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

This presentation/animation audits the "2016 4% Low" CO_2-contraction:atmospheric-CO_2-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_2 emissions budget ['2016 4% Low'] constant and selecting the 'median' case for the resultant CO_2 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.

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Major contradiction from DECC/AVOID in future Ocean CO_2 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:concentrations 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_2 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_2 emissions budget [[2016 4% Low]
6. project an array of atmosphere CO_2 concentrations paths [10%-ile;median;90%-ile] that result from this and then separately
7. project arrays of ocean CO_2 acidification paths resulting from these atmosphere concentration path.
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What the DECC/AVOID/Hadley modellers didn't do was to look at ocean CO_2-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 Economcy' [2008], Chapter 1 spreadshhet, Model Emissions and Climate Data, GCI produced a time-series as follows: -

8. quantify the carbon-weights of the CO_2 concentration pathways and then, against the CO_2 budget . . .
9. quantify the carbon-weights of the 'fractions-of-CO_2-emissions-returned-to-the-sinks' [FERTS] . . .
10. quantify the 'fractions-of-CO_2 emissions-retained-in-the-atmosphere' [FERTA] that result . . .
11. quantify the 'accumulated-fractions-of-emissions-returned-to-the-sinks' [AFERTS] . . .
12. assign 50% of AFERTS to the ocean-sinks [AFERTOS] . . .
13. 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_2 emissions:ocean-atmosphere-concentrations:ocean-acidification has a major contradiction. They claim: -

14. ocean CO_2 acidification is a function only of increasing atmospheric CO_2 concentration and
15. increasing ocean acidification is not a function of increasing oceanic CO_2 concentration but that
16. increasing oceanic CO_2 concentration is a function of increasing atmospheric CO_2 concentration
17. and further that oceanic CO_2 acidification increases while oceanic CO_2 concentration does not
18. or conversely oceanic CO_2 concentration increases while oceanic CO_2 acidification does not.

In other words the AVOID/DECC results claim what is impossible in the real world: that ocean CO_2 acidification can just stop while ocean CO_2 concentration continues to increase and/or that ocean CO_2 concentration can just stop while ocean CO_2 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_2 acidification. This omission results from 'fixing' and prescribing the CO_2 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_2 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_2 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_2 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_2 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_2 emissions and CO_2 concentrations. Southampton's imposing the CO_2 concentrations only to calculate the resulting impact on ocean CO_2 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_2 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_2 concentration path estimated to equal no more than a two degree rise in temperature [b] varying the size of the CO_2 '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_2 concentration path in the atmosphere, is 'fixed' in synch with the constant CO_2 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 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.

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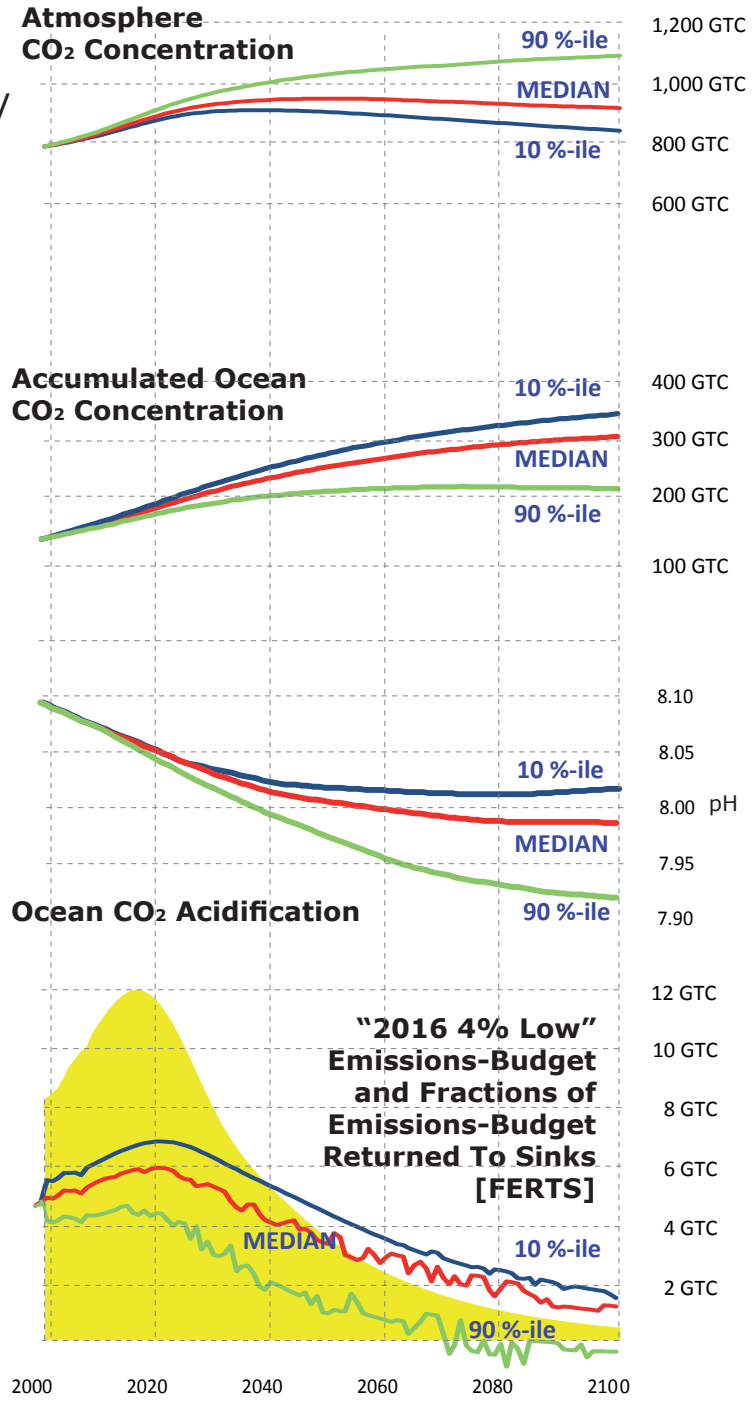
(a) Accumulated CO_2 deposition [or CO2 concentration] in the global atmosphere [here in Gigatonnes carbon] that Hadley/Lowe/MAGICC say accompany the "2016 4% Low" CO_2 Emissions Budget, as presribed in the UK Climate Act [see (d) below] at Median, 10%-ile and 90%-ile values.

(b) Accumulated CO_2 deposition [or CO_2 concentration] in the global oceans [here in Gigatonnes carbon] that accompany the "2016 4% Low" CO_2 Emissions Budget in the UK Climate Act [see (d) below] at Median, 10%-ile & 90%-ile values, [calculated GCI].

(c) Increased CO_2 acidification in the global oceans [on pH scale] that DECC/AVOID/Lowe/Tyrrell say accompany the "2016 4% Low" CO_2 Emissions Budget in the UK Climate Act [see (d) below] at Median, 10%-ile and 90%-ile values [calculated by AVOID].

(d) "2016 4% Low" CO_2 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.

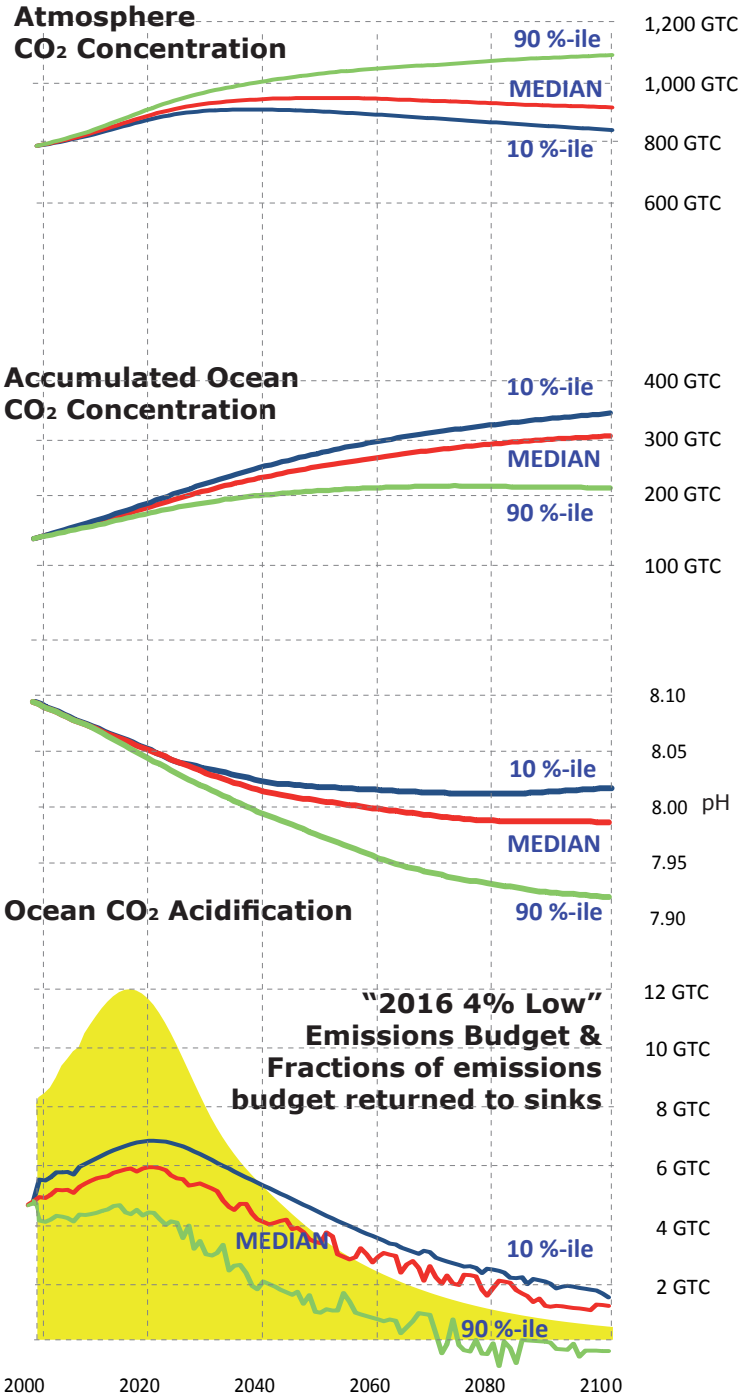


Source: - UK Climate Change Committee [CCC] spreadsheets for CO_2 emissions-budget, '2016 4% LOW', as adopted in the UK Climate Act.

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

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

Source: - UK Climate Change Committee [CCC] spreadsheets for CO_2 emissions-budget, '2016 4% LOW', with FERTS levels calculated by GCI in the audit of '2016 4% Low'.



The "2016 4% Low" CO_2 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 atmopshere. 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_2 accumulation curves' in graphic (b) alongside again at Median, 10%-ile and 90%-ile values.

AVOID/Lowe/Hadley state that CO_2 acidification of the ocean will cease by around 2050 in the median case of "2016 4% Low", as [they say] atmosphere CO_2 accumulations will cease at that time due to the CO_2 sinks contracting more slowly than CO_2 emissions.

The error in this methodology becomes quite obvious once it is revealed they show that the greatest increase of CO_2 acidification in the ocean, accompanies the greatest increase of CO_2 accumulation in the atmosphere [90%-ile], but with the smallest increase of CO_2 accumulation in the ocean and *conversely*, the smallest increase of CO_2 acidification in the ocean, accompanies the smallest increase of CO_2 accumulation in the atmosphere [10%-ile], but with the greatest increase of CO_2 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_2, accelerating climate change because more man-made emissions remain in the atmosphere."