Global Warming:
How to approach the science.

(Climate Models and the Evidence?)

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Here are two statements that are completely agreed on by the IPCC. It is crucial to be aware of these facts and of their implications.

1. A doubling of CO_2, by itself, contributes only about 1C to greenhouse warming. All models project more warming, because, within models, there are positive feedbacks from water vapor and clouds, and these feedbacks are considered by the IPCC to be uncertain.

2. If one assumes all warming over the past century is due to anthropogenic greenhouse forcing, then the derived sensitivity of the climate to a doubling of CO_2 is less than 1C. The higher sensitivity of existing models is made consistent with observed warming by invoking unknown additional negative forcings from aerosols and solar variability as arbitrary adjustments.

Given the above, the notion that alarming warming is 'settled science' should be offensive to any sentient individual, though to be sure, the above is hardly emphasized by the IPCC.

The notion that models are our only tool, even, if it were true, depends on models being objective and not arbitrarily adjusted.

However, models are hardly our only tool. Models do show why they get the results they get. The reasons involve physical processes that can be independently assessed by both observations and basic theory. This has, in fact, been done, and the results suggest that all models are exaggerating warming.

The details of one such study will be shown if time permits.

Even without this very basic breakdown of the case for global warming alarm, there are numerous reasons why an intelligent observer should be suspicious of the presentation of alarm.

1. The claim of ‘incontrovertibility.’

2. Arguing from ‘authority’ in lieu of scientific reasoning and data or even elementary logic.

3. Use of term ‘global warming’ without either definition or quantification.

4. Identification of complex phenomena with multiple causes with global warming and even as ‘proof’ of global warming.

5. Conflation of existence of climate change with anthropogenic climate change.

Some Salient Points:

1. Virtually by definition, nothing in science is ‘incontrovertible’ – especially in a primitive and complex field as climate. ‘Incontrovertibility’ belongs to religion where it is referred to as dogma.

2. The value of ‘authority’ in a primitive and politicized field like climate is of dubious value – it is essential to deal with the science itself.

With respect to the last item, the situation may not be as difficult as it sounds. Consider the following example:

This letter appeared a couple of weeks ago in *Science*. It was signed by 250 members of the National Academy of Science. Most signers had no background whatever in climate sciences. Many were the 'usual suspects.' (ie, Paul Ehrlich, Steve Schneider, George Woodwell, Don Kennedy, John Schellnhuber, …) but a few were indeed active contributors.

LETTERS

edited by Jennifer Sills

Climate Change and the Integrity of Science

WE ARE DEEPLY DISTURBED BY THE RECENT ESCALATION OF POLITICAL ASSAULTS ON SCIENTISTS in general and on climate scientists in particular. All citizens should understand some basic scientific facts. There is always some uncertainty associated with scientific conclusions; science never absolutely proves anything. When someone says that society should wait until scientists are absolutely certain before taking any action, it is the same as saying society should never take action. For a problem as potentially catastrophic as climate change, taking no action poses a dangerous risk for our planet.

Scientific conclusions derive from an understanding of basic laws supported by laboratory experiments, observations of nature, and mathematical and computer modeling. Like all human beings, scientists make mistakes, but the scientific process is designed to find and correct them. This process is inherently adversarial—scientists build reputations and gain recognition not only for supporting conventional wisdom, but even more so for demonstrating that the scientific consensus is wrong and that there is a better explanation. That's what Galileo, Pasteur, Darwin, and Einstein did. But when some conclusions have been thoroughly and deeply tested, questioned, and examined, they gain the status of "well-established theories" and are often spoken of as "facts."

For instance, there is compelling scientific evidence that our planet is about 4.5 billion years old (the theory of the origin of Earth), that our universe was born from a single event about 14 billion years ago (the Big Bang theory), and that today's organisms evolved from ones living in the past (the theory of evolution). Even as these is nothing remotely identified in the recent events that changes the fundamental conclusions about climate change:

(i) The planet is warming due to increased concentrations of heat-trapping gases in our atmosphere. A snowy winter in Washington does not alter this fact.

(ii) Most of the increase in the concentration of these gases over the last century is due to human activities, especially the burning of fossil fuels and deforestation.

(iii) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

(iv) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic.

(v) The combination of these complex climate changes threatens coastal communities and cities, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.

Much more can be, and has been, said by the world's scientific societies, national academies, and individuals, but these conclusions should be enough to indicate why scientists are concerned about what future generations will face from business-as-usual practices. We urge our policy-makers and the public to move forward immediately to address the causes of climate change, including the unrestrained burning of fossil fuels.

We also call for an end to McCarthy-like

Here are two of their assertions:

(iii) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

(iv) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle.

Now, one of the signers was Carl Wunsch. Here is what he says in a recent paper in *Journal of Climate* (Wunsch et al, 2007):

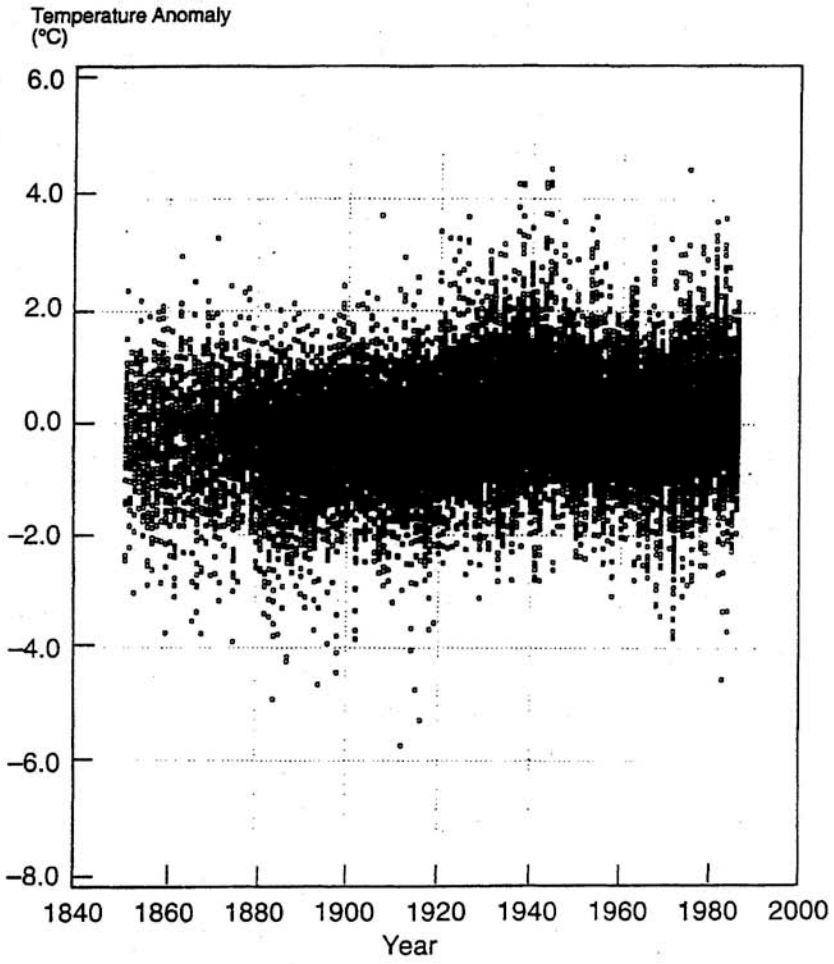
It remains possible that the data base is insufficient to compute mean sea level trends with the accuracy necessary to discuss the impact of global warming–as disappointing as this conclusion may be.

In brief, when we actually go to the scientific literature we see that the 'authoritative' assertions are no more credible than the pathetic picture of the polar bear that accompanied the letter.

3. ‘Global Warming’ refers to an obscure statistical quantity, globally averaged temperature anomaly, the small residue of far larger and mostly uncorrelated local anomalies. This quantity is highly uncertain, but may be on the order of 0.7C over the past 150 years. This quantity is always varying at this level and there have been periods of both warming and cooling on virtually all time scales. On the time scale of from 1 year to 100 years, there is no need for any externally specified forcing. The climate system is never in equilibrium because, among other things, the ocean transports heat between the surface and the depths. To be sure, however, there are other sources of internal variability as well.

Because the quantity we are speaking of is so small, and the error bars are so large, the quantity is easy to abuse in a variety of ways.

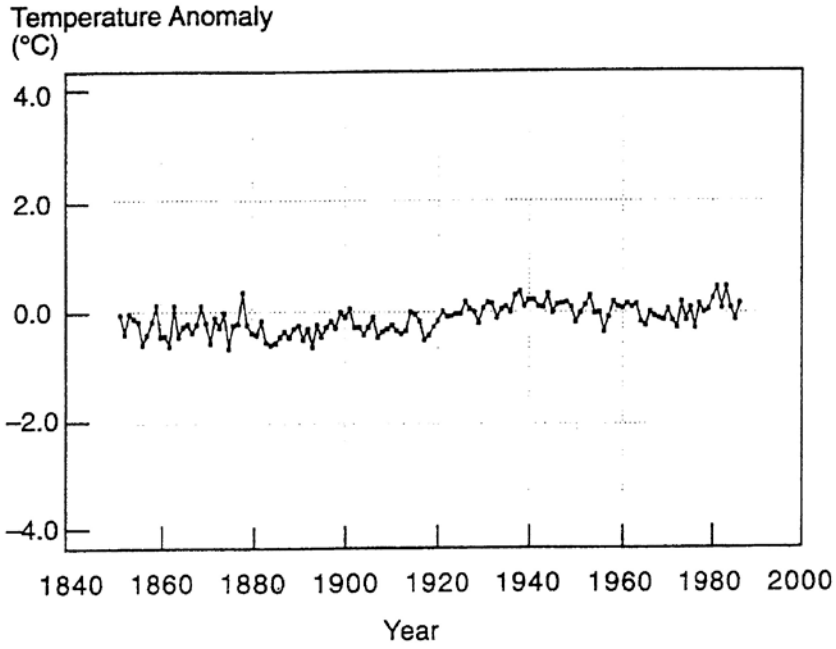
Deviations of Annual MeanTemperature from Long-term Average



1. Data points averaged to obtain time record of global mean temperature. Note points range from less than -2C to more than +2C.

Source: S. L. Grotch, Lawrence Livermore Laboratory, Livermore California

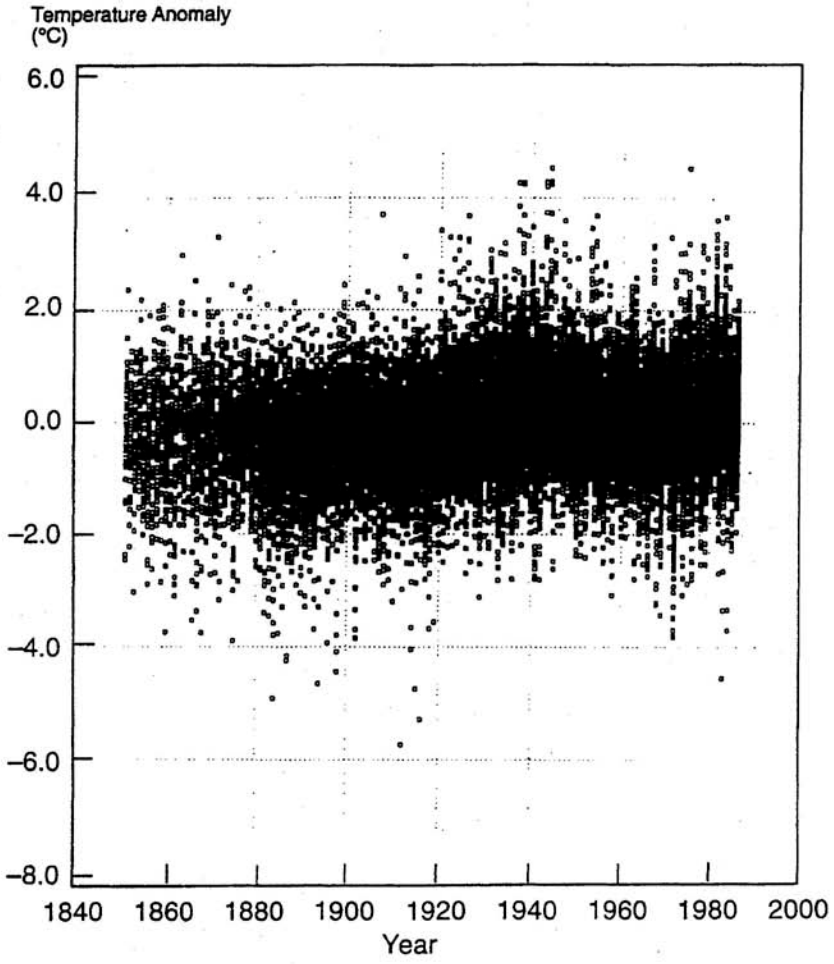
Globally Averaged Deviations from Average Temperature Plotted on a Scale Relevant to the Individual Station Deviations



2. Average of points in previous figure.

Notice the vertical scale in the above diagrams

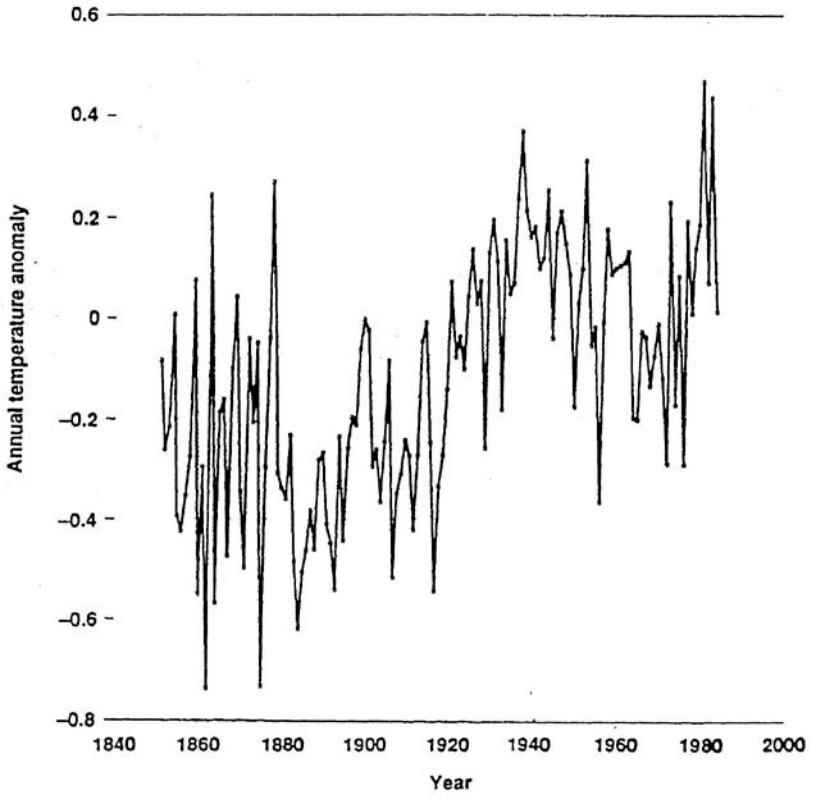
Deviations of Annual MeanTemperature from Long-term Average



1. Data points averaged to obtain time record of global mean temperature. Note points range from less than -2C to more than +2C.

Source: S. L. Grotch, Lawrence Livermore Laboratory, Livermore California

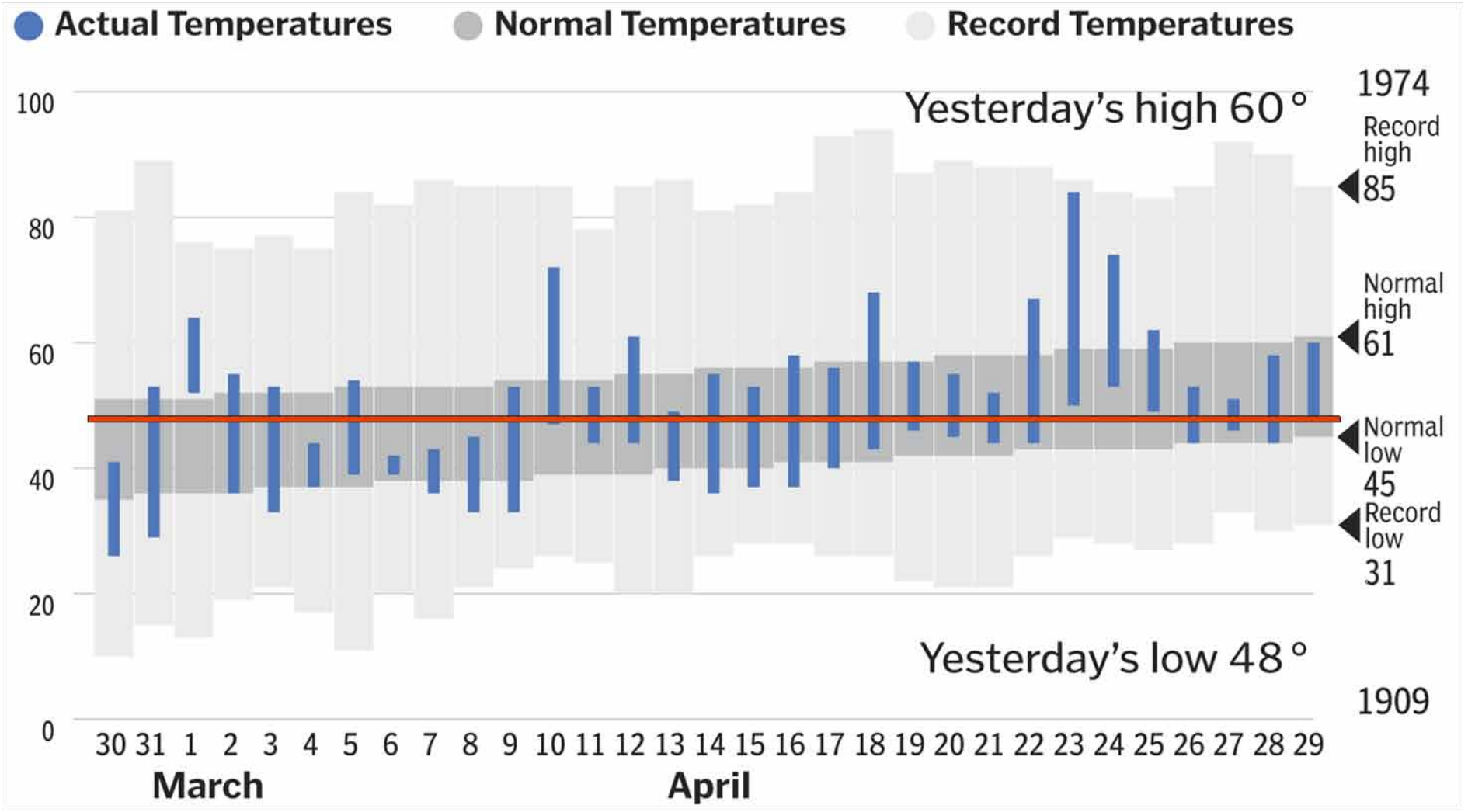
CRU NH Average Annual Anomalies (1851-1984)



3. Curve in previous figure stretched to fill graph. Note that range is now from about -0.6C to +0.3C.

April 30, 2008

The thickness of the red line represents the range of global mean temperature anomaly over the past century.



4. The claims that the earth has been warming, and that man's activities have contributed to warming, are trivially true and essentially meaningless in terms of alarm.

Two separate but frequently conflated issues are essential for alarm:

1) The magnitude of warming, and

2) The relation of warming of any magnitude to the projected catastrophe.

When it comes to unusual climate (which always occurs some place), most claims of evidence for global warming are guilty of the ‘prosecutor’s fallacy.’ For example this confuses the near certainty of the fact that if A shoots B, there will be evidence of gunpowder on A’s hand with the assertion that if C has evidence of gunpowder on his hands then C shot B.

However, with global warming the line of argument is even sillier. It generally amounts to something like if A kicked up some dirt, leaving an indentation in the ground into which a rock fell and B tripped on this rock and bumped into C who was carrying a carton of eggs which fell and broke, then if some broken eggs were found it showed that A had kicked up some dirt. These days we go even further, and decide that the best way to prevent broken eggs is to ban dirt kicking.

Some current problems with science

1. **Questionable data**. (Climategate and involvement of all three centers tracking global average temperature anomaly.) This is a complicated ethical issue for several reasons. Small temperature changes are not abnormal and even claimed changes are consistent with low climate sensitivity. However, the public has been mislead to believe that whether it is warming or cooling – no matter how little – is of vital importance. Tilting the record slightly is thus of little consequence to the science but of great importance to the public perception.

2. More sophisticated data is being analyzed with the aim of supporting rather than testing models (validation rather than testing). That certainly has been my experience during service with both the IPCC and the National Climate Assessment Program. It is also evident in the recent scandal concerning Himalayan glaciers.

3. Sensitivity is a crucial issue. This refers to how much warming one expects from a given change in CO_2 (usually a doubling). It cannot be determined by assuming that one knows the cause of change. If the cause is not what one assumes, it yields infinite sensitivity. This problem infects most attempts to infer climate sensitivity from paleoclimate data.

4. Models cannot be tested by comparing models with models. Attribution cannot be based on the ability or lack thereof of faulty models to simulate a small portion of the record. Models are simply not basic physics.

All the above and more are, nonetheless, central to the IPCC reports that supposedly are 'authoritative' and have been endorsed by National Academies and numerous professional societies.

Here is a recent letter signed by the presidents of both the Royal Society and the National Academy of Science.

It tells us a great deal about the current state of science.

FT.com
FINANCIAL TIMES
COMMENT
Letters

What's happening to the climate is unprecedented

Print

Published: April 9 2010 03:00 | Last updated: April 9 2010 03:00

From Prof Martin Rees and Dr Ralph J. Cicerone.

Sir, We were stimulated by your editorial "**Cooler on warming**" (April 5). There has undoubtedly been a shift in public and media perceptions of climate change – a consequence of, at least in part, leaked e-mails from some climate scientists and the publication of errors in the fourth Intergovernmental Panel on Climate Change report.

However, as your editorial acknowledges, neither recent controversies, nor the recent cold weather, negate the consensus among scientists: something unprecedented is now happening. The concentration of carbon dioxide in the atmosphere is rising and climate change is occurring, both due to human actions. If we continue to depend heavily on fossil fuels, by mid-century CO 2 concentrations will reach double pre-industrial levels. Straightforward physics tells us that this rise is warming the planet. Calculations demonstrate that this effect is very likely responsible for the gradual warming observed over the past 30 years and that global temperatures will continue to rise – superimposing a warming on all the other effects that make climate fluctuate. Uncertainties in the future rate of this rise, stemming largely from the "feedback" effects on water vapour and clouds, are topics of current research.

It is the responsibility of scientific organisations like ours to present the public and politicians with a balanced assessment of the evidence – and, importantly, to indicate the level of confidence and the range of uncertainties attached to them.

Our two science academies have long contributed critical, objective and open reports on climate change. We intend to draw upon the efforts of leading scientists everywhere to make our future reports more accessible and valuable and, by fostering scientific research, we hope to do a better job of reducing inherent uncertainties. We must also promote best scientific practice, especially with regard to the sharing of data. But policymakers and the public must realise that, even if scientific uncertainties could be reduced to zero, formulating effective political responses would still be controversial and challenging. Our academies will provide the scientific backdrop for the political and business leaders who must create effective policies to steer the world toward a low-carbon economy.

Martin Rees,
President of the Royal Society

Ralph J Cicerone,
President of the US National Academy of Sciences

Let us focus on three sentences in this letter.

1. *However, as your editorial acknowledges, neither recent controversies, nor the recent cold weather, negate the consensus among scientists: something unprecedented is now happening. The concentration of carbon dioxide in the atmosphere is rising and climate change is occurring, both due to human actions.*

Note that this statement seems to go well beyond the IPCC statement that claimed that only more than half the temperature change over the preceding 50 years could be attributed to man's emissions – with aerosols included in order to cancel much of the excess warming the models produce.

Moreover, the assumptions underlying this claim have been shown to be false (namely that all other possible causes had been adequately accounted for).

Of course, one could carefully parse the sentence. Perhaps they meant that there was increasing CO_2 due to man, and that there was warming due to this though it might only be a small part of the already small observed warming. If this is what they meant, then the statement is trivial and suggests no basis for alarm. However, there is no doubt that this is not what they intended the reader to infer.

2. *Uncertainties in the future rate of this rise, stemming largely from the "feedback" effects on water vapour and clouds, are topics of current research.*

Who would guess from this throw away comment, that feedbacks are a crucial issue? Without strong positive feedbacks there would be no cause for alarm, and no need for action. What Rees and Cicerone are actually saying is that we don't know if there is a problem.

3. *Our academies will provide the scientific backdrop for the political and business leaders who must create effective policies to steer the world toward a low-carbon economy.*

Rees and Cicerone are saying that regardless of the evidence the answer is predetermined. If the government wants carbon control, that is the answer that the Academies will provide. Nothing could better epitomize the notion of science in the service of politics – something that, unfortunately, has characterized so-called climate science.

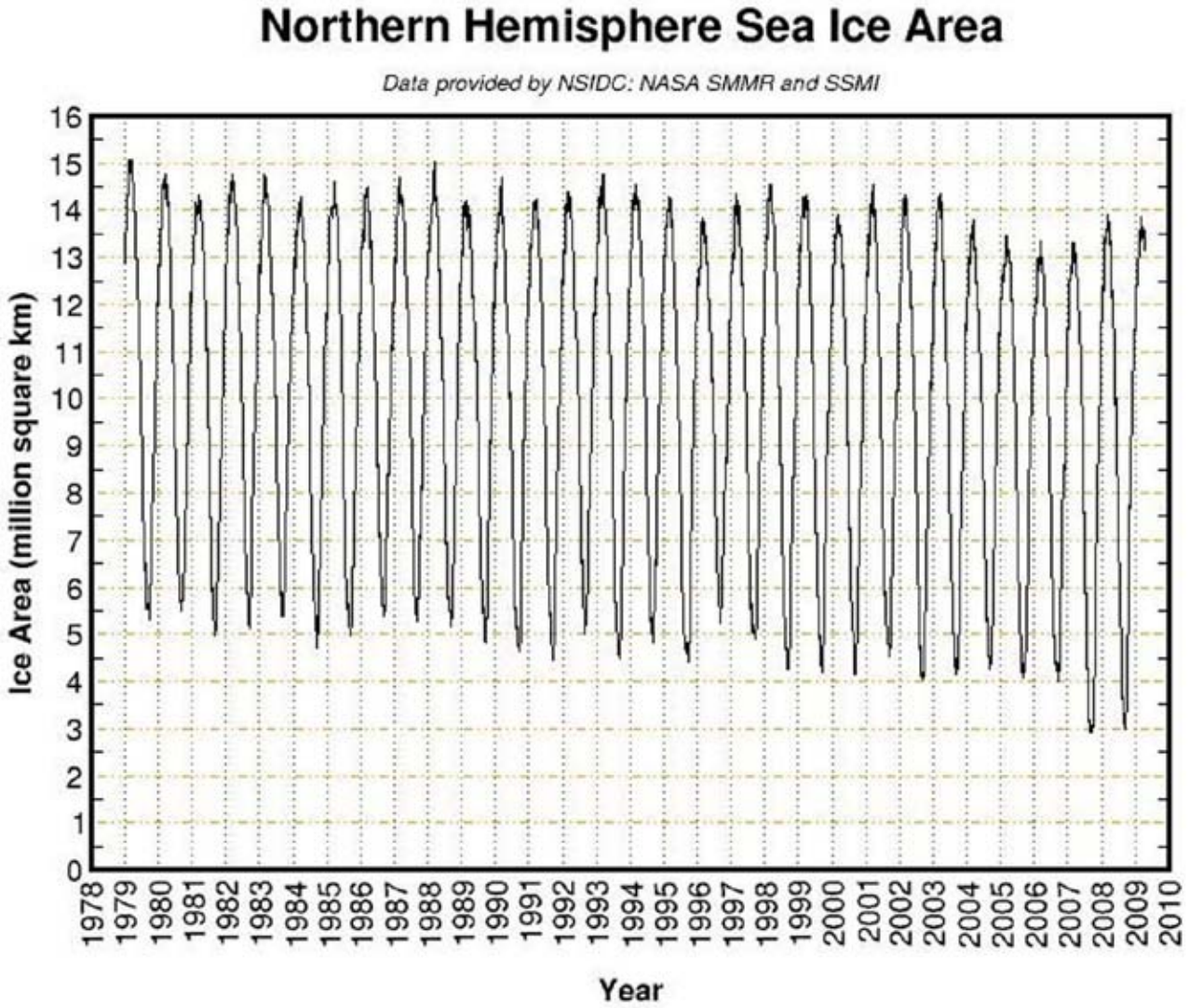
Where do we go from here?

Given that this has become a quasi-religious issue, it is hard to tell. However, my personal hope is that we will return to normative science, and try to understand how the climate actually behaves. Our present approach of dealing with climate as completely specified by a single number, globally averaged surface temperature anomaly, that is forced by another single number, atmospheric CO_2 levels, for example, clearly limits real understanding; so does the replacement of theory by model simulation. In point of fact, there has been progress along these lines and none of it demonstrates a prominent role for CO_2. It has been possible to account for the cycle of ice ages simply with orbital variations (as was thought to be the case before global warming mania); tests of sensitivity independent of the assumption that warming is due to CO_2 (a circular assumption) show sensitivities lower than models show; the resolution of the early faint sun paradox which could not be resolved by greenhouse gases, is readily resolved by clouds acting as negative feedbacks.

We don't have much time to go into much of this but let's at least start.

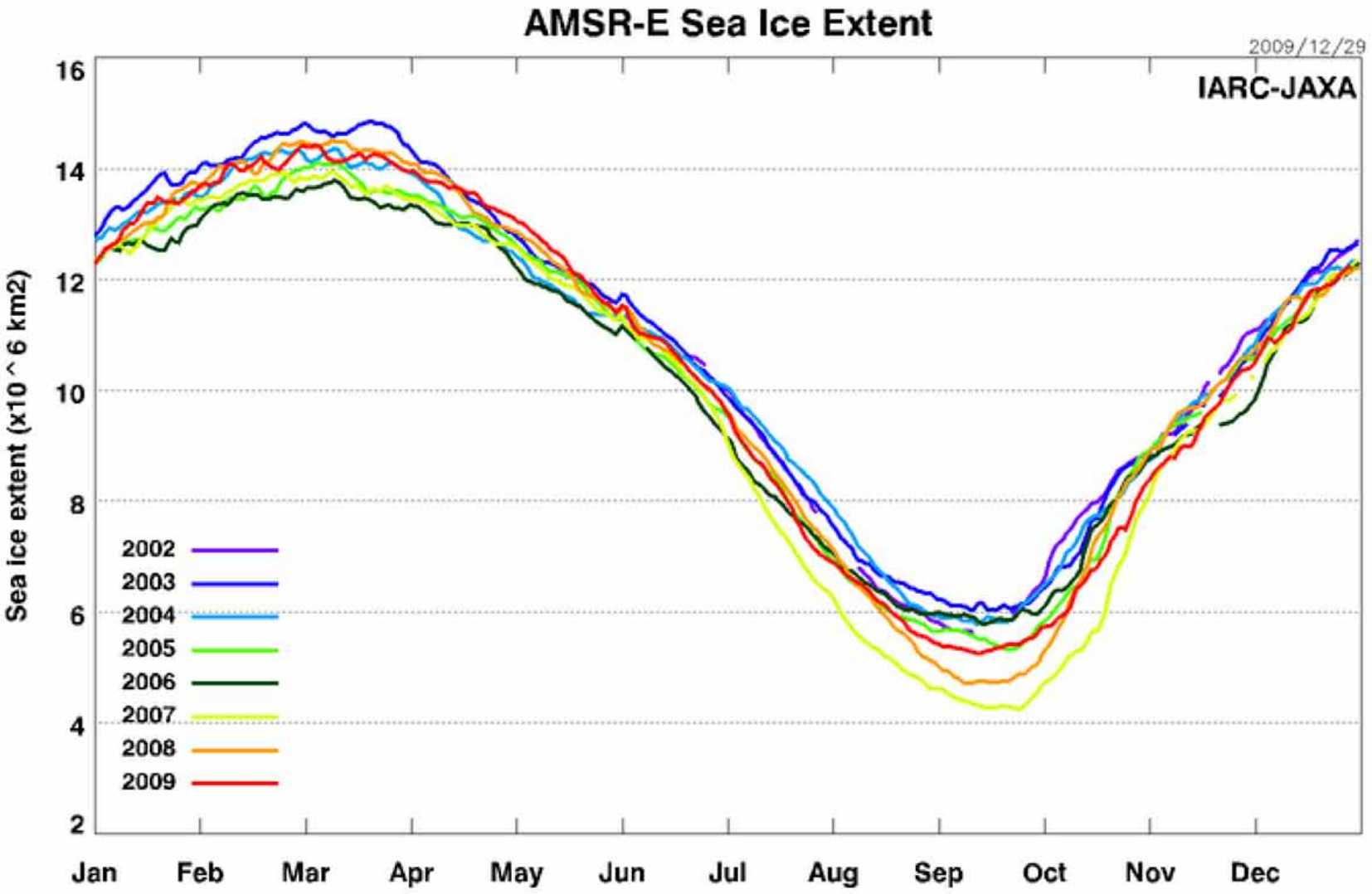
A simple example of how current approaches inhibit progress.

You have all heard about the arctic sea ice disappearing. Here is what is being spoken of.

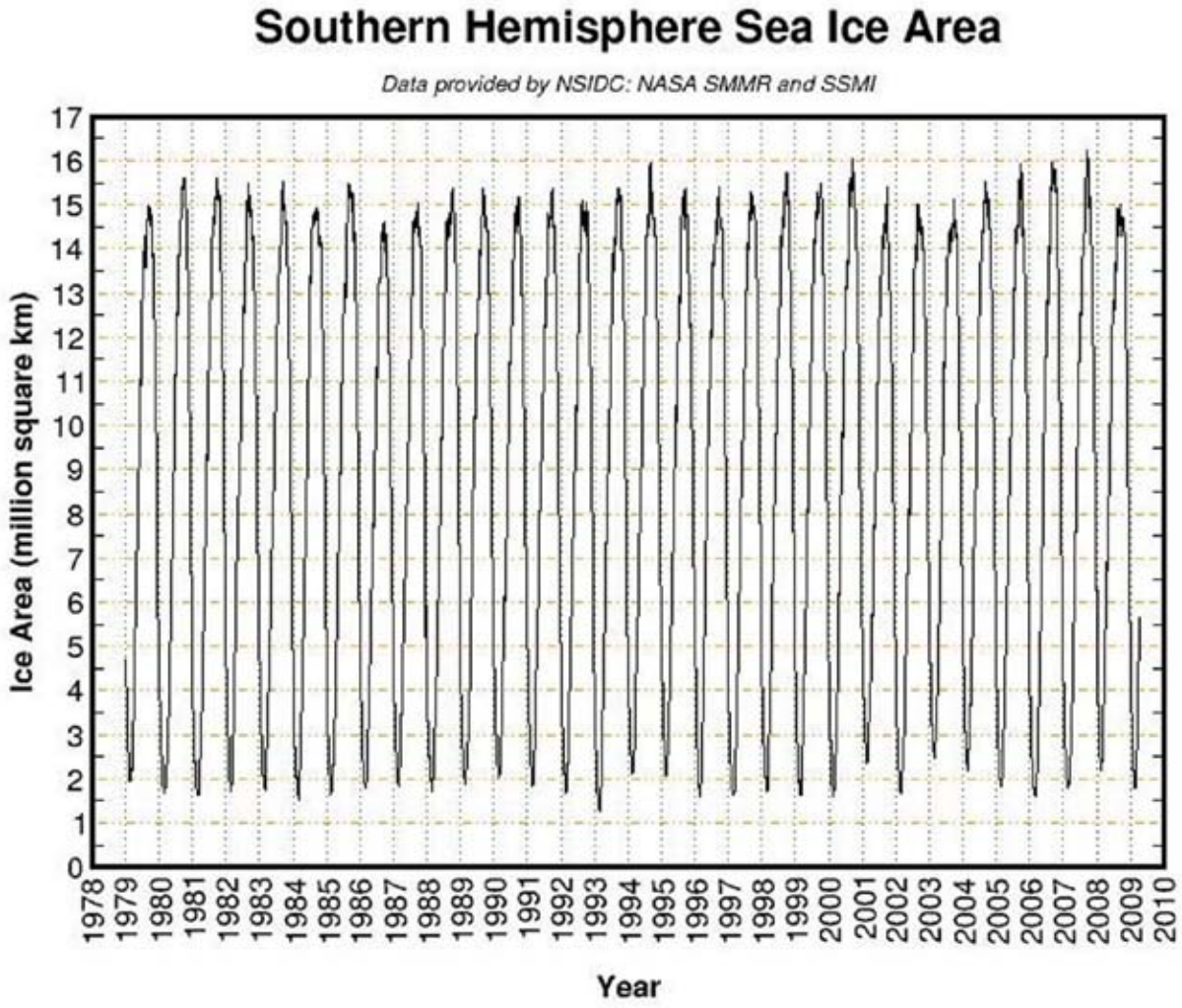


Data of Sea Ice Extent

The latest value : 12,232,969 km^2 (December 29, 2009)

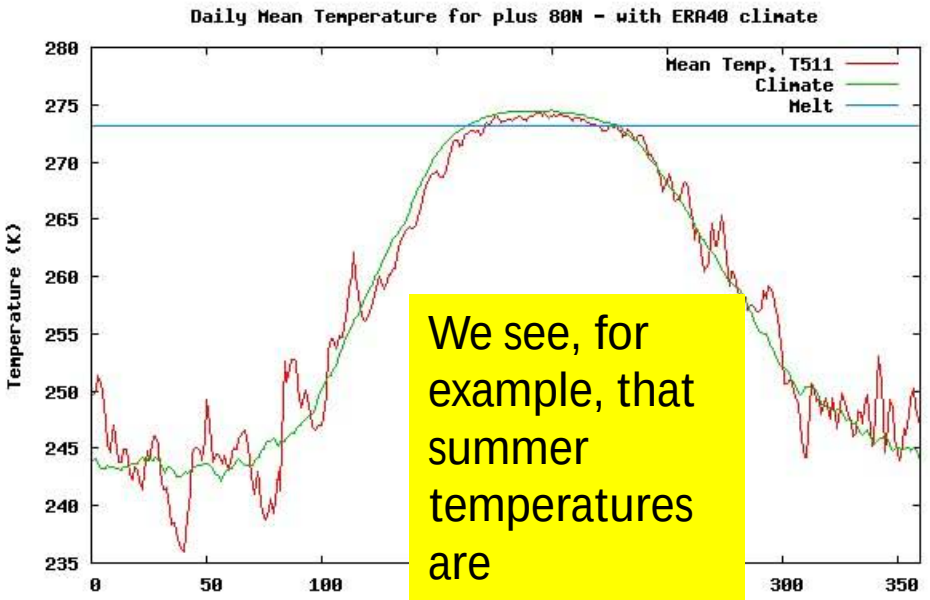


As you may have heard, nothing of the sort has been happening to Antarctic sea ice, although claims of record extent of Antarctic sea ice are also overly dramatic.

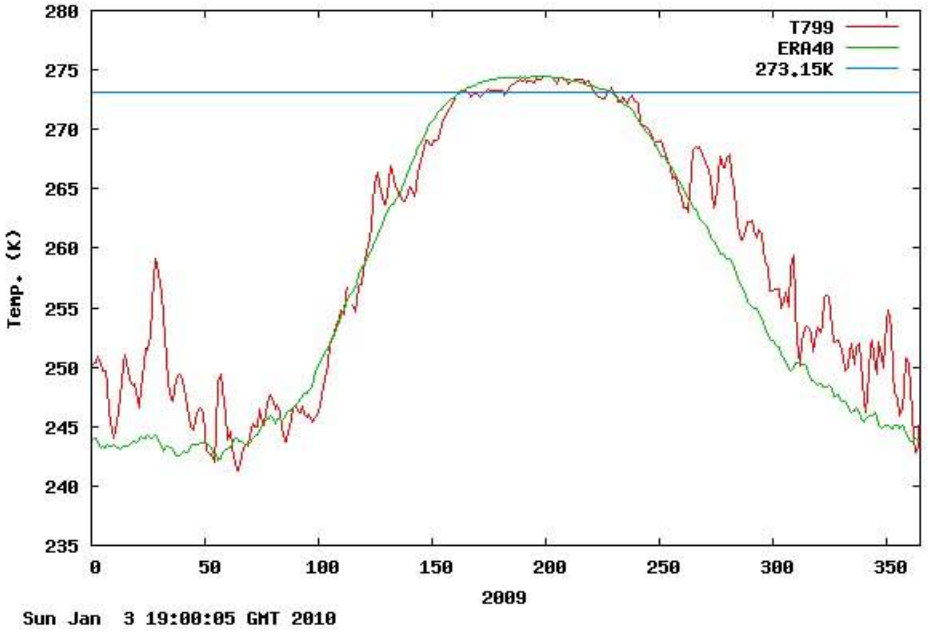


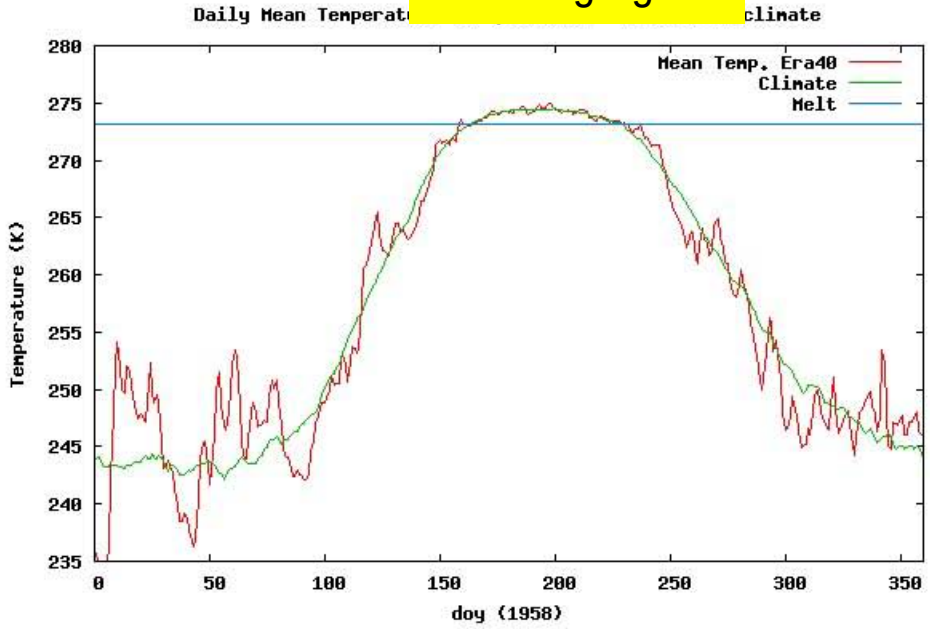
Let us now look at the temperature of polar regions in some detail. The following figures show daily arctic temperatures for each day available from reanalyses since 1958. They also show the average temperatures for each day.

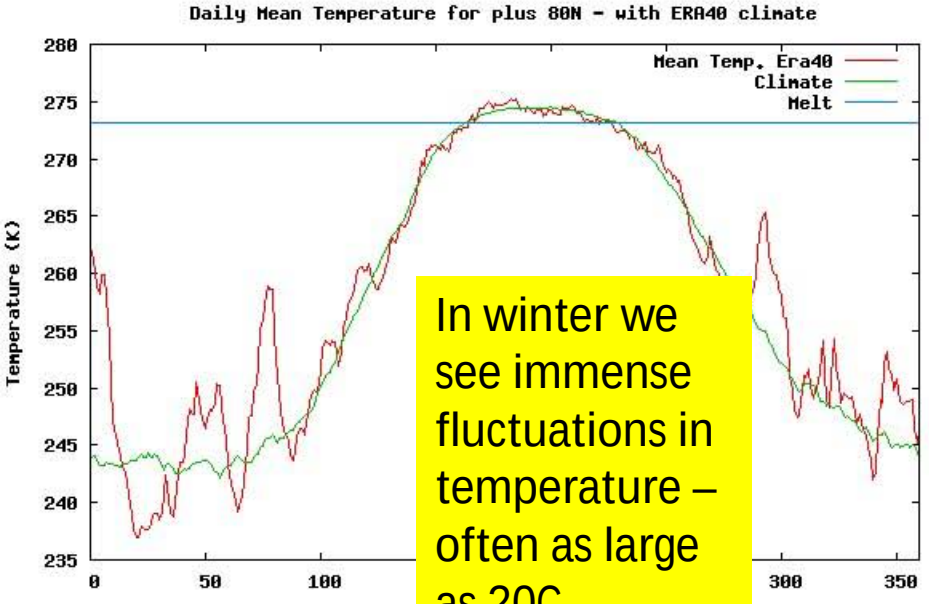
If one focuses on variations in annually averaged temperatures, one misses some crucial information, and that information tells us quite a lot.



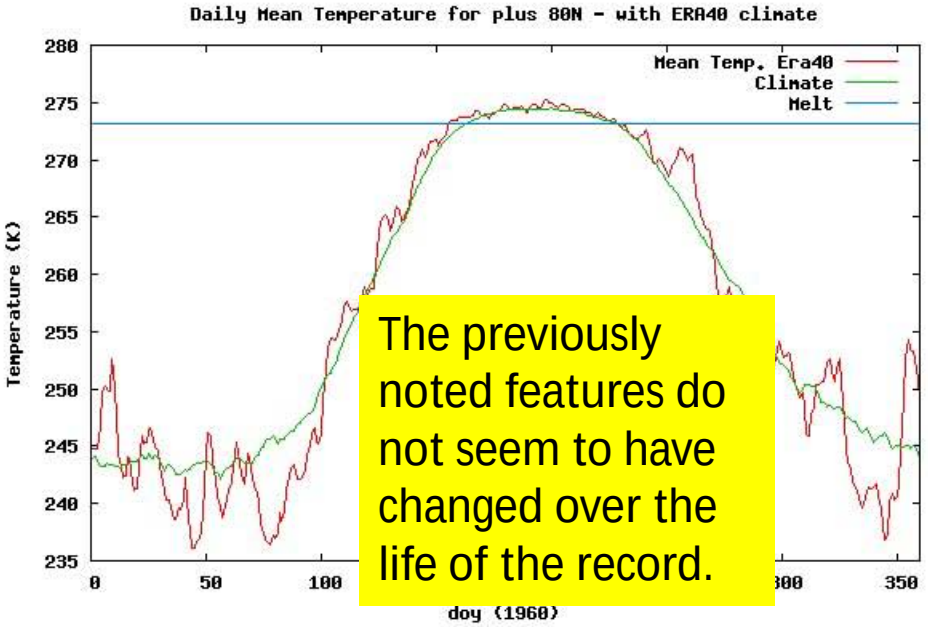
We see, for example, that summer temperatures are unchanging.



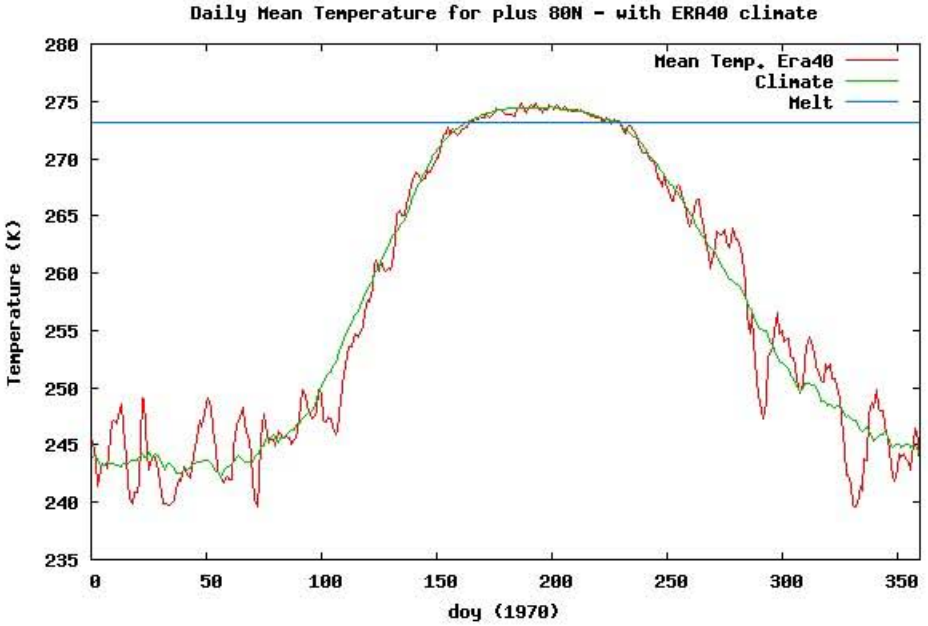


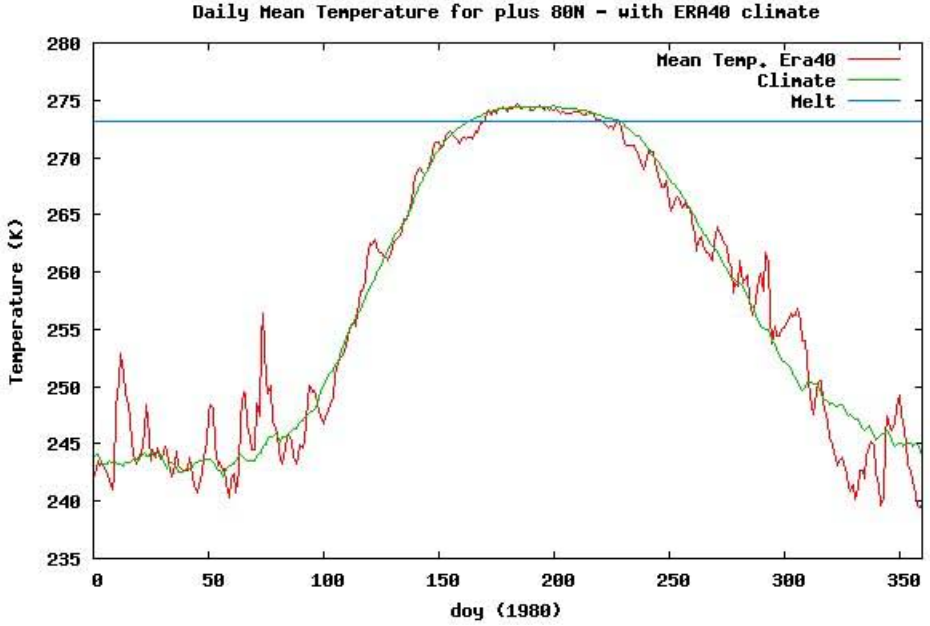


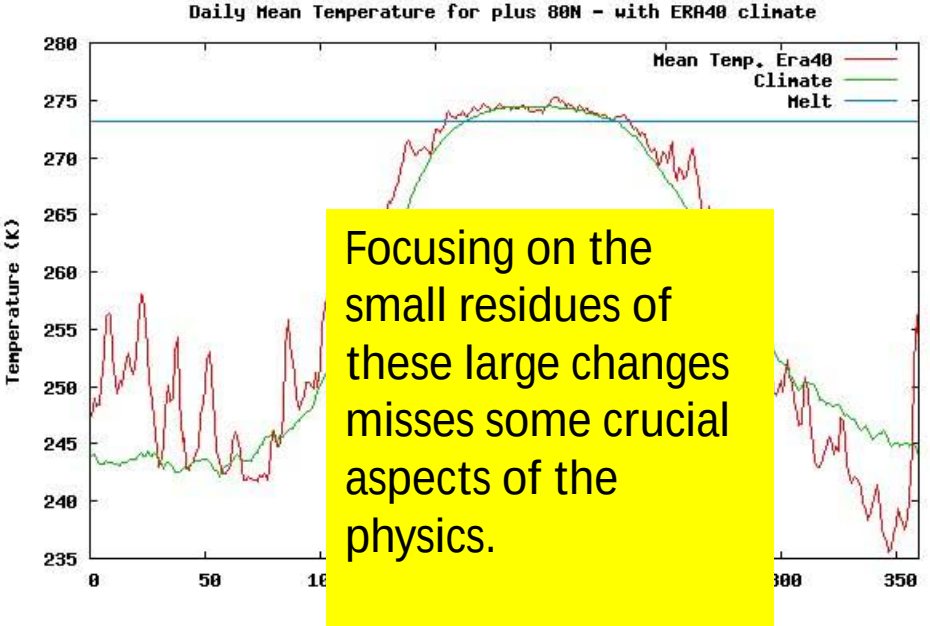
In winter we see immense fluctuations in temperature – often as large as 20C.



The previously noted features do not seem to have changed over the life of the record.







Focusing on the small residues of these large changes misses some crucial aspects of the physics.

What the previous slides illustrate is that during summers, when there is sunlight, temperatures are largely determined by local radiative balance and this does not seem to be changing. However, during the winter night, temperatures would be even colder than they are but for the transport of heat from lower latitudes. This transport is by the turbulent eddies or storms. Understanding arctic temperatures must involve understanding why these storms erratically penetrate to the arctic. Judging from the behavior of summer temperatures, CO_2 is not obviously a major player.

Just for the record, summer ice depends mostly on how much is blown out of the arctic basin – something that used to be textbook information.

While there really doesn't appear to be that much going on, anecdotal information can be more dramatic.

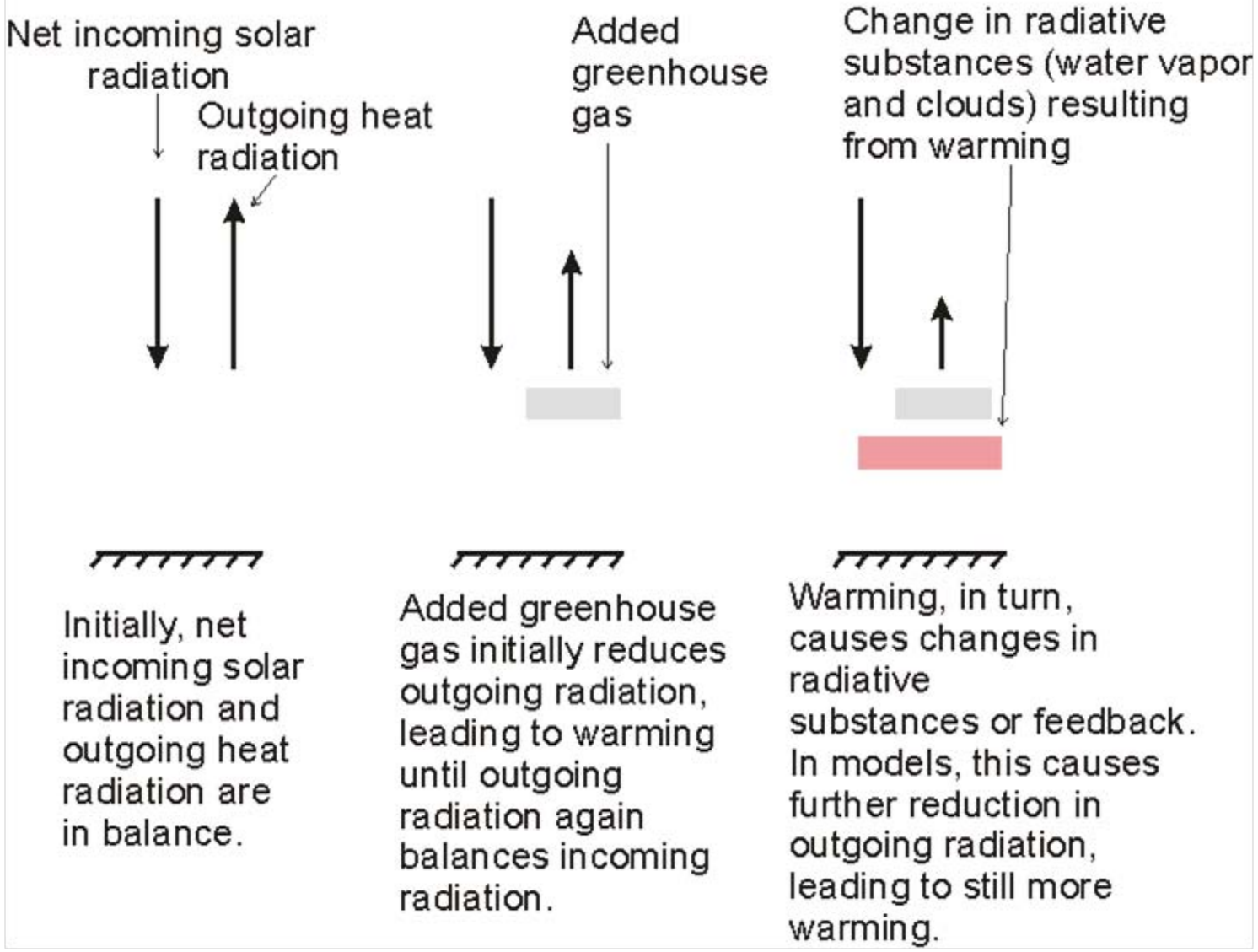
"THE ARCTIC OCEAN IS WARMING UP, ICEBERGS ARE GROWING SCARCER AND IN SOME PLACES THE SEALS ARE FINDING THE WATER TOO HOT. REPORTS ALL POINT TO A RADICAL CHANGE IN CLIMATE CONDITIONS AND HITHERTO UNHEARD-OF TEMPERATURES IN THE ARCTIC ZONE. EXPEDITIONS REPORT THAT SCARCELY ANY ICE HAS BEEN MET WITH AS FAR NORTH AS 81 DEGREES 29 MINUTES. GREAT MASSES OF ICE HAVE BEEN REPLACED BY MORAINES OF EARTH AND STONES, WHILE AT MANY POINTS WELL KNOWN GLACIERS HAVE ENTIRELY DISAPPEARED."

—US WEATHER BUREAU, 1922

In fact, the arctic is notoriously variable; similar statements are available for 1957, and the Skate surfaced at the N. Pole in 1959. So much for 'unprecedented.'

As already mentioned, it is essential to know climate sensitivity. Model predictions depend on positive feedbacks and not just the modest effect of CO_2. There follows a schematic of what we mean by feedbacks.

Feedback Schematic



One is able to use satellite data from ERBE and CERES (that measures net outgoing radiation in both the visible and infrared portions of the spectrum) to test the preceding situation, and to quantitatively evaluate climate feedback factors. These are related to climate sensitivity by the following equation:

$$\Delta T = \frac{\Delta T_0}{1 - f},$$

ΔT_0 is the zero feedback response to a doubling of CO_2. It is about 1C.

The basis of the approach is to see if the satellite measured outgoing radiation associated with short term fluctuations in Sea Surface Temperature (SST) is larger or smaller than what one gets for zero feedback. Remember that a positive feedback will lead to less outgoing radiation (increased blanket) while a negative feedback will lead to more.

It turns out that the model intercomparison program has the models used by the IPCC, forced by actual SST, calculate outgoing radiation. So one can use the same approach with models, while being sure that the models are subject to the same surface temperature fluctuations that applied to the observations.

Feedbacks as measured by ERBE and CERES
(after corrections described by Trenberth et al, 2009)

Mean+/-standard error of the variables.

	Variables	Value	Comments for likely lag
a	Slope, LW	5.2±1.3	Lag = 1
b	Slope, SW	2.2±3.0	Lag = 3
c	Slope, Total	7.1±2.2	= a+b for the same SST interval
d	f_{LW}	- 0.3±0.2	Calculated from a
e	f_{SW}	- 0.3±0.4	Calculated from b
f	f_{Total}	- 0.6±0.3	Calculated from c

Note that feedbacks are negative.

For all models, the feedbacks are positive.

		LW				SW				LW+SW			
	N	Slope	R	SE	f_{LW}	Slope	R	SE	f_{SW}	Slope	R	SE	f
CCSM3	19	1.5	0.4	1.8	0.3	-3.1	-0.5	2.2	0.5	-1.6	-0.3	2.7	**0.7**
ECHAM5/MPI-OM	18	2.8	0.6	1.7	0.1	-1.1	-0.2	3.1	0.2	1.7	0.3	3	**0.2**
FGOALS-g1.0	18	-0.2	-0.1	1.6	0.5	-2.8	-0.7	1.3	0.4	-3	-0.7	1.6	**1**
GFDL-CM2.1	18	1.5	0.6	1	0.3	-0.4	-0.1	2.8	0.1	1.1	0.2	2.5	**0.3**
GISS-ER	22	2.9	0.6	1.4	0.1	-3.3	-0.5	2.3	0.5	-0.5	-0.1	1.8	**0.6**
INM-CM3.0	24	2.9	0.6	1.5	0.1	-3.1	-0.6	1.7	0.5	-0.3	-0.1	1.9	**0.5**
IPSL-CM4	22	-0.4	-0.1	2.1	0.6	-2.6	-0.5	2	0.4	-3	-0.5	2.1	**0.9**
MRI-CGCM2.3.2	22	-1.1	-0.2	2.2	0.7	-3.9	-0.4	3.1	0.6	-5	-0.6	2.6	**1.2**
MIROC3.2(hires)	22	0.7	0.1	2.2	0.4	-2.1	-0.5	1.6	0.3	-1.4	-0.3	2.5	**0.7**
MIROC3.2(medres)	22	4.4	0.7	1.8	-0.2	-5.3	-0.7	2.3	0.8	-0.9	-0.2	1.9	**0.6**
UKMO-HadGEM1	19	5.2	0.7	2.2	-0.3	-5.9	-0.7	2.1	0.9	-0.8	-0.1	2.2	**0.6**

Note that much of the ‘error’ in the regressions arises because radiatively important factors like clouds and aerosols vary due to many factors apart from SST. For observations there is also instrumental error, though relative errors over short time scales are likely to small.

We see that all the models are characterized by positive feedback factors (associated with amplifying the effect of changes in CO_2), while the satellite data implies that the feedback should be negative. Similar results are being obtained by Roy Spencer.

This is not simply a technical matter. Without positive feedbacks, doubling CO_2 only produces 1C warming. Only with positive feedbacks from water vapor and clouds does one get the large warmings that are associated with alarm. What the satellite data seems to show is that these positive feedbacks are model artifacts.

This becomes clearer when we relate feedbacks to climate sensitivity (ie the warming associated with a doubling of CO_2).

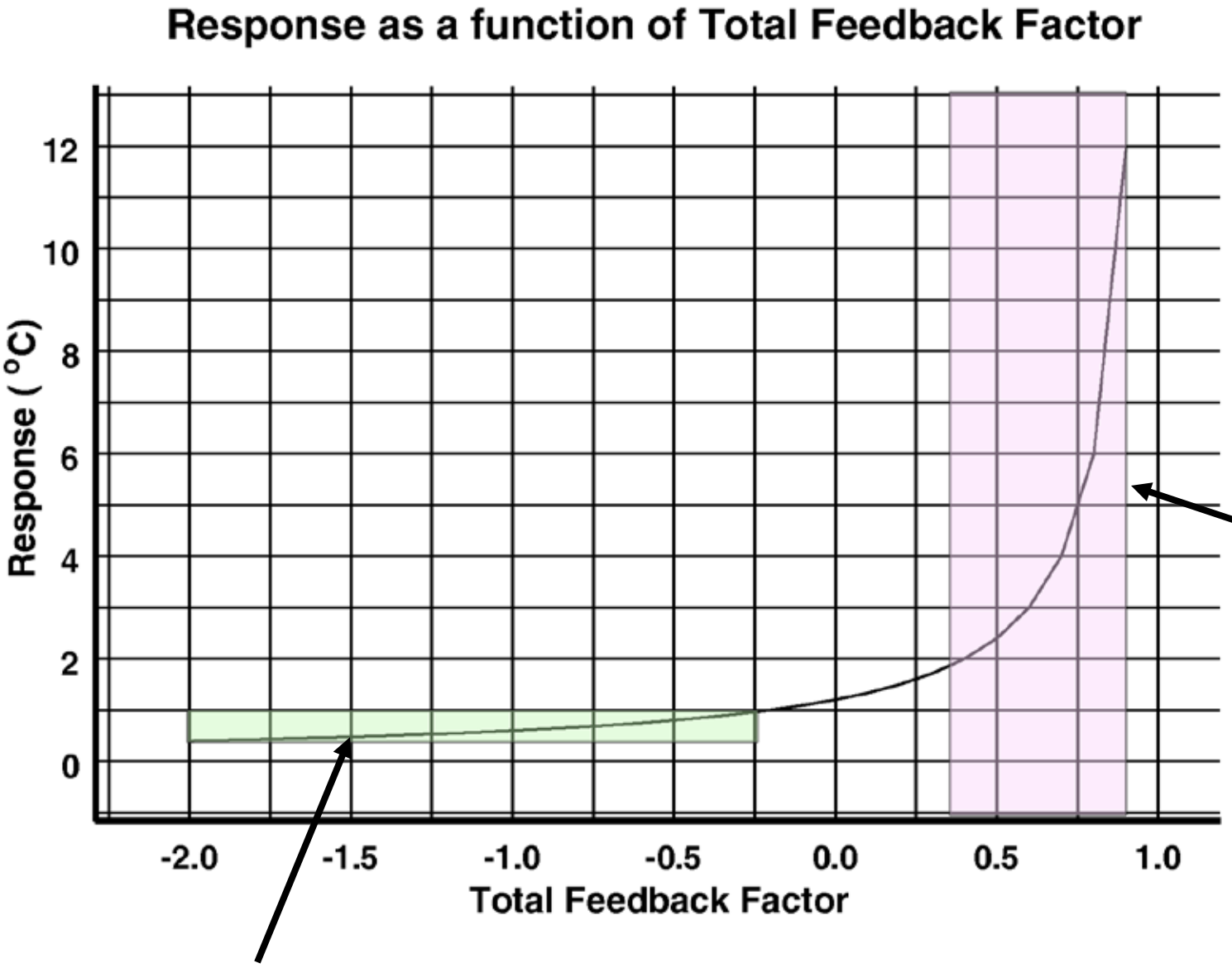
Models

Models	AR4 sensitivity	Sensitivity, mean	Sensitivity, 90%	Sensitivity, 95%
CCSM3	2.7	4.2	1.2 – Infinity	1.0 – Infinity
ECHAM5/MPI-OM	3.4	1.4	0.7 – 28.9	0.7 – Infinity
FGOALS-g1.0	2.3	22.4	2.4 – Infinity	2.1 – Infinity
GFDL-CM2.1	3.4	1.6	0.9 – 15.4	0.8 – Infinity
GISS-ER	2.7	2.5	1.2 – Infinity	1.1 – Infinity
INM-CM3.0	2.1	2.4	1.2 – Infinity	1.1 – Infinity
IPSL-CM4	4.4	19.5	1.9 – Infinity	1.6 – Infinity
MRI-CGCM2.3.2	3.2	Infinity	2.8 – Infinity	2.2 – Infinity
MIROC3.2(hires)	4.3	3.8	1.2 – Infinity	1.1 – Infinity
MIROC3.2(medres)	4	3.0	1.3 – Infinity	1.2 – Infinity
UKMO-HadGEM1	4.4	2.8	1.2 – Infinity	1.1 – Infinity

Observations

Sensitivity, mean	0.7	Calculated from f
Sensitivity, 90%	0.5-1.1	Twice standard error
Sensitivity, 95%	0.5-1.2	3 times standard error

$$\Delta T = \frac{\Delta T_0}{1 - f},$$



For positive feedbacks, relatively small variations in feedback lead to large changes in response.

It is the positive feedbacks in the models that leads to the uncertainty.

For negative feedbacks, large variations in the feedback lead to only small changes in response.

Discussion of other progress in science will be left to the Q&A session if there is any interest. Our recent work on the early faint sun may prove particularly important. 2.5 billion years ago, when the sun was 20% less bright (compared to the 2% change in the radiative budget associated with doubling CO_2), evidence suggests that the oceans were unfrozen and the temperature was not very different from today's. No greenhouse gas solution has worked, but a negative cloud feedback does.

You now have some idea of why I think that there won't be much warming due to CO_2, and without significant global warming, it is impossible to tie catastrophes to such warming. Even with significant warming it would have been extremely difficult.

Perhaps we should stop accepting the term, ‘skeptic.’ Skepticism implies doubts about a plausible proposition. Current global warming alarm hardly represents a plausible proposition. Twenty years of repetition and escalation of claims does not make it more plausible. Quite the contrary, the failure to improve the case over 20 years makes the case even less plausible as does the evidence from climategate and other instances of overt cheating.

In the meantime, while I avoid making forecasts for tenths of a degree change in globally averaged temperature anomaly, I am quite willing to state that unprecedented climate catastrophes are not on the horizon though in several thousand years we may return to an ice age.