total of all CO<sup>2</sup> out-gassed by active volcanoes amounts to about 1/150th of anthropogenic emissions.



# #16

SCIENCE SCHMIENCE

“CO<sup>2</sup> IN THE AIR COMES  
MOSTLY FROM VOLCANOES.”



*Image from Global Warming Art*

## OBJECTION

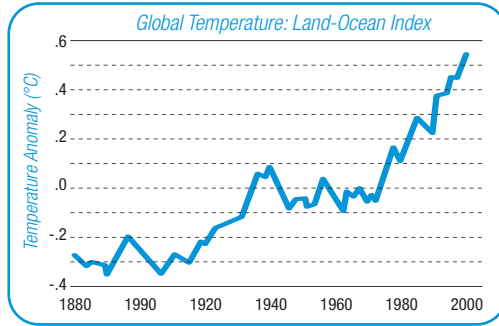
There was global cooling in the '40s, '50s, and '60s, even while human greenhouse-gas emissions were rising. Clearly, temperature is not being driven by CO<sup>2</sup>.

## ANSWER

None of the advocates of the theory of anthropogenic global warming (AGW) claim that CO<sup>2</sup> is the only factor controlling temperature in the ocean-atmosphere climate system. It is a large and complex system, responsive on many different timescales, subject to numerous forcings. AGW only makes the claim that CO<sup>2</sup> is the primary driver of the warming trend seen over the last 100 years. This rise has not been smooth and steady — nor would it be expected to be.

If you look at the temperature record for the 1990s, you'll notice a sharp drop in '92, '93, and '94. This is the effect of massive amounts of SO<sup>2</sup> ejected into the stratosphere by Mount Pinatubo's eruption. That doesn't mean CO<sup>2</sup> took a holiday and stopped influencing global temperatures; it only means that the CO<sup>2</sup> forcing was temporarily overwhelmed by another, opposite forcing.

The situation is similar to the cooling seen in the '40s and '50s. During this period, the CO<sup>2</sup>



# #17

SCIENCE SCHMIENCE

“WHAT ABOUT  
MID-CENTURY COOLING?”

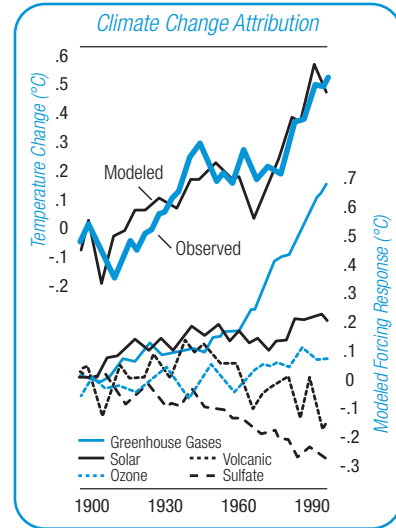
warming (a smaller forcing at the time) was temporarily overwhelmed by by other factors, perhaps foremost among them an increase in human particulates and aerosol pollution. Pollution regulations and improved technology saw a decrease in this latter kind of emissions over the '60s and '70s, and as the air cleared, the CO<sub>2</sub> signal again emerged and took over. To the right, courtesy of Global Warming Art, is an image of the current understanding of the factors and their influence for the climate of the past century.

As the graph shows, in addition to aerosol pollution (the sulphate line), volcanic influences were increasingly negative during the period of global cooling, and solar forcing slightly declined. All forcings taken together and run through the model are a very good match for the observations.

Rather than confounding the climate consensus, mid-century cooling is actually a good test for the climate models, one they are passing quite convincingly.

Addendum: The opposing effect of cooling from airborne pollutants is often referred to as "Global Dimming," and RealClimate has a couple of articles on it.

One emerging concern is that as the pollution causing this effect is gradually cleaned up, we may see even greater greenhouse gas warming.





## OBJECTION

When the Vikings settled it, Greenland was a lovely, hospitable island, not the frozen wasteland it is today. It was not until the Little Ice Age that it got so cold they abandoned it.

## ANSWER

First, Greenland is part of a single region. It can not be necessarily taken to represent a global climate shift. Briefly, the available proxy evidence indicates that global warmth during this period was not particularly pronounced, though some regions may have experienced greater warming than others.

Second, a quick reality check shows that Greenland's ice cap is hundreds of thousands of years old and covers over 80% of the island. The vast majority of land not under the ice sheet is rock and permafrost in the far north. How different could it have been just 1,000 years ago?

Below is a brief account of the Viking settlement, based on Jared Diamond's "Collapse."

Greenland was called Greenland by Erik the Red (was he red?), who was in exile and wanted to attract people to a new colony. He thought you should give a land a good name so people would



# #18

SCIENCE SCHMIENCE

“GREENLAND USED TO BE GREEN.”

want to go there! It likely was a bit warmer when he landed for the first time than it was when the last settlers starved due to a number of factors — climate change, or at least some bad weather, a major one.

But it was never lush, and their existence was always harsh and meager, especially due to the Viking's disdain for other peoples and ways of living. They attempted to live a European lifestyle in an arctic climate, side by side with Inuit who easily outlasted them. They starved surrounded by oceans and yet never ate fish! (Note: this was not a typical European behavior, and is a bit of a mystery to this day.)

Instead of hunting whales in kayaks, they farmed cattle, goats, and sheep — despite having to keep them in a barn 24 hours a day, 7 days a week, for a full 5 months out of the year. It was a constant challenge to get enough fodder for the winter. Starvation of the animals was frequent, emaciation routine. Grazing requirements and growing fodder for the winter led to over-production of pastures, erosion, and the need to go further and further afield to sustain the animals. Deforestation for pastures and firewood proceeded at unsustainable rates. After a couple of centuries, it led to such desperate measures as cutting precious sod for housing construction and even burning it for cooking and heating fuel.

When finally confronted with several severe winters in a row, they, along with the little remaining livestock, simply starved before spring arrived.

The moral of the story for the climate controversy? Much as you can not judge a book by its cover, you can't judge the climate of Greenland by its name.

## OBJECTION

Even the scientists don't know that the climate is changing more than normal and if it's our fault or not. If you read what they write it is full of "probably," "likely," "evidence of" and all kinds of qualifiers. If they don't know for sure, why should we worry yet?

## ANSWER

Probability is the language of science. There is no proof; there are no absolute certainties. Scientists are always aware that new data may overturn old theories and that human knowledge is constantly evolving. Consequently, it is viewed as unjustifiable hubris to ever claim one's findings as unassailable.

But in general, the older and more established a given theory becomes, the less and less likely it is that any new finding will drastically change things. Even the huge revolution in physics brought on by Einstein's theory of relativity did not render Newton's theories of classical mechanics useless. Classical mechanics is still used all the time; it is, quite simply, good enough for most purposes.

But how well established is the greenhouse effect?



# #19

SCIENCE SCHMIENCE

"THE SCIENTISTS AREN'T  
EVEN SURE."

Greenhouse effect theory is over 100 years old. The first predictions of anthropogenic global warming came in 1896. Time has only strengthened and refined those groundbreaking conclusions. We now have decades of very detailed and sophisticated climate observations, and super computers crunching numbers in one second it would have taken a million 19th century scientists years with a slide rule to match. Even so, you will never ever get a purely scientific source saying “the future is certain.”

But what certainty there is about the basic issue is close enough to 100 percent that for all practical purposes it should be taken as 100 percent. Don't wait any longer for scientific certainty; we are there. Every major institute that deals with climate-related science is saying anthropogenic global warming is here and real and dangerous, even though they will not remove the “very likely” and “strongly indicated” qualifiers. The translation of what the science is saying into the language of the public is this: global warming is definitely happening and it is definitely because of human activities and it will definitely continue as long as CO<sup>2</sup> keeps rising in the atmosphere.

The rest of the issue — how high will the temperature go, how fast will it get there, and how bad will this be — is much less certain. But no rational human being rushes headlong into an unknown when there is even a 10 percent chance of death or serious injury. Why should we demand 100 percent certainty before avoiding this danger? Science has given the human race a dire warning with all the urgency and certainty we should need to prompt action.

We don't have time or reason to wait any longer.

## OBJECTION

Climate scientists never talk about water vapor — the strongest greenhouse gas — because it undermines their CO<sup>2</sup> theory.

## ANSWER

Not a single climate model or climate textbook fails to discuss the role water vapor plays in the greenhouse effect. It is the strongest greenhouse gas, contributing 36% to 66% to the overall effect for vapor alone, 66% to 85% when you include clouds. It is however, not considered a climate “forcing,” because the amount of H<sub>2</sub>O in the air basically varies as a function of temperature.

If you artificially increase the level of H<sub>2</sub>O in the air, it rains out immediately (in terms of climate response times). Similarly, due to the abundance of ocean on the earth’s surface, if you somehow removed all the water from the air, it would quickly be replaced through evaporation.

This has the interesting consequence that if you could somehow instantly remove all CO<sup>2</sup> from the atmosphere, the temperature would begin to drop, causing precipitation to remove H<sub>2</sub>O from the air, causing even further drops, in a feedback effect that would not end until no liquid water was left, only ice sheets and frozen oceans.



# #20

SCIENCE SCHMIENCE

“CLIMATE SCIENTISTS DODGE  
THE SUBJECT OF WATER VAPOR.”

CO<sup>2</sup> put into the air by burning fossil fuels, on the other hand, stays in the atmosphere for centuries before natural sinks finish absorbing the excess. This is plenty of time to have substantial and long-lasting effects on the climate system. As the climate warms in response to CO<sup>2</sup>, humidity rises and increased H<sub>2</sub>O concentration acts as a significant amplifier of CO<sup>2</sup>-driven warming, basically doubling or tripling its effect.

## OBJECTION

The Kyoto treaty, even if fully implemented, would only save us about a tenth of a degree of future temperature rise many decades from now. What a waste of effort!

## ANSWER

There are three big problems with this claim.

First, it's a red herring. The purpose of Kyoto is to establish international political and economic mechanisms for dealing with global warming, by taking the first tentative steps toward a difficult goal. You may as well time me walking to the sidewalk where I parked my bicycle and then tell me at this rate I will never get home.

Second, Kyoto is a step-by-step process. The second phase (much less third, fourth, etc.) has not even been negotiated yet. How can anyone claim anything about how effective it is going to be? Junk Science and other sources of this propaganda are starting their dubious calculations from the assumption that Kyoto ends in 2012 when round one is over. That is just wrong.

Third, the temperature several decades from now is to a large extent already determined by the current energy imbalance, thanks to extra CO<sup>2</sup> already in the atmosphere. Short of a complete



# #21

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"KYOTO IS A BIG EFFORT  
FOR ALMOST NOTHING."

cessation of emissions today, there is no foreseeable way to avoid the bulk of the warming “in the pipeline.” This is mostly due to the extreme thermal inertia of the oceans and therefore the climate system as a whole. It means that our actions today, or our inaction, will have consequences several decades hence.

Finally, I have a rather personal peeve with people who vociferously criticize any attempt at a solution and yet propose nothing in its place. You’d think if they were so sincerely concerned about how ineffective Kyoto will be (as, frankly, they should be), they would be agitating for more action rather than shrugging their shoulders and saying “I guess we should just sit it out.” It’s like a guy standing on the sidewalk watching all his neighbors fight a house fire, saying “you’ll never make it, you don’t have enough people.”

Shut up and help!



## OBJECTION

The earth has had much warmer climates in the past. What's so special about the current climate? Anyway, it seems like a generally warmer world will be better.

## ANSWER

I don't know if there is a meaningful way to define an "optimum" average temperature for planet Earth. Surely it is better now for all of us than it was 20,000 years ago when so much land was trapped beneath ice sheets. Perhaps any point between the recent climate and the extreme one we may be heading for, with tropical forests inside the arctic circle, is as good as any other. Maybe it's even better with no ice caps anywhere.

It doesn't matter. The critical issue is not what the temperature is, or may be, or will be. The critical issue is how fast it is moving.

Rapid change is the real danger. Human habits and infrastructure are suited to particular weather patterns and sea levels, as are ecosystems and animal behaviors. The rate at which global temperature is rising today is likely unique in the history of our species.

This kind of sudden change is rare even in geological history, though perhaps not unprecedented.



# #22

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"WHAT'S WRONG WITH  
WARMER WEATHER?"

So the planet may have been through similar things before — that sounds reassuring, right?

Not so much. Once you look at the impact similar changes had on biodiversity at the time, the existence of historical precedent becomes anything but reassuring. Rapid climate change is the prime suspect in most mass extinction events, including the Great Dying some 250 million years ago, in which 90% of all life went extinct.

What we know about ecosystems, and what geologic history demonstrates, is that dramatic climate changes — up or down or sideways — are a tremendous shock to the biosphere and cause mass extinction events. That, all in all, is not likely to be a good thing.

## OBJECTION

The kind of drastic actions required to mitigate global warming risk the destruction of the global economy and the deaths of potentially billions of people.

## ANSWER

Is this supposed to mean the theory of anthropogenic global warming must be wrong? You can not come to a rational decision about the reality of a danger by considering how hard it might be to avoid. First things first: understand that the problem is real and present.

Once you acknowledge the necessity of addressing the problem, taking action suddenly become less daunting. There is no point in discussing the best solutions or the cost of those solutions with someone who does not yet acknowledge the problem.

But even if mitigating global warming would be harmful, given that famine, droughts, disease, loss of major coastal cities, and a tremendous mass extinction event are on the table as possible consequences of doing nothing, it may well be we are faced with a choice between the lesser of two evils. I challenge anyone to conclusively demonstrate that such catastrophes as listed above await us if we try to reduce fossil fuel use.



# #23

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"CLIMATE CHANGE MITIGATION  
COULD LEAD TO DISASTER."

Now, in terms of conservation and a global switch over to alternative fuels, the people who oppose doing this for climate change mitigation are forgetting something rather important. Fossil fuels are a non-renewable resource, and as such we have to make this global economic transformation regardless, whether now or a bit later. Many bright minds inside the industry think we are already at peak oil. So even if it turned out that climate mitigation was unnecessary, we would still be in a better place as a global society by making the coming switch sooner rather than later.

Seems like a win-win situation to me.

## OBJECTION

It was warmer during the Holocene Climatic Optimum than it is today — without any human influence.

## ANSWER

Though some temperatures during that period were in the same range as today, they were confined to the northern hemisphere and the summer months.

What's more, the cause is understood (orbital forcing similar to what controlled the Ice Ages), just as today's cause is understood (CO<sup>2</sup> emissions), and these causes are very different. National Oceanic and Atmospheric Administration has the following quote on its website:

*In summary, the mid-Holocene, roughly 6,000 years ago, was generally warmer than today, but only in summer and only in the northern hemisphere. More over, we clearly know the cause of this natural warming, and know without doubt that this proven "astronomical" climate forcing mechanism cannot be responsible for the warming over the last 100 years.*

As an aside, it's worth noting that even if the Holocene had been as warm as or warmer than today, it would do nothing to undermine the theories and data that indicate today's warming is rapid and anthropogenic.



# #24

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"IT WAS WARMER DURING THE  
HOLOCENE CLIMATIC OPTIMUM."

## SELFLESSNESS

*“My dream, my hope for the future is that we evolve into beings that care about the far distant future. That we evolve to care not just about our own species, but also about the other living creatures with which we share this planet. That will be the ultimate definition of selflessness.”*

*Maya Lin, Architect and Artist*

## OBJECTION

Why should we trust a bunch of contrived computer models that have never had a prediction confirmed? Talk to me in 100 years.

## ANSWER

Given the absence of a few duplicate planets and some large time machines, we can't test a 100-year temperature projection. Does that mean the models can't be validated without waiting 100 years? No.

The climate is an extremely complex system. Our observations of it are by no means complete — even with regard to what's going on today.

Still, there are global temperature predictions that have been validated.

In 1988, James Hansen of NASA GISS fame predicted that temperature would climb over the next 12 years, with a possible brief episode of cooling in the event of a large volcanic eruption. He made this prediction in a landmark paper and before a Senate hearing, which marked the official “coming out” to the general public of anthropogenic global warming. Twelve years later, he was proven remarkably correct, requiring adjustment only for the timing difference between the simulated future volcanic eruption and the actual eruption of Mount Pinatubo.

Putting global surface temperatures aside, there are some other significant model predictions made and confirmed:

# #25

UNINFORMED, MISINFORMED & CRACKPOTTERY  
“WE CANNOT TRUST UNPROVEN  
COMPUTER MODELS.”

- models predict that surface warming should be accompanied by cooling of the stratosphere
- models have long predicted warming of the lower, mid, and upper troposphere, even while satellite readings seemed to disagree — but it turns out the satellite analysis was full of errors and on correction
- models predict warming of ocean surface waters
- models predict an energy imbalance between incoming sunlight and outgoing infrared radiation
- models predict sharp and short-lived cooling of a few tenths of a degree in the event of large volcanic eruptions, and Mount Pinatubo confirmed this
- models predict an amplification of warming trends in the Arctic region
- and finally, to get back to where we started, models predict continuing and accelerating warming of the surface, and so far they are correct

There is another way to test a model's predictive power over long time periods: hindcasting. By starting the model at some point in the past — say, the turn of the 20th century — and running it forward, feeding it confirmed observational data on GHG, aerosol, solar, volcanic, and albedo forcing, we can directly compare modeled behavior with the actual, observed course of events. Of course, this has been done many times.

Would a prediction made in 1900 of temperature for year 2000 have been validated? Would politicians in 1900 have been wise to heed the warnings of science, had science had today's climate models then?

Clearly, yes.



## OBJECTION

The Antarctic ice sheets are actually growing, which wouldn't be happening if global warming were real.

## ANSWER

There are two distinct problems with this argument.

First, any argument that tries to use a regional phenomenon to disprove a global trend is dead in the water. Anthropogenic global warming theory does not predict uniform warming throughout the globe. We need to assess the balance of the evidence.

In the case of this particular region, there is actually very little data about the changes in the ice sheets. The growth in the East Antarctic ice sheet indicated by some evidence is so small, and the evidence itself so uncertain, the sheet may well be shrinking.

But even this weak piece of evidence may no longer be current. Some recent results from NASA's GRACE experiment, measuring the gravitational pull of the massive Antarctic ice sheets, have indicated that on the whole, ice mass is being lost.



# #26

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"ANTARCTIC ICE IS GROWING."

Second, ice-sheet thickening is not inconsistent with warming! Warmer climates tend toward more precipitation. The Antarctic is one of the most extreme deserts on the planet. As it warms, we would expect it to receive more snow. But even a whopping warming of 20 degrees — say, from -50 degrees C to -30 degrees C — would still leave it below freezing, so the snow wouldn't melt. Thus, an increase in ice mass.

While on the subject of ice sheets: Greenland is also growing ice in the center, for the same reasons described above. But it is melting on the exterior regions, on the whole losing approximately 200 km<sup>3</sup> of ice annually, doubled from just a decade ago. This is a huge amount compared to changes in the Antarctic — around three orders of magnitude larger. So in terms of sea-level rise, any potential mitigation due to East Antarctic Ice Sheet growth is wiped out many times over by Greenland's melting.

## OBJECTION

Satellite readings, which are much more accurate, show that the earth is in fact cooling.

I wonder how long before this one stops coming up?

## ANSWER

There are a few advantages to the satellite readings, mainly the more uniform global coverage and the fact that readings can be taken at different altitudes. However, it is an extremely complicated process which uses microwaves emitted by the oxygen in the atmosphere as a proxy for temperature.

The complications arise from many things, including decay of the satellite orbits, splicing together and calibrating records from different instruments, trying to separate the signals by the layer of atmosphere they originate from, etc. It is a little ironic that the same people who distrust the surface record so happily embrace this even-more-convoluted exercise in data processing!

Anyway, it has been many years since the satellite analysis showed cooling.

Until recently, though, one of the many analyses of tropospheric temperatures did show very little warming and was in direct contradiction to model predictions that say the troposphere should warm significantly in an enhanced greenhouse environment. Something had to be wrong,



# #27

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"THE SATELLITES SHOW COOLING."

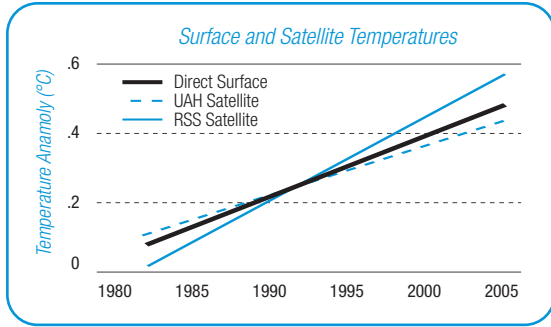


Image from *Global Warming Art*

the observations or the model predictions. Naturally, the skeptics had no doubt it was the models that were off.

However, it turns out that additional errors were uncovered and the MSU Satellite temperature analysis now shows warming well in line with model expectations. RealClimate has a good rundown of the technical details for those with the stomach for it. In short, this long-running debate turned out to be a great validation of the models and a real death blow to the “earth is not warming” crowd.

Beware of zombies!

## OBJECTION

According to the IPCC, 150 billion tons of carbon go into the atmosphere from natural processes every year. This is almost 30 times the amount of carbon humans emit. What difference can we make?

## ANSWER

It's true that natural fluxes in the carbon cycle are much larger than anthropogenic emissions. But for roughly the last 10,000 years, until the industrial revolution, every gigaton of carbon going into the atmosphere was balanced by one coming out.

What humans have done is alter one side of this cycle. We put approximately 6 gigatons of carbon into the air but, unlike nature, we are not taking any out.

Thankfully, nature is compensating in part for our emissions, because only about half the CO<sup>2</sup> we emit stays in the air. Nevertheless, since we began burning fossil fuels in earnest over 150 years ago, the atmospheric concentration that was relatively stable for the previous several thousand years has now risen by over 35%.

So whatever the total amounts going in and out "naturally," humans have clearly upset the balance and significantly altered an important part of the climate system.



# #28

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"NATURAL EMISSIONS DWARF  
HUMAN EMISSIONS."

## SEEING THE TREES THROUGH THE FOREST

*A single tree will absorb one ton of carbon dioxide over its lifetime.*

*Source: [www.climatecrisis.net](http://www.climatecrisis.net)*

## OBJECTION

Clouds are a large negative feedback that will stop any drastic warming. The climate models don't even take cloud effects into account.

## ANSWER

All of the atmospheric global climate models used for the kind of climate projections synthesized by the IPCC take the effects of clouds into account. You can read a discussion about cloud processes and feedback in the IPCC TAR.

It is true, however, that clouds are one of the largest sources of uncertainty in the global climate models. They are complicated to model because they have both positive feedback, preventing surface heat from escaping back into space, and negative feedback, reflecting incoming sunlight before it can reach the surface. The precise balance of these opposing effects depends on time of day, time of year, altitude, size of the water droplets and/or ice particles, latitude, current air temperature, and size and shape.

On top of that, different types of clouds will interact, amplifying or mitigating one another's effects as they coexist in different layers of the atmosphere. There are also latent heat



# #29

UNINFORMED, MISINFORMED & CRACKPOTTERY  
“THE MODELS DON'T HAVE CLOUDS.”

considerations — water vapor condenses during cloud formation and precipitation events, and water droplets evaporate when clouds dissipate.

The ultimate contribution of clouds to global temperature trends is highly uncertain, but according to the best estimates is likely to be positive over the coming century. There is no indication anywhere that any kind of cloud processes will stop greenhouse-gas-driven warming, and this includes observations of the past as well as modeling experiment



## OBJECTION

Climate has always changed. Why are we worried now, and why does it have to be humans' fault?

## ANSWER

Yes, climate has varied in the past, for many different reasons, some better understood than others. Present-day climate change is well understood, and different. Noting that something happened before without humans does not demonstrate that humans are not causing it today.

For example, we see in ice core records from Antarctica and Greenland that the world cycled in and out of glacial periods over 120,000-year cycles. That climate cycle's timing is fairly well understood to be caused by changes in the orbit of the earth, though the mechanism behind the response has not been conclusively established. These orbital cycles are regular and predictable and they are definitely not the cause of today's warming. The other important difference between the glacial-interglacial cycles and today is the rapidity of the current change. The rate of warming is on the order of 10 times faster today than in the ice cores.

Such rapid warming on a global scale is quite rare in the geological record, and while it may not be entirely unprecedented, there is strong evidence that whenever such a change has happened, whatever the cause, it was a catastrophic event for the biosphere.



# #30

UNINFORMED, MISINFORMED & CRACKPOTTERY  
"CLIMATE IS ALWAYS CHANGING."

## PROTECTING IS PART OF BEING HUMAN

*“At its core, global climate change is not about economic theory or political platforms, nor about partisan advantage or interest group pressures. It is about the future of God’s creation and the one human family. It is about protecting both ‘the human environment’ and the natural environment.”*

*United States Conference of Catholic Bishops statement*

References made several times to RealClimate — refer to [www.realclimate.org](http://www.realclimate.org)

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