

Findings about Chapter 8

John McLean

Jan 2019

1. There is NO empirical evidence in chapter 8 to support the notion that trace amounts of GHGs have caused warming since 1950.
2. The chapter asserts "*The Industrial Era RF for CO₂ alone is 1.82 (1.63 to 2.01) W m⁻² ...*" (Executive summary) and later "*Using the formula from Table 3 of Myhre et al. (1998), and see Supplementary Material Table 8.SM.1, the CO₂ RF (as defined in Section 8.1) from 1750 to 2011 is 1.82 (1.63 to 2.01) W m⁻²...*" (section 8.3.2.1) but provides no evidence to support the accuracy of such statements. (Not only does it provide no evidence but it cites a single paper, just as it did with the infamous "hockey-stick" temperature graph.)
3. Chapter 8 relies on models to estimate the influence of various greenhouse gases but there is nothing to indicate that any of those models are accurate. There is, for example, no proof that they accurately reflect real world situations. On top of that, the output of models is not evidence *per se* but merely what, according to the algorithms in the model, would happen given certain input.
4. The chapter cites the corresponding chapter of AR4 (chapter 2) multiple times but that chapter of AR4 also presents no evidence that manmade GHGs have caused warming.
5. The chapter ignores other paths by which the Earth's surface warms cools and any changes that might occur in those paths over time. There is a weak attempt to dismiss just a few of the many plausible alternative hypotheses, on top of which there is no reason why warming could not have multiple causes over time. For example, Myhre (2001), which is cited in the corresponding chapter of AR4, suggests that changes anthropogenic particle emissions might have caused the decline in radiative forcing in the 1945-1970 period but no AR5 fails to consider that ongoing reductions in air pollution are continuing to reduce particle emissions.
6. The chapter is a continuation of the IPCC's "We don't know what else could be causing the warming so it must be anthropogenic GHGs". This would only be a reasonable argument if the IPCC could demonstrate that every possible climate forcing is very well understood, which it does not and cannot.
7. Several papers cited by the chapter use climate models, many refer to historical temperature patterns and some appear to do both. There is no obvious reason to consider those climate models to be accurate (see IPCC AR5 chapter 9, especially text box 9.2) and no reason to think that the temperature record is accurate (see McLean, 2018).
8. If the climate models used in chapter 9 incorporate the findings of chapter 8 then, given that AR5 chapter 9 and the WGI SPM show the models to be flawed and even note as one possible reason "an overestimate of the response to increasing greenhouse gas", then there is little confidence in the claims made in chapter 8.

Chapter 8 Review

Geoff Duffy

4 Feb 2019

COMMENTS ON AR5 CHAPTER 8: 'ANTHROPOGENIC and NATURAL RADIATIVE FORCING'

The AR5 report contains some excellent and valuable information, data, concepts, analysis, and insights on the topic. However, it is highly focussed on radiation only thus radiation forcings, and a lot of investigations are centred on various chemicals that have minuscule concentrations in the atmosphere.

Truly radiation is the key INITIATOR in all atmospheric processes, but the flow-on effects of OTHER thermal driving forces, and energy transfer by convection mixing in the atmosphere and oceans, macro-transport of 'packets of energy' by differences in pressure, density and mass concentration, the simultaneous heat-mass transfer mechanism (humidification), as well as the enormous energy transfer processes of evaporation and condensation (phase change), simply MUST be considered in assessing the TOTAL picture. If not, the overview and assignment of causes must be deficient or even wrong!

The effect of the individual concentration contributions of each chemical can have significance, the RANKING of concentration DOMINANCE must be overruled or carefully considered. The effect of EACH gas, not just on radiation per se, but on specific wavelengths of radiation, MUST control the analysis.

These issues are mostly lacking in this Report Chapter 8, and clearly they should be addressed FIRST!

The 3rd highest concentration gas in the atmosphere (after nitrogen and oxygen) is water vapour, and this totally dominates incoming solar radiation with the potential to interact with 50% of solar radiation compared with say carbon dioxide's potential of 7% (*5 strong bands compared to only 2 with carbon dioxide*). It is even worse with the long-wave re-radiation from earth (3 μm to 70 μm), with water vapour affecting about 85% of the range compared with only 7% with carbon dioxide (area under the curve analysis in slides 5 and 6).

So while it is commendable that all other factors in the report should be considered, there are three important factors that should have been addressed before the estimates and proposals made in Chapter 8 of AR5 were made. These have not been addressed in any significant way in the report even though they are extremely significant to all the arguments expressed in it.

Some KEY Factors ... **A Summary** >>>

1. There is a danger of addressing and over-emphasising radiation only while disregarding *other* highly effective energy transfer atmospheric mechanisms that in some cases overrule or interact with the radiation mechanisms (evaporation, humidification, condensation, precipitation), convective mixing (winds, storms, ocean currents and turbulence and far more).
2. The effect of RELATIVE concentration of a particular gas should have been the major consideration (we cannot just refer to the gas without highlighting the significance of the magnitude of its atmospheric concentration. For example, water vapour can be 5 to 100+ times higher in concentration than carbon dioxide (*that is 50 to over 1,000 times higher than that of the man-made contribution of carbon dioxide*) and this affects ALL the relative radiative forcing contribution calculations and arguments.
3. The electromagnetic spectrum and how EACH gas is individually affected (see Slides 5 and 6). As mentioned already, in *Solar Radiation* carbon dioxide only has 2 narrow bands (*one competes with water vapour anyway*) and interacts with ONLY 9% of the total incoming solar radiation, whereas water vapour has 7, actually 5 strong bands, and interacts with about 50% of all the incoming solar radiation. It is even worse for re-radiation from earth! Carbon dioxide just has two more bands which can interact with only about 7%, compared to water vapour which covers 86% of the entire long-wave span of re-radiation from 3 μ m to 70 μ m. Clearly the research data and published evidence alone prove that carbon dioxide is a minor player, and as it is over 220 times greater than say methane, makes methane (as well as nitrous oxide) inconsequential.
4. Rapidity of response rate. Long-term anthropogenic versus short-term natural: Changes in atmospheric water vapour concentration can increase over very small time periods (even in minutes or less than an hour) compared to the same effects for ALL the carbon dioxide increase, which is over 100 years. The topic of humidification is totally missing in this report, yet it is a VITALLY important factor in the competitive mechanisms and Weather Change analysis.

* Actually 2 here, not 1 ... BUT we MUST add a third: 1 more evaporation

Water vapour behaves differently from CO₂ in one fundamental way: it can condense and precipitate. When air with high humidity cools, some of the vapour condenses into water droplets or ice particles and precipitates. The typical residence time of water vapour in the atmosphere is ten days. The flux of water vapour into the atmosphere from anthropogenic sources is considerably less than from 'natural' evaporation. Therefore, it has a negligible impact on overall concentrations, and does not contribute significantly to the long-term greenhouse effect. This is the main reason why tropospheric water vapour (typically below 10 km altitude) is not considered to be an anthropogenic gas contributing to radiative forcing.

**** EXTRA** water from anthropogenic-only sources is indeed minuscule: agreed!
However, **RAPID natural** water vapour concentration changes are enormous as observed by the rapid formation, aggregation and structural changes in CLOUDS (*65 to 70% of the planet is covered by clouds at any time*). For this to happen the humidity variations must be vast, both horizontally and vertically: and **water vapour is the No. 3 gas in the atmosphere**.

In stark contrast, number 5 atmospheric gas CO₂ at a much lower concentration (0.04% atmosphere) takes a year to increase by 0.0001% to 0.0401% (CO₂ increases about 1 ppm/year). **Water vapour can increase hundreds of parts per million in minutes or hours!** It is dominant. It adapts to the smallest local temperature differences! The changes are **NATURAL** and **RAPID** and are far, far larger and faster and more effective than the small and very slow changes in CO₂.

[CLOUDS CAN FILL A VISUAL SKY 20km x 30km x 100m **IN UNDER AN HOUR: >20,000 tonnes water condensed**]

EXAMPLE:

If the temperature is constant at 15C, and the **Relative Humidity goes up from 60% to say 65%**, the **moisture in the air goes up** from 6,420 ppm to 6,960 ppm .. OR .. **540 ppm which is more than the 100 year increase in TOTAL CO₂, with NO temperature change**. This can occur in **less than a few minutes!!** [If temperature increases from 14 to 15C at the SAME Relative Humidity of say 75%, the water vapour CHANGE goes from 7,540 to 8,030 ppm ..and INCREASE of 490 ppm. This is FAR MORE than 100 years of total CO₂ increase (120 ppm actual increase in CO₂). A natural phenomenon! This is the biggest single atmospheric adaption factor and **TOTALLY MISSING** in this Report.

THIS UNCLEAR and CONFUSING STATEMENT page 666 DAMAGES THE ENTIRE VAULE of the REPORT

Therefore, it has a negligible impact on overall concentrations, and does not contribute significantly to the long-term greenhouse effect. This is the main reason why tropospheric water vapour (typically below 10 km altitude) is not considered to be an anthropogenic gas contributing to radiative forcing.

>> BUT WATER VAPOUR MUST BE SEEN AS THE MAJOR IN RADIATIVE FORCING

The statement about that water on page 666:

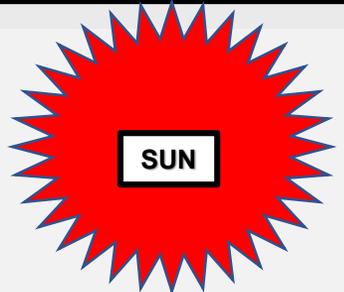
'water vapour ...has negligible impact on overall concentrations, and does not contribute to the long-term greenhouse effect' is not only totally misleading, it is indeed totally wrong.

Sure it is NOT the man-made (ANTHROPOGENIC) contribution, but the driving forces dominating in the **NATURAL**, rapid, and large changes in the Number 1 greenhouse gas water vapour, which totally swamp all others as outlined in the Report AR5. This should have been highlighted and a MAJOR point in the REPORT.

ONE MUST CONCLUDE FROM TYPICAL RAW DATA THAT RAPID WATER VAPOUR-CHANGES ALONE FAR, FAR OUTWEIGH THE SMALL 100 YEAR CO₂ CONCENTRATION CHANGES (120PPM INCREASE), WHILE THE SMALL ANTHROPOGENIC CHANGES AMOUNT IS ONLY <10 ppm / 100YEARS
Water vapour is self-correcting, self-moderating, self-buffering, self-compensating!

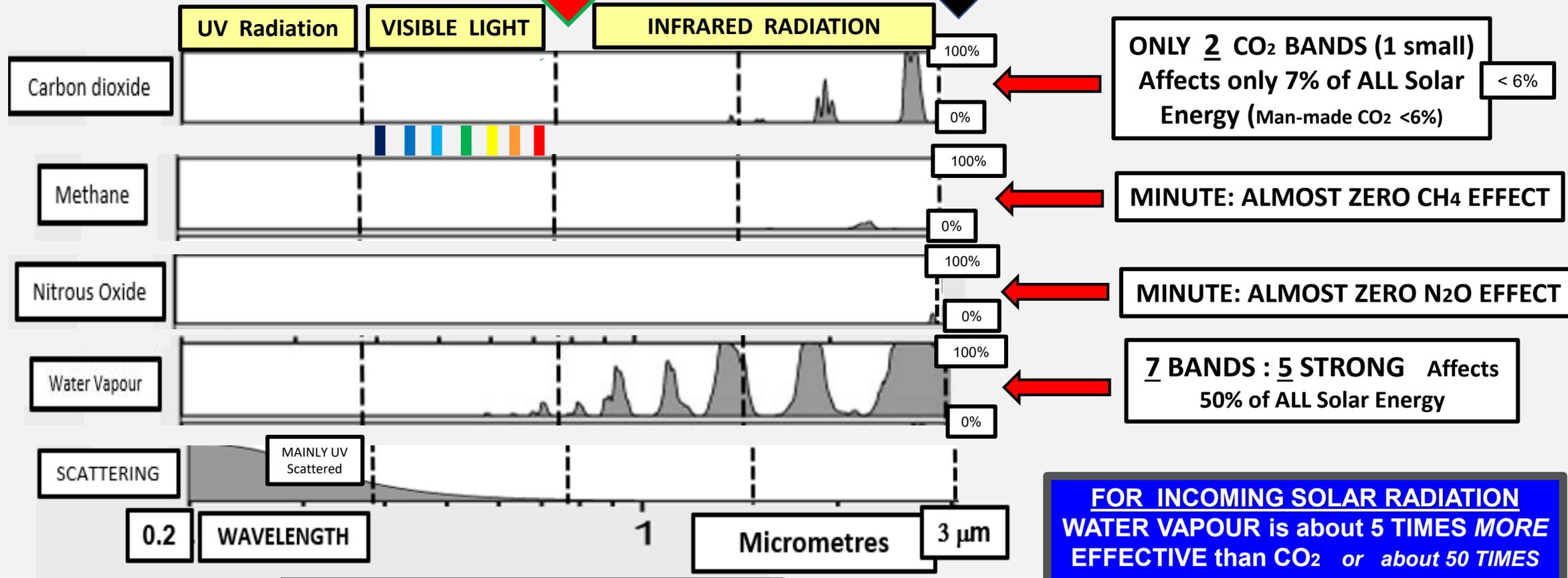
SOLAR RADIATION INTO EARTH'S ATMOSPHERE

ONLY 56% of ALL SOLAR RADIANT ENERGY ACTUALLY REACHES EARTH



PERCENTAGE SOLAR ENERGY ABSORBED IN EARTH'S ATMOSPHERE

Please use the 'Presentation Icon' at the bottom of the Screen and keep clicking

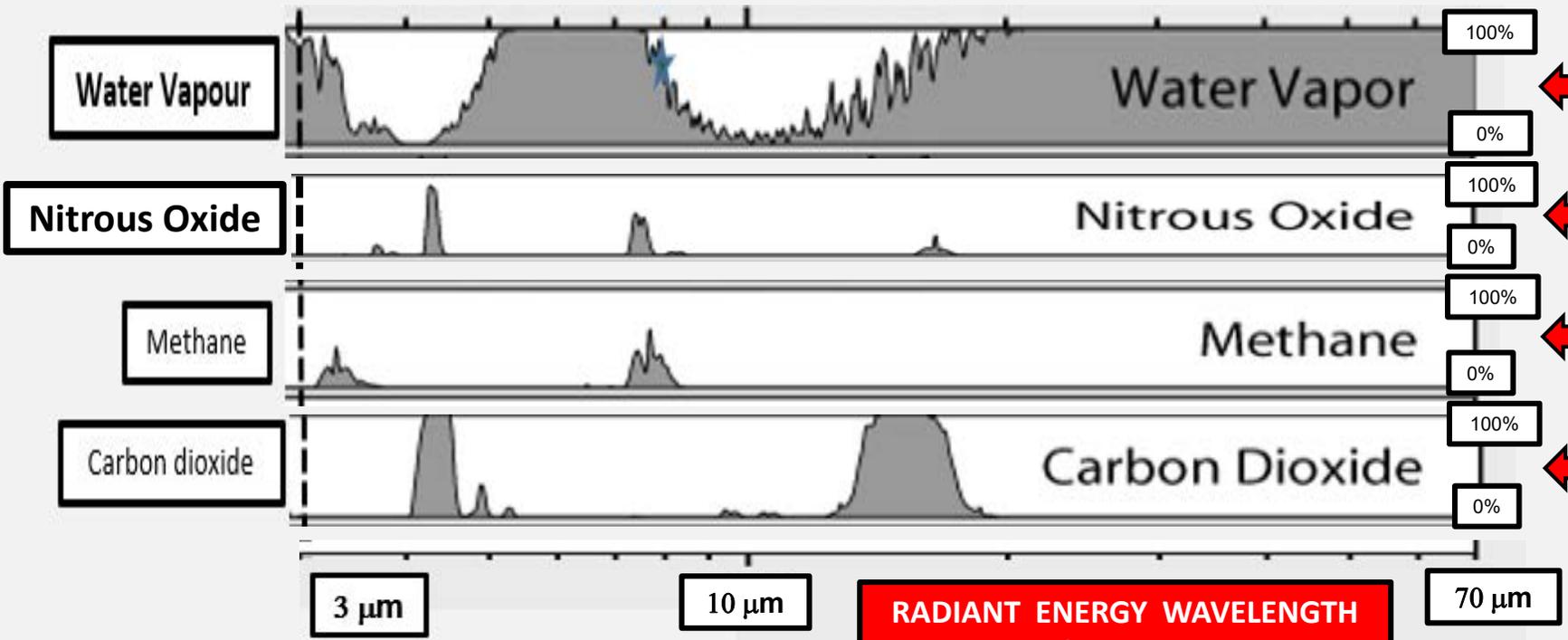


RADIANT ENERGY WAVELENGTH

FOR INCOMING SOLAR RADIATION WATER VAPOUR is about 5 TIMES MORE EFFECTIVE than CO2 or about 50 TIMES MORE EFFECTIVE than MAN-MADE CO2 (Area under the curve comparison)

RE-RADIATION BACK FROM EARTH TO SPACE

PERCENTAGE RADIANT ENERGY ABSORBED



DOMINANT COVERS >85% ENTIRE SPAN
5 to 100 times the concentration of CO₂

ONLY 2 N₂O BANDS – Minute concentration: 7/10,000 of CO₂

ONLY 2 SMALL CH₄ BANDS Minute concentration 4/1,000 of CO₂

ONLY 2 MORE CO₂ BANDS Affects only 7% of Earth re-radiation Man-Made CO₂ is less than 6% CO₂

FROM EARTH

FOR RADIATION BACK FROM EARTH WATER VAPOUR is >12 TIMES MORE EFFECTIVE than CO₂ or >120 TIMES MORE EFFECTIVE than MAN-MADE CO₂ (Area under the curve comparison)

EARTH - 60C to +40C



RADIANT ENERGY ALL Long-wave Infrared Energy

THE EFFECT of THE INCREASE in ATMOSPHERIC WATER VAPOUR DUE TO AN ALLEGED ONE DEGREE INCREASE IN TEMPERATURE IS FAR GREATER THAN THE EFFECT of AN INCREASE IN CARBON DIOXIDE over 120 YEARS

ASSUME:

WORLDWIDE TEMPERATURE 1900: 14°C	Carbon Dioxide level: 285 ppm
WORLDWIDE TEMPERATURE 2018: 15°C	Carbon Dioxide level: 405 ppm
ALLEGED TEMPERATURE <u>RISE</u> 1900 - 2018: 1°C	Carbon Dioxide <u>RISE</u> : 120 ppm

**WHY HUMIDITY CHANGES
RULE in WEATHER and
CLIMATE CHANGE !!**

FOR A MEAN TEMPERATURE RISE of 1°C in 120 YEARS

60% Relative Humidity @ 14°C: 6,030 ppm

60% Relative Humidity @ 15°C: 6,420 ppm

WATER VAPOUR INCREASE: 390 ppm

CO₂ INCREASE = 120 ppm

CONCLUSION: A 1°C increase in 120 years produces FAR MORE EXTRA water vapour than the 120 ppm increase CO₂ in 120 years

FOR NO TEMPERATURE RISE: 60% RH >> 62% RH >> 65% Relative Humidity

Relative HUMIDTY INCREASE ONLY

60% Relative Humidity @ 15°C: 6,420 ppm

62% Relative Humidity @ 15°C: 6,630 ppm **INCREASE 2% = 210 ppm** [60 TO 62% RH]

65% Relative Humidity @ 15°C: 6,960 ppm **INCREASE 3% = 330 ppm** [62 TO 65% RH]

INCREASE 5% = 540 ppm [60 TO 65% RH]

A 2% Relative Humidity rise in with NO temperature rise is greater than the 120ppm rise in Carbon Dioxide in 120 years.

Of course less than 12 ppm CO₂ per 100 years is man-made!!

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Water Vapour is 5 to 100 times higher in concentration than carbon dioxide (50 to 1,000 times higher in concentration than MAN-MADE carbon dioxide), over 5 times more effective in absorbing incoming solar electromagnetic energy, and 12 times more effective in absorbing re-radiated electromagnetic energy back from Planet Earth.

ANONYMOUS

Feb 1 2019

1. The IPCC reports are reviews of supposedly published, peer-reviewed science, and not scientific studies in their own right. There is an expectation that the authors of the reviews do not highlight their own research, but I note that in Chapter 8 there is in my opinion an unacceptably high rate of self-citation by the various authors and review authors.
2. Chapter 8 is not intended to attribute the cause of climate change, that is the purpose of Chapter 10. Chapter 8 considers only the radiative forcing component of the climate system, and assumes the Chapter 10 interpretation, that only the GHG component RF changes are sufficiently large to account for historical climate change (since 1950). However, Chapter 10 considers only a subset of radiative forcings and relies on “expert judgement” and models to arrive at its conclusion.
3. I expect the evidence to be available as paper(s) A, that demonstrate an empirical causal link between GHG forcing and observed climate response, and this is supported by paper(s) B, that have replicated and validated the original work. This is completely absent in Chapter 8. Chapter 10 does attempt to do this, but relies on climate models and expert judgement and not empirical studies. Rather surprisingly, given the acknowledged uncertainties and lack of consistency in model results (what I, as a numerical modeller, would call a lack of verification and validation), the authors claim high confidence in a causal link. This is not rigorous science, but appears an attempt to justify a pre-ordained outcome.

So, in short, consistent with the SAR report I was involved in, there is no evidence presented in Chapter 8 to support concerns of a climate crisis.

ANONYMOUS

John Nicol
1 Feb 2019

The real weakness in the global warming case is the stupid use of the non-material model, which they always quote, showing that the earth with no atmospheric CO₂ has a temperature of 254.9 K. This of course requires a further 33 K to reach the known average temperature of the earth of 288 K, glibly explained as about 12 K from CO₂ plus a feedback of 21 K enhancement from the extra water vapour. Quite bizarre really. No acknowledgement of the thermal capacity of the solid ground and oceans which provide a significant ballast, nor of the atmosphere itself of O₂ and N₂ which are non-radiative and while of lower thermal capacitance than the ground and oceans, do not have any means of radiative cooling except through the greenhouse gases and aerosols.

Another huge error exists in the assumption that the earth has an albedo of 0.3 but from which the complementary emissivity – reflection from the base of clouds and similar scattering from aerosols, MUST provide an emissivity of similar magnitude – a representation of a VERY BASIC law of physics that emissivity must equal absorptivity. The wavelengths are different but are actually in the direction of lower IR emissivity than visible radiation and hence lower than the 0.3 of the albedo. From this, the temperature of the earth MUST actually be that from a radiation field of 1368 Wm², NOT the 957.3 which is assumed in the silly model used to justify the greenhouse effect and for some reason accepted (quite incorrectly from the point of view of the physics) by most people considering global warming, even very serious sceptics. (Many sceptics accept the 33 K increase from CO₂ and water vapour, and base their arguments on the lack of evidence of an increase in warming from increased CO₂).

I would also point out that the comparison made by the IPCC for their key argument uses the “Effective Emission Temperature” (254.9 K) as defined by them in TAR and AR4 for comparison with the Earth’s linear average temperature of about 288 K. The actual linear average for their model is the very striking and obviously impossible 144 K, but never mind that small feature. They never mention this average temperature of course, as it would be too embarrassing, I believe. Surely CO₂ could not provide the required additional 144 K of warming and even the IPCC would see the ridiculous side of that.

2 Feb 2019

I would point to two major problems with the IPCC models, which sadly are the only source of evidence they provide and which they claim represent “scientific evidence.” Real scientific evidence only ever comes from logical and almost unchallengeable theory and from experimental measurements. In both of these areas the IPCC and followers fail completely.

1. The science: It is obvious that the IPCC do not follow any logically structured scientific theory or material. Otherwise they could send you their internal reports or publications (peer reviewed, of course) which set out this theory. My own experience

with the CSIRO showed they could not provide one single document off their office shelf demonstrating just how carbon dioxide operates in the atmosphere.

Further to that, none of the IPCC reports, to my knowledge, sets out any real scientific argument in support of their assumptions. Everything they claim is couched in the context of probabilities, not results.

In addition, for the last 12 or 15 years, none of the 122 or so models promoted in the IPCC reports has provided values for the global temperatures which coincided with the results of measurements. No errors are ever appended to their data from the models when it is perfectly obvious that when all 122 models give different values for the projected global temperature at least 121 must be in error by at least the amount by which their value differs from the (unknown) correct value. This error therefore covers the spread of values (from about 1.5 to 4.5 °C I think) for the climate sensitivity which represents the breadth of their results. (Thus if one wishes to nit-pick, the error in the lowest result obtained (1.5 °C) extends to a point below it which actually allows cooling to be a distinct possibility of their calculations down to a value of -3 °C for the climate sensitivity.)

AR4, I think in section 8.1.2.2, states unequivocally that the models must be able to be verified by “hindcasting” — reproducing a known past climate. It was stated that, in order to have confidence in the model results, this testing was “absolutely essential”, which went without saying. Come 2013/14, AR5 in a similar section states equally unequivocally that none of the models – not one – could pass their verification test. At which they announced, “we are therefore considering “ranking” the models.”

It may be worthwhile uncovering these statements if possible. I have copies somewhere but may have difficulty in finding them now, and unfortunately I have found in returning to the reports, some of these sections are either changed or removed. It may not be helpful but would be very interesting to get NASA or NOAA comments on these issues. I believe that it may be more rewarding to write to HADCRU as from my experience I have found them to be very helpful – in describing in great detail for instance, just how the annual anomalies are determined. (This was a question I put to all of the known climate units people in Australia and not one could answer the question.

Peter Ridd
1 Feb 2019

Chapter 8 seems to be just evidence for a change in the radiative forcing due to extra CO₂, and other influences. I am sure much of it is solid but it misses the question, which is: “Does this cause a significant warming?”

Given the various feedbacks associated with clouds and the water cycle in general, and the fact that these are very poorly understood, it is a long way from conclusive proof of anything except, maybe, a small perturbation in the radiative forcing.

At risk of going over ground that we have all seen before, in the end, they rely on two things for their evidence.

(1) The models' reliability. This is doubtful for reasons we all know but the top of my list are (a) the Russian model seems to have been tweaked to get a different result — it uses the same physics, (b) failure of the predictions for the last 20 years, (c) we do not understand the physical processes well enough (especially with cloud and water cycle physics).

(2) The historical and geological evidence apparently indicating that we are hotter than the past and warming faster. This seems to fail at almost every level.

Peter

The IPCC do not do original research and they don't do forecasts. What little original research they use is limited by the definition of climate change they use. My guess it is less than 5% of the research and data available.

In the first IPCC Report in 1990 they did some forecasts but they were so abysmally wrong that it was unacceptable to their new high-profile political approach to the topic. Instead, to broaden the target and possibly hit it a glancing blow they created three scenarios, low, medium and high, and did projections.

Unfortunately for them even these are wrong. From the part of the world I come from they say they couldn't hit a barndoor with a horse's ass.

They do not produce any empirical evidence of human-caused global warming. I convinced Malcolm Roberts to ask the Australian people (CSIRO) for empirical evidence as he did in his maiden speech in the Australian Senate and all he got was IPCC rubbish.

When they direct you to Chapter 8 they are effectively telling you that the output of their computer models is empirical evidence. What is really pathetic is that most of the people directly or indirectly involved don't even know the difference.

Part of this stems from the practice of creating a small model to generate 'data' for one small part of the global system then using it as 'real' data in the larger model. Don't forget these are the same people who argue that the weather at one station is representative of the entire area within a 1200 km radius.

It is the same as fake news and gets so you can't distinguish anything any more. My estimate is that less than one per cent of everything in the models is based on real data.

Tim Ball
5 March 2019

Dr Tom Sheahen

1 Feb 2019

When you look at the numbers within the error brackets (e.g., mean value = 0.5 ± 0.3) in the Chapter 8 Executive Summary, it turns out that they're not sure about very much at all. Here's a key sentence (early on page 2):

The large uncertainty in aerosol ERF is the dominant contributor to overall net Industrial Era forcing uncertainty.

ERF means “effective radiative forcing.” In the sentences adjacent to that one, the aerosol-error-brackets turn out to be huge. Within the Executive Summary, they frequently use the phrase “limitations and inconsistencies.”

At the outset of the Executive Summary, they introduce the notation “WMGHG” to refer to the “well-mixed greenhouse gases.” This **excludes H₂O**, because H₂O isn't “well mixed,” but occurs in clumps called “clouds.” They make mention of the minor things like CH₄ and N₂O and even give some numbers about fluorocarbons (Freon), but hardly ever mention H₂O. The one instance where H₂O gets a mention is in the stratosphere, where H₂O is produced (at a concentration level of about 4 ppm) by the oxidation of CH₄ – in that case, the H₂O is “well mixed,” because the CH₄ was well mixed in the first place. But throughout, they never mention the role of H₂O in the troposphere.

As you may recall from way back when (AR1, but even in the Charney report of 1979, I think), H₂O is treated as a “feedback” which amplifies the effects of CO₂. Monckton et al. have had a lot to say about that over a decade or more, but they have trouble getting published because of the gatekeepers at the major journals. It is completely incorrect to deal with H₂O in that way. In the 2018 paper by Jock Allison and myself in NZPIM, we stress the point that H₂O is by far the dominant GHG.

We also point out the completely silly practice of drawing a pie chart showing the percentages of GHGs like CO₂, CH₄, N₂O, etc., and leaving H₂O out of the pie chart. However, what they have done in Chapter 8 is exactly that: they restrict their interest to WMGHGs, and then rule out H₂O because they don't consider it “well mixed.” Indeed, it is NOT well mixed, because the humidity is different all around the world and there are clouds here and there; nonetheless, H₂O is *still* by far the dominant GHG.

A special word about aerosols: That has become the catch-all excuse for why the climate models don't match the observed data. You can calculate whatever you please, and then throw in the word “aerosols” to swing your goofy number around as necessary to bring your result into conformity with observations. “Aerosols” is the perfect excuse, the always-trump-suit wild card, the “free parameter” (or colloquially the “free lunch”) of climate calculations. It seems to me that there should have been some decent measurements made of aerosols over the decades: Los Angeles or New York, London, Cairo, wherever. Or at least there ought to be data going back years and years from places that *don't* have aerosols, such as an island nation like New

Zealand. It seems reasonable to me to demand that the climate calculations for a place without aerosols (NZ?) should have to agree with the observational data.

Overall, the world would have been a lot better off if instead of writing a separate “Summary for Policymakers,” they had stapled together each of the “executive Summary” elements for each chapter. Then at least it would have become clear how huge the error brackets are. Unfortunately, if the delegates to the big UN conferences had been asked to read the individual chapters’ “executive summaries,” they wouldn’t have had the foggiest notion of their meaning. Fortunately, those of us who can read science (even at the elementary level of knowing what a \pm error bracket means) can see that the uncertainty inherent in climate science – and the uncertainty stated in these pages – is so great as to make any future predictions totally worthless.

The whole chapter is < 30 pages, so it's not tough to read. But reading it with care and grasping the meaning of individual sentences takes a lot longer than speed-reading it to “get the general idea” – which is what nearly everybody did the first time around.

Tom Sheahen