

Date: Wed, 08 Jun 2011 13:57:19 +0100  
 To: John Shepherd <jgs@noc.soton.ac.uk>  
 From: Aubrey Meyer <aubrey.meyer@btinternet.com>  
 Subject: Re: ocean acidification  
 Cc: Jason Lowe <jason.lowe@metoffice.gov.uk>  
 Bcc: terry.oconnell@blueyonder.co.uk

Dear John -

16.15 - I am sending this again as apparently the tables didn't embed properly in the email. Also as I said, to remove any possible 'ambiguity' in the *words* in the tables, they are adjusted slightly - the *numbers* are exactly as was sent first time.

Thank you for your final 'in haste' email before you went abroad.  
 I trust you are back now and in good shape.

I am copying this to Jason Lowe as he may care to comment.

The matter of 'what the Government figures said' with "2016 4% Low" is easy to resolve by looking at their published spreadsheets \* - in summary: -

[1] The UK Government's carbon-emissions-budget "2016 4% Low", for the period 2000-2100, weighs 480 Gigatonnes carbon.

[2] For 2000, 2050 and 2100 their atmospheric concentrations as weights of carbon are variously: -

	2000		2050		2100
<b>CO2 emissions in the "2016 4% Low" Carbon Emissions Budget</b>					
	7.9 GTC	accumulating to	411.0 GTC	accumulating to	480.0 GTC
<b>Atmosphere CO2 concentrations shown by HMG with "2016 4% Low"</b>					
<b>10%-ile</b>	780.4 GTC	rising to	903.2 GTC	falling to	841.7 GTC
<b>median</b>	780.4 GTC	rising to	948.8 GTC	falling to	917.5 GTC
<b>90%-ile</b>	780.4 GTC	rising to	1,032.0 GTC	rising to	1,092.6 GTC

Consequently - assuming that only the CO<sub>2</sub> emissions are from "2016 4% Low" are emitted - the weights of carbon in the atmosphere by 2100 are as follows, where 'what is taken by sinks', added to 'what extra remains in the atmosphere', totals the 480 GTC as in the "2016 4% Low" budget: -

<b>Atmosphere CO2 concentrations shown by HMG with "2016 4% Low"</b>					
<b>10%-ile</b>	so of 480 GTC emissions budget	418.7 GTC	is being taken away by sinks, <b>i.e. that is more than</b> the 'median' case, leaving . . . .	61.3 GTC	extra in atmosphere <b>i.e. that is less than</b> the 'median' case
<b>median</b>	so of 480 GTC emissions budget	342.9 GTC	is being taken away by sinks, <b>i.e. that is equal to</b> the 'median' case, leaving . . . .	137.1 GTC	extra in atmosphere <b>i.e. that is equal to</b> the 'median' case
<b>90%-ile</b>	so of 480 GTC emissions budget	167.8 GTC	is being taken away by sinks, <b>i.e. that is less than</b> the 'median' case, leaving . . . .	312.2 GTC	extra in atmosphere <b>i.e. that is more than</b> the 'median' case

So what results from these figures is: -

[1] if there is more in the atmosphere then there is less in the sinks, [however they are sub-divided between the ocean-sinks and the land-sinks] and

[2] if there is less in the atmosphere then there is more in the sinks, [i.e. however ocean and land sinks are sub-divided, 50:50 or not - if not, what are they?].

Consequently, to say - as AVOID does - that: -

[1] there is greater ocean CO<sub>2</sub>-acidification when there is less CO<sub>2</sub> in the ocean or

[2] there is lesser ocean CO<sub>2</sub>-acidification when there is more CO<sub>2</sub> in the ocean

[as shown in the original memo - attached at the end here] doesn't make any sense.

Is there more CO<sub>2</sub> being released from other *undeclared* sources perhaps? For what its worth, I see that there certainly will be other sources due to constantly rising temperature [melting permafrost etc] as it is the only way to explain what the Government is claiming. If this is the case, they need to specify: -

- [1] what are these sources of these 'other releases' and path-integrals are needed showing
- [2] in what amounts these releases are occurring
- [3] and at what rates these are releases occurring.

However, with the emissions budget "2016 4% Low", as in the UK Climate Act, none of that is not shown or even intimated at in the Government's published figures.\*

My comments on your earlier comments are in bold below . . .

With kind regards

Aubrey

\* <http://www.theccc.org.uk/pdfs/Ch1%20spreadsheet%20-%20model%20emissions%20and%20climate%20data%20-%20final.xls>

At 18:00 01/06/2011, you wrote:

Aubrey

In even greater haste: see comments below

John

On 1 Jun 2011, at 17:24, Aubrey Meyer wrote:

**Dear John**

**Thank you very much for your hasty response. Please understand I agree with you so could you please look again but with less haste . . . .**

**When you write,**

"Specifically you say "12: assign 50% of AFERTS to the ocean-sinks [AFERTOS] . . . " *but I can see no basis for this assumption (under these different future conditions)" . . . .*

**the difficulty perhaps becomes clearer because neither can I. However, that is exactly what DECC wrote and informed me was the assumption they had made.**

Yes, I remember that you said that they said that (!), but they have no need to make any such assumption (indeed it would be v.v. difficult to force the model to do that) so I suspect crossed wires and/or finger trouble here...

**Maybe its crossed-wires/finger-trouble as you suggest - but its not my fingers that were crossed it was theirs. Agreed?**

When you also say, "*In passing, I'm afraid that your statements 15, 17 & 18 regarding the Hadley et al work are wrong*" [here they are] . . .

**15. increasing ocean acidification is not a function of increasing oceanic CO<sub>2</sub> concentration but that**

**17. and further that oceanic CO<sub>2</sub> acidification increases while oceanic CO<sub>2</sub> concentration does not**

**18. or conversely oceanic CO<sub>2</sub> concentration increases while oceanic CO<sub>2</sub> acidification does not. . . . again the difficulty perhaps become clearer because I agree with you.**

**However, the statements are wrong not because I said them. They are wrong because they simply could not rationally be the case!**

I meant that you state in your slides that they claim these things, but I don't believe that they do (more misunderstanding ?)

**Its not about 'belief' - its just simple obvious arithmetic - [but you can have the spreadsheets if you want].**

**But this what emerges from the audit of DECC/CCC/Hadley/AVOID modelling of future CO2.**

I don't agree that these "emerge" from your "audit": as above, you state that they claim these things, but they don't (so far as I am aware).

**Well you can phrase it what it ever suits your taste but that's the whole point: - Its not a 'belief-system' or speculative/fuzzy climate-modelling. The numbers for the emission/concentration path-integrals they published are - like it or not - what they published.**

**. . . The rest is simple arithmetic.**

**When the audit: -**

[http://www.gci.org.uk/animations/Sources\\_and\\_Sinks\\_UK\\_Climate\\_Act.swf](http://www.gci.org.uk/animations/Sources_and_Sinks_UK_Climate_Act.swf)

**. . . was first published, Jason Lowe of Hadley/AVOID said to me, "how did you do that? That really got us thinking."**

**I explained and then he said, "OK, but so what? The what-you-call '100% sink-efficiency by 2050', is not an unreasonable result given the state of scientific uncertainty." So we agreed that was what they said and we agreed that was what followed as well.**

**Then they put the same error bars as for atmosphere-CO2 ppmv in "2016 4% Low" onto the acidification curves that Southampton computed from the ppmv curves only for them and they - in total - created the contradiction where: -**

**further that oceanic CO2 acidification increases while oceanic CO2 concentration does not or conversely oceanic CO2 concentration increases while oceanic CO2 acidification does not.**

**Its not rocket-science. What the results of that simple arithmetic quite obviously show, is a significant procedural error on the part of DECC/CCC/AVOID and that Southampton Oceanography has it seems unwittingly become implicated in that.**

**If your position is simply to say 'they didn't say that', the answer is 'they did' - perhaps like Southampton 'unwittingly'.**

**This has to be sorted out and I am sure you agree with that.**

**With warm regards**

**Aubrey**

Over & out (sorry)

John

## **An assessment of 'Contraction & Concentrations' - 'Contraction & Convergence' & C&C targets & modelling behind various rates of 'sink-efficiency' in the UK Government's 'Climate Act' [2008].**

Presentation/animation: - [http://www.gci.org.uk/animations/Sources\\_and\\_Sinks\\_UK\\_Climate\\_Act.swf](http://www.gci.org.uk/animations/Sources_and_Sinks_UK_Climate_Act.swf)

This presentation/animation audits the "2016 4% Low" CO<sub>2</sub>-contraction:atmospheric-CO<sub>2</sub>-concentrations:convergence budget that is the Government's prescribed basis of the UK Climate-Act. The Government's prescription results from runs of the MAGICC climate-model that the UK Hadley Centre was requested to conduct with an overall view to avoiding a global temperature rise of more than two degrees. Keeping the CO<sub>2</sub> emissions budget ['2016 4% Low'] constant and selecting the 'median' case for the resultant CO<sub>2</sub> concentrations in the atmosphere, Government published the view that this scenario gave only 44% odds for not exceeding an overall temperature rise of 2 degrees by 2100.

~ ~ ~ ~ ~

### **Major contradiction from DECC/AVOID in future Ocean CO<sub>2</sub> Acidification projections.**

Subsequently DECC, using analysis from members of the consortium in the AVOID programme, projected calculations of future increases in 'ocean acidification', or pH decreases, onto this fixed emissions:contractions prescription. In the total ensemble of results from this "2016 4% Low" 'scenario', 2050 emerges as a year of great significance as the Government's prescription displays the following four features: -

1. atmospheric CO<sub>2</sub> concentrations peak in 2050 and then start declining, consequently . . .
2. sinks are absorbing more than the emissions equivalent from 2050 onwards and . . .
3. Ocean acidification stops increasing from 2050 onwards and within contraction
4. Convergence to globally equal emissions entitlements per capita is completed by 2050.

GCI audited this ensemble and serious contradictions emerge.

What DECC/AVOID have done was to: -

5. Prescribe a fixed CO<sub>2</sub> emissions budget [[2016 4% Low]
6. Project an array of atmosphere CO<sub>2</sub> concentrations paths [10%-ile;median;90%-ile] that result from this and then separately
7. project arrays of ocean CO<sub>2</sub> acidification paths resulting from these atmosphere concentration path.

What the DECC/AVOID/Hadley modellers didn't do was to look at ocean CO<sub>2</sub>-concentration pathways that resulted from the above and it is these which reveal the contradiction observed and discussed here.

Using the detailed projections of emissions and concentrations for 2016 4% Low given in the Committee of Climate change report 'Building a Low Carbon Economy' [2008], Chapter 1 spreadsheet, Model Emissions and Climate Data, GCI produced a time-series as follows: -

1. Quantify the carbon-weights of the CO<sub>2</sub> concentration pathways and then, against the CO<sub>2</sub> budget . . .
2. Quantify the carbon-weights of the 'fractions-of-CO<sub>2</sub>-emissions-retained-to-the-sinks' [FERTS] . . .
3. Quantify the 'fractions-of-CO<sub>2</sub> emissions-retained-in-the-atmosphere' [FERTA] that result . . .
4. Quantify the 'accumulated-fractions-of-emissions-retained-to-the-sinks' [AFERTS] . . .
5. Assign 50% of AFERTS to the ocean-sinks [AFERTOS] . . .
6. Compare the various rates of AFERTOS with the rates of ocean-acidification.

What emerges from this audit is the DECC/Hadley/AVOID modelling of future CO<sub>2</sub> emissions:ocean-atmosphere-concentrations:ocean-acidification has a major contradiction. They claim: -

7. Ocean CO<sub>2</sub> acidification is a function only of increasing atmospheric CO<sub>2</sub> concentration and
8. Increasing ocean acidification is not a function of increasing oceanic CO<sub>2</sub> concentration but that
9. Increasing oceanic CO<sub>2</sub> concentration is a function of increasing atmospheric CO<sub>2</sub> concentration
10. And further that oceanic CO<sub>2</sub> acidification increases while oceanic CO<sub>2</sub> concentration does not
11. Or conversely oceanic CO<sub>2</sub> concentration increases while oceanic CO<sub>2</sub> acidification does not.

In other words the AVOID/DECC results claim what is impossible in the real world: that ocean CO<sub>2</sub> acidification can just stop while ocean CO<sub>2</sub> concentration continues to increase and/or that ocean CO<sub>2</sub> concentration can just stop while ocean CO<sub>2</sub> acidification continues to increase.

This impossibility shows that the key part of this modelling was omitted, namely the effect on the biological aspect of the ocean sink of increased levels of CO<sub>2</sub> acidification. This omission results from 'fixing' and pre-scribing the CO<sub>2</sub> budget and the concentrations paths that are portrayed as 'high/middle/low' and then just telling oceanographers to predict ocean-acidification-levels off the concentration paths only.



It is of central importance in the exercise to realize that this isn't simply a dispute about the quantum of projected rates of ocean CO<sub>2</sub> acidification. This is about an audit of "2016 4% Low" revealing the use by DECC/AVOID of a bureaucratic and demonstrably flawed modelling procedure to achieve projections of CO<sub>2</sub> concentration in the atmosphere and the oceans.

Dr Toby Tyrrell of Southampton Oceanography Department, who was tasked with projecting the rates of ocean acidification under "2016 4% Low" said: -

1. *"The time evolution of atmospheric CO<sub>2</sub> was prescribed. We imposed it on the model and then calculated the resulting impact on pH"* and
2. *"These model runs are not suitable for calculating the ocean CO<sub>2</sub> sink over time, and therefore neither are they suitable for calculating the fraction of emissions that is retained in the atmosphere."*

He's welcome to say that, but that is exactly what the DECC/AVOID model runs did. The spreadsheets accompanying the publication of the UK Climate-Act give year-on-year values for CO<sub>2</sub> emissions and CO<sub>2</sub> concentrations. Southampton's imposing the CO<sub>2</sub> concentrations only to calculate the resulting impact on ocean CO<sub>2</sub> acidification is flawed as it cuts out a - if not the - key bit of the modelling challenge [quantifying the impact on ocean-sink biology] and contradicts the Met Office's own statement on its web-site which says: -

*"As the oceans acidify they are less able to absorb further CO<sub>2</sub> accelerating climate change because more man-made emissions remain in the atmosphere."*

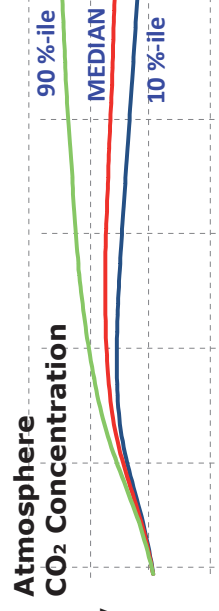
The sensible way to model this, and the more responsible way ahead is recommending fixed concentration pathways [RCPs]. This means: - [a] 'fixing' an atmosphere CO<sub>2</sub> concentration path estimated to equal no more than a two degree rise in temperature [b] varying the size of the CO<sub>2</sub> 'emissions-budget' - 90%-ile/median/10%-ile - around that RCP and [c] seeing that the ocean-acidification-level read off the fixed and constant CO<sub>2</sub> concentration path in the atmosphere, is 'fixed' in synch with the constant CO<sub>2</sub> concentration path in the ocean bars noting the AFERTOS pathway arising doesn't change either.

This procedure avoids the concentration/acidification conflict stated above and focuses on the one thing over which we still [tentatively] have control for UNFCCC-compliance and that is 'emissions' and the size and international sharing of the emissions-budget that achieves UNFCCC-compliance - i.e. Contraction and convergence. This is over-riding reason to work to RCPs and the IPCC 5th Assessment calls for RCPs.

Aubrey Meyer GCI LONDON E17 4SH [www.gci.org.uk](http://www.gci.org.uk)

**(a) Accumulated CO<sub>2</sub> deposition**

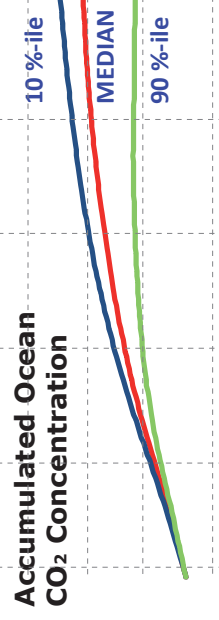
[or CO<sub>2</sub> concentration] in the global atmosphere [here in Gigatonnes carbon] that Hadley/Lowe/MAGICC say accompany the "2016 4% Low" CO<sub>2</sub> Emissions Budget, as prescribed in the UK Climate Act [see (d) below] at Median, 10%-ile and 90%-ile values.



Source: - UK Climate Change Committee [CCC] spreadsheets for CO<sub>2</sub> emissions-budget, '2016 4% LOW', as adopted in the UK Climate Act.

**(b) Accumulated CO<sub>2</sub> deposition**

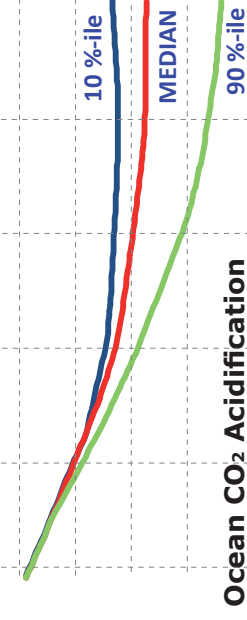
[or CO<sub>2</sub> concentration] in the global oceans [here in Gigatonnes carbon] that accompany the "2016 4% Low" CO<sub>2</sub> Emissions Budget in the UK Climate Act [see (d) below] at Median, 10%-ile & 90%-ile values, [calculated GCI].



Source: - these AFERTOS levels were calculated by GCI in an audit of '2016 4% Low'.

**(c) Increased CO<sub>2</sub> acidification**

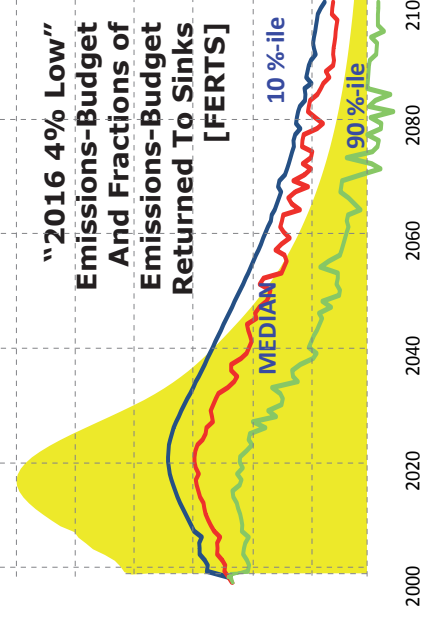
in the global oceans [on pH scale] that DECC/AVOID/Lowe/Tyrrell say accompany the "2016 4% Low" CO<sub>2</sub> Emissions Budget in the UK Climate Act [see (d) below] at Median, 10%-ile and 90%-ile values [calculated by AVOID].



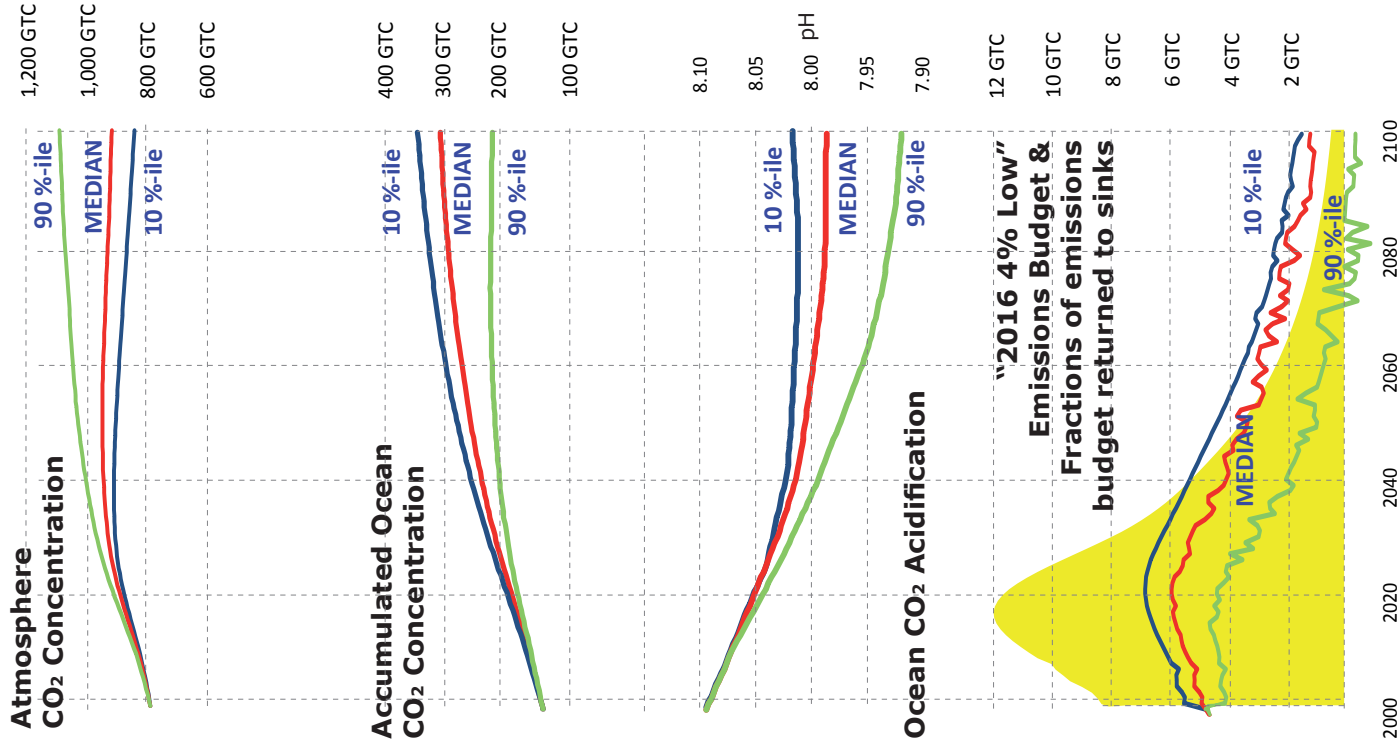
Source: - these levels were calculated and published by the UK Government funded AVOID programme.

**(d) "2016 4% Low" CO<sub>2</sub> Emissions**

**Budget** prescribed in the UK Climate Act, showing Fraction of emissions returned to sinks [calculated by GCI following the DECC/Hadley/Lowe/MAGICC prescription at Median, 10%-ile and 90%-ile values.



Source: - UK Climate Change Committee [CCC] spreadsheets for CO<sub>2</sub> emissions-budget, '2016 4% LOW', with FERTS levels calculated by GCI in the audit of '2016 4% Low'.



The “2016 4% Low” CO<sub>2</sub> Emissions Budget prescribed in the UK Climate Act gave [they say] these atmosphere concentrations at Median [Red], 10%-ile [Dark Blue] and 90%-ile [Green] values.

The combination of these values with values of the Emissions Budget [in yellow, at (d) below] made it possible to calculate the ‘Fraction of this Emissions Budget’ that [they say] was theoretically returned to the global sinks and the Fraction that was retained in the atmosphere. These values are shown superimposed on the Emissions Budget below at Median, 10%-ile and 90%-ile values.

DECC/Hadley/Lowe state that ~half the ‘Fraction Returned’ will accumulate in the oceans: - shown as ‘CO<sub>2</sub> accumulation curves’ in graphic (b) alongside again at Median, 10%-ile and 90%-ile values.

AVOID/Lowe/Hadley state that CO<sub>2</sub> acidification of the ocean will cease by around 2050 in the median case of “2016 4% Low”, as [they say] atmosphere CO<sub>2</sub> accumulations will cease at that time due to the CO<sub>2</sub> sinks contracting more slowly than CO<sub>2</sub> emissions.

The error in this methodology becomes quite obvious once it is revealed they show that the greatest increase of CO<sub>2</sub> acidification in the ocean, accompanies the greatest increase of CO<sub>2</sub> accumulation in the atmosphere [90%-ile], but with the smallest increase of CO<sub>2</sub> accumulation in the ocean and *conversely*, the smallest increase of CO<sub>2</sub> acidification in the ocean, accompanies the smallest increase of CO<sub>2</sub> accumulation in the atmosphere [10%-ile], but with the greatest increase of CO<sub>2</sub> accumulation in the ocean.

This is obviously nonsense and also contradicts a recent Met Office statement which says: -

*“As the oceans acidify they are less able to absorb further CO<sub>2</sub>, accelerating climate change because more man-made emissions remain in the atmosphere.”*