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# How sensitive is our climate?

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**What the science says...**

|  |  |  |  |  |  |  |  |
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| Select a level... | [[http://www.skepticalscience.com/images/_core/other/level1.gif](http://www.skepticalscience.com/climate-sensitivity-basic.htm) Basic](http://www.skepticalscience.com/climate-sensitivity-basic.htm) |  | [[http://www.skepticalscience.com/images/_core/other/level2.gif](http://www.skepticalscience.com/climate-sensitivity-intermediate.htm) Intermediate](http://www.skepticalscience.com/climate-sensitivity-intermediate.htm) |  | http://www.skepticalscience.com/images/_core/other/level3.gif **Advanced** |  |  |
| Some global warming 'skeptics' argue that the Earth's climate sensitivity is so low that a doubling of atmospheric CO2 will result in a surface temperature change on the order of 1°C or less, and that therefore global warming is nothing to worry about. However, values this low are inconsistent with numerous studies using a wide variety of methods, including (i) paleoclimate data, (ii) recent empirical data, and (iii) generally accepted climate models. | | | | | | | |

**Climate Myth...**

Climate sensitivity is low  
"His [Dr Spencer's] latest research demonstrates that – in the short term, at any rate – the temperature feedbacks that the IPCC imagines will greatly amplify any initial warming caused by CO2 are net-negative, attenuating the warming they are supposed to enhance. His best estimate is that the warming in response to a doubling of CO2concentration, which may happen this century unless the usual suspects get away with shutting down the economies of the West, will be a harmless 1 Fahrenheit degree, not the 6 F predicted by the IPCC." ([Christopher Monckton](http://sppiblog.org/news/yes-we-have-no-bananas))

Climate sensitivity describes how sensitive the global climate is to a change in the amount of energy reaching the Earth's surface and lower atmosphere (a.k.a. a radiative forcing).  For example, we know that if the amount of carbon dioxide (CO2) in the Earth's atmosphere doubles from the pre-industrial level of 280 parts per million  by volume (ppmv) to 560 ppmv, this will cause an energy imbalance by trapping more outgoing thermal radiation in the atmosphere, enough to directly warm the surface approximately 1.2°C.  However, this doesn't account for feedbacks, for example ice melting and making the planet less reflective, and the warmer atmosphere holding more water vapor (another greenhouse gas).

**Climate sensitivity is** the amount the planet will warm when accounting for the various feedbacks affecting the global climate.  The relevant formula is:

dT = λ\*dF

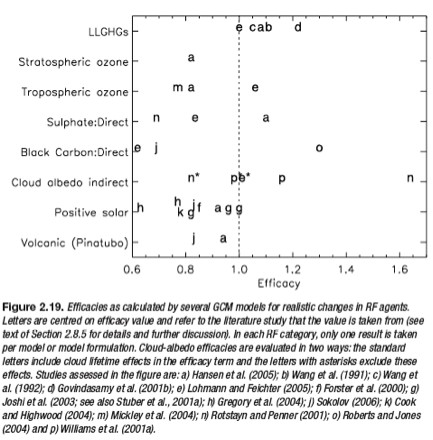
Where

1. 'dT' is the change in the Earth's average surface temperature, 'λ' is the climate sensitivity, usually with units in Kelvin or degrees Celsius per Watts per square meter (°C/[W m-2]), and
2. 'dF' is the [change in (amount of)]  radiative forcing, [over the same time interval]

which is discussed in further detail in the [Advanced rebuttal to the 'CO2 effect is weak' argument](http://www.skepticalscience.com/empirical-evidence-for-co2-enhanced-greenhouse-effect-advanced.htm).

**Climate sensitivity is not specific to CO2**

It's important to note that the surface temperature change is proportional to the sensitivity and radiative forcing (in W m-2), regardless of the source of the energy imbalance. The climate sensitivity to different radiative forcings differs depending on the [efficacy](http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf) of the forcing, but the climate is not significantly more sensitive to other radiative forcings besides greenhouse gases.



*Figure 1: Efficacies of various radiative forcings as calculated in numerous different studies (*[*IPCC 2007*](http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf)*)*

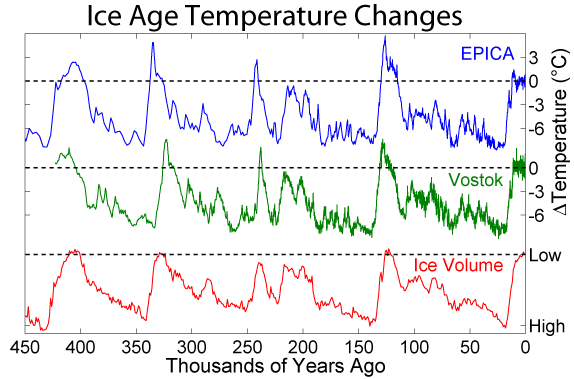
In other words, if you argue that the Earth has a low climate sensitivity to CO2, [

“Earth has a low climate sensitivity to CO2” Is a meaningless statement, which cannot, then, be true or false! (Climate Sensitivity *by definition* does not vary by any subset of it’s probable components but instead by the aggregate of all of them – known and unknown!!

If, instead the writer meant  
“Earth’s climate sensitivity cannot be significantly altered by even dramatic reductions to the CO2 contribution to it.”  
then

1. the statement’s truth or falsity is worthy of debate, and
2. the foolishness of the rest of this paragraph becomes apparent!!

] you are also arguing for a low climate sensitivity to other influences such as solar irradiance, orbital changes, and volcanic emissions.  In fact, as shown in Figure 1, the climate is less sensitive to changes in solar activity than greenhouse gases.  Thus [not thus!! this sentence is a truism!] when arguing for low climate sensitivity, it becomes difficult to explain past climate changes. For example, between glacial and interglacial periods, the planet's average temperature changes on the order of 6°C (more like 8-10°C in the Antarctic).  If the climate sensitivity is low, for example due to increasing low-lying cloud cover reflecting more sunlight as a response to global warming, then how can these large past climate changes be explained?

[](http://globalwarmingart.com/images/8/8f/Ice_Age_Temperature_Rev.png)

*Figure 2: Antarctic temperature changes over the past 450,000 years as measured from ice cores*

**What is the possible range of climate sensitivity?**

The [IPCC Fourth Assessment Report](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm) summarized climate sensitivity as *"likely to be in the range 2 to 4.5°C with a best estimate of about 3°C, and is very unlikely to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded, but agreement of models with observations is not as good for those values*."  
  
Individual studies have put climate sensitivity from a doubling of CO2 at anywhere between 0.5°C and 10°C; however, as a consequence  of increasingly better data, it appears that the extreme higher and lower values are very unlikely.  In fact, as climate science has developed and advanced over time , estimates have converged around 3°C. A summary of recent climate sensitivity studies can be found [here](http://en.wikipedia.org/wiki/Climate_sensitivity#Other_estimates).

A study led by Stefan Rahmstorf concluded *"many vastly improved models have been developed by a number of climate research centers around the world. Current state-of-the-art climate models span a range of 2.6–4.1°C, most clustering around 3°C"*([Rahmstorf 2008](http://www.pik-potsdam.de/~stefan/Publications/Book_chapters/Rahmstorf_Zedillo_2008.pdf" \t "_self" \o "Rahmstorf 2008)).  Several studies have put the lower bound of climate sensitivity at about 1.5°C,on the other hand, several others have found that a sensitivity higher than 4.5°C can't be ruled out.  
  
A [2008 study led by James Hansen](http://pubs.giss.nasa.gov/docs/2008/2008_Hansen_etal.pdf) found that climate sensitivity to "fast feedbackprocesses" is 3°C, [ “only” a 100 years”? or what?] but when accounting for longer-term feedbacks (such as

* ice sheetdisintegration,
* vegetation migration, and
* greenhouse gas release from soils, tundra or ocean),

if atmospheric CO2 remains at the doubled level, the sensitivity increases to 6°C based on paleoclimatic (historical climate) data. [There should be a debate about whether to count these longer term things *at all*! See Tom Curtis@314]

**What are the limits on the climate sensitivity value?**

**Paleoclimate**

The main limit on the sensitivity value is that it has to be consistent with paleoclimatic data.  A sensitivity which is too low will be inconsistent with past climate changes - basically if there is some large negative feedback which makes the sensitivity too low, it would have prevented the planet from transitioning from ice ages to interglacial periods, for example.  Similarly a high climate sensitivity would have caused more and larger past climate changes.  
  
One recent study examining the Palaeocene–Eocene Thermal Maximum (about 55 million years ago), during which the planet warmed 5-9°C, found that *"At accepted values for the climate sensitivity to a doubling of the atmospheric CO2 concentration, this rise in CO2 can explain only between 1 and 3.5°C of the warming inferred from proxy records"* ([Zeebe 2009](http://www.nature.com/ngeo/journal/v2/n8/abs/ngeo578.html" \t "_self" \o "Zeebe 2009)).  This suggests that climate sensitivity may be higher than we currently believe, but it likely isn't lower.

**Recent responses to large volcanic eruptions**

Climate scientists have also attempted to estimate climate sensitivity based on the response to recent large volcanic eruptions, such as Mount Pinatubo in 1991.  [Wigley et al. (2005)](http://www.agu.org/pubs/crossref/2005/2004JD005557.shtml) found:

"Comparisons of observed and modeled coolings after the eruptions of Agung, El Chichón, and Pinatubo give implied climate sensitivities that are consistent with the Intergovernmental Panel on Climate Change (IPCC) range of 1.5–4.5°C. The cooling associated with Pinatubo appears to require a sensitivity above the IPCC lower bound of 1.5°C, and none of the observed eruption responses rules out a sensitivity above 4.5°C."

Similarly, [Forster et al. (2006)](http://homepages.see.leeds.ac.uk/~earpmf/papers/ForsterandGregory2006.pdf)concluded as follows.

"A climate feedback parameter of 2.3 +/- 1.4 W m-2 K-1 is found. This corresponds to a 1.0–4.1 K range for the equilibrium warming due to a doubling of carbon dioxide"

**Recent responses to the 11-year solar cycle**

[Tung and Camp (2007)](http://www.amath.washington.edu/research/articles/Tung/journals/solar-jgr.pdf) noted that

"the annual rate of increase in radiative forcing of the lower atmosphere from solar min to solar max happens to be equivalent to that from a 1% per year increase in greenhouse gases, a rate commonly used in greenhouse-gas emission scenarios [Houghton and et al., 2001]. So it is interesting to compare the magnitude and pattern of the observed solar-cycle response to the transient warming expected due to increasing greenhouse gases in five years."

Tung and Camp were thus able to use satellite-based solar data over 4.5 cycles to calculate an observationally-determined model-independent climate sensitivity of 2.3-4.1°C for a doubling of CO2.

**Empirical or 'Instrumental' Observation Methods**

[Gregory et al. (2002)](http://www.gfdl.noaa.gov/bibliography/related_files/jmgregory0201.pdf) used observed interior-ocean temperature changes, surface temperature changes measured since 1860, and estimates of anthropogenic and natural radiative forcing of the climate system to estimate its climate sensitivity.  They found:

"...we obtain a 90% confidence interval, whose lower bound (the 5th percentile) is 1.6 K. The median is 6.1 K, above the canonical range of 1.5–4.5 K; the mode is 2.1 K."

Recently, several other studies have taken a similar approach and yielded lower equilibrium climate sensitivity estimates, i.e. [Ring et al. (2012)](http://www.scirp.org/journal/PaperInformation.aspx?paperID=24283), [Aldrin et al. (2012)](http://scholar.google.com/scholar?cluster=11325330356963596372&hl=en&as_sdt=0,48&as_ylo=2012), [Lewis (2013)](http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00473.1), and [Otto et al. (2013)](http://www.nature.com/ngeo/journal/v6/n6/full/ngeo1836.html), in most cases with central estimates closer to 2°C for a doubling of CO2.

However, [Shindell (2014)](http://www.nature.com/doifinder/10.1038/nclimate2136) reconciles the difference between the climate sensitivity estimates in these varying approaches.  Shindell notes that the 'empircal' or 'instrumental' approach studies assume that the global mean temperature response to all forcings is equal.  His study investigates this assumption by comparing climate model temperature responses to greenhouse gases with their responses to aerosols and ozone.

Shindell, who was a co-author on Otto et al. (2013), notes that “*forcing in the NHextratropics*[above 30° latitude]*causes a greater global mean temperature response than forcing in the tropic*s”; a result noted by [Hansen et al. (1997)](http://onlinelibrary.wiley.com/doi/10.1029/96JD03436/abstract;jsessionid=921F4B89A33198CC929A8F7ADEDD5A81.f01t03?deniedAccessCustomisedMessage=&userIsAuthenticated=false):

*“A forcing at high latitudes yields a larger response than a forcing at low latitudes. This is expected because of the sea ice feedback at high latitudes and the more stable lapse rate at high latitudes****”***

The forcing from aerosols and ozone isn’t globally uniform, but instead focused more in the northern hemisphere extratropics.  Hence it results in a relatively larger temperature response than an equivalent forcing from greenhouse gases, which are well mixed throughout the atmosphere.

When assuming equal sensitivity to all forcings, Shindell estimates the transient climate response (TCR) at 1.0–2.1°C, most likely 1.4°C, which is similar to the estimate in Otto et al. (2013).  However, when Shindell accounts for the higher sensitivity to the aerosol andozone forcings, the estimated TCR range rises to 1.3–3.2°C, most likely 1.7°C.  Compared to the IPCC estimated TCR range of 1–2.5°C, and the range in climate models of 1.1–2.6°C, Shindell's results give a low probability for the low end of the range and higher probability for the high end.  Given the strong correlation between TCR and equilibrium climate sensitivity, Shindell’s results also suggest that the lower climate sensitivity estimates are unlikely to be accurate.

**Examining Past Temperature Projections**

In 1988, NASA climate scientist Dr James Hansen produced a groundbreaking study in which he produced a global climate model that calculated future warming based on three different CO2 emissions scenarios labeled A, B, and C ([Hansen 1988](http://pubs.giss.nasa.gov/docs/1988/1988_Hansen_etal.pdf)).   Now, after more than 20 years, we are able to review Hansen’s projections.

Hansen's model assumed a rather high climate sensitivity of 4.2°C for a doubling of CO2.  His Scenario B has been the closest to reality, with the actual total radiative forcing being about [10% higher](http://www.realclimate.org/index.php/archives/2009/12/updates-to-model-data-comparisons/) than in this emissions scenario.  The warming trend predicted in this scenario from 1988 to 2010 was about [0.26°C per decade](http://www.realclimate.org/index.php/archives/2009/12/updates-to-model-data-comparisons/) whereas the measured temperature increase over that period was approximately [0.18°C per decade](http://data.giss.nasa.gov/gistemp/graphs/Fig.A2.lrg.gif), or about 40% lower than Scenario B.

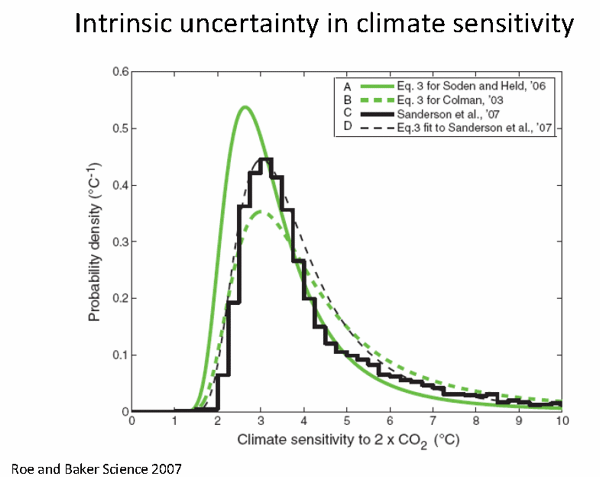
Therefore, what Hansen's models and the real-world observations tell us is that climate sensitivity is about 40% below 4.2°C, or once again, right around **3°C** for a doubling of atmospheric CO2.  For further details, see the [Advanced rebuttal to "Hansen's 1988 prediction was wrong."](http://www.skepticalscience.com/Hansen-1988-prediction-advanced.htm)

**Probabilistic Estimate Analysis**

[Annan and Hargreaves (2009)](http://www.jamstec.go.jp/frsgc/research/d5/jdannan/probrevised.pdf) investigated various probabilistic estimates of climate sensitivity, many of which suggested a "worryingly high probability" (greater than 5%) that the sensitivity is in excess of than 6°C for a doubling of CO2.  Using a Bayesian statistical approach, this study concluded that

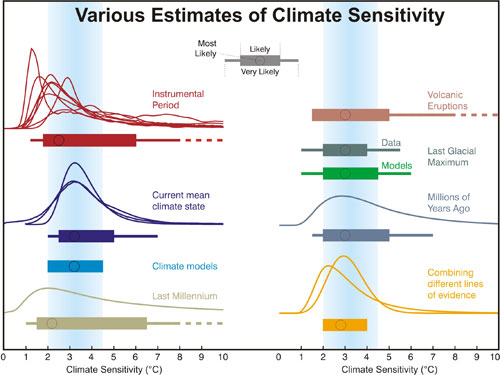
"the long fat tail that is characteristic of all recent estimates of climate sensitivity simply disappears, with an upper 95% probability limit...easily shown to lie close to 4°C, and certainly well below 6°C."

Annan and Hargreaves concluded that the climate sensitivity to a doubling of atmospheric CO2 is probably [close to 3°C](http://julesandjames.blogspot.com/2006/03/climate-sensitivity-is-3c.html), it may be higher, but it's probably not much lower.

[](http://www.skepticalscience.com/pics/RoeBaker.jpg)  
   
*Figure 3: Probability distribution of climate sensitivity to a doubling of atmospheric CO2*

**Summary of these results**

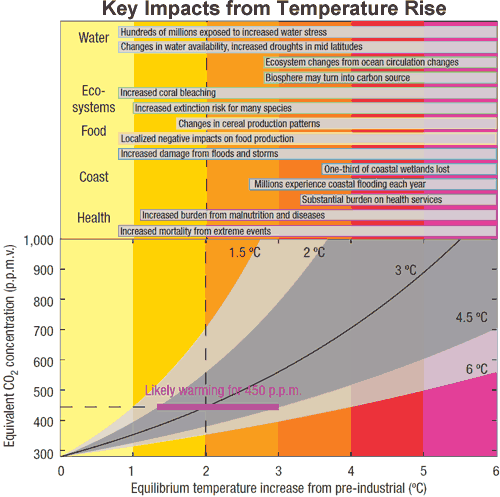
[Knutti and Hegerl (2008)](http://www.iac.ethz.ch/people/knuttir/papers/knutti08natgeo.pdf) presents a comprehensive, concise overview of our scientific [ understanding of climate sensitivity.  In their paper, they present a figure which neatly encapsulates how various methods of estimating climate sensitivity examining different time periods have yielded consistent results, as the studies described above show.  As you can see, the various methodologies are generally consistent with the range of 2-4.5°C, with few methods leaving the possibility of lower values, but several unable to rule out higher values.

[](http://www.skepticalscience.com/graphics/Climate_Sensitivity_500.jpg)

*Figure 4: Distributions and ranges for climate sensitivity from different lines of evidence. The circle indicates the most likely value. The thin colored bars indicate very likely value (more than 90% probability). The thicker colored bars indicate likely values (more than 66% probability). Dashed lines indicate no robust constraint on an upper bound. The IPCC likely range (2 to 4.5°C) is indicated by the vertical light blue bar.*

**What Does it all Mean?**

According to a [recent MIT study](http://globalchange.mit.edu/pubs/abstract.php?publication_id=990), we're currently on pace to reach this doubled atmospheric CO2 level by the mid-to-late 21st century.

[](http://www.greenoptions.com/image/id/17628/width/1000/height/800)  
*Figure 5: Projected decadal mean concentrations of CO2.  Red solid lines are median, 5%, and 95% for the MIT study, the dashed blue line is the same from the 2003 MIT projection.*  
   
So unless we change course, we're looking at a rapid warming over the 21st century.  Most climate scientists agree that a 2°C warming is the 'danger limit'.   Figure 5 shows temperature rise for a given CO2 level. The dark grey area indicates the climate sensitivity likely range of 2 to 4.5°C.  
   
[](http://www.skepticalscience.com/images/Key_Impacts.gif)   
*Figure 6: Relation between atmospheric CO2 concentration and key impacts associated with equilibrium global temperature increase. The most likely warming is indicated for climate sensitivity 3°C (black solid). The likely range (dark grey) is for the climate sensitivityrange 2 to 4.5°C. Selected key impacts (some delayed) for several sectors and different temperatures are indicated in the top part of the figure ([Knutti and Hegerl 2008](http://www.iac.ethz.ch/people/knuttir/papers/knutti08natgeo.pdf" \t "_self))*

If we manage to stabilize CO2 levels at 450 ppmv (the atmospheric CO2 concentration as of 2010 is about [390 ppmv](http://www.esrl.noaa.gov/gmd/ccgg/trends/#global)), according to the best estimate, we have a probability of less than 50% of meeting the 2°C target. The key impacts associated with 2°C warming can be seen at the top of Figure 6. The tight constraint on the lower limit of climate sensitivity indicates we're looking down the barrel of significant warming in future decades.

[There is NO need to discuss impacts (how bad this is), in this context, if what we can do in the near future about CO2 in the atmosphere will not significantly increase that 50%. THAT is what we should talk about next. Dicsussing climate sensitivity or climate sensitivity re CO2 and CO2 policy has nothing, directly, to do with costal flooding!]

As the scientists at [RealClimate put it,](http://www.realclimate.org/index.php/archives/2009/04/hit-the-brakes-hard/" \t "_blank)

"Global warming of 2°C would leave the Earth warmer than it has been in millions of years, a disruption of climate conditions that have been stable for longer than the history of human agriculture. Given the drought that already afflicts Australia, the crumbling of the sea ice in the Arctic, and the increasing storm damage after only 0.8°C of warming so far, calling 2°C a danger limit seems to us pretty cavalier."

Advanced rebuttal written by dana1981

**Update July 2015:**

Here is a related lecture-video from [Denial101x - Making Sense of Climate Science Denial](https://www.edx.org/course/making-sense-climate-science-denial-uqx-denial101x-0)

Last updated on 5 July 2015 by pattimer. [View Archives](http://www.skepticalscience.com/archive.php?a=115&l=3)

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**Related Arguments**

* [There's no empirical evidence](http://www.skepticalscience.com/empirical-evidence-for-global-warming.htm)
* [CO2 effect is saturated](http://www.skepticalscience.com/saturated-co2-effect.htm)

**Further reading**

Tamino posts a useful article [Uncertain Sensitivity](http://web.archive.org/web/20080501120935/tamino.wordpress.com/2007/10/27/uncertain-sensitivity/) that looks at how positive feedbacks are calculated, explaining why the probability distribution of climate sensitivity has such a long tail.

There have been a number of critiques of Schwartz' paper:

* Bursting out of the blocks was [James Annan's critique](http://julesandjames.blogspot.com/2007/08/schwartz-sensitivity-estimate.html). He followed this up with a [more detailed critique](http://julesandjames.blogspot.com/2007/09/comment-on-schwartz.html).
* Tamino guests posts at Real Climate with [Climate Insensitivity](http://www.realclimate.org/index.php/archives/2007/09/climate-insensitivity/).
* A comment was submitted to the Journal of Geophysical Research by [Grant Foster, James Annan, Gavin Schmidt and Michael E. Mann](http://www.jamstec.go.jp/frsgc/research/d5/jdannan/comment_on_schwartz.pdf).

Comments

# COMMENTS PAGE 1

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Comments 1 to 50 out of 370:

1. **horatio algeranon** at [14:50 PM on 22 October, 2007](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#71)

Hi John,  
  
Excellent blog.   
  
With regard to the climate sensitivity issue, I did an analysis based on Schwartz' assumptions for climate sensitivity (1.1 deg C) and time constant (5 yrs) [described here.](http://halgeranon.blogspot.com/2007/10/climate-sensitivity.html)  
  
I wanted to see what kind of warming (due to CO2) that his assumptions would predict for the past 3 decades and how that compares to what actually happened. His predicted result does not appear to jibe with what actually happened.

1. **GMB** at [13:51 PM on 29 December, 2007](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#205)

Do all of these people make the same basic mistakes as Annan? That is to assume CO2-warming with reference to volcanic cooling or solar warming?  
  
Annans snapshot of 20,000 years ago is an example of studiously IGNORING the empirical evidence rather than empirically showing anything. We know that glaciations come and go. We also know that the CO2 FOLLOWS AND DOES NOT LEAD the changes in temperature. So for him to grab that snapshot in time was just him filling out a troika of Unscience and non-evidence.  
  
Hopefully someone will let me know if any actual evidence is contained in any of the studies.

1. **[frankbi](http://ijish.livejournal.com/)** at [12:33 PM on 14 April, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#643)

So what method do you propose, GWB?

1. **Quietman** at [16:00 PM on 9 August, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1169)

GMB  
Apparently you have some good backup out there. The last 3 papers I read on prior warming maximums all said that CO2 lagged temps by quite a bit. Dr. R. Spencer of NASA is explaining to congress that the sensitivity is much less than what the IPCC says it is.

1. **chris** at [21:26 PM on 7 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1711)

Re #2 GMB  
  
You've got that wrong. Schwartz is the one that is using very short time series (largely 40-50 year periods in the 20th century) to estimate his "sensitivity". Your comments about CO2 and its relation to temperature change during ice age cycle transitions are not relevant in the manner that you might wish your capitalized phrase to insinuate.  
  
There are two essential methods of determining climate sensitivity in relation to real world measurements (a third would be to use a completely theoretical analysis). These are:  
  
(i) Determination of the relationship between equilibrium temperature and atmospheric CO2 from paleodata. This is in principle preferable since the analyis can be made with respect to "equilibrium" situations. i.e. since the climate sensitivity relates explicitly to the earth's surface temperature rise AT EQUILIBRIUM per doubling of atmospheric CO2, this should give us the more accurate analysis. Unfortunately there are uncertainties due to the uncertainties in the paleodata.  
  
(ii) The second is to eschew equilibrium measurements and monitor the temperature response to enhanced greenhouse forcing as the temperature rises TOWARDS it's new equilibrium temperature. Simplistically (and Schwartz has used this simplisitic approach) one considers that there will be a hyperbolic rise to a new equilibrium temperature. A regular hyperbola is characterized by its MAXIMUM VALUE at equilibrium (in this case the climate sensitivity) and a TIME CONSTANT that characterises the rate at which equilibrium is achieved. Obviously if the maximum (equilibrium) hasn't been reached one needs to estimate the parameters defining the "shape" of the response.  
  
Schwartz makes several errors and unrealistic asumptions that are outlined in some of the links in John's top post. He uses detrended time series of 20th century temperature trends, makes an unrealistic assumption that the climate system response can be characterised by a single exponential (one time constant), and comes up with a time constant of 5 years. Unfortunately his detrending smooths out the longer time constants that alomst certainly apply to the system.   
  
In essence he's attempting to pursue the conclusion that we've had much of the warming due to the increased forcing already. However if more realistic multiple time constant series are used (i.e. his data are heavily biased towards the very rapid time constant(s) for atmospheric warming in response, for example, to volcanic eruptions, the less rapid time constant for ocean surface warming and so on), his climate sensitivty value increase rather markedly. And since the oceans are a repository of thermal inertia limit a rapid re-equilibration of the earth's surface temperature, it's rather more valid to include long time constants when considering the EQUILIBRIUM response of the Earth's temperature to greenhouse warming.  
  
In fact if a rather more realistic time constant of 15 years is used, Schwartz's climate sensitivty becomes near 3°C per doubling of atmospheric CO2, pretty much equivalent to all of the other published data.   
  
It's pretty clear from reading Schwartz's paper that he realises that his analysis is extremely oversimplified.   
  
I'm not sure what you consider to be the relevance of the fact that warming leads rising atmospheric CO2during the glacial-interglacial transitions for this analysis. The aim of all of these analysis is to determine the best estimate of the climate sensitivity to rising atmospheric CO2 levels. The source of the rise in atmospheric CO2 is not really relevant for these analyses...  
  
  
  
PS: Having read what I've written before posting it, I realize I've said quite a bit of what John Cook has already said in his top article !

1. **Patrick 027** at [11:27 AM on 8 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1724)

Response to comment 62 (Quietman) in "It's volcanoes (or lack thereof)":  
  
"You still assume AGW is a big player and I do not. [Aha, a denier lurking about!] See the sensitivity thread. "  
  
No, I don't assume, I conclude. There isn't much more I could say about that, after:  
  
http://blogs.abcnews.com/scienceandsociety/2008/07/tropical-storm.html  
  
http://blogs.abcnews.com/scienceandsociety/2008/07/global-warming.html#comments  
  
http://blogs.abcnews.com/scienceandsociety/2008/09/nature-is-not-a.html  
  
(PS in the first of those, before I realized "Science and Society" deletes website addresses, I had posted some links to some RealClimate posts where I had some comments. Might go back and repost those RealClimate sites here later... I remember one was about basic thermodynamics.)  
  
Relavant to climate sensitivity and time constants, I had made some comments in the last of those three "Science and Society" sites above, where it was found:  
  
For a linearized approximation of climate behavior, in terms of global average surface temperature, with constant effective heat capacity and climate sensitivity:  
  
If the time constant is also the e-folding time for exponential decay to equilibrium (that's my understanding of the term 'time constant'):  
  
Time constant (or e-folding time) = heat capacity (average per unit area) \* climate sensitivity.  
  
For example, for a climate sensitivity of 0.7 K/(W/m2) and the globally-averaged effect of the heat capacity of the top 100 m of ocean, I found an e-folding time of about 6 years. From this website, the time constant may be more like 15 years or so (for a prolonged climate forcing change, which can then penetrate below the top of the ocean), so with the same climate sensitivity, the effect heat capacity may be more like that of the top ~ 250 m of ocean (but this is only a mathematical equivalence - the warming signal would penetrate more or less deeply at different locations depending on the circulation patterns).  
  
If it turns out that   
  
1.  
solar effects outside of TSI(multiplied by 0.7/4 to get climate forcing) and enhanced solar UV (I'm assuming that's taken into account in at least some models, since it is understood that a greater portion of solar variation is in UV and UV affects the upper atmosphere (stratosphere, etc.) in particular), such as magnetic effects and solar wind,   
  
2.  
variations in ocean tidal forcing, it's effect on ocean circulation and mixing.  
  
3.  
geomagnetic changes outside of effects of solar changes on magnetosphere  
  
4.  
volcanism or whatever  
  
...  
if any of these turns out to have been more important than previously judged, the conclusion would not be that AGW is not important but that the climate forcing has been bigger than it was thought and so the climate sensitivity must not be as great -   
  
OR  
  
perhaps the climate sensivity is what we thought but we have underestimated the cooling effect of our aerosol emissions...  
  
Etc.  
  
PS of 1-4 above, ... well I'm skeptical. I'm interested in learning more about 1-3, though, although I'm doubtful of the effectiveness of proposed mechanisms for 1 and 3 (though there was one article you had mentioned some time ago that looked intriguing... about variations in transmissivity of clear sky atmosphere due to electromagnetic/ionospherice/solar wind/related stuff...); for 2, I'm doubtful as to the strength of the variations over the time periods pertinent to AGW (and not clear that it was really asserted that 2 would account for some significant portion of what has been attributed to AGW forcing)

1. **Patrick 027** at [16:24 PM on 8 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1725)

Some general info: "The Physical Science behind Climate Change Why are climatologists so highly confident that human activities are dangerously warming Earth? Members of the IPCC, the 2007 peace winner, write on climate change By William Collins, Robert Colman, James Haywood, Martin R. Manning and Philip Mote" [link](http://www.sciam.com/article.cfm?id=science-behind-climate-change) "Simple Question, Simple Answer… Not" [Real Climate,](http://www.realclimate.org/index.php/archives/2008/09/simple-question-simple-answer-no/langswitch_lang/sw) I have comments here (numbers of comments that were mine:) [Real Climate](http://www.realclimate.org/index.php/archives/2008/08/friday-round-up/langswitch_lang/sw) (11,86,98,109,132,138,141) [Real Climate](http://www.realclimate.org/index.php/archives/2008/08/climate-change-methadone/langswitch_lang/sw) (104,105,111) [Real Climate](http://www.realclimate.org/index.php/archives/2008/08/are-geologists-different/langswitch_lang/sw)(59,123,147,152,153,159,160,171,175,189,193,195,197,218,234,236,239,251,257,265,266,267,268(repeated an error regarding $700 billion, oops!),271,273,285,294, NOTE ALSO these comments that are not mine: 102,226 and the the responses to 81,166,201) [Real Climate](http://www.realclimate.org/index.php/archives/2008/08/hypothesis-testing-and-long-term-memory/langswitch_lang/sw%20) (9,10,11,49,50,60,138,142,161,166,170,171,175) HERE IS THE COMMENT ON THERMODYNAMICS (and some other comments): [Real Climate](http://www.realclimate.org/index.php/archives/2008/06/wired-magazines-incoherent-truths/langswitch_lang/sw)(69,73,74,75)

**Response:**

[RH] Fixed links that were breaking page format.

1. **Quietman** at [14:54 PM on 9 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1731)

Patrick   
  
William Collins, Robert Colman, James Haywood, Martin R. Manning and Philip Mote"  
  
"Drivers of Climate Change  
Atmospheric concentrations of many gases—primarily carbon dioxide, methane, nitrous oxide and halocarbons (gases once used widely as refrigerants and spray propellants)—have increased because of human activities."  
  
True IF based on high sensitivity.

1. **Quietman** at [15:04 PM on 9 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1732)

Re: "Simple Question, Simple Answer… Not"  
  
Interesting comments from John Mashey:  
  
[[ John Mashey Says:   
8 September 2008 at 2:31 PM   
“These people, typically senior engineers, get suspicious”.  
  
Please, can we get deeper than “senior engineers” - that really isn’t improving insight. If we want to do that, we need to probe a lot deeper than just “senior engineers”.   
  
Let me offer a speculation, although not yet a serious hypothesis:  
  
1. SPECULATION  
Amongst technically-trained people, and ignoring any economic/ideological leanings:  
  
1) Some are used to having  
a) Proofs  
OR  
b) Simple formulae  
OR  
c) Simulations that provide exact, correct answers, and must do so to be useful  
d) And sometimes, exposure to simulations/models that they think should give good answers, but don’t.  
  
2) Whereas others:  
a) Are used to missing data, error bars,  
b) Complex combinations of formulae  
c) Models with varying resolutions, approximations, and that give probabilistic projections, often only via ensemble simulations.  
d) Models that are “wrong”, but very useful.  
  
My conjecture is that people in category 1) are much more likely to be disbelieving, whether in science, math, or engineering.  
  
2. ANECDOTAL EXAMPLES:  
1) In this thread, a well-educated scientist (Keith) was convinced that climate models couldn’t be useful, because he was used to models (protein-folding) where even a slight mismodel of the real world at one step caused final results to diverge wildly … just as a one-byte wrong change in source code can produce broken results.  
  
See #197 where I explained this to him, and #233 where light dawned, and if you’re a glutton for detail: #66, #75,l #89, #1230, #132, #145, $151, #166 for a sample.  
  
2) See Discussion here, especially between John O’Connor & I. See #64 and #78. John is an EE who does software configuration management. When someone runs a rebuild of a large software system, everything must be \*perfect\*. There’s no such thing as “close”.  
  
Also in that thread, Keith returned with some more comments (#137) and me with (#146), i.e., that protein-folding was about as far away from climate modeling as you could get.  
  
3) Walter Manny is a Yale EE who teaches calculus in high school. He’s posted here occasionally (Ray may recall him :-), and participated in a long discussion at Deltoid, and has strong (contrarian) views. In many areas of high school/college math, there are proofs, methods known for centuries, and answers that are clearly right or wrong.  
  
4) “moonsoonevans” at Deltoid, in #21 & #32 describes some reasons for his skepticism, #35 is where light dawns on me. He’s in financial services, had experienced many cases where computer simulations done by smart people didn’t yield the claimed benefits. In #35 I tried to explain the difference.  
  
All this says that if one is talking with an open-minded technical person, one must understand where \*they\* are coming from, and be able to give appropriate examples and comparisons, because many people’s day-to-day experience with models and simulations might lead them to think climate scientists are nuts.  
  
3. A FEW SPECIFIC DISCIPLINES & CONJECTURES  
  
1) Electrical engineers (a \*huge\* group, of which only tiny fraction are here)  
  
Many EEs these days do logic design, which requires (essentially) perfection, not just in the design, but (especially) in simulation.  
  
Design + input =>(logic simulator) => results  
  
At any step, the design may or may not be bug-free, but the simulator \*must\* predict the results that the real design would do given the input, exactly, bit for bit. Many test-cases have builtin self-checks, but the bottom line is that every test-case yields PASS or FAIL, and the simulator must be right.  
  
Many people buy simulators (from folks like Cadence or Synopsys), and run thousands of computers day and night simulating millions of test-case inputs. But, with a million test-cases, they’re not looking for an ensemble that provides a distribution, they’re looking for the set of test-cases to cover all the important cases, and for EVERY one to pass, having been simulated correctly. This has some resemblance to the protein-folding problem mentioned above.  
  
Now, at lower levels of timing and circuit design, it isn’t just ones and zeroes (there’s lots of analog waveforms, probabilistic timing issues, where one must guarantee enough margin, etc). When I’d tease my circuit designer friends “Give me honest ones and zeroes”, they’d bring in really ugly, glitchy HSPICE waveforms and say “so much for your ones and zeroes”. (This is more like the molecular “docking” problems that Keith’s colleagues mentioned.)  
  
At these levels, people try to set up rules (”design rules”) so that logic designers can just act at the ones-and-zeroes level.  
  
If one looks at EEs who worry about semiconductor manufacturing, they think hard about yields, failure attribution, and live with time-series. (Standard answer to “We got better yield this month, how do you think it looks?” was “Two points don’t make a trend.”  
  
2) Software engineers  
  
Programs often have bugs, but even a bug-free program can fall apart if you change the wrong one byte of code, i.e., fragile. (I don’t recall the source, but the old saw goes something like: if skyscrapers were like software, the first woodpecker would knock them over.)  
  
Configuration management / software rebuilds are fairly automated these days, and they must be correct. One cannot include the wrong version of code, or compile with incompatible options.  
  
Performance engineering and benchmarking tend to be more probabilistic-oriented, and although a lot of people want to believe in one number (once the mythical “MIPS” rating), we’ve (mostly) fixed that over the last 20 years. Good performance engineers have always given relative performance ranges and said YMMV (Your Mileage May Vary).  
  
3) Mechanical engineers  
  
This, I expect, varies. In some cases, closed-form equations work pretty well. In other cases, one is using big structural dynamics and computational fluid dynamics codes to obtain “good-enough” approximations to reality before actually building something. For example, automobiles are extensively modeled via “crash codes”.  
  
4) Petroleum engineers  
  
It’s been a while, but certainly, people who do seismic analysis and reservoir modeling \*start\* with data from the real world, analyze it to make decisions, so ought to be a little more accustomed to probabilistic analyses.  
  
5) Financial engineers (Google: financial engineering)  
  
Not having physics to constrain simulations yields some wild results, although at least, some people are very comfortable with risk, uncertainty, and ensemble projections. I especially like Sam Savage’s Flaw of Averages”.  
On the other hand, when Nobel Economists lose $B (LTCM), I’m not surprised there is skepticism about climate models.  
  
4. CONCLUSIONS  
  
That’s a speculative start. I do \*not\* think lumping a large group together as “senior engineers” helps progress, because I have at least anecdotal evidence that the sources of skepticism tend to be attached to the kinds of models and (maybe) simulations that someone does day-by-day. The problem is that many people tend to generalize from their discipline to others, and especially if they have trouble getting useful models, they tend to be suspicious of others’.   
  
At one extreme, people have long-established mathematical proofs, and answers that are clearly right or wrong.  
  
At the other extreme, people have to make decisions based on the best approximations they can get, and if their discipline has good-enough approximations, they tend to think one way, and if the approximations aren’t so good, they may think another about equations and climate models. ]]  
  
Since both 2 and 3 apply personally I can relate.

1. **Quietman** at [04:52 AM on 10 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1740)

Patrick  
Science and Society is a good blog but Disney owns ABC and therefore the site and does not allow links. That is why an argument on AGW is better done here. John allows links and actually prefers hyperlinks. But he has asked us to keep the discussion pertinent to the thread and not post "lists of links" so I try to break up my comments for readability.  
  
PS  
I looked at your remark on THERMODYNAMICS but skipped most of the other links purely because I don't care to go to that web site. Articles and Papers are much more appreciated as links (less opinion and more facts).

1. **Patrick 027** at [14:53 PM on 10 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1748)

I decided to repost some comments at http://blogs.abcnews.com/scienceandsociety/2008/07/global-warming.html#comments - The comments about Monckton's paper, at least one (big) one of which was deleted from that website, hence this repost:  
  
---   
  
MORE ARTFULLY WRITTEN CRITIQUES FOUND AT RealClimate: "Once more unto the bray", DELTOID: "Monckton's Triple Counting"  
  
MONCKTON'S PAPER "Climate Sensitivity Reconsidered":  
  
(Monckton has a prior record of demonstrating an apparent lack of accuracy in this subject matter.)  
  
INTERNAL VARIABILITY  
  
--"[G]LOBALLY-AVERAGED land and sea surface absolute temperature TS has not risen since 1998 (Hadley Center; US National Climatic Data Center; University of Alabama at Huntsville; etc.). For almost seven years, TS may even have fallen (Figure 1). There may be no new peak until 2015 (Keenlysideet al., 2008)."  
"The models heavily relied upon by the Intergovernmental Panel on Climate Change (IPCC) had not projected this multidecadal stasis in “global warming”; "  
  
Of course they haven't, because:   
  
1.the timing of specific cases of such *short term interannual to decadal variability is not so important to longer term climate trends, and even to the extent that models may reproduce the general characteristics of variability, such variations get averaged to near-zero in combining multiple runs of models.  
  
2. 1998 was extra warm because of the El Nino*. There will be, in any given period of sufficient length, some number of warmer years and cooler years relative to any longer trend. One can't conclude there is/has been a 'stasis', especially a 'multidecadal stasis', in the warming.  
  
\_\_\_\_\_\_\_\_  
  
--"nor (until trained ex post facto) the fall in TS from 1940-1975;"  
  
what 'trained'?  
  
--"nor 50 years’ cooling in Antarctica (Doran et al., 2002)"  
  
Ozone hole has a regional effect there, and I can't take Monckton's word for it that the Antarctic has cooled for as long as 50 years. Anyway, at least a part of it have warmed.   
  
--"and the Arctic (Soon, 2005);"  
  
The arctic has been warming.  
  
--"nor the onset, duration, or intensity of the Madden-Julian intraseasonal oscillation, "...  
  
Models can't reproduce all aspects of internal variability yet. So they aren't perfect. That doesn't invalidate all of what they can do.  
  
--"(oceanic oscillations which, on their own, may account for all of the observed warmings and coolings over the past half-century: Tsoniset al., 2007);"  
  
Then where has all the warming from greenhouse gases gone?  
  
The rest of that paragraph - short term variability, so what. Medieval Warm Period - perhaps mainly a Northern Hemisphere or European phenomenon; not so big globally. Warming on other planets - Pluto's temperature response to the eccentricity in it's orbit lags the forcing due to thermal inertia; what warming on Jupiter? (recent circulation changes may be an internal variability - which, I believe, was predicted by a model!); Mars' albedo is affected by Dust storms, and is the warming global? Earth's climate history is understood generally better than those of other planets. Solar Grand Maximum - is it grand enough?  
  
\_\_\_\_\_\_\_\_  
  
Reproduction of Hansen's graph from 1988: - it's a mischaracterization; for the emissions scenario we've most closely followed, the temperatures have followed quite closely thus far.  
  
\_\_\_\_\_\_\_\_  
  
CLIMATE VS WEATHER  
  
--"The climate is “a complex, non-linear, chaotic object” that defies long-run prediction of its future states (IPCC, 2001), unless the initial state of its millions of variables is known to a precision that is in practice unattainable,"   
  
He's confusing climate with weather and ignoring different timescales.  
  
--"combined with a heavy reliance upon computer models unskilled even in short-term projection, with initial values of key variables unmeasurable and unknown, with advancement of multiple, untestable""  
  
so what? This isn't weather prediction.  
\_\_\_\_\_\_\_\_  
  
DEFINITIONS  
  
--"consequent increase in aggregate forcing (from Eqn. 3 below) of ~0.26 W m–2, or <1%. That is one-twentieth of the value stated by the IPCC. The absence of any definition of “radiative forcing” in the 2007 Summary led many to believe that the aggregate (as opposed to anthropogenic) effect of CO2 on TS had increased by 20% in 10 years. The IPCC – despite requests for correction – retained this confusing statement in its report."  
  
Anyone who's confused could have looked at the other numbers given by the IPCC to figure it out. In the context of climate CHANGE radiative forcing is often discussed as the CHANGE from some reference level.  
  
\_\_\_\_\_\_\_\_  
  
--"non-Popper-falsifiable theories,"  
  
Give it time and we'll see. So far things are happenning that have been expected. But for the purposes of public policy, this could also be seen to a degree as an application of scientific knowledge already gained - we know A, B, C, so we expect if we do D we'll get E. etc.  
  
--"and, above all, with the now-prolonged failure of TS to rise as predicted (Figures 1, 2), raise questions about the reliability and hence policy-relevance of the IPCC’s central projections.""  
  
There has not been such a prolonged failure. We expect a few bumps and dips.  
  
\_\_\_\_\_\_\_\_  
  
feedbacks:  
  
Unless otherwise specified, the climate sensitivity to radiative forcing by a doubling (or whatever change) of CO2 is based on the radiative forcing of the doubling of CO2, whatever the source of CO2 is, including feedbacks.  
  
--"For this and other reasons, it is not possible to obtain climate sensitivity numerically using general-circulation models: for, as Akasofu (2008) has pointed out, climate sensitivity must be an input to any such model, not an output from it."  
  
Nonsense. Climate sensitivity is input only implicit - it is the evaluation of model output that can determine explicitly what the sensitivity is.  
  
\_\_\_\_\_\_\_\_  
  
Radiative forcing: This is basic physics; if the amount and the radiative properties are known, radiative forcing can be calculated. For CO2 and generally other gases, both are known quite well. Some things about clouds are known, but the feedbacks from changes in the amount of different types of cloud in different places is a source of uncertainty. In so far as external radiative forcing, I think aerosols have the greatest uncertainty, in part because of more complex effects.  
\_\_\_\_\_\_\_\_  
  
--"The signature or fingerprint of anthropogenic greenhouse-gas forcing, as predicted by the models on which the IPCC relies, is distinct from that of any other forcing, in that the models project that the rate of change in temperature in the tropical mid-troposphere – the region some 6-10 km above the surface – will be twice or thrice the rate of change at the surface (Figure 4):"  
  
That's a general tendency with any global warming - it isn't as apparent in the graph for the response to solar forcing because the solar forcing used is so small in comparison. The fingerprint of increased greenhouse gases is cooling of the upper atmosphere, which has occured, and is not expected from a positive solar forcing. Granted that the response to ozone changes is more similar to greenhouse gas forcing (though there are differences), but it wouldn't make sense to arbitrarily suppose we can't tell at all how much is from what, especially given knowledge of radiative forcing.  
  
--"However, as Douglass et al. (2004) and Douglass et al. (2007) have demonstrated, the projected fingerprint of anthropogenic greenhouse-gas warming in the tropical mid-troposphere is not observed in reality. Figure 6 is a plot of observed tropospheric rates of temperature change from the Hadley Center for Forecasting. In the tropical mid-troposphere, at approximately 300 hPa pressure, the model-projected fingerprint of anthropogenic greenhouse warming is absent from this and all other observed records of temperature changes in the satellite and radiosonde eras:"  
  
The radiosonde record may have a bias due to the nature of the devices used.  
There has been some disagreement but I think the satellite record turned out to reveal tropospheric warming and stratospheric cooling, as expected, though off hand I don't know about the distribution within the troposphere.  
The graph shown appears to indicate tropospheric warming and stratospheric cooling, which seems to support the idea of greenhouse-forcing induced warming.   
  
--"There are two principal reasons why the models appear to be misrepresenting the tropical atmosphere so starkly. First, the concentration of water vapor in the tropical lower troposphere is already so great that there is little scope for additional greenhouse-gas forcing."  
  
Interesting, but increasing water vapor higher in the troposphere would still have important effects.  
  
--"Secondly, though the models assume that the concentration of water vapor will increase in the tropical mid-troposphere as the space occupied by the atmosphere warms, advection transports much of the additional water vapor poleward from the tropics at that altitude."  
  
That likely only would happen if the water vapor amount increases in the tropics at that altitude. Increased water vapor in the tropics and increased advection of water vapor don't contradict the other - they should tend to go together.  
  
--"Since the great majority of the incoming solar radiation incident upon the Earth strikes the tropics, any reduction in tropical radiative forcing has a disproportionate effect on mean global forcings."  
  
Only in the wavelengths dominated by solar radiation (SW radiation; the greenhouse effect deals with LWradiation - it too can vary with latitude, but ...).   
  
--"On the basis of Lindzen (2007), the anthropogenic-ear radiative forcing as established in Eqn. (3) are divided by 3 to take account of the observed failure of the tropical mid-troposphere to warm as projected by the models –"  
  
This is nonsense. The radiative forcing being considered is clearly the external forcing. What is being asserted here is that the feedbacks are not the same as expected - distinctly different, even if it were correct. None of this discussion justifies dividing external radiative forcing by 3 or any number.  
  
-----------  
PS Lindzen himself, though not free of mistakes in general, did not make this same mistake in the work Monckton is citing. See DELTOID: "Monckton's triple counting"  
  
I didn't go into a lot of Monckton's statements over k (seems like a waste of time considering...) but see the DELTOID work just mentioned, which states:  
  
--"What Monckton is doing is double counting his (dubious) evidence that sensitivity is lower than the IPCC number. If he had two pieces of evidence that sensitivity is half the IPCC number he would multiply them together to claim that sensitivity is one quarter the IPCC number. This is not correct."  
  
PS this DELTOID writing is far more brief than what I wrote here.  
-----------  
  
  
--"it is simple to calculate that, in 2001, one of the IPCC’s values for f was 2.08. Thus the value f = 3.077 in IPCC (2007) represents a near-50% increase in the value of f in only five years."  
  
He's comparing one value to what? An average? That's an odd way to assert a 50 % increase.  
  
--"With these assumptions, ? is shown to be less, and perhaps considerably less, than the value implicit in IPCC (2007). The method of finding ? shown in Eqn. (24), which yields a value very close to that of IPCC (2007), is such that progressively smaller forcing increments would deliver progressively larger temperature increases at all levels of the atmosphere, contrary to the laws of thermodynamics and to the Stefan-Boltzmann radiative-transfer equation (Eqn. 18), which mandate the opposite."  
  
Well, that's odd, since IPCC temperature projections increase with increasing radiative forcing. I didn't bother to check whether Monckton's application of Stefan-Boltzman was correct or not.  
  
  
--"the feedback-sum b cannot exceed 3.2 W m–2 K–1 without inducing a runaway greenhouse effect. "  
  
I think he's misunderstanding something here. I suspect the IPCC listing of feedbacks are in total after taking into account their responses to each other.  
  
--"Figure 7" "Fluctuating CO2 but stable temperature for 600m years"  
  
The sun increases in brightness over hundreds of millions of years, so the same CO2 level 500 million years ago would allow a cooling relative to now. CO2 forcing is roughly logarithmic to changes in concentration within a certain range; An increase from 280 ppm to 7000 ppm is 4.64 doublings. 7000 ppm is one of the higher estimates of CO2 for that time period. Not shown is a possible dip in CO2 in the late Ordivician. The temperature graph is unrealistic and cartoonish (which may be fine for some purposes, but not here) and no one can say that global average surface temperature has not exceeded 22 deg C during the time span shown.  
  
  
--"The Bode equation, furthermore, is of questionable utility because it was not designed to model feedbacks in non-linear objects such as the climate."  
  
Yes, that's what the climate models are for.  
  
--"since CO2 occupies only one-ten-thousandth part more of the atmosphere that it did in 1750"  
  
That's over 30% relative to CO2 concentration in 1750. Which is enough for CO2.  
  
  
  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
  
The other (opposing) paper "A Tutorial on the Basic Physics of Climate Change":  
  
A decent brief overview for introductory purposes, although they leave themselves open to not taking into account convection and variations in optical properties over wavelength. But the IPCC, etc. findings certainly do take into account these things.  
  
For more, see my attempt to explain it qualitatively but clearly at "Tropical Storm Bertha" I mention there a particularly useful book (draft copy available online) by Ray Pierrehumbert: "Principles of Planetary Climate".  
  
  
  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   
  
  
  
CLARIFICATION/CORRECTION:  
  
--"Since the great majority of the incoming solar radiation incident upon the Earth strikes the tropics, any reduction in tropical radiative forcing has a disproportionate effect on mean global forcings."  
  
I wrote: "Only in the wavelengths dominated by solar radiation (SW radiation; the greenhouse effect deals with LW radiation - it too can vary with latitude, but ...). "  
  
Actually, I should have just said No. Because radiative forcing is what it is; that it might be a smaller percentage of the radiative fluxes in the tropics if it itself doesn't vary in latitude much is irrelevent for finding the global average.   
  
Actually, invariance over latitude invariance isn't the case - direct forcing by increases of CO2 and some other greenhouse gases is greatest in the subtropics and least in polar regions; the near surface climate responseis opposite that pattern because of the distribution of feedbacks - albedo feedbacks of less winter snow (at latitudes that get winter sun) and summer polar sea-ice loss (open water stores solar heat and releases it in the dark polar winter, delaying ice formation), and greater evaporative cooling of tropical waters which reduces surface warming but contributes (upon condensation) to the warming of the middle-to-upper troposphere.  
  
  
  
  
-----------------------  
3.models can not reproduce every aspect of the weather and climate system exactly - this does not mean they are not very useful.  
  
The apparent reduced warming of the mid to upper low-latitude troposphere would be just as puzzling if the cause of warming were solar brightenning.

1. **Patrick 027** at [15:08 PM on 10 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1749)

Last comment posted before seeing your last comment -  
  
"John allows links and actually prefers hyperlinks. But he has asked us to keep the discussion pertinent to the thread and not post "lists of links" so I try to break up my comments for readability."  
  
Duly noted. (I know I wandered a bit from 'Volcanoes' in the prior segment of discussion... part of it was centered on tides and that naturally expanded to other things...)  
  
  
  
"PS  
I looked at your remark on THERMODYNAMICS but skipped"..." Articles and Papers are much more appreciated as links (less opinion and more facts)."  
  
That's fine - the rest of my RealClimate comments I listed above were for just in case you were interested (many covering topics we discussed back at Science and Society, but each time I write something I don't do it the exact same way, so... etc.).  
  
I did have some RC comments on radiative physics in the atmosphere in particular and when I finnish tracking those down I will post a reference to those and ONLY those.

1. **Patrick 027** at [10:26 AM on 11 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1762)

More on radiation transfer within and through the atmosphere: [Regional Climate Projections](http://www.realclimate.org/index.php/archives/2007/08/regional-climate-projections/langswitch_lang/in%20)(25,26\*,55\*\*,56\*\*,57\*\*,58\*\*,83\*\*\*,85\*\*\*,104,110\*\*\*\*,111,146,191) asterisks pertain more to [visualizing greenhouse effect physics](http://www.realclimate.org/index.php/archives/2007/08/the-co2-problem-in-6-easy-steps/langswitch_lang/sw)  (171-173,174\*,175,176\*,180~,181~,184\*\*\*\*\*,189\*\*\*\*,192\*\*\*,193,194,203,214,215,218 (\*\*\* near bottom),232\*\*,235,238,245,246) [Real Climate](http://www.realclimate.org/index.php/archives/2007/04/learning-from-a-simple-model/langswitch_lang/sw) (105\*\*,144\*\*,168 (LTE) ,170\*\* (and LTE),172 (mainly LTE),192\*\*,229\*\*,241\*\*(ext),251\*\*\*(BB),252\*\*\*(BB),261\*\*(ext),274\*,275\*,285\*,289) LTE = local thermodynamic equilibrium BB = fundamentals of blackbody radiation and radiative physics ext = what happens in extreme scenarios

**Response:**

[RH] Fixed links that were breaking page formatting.

1. **Patrick 027** at [10:42 AM on 11 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1766)

Back to basics:  
  
Remind me again what it is that makes you doubtful of AGW?   
  
Because it occurs to me we're on the climate sensitivity thread now, and your position is not the climate is more stable but that it it is more stable specifically to greenhouse forcing and not to some various other factors...  
  
---  
  
"Articles and Papers are much more appreciated as links (less opinion and more facts)"   
  
- understandable, but in matters of science (and some other things), good opinion writing includes reasoning and facts, and/or references to facts and reasoning.  
  
---  
  
From comment 8 above:  
  
Your argument must be against the title of that section, "Drivers of Climate Change". Because climate sensitivity has nothing to do with how sure we are that it is human activity that is responsible for the recent changes in those things.

1. **Patrick 027** at [10:49 AM on 11 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1768)

(refering again to your comment, 8, above) The part you would want to argue against starts on p. 3:  
  
"Attribution of Observed Changes  
Although confidence is high both that human activities have caused a positive radiative forcing and that the climate has actually changed, can we confidently link the two? This is the question of attribution: Are human activities primarily responsible for observed climate changes, or is it possible they result from some other cause, such as some natural forcing or simply spontaneous variability within the climate system?"

1. **Quietman** at [14:21 PM on 11 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1770)

Patrick  
My argument is that the sensitivity is low (always has been) ie. I agree with Spencer. My agrument is for the earth itself combined with the sun are the primary drivers and while I do not actually argue against the Green House Effect, I feel that it is overstated. That the problem 1975-2007 was caused by high solar activity and vulcanism/tectonic activity. I have posted the most current articles in the volcano thread, the greenland glaciers thread and an abstract in the "Arctic sea ice melt - natural or man-made?" thread.

1. **Patrick 027** at [03:58 AM on 12 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1773)

But  
1. which of Spencer's arguments do you agree with?  
2.   
-A. if the climate sensitivity is low than how does one explain the recent changes being caused by the minor changes in solar forcing or likely small forcing of changes in geomagnetism (?) or likely very very small forcing if any of submarine volcanic activity (volcanic aerosols already having been accounted for by IPCC etc.)?  
OR  
-B. what values do you expect when quantifying changes in non-TSI (and non-UV/TSI, as I expect that the UVenhancement associated with TSI is already accounted for (?)) solar forcing, geomagnetic forcing, tidal forcing, etc, in terms of radiative forcing or some equivalent or direct 'temperature' forcing by circulation changes in the ocean? For example, that article you referenced some time ago back in Science and Society regarding effects on transmissivity in clear air due to heliospheric current sheet crossing or 'Forbush' - whatever those things were (PS could you explain that to me?).

1. **Quietman** at [04:50 AM on 13 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1779)

Patrick  
1: His idea that CO2 sensitivity is low.  
2.A: The concept that the solar wind does not have an effect on climate is wrong.  
3: Tectonics

1. **Quietman** at [04:52 AM on 13 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1780)

PS  
You apparently confuse ocean tides with tectonic tides.

1. **Quietman** at [05:03 AM on 13 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1782)

PPS  
I have a link posted [here](http://www.skepticalscience.com/empirical-evidence-for-global-warming.htm%22) to Spencer's argument in comment 9.

1. **Patrick 027** at [16:12 PM on 13 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1794)

"You apparently confuse ocean tides with tectonic tides"  
  
No, but I do recognize that solid earth tides must respond to oceanic tides and vice versa, but except maybe for around the Bay of Fundy and that one place in France - well...  
  
"The concept that the solar wind does not have an effect on climate is wrong."  
  
Could you explain how it works or describe the observations supporting it? For example, from the article on Forbush and Heliospheric current sheet crossings etc. (PS you'd have to quantify the radiative forcing of that and then figure out a multidecadal trend...) Or does it affect circulation patterns directly via the E-regiondynamo (within the base of the thermosphere) - ps mass of E-region dynamo is something like a millionth of the whole atmopshere, give or take a factor of ten (just because I can't look it up right now), but if you could find some mechanism to propogate a pressure perturbation or pattern downward while amplifying it...  
  
"I have a link posted here to Spencer's argument in comment 9. "  
  
I covered that very argument in some of our last comments in "Science and Society".

1. **Quietman** at [08:28 AM on 14 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1797)

Patrick  
Re: "I covered that very argument in some of our last comments in "Science and Society"."  
Actually you dismissed the idea rather abruptly, but that's OK. But it doesn't mean that I did.  
  
On the solar wind I will have to find the links again. I know I posted them on this site somewhere.

1. **Patrick 027** at [10:16 AM on 14 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1804)

"Actually you dismissed the idea rather abruptly"  
  
But I did explain why I was dismissing it (or perhaps more accurately, debunking it, or at least trying to debunk it). So what would really be helpful is if you could find errors in my reasoning - the gist of which was that Spencer was considering temperature response to cloud variability on short timescales, short enough that thermal inertia would limit the temperature response.  
  
And now I don't remember off hand, but I do wonder how it could be determined with such an apparently simple method to what extent the cloud variability caused the temperature and vice-versa.  
  
And the other problem - it seems to me cloud feedback is a part of climate sensitivity to other things, but there is little (on these short timescales) CO2 feedback to cloud 'forcing', and even less so feedback by changes in solar activity, etc.

1. **Quietman** at [04:49 AM on 16 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1814)

Patrick  
You did start explaining your logic but diverted to an unrelated subject. While I did find your argument very interesting, I was not convinced that you actually proved Spencer incorrect. Actually, I have not read any papers or articles that show him incorrect, only alternatives. I view the IPCC alternative as incorrect because it has not produced the promised evidence in degree ie. Spencer has shown that his numbers equal observation while the IPCC numbers are way off from the observations. This is why their models don't work.

1. **chris** at [22:55 PM on 21 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1848)

It's worth pointing out that Stephen Schwartz has recognised some of the essential errors in is analysis (see John Cook's top article and also my post #5), and has issued a correction in relation to the original analysis that everyone got very excited about.  
  
Now Schwartz considers that his analysis (still a rather weak approach - see Tom Cook's top post and my post #5), yields a climate sensitivity of 1.9 +/- 1.0 oC per doubling of atmospheric CO2. That's within the range of all the pukka science out there (a climate sensitivity near 3 oC +/- a bit), and if Schwartz were to relax his (rather arbitrarily determined) time constant for the earth's inertial respense to forcings a bit more, then he'd be smack on the value that everyone else gets.  
  
So another storm in a teacup! Sadly, while Schwartz's original paper was flashed all over the blogosphere, we can be pretty sure that Schwartz's reassessment will be left unmentioned...  
  
..but not here!

1. **chris** at [22:57 PM on 21 October, 2008](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#1849)

re #25:  
  
I forget to give the url to Schwartz's reassessment/correction of his original work:  
  
http://www.ecd.bnl.gov/steve/pubs/HeatCapCommentResponse.pdf

1. **Quietman** at [03:11 AM on 23 January, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2456)

Do you mean this paper?   
[HEAT CAPACITY, TIME CONSTANT, AND SENSITIVITY OF EARTH'S CLIMATE SYSTEM](http://www.ecd.bnl.gov/steve/pubs/HeatCapacity.pdf) by Stephen E. Schwartz

1. **chris** at [21:47 PM on 7 February, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2527)

please pay attention Quietman!   
  
We've already seen that paper (linked in John Cook's top post). My link is to the *correction* that Stephen Schwartz published in which he determined that the conclusions of the original version of the paper (your link), were incorrect and that his original climate sensitivity value was far too low.....

1. **Quietman** at [16:32 PM on 28 February, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2688)

chris  
I was asking if that was the original paper that you referred to. A little testy?

1. **Quietman** at [08:00 AM on 3 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2706)

CLIMATE SENSITIVITY   
"The sensitivity of the climate system to a forcing is commonly expressed in terms of the global mean temperature change that would be expected after a time sufficiently long for both the atmosphere and ocean to come to equilibrium with the change in climate forcing. If there were no climate feedbacks, the response of Earth's mean temperature to a forcing of 4 W/m2 (the forcing for a doubled atmospheric CO2) would be an increase of about 1.2 °C (about 2.2 °F). However, the total climate change is affected not only by the immediate direct forcing, but also by climate “feedbacks” that come into play in response to the forcing."   
  
"As just mentioned, a doubling of the concentration of carbon dioxide (from the pre-Industrial value of 280 parts per million) in the global atmosphere causes a forcing of 4 W/m2. The central value of the climate sensitivity to this change is a global average temperature increase of 3 °C (5.4 °F), but with a range from 1.5 °C to 4.5 °C (2.7 to 8.1 °F) (based on climate system models: see section 4). The central value of 3 °C is an amplification by a factor of 2.5 over the direct effect of 1.2 °C (2.2 °F). Well-documented climate changes during the history of Earth, especially the changes between the last major ice age (20,000 years ago) and the current warm period, imply that the climate sensitivity is near the 3 °C value. However, the true climate sensitivity remains uncertain, in part because it is difficult to model the effect of feedback. In particular, the magnitude and even the sign of the feedback can differ according to the composition, thickness, and altitude of the clouds, and some studies have suggested a lesser climate sensitivity."   
  
Climate Change Science: An Analysis of Some Key Questions, pp 6-7,  
Committee on the Science of Climate Change  
National Research Council   
  
"Climate models calculate outcomes after taking into account the great number of climate variables and the complex interactions inherent in the climate system. Their purpose is the creation of a synthetic reality that can be compared with the observed reality, subject to appropriate averaging of the measurements. Thus, such models can be evaluated through comparison with observations, provided that suitable observations exist. Furthermore, model solutions can be diagnosed to assess contributing causes of particular phenomena. Because climate is uncontrollable (albeit influenceable by humans), the models are the only available experimental laboratory for climate. They also are the appropriate high-end tool for forecasting hypothetical climates in the years and centuries ahead. However, climate models are imperfect. Their simulation skill is limited by uncertainties in their formulation, the limited size of their calculations, and the difficulty of interpreting their answers that exhibit almost as much complexity as in nature."   
  
Climate Change Science: An Analysis of Some Key Questions, p 15,  
Committee on the Science of Climate Change  
National Research Council  
  
Ref: The Real 'Inconvenient Truth' [Some facts about greenhouse and global warming](http://www.junkscience.com/Greenhouse/index.html) - JunkScience.com, Updated August 2007

1. **Patrick 027** at [06:22 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2717)

JunkScience is a place where truth goes to die. I haven't looked at the link, yet.  
  
But aside from that, I don't see anything in comment 30 that disagrees with

* my points or
* chris's or
* Philippe's or
* the host of this website,
* RealClimate,
* IPCC,
* The Weather Channel,
* Scientific American,
* James Hansen,
* Shakira (well actually I don't know what she specifically says on the matter but she did perform for Live Earth and one or more inaugural balls), ...
* etc.

1. **Patrick 027** at [06:38 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2718)

"We should note that devoid of atmosphere Earth would actually be a less-cold -1 °C (272 K) because the first calculation strangely includes 31% reflection of solar radiation by clouds (which obviously could not occur without an atmosphere) while ignoring that clouds add significantly to the greenhouse effect. Granted it's kind of a bizarre to include clouds in one half the calculation and not the other but that is the way it's commonly done, so, for simplicity, just stick with ~33 °C."  
  
The reason for including the LW effects and not the SW effects of clouds is because what is being discussed in the effect of greenhouse agents via LW radiation.  
  
If we really consider what would actually happen with the removal of all greenhouse agents, including SWeffects, then yes, the cooling won't be so great, but it would still be enough to cause dramatic cooling by ice/snow albedo feedback.  
  
Thus far, no techical errors, but the distinction between a real greenhouse and a radiative greenhouse, and that greenhouse agents do not 'form a blanket' is rather nit-picky and besides the point. Real greenhouses don't have fabric blankets either - they have glass (or some other generally SW transparent material). I don't cover my self with glass when I get into bed in the winter!  
  
What they all have in common is that they slow the flow of heat from hot to cold - by inhibiting convection, reducing thermal conductivity, and/or increasing LW opacity - so that a greater temperature difference (between inside and outside, between my skin and the air in my room, between Earth's average surface temperature and the temperature of a blackbody that would emit the same LW power to space) is required to sustain a rate of heat loss to balance a given heat supply (the sun, my metabolism).

1. **Patrick 027** at [06:41 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2719)

(Thus far, no techical errors) - I haven't varified the temperature calculated for no albedo and no greenhouse effect. Actually though, there is some error if they reduced the albedo to zero, because there is some surface albedo and some backscattering to space from clear air.

1. **Patrick 027** at [07:00 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2720)

Some less trivial errors popping up now, such as this:  
  
"Greenhouse gases do not emit energy in the same bandwidth in which they absorb energy and thus emissions from carbon dioxide are not absorbed by carbon dioxide."  
  
That might be true (? - something about quantum mechanics) if there were no absorption-line broadenning by doppler and pressure effects, ... BUT IT IS MOST CERTAINLY NOT TRUE in the case of atmospheric greenhouse gases and clouds, etc.  
  
Height of tropopause: "10-50Km or 6-30 miles above the surface" - NO WAY! WAY OFF! 10 km is a typical midlatitude value, but it never gets even halfway to 50 km (I think it's somewhere around 15 to 18 km in the tropics - around the 100 mb level - see Holton, chapter 12). 50 km is actually about the height of the stratopause.  
  
"Sidebar:"  
  
Even absolute errors that are larger than projected changes are tolerable because ... well, you know I'll be taller if I stand on my toes than flat on my feet; you essentially only need to know the dimensions of my feet to calculate the difference (perhaps some feedback from posture changes...). Another way of looking at it - suppose the relative error in change is about the same as the relative error in absolute values. 10 % of 288 K would be HUGE, yet a 10 % error in 3 K is not too bad. Of course there is not a particular basis for arguing that the errors are related precisely that way, but ...  
  
Aside from that, I can bet what's coming up - greenhouse effect short-circuited by convection. Okay, but models take that into account! Remember it's tropopause level radiative forcing that tends to be important in driving surface and tropospheric temperatures - which are convectively coupled; this does not mean they don't respond to anything.  
  
I'm not going to bother with the link anymore; I'm quite sure there's nothing new there.

1. **Patrick 027** at [07:03 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2721)

"Of course there is not a particular basis for arguing that the errors are related precisely that way,"  
  
Actually they must not be that way; given that there is a correct value, the error range is quite sizable in projected changes. Too big, and yet not big enough.

1. **Patrick 027** at [07:08 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2722)

Okay, I skimmed the rest of it.  
  
There are some factual points that are true (and some that are true but irrelevant to anything), but the picture they paint is a worthless piece of trash. Forget the science, this is JUNK!

1. **Patrick 027** at [11:00 AM on 5 March, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#2723)

"That might be true (? - something about quantum mechanics) if there were no absorption-line broadenning by doppler and pressure effects"...  
  
Actually, any macroscopic material in local thermodynamic equilibrium must have the same emissivity as absorptivity along any path length in any direction at any wavelength; otherwise, I've got some plans for a perpetual motion machine you might be interested in...

1. **Mizimi** at [06:46 AM on 11 May, 2009](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#3089)

Have a read: http://www.john-daly.com/forcing/review.htm  
  
which has commentaries on Hug & Barrett's presentation on climate sensitivity. You can access the original paper direst from the web page.

1. **Bodo** at [03:00 AM on 11 February, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#8380)

Hello!  
You could add that Schwartz updated and corrected (in some aspects) his analysis. He now claims that climate response time is 8.5 ± 2.5 years. According to this climate sensivity is 1.9 ± 1.0 K. http://www.ecd.bnl.gov/pubs/BNL-80226-2008-JA.pdf  
Thus his estimate of climate sensitivity now is at the lower bound of the IPCC range.

**Response:** Thanks for the link, I wasn't aware of Schwartz' response and have updated the article accordingly.

1. **cloneof** at [06:27 AM on 5 April, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#11666)

So how about that Spencer & Braswell et al 2008?  
  
It has a few nice ideas about climate models and their feedbacks... and so far I haven't found anyone who has been able to debunk it. Has anyone found one?

1. **[Tom Dayton](https://sites.google.com/site/openmct/)** at [01:16 AM on 10 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#13643)

Sensitivity to cumulative carbon *emissions* is a new metric of sensitivity proposed in papers published in 2009 and discussed on the brand new blog [Climate Physics Forums](http://climatephysicsforums.com/topic/3057275/1/).

1. **Riccardo** at [01:42 AM on 10 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#13646)

Tom Dayton unintentionally reminded me that this is the right place to discuss the forthcoming Spencer paper on climate sensitivity. So this is in a sense a repost.  
For sure we need to wait to read the paper but one thing can already be said. From what [Spencer himself says](http://www.drroyspencer.com/2010/05/strong-negative-feedback-from-the-latest-ceres-radiation-budget-measurements-over-the-global-oceans/), he shows "monthly variations in the Earth’s net radiation [...] compared to similarly averaged tropospheric temperature". This is not wrong by itself but it should be clear that in this way he's looking just at the fast response component.   
From this work nothing can be said on the overall climate sensitivity which definitely includes components much slower than a month.

1. **Riccardo** at [06:51 AM on 10 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#13692)

The problem is that Spencer keeps repeating the same wrong conclusions in his blog ("These results suggest that the sensitivity of the real climate system is less than that exhibited by ANY of the IPCC climate models. ") so that they're still usefull for the skeptic community.  
I prefer not to comment on this attitude that he has in common with other (luckly few) skeptic scientists.

1. **[Tom Dayton](https://sites.google.com/site/openmct/)** at [00:17 AM on 14 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#14019)

Details about [Riccardo's point](http://www.skepticalscience.com/climate-sensitivity.htm#13646) about Spencer's papers are provided by chris in [an excellent comment](http://www.skepticalscience.com/news.php?p=3&t=115&&n=193#13984) on another thread.

1. **PaulK** at [15:34 PM on 16 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#14111)

Riccardo at 01:42 AM on 10 May, 2010  
I think it is a bit dangerous for any of us to comment on a paper that has not yet been published. However, on my reading of the article published so far, it does not appear that Spencer is claiming that he can calculate the equilibrium climate sensitivity from his approach. He is comparing the observed response against the statistics FROM THE MODELS OVER THE SAME RESPONSE PERIODS, and thereby suggesting that the models are overestimating the temperature/flux reponse. From this, one can PERHAPS validly draw the conclusion that the models are overestimating the equilibrium climate sensitivity (expressed in temp/flux). It is therefore not valid (or at least not valid until we have seen the paper) to say that "nothing can be said on the overall climate sensitivity".

1. **Riccardo** at [19:09 PM on 16 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#14117)

PaulK,  
even assuming that the comparison with climate models is appropiate, my point still stands. One cannot judge the sensitivy just looking at the first part of it, let alone deduce the long term behaviour of the climate systemnor of the models. For example, what if the models miss just a damping factor? In the short term they produce larger postive and negative variations, but they will average out.  
But, as pointed out in my last comment, my guess is that Spencerr will not explicitly say anything like this in the paper, it's something just for his blog.

1. **Peter Hogarth** at [07:36 AM on 31 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#15039)

I am not sure this paper has been mentioned yet. See   
  
[Lin 2010](http://atmos-chem-phys-discuss.net/9/24731/2009/acpd-9-24731-2009.pdf).  
  
Obtains 3.1K for sensitivity, constraining the estimates a little to between 2.8K and 3.7K

1. **Riccardo** at [08:17 AM on 31 May, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#15042)

[here is](http://www.atmos-chem-phys.net/10/1923/2010/acp-10-1923-2010.pdf) a more readable formatting of Lin 2010. ;)

1. **macwithoutfries** at [18:14 PM on 20 July, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#18880)

I think on this subject somewhere at the top of this page the paper(s) from Spencer should also be clearly addressed - while Schwartz was probably what started this debate I believe right now the focus of the deniers is moving to Spencer ...

1. **[Timothy Chase](http://www.climate-guardian.com/avatar)** at [09:14 AM on 20 September, 2010](http://www.skepticalscience.com/climate-sensitivity-advanced.htm#25238)

From the main article:

A 2008 study led by James Hansen found that climate sensitivity to "fast feedback processes" is 3°C, but when accounting for longer-term feedbacks (such as ice sheet disintegration, vegetation migration, and greenhouse gas release from soils, tundra or ocean), if atmospheric CO2 remains at the doubled level, the sensitivity increases to 6°C based on paleoclimatic (historical climate) data.

Hansen et al estimate Earth System Sensitivity (ESS - that includes slow feedbacks) over Charney Sensitivity (CS - that only includes fast feedbacks) - or ESS/CS - at 2:

Paleoclimate data permit evaluation of long-term sensitivity to specified GHG change. We assume only that, to first order, the area of ice is a function of global temperature. Plotting GHGforcing [7] from ice core data [18] against temperature shows that global climate sensitivityincluding the slow surface albedo feedback is 1.5°C per W/m 2 or 6°C for doubled CO2 (Fig. 2), twice as large as the Charney fastfeedback sensitivity. Note that we assume the area of ice and snow on the planet to be predominately dependent on global temperature, but some changes of regional ice sheet properties occur as part of the Earth orbital climate forcing (see Supplementary Material).  
  
pg. 220, James Hansen et al.(2008) Target Atmospheric CO2: Where Should Humanity Aim?,The Open Atmospheric Science Journal, 2, pp. 217-31  
<http://pubs.giss.nasa.gov/docs/2008/2008_Hansen_etal.pdf>

A more recent estimate puts ESS/CS at about 1.4:

As shown in Table 1, none of these assumptions greatly changes our estimate of ESS/CSacross all of the analyses presented in this article, the smallest value of ESS/CS we obtain is 1.3, and the largest is 1.5. Our combined modelling and data approach results in a smaller response (ESS/CS~ 1.4) than has recently been estimated using palaeo data from the Last Glacial Maximum, 21,000 years ago (ESS/CS ~ 2). This is probably due to the fact that transitions from glacial to interglacial conditions in the Quaternary involve large changes in the Laurentide and Eurasian ice sheets (see, for example, ref. 36), which result in a significant large-scale albedo feedback in these regions that is irrelevant for climates warmer that present.  
  
pg. 63, Daniel J. Lunt et al. (January 2010) Earth system sensitivity inferred from Pliocene modelling and data, Nature Geoscience, Vol. 3

Either way the climate sensitivity that people have been talking about underestimates the warming that we can expect because by definition it omits the slow feedbacks -- which aren't necessarily that slow (e.g., the reduction in plant efficiency over the past decade, the saturation of some ocean CO2 sinks, Boreal forests in Canada, rising levels of methane emissions due to permafrost melt in Arctic tundra and Arctic shallow water continental shelves, e.g., near the coastline of Siberia.

1  [2](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115)  [3](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115)  [4](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115)  [5](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115)  [6](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115)  [7](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115)  [8](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115)  [Next](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115)

# COMMENTS PAGE 2

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Comments 51 to 100 out of 370:

1. **[Timothy Chase](http://www.climate-guardian.com/avatar)** at [09:26 AM on 20 September, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#25241)

Dana, over at Climate Progress you [wrote](http://climateprogress.org/2010/09/19/climate-sensitivity-lukewarmers/#comment-296995):

I should mention, the 'Climate sensitivity' is not specific to CO2′ section isn't quite correct because different forcings have different efficacies. I updated the advanced version of this rebuttal to clarify this point. Here's the link if you want to do the same:  
  
<http://www.skepticalscience.com/climate-sensitivity-advanced.htm>

I was trying to respond to that, but too many links has put my post in the could-be-spam queue, so I thought I might post this here as well in the hope that some might find it helpful.  
  
Definition of Radiative Forcing:

The definition of RF from the TAR and earlier IPCC assessment reports is retained. Ramaswamy et al. (2001) define it as 'the change in net (down minus up) irradiance (solar plus longwave; in W m^–2) at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values'.  
  
2.2 Concept of Radiative Forcing  
<http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-2.html>

The idea here is that increased solar radiance or increases in CO2 concentration affect the balance of radiation entering/leaving the climate system -- and will result in a response at the "top of the atmosphere" or - tos - which is typically taken to be at the tropopause which separates the troposphere and the stratosphere. Feedbacks are in response to this change.  
  
Definition of Climate Sensitivity:

The long-term change in surface air temperature following a doubling of carbon dioxide (referred to as the climate sensitivity) is generally used as a benchmark to compare models.  
  
Climate Change 1992 The Supplementary Report to the IPCC Scientific Assessment, pg. 16  
<http://www.ipcc.ch/ipccreports/far/IPCC_Suppl_Report_1992_wg_I/ipcc_far_wg_I_suppl_material_full_report.pdf>

The above definition of climate sensitivity is however for the Charney Climate Sensitivity that takes into account the fast feedbacks, e.g., water vapor, clouds, sea ice, etc., but omits the slow feedbacks associated with changes in vegitation, feedbacks due to the carbon cycle and ice sheets -- the latter of which are land-based.  
  
Definition of Efficacy:

Efficacy (E) is defined as the ratio of the climate sensitivity parameter for a given forcing agent (λi) to the climate sensitivity parameter for CO2 changes, that is, Ei = λi / λCO2 (Joshi et al., 2003; Hansen and Nazarenko, 2004). Efficacy can then be used to define an effective RF (= Ei RFi) (Joshi et al., 2003; Hansen et al., 2005). For the effective RF, the climate sensitivity parameter is independent of the mechanism, so comparing this forcing is equivalent to comparing the equilibrium global mean surface temperature change.   
  
2.8.5 Efficacy and Effective Radiative Forcing  
[http://www.ipcc.ch/publications\_and\_data/ar4/wg1/en/ch2s2-8-5.html](http://www.skepticalscience.com/%3Ehttp:/www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-8-5.html)

Why Efficacies of Different Forcings are Different:

The efficacy primarily depends on the spatial structure of the forcings and the way they project onto the various different feedback mechanisms (Boer and Yu, 2003b). Therefore, different patterns of RF and any nonlinearities in the forcing response relationship affects the efficacy (Boer and Yu, 2003b; Joshi et al., 2003; Hansen et al., 2005; Stuber et al., 2005; Sokolov, 2006). Many of the studies presented in Figure 2.19 find that both the geographical and vertical distribution of the forcing can have the most significant effect on efficacy (in particular see Boer and Yu, 2003b; Joshi et al., 2003; Stuber et al., 2005; Sokolov, 2006)...  
  
2.8.5.1 Generic Understanding  
<http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-8-5-1.html>

For more on radiative forcing and related concepts please see:  
  
Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing  
<http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2.html>  
  
**Note**: calculations performed by climate models do not involve the concepts of forcing, climate sensitivity or efficacy. The calculations of climate models are themselves based up the physics. Analysis in terms of forcings, climate sensitivity and efficacy only come afterward -- as a means of conceptualizing the results for the ease of our understanding.

1. **Daniel Bailey** at [12:47 PM on 20 September, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#25251)

Re: Timothy Chase (51)  
  
Thanks for taking the time to put together such a thorough comment. It's appreciated.  
  
The Yooper

1. **Glenn Tamblyn** at [18:15 PM on 21 September, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#25356)

A common misconception that people have about Climate Sensitivity is that it is a fixed value over a wide range of climatic conditions. This leads to some quite bizarre 'analyses' in the denialosphere, attempting to show that CS couldn't be that high because that implies that CO2 contributes far too much of the 33 DegC of extra warmth attributed to the Greenhouse Effect. The fallacy they make is projecting the same CS value back through lower and lower CO2 levels and temperature regimes.  
  
Climate sensitivity is an idea used to encapsulate how the planet IN A PARTICULAR CONFIGURATION - temperature, distribution of land masses, ocean currents, air movements, ice cover, vegetation patterns etc - will respond to a change in radiative forcing from whatever source - GH Gases, Solar changes, Aerosols.   
  
So Climate sensitivity will certainly be different at different times. In fact sensitivity to a warming pressure would likely be different to the sensitivity to a cooling pressure in the same climate. So sensitivity to a warming pressure at the bottom of an ice age would be higher than at the top of the ice age; with ice down to lower latitudes, any retreat of that ice due to temp rise exposes a larger area of land and sea and thus has a bigger effect on albedo than the same distance of retreat when the ice is only at higher latitudes. However given the thickness of the ice sheets, the time lags in responding to the warming will be large as it takes time for the ice to melt away. Conversely sensitivity to a cooling pressure coming out of an inter-glacial is likely to be high since even modest cooling can quickly increase the area and duration of snow fall; 1 metre of snow has much the same albedo as ice sheets kilometers thick. The time lag responding to any such cooling is thus also likely to be quicker.   
  
In an Ice free world, CS to a warming pressure might be much lower since Ice based albedo change doesn't occur.  
  
Similarly in a world with very low CO2, a Snowball Earth, CS might also be low. If the world is literally covered in ice, modest warming may not be enough to cause any ice melt - going from -18 DegC to - 15 DegC for example may not cause any ice cover reduction. It would only be when enough warming pressure has occurred that ice cover retreat begins that change might be rapid. In effect, CS would change when the climatic conditions change enough.  
  
This is also important when considering the oft cited figure of 33 DegC of warming due to the GH effect. The calculation that arrives at this number is based on the Earths current Albedo; that around 30% of sunlight is reflected away and isn't part of the energy balance. However in a world that is -18 DegC ON AVERAGE, Ice Cover would be much greater, more even than an Ice AGe which still has a positive average temp. At minus 18 DegC, ice cover sufficient to cause 50% of sunlight to be reflected is quite conceivable. The calculation for this albedo gives 53 Deg extra warmth: -38 DegC

1. **JMurphy** at [04:19 AM on 2 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#26575)

**ClimateWatcher** (on [another thread](http://www.skepticalscience.com/news.php?n=404#26570)), you would be more credible if you gave the whole quote, thus :  
  
*Progress since the TAR enables an assessment that climate sensitivity is likely to be in the range of 2 to 4.5°C with a best estimate of about 3°C, and is very unlikely to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded, but agreement of models with observations is not as good for those values.*  
  
Which is not based on "those climate scientist [who] happen to be part of the IPCC", but a vast body of work given here :  
  
  
[Working Group I: The Physical Science Basis  
8.6 Climate Sensitivity and Feedbacks](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch8s8-6.html)  
  
[Working Group I: The Physical Science Basis  
9.6 Observational Constraints on Climate Sensitivity](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch9s9-6.html)  
  
[Working Group I: The Physical Science Basis  
10.5 Quantifying the Range of Climate Change Projections](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch10s10-5.html#footnote1)

1. **[Berényi Péter](http://ber.parawag.net/)** at [21:05 PM on 27 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29263)

There was a discussion of MEP (Maximum Entropy Production) principle and its possible bearings on climate sensitivityunder [The 2nd law of thermodynamics and the greenhouse effect](http://www.skepticalscience.com/The-2nd-law-of-thermodynamics-and-the-greenhouse-effect.html). We were [asked](http://www.skepticalscience.com/news.php?p=2&t=98&&n=429#29226) to move it to this thread.  
  
MEP theme was started [here](http://www.skepticalscience.com/news.php?p=1&t=98&&n=429#29099) and after some lengthy exchanges there's a [clarification attempt](http://www.skepticalscience.com/news.php?p=2&t=98&&n=429#29186).  
  
If valid, it would mean equilibrium climate sensitivity, whenever "forcings" are small enough to warrant a linear approximation, is moderate (no positive feedbacks). There could still be large shifts in climate, either forced or unforced, but they would not fit into the standard climate sensitivity formalism and entirely different analytical techniques would be required to uncover them (e.g. topological analysis of the entropy production rate function over the phase space of climate states).

1. **KR** at [01:26 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29278)

**Moderator** - Starting from the "Advanced" version of this topic, then going to page 2 of comments, I see the "Basic" version appear as the topic header. Using the "Prev" link, I get the "Basic" version again.   
  
Is this the desired behavior? I would think that the advanced discussion should remain if starting there...

1. **KR** at [01:44 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29282)

**Berényi** - You argue that [MEP would limit climate sensitivity and eliminate positive feedbacks](http://www.skepticalscience.com/argument.php?p=2&t=55&&a=115#29263).   
  
This is contradicted by real world measurements, model results, paleo-temperature records, etc., which are well demonstrated in [Knutti and Hegerl (2008)](http://www.iac.ethz.ch/people/knuttir/papers/knutti08natgeo.pdf) - where any number of small linear forcings are used to estimate climate sensitivity, all ending up roughly in the 2–4.5 °C range. That means a range of non-negative positive feedback. The lower end of that range, still with a moderate amount of positive feedback, is quite solid.   
  
If MEP is a factor, it's *always* been a factor, and can be considered to be included in measured climate sensitivity. There is no data supporting your assertion of *"no positive feedbacks"*, and in fact quite a lot of data showing that assertion to be incorrect.   
  
I would consider this 'low sensitivity' hypothesis clearly disproven, as contradicted by all the evidence.

1. **[Berényi Péter](http://ber.parawag.net/)** at [04:17 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29298)

[#57](http://www.skepticalscience.com/argument.php?a=115&p=2#29282) **KR at 01:44 AM on 28 October, 2010**  
*If MEP is a factor, it's*always*been a factor, and can be considered to be included in measured climate sensitivity*  
  
No, it is not that simple. Please try to *understand* what was [said](http://www.skepticalscience.com/news.php?p=2&t=98&&n=429#29186) before you venture in.  
  
You would make me happy if just once you could abandon the [*holistic* approach](http://www.skepticalscience.com/big-picture.html) and concentrate on the problem at hand with an analytical mind. This kind of thinking, although requires some *discipline*, is surprisingly effective and is much more in line with our own [cultural heritage](http://www.usask.ca/education/people/aikenhead/IKS_revisited.pdf).

**Response:** BP, out of respect to KR and his reply to this I won't delete this, but please try to be less adversarial in the future. Disagree, certainly, but keep it cordial.

1. **KR** at [04:42 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29301)

[Berényi](http://www.skepticalscience.com/argument.php?a=115&p=2#29298) - I did read what you wrote, [*ad hominem*](http://www.skepticalscience.com/argument.php?a=115&p=2#29298) responses on your part not-withstanding.   
  
There is considerable evidence for positive feedback in climate sensitivity, and **none** for the [*"no positive feedbacks"*](http://www.skepticalscience.com/argument.php?a=115&p=2#29263) claim you have made.   
  
In fact, the MEP is inappropriate when discussing the final destination in thermodynamics. *"A system will select the path or assemblage of paths out of available paths that minimizes the potential or maximizes the entropy at the****fastest rate****given the constraints"* [(Swenson, R. 1989)](http://rodswenson.com/global.html). This means that the MEP principle will *"select the pathway or assembly of pathways that minimizes the potential or maximizes the entropy at the****fastest rate****given the constraints"* [(Swenson, R. and Turvey, M.T. 1991)](http://www.ecologicalpsychology.com/), emphasis added.  
  
The Second Law indicates that systems act to minimize potential/maximize entropy. It does not say by what path. MEP is an additional constraint on the 2nd law, not a replacement thereof. At most (if correct) it will affect the speed of climateconvergence upon equilibrium when forcings change, not the final equilibrium.   
  
  
To quote Christopher Hitchens: *"That which can be asserted without evidence, can be dismissed without evidence."* MEP certainly qualifies in regards to climate sensitivity.

1. **KR** at [05:18 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29304)

To address some of what I might expect as a response to my last posting, I would like to note that if some mechanism (such as maximum entropy production, MEP) were operative in regards to thermodynamic equilibrium, it would certainly operate at all times.   
  
If it operated in the fashion described by Berényi, by increasing energy release to space and preventing temperature rises when GHG forcings would otherwise cause them to occur, it would operate at all times to maximize entropy, lowering the climate temperature as far as the system degrees of freedom allowed. TSI increases, for example, as seen in the early 20th century, would have no effect. Unfortunately for Berényi's formulation, it does.   
  
The 2nd law of thermodynamics sets the equilibrium (and yes, the steady-state) points, not an MEP effect, which is merely a constraint on how systems reach such states under the 2nd law.   
  
Climate sensitivity exhibits positive feedback. **MEP cancellation of positive feedback is therefore *prima facie* incorrect**; that emperor has no clothes.

1. **[Berényi Péter](http://ber.parawag.net/)** at [06:19 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29309)

[#59](http://www.skepticalscience.com/argument.php?a=115&p=2#29301) **KR at 04:42 AM on 28 October, 2010**  
*At most (if correct) it will affect the speed of climate convergence upon equilibrium when forcings change, not the final equilibrium.*  
  
Dear **KR**, what you say, does not make sense. Until you learn to differentiate between *thermodynamic equilibrium* (isolated system, no entropy production) and *steady state* with energy flowing through the system and entropy produced by it at a constant rate, unfortunately we can't move a single step further.

1. **Riccardo** at [07:07 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29314)

Berényi Péter  
following your definition, the entropy production (EP) is determined by the temperature of the atmosphere at TOA (Ta), the temperature of the sun (Ts) and the earth albedo (α). Starting with the system in steady state, by suddenly increasing IR atmospheric absorption you're indeed lowering the EP via a reduction in Ta. Restoring steady state requires to increase Ta back to its original value and/or lowering the "incoming part" of EP through α. The latter alone would lead to a positive feedback which decreases Ta further.   
This is as far as we can get with this simple use of the MEP principle. We see the *possibility* of a negative feeback, which we already knew, and cannot rule out other positive feedbacks. Definitely more work need to be done in this field to obtain usefull insights from the use of the MEP principle in climate science. As of now, scientists are just looking at its range of validity mainly studying steady state situations, which presumably won't give new "practical" informations.  
Quoting [Kooiti Masuda](http://www.skepticalscience.com/news.php?p=2&t=102&&n=429" \l "29225), "So MEP does not seem to me helpful as a piece of policy-relevant science of climate at present.".

1. **Kooiti Masuda** at [07:35 AM on 28 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29319)

Maybe we discuss different things by the same term MEP (Maximum Entropy Production).  
  
I am not familiar with Swenson's theory, but as I browse abstracts shown at links by **KR** (#59), they seem to say too far-fetched things to be demonstrated by physical science (though they may be interesting philosophical thoughts). I do not think it helpful to discuss matters of physical science following Swenson's reasoning.  
  
What I remember by the key word "maximum entropy production" is something like the Wikipedia articles [Non-equilibrium thermodynamics](http://en.wikipedia.org/wiki/Non-equilibrium_thermodynamics) and [Extremal principles in non-equilibrium thermodynamics](http://en.wikipedia.org/wiki/Extremal_principles_in_non-equilibrium_thermodynamics) mention by the key word. (Wikipedia may be rewritten. I mean the contents as of today.) I do not fully understand these theories, but I understand themes which some of these authors wanted to discuss.

1. **KR** at [00:59 AM on 29 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29400)

Berényi - Further reading into non-equilibrium thermodynamics is proving interesting; in particular the internal fluctuations of such a system. You are correct, the climate is a non-equilibrium system, due to the energy flows.   
  
So: You hypothesize that maximal entropy production will prevent positive feedback to greenhouse gases, minimizing climate sensitivity.  
  
**First objection to your hypothesis:** I would hold that the climate has stable stationary states, where there is a local max of entropy. Given the internal fluctuations (including seasons, PDO, ice ages) over the history of the climate, I would find itdifficult to believe that the climate could find nearby local entropy maxima to switch to based on small linear forcings; surely the climate would have long since hit those maxima based simply on climate variability. not impossible, but **highly unlikely**. There may indeed be critical points (ice age initiations, major clathrate/permafrost upheavals); those are points of concern, but certainly not involved in response to small linear forcing changes.   
  
**Second objection:** Climate sensitivity has been measured, and shown to have positive feedback. Your claim that the MEP effect would cause "no positive feedback" (your words) is thereby falsified. Until you recognize this (and you've spent quite some time ignoring this issue raised repeatedly both by me and also by 'e'), the conversation will go nowhere, and I will continue to consider this a lengthy thought experiment unrelated to the real world.

1. **Kooiti Masuda** at [09:17 AM on 29 October, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29418)

Berényi Péter makes many interesting remarks, but I am afraid his arguments are incoherent in the sense Stephan Lewandowsky wrote here in the areticle [The value of coherence in science](http://www.skepticalscience.com/The-value-of-coherence-in-science.html). I admit that my own arguments are sometimes incoherent, but I then also admit that I am not confident about what I say.  
  
I read his comments on the blog article here [The 2nd law of thermodynamics and the greenhouse effect](http://www.skepticalscience.com/The-2nd-law-of-thermodynamics-and-the-greenhouse-effect.html). Though it may be different from his own summary, I think he effectively say that the way how to apply thermodynamics to the actual climate of the earth is not very sure on one hand, and that he can say something certain about the climate of the earth by applying the maximum entropy production (MEP) principle, that is an advanced part of thermodynamics, on the other hand.  
  
Also, [in his recent comment in thread on the 2nd law](http://www.skepticalscience.com/news.php?p=3&t=110&&n=429#29402), he suggested that the average temperature at the surface (the surface between air and sea or between air and land) may not be a good measure for thermodynamic discussion of the climate system. On the other hand, the concept called "climate sensitivity" conventionally by climate scientists is defined in terms of the average surface temperature. It may be coherent from his position to say that the "climate sensitivity" is not a well defined quantity and we cannot say anything certain about it. I do not think he can be sure that the value must be low.

1. **[Berényi Péter](http://ber.parawag.net/)** at [08:09 AM on 2 November, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#29711)

Well, I have looked into the issue a bit deeper and have found that my [point 1. in #85 under **The 2nd law of thermodynamics and the greenhouse effect**](http://www.skepticalscience.com/news.php?p=2&t=98&&n=429#29186) is actually not a valid claim.  
  
It says *"If IR optical depth of the atmosphere is increased by a small amount by adding to it some well mixed greenhouse gaswhile*everything else is held constant*, entropy production rate would decrease"*.  
  
In fact it is only true if *optical depth is high enough*, that is, in a high IR opacity approximation. For optically thin atmospheres the opposite is true.  
  
In other words there is a limit value of IR optical depth for which entropy production rate is at its maximum. I still think IR optical depth of the real atmosphere has to be close to this value (due to MEP), but it would need some deeper analysis and actual data to determine if it is below or above this threshold at the moment.  
  
Under these circumstances the original argument may not work without restrictions, however, the very existence of an "optimal" IR optical depth suggests a negative water vapor feedback (on overall IR opacity).

1. **[Berényi Péter](http://ber.parawag.net/)** at [11:40 AM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35564)

[#57](http://www.skepticalscience.com/news.php?n=495&p=2#35530) **Albatross at 08:23 AM on 30 December, 2010** under  [**Did global warming stop in ~~1998~~, ~~1995~~, ~~2002~~, ~~2007~~, 2010?**](http://www.skepticalscience.com/Tracking-the-energy-from-global-warming.html)  
*I see that you are failing to differentiate between Charney feedbacks (transient climate response,*[*Gregory and Forster 2005*](http://www.agu.org/pubs/crossref/2008/2008JD010405.shtml)*) and equilibrium climate sensitivity. Annan and Hargreaves, and others, show the PDF for EQS dropping off sharply below about 2.5 C.*  
  
(On moderator's advice discussion started [there](http://www.skepticalscience.com/news.php?n=495&p=2#35527) is continued here)  
  
Well, let's suppose there is a first order low pass filter between "forcing" and "climate response" (lower tropospheretemperature anomaly). If we apply a small step-like forcing **ΔF** to a climate system in equilibrium and the long term temperature anomaly response is **ΔT = βΔF**, than **β** is said to be the *equilibrium sensitivity*, right? The impulse response function of the filter in this case is **(β/τ)e-t/τ** for t > 0, zero otherwise, where **t** is the time variable and **τ** is a time constant characteristic to the *relaxation time* of the system. The response to a step-function is of course **β(1-e-t/τ)**.  
  
Now, let's suppose the forcing is increasing *linearly* with time (instead of kicking in in a step-like fashion). With CO2 more or less this is the case, that is, **ΔF = ft**, where **f ~ 0.006 year-1**, if *unit* of forcing is CO2 doubling. The relation seems to hold pretty well at least during the last 70 years.  
  
The response of the low pass filter above to such a forcing is **βf(t-τ)**. That is, the time constant **τ** has no effect other than introducing a delay in this case - or an additive constant, if we look at it the other way around. It has no influence on the trendwhatsoever.  
  
Provided of course **τ** is not larger than several decades, that is, the pre-industrial flat part of the CO2 forcing curve has negligible effect beyond the start of satellite era (late 1978).  
  
Therefore my calculation is correct, the climate sensitivity is considerably less than 2°C (per CO2 doubling), for the reasons I've stated in the other thread.  
  
BTW, I think it is even lower, because satellite lower troposphere temperature anomalies are not reliable either. Back-calculation of temperature from narrow band radiances depends heavily on the atmospheric model used, especially on fine details of water vapor distribution, which is neither measured nor modeled properly. On top of that all climate variables behave like pink noise even in the unforced case, that is, they have large spontaneous fluctuations on all scales (this is characteristic of systems in a state of self-organized criticality).

1. **KR** at [13:51 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35567)

Berényi - [*"satellite lower troposphere temperature anomalies are not reliable either"*](http://www.skepticalscience.com/argument.php?a=115&p=2#35564): Please keep in mind that this cuts both ways - if the records are not as reliable as we would like (which you have *really* not established, mind you), any errors could go in either direction, so claiming temperature measurements are bad (which should [be discussed here,](http://www.skepticalscience.com/surface-temperature-measurements-advanced.htm) really) does notestablish that warming isn't happening.

1. **KR** at [13:55 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35569)

Berényi - [*"Provided of course τ is not larger than several decades"*](http://www.skepticalscience.com/argument.php?a=115&p=2#35564) - many of them (the feedbacks) have time constants longer than this.   
  
I listed a few (certainly not an exhaustive list) in [this post](http://www.skepticalscience.com/argument.php?a=212&p=9#35401). I'm not a specialist in this field - I'm certain that other feedbacks with fairly long time constants could be added.

1. **archiesteel** at [14:03 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35573)

@BP: "That is, the time constant τ has no effect other than introducing a delay in this case - or an additive constant, if we look at it the other way around. It has no influence on the trend whatsoever."  
  
That's nonsense: a delay will in effect raise the temperature of the system, as the sun continues to send energy.  
  
Like RW1 and co2isnotevil in another thread, you seem to forget this is a dynamic system, and that power input is constant.

1. **muoncounter** at [15:44 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35581)

#67: "Therefore my calculation is correct,"  
  
Since no new information other than a transfer function was involved, what exactly did you calculate?  
  
And given that you started with "Well, let's suppose there is ... ", even that is cast in some doubt by your own presentation.  
  
A sensitivity calculation that does not match the observed changes in temperature isn't worth much. But you'll likely deny those observations as well. So the only logical result of this latest exposition is that there's some grand unknown force operating beyond our ability to influence or even measure.   
  
A fine science, that, as it is ultimately not falsifiable. But [the truth is out there ...](http://www.xfiles.com/).

1. **[Berényi Péter](http://ber.parawag.net/)** at [20:33 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35594)

[#70](http://www.skepticalscience.com/argument.php?p=2&t=66&&a=115#35573) **archiesteel at 14:03 PM on 30 December, 2010**  
*That's nonsense: a delay will in effect raise the temperature of the system, as the sun continues to send energy.*  
  
Listen, you either know how a linear time-invariant filter works or not. In the latter case you'd better have a look at [convolution integrals](http://mathworld.wolfram.com/Convolution.html).  
  
If **g(t) = ft**and **h(t) = (β/τ)e-t/τ**, then **g\*h(t) = βf(t-τ)**. It is a fact, no amount of babbling about the sun would change that. It is also equal to **βft-βfτ**. If climate sensitivity is *positive* (**β > 0**) and there is an *increasing* forcing (**f > 0**), the additive constant **-βfτ** is surely *negative*. Therefore the delay would *not* increase the temperature, but it would *decrease*it, while the trend itself (temporal derivative of temperature, **βf**) is clearly independent of said delay. So much about nonsense.  
  
(You could also work on your physics. There *is* a difference between temperature and heat.)

1. **JMurphy** at [22:10 PM on 30 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35596)

**Berényi Péter wrote** : *"So much about nonsense."*  
  
  
At last : something you have written which all can agree with ! I just wish you would heed your own words...  
  
PS Have you read the [Advanced Version](http://www.skepticalscience.com/climate-sensitivity-advanced.htm) of this topic ? It may help.

1. **archiesteel** at [02:32 AM on 31 December, 2010](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#35615)

@BP: I'm sorry, BP, but you're just throwing numbers around and hiding behind formulas. If you really understood the science, you'd be able to explain it simply.  
  
You might also try to explain why your (purposefully confusing) argument does not agree with actual observations.  
  
If you want to go and play the savant, why don't you write an actual scientific article and have it peer-reviewed. After all, since you're apparently able to disprove AGW theory is an important scientific discovery.  
  
The fact you haven't is a good indication you don't really believe your theory is exact, but are in fact only trying to further obfuscate the debate.

1. **muoncounter** at [13:14 PM on 14 January, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#36977)

UCAR strikes again: [New study sure to stir up the sensitivity discussion](http://www2.ucar.edu/news/3628/earth-s-hot-past-could-be-prologue-future-climate):  
  
*The study also indicates that the planet’s climate system, over long periods of times,****may be at least twice as sensitive to carbon dioxide than currently projected by computer models****, which have generally focused on shorter-term warming trends. This is largely because even sophisticated computer models have not yet been able to incorporate critical processes, such as the loss of ice sheets, that take place over centuries or millennia and amplify the initial warming effects of carbon dioxide.*  
--emphasis added

1. **KR** at [03:34 AM on 15 January, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#37058)

**thepoodlebites** - If you look at the "Intermediate" tab of this discussion you will see half a dozen empirically observed estimates of climate sensitivity, along with another half dozen model based ones. Does this address your request for observational data?

1. **KR** at [04:13 AM on 15 January, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#37063)

[thepoodlebites](http://www.skepticalscience.com/argument.php?a=18&p=16#37061) - My *"favorite paper"*??? All of them are interesting.   
  
Some of the more directly relevant ones from your question (observations) are Hansen 1993 *(energy changes since the last ice age)*, Tung 2007 *(sensitivity from climate response to solar variations)* and Bender 2010 *(responses to the Mount Pinatubo eruption)*. All of the papers listed on the intermediate page are worth reading, though.   
  
I will not continue the climate sensitivity discussion on the "Is it the sun" thread - that's off topic.

1. **KR** at [09:07 AM on 16 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#40193)

A question for the group - I hope this is a reasonable place for it, and even more that I'm phrasing this intelligibly.   
  
Given that we have raised the CO2 concentration quite high, it's now high enough that the oceans are acting like a sink despite their warming (above solubility pressures) - the oceans are absorbing 2ppm/year or so.   
  
If we maintain, as we are doing now, a CO2 concentration above that which would induce CO2 output by the oceans, does that remove one of the feedbacks (CO2 outgassing from said oceans) from the climate sensitivity calculations?   
  
In other words, does the forcing by CO2 emissions block the CO2 element of forcing feedback, and thus reduce climate sensitivity??

1. **scaddenp** at [13:48 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41040)

RW1 - there is another way to look at whether the radiative change is correct or not without going into the mathematics deeply.  
  
Step 1/ assume scientists have the maths and physics right. Use the model to calculate TOA emissions. Not just the energy, but also the spectra. Compare with REAL measured spectra.  
  
Step 2/ Assuming that was right, you can see whether the calculation for incremental CO2 increase is also correct by doing the same procedure but doing it for different decades and seeing whether the change matches the change in CO2.  
  
Sound fair enough test? In fact you could do the calculation for downward IR at surface or for outward IR by satellite. For results, see the papers on [this](http://www.skepticalscience.com/empirical-evidence-for-global-warming.htm)  
  
Now lets see George White produce some calculations from his approach that can match these empirical results.

1. **scaddenp** at [13:52 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41042)

(Oops, the above is response to comments from RW1 at [A swift kick in the ice](http://www.skepticalscience.com/news.php?p=5&t=214&&n=588#41041)

1. **RW1** at [13:58 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41043)

scaddenp (RE: 79),  
  
I don't understand, sorry.

1. **scaddenp** at [14:23 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41050)

If George was right, (ie should be 1.85W/m2), then the model result that calculated 3.7W/m2 would not agree with the actual measurements of IR. Similarly, if you compare spectrum measured in 1979 with that in 2004, if the incremental change in IR was wrong then the measurement wouldnt agree. This is experimental verification that 3.7W/m2 for doubling is correct. Furthermore, you check that the change in IR is due to CO2 by looking at the spectrum.

1. **RW1** at [14:29 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41051)

I'm not following.

1. **KR** at [14:59 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41054)

[scaddenp](http://www.skepticalscience.com/argument.php?p=2&t=83&&a=115#41050), [RW1](http://www.skepticalscience.com/argument.php?p=2&t=83&&a=115#41051) - George White has stated that running the HITRAN models results in an imbalance of 3.6 W/m^2 [(here, post #19)](http://joannenova.com.au/2011/01/half-of-the-energy-is-flung-out-to-space-along-with-the-model-projections/).  
  
And then he, for some reason, halves that value. Which I cannot consider as other than a blatant mistake.

**Response:** [DB] Fixed URL link.

1. **muoncounter** at [15:20 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41057)

KR,  
You may recall the last time we went around this tree (the endless Lindzen and Choi thread), this came from the assumption that 50% of emitted IR photons go up and out - 50% down.

1. **Tom Curtis** at [15:29 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41060)

Muoncounter @85, it comes from the incorrect assumption that line by line radiation models do not already apply that effect already, and then applying it again to the output of the line by line models.

1. **scaddenp** at [15:43 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41061)

Yes, hence my attempt to show that science had it right by direct empirical means since I despaired that RW1 would understand the calculation.

1. **RW1** at [15:51 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41064)

Tom Curtis (RE: 86),  
  
*"it comes from the incorrect assumption that line by line radiation models do not already apply that effect already"*  
  
Where is the documentation that the halving is already applied? That's all I'm asking for. I've looked around and cannot find it.

1. **scaddenp** at [17:39 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41077)

I know I am sounding like a broken record but you start with Ramanathan and Coatley 1978.

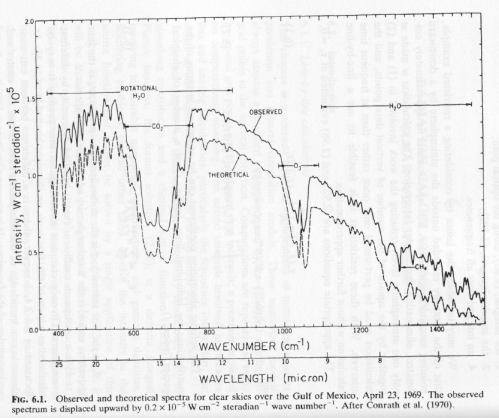
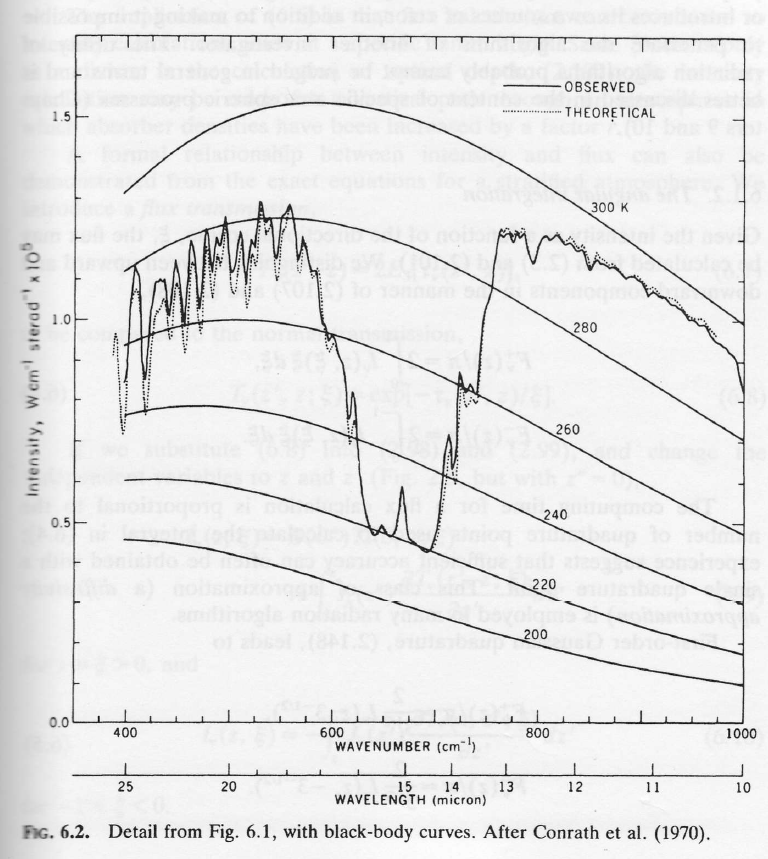
1. **Tom Curtis** at [22:01 PM on 21 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41084)

RW1, where is George White's documentation that it was not applied?  
  
Currently your "critical thinking" will not accept the results of several scientific papers, the two most seminal of which have been cited to you, it will not accept the IPCC report, it will not even accept the results of the public domain version of a radiation model designed by the USAF, and it will not accept the reports of a large number of people knowlegeable on the subject. But it will accept the say so of a single electrical engineer based on zero documentation to the contrary. This extreme contrast in willingness to believe shows it is not critical thinking at all.  
  
So, before we go any further, how about you show us the peer reviewed paper, or technical description of a line by line radiation model, or the code of such a model in which the effect is not applied already.  
  
Current evidence is that you will accept any belief contrary to AGW on zero evidence, but will not accept any belief supportive of AGW on even a mountain of evidence. Given that I am not going to waste my time presenting evidence to you that you will not consider anyway. (Afterall, I already have given that evidence to you in at least two different forms; both from very creditable academic sources.) So, either show me that you apply the same evidentiary standards you apply to Gearge White's ravings; or give principled reasons why you will not accept a straightforward truth that can be verified in **any first year text on atmospheric physics, or on climate modelling**?

1. **scaddenp** at [06:19 AM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41108)

And also, in scientific arguments, nature is the arbiter. The codes can used to calculate what experiments should observe. If George was right, then the experiments should be giving results half what they in fact do so.

1. **Tom Curtis** at [09:03 AM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41115)

saddenp @91, you mean that if the models where wrong, you would not get results like this:  
  
  
  
Note: the spectral lines have been deliberately offset so they can be seen clearly. Without the offset, it looks like this:  
  


1. **scaddenp** at [11:07 AM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41131)

Yes, precisely what I mean.

1. **RW1** at [15:34 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41138)

It was and remains a simple question unanswered. If it's so obviously wrong as being claimed here, it should be easy to point to the documentation that the "halving" is already applied to the 3.7 W/m^2 forcing. I have search around too. I couldn't find anything.

1. **KR** at [15:51 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41139)

[RW1](http://url/) - When the HITRAN model (and others) indicate a 3.6/3.7 W/m^2 imbalance, they are indicating photons going outward.   
  
The line-by-line calculations include *photons going up and down by absorption and re-emission*, for every level of the atmosphere covered by the model. The imbalance is the end difference between incoming and outgoing, the leftover quantity. Not emitted in all directions from some level of the atmosphere, but just the value emitted to space.   
  
That's what you get when you model the absorption/re-emission over the entire atmosphere. What's going back down to lower levels of the atmosphere or to the surface is part and parcel of the model - **the imbalance is only the portion going in one direction**, whether that's positive or negative depending on conditions.   
  
I'm afraid that George White's misunderstanding of this (and subsequent "halving" of the imbalance) indicates his overall poor understanding of the models he's been running.

1. **RW1** at [15:59 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41141)

KR,  
  
*"The line-by-line calculations include photons going up and down by absorption and re-emission, for every level of the atmosphere covered by the model. The imbalance is the end difference between incoming and outgoing, the leftover quantity. Not emitted in all directions from some level of the atmosphere, but just the value emitted to space."*  
  
OK, show me where this is documented.

1. **KR** at [16:20 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41142)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=2#41141) - Assuming that GW is using the HITRAN spectral database and something like JavaHAWKS for full atmospheric simulations, the spectral database includes absorption/emission spectra for a large number of IR interactive molecules.   
  
Full atmospheric emission modeling means looking at absorption, emission, and transmission across the full black body spectra of the Earth emission, over the depth of the atmosphere. Some IR gets radiated back to the surface, some gets radiated around and re-absorbed in the atmosphere, a certain percentage in the 'IR window' goes straight to space, etc.   
  
The [output from JavaHAWKS](http://www.cfa.harvard.edu/hitran/Download/HAWKSmanual.pdf) is the amount of radiation that actually leaves the atmosphere. Now, I cannot speak for GW, but "imbalance" should be a difference between the outgoing radiation from JavaHAWKS and incoming from the sun (a reasonably known value). Not the amount isotropically radiated from some level of the atmosphere, but the amount finally leaving the atmosphere (one directional) at the end of the modeling. And that's because the model includes the isotropic (omnidirectional, spherical) radiation as part of the calculation, summing up the anisotropic portion as output.   
  
That's certainly what *everyone else* running these models gets; 3.6-3.7 W/m^2 anisotropic radiation going to space for a doubling of CO2. An imbalance (difference!) between incoming and outgoing, an amount going in one direction not balanced by an amount going the other.   
  
I hate to say it, but GW does not understand the model he's running...

1. **KR** at [16:26 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41143)

RW1 - To put it more clearly: If it's not an anisotropic emission, it won't show up. Isotropic emissions, absorptions, and re-emissions are part of the model, not part of the output spectra. Total power emitted from the atmosphere given the model conditions is the output - not a sub-portion of internal isotropic emissions that will then get bounced around.

1. **RW1** at [16:51 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41145)

I'm willing to be shown incorrect on this issue (and I believe George is too), but you're talking around the crux of the issue. Words like "should" and "everyone else" isn't evidence to the contrary, and more importantly doesn't answer the fundamental question. In another thread, you said the total additional absorbed infrared from models/simulations from 2xCO2 was 7.4 W/m^2.  
  
And why haven't you said all this to George on his article and post on the issue at joannenova that you linked?

1. **RW1** at [16:57 PM on 22 February, 2011](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115#41146)

KR,  
  
*"To put it more clearly: If it's not an anisotropic emission, it won't show up. Isotropic emissions, absorptions, and re-emissions are part of the model, not part of the output spectra. Total power emitted from the atmosphere given the model conditions is the output - not a sub-portion of internal isotropic emissions that will then get bounced around."*  
  
OK, where is this documented? Point me to the paragraphs or pages that state this is what the output spectra represent.

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Comments 101 to 150 out of 370:

1. **KR** at [01:14 AM on 23 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41161)

RW1 - To use a database like HITRAN, you set up your parameters (in whatever spectral software you are using, such as JavaHAWKS) for two different conditions, run it twice, and look at the differences between the outputs.   
  
The output of interest is the summed energy radiated from the atmosphere given a particular surface temperature and atmospheric mix. The difference between them (~3.6 W/m^2 for doubling CO2 with HITRAN data, 3.7 for more up to date models) is the difference in total radiated energy - outgoing energy. **Not isotropic radiation from a particular level of the atmosphere, but the difference in total emissions**. Changes in atmosphere modify the emissivity of the Earth, as per the [Stefan–Boltzmann law](http://en.wikipedia.org/wiki/Stefan%E2%80%93Boltzmann_law); the amount of thermal radiation emitted at any particular temperature. And that leads to imbalances with incoming sunlight that result in climate changes as energy accumulates or leaves.   
  
It's as simple as that - what is the sum difference between radiated powers after an atmospheric change. That 3.6/3.7 Watts is *the integrated difference in total radiation going out to space at a particular temperature* - which is the very definition of "radiative imbalance".

1. **scaddenp** at [12:15 PM on 23 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41276)

RW1 - you are asking for documentation of what is implicit in the equations. Lets see if I can attempt it.  
  
At heart of equations, you consider a small slice of atmosphere. It has radiation from

1. in from below, (from surface and lower layers) and
2. from above (from upper layers in atmosphere).

The equations capture absorption, transmission, emission (in ALL directions - which of course is the inputs to layers above and below) for a given gas composition, P,T. The integral of all the layers is what then allows you to calculate what comes out of the top. All the interaction is captured. You know it correct because the model results agree with empirical measurement.  
  
[Science of doom](http://scienceofdoom.com/2010/11/01/theory-and-experiment-atmospheric-radiation/) explains the textbook.

1. **RW1** at [11:49 AM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41469)

scaddenp,  
  
I'm not finding the information and/or documentation I'm looking for to verify the claims made by you and KR. You are saying the 3.7 W/m^2 increase is not the reduction in the atmospheric window?

1. **scaddenp** at [13:57 PM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41484)
   1. Sigh. The Science of Doom takes you through text book. Is that documentation enough? The problem seems to be that you are looking for a statement that doesn’t exist because it would make no sense. The way real physics is done is bears little relationship to way you are trying to approach it. We are trying desperately to show why that is. As far as I can see you either:  
      a/ study the physics  
      b/ see that since model matches measurement so model must be right.  
        
      I am guess that are ignoring the textbook, SoD, papers, because they don’t relate to George White's "logic" and you search in vain for an analogous treatment. However, this is the right way to do it. I'm beyond my power to help you further.
2. **RW1** at [14:06 PM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41485)

My goodness, the answer is yes or no. You are claiming the 3.7 W/m^2 does NOT represent the reduction in the atmospheric window, right? (This is what I'm assuming you're saying).  
  
I do not find this information in the stuff you've referenced, and I've continued to search online to no avail. What we are talking about here represents a fairly simple thing.  
  
I sent an email to one of the links from the source you referenced to inquire:  
  
[SpectralCalc.com](http://www.spectralcalc.com/info/about.php)  
  
Hopefully they will respond.

1. **muoncounter** at [14:25 PM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41486)

[Rahmstorf 2008](http://www.pik-potsdam.de/~stefan/Publications/Book_chapters/Rahmstorf_Zedillo_2008.pdf), linked in the Advanced version of this post, gives **3.7 W/m^2 as an undisputed figure for CO2 forcing**.  
  
*Without any feedbacks, a doubling of CO2 (which amounts to a forcing of 3.7 W/m2) would result in 1°C global warming, which is easy to calculate and is undisputed. ... consensus holds that a doubling of CO2 causes a radiative forcing of 3.7 W/m2, which in equilibrium would cause 3°C±1.5°C of global warming.*

1. **scaddenp** at [15:09 PM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41488)

muon - the issue is does "reduction in the atmospheric window" mean the same thing to RW1 as I think it means.  
You can say yes, but I suspect that RW1 then has corollary from that shows a very different understanding.

1. **muoncounter** at [16:07 PM on 24 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41492)

scaddenp - Yeah, I thought that was a peculiar phrase, which seems to add an unnecessary layer of complication. All I did was point to the link, as it seemed (in #105) that he couldn't find it. How he chooses to interpret this particular 3.7 W/m^2 is up to him, although both KR and you have made it very clear.

1. **KR** at [01:16 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41515)

I believe the "atmospheric window" issue is tied (again) to George White - he believes the window of IR going straight to space is >90 W/m^2, whereas Trenberth estimates 40 W/m^2, and asserts that all greenhouse gas effects operate by narrowing that window. He seems to neglect lapse rate and GHG concentration effects raising the altitude (and dropping the temperature) of emission, and in addition argues that the 90 W/m^2 represents a limiting band on GHG effects.   
  
**RW1** - The models operate by calculating upwards and downwards emissions from all levels of the atmosphere, and the 3.7 W/m^2 represents all the effects: band broadening due to higher GHG concentrations, band deepening due to higher effective altitudes of emission to space, higher reemission to the ground, etc. So the answer to your question is partially, although not readily picked out of the other effects.

1. **scaddenp** at [08:23 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41556)

The problem of getting your "physics" from George White instead of from a textbook. Is George untroubled by lack of match with empirical data?

1. **RW1** at [09:54 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41570)

KR,  
  
My question isn't related to what the number for the window is.  
  
scaddenp,  
  
No, the problem is no one is answering my question.

1. **RickG** at [10:03 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41571)

@ #111 *"No, the problem is no one is answering my question.*  
  
Or perhaps its just not the answer you want to hear.

1. **scaddenp** at [10:39 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41577)

RW1 - "You are saying the 3.7 W/m^2 increase is not the reduction in the atmospheric window? " Hmm, but we have this rather odd expression about "reduction in the atmosphere window". What does this mean? KR identifies it with a GW idea. Can you phrase the question in a way that we can understand, and preferably makes physical sense?

1. **RW1** at [11:17 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41581)

scaddenp,  
  
I'll break it down into a series of separate small questions:  
  
1. Do you agree that some of the emitted surface infrared power passes through the atmosphere unabsorbed by GHGs or clouds?  
  
2. Do agree that the remainder is absorbed by the atmosphere?  
  
3. Does the 3.7 W/m^2 of 'radiative forcing' represent a reduction in the atmospheric window of 3.7 W/m^2?  
  
4. Does the 3.7 W/m^2 of 'radiative forcing' represent an increase of 3.7 W/m^2 in the amount of infrared absorbed by the atmosphere.  
  
My understanding is your answer to 1 & 2 is YES and your answer to 3 & 4 is NO. Is this correct?

1. **KR** at [11:53 AM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41588)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41581) - The answers to your four questions are

* 1. "Yes, ~40 W/m^2",
  2. "Yes, although a fair amount of energy also goes into the atmosphere via convection and latent heat(~20%)",
  3. "Only partially", and
  4. "Almost, it's the amount prevented from leaving via various effects - more absorption and higher/colder emissions".

Sorry, but these are obviously important questions for you, and I would be doing a disservice by giving un-nuanced answers.

1. **RW1** at [12:23 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41592)

KR,  
  
The actual number for the atmospheric window is irrelevant to the particular question at hand here. Whether it's 40 W/m^2 or 90 W/m^2 - it doesn't matter, nor do I care.  
  
The estimated 3.7 W/m^2 from 2xCO2 either represents a reduction in the atmospheric window or not. The fact you seem to be side stepping this fundamental question is quite revealing. It's a ridiculously simple and straightforward question with a simple yes or no answer.   
  
I can see no one here is interested in getting to bottom of this, so it appears like I'll have to do some more searching around and figure out for myself.

1. **KR** at [12:31 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41594)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41592) - *"The estimated 3.7 W/m^2 from 2xCO2 either represents a reduction in the atmospheric window or not."*  
  
**Wrong.** It's partially a reduction in the "window", and partially a reduction, a drop in the intensity, in the GHG bands - the ones already inhibited by the presence of greenhouse gases. Not yes or now, but "in part".  
  
As GHG concentration rises, the effective emission altitude goes higher and higher in the troposphere, and hence (due to the lapse rate) comes out of colder and colder GHG's. They emit less than warmer lower GHG's - the additional altitude means that the repeated reduction in IR transmission as part gets emitted up (to higher levels) and parts down attenuate the IR levels. That and widening bands, the reduction of the window, combine to provide the 3.7 W/m^2 effect from doubling CO2.  
  
That is why I gave a nuanced answer, one that *actually answered your question without conveying incorrect information*. It's not A or B - it's both.

1. **RW1** at [12:52 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41595)

KR,  
  
Let's take this one question at a time. What does the atmospheric window represent? Please define it for me.

1. **RW1** at [13:05 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41597)

KR (RE: 117),  
  
Then the answer is no. What's so hard to understand here? I'm trying to find specifically where the disagreement lies. This is pretty basic stuff.

1. **scaddenp** at [13:51 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41598)

RW1 - actually that's what I don’t understand. What do you mean by "atmosphere window"? A clearer understanding of that might illuminate this.

1. **RW1** at [13:52 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41599)

By 'atmospheric window', I'm referring to the amount of the emitted surface power that passes through the atmosphere completely unabsorbed by GHGs or clouds.

1. **KR** at [14:53 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41602)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41597) - The answer is not "no", it is "in part". I've (repeatedly) clearly answered your question - narrowing of the atmospheric window is part of the 3.7 W/m^2, and deepening of the intercepted bands due to higher effective emission altitude is also part of the 3.7 W/m^2. It's not an either/or question!

1. **RickG** at [23:01 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41630)

RW1: *By 'atmospheric window', I'm referring to the amount of the emitted surface power that passes through the atmosphere completely unabsorbed by GHGs or clouds.*  
  
How do you distinguish what is surface emitted from other emitted sources. And why do you use the word "power"? What is power?

1. **Tom Curtis** at [23:48 PM on 25 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41634)

RW1:  
  
1) When physicists refer to "the atmospheric window" they refer to a portion of the spectrum in which radiation is not absorbed, so radiation can pass through that "window" without appreciable loss or distortion. The atmosphere has several windows - one at the frequencies of visible light, another in the IR spectrum, and still others in the radio spectrum.  
  
2) One of the atmospheric windows in the IR spectrum is in that range of frequencies where the majority of the surfaces IR radiation is emited. As a result, about 40 w/m^2 of IR radiation escapes to space without being absorbed by any atmospheric components (except clouds, if present).  
  
3) Increasing CO2, O3 or H2O content into the atmosphere, or introducing novel GHG can narrow this window slightly, but the effect is very small.  
  
4) Outside of the atmospheric window, IR radiation from the Earth's surface is entirely absorbed by GHGs; **but**  
  
5) Those GHGs then emit radiation at the same frequency at an intensity that depends on their temperature. The IR radiation emitted towards space by GHGs is then absorbed by higher GHGs, which in turn emit radiation at an intensity depending on their temperature, which is in turn absorbed and so on until the atmosphere is thin enough for the upward emitted radiation to escape to space.  
  
6) Because the radiation outside the atmospheric window that escapes to space is emitted high in the atmosphere, it is emitted by gases that are much cooler than the surface. Therefore, that radiation has a much lower intensity, ie, transmits much less energy than the radiation emitted from the surface at the same frequency. **The difference between the energy that is radiated to space outside of the atmospheric window and the energy originally radiated from the surface at those same frequencies is the fundamental basis of the green house effect.**  
  
7) If you increase the concentration of a GHG, then the altitude at which radiation from that GHG will effectively escape to space will increase. **Because the altitude has increased, the temperature of the radiating gas is lower, so the total energy radiated is also lower**.  
  
8) If you double the CO2 concentration, the atmospheric window will narrow slightly as the absorption band of CO2 widens. This does not mean no IR radiation will escape in the frequencies where the absorption band widens - it just means that the IR radiation in those frequencies will come from a higher, ergo cooler, ergo less energetic altitude, reducing the total IR energy escaping in that frequency band by about a third.  
  
9) At the same time, IR in the frequencies of the previously existing absorption band will come from slightly higher in the atmosphere, and therefore carry less energy (because the emitting CO2 is colder).  
  
10) The combination of these two effects will reduce the total energy leaving the atmosphere by 3.7 w/m^2  
  
That is the full and complete answer to your questions (given space limits). It has been given to you ad nauseum above but you refuse to hear the answer because it is not framed according to the frankly fallacious model of the Green House effect used by George White. However, we cannot ignore the physics and give you answers that only make sense if framed in terms of George White's fallacious physics. If you try frame your question in terms of the actual physics, however, you will find you have already been answered repeatedly.

1. **scaddenp** at [06:27 AM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41682)

" And why do you use the word "power"? What is power?". It's the surest sign that you are dealing with someone who has got their education from George White. This incorrect usage has been pointed out to RW1 before.

1. **Tom Curtis** at [09:52 AM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41692)

RickG @123, scaddnp @125, being fair to RW1, power is just energy over time, and the Watt is a unit of power, not of energy. For convenience, when measuring the energy balance of the Earth, climatologists use the unit of watts/meter^2 rather than joules/second meter^2, which would be more formally correct when talking about energy.  
  
Talking about the "power that escapes the atmosphere" rather than the "energy that escapes the atmosphere" would be peculiar; but talking about the "power that is transmitted" or the "power that passes through" the atmosphere is not, so I don't see your point.

1. **scaddenp** at [12:46 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41701)

Well, I am used to the more usual definition of power as rate of energy conversion. The GW usage just sounds so strange when used instead of energy flux. Mix it in with amplifier analogues and its a real recipe for confusion. There is a lot to said for accuracy ( though I know I am pot calling kettle black at times). On other hand, met anyone not acquainted with GW using power in this peculiar way when discussing radiative physics?

1. **RW1** at [13:53 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41706)

So the 3.7 W/m^2 does not represent the reduction in the atmospheric window, nor does it represent the incremental absorption?

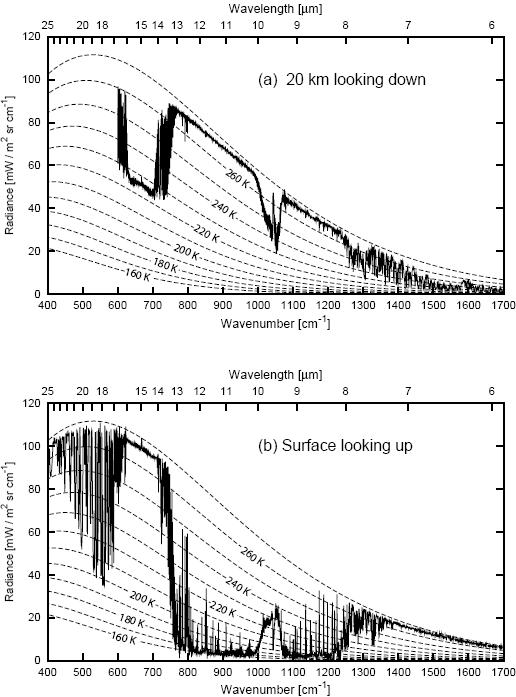
1. **RW1** at [13:57 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41707)

Tom Curtis (RE: 125),  
  
*"The combination of these two effects will reduce the total energy leaving the atmosphere by 3.7 w/m^2"*  
  
Wonderful. Now please provide me the documentation for this. What you don't seem to understand is I already know this is what is being claimed - I don't need to you to tell me it's true.

1. **RW1** at [14:01 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41709)

Here is a question:  
  
If the 3.7 W/m^2 does not represent the reduction in the atmospheric window, then what is the reduction in the atmospheric window from 2xCO2?

1. **KR** at [14:25 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41712)

[RW1](http://www.skepticalscience.com/argument.php?p=3&t=130&&a=115#41709) - The reduction in the atmospheric window represents only a small portion of the 3.7 W/m^2, as [Tom Curtis said](http://www.skepticalscience.com/argument.php?p=3&t=130&&a=115#41634). Sorry I don't have exact numbers, but (as I have a day job) I haven't put in a request for the HITRAN data.   
  
If you look at the [actual spectra](http://www.skepticalscience.com/Second-law-of-thermodynamics-greenhouse-theory-intermediate.htm) of top of atmosphere (TOA) emissions, you will see the GHG blocked bands:   
  
  
  
The baseline of around 225K (around 650 microns) in the first graph represents the lapse-rate cooled greenhouse gas emission at the altitude where the IR can actually reach space without being intercepted by more GHG's. The higher this goes, the cooler the gases, the lower the temperature for emission, the lower the bottom of that curve. And hence the lower the integrated power over the entire spectra.   
  
My question to you is: Why does it matter? What's the issue with the 'window' versus lowest temperature of fully intercepted bands? I'm genuinely curious, especially since you've been poking at that for some days now - why is the percentage involved in 'window' narrowing important relative to the total integrated power blocked by a doubling of CO2? Do you have an argument based upon 'window' size?   
  
The reason I ask is because I *don't see* why the distribution would be an issue - the total energy imbalance (change in emitted energy with doubled CO2) is what is important as a forcing, rather than exact spectral distribution (and I say that as someone who works with spectrometers all the time!).

1. **RW1** at [14:53 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41713)

I tried. I'm going to get to bottom of this. I'll be back when I know and can show the proof.

1. **Tom Curtis** at [15:43 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41716)

RW1 @129, if you already understand this then why are you asking a question which is almost nonsensical, and is certainly irrelevant, given that knowledge?  
  
Your ask it again @130. However, it is irrelevant for all except the most abstruse studies. What concerns us it the total change in Outgoing IR Radiation, not the change at particular wave numbers.   
  
It is also very difficult to calculate independently. For each wave number effected, you would need to calculate the energy flows by radiation and convection/latent heat from the surface to the top of the atmosphere, including both upwards and downwards energy transfers. Line By Line models do in fact calculate exactly that for every wave number (or small band of wave numbers depending on their resolution), so if you were to ask a scientist who regularly dealt with LBL models, they would no doubt be able to find the information you seek. But unless you can show a very good reason why it matters, I see no reason to pander to your request, anymore than I would pander to a geocentrist's request to show the gravitational impact of Mount Everest on the moon's orbit.  
  
Given the very accurate prediction of LBL models as shown [here](http://www.skepticalscience.com/argument.php?p=2&t=132&&a=115#41115), and the detailed discussion of that accuracy by Science of Dooom (linked by scaddenp @102 above) and the many quoted direct claims that the change in OLWR from a doubling in CO2 is 3.7 w/m^2, you have no reasonable basis to doubt that figure.  
  
You need to come good with a **very good** reason as to why you doubt the 3.7 w/m^2 figure, and as to why you persist in your obtuse question.

1. **muoncounter** at [16:03 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41717)

[Tom](http://www.skepticalscience.com/argument.php?a=115&p=3#41716),  
  
"if you already understand this then why are you asking a question which is almost nonsensical, and is certainly irrelevant, given that knowledge?"  
  
That is a very troubling question. It appears that if the 'answer' supplied can't be put into the [exact format required](http://www.skepticalscience.com/argument.php?a=115&p=3#41706), it's either alleged to be [undocumented](http://www.skepticalscience.com/argument.php?a=115&p=3#41707) (when it [actually was documented](http://www.skepticalscience.com/argument.php?a=115&p=3#41486)) or alleged to be [unacceptable](http://www.skepticalscience.com/argument.php?a=115&p=3#41713).  
  
Sadly, we've seen this [drag on for hundreds of comments](http://www.skepticalscience.com/Lindzen-Choi-2009-low-climate-sensitivity.htm). How this rather elliptical debating process can be considered scientific eludes me.

**Response:** [DB] Tamino has a [new post](http://tamino.wordpress.com/2011/02/26/mathturbation/) up very "tangential" to those "elliptical" thinkers of whom you speak.

1. **RW1** at [16:10 PM on 26 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41718)

*"You need to come good with a very good reason as to why you doubt the 3.7 w/m^2 figure"*  
  
Agreed - I'm working on it.  
  
I really don't doubt the figure - just what the figure supposedly represents. I'm not getting any 'proof' here of anything, so I'm left to figure it out on my own.

1. **KR** at [07:32 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41749)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41718) - *"I'm not getting any 'proof' here of anything, so I'm left to figure it out on my own."*  
  
Actually, I will have to disagree with you. You've been pointed to the documentation, you have statements from several people who are quite familiar with line-by-line atmospheric calculations, and even George White sees a ~3.6 W/m^2 **imbalance** with his own runs of the HITRAN code.   
  
Unfortunately, as [muoncounter pointed out](http://www.skepticalscience.com/argument.php?a=115&p=3" \l "41717), these efforts are met with disbelief, rejection, and (yes) denial - [*"I'm going to get to bottom of this. I'll be back when I know and can show the proof"*](http://www.skepticalscience.com/argument.php?a=115&p=3#41713). I have the impression from this conversation that you will reject anything that does not conform to your preconceptions, and that is very sad.   
  
3.7 or so W/m^2 is the difference in total planetary emissions upon doubling CO2, the amount of extra IR not leaving at a particular temperature, the change in outward directed energy.   
  
Please - we've offered this information honestly and clearly, as the best established data available. I would suggest you consider *your own reasons for not believing it, and why you are so insistent that we are wrong*.

1. **scaddenp** at [07:39 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41750)

Guys, noticed RW asked at Realclimate:  
"’m wondering if someone can shed some light on this subject for me. I’ve searched around at length all over and cannot find a clear answer. The 3.7 W/m^2 estimated from simulations for the increase in ‘radiative forcing’ from a doubling of atmospheric CO2 – does the 3.7 W/m^2 represent a reduction in the atmospheric window or does it represent the half directed down due to isotropic re-radiation/redistribution (meaning a reduction in the atmospheric window of 7.4 W/m^2)???"  
  
Clearly absolutely nothing we have said has been understood at all. I doubt he will like Gavin's accurate response either.

1. **Tom Curtis** at [08:31 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41752)

scaddenp @137, out of a morbid curiousity, what thread?

1. **Daniel Bailey** at [08:36 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41753)

[Here it is](http://www.realclimate.org/index.php/archives/2011/02/how-easily-it-is-to-get-fooled/#comment-201760):  
  
*"RW says:  
24 Feb 2011 at 8:50 PM  
  
Interesting thread. I have a question about some frequently referenced data:  
  
I’m wondering if someone can shed some light on this subject for me. I’ve searched around at length all over and cannot find a clear answer. The 3.7 W/m^2 estimated from simulations for the increase in ‘radiative forcing’ from a doubling of atmospheric CO2 – does the 3.7 W/m^2 represent a reduction in the atmospheric window or does it represent the half directed down due to isotropic re-radiation/redistribution (meaning a reduction in the atmospheric window of 7.4 W/m^2)???"*  
  
[**Response: It is the global mean change in outgoing LW flux at the tropopause (integrated over the whole spectrum) for a doubling of CO2. - gavin**]  
  
[ -Edit: More ensuing discussion follows- ]  
  
The Yooper

1. **RickG** at [08:38 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41754)

@138  
  
[**How easy is it to get fooled?**](http://www.realclimate.org/index.php/archives/2011/02/how-easily-it-is-to-get-fooled/#comment-201760)

1. **RW1** at [08:41 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41755)

Another question:  
  
Do we all agree that not all of the absorbed infrared affects the surface?   
  
That a portion of it is directed up out to space and the remaining portion of it is directed down to the surface?

1. **KR** at [08:57 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41757)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41755) - The 3.7 W/m^2 energy imbalance from doubling CO2 is kept in the Earth climate system, atmosphere and surface.  
  
This is the sum result of multiple absorption/emission events distributed throughout the atmosphere, as we've told you, and as (it appears) Gavin Schmidt has repeated. Each of those **individually** is isotropic, with nearly equal (due to horizon effects) probability of upwards or downwards.   
  
The **sum radiation change** upon doubling CO2 is that a global mean of 3.7 W/m^2 less energy leaves the top of the atmosphere.   
  
Shopping around for a different answer won't change that...

1. **RW1** at [09:07 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41758)

KR,  
  
As stated before, you're just repeating and declaring conclusions I'm already aware of. This is not how science, logic and reasoning works.

1. **KR** at [09:45 AM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41761)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=3#41758l) - You've repeatedly, and by multiple people, been told what the data is, and continue to argue for your (mis)perception of it. We've told you what the results are - denying the data is the unscientific approach here.   
  
Something to think about, RW1 - which is more likely? That everyone's interpretation of LBL analysis of CO2 forcing is somehow *blatantly wrong*? Or that George White (not published AFAIK, certainly not in climatology) is misinterpreting the results of the model he's run? I'm not asking for an answer from you, but just for you to consider the question.   
  
I'm out of this thread until real questions are discussed again.

1. **Tom Curtis** at [12:43 PM on 27 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41771)

RW1 @143:  
  
Science works by verification and observation. In this instance, to verify the Line By Line models, or the Energy Balance models (which give essentially the same results) you would need to verify the physical laws involved, ie, the Beer-Lambert Law, Kirchoff's Law, Planck's Law, Wien's Law and Stefan Boltzmann's Law, not to mention the laws of convective heat transfer in the atmosphere and heat transfer from changes of state of H2O.  
  
Having done that, you then need to go through the models line by line to make sure they actually implement the relevant laws appropriately. You also need to have detailed records of the composition and temperature profile of the atmosphere, and confirm that they are correctly entered into the model. You also need to check the emissivity of the various compounds in the atmosphere and make sure they are correctly fed into the model.  
  
You have been referred to sources in this discussion where you can do each one of these things, either in little detail (Science of Doom), moderate detail (relevant textbooks) or great detail (relevant scientific papers). You have ignored all of that because, apparently, we cannot find a source that encapsulates all that knowledge into just one sentence.  
  
Having done all that, or accepted expert opinion that it was done correctly (which is the sensible approach in that none of the above is in dispute by any practicing scientist including well known skeptics such as Pielke and Spencer), you can then compare the results of the models with observation, as has been done here. In fact, line by line, if given approximately current information on atmospheric composition at each level, models have been shown to be accurate within less than 1% - again something you have been shown in this thread. With only approximate information, the models are accurate to within 5% or 0.2 w/m^2 for a doubling of CO2. Again this is not in dispute by any practicing scientist once a few transparent crack pots are excluded.  
  
Your problem is not that we are not confirming to how logic or science should work. Your problem is that we are, and for some strange reason, you don't like the answer.

1. **[hank](http://hankroberts.wordpress.com/)** at [04:25 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41821)

Oh.  
  
Jan 13, 2011 ... Guest Post by George White. Evolution of an Energy Budget ..... Trenberth's atmospheric window includes 40 W/m^2 coming from the surface and ...  
joannenova.com.au/.../half-of-the-energy-is-flung-out-to-space-along-with-the-model-projections/

1. **RW1** at [04:34 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41823)

*"Your problem is not that we are not confirming to how logic or science should work. Your problem is that we are, and for some strange reason, you don't like the answer."*  
  
Whatever, Tom. I'm not getting the answers to the questions I'm asking. All I'm really getting is declarations.

1. **[hank](http://hankroberts.wordpress.com/)** at [04:56 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41825)

Oh. My.   
  
"co2isnotevil: February 10th, 2011 at 8:53 am  
"... looking up during the day you will see both primary and secondary IR directly originating from the Sun. This is not ‘back radiation’, but forward radiation from the Sun. Trenberth likes to call this ‘back radiation’ in order to give the false impression that GHG’s radiate this much."   
(from the joannenova thread still in progress).  
\_\_\_\_\_\_\_\_\_\_\_\_  
'The question is,' said Alice, 'whether you can make words mean so many different things.'   
'The question is,' said Humpty Dumpty, 'which is to be master ...'

1. **[hank](http://hankroberts.wordpress.com/)** at [06:15 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41844)

Oh, heck, RW/GW were answered previously e.g. http://skepticalscience.com/news.php?p=5&t=216&&n=588#41029 and earlier. Sorry, I didn't realized I'd walked into the late stages of a thread-to-thread-to-thread Gish Gallop.

1. **RW1** at [06:29 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115#41848)

*"George White's arguments are rife with errors. (There was going to be a third and fourth post on his errors, but the page containing his essential argument is currently down.) One of the most egregious is the halving of the reduction in outgoing radiation due to IR gases. This is very easily verified for your self using the modtran model hosted by David Archer. This is an obsolete model available on the public domain, but it still shows a change in TOA OLR of -3.17 w/m^2 for a doubling of CO2 from the default settings. Note, that is the reduction in the Outgoing Longwave Radiation, it is not "the amount of IR radiation captured" or some other vague term designed to confuse. Based on this model, with 375 ppm CO2, approx 287.8 w/m^2, while with 750 ppm, approx 284.7 w/m^2 leaves the planet."*  
  
How can 287 W/m^2 be leaving the planet? From Stefan-Boltzman, 287 W/m^2 = 266K (255K expected)?  
  
What about Trenberth's transparent window of 40 W/m^2? 287.8 W/m^2 + 40 W/m^2 = 327.8 W/m^2 = 275.5K (255K expected)????

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Comments 151 to 200 out of 370:

1. **RW1** at [06:49 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41851)

Actually the Archer model you reference seems to be consistent with White's numbers:  
  
385 W/m^2 x .566 (% absorbed clear sky) = 217.9; 217.9 W/m^2 x 0.333 (% clear sky) = 72.6 W/m^2  
  
385 x .857 (% absorbed cloudy sky) = 329.9; 329.9 W/m^2 x 0.666 (% cloudy sky) = 219.7 W/m^2  
  
219.7 W/m^2 + 72.6 W/m^2 = 292.3 W/m^2; Archer = 287.8 W/m^2, which is awfully close.

1. **[hank](http://hankroberts.wordpress.com/)** at [06:57 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41853)

http://www.google.com/search?q=top+of+atmosphere+255K  
  
First hit:   
meteo04.chpc.utah.edu/class/1020/Lecture2.201009.pdf   
Start around slide 31.

1. **Tom Curtis** at [10:55 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41887)

RW1 @150, if you care to look at the settings, Modtran is run for specific typical locations, with the default being the tropics. It does not produce a globally averaged result. Because the tropics is warmer than the global average, OLR at the tropics is warmer than the global average of approx 240 w/m^2. As set for default, it also does not include the effect of clouds.  
  
Further, and for the umpteenth time (as this is just your same question in a different guise) the OLR from the atmospheric window is included in the calculation. This can clearly be seen in the graph of the emissions for each model run. It can also be seen with line by line detailed data by viewing the whole output file.  
  
If you want a closer approximation to the global average, use the 1976 US Standard atmosphere (effective brightness temperature = 259 K). Alternatively, use the ground temperature offset to either set the surface temperature at 288 K (effective brightness temperature = 257 K), or adjust it to match an output of 240 w/m^2, and then run the doubling of CO2 experiment.  
  
As previously indicated, this is an obsolete model. And as implemented on the net, it does not even allow us to control all parameters so that you cannot set up a globally averaged surface temperature plus cloud cover. It's use is to show you quite clearly that the 3.7 w/m^2 is the difference in total OLR from doubling CO2. If you want a more up to date model, you'll have to pay the licensing fees.

1. **Tom Curtis** at [11:27 AM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41889)

RW1 @151, it is no surprise that the figures are close to George White's in that GW used a hi-tran model to get his figures. He then **misinterpreted** the Outgoing Long-wave Radiation as being the the total energy emitted from the top most layer of the atmosphere, and divided it by two to get what he believes to be the OLR.  
  
Looking at the Modtran model you can clearly see that that is a mistake. That model calculates the IR radiance at a given location that is either out going, or incoming. You can set the altitude to 0 and Look Up to calculate the back radiation. Or you can use the default to set the altitude to 70 km and look down to model what a satelite at 70 km altitude would detect. Clearly that satellite is not going to detect the radiation that is returning to the Earth, it will only detect the OLR. So, the I(out) of the model with that setting is the OLR. There is no need to divide it by two, and doing so shows complete incompetence on this subject. (Not a problem in somebody who is trying to learn, but a huge problem in someone like George White who purports to lecture.)

1. **RW1** at [12:27 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41895)

*"Looking at the Modtran model you can clearly see that that is a mistake."*  
  
I've spent the last hour or more looking at the detailed line by line output and don't see the 'mistake' you're referring to. I do see that the atmospheric window is included in the data though (more on that in my next post).  
  
Also, I know this model is out of date, but for the purposes of understanding what these numbers mean, let's break them down as they are.  
  
Here are the inputs I'm using:  
  
CO2 (ppm) 375 & 750   
CH4 (ppm) 1.7  
Trop. Ozone (ppb) 28  
Strat. Ozone scale 1  
  
Ground T offset, C -1   
hold water vapor pressure   
Water Vapor Scale 1  
  
Locality 1976 US Standard Atmosphere  
No clouds or rain  
  
Sensor Altitude km 70  
Looking Down  
  
This is the data output I'm looking at.

1. **Tom Curtis** at [13:04 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41897)

You did not show the data output. However, with settings as indicated and 375 ppm CO2, the base output is:  
  
  
I, W / m2 = 255.565  
Ground T, K = 287.20  
  
For 750 ppm, the output is:  
  
I, W / m2 = 252.801  
Ground T, K = 287.20  
  
The difference in I is 2.764 w/m^2.  
  
That is the difference, according to this model, between the IR leaving the atmosphere with 350 ppm and with 750 ppm. Plainly, if that is the IR leaving the atmosphere, it is incorrect to divide it by two to determine the difference in the IR energy leaving the planet in the two cases. But that is exactly what George White does with his equivalent calculation.

1. **[hank](http://hankroberts.wordpress.com/)** at [13:28 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41899)

"he then misinterpreted ... that is a mistake."  
  
The misinterpretation.

1. **RW1** at [13:31 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41900)

The first thing I notice in the data is that at 375 ppm, the average transmittance is 0.2526, and the average transmittance at 750 ppm is 0.2465 (a reduction of 0.0061 or about 2.4%).   
  
At temperature of 287.2K, the earth's surface emits about 385 W/m^2. 385 W/m^2 x .2526 = 97.251 W/m^2 passing through the atmospheric window at 375 ppm, and 385 W/m^2 x .2465 = 94.903 passing through at 750 ppm for (a reduction of 2.348 W/m^2).   
  
385 W/m^2 - 97.251 W/m^2 = 287.749 W/m^2 absorbed by the atmosphere at 375 ppm. 385 W/m^2 - 94.903 W/m^2 = 290.907 W/m^2 absorbed at 750 ppm.  
  
Here is what I can't figure out: The output of the data is showing 255.565 W/m^2 leaving at 375 ppm and 252.801 W/m^2 leaving at 750 ppm (a reduction of 2.764 W/m^2).  
  
If I divide 287.749 W/m^2 (375 ppm) by 2, I get 143.8745 W/m^2. 143.8745 + 97.251 = 241.1255 W/m^2 leaving (255.565 W/m^2 needed to match the data?).  
  
If I divide 290.907 W/m^2 (750 ppm) by 2, I get 145.0485 W/m^2. 145.0485 W/m^2 + 94.903 = 239.9515 W/m^2 leaving (252.801 W/m^2 needed to match the data?).   
  
145.0485 W/m^2 - 143.8745 W/m^2 = 1.174 W/m^2, which is exactly half of the 2.348 W/m^2 reduction in the atmospheric window.  
  
To match output of the data exactly, at 375 ppm there needs to be 158.314 W/m^2 from the atmosphere (158.314 + 97.251 = 255.565 W/m^2). For 750 ppm there needs to be 157.898 W/m^2 from the atmosphere (157.898 + 94.903 = 252.801 W/m^2).   
  
The difference between 158.314 W/m^2 and 157.898 W/m^2 is 0.416 W/m^2, which is the exact difference between 2.348 W/m^2 reduction in the window and the reduction in the data output of 2.764 W/m^2).  
  
What accounts for the missing 0.416 W/m^2???

1. **KR** at [13:37 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41901)

RW1 - Why are you dividing by 2? Seriously, why? What Modtrans outputs is the total outgoing IR, and hence the 2.764 change on doubling CO2 is the entire, whole, complete difference between outgoing IR. Not half the amount, not twice the amount, but the whole amount.   
  
Dividing by 2 is wholly unphysical and **wrong**. This is the basic mistake that GW makes, and that you have repeated. **It is wrong**.

1. **RW1** at [14:06 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41903)

KR,  
  
Then why does the 2.764 W/m^2 difference outputed NOT match up to the difference in the transmittance data outputed? Are you saying it shouldn't? Explain why. What accounts for the difference?  
  
All I've done is run some calculations showing what the numbers would be dividing by 2. Those calculations using the exact transmittance data provided at least yield about 240 W/m^2 (255K) leaving.

1. **Tom Curtis** at [14:15 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41906)

RW1 @158:  
  
1) You did not account for the emissivity of 0.98 for the Earth's surface. That means Surface Radiation (SR) = 385.8 \* 0.98 = approx 378 w/m^2  
  
2) The average transmittance, ie, the sum of each line's transmittance divided by the number of lines, cannot be used as you have done it. The energy emitted at each line is not constant, so the distribution in variation in transmittance relative to the distribution in emitted energy can make very large differences in the net transmission. Therefore using a simple average of transmission will give invalid results.  
  
3) Total radiance obviously includes values for emissions by the atmosphere, as for example at line 400:  
  
Surface Transmission: 3.18E-29  
Total Radiance: 1.42E-03   
Transmittance: 0.00000  
  
Clearly with a transmittance of 0, Total Radiance would be 0 if radiation emitted from the atmosphere was excluded.  
  
To conduct the analysis you wish to make, you need to go through line by line, and sum the total of surface radiation \* transmittance to get the amount of radiation from the surface that escapes to space unabsorbed. You then need to go through line by line and sum (total radiance - (surface radiation \* transmittance)) to get the amount of radiation emitted from the atmosphere to space. You will then be in a position to do what you are trying to do in 158.  
  
Have fun.

1. **RW1** at [14:22 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41907)

Tom,  
  
The average transmittance for '100 TO 1500 CM-1' is given at the bottom.  
  
Also, I tried using an emissivity of .98 and it didn't make much difference (2.3058 W/m^2 instead of 2.348 W/m^2).

1. **Tom Curtis** at [14:22 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41908)

Addendum to 161:  
  
Looking at the values, it appears quite probable that "Surface transmittance" **is** the surface radiation that escapes to space at each line, with transmittance rounded to five significant figures, thus showing 0 in this case.  
  
In that case, to get the transmittance you would have to calculate independently the surface radiance at the surface for each line. However, it would save you a step in integrating determining the total emissions from the atmosphere.  
  
You may need to find a manual to clarify this.  
  
Of course, the sensible thing to do would probably be to assume that no fundamental errors slipped into the programing based on the fact that a large number of independently programed models yield essentially the same result.

1. **Tom Curtis** at [14:24 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41909)

@162, I know the average is given at the bottom. That does not mean you can use it as you are doing.

1. **RW1** at [14:27 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41910)

Tom,  
  
'INTEGRATED ABSORPTION FROM 100 TO 1500 CM-1 = 1054.84 CM-1  
AVERAGE TRANSMITTANCE =0.2465'  
  
You're saying this doesn't account for the differences in energy emitted at each line? How do you know this?

1. **RW1** at [14:28 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41911)

Tom,  
  
*"I know the average is given at the bottom. That does not mean you can use it as you are doing."*  
  
How do you know? Have you added all the lines up and divided?

1. **KR** at [14:30 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41912)

Tom Curtis, RW1 - do you have a link to the Modtran model you are using? I'm not seeing the same freedom of parameters you seem to have discussed at [the model here](http://geoflop.uchicago.edu/forecast/docs/Projects/modtran.html).

1. **RW1** at [14:33 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41915)

Tom,  
  
Most of the radiance is in the window, so if anything that would seem like it would make the number much higher than only about 0.25?

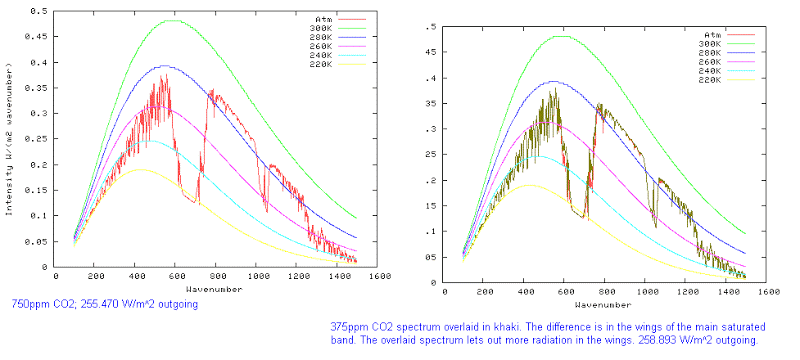
1. **RW1** at [14:36 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41916)

Tom,  
  
Should I add up all individual transmittance lines and divide?

1. **RW1** at [14:50 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41919)

RE: my 168  
  
Actually most of the energy is not really in the window.

1. **Tom Curtis** at [15:00 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41921)

KR @167, that is the model. If you run it there will be a link to "View the whole output file" which shows a large number of additional values.  
  
RW1 @168, as can be seen in this image, the peak of the surface transmission is in the 400 to 800 wavenumber band, ie, in the band with a deep trough due to CO2 and a number of troughs due to H2O. The peak radiance is at wavenumber 592, inside the left hand side of the CO2 trough. Therefore if the average transmittance is the mean, it would definitely underestimate the reduction in outgoing IR from the surface.  
  
  
  
@164 and 165, I don't know, but that seems the most natural reading to me. You should always take average to mean "mean", not "weighted mean" (or median or mode) unless there are clear contextual reasons to think otherwise. There are no such contextual reasons here; and furthermore, your discreprancy gives weight to that interpretation. Which is more likely, that a program developed by the air force for research and which has been used in various incarnations since 1988 with good correspondence to observational results has an error that produces up to 20% errors in its output? Or that you are simply mistaken in your interpretation of average?  
  
Regardless, if you disagree with me, you do the LBL integration. I am not the one chasing windmills here.  
  
@169, no, you just add up the individual lines. Any divisions (if necessary, see 163) shoud be done for each line only.

**Response:** Fixed image width.

1. **RW1** at [15:11 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41923)

I'm downloading the manual.

1. **RW1** at [15:20 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41926)

wrong version.

1. **RW1** at [15:25 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41929)

Tom,  
  
Do we agree that the reduction in the window should be twice the 2.764 w/m^ outputed (or about 5.528 W/m^2)?  
  
If not, why not? You don't think that all the infrared the atmosphere absorbs is directed toward the surface? Clearly it's not.

1. **KR** at [15:38 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41931)

[RW1](http://www.skepticalscience.com/argument.php?a=115&p=4#41929) - *"Do we agree that the reduction in the window should be twice the 2.764 w/m^ outputed"* Ummm, absolutely not.   
  
It's both a reduction in the atmospheric window and a deepening in the GHG emission bands. As we have said repeatedly. **Not just a single effect, but two different ones that make up the total reduction in emissions.**

1. **KR** at [15:39 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41932)

RW1 - Why is it that you cannot accept that it's two effects adding up to the total IR reduction?

1. **RW1** at [15:50 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41933)

*"Why is it that you cannot accept that it's two effects adding up to the total IR reduction?"*  
  
Simple. I haven't seen the evidence showing/prooving it, nor do I understand what a "deepening in the GHG emission bands" actually means.

1. **RW1** at [15:53 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41934)

I can't find the manual online. I emailed Ontar to see if they can provide it.

1. **RW1** at [15:56 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41935)

Tom,  
  
What use would the 'average transmittance' number be if it were NOT how I interpreted it? Maybe you're correct, but then the information is totally useless as far as I can tell.

1. **RW1** at [16:12 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41936)

Tom,  
  
*"Which is more likely, that a program developed by the air force for research and which has been used in various incarnations since 1988 with good correspondence to observational results has an error that produces up to 20% errors in its output? Or that you are simply mistaken in your interpretation of average?"*  
  
Not the program itself, but the web interface integration of the program. Where do you see the 2.764 W/m^2 in the line by line output, either directly or indirectly? I don't see it in there.

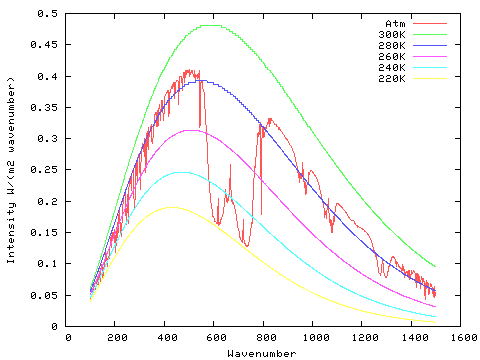
1. **RW1** at [16:15 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41937)

Tom,  
  
Nor do I see the 252.801 W/m^2 or 255.565 W/m^2.

1. **RW1** at [16:18 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41938)

Tom,  
  
Is it just a coincidence that using the average transmittance numbers and dividing the surface difference by 2 yielded nearly exactly 240 W/m^2 leaving (for 255K)? Maybe, but it certainly warrants further investigation.

1. **Tom Curtis** at [16:49 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41940)

RW1, I cannot keep up with your stream of consciousness posting, and nor will I try to. Sit down, think it out, and work our your objections and problems after a little thought.  
  
As regards the "average transmittance", I have seen a comparison of the Modtran model at David Acher's site with the data from a satellite over Barrow Island, and the match is pretty good. Close enogh that you can't tell the difference by eyeball, although if you overlaid them I'm sure some differences would jump out. The "error" you have found is too large for that to be plausible.  
  
If you have a further problem with it, work the problem out line by line as I suggest. If you are correct, there will be no difference in the result. If I am correct, you initial calculation will be shown to be in error.  
  
As regards the window, the figure above @ 171 shows the radiance for 325 ppm CO2 overlaid on the radiance for 750 ppm CO2 on the right. As you can see, the main difference is on the wings of the trough, where a slight step pattern is deeper with 750 ppm than with 325 ppm. That is not a change in the atmospheric window, because IR radiation at those frequencies were already absorbed, possibly completely absorbed as far as radiation from the surface is concerned. If you look even closer, (closer than the resolution will allow, unfortunately), you will also see that the center of the trough is slightly deeper. You will also see the walls of the trough at the top are slightly wider (which is a reduction of the window). You will also see some of the secondary troughs generated by CO2 are deeper. There is one just to the right of the main CO2 trough where a single spike shows up in the center.  
  
Here for comparison is a modtran graph for 10,000 ppm CO2 with not H2O or O3:  
  
  
  
You will notice that that small spike noted above has become a deep trough that overlaps with the first trough, with a resulting large reduction in the atmospheric window. But that widening took place step by step, and in each step, it was always the smallest effect.

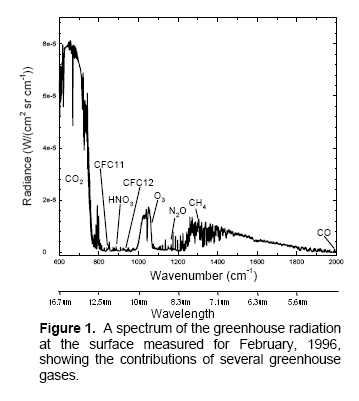
1. **RW1** at [17:10 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41942)

Tom,  
  
*"As regards the window, the figure above @ 171 shows the radiance for 325 ppm CO2 overlaid on the radiance for 750 ppm CO2 on the right. As you can see, the main difference is on the wings of the trough, where a slight step pattern is deeper with 750 ppm than with 325 ppm. That is not a change in the atmospheric window, because IR radiation at those frequencies were already absorbed, possibly completely absorbed as far as radiation from the surface is concerned. If you look even closer, (closer than the resolution will allow, unfortunately), you will also see that the center of the trough is slightly deeper. You will also see the walls of the trough at the top are slightly wider (which is a reduction of the window). You will also see some of the secondary troughs generated by CO2 are deeper. There is one just to the right of the main CO2 trough where a single spike shows up in the center."*  
  
I know all of this. The total atmospheric window is simply the quantity of the whole spectrum of surface emitted infrared that passes through the atmosphere completely unabsorbed and goes straight out to space. Visually, there is a slight widening of the CO2 absorbing bands at 750ppm, which narrows the more overtly visual part of the 'window', but it's a specific quantity - not just a visual reduction. The outputs of these programs are detailed numbers, specifically the transmittance - not just what can be seen overtly in visuals of a graph. The decrease in transmittance directly tells us how much more outgoing surface power, across the entire emitted spectrum, is absorbed by the atmosphere.

1. **RW1** at [17:16 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41944)

Tom,  
  
*"The decrease in transmittance directly tells us how much more outgoing surface power, across the entire emitted spectrum, is absorbed by the atmosphere."*  
  
If 'transmittance' does NOT tell us this, then what does it tell us?

1. **Tom Curtis** at [18:19 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41951)

RW1 @184, evidently you **do not** know all this. You may think you do, but that is another question entirely.  
  
Consider the "atmospheric window". An "atmospheric window" is any part of the spectrum where transmittance is sufficiently high that you can place a telescope on a mountain, and observe the stars effectively at that frequency. Alternatively, it is a part of the spectrum where the transmittance is sufficiently high that you can use it as a channel for communication to space.  
  
If you want to see the atmospheric window in the IR spectrum, you should look at the back radiation at the surface:  
  
  
  
Clearly, if you looked up at 680 cm^-1 wave number, all you would see is the thermal radiation of the atmosphere. You would not even be able to see the sun in that portion of the spectrum, from the surface. In contrast, the intervals between 810 and 950 probably have sufficiently high transmittance to be useful for telescopes (and sidewinders). That is a atmospheric window. There is another, smaller one on the other side of the O3 trough.  
  
With that in mind, closing the window means reducing the IR radiation **from the surface** that escapes to space, particularly in those parts of the spectrum; and it is a minor effect. **Deepening of the CO2 emission band** means that in that part of the spectrum outside of the atmospheric window, the amount of IR from the atmosphere itself is reduced because it comes from a higher altitude and hence has a colder temperature.  
  
These effects are not strictly independent. For example, at the right edge of the CO2 trough, there are transmittances that rise from around 0.2 to 0.8 over a 60 wave number interval. Over this interval, both trough deepening, and narrowing of the atmospheric window occur with rising CO2. On the equivalent left side, however, transmittances peak around 0.2 because of the overlapping effects of H2O. The trough deepening, however, contributes almost as much to the reduced OLR as does the equivalent on the other side.  
  
Speaking of which, on the graph shown, total area under the line equals the total power (watt's per square meter) radiated to space, so the difference in area **is** the difference in radiated power. As you can see, the most significant part of this comes from the deepening of the trough on the wings, and that is approximately equal on both sides, even where transmittances are very low. Therefore it is clearly not a narrowing of the atmospheric window.

1. **Tom Curtis** at [18:20 PM on 28 February, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#41954)

RW1 @185, sorry, I don't recognize the quote. Could you please cite the source and link to it if on the web. If not on the web, could you please embed the quote in a wider context.

1. **[hank](http://hankroberts.wordpress.com/)** at [04:37 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42016)

Tom, RW1 185 quotes himself. No other source for it.  
  
http://www.google.com/search?q=%2Bdecrease+%2Btransmittance+"outgoing+surface+power"+"emitted+spectrum"+"absorbed+by+the+atmosphere"

1. **[hank](http://hankroberts.wordpress.com/)** at [07:30 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42038)

> total atmospheric window is simply the quantity   
  
No, it's not a quantity.  
  
It's a term defined in various ways in papers published in science journals.  
  
It's never defined as a quantity.

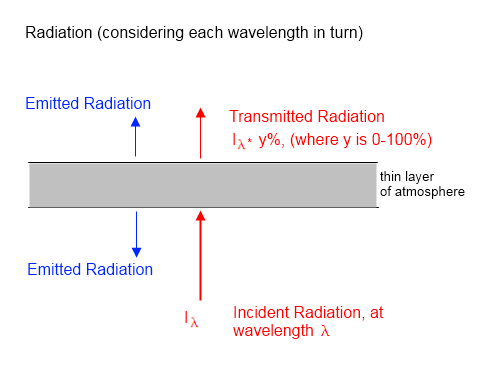
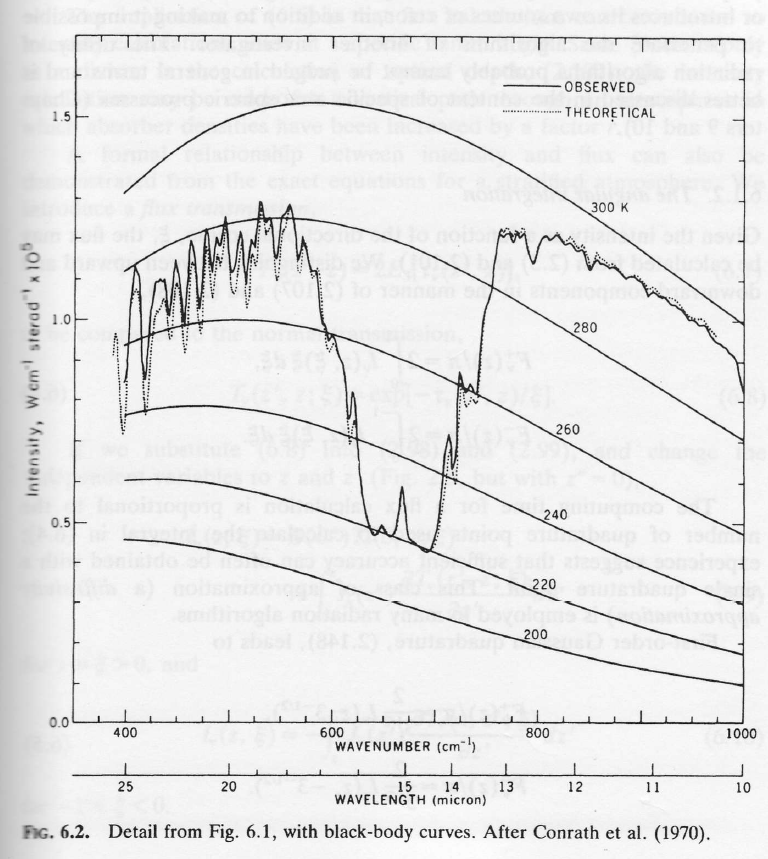
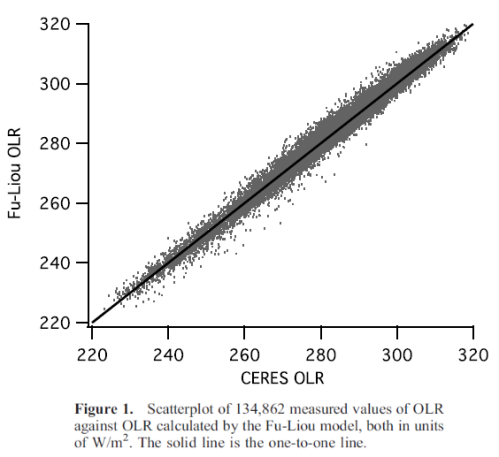
1. **RW1** at [09:37 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42061)

Tom,  
  
When I use the term "atmospheric window" I mean the total transmittance - the specific amount of emitted surface power that passes through the atmosphere unabsorbed and goes straight out to space. If that is not the technical definition, then I stand corrected, but that's what I mean when I use the term.

1. **RW1** at [10:03 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42070)

Are you claiming that the 3.7 W/m^2 of additional absorption from 2xCO2 does NOT represent a 3.7 W/m^2 reduction in transmittance?  
  
What I don't think you understand is that unless the specific wavelengths are saturated, some of the outgoing surface power still passes through them unabsorbed, and this amount is included in the transmittance. Increasing the concentration of CO2, for example, will reducing the amount that passes through at wavelengths NOT already saturated (i.e. widening the band or deepening the trough). The effect of more CO2 at saturated wavelengths will just reduce the height from the surface where 100% absorption occurs.

1. **Tom Curtis** at [11:03 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42076)

RW1 @190 &191, given that at many frequencies, the atmosphere has an optical thickness greater than 1 (ie, transmittance is 0 for less than the full thickness of the atmosphere) than much of the IR absorbed by that region of the atmosphere that actually radiates to space **does not come from the surface**, but only from lower regions of the atmosphere. So an increase of absorption by 3.7 w/m^2 may have absolutely no effect on transmittance, or the atmospheric window (as you have defined it).  
  
Further, as much of the heat in the atmosphere is carried there by evaporation or transpiration, there is not even a necessary correlation between surface radiation and the thermal radiation of the lower levels of the atmosphere. Certainly that correlation is broken over antarctica in the winter, and may be broken at other places periodically as well. That is why Line By Line models use temperature profiles in developing their predictions, either a simple lapse rate (as in Modtran) or measured (or modelled) values in more sophisticated programs.  
  
Worse for your interpretation, a decrease in transmittance will automatically mean that a higher proportion of radiation from lower in the atmosphere is absorbed higher in the atmosphere, even with opticat thicknesss less than 1, but greater than 0. Because the higher gas is cooler (in the troposphere) it will radiate less energy, thus reducing the total IR radiation leaving the planet. That means a change in transmittance has more effect than simply reducing surface radiation to space.  
  
The only way to properly calculate its effect is, as the LBL models do, calulate its effect on each layer of a large number of layers of the atmosphere (in modtran's case, 33).   
  
The LBL models take account of radiation flows in both directions. That is, for each layer, they determine its emission at each individual wavenumber (or wavenumber couplet for modtran), based on its temperature. They then apply that radiation as both upward and downwelling radiation. For each layer, they also take the total incoming radiation (upward and downward), multiply by the transmittance for that layer, and apply the result as upwelling or down welling radiation from that layer as appropriate.  
  
Here is a diagram illustrating the process from [Science of Doom](http://scienceofdoom.com/2010/12/23/understanding-atmospheric-radiation-and-the-greenhouse-effect-part-one/):  
  
  
  
Although this only indicates transmittance in one direction, be assured it is calculated in both. In the thread from which this comes SoD is developing a simple radiation model, and you can see in the code that he makes the calculations first for upwelling, and then for downwelling radiation.  
  
(By the way, this illustration also appears in SoD's thread on [theory and experiment](http://scienceofdoom.com/2010/11/01/theory-and-experiment-atmospheric-radiation/) in atmospheric radiation, from which I got the diagrams which showed the close correlation between the model predictions and observations. That thread has already been linked here. So your claim that all you have received is statements, not evidence, is nonsense.)  
  
Because the transfers in radiation are calculated for each wavenumber, and for each level independently, there is no single calculation that corresponds to what you are seeking, ie, a level in which all incoming radiation is from the surface, and all upwelling radiation goes to space. But that does not mean that both the upwelling and downwelling emittance from each level is ignored, or that the absorption at any level is ignored **which is what is required for George White's adjustment to make any sense**.  
  
Of course, in the LBL models, the total upwelling radiation of the highest level (emitted and transmitted) is just the Outgoing Long-wave Radiation. And the difference between that for 375 ppm and for 750 ppm is the increase of the greenhouse effect for doubling of CO2.  
  
So, if you want to verify Modtran, and all the other LBL models programed by different teams around the world, and all the energy balance models also programed by different teams around the world, which all come up with essentially the same result; which just happens to match observations almost exactly, you either need to accept the observational match as confirming the models, or you need to go through the models line by line. There is no other short cut.  
  
  
  


1. **RW1** at [11:52 AM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42083)

*"given that at many frequencies, the atmosphere has an optical thickness greater than 1 (ie, transmittance is 0 for less than the full thickness of the atmosphere) than much of the IR absorbed by that region of the atmosphere that actually radiates to space does not come from the surface, but only from lower regions of the atmosphere. So an increase of absorption by 3.7 w/m^2 may have absolutely no effect on transmittance, or the atmospheric window (as you have defined it)."*  
  
And where does the radiation from the lower regions of the atmosphere come from?  
  
So this is what you're claiming? That the 3.7 W/m^2 does NOT represent a reduction in total transmittance, as I have defined it? I just want to be clear.  
  
*"Further, as much of the heat in the atmosphere is carried there by evaporation or transpiration, there is not even a necessary correlation between surface radiation and the thermal radiation of the lower levels of the atmosphere."*  
  
Define what you mean by "correlation". I understand that a good amount of the heat in the atmosphere is carried there by evaporation and transpiration, but those amounts are in addition to emitted surface power and are non-radiative, which means they have to be returned to the surface in equal and opposite amounts, because all the infrared energy leaving at the top of the atmosphere is radiative. It's true that some of the kinetic energy moved into the atmospherefrom the surface by evaporation and transpiration can radiate some energy into the atmosphere, but again it has to be offset by the surface radiation in equal and opposite amounts. If some of the surface originating kinetic energy is radiated into the atmosphere and that energy is ultimately radiated out to space, the amount of kinetic energy returned to the surface will be less, having a cooling effect on the surface, effectively reducing the emitted surface power by the opposite amount.

1. **Tom Curtis** at [12:30 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42089)

RW1 @193:  
  
"*And where does the radiation from the lower regions of the atmosphere come from?*"  
  
Any substance with an emissivity greater will radiate energy with a total energy proportional to its emissivity times the fourth power of its temperature. **That** is where the radiation comes from, from the gases in the lower atmosphere which radiate in the IR spectrum and have non-zero temperatures (primarily water vapour and CO2).  
  
The heat that warms that gas comes evapo/transpiration from the surface, radiation from the surface, and atmospheric absorption of incoming solar radiation, although at any given layer, a large part of it will come from thermal radiationfrom adjacent layers, or convective heat transfer from adjacent layers.  
  
"*So this is what you're claiming? That the 3.7 W/m^2 does NOT represent a reduction in total transmittance, as I have defined it? I just want to be clear.*"  
  
If your definition of total transmittance is "... the specific amount of emitted surface power that passes through the atmosphere unabsorbed and goes straight out to space", then no it is not. A small part is reduction of transmittance, but a more significant part is the reduction of thermal radiation from lower levels of the atmosphere to space, as per the diagram @171.  
  
"*Define what you mean by correlation ...*"  
  
The normal statistical sense. What I am pointing out is that because not all energy transfers are radiative, situations can arise in which the atmosphere returns more energy to the surface than it receives from the surface. This will only happen when there is a temperature inversion, as sometimes happens with low lying clouds. In Antarctica in the winter it can happen on a continental scale because Antarctica is receiving no insolation, and there is still an energy transfer from the Antarctic Ocean to the Antarctic interior carries [carried?] by the atmosphere.  
  
However, when you say "If some of the surface originating kinetic energy is radiated into the atmosphere and that energy is ultimately radiated out to space, the amount of kinetic energy returned to the surface will be less, having a cooling effect on the surface, effectively reducing the emitted surface power by the opposite amount", you *appear* to be making an error. Specifically, when energy is transferred to the atmosphere, it makes no distinction in the source of that energy when it radiates. So, the sum total of the energy it receives is radiated away, and half of that energy must be downwelling, and half upwelling. And if the sum of Insolation plus back radiation is less than the sum of Surface radiation plus energy transfer by evapo/transpiration and (a small) energy transfer by by collisions between gas molecules and the surface, then the surface will indeed cool.  
  
You also *may* be not making a mistake, and I have simply misunderstood you. **It is true** that the presence of evapo/transpiration and convection, by making energy transfer more efficient, cool the surface compared to the temperature it would be if all energy transfers in the atmosphere were radiative (about 70 degrees C). So in that respect, the fact that evapo/transpiration carries energy into the atmosphere, a portion of which does eventually escape to space does mean the surface is cooler than it otherwise would have been.  
  
Having said that, I do not see the relevance to the basic point at issue - is it George White, or all the world's radiative transfer modelers who are correct in their interpretation of the output of radiative transfer models?

1. **RW1** at [12:37 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42091)

*"Worse for your interpretation, a decrease in transmittance will automatically mean that a higher proportion of radiation from lower in the atmosphere is absorbed higher in the atmosphere, even with opticat thicknesss less than 1, but greater than 0. Because the higher gas is cooler (in the troposphere) it will radiate less energy, thus reducing the total IR radiation leaving the planet. That means a change in transmittance has more effect than simply reducing surface radiation to space."*  
  
How do you figure? If anything, it seems a decrease in transmittance will shorten the height from the surface where the atmospheric absorption occurs.   
  
*"The only way to properly calculate its effect is, as the LBL models do, calulate its effect on each layer of a large number of layers of the atmosphere (in modtran's case, 33).  
  
The LBL models take account of radiation flows in both directions. That is, for each layer, they determine its emission at each individual wavenumber (or wavenumber couplet for modtran), based on its temperature. They then apply that radiation as both upward and downwelling radiation. For each layer, they also take the total incoming radiation (upward and downward), multiply by the transmittance for that layer, and apply the result as upwelling or down welling radiation from that layer as appropriate.  
  
Because the transfers in radiation are calculated for each wavenumber, and for each level independently, there is no single calculation that corresponds to what you are seeking, ie, a level in which all incoming radiation is from the surface, and all upwelling radiation goes to space. But that does not mean that both the upwelling and downwelling emittance from each level is ignored, or that the absorption at any level is ignored which is what is required for George White's adjustment to make any sense."*  
  
Have you verified with GW that this is what he's claiming? Because that's not my interpretation of it. The model simulations he's using are multi-layered through the atmosphere - he's simply showing the aggregate effect through all the layers. Is it just another coincidence that he's getting an incremental absorption or reduction in transmittance of 3.7 W/m^2 for 2xCO@ from his HITRAN based simulations?

1. **RW1** at [12:54 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42092)

*"What I am pointing out is that because not all energy transfers are radiative, situations can arise in which the atmosphere returns more energy to the surface than it receives from the surface. This will only happen when there is a temperature inversion, as sometimes happens with low lying clouds. In Antarctica in the winter it can happen on a continental scale because Antarctica is receiving no insolation, and there is still an energy transfer from the Antarctic Ocean to the Antarctic interior carries by the atmosphere.  
  
However, when you say "If some of the surface originating kinetic energy is radiated into the atmosphere and that energy is ultimately radiated out to space, the amount of kinetic energy returned to the surface will be less, having a cooling effect on the surface, effectively reducing the emitted surface power by the opposite amount", you appear to be making an error. Specifically, when energy is transferred to the atmosphere, it makes no distinction in the source of that energy when it radiates. So, the sum total of the energy it receives is radiated away, and half of that energy must be downwelling, and half upwelling. And if the sum of Insolation plus back radiation is less than the sum of Surface radiation plus energy transfer by evapo/transpiration and (a small) energy transfer by by collisions between gas molecules and the surface, then the surface will indeed cool.  
  
You also may be not making a mistake, and I have simply misunderstood you. It is true that the presence of evapo/transpiration and convection, by making energy transfer more efficient, cool the surface compared to the temperature it would be if all energy transfers in the atmosphere were radiative (about 70 degrees C). So in that respect, the fact that evapo/transpiration carries energy into the atmosphere, a portion of which does eventually escape to space does mean the surface is cooler than it otherwise would have been."*  
  
Tom,  
  
All I'm saying is that globally, energy has to be conserved. Any kinetic energy moved from the surface into the atmosphere, some of which ultimately leaves radiatively at the top of the atmosphere, has to reduce the amount of emitted surface power by an equal opposite amount due to less being returned to the surface in kinetic form, which has the effect of reducing the surface temperature; thus reducing surface emitted radiation.   
  
I know about the Antarctic temperature inversion. It's highly localized.

1. **RW1** at [13:04 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42094)

*"Any substance with an emissivity greater will radiate energy with a total energy proportional to its emissivity times the fourth power of its temperature. That is where the radiation comes from, from the gases in the lower atmosphere which radiate in the IR spectrum and have non-zero temperatures (primarily water vapour and CO2).  
  
The heat that warms that gas comes evapo/transpiration from the surface, radiation from the surface, and atmospheric absorption of incoming solar radiation, although at any given layer, a large part of it will come from thermal radiationfrom adjacent layers, or convective heat transfer from adjacent layers."*  
  
Agreed, but ultimately what matters here is the net combined effect of all these things relative to surface emitted radiation. Aferall, that's what we're talking about here is it not? That's what determines global average temperatures, right? Heat flows - how much from the surface is coming back from the atmosphere and how much is passing through. This is determining the heat flux or power flux at the surface, which ultimately is determining the temperature.

1. **RW1** at [13:17 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42096)

*"Having said that, I do not see the relevance to the basic point at issue - is it George White, or all the world's radiative transfer modelers who are correct in their interpretation of the output of radiative transfer models?"*  
  
Yes this is crux, but if GW is so obviously wrong as you claim, where is the smoking gun? And why haven't you presented it to him? I mean if it's so egregiously wrong, it should be easy to point directly to the specific evidence that disproves it, right?  
  
I admit I have not yet verified if what he's claiming is correct or not, but you have neither verified what the IPCC is claiming the 3.7 W/m^2 represents from the model simulations. I've looked all through the IPCC 2007 report, I don't find this information - they seem to be really ambiguous about where exactly the 3.7 W/m^2 is derived from. I've also looked all over the internet and cannot find verification either way.   
  
Regardless, I'm determined to get to bottom of this - even it means I have to get the MODTRAN software and run the simulations myself.

1. **[hank](http://hankroberts.wordpress.com/)** at [14:22 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42104)

Enjoy!  
http://www.modtran.org/  
http://download.cnet.com/Modo/3000-2054\_4-77505.html

1. **RW1** at [14:27 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115#42107)

*"Having said that, I do not see the relevance to the basic point at issue - is it George White, or all the world's radiative transfer modelers who are correct in their interpretation of the output of radiative transfer models?"*  
  
There is yet another possibility too. They assumed or convinced themselves that there was a remote possibility that the full 3.7 W/m^2 of incremental absorption could somehow make it back to the surface through multiple absorptions and re-emissions. I've seen this claim argued before, though ultimately never convincingly. Maybe they used this as a rationalization to count it all as a "just in case" precaution. I don't know.   
  
Without knowing the detailed specifics of the outputs of these model simulations there's no way to know.

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Comments 201 to 250 out of 370:

1. **Tom Curtis** at [15:46 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42114)

RW1 @198:

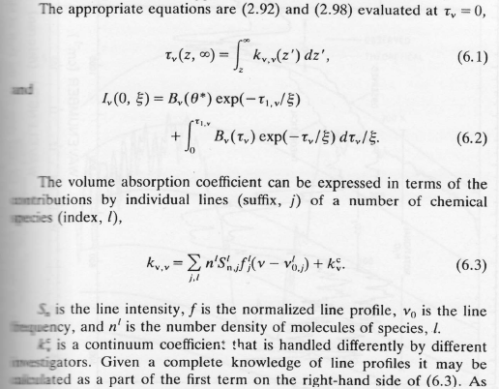
“I admit I have not yet verified if what he's claiming is correct or not, but you have neither verified what the IPCC is claiming the 3.7 W/m^2 represents from the model simulations. I've looked all through the IPCC 2007 report, I don't find this information - they seem to be really ambiguous about where exactly the 3.7 W/m^2 is derived from. I've also looked all over the internet and cannot find verification either way.”

Let me reiterate what I first pointed out to you [@209 on the "A Swift Kick in the Ice Thread"](http://www.skepticalscience.com/news.php?p=5&t=214&&n=588#41029) where this discussion started; ie, that the IPCC explicitly claims that the radiative forcing from doubling CO2 is 3.7 w/m^2, and that "radiative forcing" is the change in net irradiance at the top of the atmosphere. To be quite clear, an increase in incoming radiation or a decrease in outgoing radiation both increase the radiative forcing, so a reduction in Outgoing Long-wave Radiation increases radiative forcing. **Therefore, by simple logic, if the IPCC claims that doubling CO2 will increase radiative forcing by 3.7 w/m^2, then it is also claiming that doubling CO2 will reduce OLR by 3.7 w/m^2.** The only way it does not have this implication is if changing CO2 levels in Earth's atmosphere could some how change the Sun's level of activity.  
  
So, what did the IPCC say in these mysteriously hard to find [sarcasm?] passages for which I have already provided you a link?  
  
[The definition of Radiative Forcing](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-2.html):

The definition of RF from the TAR and earlier IPCC assessment reports is retained. Ramaswamy et al. (2001) define it as ‘the change in net (down minus up) irradiance (solar plus longwave; in W m–2) at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values’. Radiative forcing is used to assess and compare the anthropogenic and natural drivers of climate change. The concept arose from early studies of the climate response to changes in solar insolation and CO2, using simple radiative-convective models. However, it has proven to be particularly applicable for the assessment of the climateimpact of LLGHGs (Ramaswamy et al., 2001). Radiative forcing can be related through a linear relationship to the global mean equilibrium temperature change at the surface (ΔTs): ΔTs = λRF, where λ is the climate sensitivity parameter (e.g., Ramaswamy et al., 2001).

That was from section 2.2 of WG1 concealed under the obscure title [sarcasm?] of "The Concept of Radiative Forcing".  
  
[The effect of CO2](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-3.html#2-3-1):

The simple formulae for RF of the LLGHG quoted in Ramaswamy et al. (2001) are still valid. **These formulae are based on global RF calculations where clouds, stratospheric adjustment and solar absorption are included, and give an RF of +3.7 W m–2 for a doubling in the CO2 mixing ratio.** (The formula used for the CO2 RFcalculation in this chapter is the IPCC (1990) expression as revised in the TAR. Note that for CO2, RF increases logarithmically with mixing ratio.) Collins et al. (2006) performed a comparison of five detailed line-by-line models and 20 GCM radiation schemes. The spread of line-by-line model results were consistent with the ±10% uncertainty estimate for the LLGHG RFs adopted in Ramaswamy et al. (2001) and a similar ±10% for the 90% confidence interval is adopted here. However, it is also important to note that these relatively small uncertainties are not always achievable when incorporating the LLGHG forcings into GCMs. For example, both Collins et al. (2006) and Forster and Taylor (2006) found that GCM radiation schemes could have inaccuracies of around 20% in their total LLGHG RF (see also Sections 2.3.2 and 10.2).

That was carefully concealed [sarcasm?] in section 2.3.1 of WG1, titled "Atmospheric Carbon Dioxide".  
  
So what was it you wrote? That you've "...looked all through the IPCC 2007 report, I don't find this information - they seem to be really ambiguous about where exactly the 3.7 W/m^2 is derived from"? Really, you've looked all over, but never managed to look at the specific pages you were explicitly linked to? And specific mention of the types of models used, with references to three scientific papers that include the equations is being "really ambigous about where exactly the 3.7 w/m^2 is derived from"? Don't be absurd.  
  
Apparently you have also looked "all over the internet" with similar lack of success. But, again, without looking at the [page](http://scienceofdoom.com/2010/11/01/theory-and-experiment-atmospheric-radiation/) that scaddenp [explicitly linked you to](http://www.skepticalscience.com/argument.php?p=3&t=201&&a=115#41276). On that page you would have found a detailed discussion of all the issues raised here, along with images from a textbook, including the three @192 above showing the detailed mechanism used in calculating spectra in LBL models, and comparing LBLmodel results with reality. You would even find the actual formula (as if that would do you any good):  
  
  
  
And if that was not enough to clarify, you could always have looked up the actual textbook (as I have previously suggested).  
  
If that was not enough, you could also followed my link @192 above to SoD's seven part discussion of climate models and atmospheric physics in which he step by step builds an open code radiative transfer model. That is, of course, if your diligent search of the net had not already found it by noticing all seven posts in the "Recent Posts" section of SoD, or finding them in the "Atmospheric Physics" category (again, such careful concealment of information).  
  
If that was not enough, you have had, for over a hundred posts now, the opportunity to double check one well known radiative transfer model (Modtran) for internal consistency, as I linked you to that before the discussion came to this thread. Of course, that would be difficult and time consuming, just as it was difficult and time consuming for all those scientists who developed multiple models, and fact checked them against literally hundreds of thousands of observations, only to have their work dismissed by a electrical engineer who thinks his word is better than their about what the output of their models actually represents. And his acolyte.  
  
This whole discussion has become a waste of time. Clearly you will not do even basic research, and will not think about the outcomes of what research you do. I have long believed you are a troll, but have persisted in the discussion on the basis that interested readers may also have been confused by George White. Well for anyone who can think, it is diamond clear by now that George White's claim about the 3.7 w/m^2 radiative forcing from doubling CO2 is simply an error, and an error that anyone half way knowledgeable on the subject could not make. If you are still confused, it is because you want to be - you do not want to know the truth.

1. **Albatross** at [15:53 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42115)

Tom @201,  
  
Devastating. Your last sentence also nails it.

1. **RW1** at [16:00 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42117)

*"You also may be not making a mistake, and I have simply misunderstood you. It is true that the presence of evapo/transpiration and convection, by making energy transfer more efficient, cool the surface compared to the temperature it would be if all energy transfers in the atmosphere were radiative (about 70 degrees C). So in that respect, the fact that evapo/transpiration carries energy into the atmosphere, a portion of which does eventually escape to space does mean the surface is cooler than it otherwise would have been."*  
  
Having re-read this of yours, it is NOT what I meant. What I was saying is that kinetic energy (evaporation & transpiration) transferred from the surface into the atmosphere has be returned to the surface in equal and opposite amounts - mostly in the form of precipitation, weather, etc. Any amount of it radiated into the atmosphere that ultimately leaves at the top of the atmosphere, results in less kinetic energy returned to the surface in the form of colder precipitation mostly, which cools the surface, resulting in the surface emitting an equally opposite amount less than it would otherwise.

1. **Daniel Bailey** at [16:18 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42120)

@ [Tom Curtis](http://www.skepticalscience.com/argument.php?a=115&p=5#42114) (201)  
  
Ditto to what Albatross said. Devastating.  
Game, set, match to TC.  
  
Though I'm undecided if ending your comment with a simple "QED" would've been over the top or a masterstroke ***coup de grâce***.  
  
The Yooper

1. **RW1** at [16:23 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42121)

Tom (RE: 201),  
  
I'm well aware of the IPCC definition of 'radiative forcing' and the passages you're citing, and I know exactly what they are claiming. In a more general sense of the term, technically all the 3.7 W/m^2 is 'radiatively forced'.  
  
Show me the detailed output data of the radiative transfer models used that corroborates that the 3.7 W/m^2 number claimed by the IPCC is the downward emitted amount and not the incremental absorption or reduction in total transmittance. If it's agreed that only half the incremental absorption affects the surface, and the model simulations take this effect into account, then the incremental absorption should be 7.4 W/m^2. Show me this. I don't see this information in any of the sources provided by your or anyone else here.   
  
You can lecture me all you want about not being interested in the truth or call me a troll, but simply declaring these things correct on the basis of authority or majority goes against science and logic.  
  
One way or another I'm going to get to the bottom of this.

1. **[hank](http://hankroberts.wordpress.com/)** at [16:24 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42122)

Word salad.

1. **[hank](http://hankroberts.wordpress.com/)** at [16:32 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42123)

Another reference and explanation:  
http://www.physicsforums.com/showpost.php?p=2288531&postcount=35

1. **[hank](http://hankroberts.wordpress.com/)** at [16:36 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42124)

Brief quote below: see original and thread for more:  
http://www.physicsforums.com/showpost.php?p=2288531&postcount=35  
  
"... Unfortunately, you can't read this off MODTRAN very well. There are two reasons for this. One is that it depends on the latitude. The second is that it depends on the altitude of the sensor.  
  
Part of the problem is the appropriate definition of a forcing. I describe it, with references, in msg #1 of "Estimating the impact of CO2 on global mean temperature". ...  
  
The reason you get a difference at higher altitude is that the atmospheric temperature profile in this calculator is held fixed, and so the calculator actually has stratospheric warming as a response to an increase temperature offset. What happens in reality is that the stratosphere cools....  
  
The upshot is that to get a sensible value for the forcing response to doubled CO2, you should really take the lower altitude sensor.

Also, you can't have a tropical atmosphere over the whole planet.

The value you get will be somewhere between the tropical atmosphere and the standard 1976 atmosphere; and

you also need to consider clear sky and cloud as well.  
  
All told, the MODTRAN calculator will get you into the right ball park; but it can't serve as a refutation of the forcing for doubled CO2, which is about 3.7 W/m2 to 10% accuracy or better."

1. **RW1** at [16:49 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42125)

Again, technically all the incremental absorption, whatever it may actually be, is 'radiatively forced' - it's just that half of it is 'forced' in the same general direction it was already going.

1. **[hank](http://hankroberts.wordpress.com/)** at [16:53 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42126)

PS, as you've made it clear you don't know how to find this on your own -- here's how:  
  
http://www.google.com/search?q=site%3Aipcc.ch+"3.7w"  
  
By contrast, if you just searched for IPCC 3.7w you would get about 13,400 results -- many of them copypasted denial stuff, johndaly, wattsup, and so on. While there's a pony in there somewhere, the site-limited search finds it fast.

1. **Albatross** at [17:14 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42128)

RW1 opines,  
  
*"Show me the detailed output data of the radiative transfer models used that corroborates that the 3.7 W/m^2 number claimed by the IPCC is the downward emitted amount and not the incremental absorption or reduction in total transmittance."*  
  
Que?!  
  
Gregory, Jonathan, Mark Webb, 2008: Tropospheric Adjustment Induces a Cloud Component in CO2 Forcing. J. Climate, 21, 58–71.  
  
Forster, P. M., and J. M. Gregory, 2006: The climate sensitivity and its components diagnosed from Earth Radiation Budget data. J. Climate, 19, 39–52  
  
Myhre, G., E. J. Highwood, K. P. Shine, and F. Stordal, 1998: New estimates of radiative forcing due to well mixed greenhouse gases. Geophys. Res. Lett., 25, 2715–2718.  
  
Forster and Gregory (2006) is especially helpful.   
  
*"One way or another I'm going to get to the bottom of this."*  
  
Wow-- I can't wait for the revelations. Back to earth though--you really are way behind in the game. You can indeed get to the bottom of this" by

a) actually, listening to others who are sincerely trying to guide you,

b) actually then reading the pertinent literature and allowing the content to resonate,

c) being willing to learn from others, and

d) not assuming something nefarious is going on.  
  
For goodness' sakes even Spencer and Lindzen et al. do not dispute the 3.7 W/m number or what it represents. Either you are a brilliant soon-to-be Nobel physicist laureate or you are a D-K. Please do not try and insult others by trying to claim otherwise, you have been called on your game. You have been wasting everyone's time for a while now-- enough is enough.  
  
Do you perhaps also have issues with the Stefan-Boltzmann constant that you need to get to the bottom of?

1. **[hank](http://hankroberts.wordpress.com/)** at [18:22 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42130)

It may amuse (warning, facepalm risk) to see the same issue raised here: judithcurry.com/2010/12/02/best-of-the-greenhouse/

1. **Tom Curtis** at [20:44 PM on 1 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42139)

Hank @212, that is actually a very informative and helpful post for anyone not clear on the greenhouse effect. I heartily recommend it, something I could not say about almost all of Judith Curry's other posts.  
  
Of course, the crazies still come out in the comments ...

1. **[hank](http://hankroberts.wordpress.com/)** at [05:01 AM on 2 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42168)

Tom, I agree; same for Spencer's comparable effort at http://www.drroyspencer.com/2010/07/yes-virginia-cooler-objects-can-make-warmer-objects-even-warmer-still/

1. **KR** at [09:30 AM on 3 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42308)

A curious digression on this topic - Dr. Roger Pielke Sr recently [posted something on his blog](http://pielkeclimatesci.wordpress.com/2011/02/28/missing-the-major-point-of-what-is-climate-sensitivity/), attempting to redefine the term **Climate Sensitivity** as:  
  
*"****Climate Sensitivity****is the response of the statistics of weather (e.g. extreme events such as droughts, land falling hurricanes, etc), and other climate systemcomponents (e.g. alterations in the pH of the oceans, changes in the spatial distribution of malaria carrying mosquitos, etc) to a climate forcing (e.g. added CO2, land use change, solar output changes, etc). This more accurate definition of climate sensitivity is what should be discussed rather than the dubious use of a global annual average surface temperature anomaly for this purpose."*  
  
Redefining a term used in all of climate science? I wonder why [*measuring the temperature response of the climate to a particular amount of radiative forcing*](http://en.wikipedia.org/wiki/Climate_sensitivity)wasn't working for him?  
  
This is a clear example of the [Moving the Goalposts](http://www.don-lindsay-archive.org/skeptic/arguments.html#goalposts) fallacy, often a sign that the original argument has been lost.

1. **RickG** at [09:42 AM on 3 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42309)

*A curious digression on this topic - Dr. Roger Pielke Sr recently posted something on his blog, attempting to redefine the term Climate Sensitivity*  
  
I wonder what's next, redefining the laws of physics to fit a specific outcome?

1. **[hank](http://hankroberts.wordpress.com/)** at [04:29 AM on 8 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42778)

> what's next, redefining the laws of physics ....?  
  
Chuckle. Yep.  
  
http://www.google.com/search?q=%2Bspencer+%2Bpoptech+%2Brefute

1. **[hank](http://hankroberts.wordpress.com/)** at [04:32 AM on 8 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42779)

http://www.gfdl.noaa.gov/blog/isaac-held/2011/03/05/2-linearity-of-the-forced-response/  
  
hat tip to: http://scienceblogs.com/stoat/2011/03/dr\_roy\_spencer\_is\_sad\_and\_lone.php

1. **[hank](http://hankroberts.wordpress.com/)** at [05:22 AM on 8 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42782)

http://www.barrettbellamyclimate.com/page17.htm

**Response:** Please provide some context for links. Link-only comments will be deleted.

1. **[hank](http://hankroberts.wordpress.com/)** at [02:09 AM on 9 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42872)

wups, lost the comment part, sorry. Suggesting a look at this site, which is trying a grade-school-level approach (well, for a very scientifically literate grade school population). Worth a look given the amount of confusion shown in the comments.  
  
"... ... we explain what a greenhouse gas does. The two spectra are crucial to the understanding of the role of greenhouse gases in the atmosphere.....  
...  
... The next simulated spectra are those for 380 ppmv and 760 ppmv of CO2respectively looking down from an altitude of 70 km and hopefully show the slight broadening of the 'well' that is crucial to the understanding of why more CO2 leads to a little more warming, even though such warming might not be measureable...."

1. **[hank](http://hankroberts.wordpress.com/)** at [02:13 AM on 9 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42874)

The prior suggestions are  
1) poptech redefining the laws of physics, a notorious outlier shows his stuff everywhere  
  
2) Isaac Held has a blog, finally. If you don't know his name, read some of his papers and look for his rare posts at other climate blogs about his work. Very good news to see him start writing more for the public in this blog form.  
  
3) Stoat on Spencer on climate sensitivity: Spencer thinks he can't possibly be wrong, and given that assumption, what else can explain why he's so alone?

1. **[hank](http://hankroberts.wordpress.com/)** at [06:19 AM on 9 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#42904)

oh, and on the first link -- I point it out as one that needs to be looked at carefully on the question of climate sensitivity. The 'discussion' page is going to be very attractive to self-identified skeptics; it may be in the same ballpark as Spencer's "yes Virginia" or Curry's "Sky Dragon" attempts to explain the basic science in a way that will draw in people who don't want to believe there could be a problem. It may be well presented stuff with a denier core -- hard to say without reading every bit:  
http://www.barrettbellamyclimate.com/page46.htm  
  
But this doesn't look good (sigh) they're "Teaching the Controversy" (TM Doonesbury) on ocean pH, leaving out the rates of change and the observed results so far: http://www.barrettbellamyclimate.com/page50.htm

1. **KR** at [14:50 PM on 13 March, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#43385)

For your amusement - this is now an active topic on Jo Nova's site. One of her readers did a blog post for her on this very thread, claiming that efficacy was a*"fudge factor"* allowing made-up numbers.   
  
Discussion ensued...

1. **Dikran Marsupial** at [19:15 PM on 17 April, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#48443)

[Gilles wrote](http://www.skepticalscience.com/news.php?n=695#48387): "I am completely ready to admit that CO2 contributes to warm the atmosphere , on very simple arguments of radiative transfer. My only questions are quantitative."  
  
This is the best place to have such questions answered; I am sure there are plenty of knowledgeable posters here who would be happy to answer them for you.

1. **RW1** at [15:36 PM on 22 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51764)

A brief follow up:  
  
I've spent quite a bit of time emailing around the climate science community on this. None of the scientists I've communicated with seem to know much about it, and appear to have more or less just accepted the number with little (if any) thought. I'm still pursuing the issue with one of them in particular though.   
  
Meanwhile, GW has given me the details on the simulations he's done and I see no indication that he's incorrectly interpreting the results as claimed here.  
  
For example, this is plot of the clear sky absorption spectra he used, where each gas is represented by a different color. The Y axis is the amount of emitted surface power absorbed by the atmosphere. You can clearly see that the line by line transmittance is 1 minus the value. If the half up/half down effect was included, the maximum value would be 0.5 and not 1.0, because even if 100% is absorbed, half is emitted to space anyway:  
  
[Click](http://www.palisad.com/co2/absorb_all.png)

1. **RW1** at [15:45 PM on 22 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51765)

Here is another showing which gases are most responsible for absorption at various wavelengths:  
  
[Click](http://www.palisad.com/co2/absorb_comp.png)

1. **RW1** at [16:02 PM on 22 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51766)

Here is the composite absorption with the emitted energy spectrum (grey line), which gives 255K. You can see that where the wavelengths are completely saturated (i.e. the 15u band of CO2), the transmittance is zero. If the halving effect was included, the maximum for the saturated bands would be only 0.5 and not zero:  
  
[Click](http://www.palisad.com/co2/absorb.gif)

1. **Riccardo** at [16:48 PM on 22 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51767)

RW1  
immagine a light source and a absorbing medium. A transmission experiment will give you the fraction of light passing through the medium along the line connecting the source and the detector. On the contrary, the light eventually re-emitted by the medium has no preferential directions. You should not expect the transmittance to saturate at 0.5.

1. **RW1** at [00:33 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51786)

Riccardo (RE: 229),  
  
*"You should not expect the transmittance to saturate at 0.5"*  
  
I don't. The point is if the half up/half down effect was included in the spectral data and Modtran simulation output, the maximum transmittance would be 0.5 since even if absorption is 100% half escapes to space anyway. That transmittance in the saturated lines is 1.0 means it represents the total absorption - not the downward emitted half.

1. **Riccardo** at [02:01 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51794)

RW1  
modtrans does take into account emission; infact, you can see light coming from the saturated bands. On the contrary, transmittance measurements or calculations don't.

1. **RW1** at [02:30 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51795)

Riccardo (RE: 231),  
  
*"RW1  
modtrans does take into account emission; infact, you can see light coming from the saturated bands. On the contrary, transmittance measurements or calculations don't."*  
  
OK, show me where or how it does this. Is it your contention that the reduction in transmittance from 2xCO2 is 7.4 W/m^2?

1. **Riccardo** at [07:00 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51816)

RW1  
*any* textbook will explain you this point.  
As for the contention, I did not quote any number, just explaining the meaning of transmittance with which apparently you're not familiar.

1. **RW1** at [07:20 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51819)

Riccardo (RE: 233),  
  
Obviously you haven't followed the discussion in this thread. The definition of transmittance, in the context of this discussion, is the amount of surface emitted LW that passes straight through to space as if the atmosphere wasn't even there. The claim is this reduces by 7.4 W/m^2 when CO2 is doubled, because the referenced 3.7 W/m^2 from 2xCO2 supposedly already includes the effects of half up/half down.

1. **Riccardo** at [07:36 AM on 23 May, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#51822)

RW1  
it's typical of many to show up transmittance spectra and draw conclusions from them. I was just trying to show how one should look at this kind of spectra. It is essential for a proper understanding of radiation in the atmosphere.  
Never mind, those are pretty standard concepts. You will easily find them whenever you think it's appropiate.

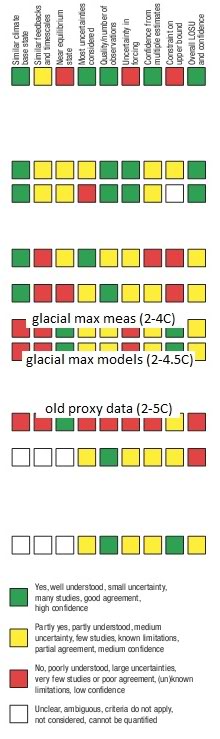
1. **MajorKoko** at [23:17 PM on 10 June, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#54068)

"basically if there is some large negative feedback which makes the sensitivity too low, it would have prevented the planet from transitioning from ice ages to interglacial periods"  
  
Doesn't the above assume that the negative feedback is linearly related to T? Is that a safe assumption if so?

1. **KR** at [01:36 AM on 11 June, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#54092)

**MajorKoko** - Feedbacks are amplifications (positive) or dampenings (negative) of a forcing change. So they're related to changes in T, not T itself.   
  
That said, there are definitely phase changes (melt of clathrates, lack of summer ice in the Arctic, etc.) where feedback levels can be expected to change.   
  
As to the original [bad] statement:   
  
*"basically if there is some large negative feedback which makes the sensitivity too low, it would have prevented the planet from transitioning from ice ages to interglacial periods"*  
  
The Milankovitch cycle forcing change between ice age and interglacial is estimated to be on the order of 3.4 W/m^2, for a direct forcing change of ~1C. Global temperature changes for those cycles, however, are on on the order of 5-6C or so.   
  
So a short term sensitivity of ~3C for a doubling of CO2 (3.7 W/m^2) with additional long term feedbacks (ice melt, vegetative changes, CO2 temperature/solubility changes from deep ocean, etc) matches the feedback amplification seen in the ice age cycle.

1. **Eric (skeptic)** at [22:02 PM on 22 September, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#63452)

In the Pielke Sr thread, [dana1981 says](http://skepticalscience.com/news.php?n=1010&p=3#63437):  
*"I think I'm most disappointed that we never got an answer regarding the discontinuity between low climate sensitivity arguments and the paleoclimate record. I've never seen any low sensitivity proponent answer this question, and unfortunately it seems Dr. Pielke was unable to answer it as well."* Also a long time ago I promised scaddenp I would address low sensitivity, and this is a start.  
  
The portion of [Knutti and Hegerl (2008)](http://www.iac.ethz.ch/people/knuttir/papers/knutti08natgeo.pdf) that goes with "Advanced" figure 4 (click on Advanced tab above) (Various Estimates of Climate Sensitivity) is shown to the left.

I labeled the 3 paleo sensitivity estimates in question. The problem arises from the red squares in the first column "similar climate to base state".  
  
The key question is how well can the dissimilarity be accounted for in the models. Specifically, the 8C rise from the last glacial came from combination of Milankovitch forcing, dust feedback, CO2 feedback, and other feedbacks that are modeled and equate to a 3C (best estimate) for 3.7 W/m2 of forcing. However, the leftmost red square is red because there are lots of unknowns compared to the present.  
  
There are many complications for modeling. In <http://www.rem.sfu.ca/COPElab/Claquinetal2003_CD_glacialdustRF.pdf> Claquin et al posit one of the factors in ice age transitions have an added factor, namely dust, that adds long term positive feedback. Less dust means higher SST but also less fertilization so less algae and more CO2 all adding to the warming. In short, there is a higher sensitivity for glacial to interglacial compared to today.  
  
Here is a general complication. A large sensitivity difference also arises from ice and snow albedo changes. During the ice age the ice and snow reflect a lot more sunlight and as it melts the surface albedo decreases as a positive feedback. The feedback is obviously higher than for the present climate which has a lot less snow and ice. The problem in determining the difference comes from highly nonlinear responses to Milankovitch forcing compared to today's CO2 forcing.  
  
Here's just one example: <http://envsci.rutgers.edu/~broccoli/reprints/Jackson+Broccoli_ClimDyn_2003.pdf>The modeling attempts to account for numerous differences from the modern climate including THC and sea ice, poleward heat transport and temperature gradient, precipitation changes, etc. All of these will be radically different with 3.7 W/m2 of CO2 forcing. Most point to a much larger feedback from Milankovitch forcing due to seasonal, geographic, and ice age climate differences.

1. **scaddenp** at [09:50 AM on 23 September, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#63520)

Just a quick comment - the question about glacial dust would certainly be something for carbon-cycle models to worry about but for a climate model, what matters is how much CO2 eventually ended up in the atmosphere. This is a known (from gas bubble) so model doesnt need to calculate it. Its tricky to see how uncertainties from glacial aerosols could lead to lower sensitivity given that the rise in CO2 is known.  
  
Albedo feedbacks would be different last glacial termination (they are so in the models), but can be reasonably estimated. (area covered by ice).

1. **scaddenp** at [14:51 PM on 4 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#64495)

Continuing further on this, I note that you have focused on the paleoclimate measures of sensitivity, though they are in broad agreement with the other measures of sensitivity.   
  
Schmidt at RC commented recently on this too.   
"It's certainly conceivable that climate sensitivity is a function of base climate and surely is at some level. How large that dependency is unclear. But you need to distinguish between estimates of sensitivity derived from comparing older climates to today, and estimates of variability within an overall different base climate. Comparing the LGM or Pliocene to today is the former, looking at the variations during an ice age would be the latter. There have been a couple of papers indicating that sensitivity at the LGM is different to today (Hargreaves - not sure of the year - for instance), but in each case the differences (while clear), are small (around 10 to 20%). - gavin"  
See [here](http://www.realclimate.org/?comments_popup=8844#comment-215773).  
  
You have commented previously that you thought climate sensitivity was low (hence no "C"AGW). What science did you examine that led you to that conclusion? At the moment, it looks you are trying to find science to back an a priori determination that sensitivity is low.

1. **Tristan** at [00:58 AM on 22 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#65818)

I'm trying to understand the relationship between climate sensitivity and C02:temp feedback.  
  
Assuming that CS is 3°C for the radiative forcing resulting from doubling atmospheric C02:  
  
1)Over what time period is this realized?  
  
2)Is this the limit of the temp:C02 feedback or is this just the first order effect?  
  
3)Wouldn't the C02:temp feedback limit be dependent on the amount of C02 already in the atmosphere?  
  
4)If the radiative forcing came from a non-C02 source, wouldn't the temperature rise be larger, as there'd be more 'room' for the feedback to occur?

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [02:52 AM on 22 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#65847)

240, Tristan,  
  
1) No one knows for sure, because it's never been doubled this quickly before. The models give some insights, but this is hard to pin down. We're also pretty early in the process, so it's hard to even estimate it at the current rate of warming. We haven't hit any step-changes yet, and the system is sluggish. What we do know is that no matter how slowly it seems to happen, it is happening, and it is going to continue well beyond the point where we stop raising CO2 levels.  
  
2) To my knowledge, this is the "Charney sensitivity" or "equilibrium sensitivity", meaning the final, end result sensitivity after everything has stabilized. Also note that while 3°C is an easy working number, the assumed range is 2C to 4.5C, and it may even be lower (unlikely) or higher (also unlikely, but more possible than lower than 2).  
  
This is in contrast to the "transient sensitivity" we would see within 20 years of doubling CO2 levels, which would see all fast feedbacks come into play, but not some slower ones.  
  
An excellent paper to consider in studying this is [Hansen and Sato (2011)](http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf). They talk exactly about these issues in a fairly clear fashion, and compare current positions to what can be inferred from previous similar changes in climate.  
  
There are, really, I think (in my mind, not officially) three levels of feedbacks... very fast, slow, and very slow. [Somewhere above somebody said there are 2.]

* 1. Very fast includes humidity and cloud changes that happen quickly.
  2. Slow feedbacks involve things like albedo and CO2 feedbacks that require major ice melt and fast ecosystem changes.
  3. Then very slow feedbacks require even longer term things (the point where oceans warm enough to release rather than absorb atmospheric CO2, and major, large-scale ecosystem changes occur that in turn change albedo and release or absorb more CO2).

But I think the hoped for answer is that 3°C is all of these effects combined.  
[And if you include 3, above, you results are of very little practical interest, IMHO. –FNC]   
[I will confess that someone else may be able to give you a more direct and perhaps different answer than this one... this is what I understand, but I could be wrong here. Hansen and Sato 2011 in particular talk about fast and slow feedbacks on other time scales.]  
  
The sad reality, though, is that we won't know if 3C is the accurate estimate of the final feedback result until 1,000 years pass.  
  
3) That's why it's expressed in terms of a doubling of current concentrations, and not based on the incremental amount added.  
  
4) Yes and no. There are logically slight differences in feedbacks depending on the source of a temperature increase, but overall feedbacks are driven by temperature change, regardless of the cause in temperature change.   
  
Refer to [this chapter on efficacy](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-8-5-1.html) (i.e. how one forcing differs from another) in the IPCC AR4 report.  
  
There would be more "room" for CO2 feedbacks, because the same amount of CO2released would be proportionally larger to a lower starting level. But at the same time we'd have pumped less CO2 into the oceans to release there. More importantly, the CO2 feedback is only one of many. Other feedbacks (water vapor, albedo changes, etc.) are in aggregate probably more important. So that difference wouldn't amount to that much.

1. **Tristan** at [15:35 PM on 22 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#65941)

Thanks Sphaerica, your response was just what the doctor ordered! xox

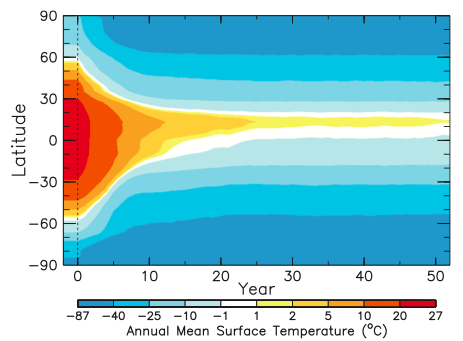
1. **cjshaker** at [18:39 PM on 23 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#65972)

You may be interested in Professor Shaviv's writings about climate sensitivity. He explains why he comes up with a lower number  
  
http://sciencebits.com/OnClimateSensitivity  
  
From: http://sciencebits.com/about  
  
"Prof. Nir J. Shaviv, who is a member of the Racah Institute of Physics in the Hebrew University of Jerusalem. According to PhysicaPlus: "...his research interests cover a wide range of topics in astrophysics, most are related to the application of fluid dynamics, radiation transfer or high energy physics to a wide range of objects - from stars and compact objects to galaxies and the early universe. His studies on the possible relationships between cosmic rays intensity and the Earth's climate, and the Milky Way's Spiral Arms and Ice Age Epochs on Earth were widely echoed in the scientific literature, as well as in the general press."  
  
Chris Shaker

1. **Riccardo** at [19:47 PM on 23 October, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#65978)

cjshaker  
I'm a bit surprised to see this old and debunked Shaviv paper pop up again. Honestly, I do not find it that much interesting.

1. **Eric (skeptic)** at [15:08 PM on 24 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68370)

A quote from the [Climate-time-lag.html](http://www.skepticalscience.com/Climate-time-lag.html) article: *"How long does the climate take to return to equilibrium? The lag is a function of climate sensitivity. The more sensitive climate is, the longer the lag. [Thus a reason not to worry about it?] Hansen 2005 estimates the climate lag time is between 25 to 50 years."*  
  
While reading through [Lacis et al](http://pubs.giss.nasa.gov/docs/2010/2010_Lacis_etal.pdf) regarding CO2 as a control knob, I noticed this diagram  
  


Taking less than 10 years to cool to equilibrium suggests a short lag. That is for full removal of CO2, etc and I don't know if the time constant would be different for a change in CO2. But if the lag time is much shorter than the 25 to 50 years suggested above, then climate sensitivity is also lower than estimated by Hansen.

1. **skywatcher** at [16:32 PM on 24 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68374)

Depends what you call equilibrium Eric - the temperature units on the Lacis diagram are pretty large, and it clearly hasn't reached perfect equilibrium even after >50 years. Why you suggest it supports a 10 year equilibrium mystifies me. From the diagram the change has reduced to being relatively slight after ~25 years, but equatorial regions are still cooling after 50 years.

1. **Tom Curtis** at [17:58 PM on 24 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68375)

Eric (skeptic) @245, the rapidity with which a system adjusts to a new equilibrium depends not just on thermal inertia, but also on the magnitude of the disequilibrium. With the enhanced greenhouse effect, the disequilibrium is small, being approximately 1 W/m^2. This is because of both the small initial perturbation and the fact that the full effects of positive feedbacks are not felt until the system approaches the equilibrium temperature.  
  
In contrast, in the model analyzed by Lacis et al, the initial perturbation is around 30 W/m^2. Consequently the system adjusts towards equilibrium much faster because of the much larger disequilibrium. Even so, as skywatcher @246 points out, the system has still not reached equilibrium after 50 years.  
  
Further, Lacis et al state that they use the Q-flux ocean model with a 250 meter mixed layer depth. Had they used a model with [deep diffusion](http://www.giss.nasa.gov/tools/modele/OPTIONS.html), time to equilibrium would have been significantly extended (by a few centuries, I suspect), but the early changes of the system would have been unaffected. It just would have taken longer to close the last 0.1 W/m^2 of disequilibrium.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [04:21 AM on 25 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68408)

245, Eric,   
246, skywatcher,  
247, Tom,   
  
I'd also point out that Lacis et al is dealing exclusively with fast feedbacks (like water vapor and clouds).  
  
As we are now seeing, things like the ice albedo feedback take a comparatively long time to develop, as would carbon feedbacks that result from methane release or major ecosystem changes.  
  
The point is, we are still, fortunately, talking about things in terms of a climate that could have a quick return to the old equilibrium if CO2 could somehow be drawn down.  
  
This will not necessarily be the case in the longer term, when those slower feedbacks begin to kick in, and so the reverse will consequently be just as slow (along with the fast feedbacks that go with the slow feedbacks instead of with the initial forcing).  
  
Beyond this, I am very, very concerned about how much CO2 the ocean has absorbed. In many past scenarios the ocean was the source of, not a damper on, added CO2. In this case the ocean is acting to hold down atmospheric CO2 levels by soaking up some of the excess.  
  
Even after we completely stop emitting CO2, where will it go? It can't go into the ocean, because it already is (and that is in balance). It has to go into biomatter, either on land or in the ocean, and in some way be sequestered, but the mechanics of it I would have to believe will take a very, very long time. And even after any part of it is drawn out of the atmosphere, the ocean will certainly respond by trying to maintain an equilibrium and so transfer it from the ocean to the atmosphere.  
  
If slow CO2 feedbacks involve things like the transition of huge swaths of the Amazon to savanna, or other ecosystems to desert, then this puts more CO2 into the atmosphere/ocean. But how does it then get back into biomatter? Temperatures must drop for rain forest or prairie to again take hold where savanna/desert has appeared, so that vegetation can then grow and put the carbon into other forms. But how does this happen until temperatures first drop? And how long will this reverse process take?  
  
The bottom line is that we're not getting anywhere near any of the fast-acting we-cut-atmospheric-CO2-back-to-285ppm scenarios any time soon, probably not for several hundreds of years, which will be more than long enough for us to see at least some if not many of the "slow feedbacks" take hold and therefore hard to reverse.  
  
[This with the understanding that "slow feedbacks" in past climate change events are going to be relatively fast in this case because we are pumping the CO2 into the atmosphere so abruptly and quickly as compared to increases due to most natural processes in the past.]

1. **Eric (skeptic)** at [09:45 AM on 25 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68429)

Sphaerica, we're never getting back to 285 anytime soon because there is an exponential decay from whatever level we are at. Q1: is it necessary to return to 285 (it may not be possible anyway)? Is a higher level ok? Q2: What about storage in the deep ocean, would that help the recovery prospects?

1. **Daniel Bailey** at [10:07 AM on 25 November, 2011](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115#68432)

Eric (skeptic), the highest levels (per the Antarctica ice cores) achieved at any point in the past 800,000 years was 298.7 ppm. Humanity has seen that in the [rear-view mirror](http://www.youtube.com/watch?v=37GrbCUvZEM) long ago.  
  
  
To an uncertain future with great temerity we go.

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Comments 251 to 300 out of 370:

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [14:22 PM on 25 November, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#68454)

249, Eric,  
  
Q1: My opinion only, but no, I don't think a return to 285 is necessary, just desirable (but impossible). I do think a return to 350 is required, but also impossible at the current rate of action (meaning that by the time we start, we'll be lucky to hold it to 500 at this point, and as I described, I think getting it down once its up will be almost impossible).  
  
Q2: How do you propose that the carbon get into the deep ocean? There are natural processes that work on huge, huge ("global") scales, but not nearly so quickly as to naturally drawn down both atmospheric and ocean CO2 levels to a reasonable degree (although I could be wrong on this... this is where an ocean expert like Doug Mackie should step in. Perhaps he knows better. But otherwise, how does someone suck all of that carbon out of the air and oceans and put it in a form that will sink to the bottom and stay there?  
  
It is interesting to note two things. The first is that the 300+ gigatonnes of carbon that man has burned in fossil fuels so far (and we're still not done) took nature hundreds of millions of years to sequester underground. It took a mere 100 years to release it, but there is no reasonable way to match nature's feat and put it back. It can go into the atmosphere, ocean or biomass, but not very easily back into the ground.  
  
The second point is that I recently did a back of the envelope calculation, trying to figure out how much land would be needed to plant giant sequoia redwoods that could suck up the carbon and turn it into biomatter (trees). The answer, with some very optimistic fudging, was that 75% of the arable and agricultural land on earth needed to be covered with redwoods in order to drawn atmospheric CO2 back down to 285 ppm in the course of 100 years from today, assuming we planted those trees right now and also instantly stopped burning more fossil fuels.  
  
  
This of course presumes that all of humanity moves to deserts and other places of the earth so that we can exclusively grow food crops on the remaining agricultural/arable land. Of course, since that represents only 25% of the total, we must also assume that food production will drop by 75%. This implies that the population of the earth (currently 7 billion) must also drop as a consequence -- so that "solution" implies:  
  
1) Plant sequoias immediately on 75% of the arable land on earth (completely ignoring the fact that sequoias will not grow just anywhere, and in fact could only grow in very specific environments)  
  
2) Move the entire human population off of such land  
  
3) 5 billion people must die (because there won't be enough land to produce enough food to feed 7 billion, but instead only 2 billion).

1. **KR** at [12:11 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69868)

(Redirected from the [Cloud Feedback thread here](http://url/))  
  
**RW1** - Quite frankly, this issue on total sensitivity has been explained to you, at length, in multiple threads here. You have yet to demonstrate any tendencies to incorporate the science you have been shown.   
  
**For new readers:** A doubling of CO2 would add 3.7 W/m^2 to the top of atmosphere (TOA) forcing of the climate. This should by all measures *(and by that, I mean spectroscopic effects as integrated through the depth of the atmosphere - very basic physics)* result in ~1.1°C warming directly.   
  
That works out to ~0.3°C/W/m^2. The 3°C warming estimated from [numerous estimates](http://www.skepticalscience.com/climate-sensitivity.htm) is in the range of roughly 2-4.5°C, most likely estimate of 3°C, indicating a TOA forcing of roughly **10 W/m^2**. That's an additional 6.3 W/m^2 forcing from feedbacks.   
  
CO2 represents roughly 1/3 of the current greenhouse effect - increases in water vapor will easily *(well within the uncertainty ranges)* account for the additional 2/3. In regards to [cloud feedback](http://www.skepticalscience.com/clouds-negative-feedback-basic.htm) (*the change in forcing with temperature, not the initial value as RW1 emphasises)*, please read the opening post on that thread. The best estimates, best data, on that topic indicate that cloud feedback with temperature is slightly positive, with a range of uncertainty that does include *(at low probability given the data)* very slightly negative. Certainly not enough to overwhelm the increase in CO2 and temperature dependent absolute humidity.

1. **RW1** at [12:23 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69873)

KR,  
  
You're very good at 'explaining' things to me and making declarations I'm wrong, but this is not offering anything to the discussion here or on the other thread.

**Response:**

[DB] Actually, KR and others have more than amply explained things to you, including the specific points where you stray from accepted understandings into error.

Thus, it is your intransigence (amounting to agenda) that is standing in the way of the discussions.

1. **scaddenp** at [13:14 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69883)

RW1 - I don't think anyone knows how to help you. People go so far and then you seem to point blank refuse to get it. "I don’t understand". Left to a 14 year girl to do your homework IIRC at one point. It seems you believe one thing and when an argument takes you to the point when that belief is challenged, then you shut down. It still seems to me that you are stuck in the "back radiation can’t warm the surface" mindset, and discussion cant go forward till you get that.

1. **KR** at [13:59 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69889)

**RW1** - Two items.   
  
First: The appropriate numbers for TOA [top-of-atmosphere] forcing with feedbacks given a 3°C climate sensitivity is ~10 W/m^2, resulting in the aforementioned 3°C rise in surface temperatures due to changes in total Earth emissivity and the surface temperature required to emit another 10 W/m^2 at TOA. Your numbers are wrong.   
  
Second: I wrote [my most recent post](http://www.skepticalscience.com/argument.php?a=115&p=6#69868) for the general public, the readers of this thread. You have not shown *any* indications that you recognize evidence contrary to your preconceptions. As per the [Debunking Handbook, Worldview Backfire](http://www.skepticalscience.com/Debunking-Handbook-Part-4-Worldview-Backfire-Effect.html), *"...outreaches should be directed towards the undecided majority rather than the unswayable minority."*

1. **RW1** at [14:41 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69891)

KR,  
  
*"Your numbers are wrong."*  
  
Are you trying to say the surface does not have to receive +16.6 W/m^2 in order to warm by 3C?

1. **KR** at [15:02 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69893)

**RW1** - You continue to mix TOA forcings with surface flux. Please note that an effective [TOA emissivity of ~0.612](http://en.wikipedia.org/wiki/Climate_model#Zero-dimensional_models), as measured and calculated, means that a TOA forcing of ~10 W/m^2 leads to 1/0.612 = ~1.64, or a required ~16.4 W/m^2 increase at the surface to increase emissions by ~10 W/m^2 at TOA to eliminate the imbalance. And that is strictly due to the emissivity of the Earth wrt. a blackbody.   
  
Your posts continue to interchange TOA with surface forcings, neglecting the effective emissivity to space (as per multiple threads), continue to invoke inappropriate "halving" of absorptions, and IMO represent errors. Nonsense statements such as [*"+6 W/m^2 (+1.1C) from 2xCO2 (3.7 W/m^2 directly from the CO2'forcing' and the remaining 2.3 W/m^2 from the current average opacity of the atmosphere"*](http://www.skepticalscience.com/argument.php?a=417&p=5#69851) do not aid your position (I have absolutely no idea where you got 2.3 from, for example). Your insistence on these issues demonstrate either (a) a lack of comprehension, or (b) an unwillingness to let data influence your position.   
  
Enough said. You have repeatedly demonstrated either a lack of knowledge or unwillingness to examine the evidence.   
  
**Readers** - if you wish to follow these conversations further, I would suggest the [Climate Sensitivity](http://www.skepticalscience.com/climate-sensitivity.htm) or [Lindzen and Choi](http://www.skepticalscience.com/Lindzen-Choi-2009-low-climate-sensitivity.htm) threads, where this issue is discussed at great length. Personally, I feel no desire to rehash these topics...

1. **KR** at [16:19 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69907)

**RW1** - Well, then, my apologies, I had not found that clear from your posts, which is probably my mistake. *Mea culpa*.   
  
So: a 10 W/m^2 TOA forcing results in a ~16.4 W/m^2 surface change. Of that 10 W/m^2 3.7 W/m^2 is direct CO2 forcing (assuming a CO2 doubling), and the remaining 6.3 W/m^2 is (as predicted by a 3°C sensitivity, with caveats due to uncertainties - 2-4.5°C) due to feedbacks.   
  
I would suggest viewing the detailed discussions at [Water Vapor vs CO2 as a “Greenhouse” Gas](http://scienceofdoom.com/2011/02/24/water-vapor-vs-co2-as-a-greenhouse-gas/) and in particular [Clouds and Water Vapor – Part Four](http://scienceofdoom.com/2011/03/17/clouds-and-water-vapor-part-four/) by Science of Doom. Note that models of outgoing longwave radiation (OLR) match very well with observations, indicating that the models are pretty accurate.  
  
Water vapor represents ~2/3 of the greenhouse effect (in conjunction with clouds), and since water vapor is temperature dependent, **it is a feedback, not a forcing**.   
  
In addition, see [Philipona et al 2005](http://www.agu.org/pubs/crossref/2005/2005GL023624.shtml) (*"...enhancing the forcing and temperature rise by about a factor of three"*) and others - water vapor is a strong positive feedback, as shown by the data.

**Response:**

[DB] Please note that RW1 has never retracted [this statement](http://www.skepticalscience.com/argument.php?a=417#48418):

*I appreciate that you seem to be interested in helping me, but I'm not really interested in being helped per say. I'm a staunch skeptic of AGW, so my purpose here is to present contradictory evidence and logic that disputes the theory. That's what I'm doing.*

By his own admission he is here to not learn.

1. **jmorpuss** at [19:12 PM on 15 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69914)

Skywater @261 I believe that is the starting point in understanding how energenic the atmosphere realy is And without the van allen belts to protect us from the solar winds and cosmic rays (charged partical) life how we see it would not exist.

That said it's my belief that what we are seeing regarding man made climate change is a result of or com's [our communications [networks] ?] and [our?] detecting that use [of?] electromagnetic radiation from the ground and space <http://missionscience.nasa.gov/ems/02_anatomy.html>   
and [what we are seeing ?] is very sensitive to this process and would create changes and hot spots through processes like this.  
<http://www.ips.gov.au/Category/Educational/Other%20Topics/Radio%20Communication/Transequatorial.pdf> There's a picture halfway down that shows hot spots expansion and a bulging at the equator that is interesting. And as you know heat and pressure differences drive the weather Just putting it together to for a bigger picture

1. **DSL** at [01:12 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69922)

DB, you should probably tack that comment on to every post that RW1 makes, so that no one makes the mistake of engaging him/her in discussion. It will also act as a standing demonstration of exactly what denialism is--a one-way street where the denialist presents the Truth and refuses to admit error.  
  
I've asked "wrongologist" [Kathryn Schulz](http://beingwrongbook.com/blog) to target the global warming issue through interviews with a number of opinion-makers and scientists. I hope she ends up doing so. It's a very rich area for her--not just in the exploration of what happens when people who are committed to alternative theories come up against hard evidence against them, but also in statisticians' and scientists' relationship with modeling, in people who are paid to be publicly wrong, and in how scientists deal with being wrong.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [02:03 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69923)

For the record, the 16.6 W/m^2 RW1 keeps throwing around is from his own entirely incorrect logic that there is a *direct* relationship between the radiation leaving the surface and the radiation emitted at TOA, and that this requires a linear "gain" and therefore the creation of non-existent energy.  
  
It basically comes from a completely flawed understanding of the system, I think because he is trying to translate it entirely into his own misapplied EE concepts of "gain," "feedback" and control theory rather than by understanding climate science and the actual system under discussion.  
  
[The clearest (convoluted) path to understanding his logic is here](http://www.skepticalscience.com/clouds-negative-feedback.htm#48384), but in a nutshell, 16.6 W/m2 is a ridiculous constraint of his own devising, and there is no arguing with it, because he can't get past the mumbled incantations and heavy incense needed for his magical spells.

1. **Tristan** at [05:15 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69941)

I love Kathryn Schulz! Her talks aren't as good as her book though.

1. **scaddenp** at [07:29 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69952)

jmorpuss, none of those links give any hint of any way by which the phenomena discussed could have any material effect on climate - by orders of magnitude. As such I cannot see how you can link this in any way to the idea that climate sensitivity is low.

1. **Richard Arrett** at [09:18 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69967)

John Russell at 04:50 AM on 16 December, 2011:  
  
I certainly did not feel like I was being banned.  
  
I am moving to this thread so as to not be off topic.  
  
The warming since 1950 has been around 1 degree F or .55 degrees C.  
  
But how much of that is due to CO2?  
  
I read 75% in one article and 50% in another.  
  
Lets say 75% of the warming from 1950 is due to CO2 and the rest is due to land use changes, black carbon on snow, methane, etc.  
  
So .75 degrees F seems like a fair estimate of the warming from 1950 caused by CO2.  
  
First off - does that seem about right to you?  
  
I am not a climate scientist - so what I see from this data is that we seem to be on target for about the amount of warming you would expect from physics - but just the direct warming - no amplification effect.  
  
Doesn't that imply about 1.5 degrees F of warming to 2100 (or about .83C) from just CO2. Of course, there would be temperature increase also due to the other 25% non-carbon causes.  
  
If you just extend the trend line - doesn't it look like we will get about 1.2 degrees C by 2100?  
  
When I look at the data, I see the direct warming from CO2 - but no indirect warming from CO2.  
  
That is my main problem with a CS of 3 degrees C - it just doesn't add up for me.

1. **skywatcher** at [10:05 AM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69972)

Richard Arrett, among many other problems, you're ignoring the possibility that *more than 100%* of the warming since 1950 is due to CO2. Impossible! I hear you cry. But not, actually, as it is quite likely that aerosols are offsetting the non-CO2 warming effects and some of the CO2 warming effects. It will be "interesting" in a Chinese curse sort of a way, when China and India sort out their pollution issues.  
  
Another issue is you keep discussing equilibrium sensitivity values when you should be discussing *transient*sensitivity values, which are closer to 2C per doubling. We don't expect to see equilibrium sensitivity-sized changes instantaneously.

1. **muoncounter** at [12:35 PM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#69987)

Richard#265: "The warming since 1950... "   
  
Let's set the record straight. Warming of ~0.7 C since 1970; approx 0.18 C per decade.  
  
  
CO2 in 1970 = ~325 ppm, now = 395 ppm (see [Mauna Loa](http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo_full)). The 'percentage caused by CO2' is a meaningless hairsplit at this cursory level of analysis; it's a system of forcings and feedbacks. But if you want more detail, you can find it here.   
  
The sensitivity of 3C per doubling of CO2 is a straightforward calculation; you can find it many places here or even on wikipedia (search 'radiative forcing'). But in *very* rough terms, if a 22% increase in CO2 results in 0.7 degrees; four 1/2 times that in CO2 gets you in the ballpark of 3C.  
  
The point is this: A 2 or 3 C increase in global temperature has effects that are not what you should want to risk.

1. **KR** at [15:42 PM on 16 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#70017)

A question to all - is it really necessary to rehash the **previous discussion** on the [Lindzen and Choi](http://www.skepticalscience.com/Lindzen-Choi-2009-low-climate-sensitivity.htm) thread, where RW1 spent considerable time pushing the same hypotheses, and where he was pointed at the same facts that he's being pointed at (and ignoring) now?  
  
RW1 - the same objections to your unbased claims still hold. What's the term? Debunked a thousand times (DATT)?  
  
**Readers** - Take a look at the [Lindzen and Choi](http://www.skepticalscience.com/Lindzen-Choi-2009-low-climate-sensitivity.htm) "Working out climate sensitivity from satellite measurements" thread if you have any questions about this discussion. Personally, I don't have the patience to discuss this *again*, as RW1 has stated:  
  
[*"I appreciate that you seem to be interested in helping me, but I'm not really interested in being helped per say. I'm a staunch skeptic of AGW, so my purpose here is to present contradictory evidence and logic that disputes the theory. That's what I'm doing."*](http://www.skepticalscience.com/argument.php?a=417#48418)  
  
Those are not the words of someone willing to discuss the data, the facts. Rather, the words of someone who just wants to argue. DNFTT - Do Not Feed The Troll.

**Response:**

[DB] *"What's the term? Debunked a thousand times (DATT)?"*

Very close.  [PRATT](http://rationalwiki.org/wiki/PRATT) - Point Refuted A Thousand Times.  Silver Star to you, circle gets the square.

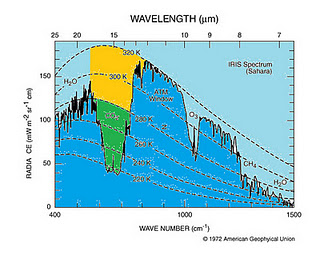
Edit:

A large number of off-topic comments by RW1 and responses to him were deleted after this, as they belonged more properly on the [2nd law of thermodynamics contradicts greenhouse theory](http://www.skepticalscience.com/argument.php?a=164) thread (or others) and were thus off-topic here.

1. **Tom Curtis** at [22:48 PM on 17 December, 2011](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#70242)

RW1, clearly you do not understand.  
  
What determines the strength of the greenhouse effect is the difference in

* 1. the energy **as it is radiated to space** from energy radiated from the atmosphere, and
  2. the energy that would have been radiated from the surface in the same spectral band with no atmosphere.

Therefore, **the thing which determines the strength of the greenhouse effect is the temperature of the gas or cloud top which radiates to space relative to surface temperature**, not the temperature of any intervening cloud top or gas which may absorb IR radiation in the same spectral band.  
  
The consequence of this is that in the band of strongest absorption (and emission by CO2), it contributes almost all of the greenhouse effect when compared to low lying cloud or water vapour. It will still contribute most of the greenhouse effect over medium level cloud. Over high cloud, the effect will be similar, depending on the cloud.  
  
Consider the spectrum below taken over the Sahara. It was taken on a day with high humidity as can be seen by the strong H20 signal in the spectrum. From the temperature difference between the black body curve of the surface (320 K) and the water vapour bands (280 K) we can tell that the effective altitude of emission to space from water vapour was about 6 Km, approximately the boundary layer between midlevel (alto) clouds and high level (cirrus) clouds. The effective altitude of emission to space of the CO2 is approximately 15 km is this case, which is also approximately the altitude of the tropopause.  
  
[](http://www.skepticalscience.com/images/saharaspectrum.jpg)  
  
The important regions of the chart for this discussion are the yellow and green areas. The yellow area is approximately the area of overlap between the absorption/emission spectrum of the water vapour and the CO2. The absorption band of water vapour weakens in that area, so that in the absence of cloud and CO2 the H2O absorption/emission band would in fact slope up to 320 K within the yellow area, so that the yellow area overstates the greenhouse effect of water vapour in the area of overlap. Of course, solid cloud tops of that temperature would result in a spectrum following the 280 K black body line except for a trough in the green area, and an ozone peak from the stratosphere.  
  
Importantly, that means that in either case, the green area represents a contribution to the greenhouse effect which exists regardless of the presence or absence of H2O, either as water vapour or clouds. More importantly, **in the complete absence of water vapour or clouds, the CO2 trough would have occupied almost the entire area of both the yellow and green zones**. In this situation, the most accurate description is that in the area of overlap, CO2 contributes the entire greenhouse effect, as CO2would have contributed all of that effect regardless of whether H2O was present or not.  
  
There are circumstances in which CO2 actually counters the greenhouse effect of very high clouds. There are also circumstances in the Antarctic winter in which CO2 contributes an anti-greenhouse warming effect. Consequently it is wrong to assume that the globally averaged effect of CO2 with water vapour present is the same as its globally averaged effect without water vapour present. But none-the-less, CO2 contributes a substantial part of the greenhouse effect in the spectral band where CO2 and H2O emissions overlap, and therefore [best estimates](http://pubs.giss.nasa.gov/docs/2010/2010_Lacis_etal.pdf) place the contribution of CO2 to the greenhouse effect at about 20%, with a further 5% coming from other well mixed green house gases (O3, CH4, NO2, etc). Therefore your persistent claim that CO2 contributes 10% or less of the greenhouse effect is just false.  
  
Finally, I note on rereading your posts that you continually claim that half of absorbed radiation is emitted upward to space, while half is emitted downward to Earth. For a layer of atmosphere thin enough to have approximately the same temperature through its entire thickness, this is true, **but it is not true of the atmosphere as a whole** as can be easily determined by looking at the diagram @273. That you should think so suggests you continue to use a single slab model of the atmosphere to guide your thinking. Such models are false representations of the atmosphere, and only used in climate science as instructional tools to introduce more complex models with (in typical cases) around 20 layers. Using a single slab model reduces the atmosphere to a 2 dimensional shell, making my comment @275 exactly correct. Please take due note of the Trenberth et al diagram, and of the explanation above, and allow some reality into your model of the atmosphere.

**Response:**

[DB] Note:  This comment was inadvertently deleted and has been reinstated.  Apologies.

1. **SirNubwub** at [08:29 AM on 18 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#74669)

Hello  
First of all, hats off to this website for its clarity and ease-of use. It has been a great source of information for me.  
  
I am developing a high-school physics chapter where I show the back-and-forth debate on AGW.   
  
Here is a skeptic's graph that they say shows that observed temps/CO2 levels of the last 100+ years indicate a climate sensitivity of about 1.85. Can you please tell me how the skeptics have their data/graph/conclusions wrong? (please remember that the audience is going to be high-schoolers).   
  
the graph can be seen more clearly at http://img152.imageshack.us/img152/6972/zoominco2logwarmingwp3.png  
  
I am not here to debate the issue, just to get information and to move on to the next topic.  
  
I thank you in advance.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [09:08 AM on 18 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#74670)

269, SirNubWub,  
  
First, for a high school text I suggest you use log2 rather than natural logs. If you do so, then your constants will actually be the climate sensitivity (3, 1.85 instead of 4.7, 2.73).  
  
For the discrepancy, the short answers:  
  
1) The model as described is far too simplistic. For instance, it presumes that the only influence on climate in the past 100 years has been CO2. More specifically, it ignores the opposing anthropogenic negative forcing of aerosols. Unfortunately, as we work for cleaner air we are reducing the aerosols without reducing CO2 emissions. And if we were to stop abruptly, the added aerosols would quickly fall out of the atmosphere while the CO2 would stay active for hundreds/thousands of years.  
  
[See this page of the IPCC AR4 report](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-2-1.html) and more specifically [this diagram](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-2-1-figure-2.html).  
  
2) The [high school] model presented only measures transient, not equilibrium climate sensitivity. The first is what you get from fairly fast feedbacks, while the latter is what you get if you wait long enough for the system to stabilize (which includes all ice sheet melting, ocean warming, ecosystem transitions, permafrost methane releases, etc.). [That’s not going to happen!!] Transient climate sensitivity is estimated to be about 2˚C per doubling, and equilibrium sensitivity about 3˚C, so your 1.85˚C/doubling number is pretty close, especially after you consider the negative influence of aerosols.  
  
Sadly, [Sadly??!! Right, that’s not going to happen!!] the ice on Earth is far from finished melting, the carbon cycle is far from equalizing, and the oceans are far from absorbing as much heat as they can.  
  
3) The model presumes that warming is instantaneous. Honestly, very few times in the history of the earth has a forcing of this magnitude been applied this quickly. It is very hard to predict how long it will take for the forcing imbalance to raise the planet to new equilibrium temperatures, even without considering the slow (equilibrium) feedbacks.

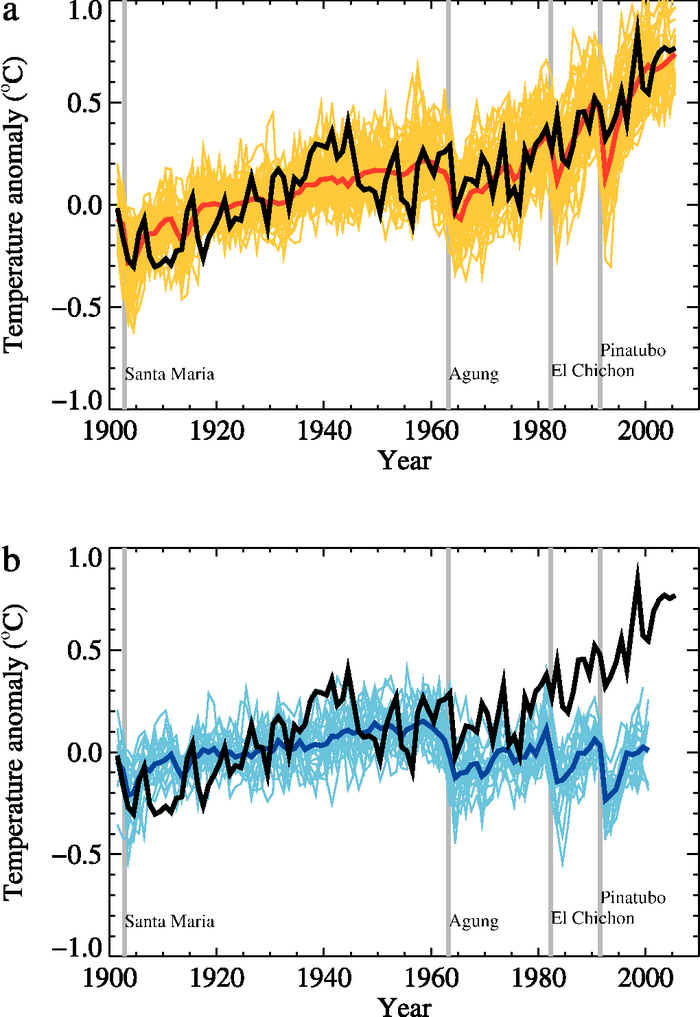
1. **Stephen Baines** at [09:24 AM on 18 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#74671)

It should also be pointed out that the IPCC quotes 3C/doubling as the most likely sensitivity. The value of 3.25 used above is a slight misrepresentation that overstates the mismatch. It is the average of the upper and lower extremes (2 and 4.5 respectively) cited by the IPCC, but the probability distribution is not symmetrical between these extremes.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [09:48 AM on 18 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#74672)

Stephen,  
  
I didn't even notice that the graph had upped it to 3.25.  
  
SirNubWub, I'd almost think you were a denier-in-disguise, playing hard-to-notice tricks with your audience.  
  
The number is 3 (or better yet, the range between 2 and 4.5). And transient sensitivity is around 2.  
  
And there is absolutely nothing at all behind any such denial argument (and please don't call them skeptics, because they aren't, if they were skeptical they would have researched the issue well enough to figure this out for themselves and not bother to make such a specious argument).

1. **Tom Curtis** at [12:44 PM on 18 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#74687)

SirNubWub @269, that is a strange graph. In addition to the errors noted by Stephen Baines and Sphaerica, I notice that the line marked "Global Warming Models" is almost certainly mislabeled. I draw your attention to the [comparison of actual temperatures (HadCRUT3) and model results](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-9-5.html) from the IPCC AR4 below:  
  
[](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-9-5.html)  
  
As you can see, the model results for actual forcings (Red line, graph a) very closely follow the observations (black line). Therefore in a graph such as you show, the model results would be shown by a scatter plot that overlapped with the observed data through out its entire range, and which had nearly the same mean for most of it.  
  
Fairly obviously **the line labelled "Model Range"is therefore not the model range** at all. Rather it is a simple plot based on a projected response function of temperature to CO2 of 3 degrees per doubling. **As noted by Sphaerica, that response function is not the climate sensitivity**. I note, however, that the [IPCC definition](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/annexessglossary-a-d.html) of Transient Climate Response states:

*"The transient climate response is the change in the global surface temperature, averaged over a 20-year period, centred at the time of atmospheric carbon dioxide doubling, that is, at year 70 in a 1% yr–1 compound carbon dioxide increase experiment with a global coupled climate model. It is a measure of the strength and rapidity of the surface temperature response to greenhouse gas forcing."*

In other words, the Transient Climate Response is **not** the immediate response of temperature in the year of the change of CO2 concentration. As such, and contrary to Sphaerica, **the graph plotted is not a graph of the Transient Climate Response**. To plot that you would need to plot CO2 concentration against lagged temperature. Even then you would still face confounding factors in the effects of other Green House Gases, increases in solar radiation, and most particularly, changes in Aerosol Optical Depth. It is dubious, therefore, that such a plot will give anything better than a vague approximation of the Transient Climate Response.  
  
However, if you were to plot the IPCC TCR on the graph for comparison, the [IPCC AR4](http://www.ipcc.ch/publications_and_data/ar4/wg1/en/tssts-4-5.html) value for the TCRfor a doubling of CO2 is between 1 and 3 degrees C:

*"Agreement among models for projected transient climate change has also improved since the TAR. The range of transient climate responses (defined as the global average surface air temperature averaged over a 20-year period centred at the time of CO2 doubling in a 1% yr–1 increase experiment) among models is smaller than the range in the equilibrium climate sensitivity. This parameter is now better constrained by multi-model ensembles and comparisons with observations; it is very likely to be greater than 1°C and very unlikely to be greater than 3°C. The transient climate response is related to sensitivity in a nonlinear way such that high sensitivities are not immediately manifested in the short-term response. Transient climate response is strongly affected by the rate of ocean heat uptake. Although the ocean models have improved,*

* + 1. *systematic model biases and*
    2. *limited ocean temperature data to evaluate transient ocean heat uptake*

*affect the accuracy of current estimates. {8.3, 8.6, 9.4, 9.6, 10.5}"*

(Note, this quote is from the Working Group 1 technical summary. The numbers at the end are relevant section of the WG1 report for further details.)   
  
In looking at the graph I noticed that the measurement range of CO2 was from 287.50 – 388 ppmv. The temperature range was 0.8 degrees C. That strongly suggests the temperature data was taken from Gisstemp, and that the time interval of the graph was from 1880 to approx 2009. This information, and the information about who produced the graph should always be included in any graph used for teaching (or science in general).  
  
I also notice from the large number of temperature values at the lowest CO2 value that the plot was made against the most recent ice core value of CO2 concentration prior to the availability of Mauna Loa data. Using that method instead of plotting against a smoothed value introduces further inaccuracies to the graph. There is some possibility that values other than ice core values where used prior to 1959. If so, that should be specified, and great care taken as many CO2 measurements prior to 1958 are strongly distorted by local sources and sinks of CO2 (factories, roads, forests).  
  
In sum, this graph provides an excellent teaching opportunity. Specifically, it can be used to show how so called "skeptics"

* 1. use incorrect values (3.25 instead of 3 for the IPCC central estimate of climate sensitivity;
  2. mislabel data (labeling a mathematical estimate as "Global Warming Models");
  3. do not properly understand the data they are analyzing (ie, presenting it as a plot showing climate sensitivity, when the technique can show Transient Climate Response at best, and is likely to underestimate it); and
  4. do not take into account proper caveattes on the data (due to the unmentioned confounding factors).

As such, it presents an excellent opportunity to show the difference between the pseudo-science of so-called skeptics and the genuine science as reported on by the IPCC. It also is an excellent opportunity to show that the vast majority of objections to climate science only masquerade as being science based, but are in fact political in nature, employing as they do pseudo-science rather than science to back up their claims.

1. **SirNubwub** at [04:18 AM on 22 February, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#75107)

Sphaerica and Tom Curtis,  
Thank you for your replies. I have not heard of a response to this issue before. I will have to read it carefully and repeatedly to understand it all.   
  
If I have further questions I will ask.  
  
I appreciate your time.

1. **RW1** at [00:25 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79286)

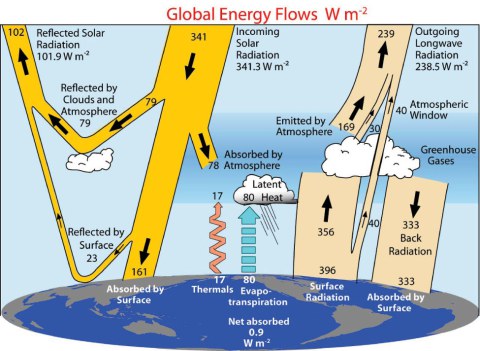
Continued from [HERE](http://www.skepticalscience.com/news.php?n=1396&p=2#79170)  
  
Tom Curtis says:  
  
*"RW1's bizarre claims assume that solar forcing results in no feedback response. That is, if the world's oceans are heated by 1 degree C by an increased GHG concentration, that will result in increased evaporation and an increase in absolute humidity (and hence a water vapour feedback), but that an increased temperature of the same proportion brought about by a brighter sun will not increase evaporation at all, nor melt any snow, or in any other way have feedbacks. RW1 can only attribute this view to climate scientists because, as always, he operates in complete disregard of what climate scientists actually say."*  
  
What I'm saying is the ratio of surface radiative power to post albedo incident solar power, from which the so-called 'zero-feedback' response is ultimately derived, is already giving a measure of the lion's share of all the feedbacks operating in the system, including especially water vapor and clouds, as the two are by far the most dynamic components of the whole atmosphere.  
  
*"Still more bizarre is RW1's claim that CO2 should result in less warming because of the energy needed to modify the internal energy structure of the atmosphere. What is bizarre here is that inside the troposphere, there is no significant difference in the change in temperature structure with time under GHG and solar warming. But solar warming heats the stratosphere, while increased GHG cools it - so as usual, RW1 gets the science completely backwards."*  
  
GHG induced warming results in the warming of the atmosphere, does it not? Warming air expands and in doing so does work against its surroundings, which requires some of the internal energy to be expended, leaving less available to heat the atmosphere (and ultimately the surface).

1. **Bernard J.** at [01:19 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79289)

GHG induced warming results in the warming of the atmosphere, does it not? Warming air expands and in doing so does work against its surroundings, which requires some of the internal energy to be expended, leaving less available to heat the atmosphere (and ultimately the surface).

RW1, an understanding of thermodynamics is not really something that you have under your belt, is it?  
  
I'm sure others will pick your statements to pieces, but do yourself a favour and in preparation learn about adiabatic processes.  
  
Seriously.

1. **Tom Curtis** at [08:31 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79300)

RW1's [original claim](http://www.skepticalscience.com/news.php?n=1396&p=2#79164) was that the forcing from Greenhouse Gases was three times that from solar.  
  
In defense of that claim he refers us to the ratio of incident solar radiation to upward long wave surface radiation to surface absorbed solar radiation, or 2.46 (396/161, see diagram below).  
  
[](http://chriscolose.files.wordpress.com/2008/12/kiehl4.jpg?w=480&h=350)  
  
With hesitance I say that RW1 should have used the ratio of LW surface radiation to total absorbed solar radiation, or 1.66 (396/239). I say "with hesitance" because his entire formulation is incorrect. For a start, 239 W/m^2 is not the solar "forcing". A "forcing" is the change in a value between two different, specified times. By convention, the reference time is 1750, notionally the pre-industrial era. Further, 396 W/m^2 is not the "greenhouse gas forcing" In fact, the difference between the upward LW surface radiation and the upward LW radiation at the top of the atmosphere (TOA) is the total greenhouse effect, but even that is not the total greenhouse forcing both because a forcing is a change between two times, and because it includes feedbacks as well as forcings.   
  
(For what it is worth, the ratio of the total greenhouse effect to total insolation is 157/239, or approximately 66%. What is more, the insolation contributes approximately 80% of mean global temperature, with the greenhouse effect contributing the majority of the extra warming and redistribution of heat, which equalizes temperatures contributing the rest.)  
  
Ignoring the terminological issues, which render RW1's claim almost incoherent, the simple fact is that the total greenhouse effect acts as a multiplier of energy from the sun. If we were in the dark of space, no amount of greenhouse gases would raise our temperature appreciably above the 2.5 K temperature of the cosmic background radiation. Therefore if insolation increased, then the total greenhouse effect also increases in proportion. For small increases in insolation, the ratio of effective insolation (incoming sunlight minus albedo) to upward LW surface radiation would remain constant. And therefore the increase in temperature from an increase in insolation of 1 W/m^2 would be approximately the same as the increase from a 1 W/m^2 forcing from CO2.  
  
**Turning to RW1's second point**, warming a gas does result in expansion, which does perform work. But a GHG forcing warms the troposphere but **cools** the stratosphere. In contrast an increased solar forcing warms both troposphere and stratosphere. Because the solar forcing is warming more gas (by a small percentage), if RW1's argument had any merit, it would indicate that solar forcing was weaker than GHGforcing.  
  
In fact, however, it is without merit. It does indicate that solar forcing must use more energy for a given increase in temperature, all else being equal. But energy leaving the system is not a function of how much energy is stored in the system, but of surface and atmospheric temperatures. Because of this, the increase in temperature is the only factor in determining if equilibrium has been restored, and the equilibrium temperature for equal solar and GHG forcings is approximately the same.  
  
**I write this solely for the benefit of interested readers who may be confused by RW1's ramblings.** He himself has a long demonstrated inability to learn or apply even the most basic of the relevant concepts, so I doubt he will gain any benefit from it. For the same reason I am unlikely to respond to any response he makes to my post. Again, he has a long history of simply regurgitating his initial confusion in slightly different words and imagining that thereby he is "debating". At the moment I do not have the time to waste pandering to his misconception.

1. **RW1** at [09:20 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79302)

Tom Curtis,  
  
Let me clarify what I'm trying to say:  
  
Designating the +1.1C as the 'zero-feedback' starting point from the so-called 'Planck response' (i.e. the effective emissivity) is not valid because it arbitrarily separates the physical processes and feedbacks in the system that will act on additional forcings, like from GHGs, from those that currently act to maintain and control the system from the forcing of the Sun, for which there is no physical or logical basis.   
  
Put another way, one can't derive the 'zero-feedback' starting point from the absolute surface response to solar forcing, which itself is the net result of and maintained by all the physical processes and feedbacks in the system, and then claim there is some nebulous feedback acting on top of this that will amplify 'forcings' or imbalances even further, let alone 3-6x times greater. The 'brakes' - if you will, have already been put on all the feedbacks in the system from the many years and years of forcing from the Sun, including especially water vapor and clouds, as the two are the most dynamic components of the whole atmosphere.   
  
If you think they have not been put on (the brakes), why did the net surface energy flux from the forcing of the Sun 'stop' at only 390 W/m^2? Why didn't the feedbacks in the system, including especially water vapor and clouds, ultimately manifest themselves to an 'effective' emissivity of 0.22 (3.7/16.6 = 0.22), where a net surface energy flux of 1077 W/m^2 (about 100C!) has 837 W/m^2 'blocked' by the atmosphere and re-circulated back to the surface (240/1077 = 0.22)?  
  
In short, the absolute solar amplification factor of about 1.6 (390/240 = 1.625) is already giving a measure of incremental sensitivity to additional forcings or imbalances, only it represents an upper bound on sensitivity because net negative feedback on imbalances (a net response less than 1.6) is required for basic stability and maintenance of the current energy balance from the forcing of the Sun.  
  
  
If the logic is still not clear, here it is broken down into a series of separate questions:  
  
Do you agree that at the Earth's current global average temperature of 288K, the Earth emits about 390 W/m^2 from its surface (assuming an emissivity of 1 or very close to 1)?  
  
Do you agree that the globally averaged solar constant is about 342 W/m^2 and the average albedo is about 0.3, resulting in a net incident solar power of about 240 W/m^2?  
  
Do you agree that the 240 W/m^2 of incident post albedo solar power is forcing the climate system?   
  
Do you agree that the 240 W/m^2 forcing the system from the Sun results in an amplification at the surface of about 390 W/m^2 entering the surface from the atmosphere to sustain 288K?  
  
Do you agree that this accounts for all the physical processes and feedbacks in the system? If not, why haven't all the physical processes and feedbacks fully manifested themselves after billions of years of forcing from the Sun? Or even after the last few hundreds or thousands of years of forcing from the Sun?  
  
Do you agree that in order to amplify +3.7 W/m^2 of 'forcing' from 2xCO2 into +3C at the surface it requires +16.6 W/m^2 entering the surface from the atmosphere (288K = 390 W/m^2; 291K or +3C = 406.6 W/m^2 and 406.6 - 390 = 16.6 W/m^2)?  
  
Do you agree that watts of GHG 'forcing' and watts of solar forcing must obey the same physics in the system? That is a watt is a watt, independent of where it last originates from.  
  
Do you agree that a watt of post albedo solar forcing and watt of GHG 'forcing' can only do the same amount of work?  
  
Do you agree that 390/240 = 1.625?  
  
Do you agree that 16.6/3.7 = 4.5?  
  
Do you agree that 4.5 is 2.8x times greater than 1.625?  
  
If watts are watts, how can watts of GHG 'forcing' have a 3x greater ability to warm the surface than watts forcing the system from the Sun?

1. **RW1** at [09:33 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79304)

Tom Curtis,  
  
Regarding my other point. Unlike additional solar forcing, with additional GHG 'forcing' there is no increased energy coming into the system, leaving only the existing internal energy available.   
  
Since GHG warming requires the troposphere to warm and the pressure is higher in the troposphere than it is in the stratosphere, I stand by my claim that if anything a watt of additional GHG 'forcing' would be a little less than a watt of solar in its ability to warm the atmosphere (and ulimately the surface).

1. **RW1** at [09:39 AM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79305)

I meant to say:  
  
"...I stand by my claim that if anything a watt of additional GHG 'forcing' would be a little less than a watt of additional solar forcing in its ability to warm the atmosphere (and ulimately the surface).

1. **Tom Curtis** at [12:32 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79308)

RW1:

"Put another way, one can't derive the 'zero-feedback' starting point from the absolute surface response to solar forcing, ..."

You are correct, but nobody does derive the zero feedback response to forcing from the absolute surface response to insolation. There is no point in further discussing your straw man.

"In short, the absolute solar amplification factor of about 1.6 (390/240 = 1.625) is already giving a measure of incremental sensitivity to additional forcings or imbalances, only it represents an upper bound on sensitivity because net negative feedback on imbalances (a net response less than 1.6) is required for basic stability and maintenance of the current energy balance from the forcing of the Sun."

1) It does not represent an upper bound. To assume that it does you must assume that the albedo of a sunless Earth would be identical to the albedo of the Earth as it currently exists. That assumption is, however, simply absurd. A sunless Earth would have an albedo of 0.7 (0.3 for treeless land areas, and 0.9 for frozen oceans) or higher. Consequently an approximate measure of the "solar amplification factor", if it is intended to reflect all feedbacks, is 2.05. What is more, your argument assumes that the "solar amplification factor" is constant over the range of temperatures that might be experienced, which is known to be false. It also assumes it is constant with regard to continental configurations (also known to be false).  
  
2) Your whole presentation is nonsense. Let's define some terms:  
  
EI = Effective Insolation = Top of atmosphere insolation \* (1-albedo);  
  
SR = Upward Long wave surface radiation  
  
OLR = Outgoing Longwave Radiation  
  
TGHE = total greenhouse effect = SR-OLR  
  
Given these definitions, we can define the solar amplification factor (SAF):  
  
SAF = (EI+TGHE)/EI  
  
Thus defined we see that your insistence that the Solar Amplification Factor remains constant under the greenhouse effect is just the insistence that (EI+TGHE)/EI = k, where k is a constant.  
  
That can only be true where TGHE = EI(k-1). So, your insistence that the ratio be constant is simply an assertion by fiat that the atmospheric greenhouse effect is completely independent of the concentrations of all greenhouse gases in the atmosphere. Put simply, your theory can only be correct if a pure nitrogen atmosphere has the same greenhouse effect as a pure CO2 atmosphere. And you want to assert this claim as a definition from which we are supposed to start reasoning.   
  
Well, you may be able to con some people, but I recognize the difference between science and utter nonsense, and it is the later that you are peddling.

1. **Tom Curtis** at [12:36 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79309)

RW1 @279, increasing the GHG concentration will reduce the OLR radiation until equilibrium is reached. You assert that because it does not increase the incoming solar radiation, it cannot cause in increase in energy stored in the Earth's surface and atmosphere. **This is logically equivalent to asserting that if you have a basin of water, being filled by a tap, and drained through a drain, that you cannot increase the water level by reducing the water flow out of the drain because doing so does not increase the water flow from the tap.** No more need be said.

1. **RW1** at [13:27 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79310)

Tom Curtis,  
  
*"You are correct, but nobody does derive the zero feedback response to forcing from the absolute surface response to insolation. There is no point in further discussing your straw man."*  
  
390/240 = 1.625; 3.7 W/m^2 x 1.625 = 6.0 W/m^2 = 1.1C from S-B.  
  
*"What is more, your argument assumes that the "solar amplification factor" is constant over the range of temperatures that might be experienced, which is known to be false."*  
  
Actually, no. The amplification factor is not constant and is indeed non-linear; however, each incremental watt causes proportionally less and less warming in the system, which is the opposite of what would be consistent with the incremental response being greater than the current absolute response (i.e. greater than about 1.6)  
  
*"So, your insistence that the ratio be constant is simply an assertion by fiat that the atmospheric greenhouse effect is completely independent of the concentrations of all greenhouse gases in the atmosphere."*  
  
I never said or implied anything of the sort. The ratio is not constant. If, from GHG 'forcing', the surface temperature were to rise by 1.1C the absolute surface response to solar forcing would increase. The new ratio would be 1.65 (396/240 = 1.65).

1. **RW1** at [13:43 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79311)

Tom Curtis,  
  
*"You assert that because it does not increase the incoming solar radiation, it cannot cause in increase in energy stored in the Earth's surface and atmosphere."*  
  
I don't assert this at all. What I'm saying is additional GHG 'forcing' does not increase the total energy input into the system as additional post albedo solar forcing would. This does not mean that GHG 'forcing' cannot increase the total energy stored in the Earth's surface and atmosphere, as of course it can.  
  
My original point was that, if anything, a watt of GHG 'forcing' would be a little less than solar because some of the existing internal energy would have to be expended for the expansion of warming air against its surroundings.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [14:07 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79312)

Tom,  
  
RW1 refuses to look at this as anything other than a linear system equivalent to electronic circuits. As long as he is in that trap you cannot help him out of it. He has tied himself in knots with his personal model of the system, and there's no way out of it, because he won't abandon his (grossly flawed) model, nor will he expand it to properly reflect the system being modeled. He'll argue in a thousand circles before he recognizes that **he is wildly wrong**.

1. **[Bob Lacatena](http://sphaerica.wordpress.com/)** at [14:14 PM on 29 April, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#79313)

RW1,

Do you agree that 390/240 = 1.625?

Yes.

Do you agree that 16.6/3.7 = 4.5?

Yes, but utterly irrelvant.

Do you agree that 4.5 is 2.8x times greater than 1.625?

Yes, but utterly irrelevant.

If watts are watts, how can watts of GHG 'forcing' have a 3x greater ability to warm the surface than watts forcing the system from the Sun?

Because the ratio is a meaningless number and the question as phrased is a nonsensical question.  
  
Put another way... if the sun increased its output by 3.7 W/m2, the earth would warm by roughly the same amount. An additional 3.7 W/m2 from any source would result in 16.6 W/m2 at the surface.  
  
The reason has to do with this thing called feedbacks, and the fact that the system does not consist solely of a big flaming ball (the sun) and a little floating ball (the earth).  
  
It's more complicated than that, and you would be far, far better served studying the other issues than arguing, for the fifty millionth time, this same, old, tired point.  
  
Have you not yet figured out that no one on the entire planet agrees with you, or cares about your particular insight in this?  
  
Do you think you are Galileo? Or perhaps merely confused and lost?  
  
Take your pick, but either way, you're wasting everyone's time with the same, old, complete **nonsense**.  
  
It's time for you to get over yourself and go learn something.

1. **Falkenherz** at [02:23 AM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86558)

Hi! It is still very hard to grasp that incoming direct TSI can be modified by "earth climate" to such a high level that it in fact marginalizes the source's direct influence. A problem many sceptics seem to have, too.  
  
Coming from the discussion of the alternative TSI (total solar irradiance) reconstruction from Shapiro e.a. <http://www.skepticalscience.com/shapiro-solar-2011.html#comments> , which is counter-argued in that linked article because his observations would imply a very low climate sensitivity when compared to the reconstructed temperature curves from Ljungqvist.  
  
I read here with special interest about Hansen 2008 and his long term comparisions from earth history.   
Hansen 2008 does not bring forth any TSI data, but from his footnotes you get the impression there is almost no significant shift in TSI levels throughout earth history. However, he also states "The possibility remains of solar variability on longer time scales.", which he debunks by pointing out the TSI development of the last decades (last page); which I find not entirly coherent.  
  
Is there any data on TSI levels throughout earth history?   
(For example, for the last 450k years from Figure 2 of this article? I never really understood what part of the 6 Degrees difference from the ice cores is attributable to GHG and what part to TSI. Sure is only that TSI was the driver of the shifts from warm to cold and vice versa. So, what level of TSI difference started and ended the shifts we observe from the ice cores?)

1. **CBDunkerson** at [04:06 AM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86559)

Falkenherz wrote: "So, what level of TSI difference started and ended the shifts we observe from the ice cores?"  
  
Rather than explain to you again why the glacial / interglacial cycle is **not** caused by changes in TSI I'll just point you to [the previous time I explained it](http://www.skepticalscience.com/argument.php?p=1&t=55&&a=121#85363).

1. **scaddenp** at [06:25 AM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86564)

"it is still very hard to grasp that incoming direct TSI can be modified by "earth climate" to such a high level that it in fact marginalizes the source's direct influence"  
  
How about considering how different the climate of the earth would be (ice ball) without any GHG then? If you dont think that theory is believable then consider that you deduce surface temperature of any rotating planet anywhere given TSI, albedo, aerosol and ... atmospheric composition (ie GHG).

1. **Philippe Chantreau** at [10:03 AM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86572)

Falkenherz, if you are referring tp the galcial/interglacial cycles, the evidence points to changes not in TSIbut in its distribution over the surface. That itself is an argument for high sensitivity to radiative forcings in general.

1. **Falkenherz** at [18:25 PM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86581)

CBDunkerson, thanks for correcting me again. But my question is still open:  
  
So, are there really no significant changes in TSI throughout the last 450k years?  
  
Philippe, I take it I then have to talk about insolation instead of TSI? So, let me rephrase: What was the difference in insolation or whatever W/m2, in order to trigger the shifts during the last 450k years?

1. **Philippe Chantreau** at [19:07 PM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86582)

Falkenherz, Tamino has a good explanation with the maths, Wobbles part1 and part2, on the WB machine:  
  
<http://web.archive.org/web/20080501124634/tamino.wordpress.com/2007/11/19/wobbles-part-1/>   
  
<http://web.archive.org/web/20080419120634/http://tamino.wordpress.com/2007/12/02/wobbles-part-2/>   
  
Wiki has the skinny on Milankovitch, I'm surprised you seem to be not yet familiar with that:  
<http://en.wikipedia.org/wiki/Milankovitch_cycles>   
  
Berger and Loutre have published quite a bit on the subject, check them out. The litterature is out there.

1. **CBDunkerson** at [23:04 PM on 16 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86593)

Falkenherz, it depends on what you mean by 'significant'.  
  
Current TSI (sometimes still called 'the Solar constant' even though we now know it isn't actually constant) is about 1361 W/m^2. The Maunder Minimum ~1700 was less than 1 W/m^2 lower. Thus, the most profound swing in TSI of the past several thousand years was a change of less than 0.1%. The difference from peak to valley of the ~11 year cycles is also about 0.1%, but obviously maintained over a shorter period.  
  
Over longer time scales TSI is increasing by about 0.1% per ~140,000 years as the Sun grows older and hotter.  
  
Yet, these 'tiny' changes in TSI have noticeable effects on the Earth's climate due to feedback sensitivity. The fact that current greenhouse gas forcings are already larger than any solar variation of the past few hundred thousand years should thus be of some concern.

1. **Falkenherz** at [03:11 AM on 17 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86609)

Philippe, I ignored Milankovitch cycles (MC) because they are uncontested and I assumed they would have a certain known impact on global temperature, thereby initiating ice ages. Reading through the links you provided, this assumtion is wrong. If I understood correctly, nobody really seems to know the physics of the trigger for global temperature changes, only that MC must be a trigger, and it is assumed that glacial changes on the landmass-rich northern hemisphere play a key role. In other words, there is no initial rise of global temperature as the initial trigger, but rather some severe local imbalances. This just in short, because there is that other article specifically on MC. My research here is about climate sensitiviy, and specifically why consenus seems to be that it is high. So right now I am puzzled why people assume a high climate sensitivity if we don't know the physical trigger process. After all, if I understood correctly, it seems like local insolation can peak at 600 W/m2, which would probably be a very strong trigger with only a low sensitivity required.  
  
I am unsure where to continue discussion. Maybe I best move on to the MC article. (I start feeling like a hyperlink nomad and comment-parasite. Do you guys maybe have a forum?)  
  
CBDunkerson, thanks for confirming no real strong TSI changes connected to the ice age cycles.

1. **Daniel Bailey** at [03:50 AM on 17 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86612)

@ [Falkenherz](http://www.skepticalscience.com/argument.php?a=115&p=6" \l "86609)

*"I ignored Milankovitch cycles (MC) because they are uncontested"*

Perhaps not by you (at this moment) nor by most scientists (some do) but there are those who deny this, daily.

*"nobody really seems to know the physics of the trigger for global temperature changes"*

You project here. Try reading [this post](http://www.skepticalscience.com/skakun-co2-temp-lag.html) (including the comments threads, which should be mandatory).

*"My research here is about climate sensitiviy, and specifically why consenus seems to be that it is high."*

Um, "consensus" is that climate sensitivity is bewteen 1.9 (or so) and 4.2 (or so) with a central estimate of 3.0 being strongest. That you characterize that as "high" speaks volumes.

*" if we don't know the physical trigger process"*

More projection, again.  
  
Suggestion: more research & reading (by you), less trying to shoehorn reality into the worldview you have chalked out for it.

1. **scaddenp** at [07:31 AM on 17 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86622)

"we don't know the physical trigger process"  
  
How on earth do you deduce that? The physical trigger is change in insolation distribution in the northern hemisphere, which in a low CO2 atmosphere sets up a web feedbacks on albedo and GHG. Untangling this web quantitatively has been a slow process. Have a look at fig 6 of [Hansen and Sato 2011](http://www.columbia.edu/~jeh1/mailings/2012/20120508_ClimateSensitivity.pdf) and tell me again that this isn’t understood.

1. **Falkenherz** at [02:23 AM on 18 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86647)

Daniel, I do question about reality, and if reality is reality, I am confident that my questions will be answered.   
  
scaddenp, Hansen and Sato 2011 are a very difficult to read for me. If I understand their chapter 5 on the Holocene correctly, they use climate forcings calculated from GHG and sea level changes (=ice sheetapproximisations) and apply climate sensitivity "consensus" values and thusly produce temperature curves which match the ice core data.   
  
Seeing that there is yet another article which again specializes within more details with regards to my questions on the ice core data, I will move on to the discussion of Shakun e.a., link provided by Daniel#295.

1. **Alexandre** at [10:28 AM on 21 October, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#86789)

Guys, can someone tell me if the Knutti & Hegerl graph is free to be reproduced in Wikipedia? Is it already in the Commons? The Nature Geoscience page says "all rights reserved"...

1. **Falkenherz** at [23:15 PM on 7 November, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#87479)

Dear Moderator, I am stuck. Apparently, the comment function on the article "Shakun e.a." seems to be bugged. It took several days before my questions actually appeared. Now, sometimes I can see my questions I posted there, sometimes not. I suspect that some answers to my questions might not have gotten through or are stuck. Could you pls check?  
  
(http://www.skepticalscience.com/news.php?p=4&t=151&&n=1391)

1. **DSL** at [06:01 AM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=6&t=370&&a=115#87552)

I'm sure Ari will be loading this one into the next weekly installment, but Trenberth and Fasullo have apparently [constrained sensitivity](http://www.sciencemag.org/content/338/6108/792.abstract?sid=d0be7d9e-f63d-41c1-9638-16319c158662) even further -- or at least made a major advancement.

[Prev](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115)  [1](http://www.skepticalscience.com/argument.php?p=1&t=370&&a=115)  [2](http://www.skepticalscience.com/argument.php?p=2&t=370&&a=115)  [3](http://www.skepticalscience.com/argument.php?p=3&t=370&&a=115)  [4](http://www.skepticalscience.com/argument.php?p=4&t=370&&a=115)  [5](http://www.skepticalscience.com/argument.php?p=5&t=370&&a=115)  6  [7](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115)  [8](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115)  [Next](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115)

# COMMENTS PAGE 7

Comments 301 to 350 out of 370:

1. **[dana1981](http://www.guardian.co.uk/environment/climate-consensus-97-per-cent)** at [06:35 AM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#87554)

I'll have a post on that paper next week, DSL. I wouldn't say they've constrained climate sensitivity - more accurately they showed that models with climate sensitivity below 3°C don't simulate cloud changes very well, so climate sensitivityis likely on the high end.

1. **KR** at [07:17 AM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#87556)

[dana1981](http://www.skepticalscience.com/argument.php?a=115&p=7#87554) - Actually, it's that those models with low sensitivity don't simulate humidity changes very well, not clouds. They note that clouds are a more difficult phenomena to observe, too.   
  
Fasullo and Trenberth 2012 ([described here](https://www2.ucar.edu/atmosnews/news/8264/future-warming-likely-be-high-side-climate-projections-analysis-finds)) appears to be much in the same vein as [Spencer and Braswell 2011](http://www.skepticalscience.com/roy-spencer-negative-feedback-climate-sensitivity-intermediate.htm), where they examined how climate models matched observations, although S&B 2011 was clearly refuted due to poor technique and the exclusion of models they themselves tested which refuted their conclusions.

1. **[dana1981](http://www.guardian.co.uk/environment/climate-consensus-97-per-cent)** at [07:50 AM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#87557)

KR @302 - yes, to be precise Fasullo and Trenberth are looking at relative humidity changes in the subtropics, which are related to subtropical cloud formation. Anyway, more details in the post next week.

1. **DSL** at [13:32 PM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#87560)

I'll stand corrected, but in my book anything that narrows the range of "likely" is constraining. Would it be fair to say that we have less confidence in the lower sensitivity models now?

1. **[dana1981](http://www.guardian.co.uk/environment/climate-consensus-97-per-cent)** at [17:23 PM on 10 November, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#87561)

DSL @304 - yes, the lower sensitivity models don't simulate subtropical humidity well, so they merit less confidence.

1. **JackO'Fall** at [09:28 AM on 14 December, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#88460)

Using a GCM to predict/verify sensitivity is flawed and hubris. We have a lot of known unknowns in the GCMs. They are not established science, but SWAGs.  
Assuming the climate is ever in equilibrium as the basis for a calculation is absurd. It is never, ever, in equilibrium. If it were, we would not see the changes that have occurred in the past.  
Until science has a better handle on clouds (and many other second-order feedbacks), any attempts to quantify sensitivity are relying on guessing about past events, but not on understanding why.

1. **scaddenp** at [09:51 AM on 14 December, 2012](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#88461)

Try reading the intermediate or advanced version of the article (or the appropriate chapter in the IPCC report). You will see that there are empirical studies of climate sensitivity. Read deeper into the papers and you will see that no one assumes climate is in equilibrium - the utility of term does not require it.  
  
Your comments on cloud feedbacks would have been justified for TAR but they are far better quantified now. Note also that models are doing a pretty good job of estimating temperature trends, even something as primitive as that used by the Broecker in 1975 ("Climatic change; are we on the brink of a pronounced global warming?" Science, v 189, n 4201, p 460-3, 8 Aug. 1975") which got temp for 2010 better good.

1. **Paul from VA** at [09:37 AM on 26 August, 2013](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#97387)

Hey, so I was linking your excellent version of Knutti and Hegerl graphic used in this post and noticed that it uses a potentially confusing notation both here and in the original paper.  The 90% confidence interval is labelled "very likely" and the 66% confidence interval is labelled as "likely."  That's sensible from a science perspective, but a bit confusing in that values from the 66% region are more likely to be the drawn values than those in the 66-90% interval.  Not sure there's any way to better label the figure, but I thought I'd just put that out there to see if there's a less confusing way of doing so....

1. **michael sweet** at [12:28 PM on 26 August, 2013](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#97390)

Paul,

The 90% interval is from 5% to 95% so it includes the 66% confidence interval.  Therefore it is more likely to occur since if the 66% occurs the 90% must also occur.

1. **Paul from VA** at [13:06 PM on 26 August, 2013](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#97391)

Michael, I'm well aware of that.  My point is that if one didn't go digging through to the original article AND understand IPCC terminology AND frequentist statistics, the graph would seem to be confusing.

If it were labelled for example "66% confidence interval" and "90 % confidenceinterval" one wouldn't have to go chasing footnotes to understand it....

1. **MA Rodger** at [19:52 PM on 26 August, 2013](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#97394)

Paul from VA @310.

You are right that it is confusing, but because it is actually more confusing than you say, as it also refers to *"the most likely value."*

The caption for Figure 4 (in the Advanced version of this post) says*"The circle indicates the most likely value. The thin colored bars indicate very likely value (more than 90% probability). The thicker colored bars indicate likely values (more than 66% probability)."* The original [Knutti & Hegerl paper](http://www.iac.ethz.ch/people/knuttir/papers/knutti08natgeo.pdf) sort of copes with this by talking of *"most like values"* and *"likely ... and very likely value ...****ranges****"* (my emphasis) but I would consider this poor description for a Review Article where the audience is *very likely* less attuned to the underlying science and so more reliant on the actual descriptions presented. And at SkS the audience is even less steeped in the science (although it is an advanced level SkS post).

The problem is also encountered in the other Knutti & Hegerl figure used in the advanced level post (SkS figure 6) where the terms*"most likely warming"* and *"likely range"* cope reasonably well. Yet if this is an advanced level post I would have thought the concept of a confidence interval would be preferable as suggested @ 310.

1. **michael sweet** at [10:44 AM on 27 August, 2013](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#97399)

Paul and MA,

This discussion seems to me to come down to how useful the IPCC terms are in a scientific paper.  These terms have been discussed a lot before and some people do not like them.  On the other hand, people also did not like using numbers before the IPCC adopted the current terms.  It seems to me *extremely likely* that the scientists reading the review paper are familiar with these terms, the paper is not intended for a lay audience.  Most of the users here at SkS are also familiar with these terms.  They are not perfect, but they are what we currently have.  I imagine that if we switched to new terms someone else would complain.  It is difficult to please everyone.

Perhaps you could write a new post that explains things better?  Good explainations are always welcome.

1. **Jutland** at [18:39 PM on 25 May, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#104405)

Long time lurker, first time poster here.David Wasdell of the Apollo-Gaia project claims climate sensitivity is closer to 7.8 deg C per CO2 doubling. <http://www.jayhanson.org/climate.pdf> What's his mistake, if any? It's based on palaeoclimate data but doesn't fit the lower palaeoclimate sensitivities given elsewhere.

1. **Tom Curtis** at [20:59 PM on 25 May, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#104407)

Jutland @313, the 7.8 deg C value is for the Earth System Climate Sensitivity, ie, the change in temperature for an initial doubling of CO2 after all feedbacks, including slow responding feedbacks from ice sheets, etc, have stabilized.  The value is similar to other reasonable estimates, but the Earth System Response will take several thousands of years to stabilize.  The value is therefore largely irrelevant to temperatures over the next century or so.  Further, provided we do stop emitting CO2 at some point in the next century, equilibriation of CO2 concentration between the surface and deep oceans will reduce CO2 concentrations to about 50% of their peak increase over preindustrial values, so that the Earth System Response would be to a much lower overall CO2 concentration.

Far more relevant to the immediate future (ie, next 100-200 years) are the Transient Climate Response and the Charney Climate Sensitivity, which the Apollo-Gaia project shows as 3 C (close to IPCC central estimates).  The only policy relevant impact of the Earth System Response is that it shows that a stable solution to the problem of global warming will require zero net anthropogenic emissions.  Merely reducing emissions to 20% of current values is not a stable long term response.

1. **chriskoz** at [22:03 PM on 25 May, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#104408)

Jutland@313

The biggest mistake in that booklet is their application of Earth System Sensitivity, which by their own definition works in millenial timescale, to the problem of AGW mitigation, which works on a century (or couple of centuries) timescale. The ESS by their own definition, is a speculative measure, based on inaccurate deep-paleo data. You cannot expect ESS to play out fully within the mitigation timeframe (until say 2100) IPCC is concerned about. Beyond the timeframe of few centuries, the CO2 level may drop signifficantly due to ocean invasion, so most of the eedbacks may not (and likely will not) play out. The same applies to Hadley & Hansen sensitivities: their positive feedbacks are not rellevant within the timeframe considered. By the same token, the rock weathering negative feedback does not play out within interglacial cycles of 100ky, therefore we don't talk about it while considering Milankovic forcings. While taking about this century, Charney sensitivity is the only one that we can be certain to play out.

Even more erroneous (actually ridiculous for me) is their calculation of[Earth System Sensitivity in this booklet.](http://www.apollo-gaia.org/Climate%20Sensitivity.pdf)

Check out the figure 8 on age 13. They claim ESS being far more accurate than other sensitivities, because it's derived from "high precision mathematics". That's just pathetically ridiculous. They don't mention how imprecise their input data is: just few points of highly uncertain values from 100 or 40 milion years ago. I'm sorry but if you are trying to estimate ESS from so highly uncertain old data (even ignoring the paleo-expert assertions that Earth sensitivity was different at that time due to continental configurations, etc.), your "high precision mathematics" won't help you to find the precise parameter you're looking for.

1. **Jutland** at [02:44 AM on 26 May, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#104414)

Tom @314 and Chriskoz @ 315 Thank you both for your helpful and swift replies. I had suspected something must be awry as he had published it online rather than in a peer-reviewed journal, but I am not a scientist, so could not work out what it might be. Incidentally, as this is the first day I've posted may I say what a valuable resource this site is, I very much appreciate it. For many years I \*thought\* I understood the greenhouse effect, because I understood those simple diagrams which show a single-layer atmosphere with equivalent arrows emerging out, one into space and one back to the ground. Then I read a piece by John Houghton which talked about the adiabatic lapse rate and how the greenhouse effect would be impossible if the lapse rate didn't exist. And I realised that I didn't really understand the greenhouse effect at all, because the lapse rate wasn't on those over-simple diagrams. This site was one of the ones I used to read up on it to improve my understanding, and it was the first place I thought of for help when I was reading Wasdell's paper, so thank you very much.

1. **Earthling** at [20:57 PM on 4 October, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#107063)

"There are some of us who remain so humbled by the task of measuring and understanding the extraordinarily complex climate system that we are skeptical of our ability to know what it is doing and why." Dr John R Christy

1. **DSL** at [22:43 PM on 4 October, 2014](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#107065)

Well-quoted, Earthling.  I, too, am "skeptical" of John Christy's ability to know what the climate is doing and why.

1. **bozzza** at [01:09 AM on 28 March, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#110421)

@316, you mean I've got **more** reading to do?

1. **Rob Honeycutt** at [07:52 AM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111142)

Stub for Klapper to move conversation from Guardian to SkS where he believes there are more informed commenters than me.

1. **Rob Honeycutt** at [08:01 AM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111143)

*Klapper: "....or where is the missing 0.5W/m2 between models and reality?"*

*Rob: "Really? Who've you asked about this one?"*

Klapper: "You for a start. However, while you've dismissed this as irrelevant, you're not very knowledgeable about greenhouse physics (your repetitive references to the irrelevant heat seeking missile examples says a lot), and I think this is time to take this argument over to Skeptical Science where there are more knowledgeable posters to discuss/argue the point."

Just to pick up the conversation with Klapper.

I don't know why you're asking me questions like this that are best answered by people who are experts in the field. All I can do is try to read the relevant research and give my non-professional opinion.

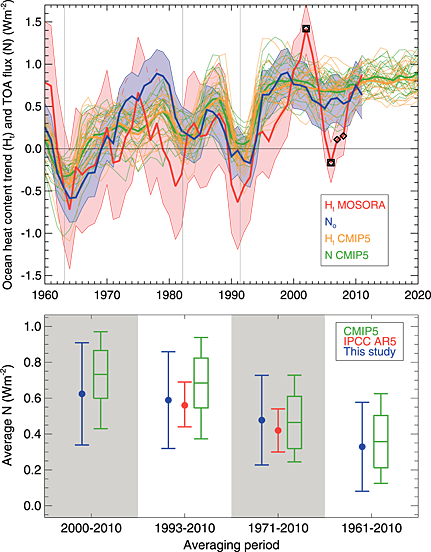
What I'm asking you is, on all these questions you're asking, which you seem to think are evidence of a failed theory of AGW, who are the experts you're asking? You say they're not answering these questions, but are you actually asking anyone who actually would best know the answer?

1. **Tom Curtis** at [09:22 AM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111145)

Rob Honeycutt @321,

there has been a [recent paper by Smith et al](http://onlinelibrary.wiley.com/doi/10.1002/2014GL062669/full)(Feb, 2015) on "Earth's energy imbalance since 1960 in observations and CMIP5 models".

For your discussion with Klapper, the key graphs are figs 3 a and b.



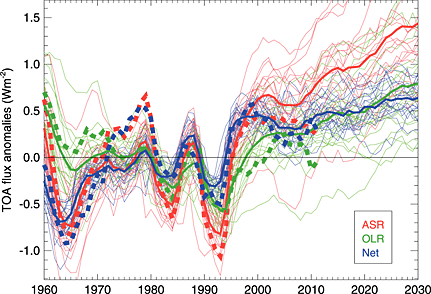
"Earth's energy imbalance. (a) Time series of 5 year running mean N and Ht (as Figure 2, second panel) for 21 CMIP5 coupled model simulations (N in green, Ht in orange, ensemble mean in thick lines) compared with Ht from MOSORA (red) and No (blue, see text). Black squares (diamonds) show where differences between MOSORA and No (CMIP5) are significant with 90% confidence. (b) N averaged over different periods in No (blue, with 1 sigma uncertainties) compared to the CMIP5 models (green, box showing the mean ±1 sigma and whiskers showing the range) and estimates from the IPCC fifth assessment (red) [Rhein et al., 2013, Box 3.1]. Numerical values are given in Table S3."

To interpret that, No is the net downward energy flux at the Top of the Atmosphere (ie, TOA energy imbalance) determined from observations, being the net difference between satellite observed outgoing long wave radiation and incoming short wave radiation benchmarked against ocean heat content data from July 2005 to June 2010.  Ht MOSORA is the ocean heat content from a Met Office reanalysis.  That makes it semi-emperical, being emperical over those zones of the ocean of which we have observations, but using a computer model constrained to the empirical values over those zones where we have observations to fill in those zones in which we do not have observations.  Ho and Ht CMIP5 are the multimodel mean equivalents.

Several things are worth noting in Fig 3a.  First, No (ie the TOA energy imbalance) from observations and models match closely except for the period of 1972-82.  They certainly match well over the last decade, although the observed No is slightly less than the modelled No in that period (of which more later).  Second, TOAenergy imbalance and OHC should match closely, and do for the models.  There are, however, wide disparities between them in observations.  That indicates there are more problems with the observations than there are with the model/observation comparison.  (For what it is worth, the problems with observations probably relate to the limited region of the ocean in which OHC is directly observed, coupled with problems in the reanalysis.)

Fig 3b is much simpler, and simply shows a direct mean TOA energy imbalance comparison between models and observations over various periods.  As you can see, the observations are statistically indistinguishable from the models for all periods.  More importantly, "the missing 0.5W/m2 between models and reality" is seen to be a fiction.  The actual difference over the most recent decade is 0.11 W/m^2.  The 0.5 figure is based on old figures from CMIP 4 and far less accurate observations, and even then is exagerated by rounding.  That Klapper is still using it shows he is clinging to old data simply because it is convenient for his message.

The paper also has some interesting information about the cause of the discrepancy between models and observations, encapsulated in Fig 4:



As you can see, the discrepancy between model and observed short wave radiation (ASR) is greater and more persistent than the discrepancy in longwave radiation (OLR) after 2000.  Ergo the primary cause of the 0.11 W/m^2 discrepancy between models and observations is the reduced observed shortwave radiation compared to the models.  At least part of the explanation of  that is that the models cease to use historical data from about 2000 onwards, and hence do not include the short wave forcing from a series of recent volcanoes.  If that forcing were included, the discrepancy between models and observations would be smaller, possibly non-existent.

(Note to Rob - I've spelt out in detail a number of points I know you know quite well for the benefit of Klapper and other potential readers.)

1. **[Tom Dayton](https://sites.google.com/site/openmct/)** at [11:24 AM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111148)

Perhaps Tom Curtis might use this recent study to add to the "It's the Sun" post, a counter to the myth that the Earth's temperature still is catching up to the increased input from the Sun that happened before around 1960?  The counter to the myth is that if the myth is true, energy imbalance should be decreasing since then, as the increased outgoing radiation due to the Earth's higher temperature increasing compensated for the now-stable input from the Sun.  Pretty please?

1. **Klapper** at [11:38 AM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111149)

@Rob Honeycutt #321:

"... who are the experts you're asking?..."

You, and Tom Curtis and if not direct me to the peer-reviewed research that you know of. I admit I have in the past used Skeptical Science as a sounding board for ideas I have, since after a few back and forths on the numbers I can normally see if there is a concrete reason to reject the reason or not.

1. **Klapper** at [12:04 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111150)

@Tom Curtis #322:

"...First, ...the TOA energy imbalance...from observations and models match closely except for the period of 1972-82"

Where would you get observations from 1972 for the TOA energy imbalance? For that matter exactly how accurate are the current observations for the TOA imbalance? There's an post over at the Guardian on the water vapour/climate change story by "MaxStavros" which claims the satellite numbers in raw form show an imbalance of 6.5W/m2 at the TOA. Since we know that is impossible the number has been adjusted down to something more believable. I can understand the instruments on the satellite are precise but not accurate, but that means the "observations" are not that reliable. I'm guessing the most reliable number is ocean heat, but that is true only since the ARGO era, from 2004 or 2005. From the NODC data, the warming rate of the oceans, corrected to global area, is about 0.5 W/m2. This is close to other estimates. The following example is ocean plus melting, plus land, but since most of the heat goes into the oceans we would expect the ocean only and total should be close (and they are).

Here's a quote from Jame Hansen et al 2012 at the NASA website: "We used other measurements to estimate the energy going into the deeper ocean, into the continents, and into melting of ice worldwide in the period 2005-2010. We found a total Earth energy imbalance of +0.58±0.15 W/m2 divided as shown in Fig. 1"

<http://www.giss.nasa.gov/research/briefs/hansen_16/>

Here's the problem with an energy imbalance of +0.58W/m2: the models show a much larger TOA energy imbalance. The GISS model shows +1.2W/m2, and the CMIP5 ensemble mean is +1.0 W/m2 for the 2000 to 2015 period.

**Response:**

[JH] Link activated.

1. **Rob Honeycutt** at [12:53 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111151)

Klapper... The Smith et al paper that Tom links to bears reviewing, especially the summary and conclusions. This sums up some of the things I've been attempting to state with regards to the relationship between observations and models, where I've said that it's reasonable to conclude that the models are better representing the climate system and our observations are challenge our ability to "close the Earth's energy budget."

What I see you doing (or at least believe I see you doing) is getting stuck in down in the weeds of our observations, assuming they have to be somehow correct. I think that's a misdirected approach. As I've said several times in our conversation so far, there are lots of uncertainties in the empirical evidence and the models are there to contrain those uncertainties.

1. **KR** at [13:11 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111152)

[Klapper](http://www.skepticalscience.com/argument.php?a=115&p=7#111150) - It is wholly unreasonable to discard ocean heat content data prior to 2005. While the XBT data has higher uncertainties than ARGO, and there have been several calibration issues with it that are recently resolved, the sampling back to the 1960's is more than sufficient to establish long term growth in ocean heatcontent. There simply isn't enough deviation in temperature anomalies over distance to reject long term warming of about 0.6C/decade even with sparse XBT sampling.

For details on this, including evaluating the standard deviation of anomalies against distance, see the [Levitus et al 2012](ftp://data.nodc.noaa.gov/nodc/web/woa.data.nodc/PUBLICATIONS/grlheat12.pdf), specifically the *"Appendix: Error Estimates of Objectively Analyzed Oceanographic Data"*, which speaks directly to this matter. The uncertainty bounds from Levitus et al are shown in [Fig. 2 here](http://skepticalscience.com/levitus-2012-global-warming-heating-oceans.html). And they are certainly tight enough to establish warming.

1. **Klapper** at [17:25 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111155)

@Rob Honeycutt #326:

"...assuming they have to be somehow correct..."

Oh I don't assume they have to be correct at all. You can take the Net observations (satellite) from the Smith paper and throw them in the trashcan. However, that's not true of the ARGO data. Our knowledge of ocean heat is much much better since 2005 or 2004 than pre 2005 or 2004.

1. **Klapper** at [17:29 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111156)

@KR #327:

The problem is the XBT data only go down to 700 m. If I had tried to use only 0-700 heat gain as my metric, I would be jumped on big time since I was "ignoring" the deeper ocean. The amount of sampling below 700 m prior to the ARGO network is extremely sparse, as noted in the Smith et al paper, particularly in the southern ocean.

1. **Klapper** at [17:40 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111157)

@Tom Curtis #322:

"...That Klapper is still using it shows he is clinging to old data simply because it is convenient for his message..."

Absolutely not true (and an unecessary cheap shot to boot). I extracted the multi-run per model ensemble mean numbers from KNMI data explorer, CMIP5 rpc4.5 scenario. I also checked one individual run from the GISS EH2 model, same emissions scenario (although it makes no real difference between the scenarios in the 2005 to 2015 period).

I used the rlut, rsdt, and rsut variables (absolute values, not anomalies) to calculate my net. I'm looking into the difference between my Net TOA imbalance and Smith et al, but not tonight.

1. **KR** at [23:33 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111163)

[Klapper](http://www.skepticalscience.com/argument.php?a=115&p=7#111156) - The XBT data does go to (and through) 2000 meters. Yes, XBT data back to the 1950's is sparse below 700 meters, but it is still data, and uncertainties due to sparse sampling are considerably smaller than the ocean heat content trends over the time of observations.

Again, I would refer you to [Levitus et al 2012](ftp://data.nodc.noaa.gov/nodc/web/woa.data.nodc/PUBLICATIONS/grlheat12.pdf), in particular Fig. 1 and the supplemental figure S10, which shows the 0-2000m 2-sigma uncertainties, variances, and trends for each ocean basin. We have enough data to establish long term OHC trends with some accuracy.

1. **KR** at [23:37 PM on 30 April, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111164)

Klapper - My apologies, S10 in Levitus et al is for the thermosteric component, while S1 shows the OHC (1022 J). Again, there is sufficient data to establish a long term trend against sampling uncertainties 0-2000m.

1. **Rob Honeycutt** at [00:51 AM on 1 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111167)

Klapper @328...  Just to trying to simplify things here, so your key issue is that measured changes in OHC data (W/m^2) do not match model results for TOA imbalance.

1. **MA Rodger** at [01:40 AM on 1 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111168)

Given the preceding thread at the Guardian prior to the start here at SKS, was a thread discussion beginning [here](http://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/apr/23/changes-in-water-vapor-and-clouds-are-amplifying-global-warming#comment-51000631) and running to 7,000 words of comment with nothing resolved, I would suggest a little discipline is required here at SKS to prevent it becoming another pantomime.

The issue to hand is *"the missing 0.5W/m2 between models and reality."* Such a quantity was identified @322 as having been *"based on old figures from CMIP 4 and far less accurate observations, and even then is exaggerated by rounding."*

This is refuted @330 as being *"absolutely not true"* because the missing 0.5W/m2 is apparently a different 0.5W/m2 to that identified @322, and for which we await a full description.

Looking back at the Guardian thread, the 0.5W/m2 appears [here](http://discussion.theguardian.com/comment-permalink/51073137) as the difference between study-based *"heat gain in the measurable part of the ocean .. in the range of 0.3 to 0.6 W/m2"* yielding a *"best guess at ocean heat gain (of) 0.5W/m2"*and*"Models show(ing) the imbalance at the top of the atmosphere through this period as being 1.0 W/m2."*

So what period? What models? Is the TOA 1.0 W/m2 anything to do with the *"TOA energy imbalance projections from the models (of) ... currently about 1.0 to 1.2 W/m2"* mentioned in the Guardian thread [here](http://discussion.theguardian.com/comment-permalink/51040507)?

Please let us not spend many thousands more words without a grip on what is being discussed.

1. **scaddenp** at [07:43 AM on 1 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111178)

Klapper - you are proposing to ignore OHC pre-Argo because there is only data to 700m. However, if you wish to postulate that the huge change in OHC 0-700m does not mean energy imbalance, then you must also be proposing that there could somehow [be] cooling of the 700-2000 layer to compensate for warming in the upper layer.

I would also be interested in your opinion on the [Loeb et al 2012](http://www.nature.com/ngeo/journal/v5/n2/full/ngeo1375.html)  paper in claiming that models and observations are at odds.

1. **KR** at [09:20 AM on 1 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111179)

Scaddenp - We do have XBT data below 700m, just rather less of it. Which is how the ocean heat content analyses going back to the 1950s have been done.

1. **Klapper** at [00:09 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111188)

@MA Rodger #334:

To cross-check my model vs actual comparison for TOA energy imbalance I extracted at the KNMI Data Explorer site data from the CMIP5 Model EnsembleRCP 4.5 (all runs) the variables rsut, rlut, and rsdt, monthly data. I averaged the monthly global data into annual global numbers and calculated the TOA energy imbalance per year as rlut + rsut - rsdt.

To compare to a published number, in this case I'll use the Hansen et al number from the GISS website linked above, I averaged the years from my model extraction data, in this case 2005 to 2010. The GISS number for global TOA energy imbalance of 0.58 W/m2 +/- 0.15. This agrees with other published estimates of similar time periods.

The average I get from my CMIP5 RCP 4.5 ensemble annual data, 2005 to 2010 inclusive is 0.92 W/m2. The models appear to be running too hot by a substantial amount.

My next experiment will be to compare these TOA CMIP5 data to OHC over a longer period, say 2000 to 2014 inclusive. Or maybe just OHC from 2005 to 2014 since the ARGO spatial density was essentially full coverage after 2004 or 2005. We can likely agree that the global energy imbalance dominantly present in the ocean heat gain, although some of the imbalance goes into the atmosphere and melting continental ice.

1. **KR** at [00:45 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111189)

[Klapper](http://www.skepticalscience.com/argument.php?a=115&p=7#111188) - 5 to *(at most)* 15 year periods are short enough that statistical significance is lacking, and that the model mean is expected to differ from short term variations such as ENSO.

I don't think you can make any significant conclusions from such a short period of data.

1. **KR** at [01:13 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111190)

Klapper/everyone - I'll note that many of Klappers issues with model fidelity have been discussed at great length over on the [Climate Models show remarkable agreement with recent surface warming](http://www.skepticalscience.com/Climate-Models-Show-Remarkable-Agreement-with-Recent-Surface-Warming.html) thread. And on that thread Klapper was shown (IMO) that his arguments did not hold.

This appears to be yet another search for a *(notably short term, and hence statistically insignificant)* criteria with which to dismiss modeling.

1. **Tom Curtis** at [01:46 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111191)

Klapper @337:

1)  Did you compute (∑rlut x 1/n) + (∑rsut x 1/n) - (∑rsdt x 1/n) or (∑(rlut + rsut - rsdt)) x 1/n?

2)  The IPCC uses just one model run per model in calculating multi-model means for a reason.  Failing to do so allows a few models with unusually large numbers of runs to be more heavilly weighted in the absence of evidence that those models are superior, and indeed, regardless of any evidence of their superiority or inferiority.  In particular, one model with multiple runs is the GISS model ER, which you have previously stated has a TOA energy imbalance from 2000-2015 of 1.2 W/m^2 - ie, it is at the high end of the CMIP 5 range, and above the CMIP 5 multi-run mean as calculated by you.  There is reason to think this distorts your result.

3)  5 years is too short a time for such comparisons for reasons given by KR.  What are your results for 2000-2010 for comparison with the Smith et al data?  Indeed, what are your results for all of the Smith et al periods as shown in the second panel of the first graph in my post @322?

4)  Why do you use the multi-model (really multi-run) mean rather than the multi-model median as do Smith et al?  In this case where damage functions are not a factor, using the median as the central estimate makes sense (IMO) in that it is less subject to distortion by outliers.  Is their some reason why you preffer it despite this disadvantage?

5)  I ask you to forgive me for not responding to your earlier posts.  I had an extensive response prepared and lost it in the attempt to post it.  Unfortunately I have been ill since then, and not had the energy for recomposing a similarly extensive response.  I am also considering whether or not to download the data from KNMI for direct comparison before more detailed response (which will take more energy and concentration).

1. **MA Rodger** at [02:06 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111192)

Klapper @337.

You are getting your  0.58 W/m2 +/- 0.15 from [Hansen et al (2012)](http://www.giss.nasa.gov/research/briefs/hansen_16/) , a paper which states:-

*"The fact that Earth gained energy at a rate 0.58 W/m2 during a deep prolonged solar minimum reveals that there is a strong positive forcing overwhelming the negative forcing by below-average solar irradiance. "*

I would suggest that such a quote is difficult to ignore, although you apparently do overlook it. It sort-of adds weight to the comment by KR @338. From memory, the negative solar forcing through those years between cycle 23 & 24 was something like -0.13W/m2, reducing your mismatch from the range 0.19-0.49 W/m2 to 0.06-0.36 W/m/2, considerably reduced from the originally stated 0.5 W/m2.

The paper goes on to say:-

*"Measured Earth energy imbalance, +0.58 W/m2 during 2005-2010, implies that the aerosol forcing is about -1.6 W/m2, a greater negative forcing than employed in most IPCC models."*and*"Most climate models contributing to the last assessment by the Intergovernmental Panel on Climate Change (IPCC, 2007) employed aerosol forcings in the range -0.5 to -1.1 W/m2."*

Again, here is very relevant data you overlook. If these AR4 models underestimate negative aerosol forcing, you would expect them to run with a greater TOA imbalance. And if they did so in AR4, would more recent models be expected now to conform to Hansen et al (2012)? Or is that a bit of an assumption on your part?

1. **Klapper** at [03:39 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111194)

@KR #338:

"I don't think you can make any significant conclusions from such a short period of data".

The quality data for OHC only begin since the ARGO system reached a reasonable spatial density (say 2004 at the earliest). However I will look for some longer OHC/global heat gain data/estimates to match longer periods, say a 15 year period from 2000 to 2014 inclusive. The average for that period is a TOA energy imbalance of 0.98W/m2 from the CMIP5 ensemble (multi-runs per model) mean rcp4.5 scenario.

1. **Klapper** at [03:49 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111195)

@Tom Curtis #340:

"..The IPCC uses just one model run per model in calculating multi-model means for a reason."

Yes very egalitarian of them. An argument could be made for using the other ensemble which says, the better resource supported models have more runs and are probably more realistic than the less resourced models. However, it doesn't make much difference, as the 2005 to 2010 average TOA imbalance changes from 0.92 to 0.90W/m2 with the one run per model ensemble.

"..What are your results for 2000-2010 for comparison with the Smith et al data?"

The 2000 to 2010 average TOA energy imbalance is +0.95W/m2.

".. rather than the multi-model median as do Smith et al?"

I would have to download all the models, a very tedious process, and create my own median; KNMI only options a mean in their ensemble exports.

1. **Klapper** at [03:58 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111196)

@MA Rodger #341:

".. reducing your mismatch from the range 0.19-0.49 W/m2 to 0.06-0.36 W/m/2, considerably reduced from the originally stated 0.5 W/m2"

You're forgetting the originally stated comparison was to OHC, not global energy imbalance (although as noted OHC pretty much is the bulk of the energy imbalance). In any case, even reduced, the numbers support my hypothesis the models run too hot.

"..implies that the aerosol forcing is about -1.6 W/m2"

Circular logic but that's a topic for whole discussion on itself. I'll say no more.

"..would more recent models be expected now to conform to Hansen et al (2012)?"

I'm using the more recent models (CMIP5) and they don't conform to Hansen et al 2012 (still too hot). I'm tempted to go get the AR4 model ensemble and try that also, but for now I'm off to work.

1. **Tom Curtis** at [04:57 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111197)

Klapper @343:

"The 2000 to 2010 average TOA energy imbalance is +0.95W/m2."

1)  I need to make a correction.  I assumed that Smith et al presented a median value based on their use of a box plot.  In their supplementary information, however, they describe the central value as a mean, and the "first quartile" and "third quartile" values as being minus and plus one standard deviation respectively, with whiskers showing the range.  The values are given as 0.73 +/- 0.13 W/m^2 with a range from 0.43 - 0.97 W/m^2.  These values are stated as being the anomaly values with respect to the preindustrial era - anomaly values being used as a correction for model drift.

2)  As noted before, the difference between observations and models over this period in Smith et al is 0.11 W/m^2.  Even using your uncorrected values, the difference between observed and modelled TOA energy imbalance from 2000-2010 is still only 0.33 W/m^2.  The +/- 2 sigma range of the observed TOA energy imbalance is 0.06 to 1.18 W/m^2.  So, even on your figures the discrepancy between mean model and mean observed TOA energy imbalance is substantially less than 0.5 W/m^2 (which as I said before, is a fiction).  Further, you are making a case that the models are shown to be seriously flawed because, the modelled TOA energy imbalance lies within error (actually, withing 1.2 SDs) of the observed value.  It may make a good emotive argument, but it is certainly not a scientific argument.

1. **KR** at [05:16 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111198)

[Klapper](http://www.skepticalscience.com/argument.php?a=115&p=7#111194) - We have OHC data of reasonable quality back to the 1960s, as I [noted here](http://www.skepticalscience.com/argument.php?a=115&p=7#111152). What you are considering is far too short a period for statistical significance, hence too short to make broad statements about model fidelity. If you want to make any claims regarding the differences I would suggest using a sufficient amount of the available data.

You're arguing about short term unforced variations, not statistically significant long term climate trends, and your complaints about the XBT data don't change that fact.

1. **KR** at [05:17 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111199)

Might suggest to one and all that this conversation about model fidelity shift to [the appropriate thread on climate models](http://www.skepticalscience.com/climate-models.htm)?

1. **Klapper** at [05:26 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111200)

@Tom Curtis #345:

"..So, even on your figures the discrepancy between mean model and mean observed TOA energy imbalance is substantially less than 0.5 W/m^2 (which as I said before, is a fiction)".

You're ignoring my comment above in which I clearly stated the 0.5 W/m2 was the difference between OHC and the TOA model output. Here's my 2 most succinct posts from the Guardian on the source of the 0.5 W/m2 number:

"*All that being said, these studies would agree the heat gain in the measurable part of the ocean is in the range of 0.3 to 0.6 W/m2. If the best guess at ocean heat gain is 0.5W/m2, then where is the rest of the heat? Models show the imbalance at the top of the atmosphere through this period as being 1.0 W/m2. We know the atmosphere has limited heat capacity, and the troposphere hasn't shown significant warming since 2005 in any case. That leaves ice melting."*

"*However, heat gain by the oceans right now might be 0.5W/m2, which is only 1/2 of the projected TOA energy imbalance, so while the oceans are warming, and the atmosphere very weakly so, together they don't account for the model predicted 1.0 to 1.2 W/m2 TOA net energy input*."

I concede in at least one post I used the OHC delta to TOA model as "shorthand" for the global energy delta to model TOA, but it's clear from my initial posts the source of the numbers. You're either not reading my full posts or you're deliberately ignoring the context.

1. **Klapper** at [05:30 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111201)

@Tom Curtis #345:

"...anomaly values being used as a correction for model drift."

Why don't you expand on what you think is going on here. I'm using the absolute numbers from the mean CMIP5 ensemble, which I think is the correct thing to do. What do you (and Smith et al) mean by "model drift"?

1. **Klapper** at [05:35 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=7&t=370&&a=115#111202)

@KR #347:

"...We have OHC data of reasonable quality back to the 1960s"

I've looked at the quarterly/annual sampling maps for pre-Argo at various depths and I wouldn't agree that's true for 0-700 m depth and certainly not true for 0-2000 m. There's a reason Lyman & Johnson 2014 (and other stuides) don't calculate heat changes prior to 2004 for depths greater than 700 m; they are not very meaningful.

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1. **Klapper** at [05:37 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111203)

@Tom Curtis #345:

"...the modelled TOA energy imbalance lies within error (actually, withing 1.2 SDs) of the observed value."

It generally always does for these model-observation discrepancies, but then again the models are always on the hot side aren't they?

1. **Klapper** at [05:46 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111204)

@Tom Curtis #345:

"...the modelled TOA energy imbalance lies within error (actually, withing 1.2 SDs) of the observed value."

It generally always does for these model-observation discrepancies. However, if the model-observation discrepancies are always on the hot side that is more than an "emotive" argument don't you think?

1. **KR** at [05:47 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111206)

[Klapper](http://www.skepticalscience.com/argument.php?a=115&p=7#111202) - I've responded [on the appropriate thread](http://www.skepticalscience.com/argument.php?p=18&t=864&&a=15#111205) for this conversation.

1. **bozzza** at [11:30 AM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111215)

Iff we were to cut CO2 emissions in half tomorrow would we still go past 580ppm by 2100 due to possible outgassing of the ocean?

1. **Tom Curtis** at [13:24 PM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111219)

Klapper @348:

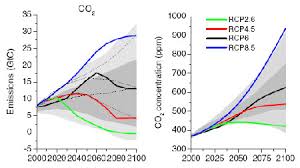
"You're ignoring my comment above in which I clearly stated the 0.5 W/m2 was the difference between OHC (Ocean Heat Content) and the TOA (net downward energy flux at the Top of the Atmosphere ) model output."

First, you were comparing the difference between model TOA energy imbalance and observed 0-2000 meter OHC.

Second, absolutely right I was ignoring that.  Just because you want to compare the model TOA energy imbalance with approximately 80% of the observed energy imbalance (ie, the 0-2000 meter rate of change in OHC) in no way makes that justified.  Nor does it justify you comparing model 2000-2015 model TOA energy imbalance with 2005-2010 TOA energy imbalance as you did @325.  You seem to have a penchant for strengthening your case by using inappropriate comparisons.  However, as you insist that I not use the appropriate comparison because you originally used the inappropriate comparison, I will notice it and call it what it is - ie, fraudulent argument.

1. **Tom Curtis** at [13:36 PM on 2 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111222)

bozza @354, even emissions at 10% of current rates would be sufficient to keep on increaseing atmospheric CO2 concentrations, and ergo prevent net ocean outgassing of CO2. The rate of increase of atmospheric CO2 would, however, slow to a standstill in that case - and slow substantially if we only halve emissions.  Having said that, the proportion of emissions retained in the atmosphere would not necessarily remain at the current 55%, and would decrease over time with increasing SST (Sea Surface Temperature) (assuming constant emissions).  It follows that while 2100 concentration would probably be below 580 ppmv, I cannot tell you how far.  The nearest I can do is show you the RCP 4.5 figures (second graph) as the nearest approximation (first graph).



1. **Tristan** at [00:30 AM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111518)

Apologies for this one folks. Bobl over at joannenova is adamant that he has been banned from sks for his truth-telling, and I told him I'd ask a question for him. A couple commentators now have a bee in their bonnet given I tried to address it myself, so here you have it:

*In 1850 the temperature was about 0.75 deg C lower than now, the CO2 was supposed to have been about 270PPM. Now it’s 400 PPM.*

*We know from Arhennius that deltaT = k ln(CO2-2/CO2-1)*

*So, therefore 0.75 = k ln(400/270) and therefore k=0.75/ln(400/270)*

*k = 1.91*

*So lets then calculate the warming for a doubling*

*DeltaT = 1.91 × ln 2 = 1.34 degrees per doubling between 1850 and 2014*

*Now the IPCC says that 50% of warming is probably coming from humans and 50 % is natural variation so if we assume that 50% of all the warming from 1850 to now is CO2 induced (which it is not, the bit from 1850 to 1950 is unlikely to be CO2related) at best we causing just 0.77 degrees of warming due to man’s gasses, and the other 0.77 degrees must be something else which won’t necessarily accumulate.*

*0.77 degrees per doubling implies feedback was negative over the period from 1850 to 2014.*

*Given CO2 warming over the last 130 PPM was at best 0.37 to 0.75 degrees and the implied climate sensitivity from that is therefore 0.77 to 1.35 degrees per doubling, therefore the magic 2 degree figure (noting that the IPCC says up to 2 degrees of warming will be positive for the human race) is likely 500 – 1000 years away from happening, why are we even worried about it?*

**Response:**

[DB] "*Bobl over at joannenova is adamant that he has been banned from sks for his truth-telling*"

There is only one SkS user with "bob" prefacing their user name that is banned from this venue and that is user "Bob Smith", who had his commenting privileges revoked for being a sock puppet of yet another SkS user.

**Bob Smith** at 18:47 PM on 18 December 2012

[*IPCC Draft Report Leaked, Shows Global Warming is NOT Due to the Sun*](http://www.skepticalscience.com/news.php?n=1776) *I am a retired Professional engineer, not a scientist but let me make a few comments: You have scared the governments into giving you the enormous amounts of their taxpayers’ money that you use to maintain your lavished lifestyle. For instance, the lead authors of this report will have their meetings on Tasmania Island, a place that is as far from everywhere as you can possibly get, with air fares in thousands dollars each and with huge CO2 footprint to match them while we, ordinary people, suppose to walk or bike to work. Last month there were 14,000 of you, including 7,000 environmental activists, on all inclusive holiday at the taxpayers’ expenses in Doha. And just the accommodation, air fare and meals for these activist cost some $50 million. And last year it was Rio and before that Durban and Cancun. CO2 and the resulting warming suppose to run out of control but you must be an organization with the largest CO2 footprint in the world. And money you spent has also enormous CO2 footprint for before you can spent it on your salary, reports grants and perks ,like travel, the taxpayers must generate good and services to make them. This is not how the people claiming that CO2 and warming is out of control ought to behave. You are also in a huge conflict of interest for unless you can keep the public scared of the warming your paycheques, careers and perks would be gone. And that applies to the authors as well as peer reviewers. And there is more.*

1. **michael sweet** at [02:09 AM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111520)

Tristan,

If Bobl claims that his estimate is "truth telling" it is easy to see why he has trouble at SkS.

Checking the [GiSS temperature records](http://data.giss.nasa.gov/gistemp/tabledata_v3/GLB.Ts+dSST.txt) I find that in 1880 the anamoly was -.38 degrees while 2014 was +.86 degrees (it is more accurate to do a least squares fit but Bobl did not say how he got his numbers).  I find that to be 1.24 degrees since 1880.  The records previous to that are incomplete and inacurate.  Bobl is probably using HADCRU which is well known to underestimate warming since it does not cover the entire globe.  Since this year is currently running .15 degrees above last year and there is an El Nino that will increase temperatures later this year it will not be surprising to see 1.4C globally this year. At .15/decade it will only be 40 years to the 2C disaster threshold.

Bobl knows that the current temperature is not in equilibrium  with the forcing.  He has left this amount out of his calculation.  Estimates range around .7C in the pipeline.  That makes 1.94 degrees for an estimated final temperature with current CO2 concentrations.  Using 1.24 degrees I get 3.18 degrees per doubling and using 1.94 I get 4.97 degrees per doubling (!!).  The IPCC estimates there is greater than 95% chance of 50% of warming being due  to humans with 106% the best estimate (Bobl knows that too).  The 3.18 must be multiplied by 1.06, not by .50.  That rounds the estimates to about 3.2 degrees per doubling for observed warming and 5 degrees including the warming in the pipeline.

The agreement is that above 2C is a disaster, not that below 2C could be good.  Warming is accelerating so I expect 2C to happen in my children's lifetime.

1. **michael sweet** at [02:19 AM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111521)

Tristan,

I used the Northern Hemishpere data instead of the global data (my link is to the correct data).  1880 was -.22 and 2014 was +.68.   That gives .90 observed and 1.6 including warming in the pipeline.  That is 2.3C per doubling or 4.1 incuding warming in the pipeline.  Multiplying by 1.06 gives 2.4 observed warming and 4.3C at equilibrium.

1. **MA Rodger** at [05:30 AM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111522)

Tristran @357.

I must say that JoannaNova comment thread is a classic. I think they could be sitting on a new direction for comedy. *"Exactly Tristan, where are the published figures on jet stream friction, where are the published figures on kinetic energy of global rainfall…. though you can calculate that one, it’s about 0.05 Watts per square meter, comprising about 10% of the imbalance energy."* Never one to shirk a challenge, if raindrops hit 20mph & average global rainfall 900mm, Bobl is only a triffling 5000% out!!

As for his question, if you use the forcings from [AR5 AII](https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexII_FINAL.pdf) Table 1.2 (which are a little higher than CO2 forcing alone), & the global numbers@359 (but assuming 0.86W/m2 imbalance) you get an ECS = 2.8ºC but most folk consider energy balance methods do underestimate ECS. The figure is also sensitive to negative forcing levels with their big error-bars.

1. **Tom Curtis** at [09:43 AM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111531)

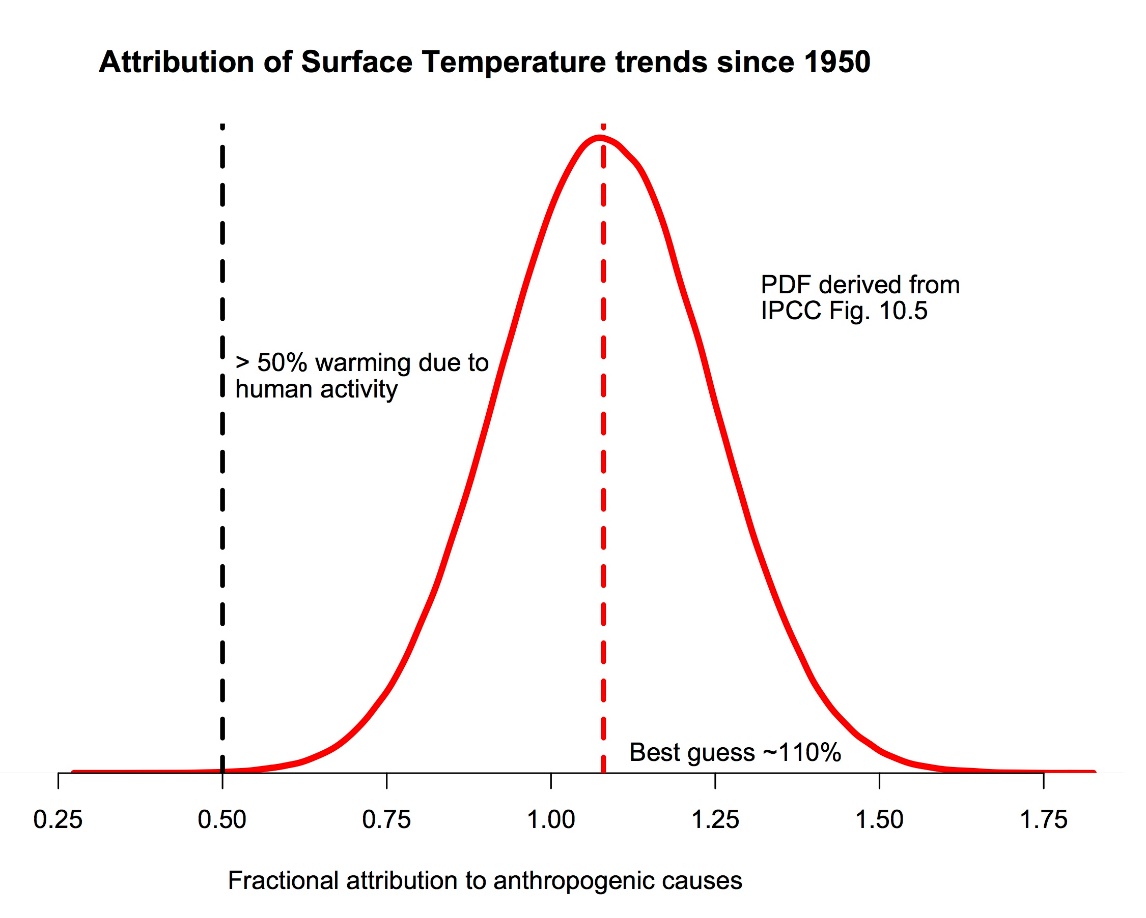
Bobl writes, "Now the IPCC says that 50% of warming is probably coming from humans and 50 % is natural variation ...".

What the IPCC actually wrote was that:

"More than half of the observed increase in global mean surface temperature (GMST) from 1951 to 2010 is very likely due to the observed anthropogenic increase in greenhouse gas (GHG) concentrations."

where "very likely" means "90-100%" likelihood.  In other words, what the IPCC claimed was that there is a less than 10% chance that only 50% or less of 1951-2010 warming was due to anthropogenic forcings.  That is sufficiently different, indeed contradictory of what Bobl claimed the IPCC wrote that *prima facie*, he is a bald faced liar.

Indeed, it is worse than that.  The IPCC also provided a figure with the mean and uncertainties of attribution.  This allows you to generate the Probability Density Function (PDF) of the AR5 attribution, [as was done by Real Climate](http://www.realclimate.org/index.php/archives/2014/08/ipcc-attribution-statements-redux-a-response-to-judith-curry/):



From this, in turn, it can be determined that the actual likelihood of less than 50% anthropogenic causes of warming since 1951 is 0.06%.  It follows that at best Bobl is calculating the lower bound of the 99.9% probability range of the "climate sensitivity".  To perform the calculation correctly (ignoring other errors), he should have used an attribution of 107.7% (the mean value of the PDF).  Correcting for this factor alone would more than double his "climate sensitivity" estimate.

It should be noted, of course, that the IPCC attribution statement only covers the period 1951-2010.  It cannot be arbitrarilly extended to cover periods back to 1900, 1880 or 1850.  Natural forcings were negative from 1850 to about 1910, strongly positive from then to 1940, and remained positive to about 1950, as they more than recouped the losses to 1910, and have been effectively neutral or slightly negative since then.  The result is that 70% is a better estimate than 108% for the anthropogenic contribution since 1900 (or 1880), but 100% is probably more accurate for the anthropogenic contribution since 1850.  These figures, of course, are highly uncertain and not particularly precise.  Sufficiently so that I consider estimating climate sensitivity from temperature differences between two dates with the first date prior to 1950 to be essentially a waste of time.  If you are going to make those estimates, you should greatly increase the data used  to counter the uncertainties.  You do this by fitting a Transient Climate Response (TCR) function to annual data [as Kevin Cowtan has done](http://www.ysbl.york.ac.uk/~cowtan/applets/nbox/nbox.html).  The result is a TCR around 2 C per doubling of CO2, with an Equilibrium Climate Sensitivity necessarilly greater than that.

1. **Tristan** at [13:42 PM on 18 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111543)

@DB, thanks for checking, those arguments definitely sound like ones he'd make, though I dont know if that's him.

@michaelsweet, thanks, can't blame a layperson for using hadcrut in this instance, and I'm waiting for his response on the as-yet-unrealised warming.

@MARodger, the best moment I've had recently was when someone told me that you couldn't use EVs for continuous random variables, and when I pointed him to a description of how you could he claimed "Queen's Gambit" and that he just was proving that I could spot a cherry pick. Which, I dunno, means he can accuse me of dishonesty in the future if I fail to agree with him that something is a cherry pick? Guess he got me.

@TomC, thanks, I actually posted that very graph before coming here, to which Bobl responded: *my math is pretty much indisputable. I expect if he did*[post it at Sks]*I’d not get one refutation, they’ll either pick an irrelevancy like Tristan did, or for example want to pick a higher figure for the warming from 1850*.

Every few months I go back, thinking, "maybe there'll be some people who respond in a reasonable manner", but the content is 40% rhetorical games, 30% slurs, 20% crazy,  and only 10% the sort of argument I'm looking for. And then you I moderated for...who knows. I was told narcissism. I guess for not showing enough deference.

1. **Tom Curtis** at [10:20 AM on 19 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111553)

Tristan @362, out of interest I just downloaded [the forcing data from the IPCC AR5](https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexII_FINAL.pdf).  From that I was able to determine the relative contributions of natural and anthropogenic components between certain dates and 2009 using five year running means:

1850 104.52%  
1880 102.34%  
1900 94.58%  
1950 109.72%

Note that the ratio of difference in forcing is not the same as contribution to difference in temperature.  That is because there is some internal variability in temperature, because volcanic temperature responses are not commensurate with instaneous volcanic forcings due to thermal inertia, and because earlier forcings will have more fully worked through the system than will have later forcings.  With these caveats, however, the relative contribution to change in forcing is a good first approximation to the relative contribution to change in temperature.

Allowing for the caveats, I believe the 1880 and 1900 figures significantly overstate the anthropogenic contribution.  In particular, the anthropogenic contribution to change in forcing falls to 57% in 1885 and to 76% in 1904.  Given the extent and intensity of volcanism that cause those falls, it would be foolish to assume a simple five year mean of the forcings captures the temperature impacts of that volcanism.  Further, there is good reason to believe there was a significant contribution from internal variability to the temperature increase from 1910-1940 which will be diluted but also relevant to the temperature increase to 2010.

Of course, Bobl is not entitled to these caveats.  In his calculation he ignores internal variablity (which of necessity cuts both ways), and by assuming TCR = ECS, he also ignores thermal inertia.  Given that, it would be inconsistent of him to not use the relative contribution to forcing increase as the relative contribution to temperatue gain.

1. **Tristan** at [12:00 PM on 19 May, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#111554)

Interesting, I would not have intuited that result at all!

bobl's difficulties in finding the sensisitivity to GHGs would be further compounded by the fact that you shouldn't be looking at the net antho effect anyway - as that ignores the negative anthro forcings.

It seems that you can't determine the ECS (or it's more relevant brother, TCR) from the recent temp record without first accepting the validity of quite a number of papers, something that bobl would never admit to doing in the first place. He's kinda stuck.

1. **psagar** at [08:55 AM on 26 October, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#114233)

The wikipedia article on Climate Sensitivity states that the transient climate sensitivity is lower than equilibrium climate sensitivity which I do not quite understand. By definition, climate sensitivity is the change in surface temperature per unit change in radiative forcing. As I understand, climate sensitivity can be obtained both from models and observations. Lets talk about models' climate sensitivity. In models, the ocean heat uptake is not quite well represented in transient simulations while in long term simulations (assuming that model reaches equilibrium), ocean heat uptake may be well represented. So in long term model simulations, one would expect that the surface temperature change per unit change in radiative forcing would be lower because the heat would be well mixed in the ocean as compared to transient simulations. Am I missing something? Could anyone comment on this?

1. **Tom Curtis** at [12:41 PM on 26 October, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#114234)

psagar @365, the IR flux from the top of the atmosphere is a function of Global Mean Surface Temperature (GMST), not of how much heat is stored at the Earth's surface.  Therefore, as a forcing is an imbalance in the Top Of Atmosphere (TOA) energy flux, to restore equilibrium with a change of forcing requires a change of GMST.  No amount of change in Ocean Heat Content (OHC) by itself will have any effect on that.

Of course, change in heat content is related to change in temperature by the heat capacity.  Therefore, increasing the OHC will also increase GMST.  That increase, however, will continue until the TOA imbalance is eliminated, which is to say, until the change in GMST causes a change in OLR sufficient to compensate for the original forcing and any consequent changes as a result of feedback.  The difference the effective heat capacity of the system makes is that the larger the capacity, the more heat must be pumped into the ocean for the same rise in GMST.

So, turning to the relationship between Transient Climate Response (TCR) and Equilibrium Climate Sensitivity (ECS).  Technically the TCR is the temperature after 70 years of increasing CO2 concentration by 1% per annum (ie, at the time the CO2 concentration reaches twice the initial value).  The ECS is the temperature after the CO2 is doubled and the temperature stops changing (ignoring slow feedbacks).  Typically that is about 200 years after the CO2 reaches 2 times its initial concentration, although it varies from model to model depending on the effective heat capacity of the Earth's surface in the model.  The smaller the effective heat capacity, the more rapidly will the model reach equilibrium, and the closer TCRwill be to ECS.

In the real world, the TCR is a close approximation to the immediate temperature response to a slow forcing change.  Thus we can treat the TCR is the current mean decadal temperaure divided by the current forcing and multiplied by 3.7 W/m^2 (ie, the forcing for doubled CO2).  However, as the TOA energy imbalance currently is about 0.8 W/m^2, we clearly are not yet at equilibrium even though we are, by the approximation above, at the TCR for the current forcing.  As closing that imbalance requires increasing GMST, it follows that ECS > TCR in real life, and not just in the models.  As an aside, ECS cannot be less than TCR by virtue of the definitions of the terms, and will only equal TCR if the effective heat capacity of the Earth's surface closely approximates to zero.

1. **psagar** at [02:08 AM on 27 October, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#114236)

Tom Curtis @366, Thank you. "The smaller the effective heat capacity, the more rapidly will the model reach equilibrium, and the closer TCR will be to ECS." I agree that the the smaller the effective heat capacity, the more rapidly will the model reach equilibrium, but I do not understand how that lead to conclude "and the closer TCR will be to ECS".

I like the definition of climate sensitivity as 'change in surface temperature per unit change in radiative forcing'. But the change in surface temperature would also cause a change in radiative forcing. So, we cannot say with certainty that ECS is higher or lower than TCS.

I clearly see that the change in surface temperature and TOA radiative forcing simulated by the model depends upon the model complexity, for example, how the ocean circulations are represented. Assuming a constant external forcing, different models would show different surface temperature change and so the climate sensitivity of different models would also be different. So I still have a thinking that ECS could be higher or lower than the TCS depending upon the complexity of the model.

Talking about real world or observations, we cannot still be certain that the TCS would be lower than ECS. For example, say we measured temperature change and radiative forcing for a decade and get a transient climate sensitivity. Now lets calculate the same for 100 years (assuming that we have the data). How can we say with certainty that one would be higher than another?

**Response:**

[JH] Please see the SkS Glossary for the commonly accepted scientific definitions of TCS and ECS.

1. **Tom Curtis** at [12:18 PM on 27 October, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#114241)

psagar @367, first, Forcing (or Radiative Forcing) is given the following [definition by the IPCC](http://ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexIII_FINAL.pdf):

"Radiative forcing Radiative forcing is the change in the net, downward minus upward, radiative flux (expressed in W m–2) at the tropopause or top of atmosphere due to a change in an external driver of climate change, such as, for example, a change in the concentration of carbon dioxide or the output of the Sun."

(My emphasis)

I have quoted the full entry in the glossary below, as it contains relevant technical information plus some comments on idiosyncracies of usage.

The important point for this discussion is that radiative forcings are only those changes in TOA energy flux due to external drivers, ie, those not effected by climate variables such as (particularly) temperture and (also) precipitation, wind velocity etc; at least not on the time scale of interest.  So, while a change in CO2concentration will cause a change in radiative forcing, and changes in temperature will cause changes in TOA energy flux, changes in temperature do not cause changes in radiative forcing (by definition of radiative forcing).  While this is a just a matter of definition, in my experience those who ignore the clarity given by distinguishing between radiative forcings and changes in TOA energy flux in response to feedbacks always end up making mistakes when thinking about issues of climate change.

 Looking at this in more detail, we have:

ΔQ = ΔF - α ΔT    (1)

where ΔQ is the change in net downward TOA energy flux, ΔF is the change in forcing, ie, the change in net downward TOA energy flux that is independent of climate states, ΔT is the change in global means surface temperature, and  α is the climate feedback parameter.  The climate feedback parameter is also defined in the IPCC glossary, and equation (1) is just an algebraic transformation of the mathematical definition of the climate sensitivity parameter given there.  (Note, however, that the IPCC uses ΔQ for forcing, and ΔF for energy flux.  I use the opposite values as it is more intuitive, and also the common practise among some climate scientists.)   The units for α is in Watts m-2 oC-1, and it is the converstion factor between GMST and change in net upward TOA energy flux.

From (1), simple algebra tells us that when the GMST is at equilibrium, ie, ΔQ = 0, then

ΔF = α ΔT    (2)

Equation (2) just tells us that ΔF and α ΔT have opposite intrinsic directions, ie, while ΔF reffers to net downward flux, α ΔT refers to net upward flux (as emphasized above).

Now, by definition, if ΔT equals the Transient Response to a given forcing, ΔF, then ΔF - α ΔTCR does not equal zero.  If it did, the TCR would be the also be the Equilibrium Climate Response.  Nor can it be greater than the ECS, for (with a positive forcing) if it were ΔF - α ΔTCR would be negative.  It would follow that at some lower temperature the TOA heat flux (ΔQ) would have been equal to zero, at which point the GMST would have stopped changing, thereby preventing the temperature rising to the greater value.  It follows that TCR < ECS, more or less of necessity.

So, while it is possible to construct unrealistic scenarios where TCR is approximately equal to ECS, it is literally not possible to construct one where TCR > ECS.  At least, not without a fantasy physics.

**Glossary Entry**

"Radiative forcing Radiative forcing is the change in the net, downward minus upward, radiative flux (expressed in W m–2) at the tropopause or top of atmosphere due to a change in an external driver of climate change, such as, for example, a change in the concentration of carbon dioxide or the output of the Sun. Sometimes internal drivers are still treated as forcings even though they result from the alteration in climate, for example aerosol or greenhouse gas changes in paleoclimates. The traditional radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium. Radiative forcing is called instantaneous if no change in stratospheric temperature is accounted for. The radiative forcing once rapid adjustments are accounted for is termed the effective radiative forcing. For the purposes of this report, radiative forcing is further defined as the change relative to the year 1750 and, unless otherwise noted, refers to a global and annual average value.  Radiative forcing is not to be confused with cloud radiative forcing, which describes an unrelated measure of the impact of clouds on the radiative flux at the top of the atmosphere."

1. **Glenn Tamblyn** at [14:00 PM on 27 October, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#114242)

psagar  
  
Some points to remember. Climate response (and thus climate sensitivity) isn't just about radiative balance, heat capacity etc. Another key factor is Albedo - how reflective the Earth is.

If the earth reflects the same percentage of sunlight then climate change is about radiation, heat capacity etc.

However if the Albedo is changed by climate change this in turn changes the energy balance and adds other climate change. There may be changes in cloud cover. Far more certainly there will be changes in surface reflectivity; changes in snow and ice cover, open water area, regions of desert, vegetation patterns etc. All these impact reflectivity. Warming certainly reduces snow & ice cover for example.

Importantly, many of these changes take long time periods to occur. Ice sheetchanges particularly take centuries to unfold.

1. **psagar** at [15:40 PM on 22 December, 2015](http://www.skepticalscience.com/argument.php?p=8&t=370&&a=115#115157)

Tom Curtis @368, thanks for the illustration. Sorry for responding late but earlier I could not completely follow your comment. I am back again to this discussion as the semester is over.

I follow and agree until your statement "Nor can it be greater than the ECS, for (with a positive forcing) if it were ΔF - α ΔTCR would be negative." I do not understand what you are saying with this statement. I also do not understand the statements that follow. How does it then establish that TCR < ECS? Could you please rephrase these explanations a bit so that I can understand.

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[There are a total of 8 pages worth of such comments. They seem generally civil and productive in tone. -FNC]