

GCI Evidence to EAC Enquiry 'Carbon Budgets & UK Climate Act' June 2013

"The inquiry will examine whether the emissions reduction targets in the Climate Change Act (which underpin the UK carbon budgets) are still valid as an appropriate UK contribution to avoiding dangerous global climate change.

The Committee will explore recent climate change science developments and what these mean for the UK's Carbon Budget regime."

'Rapidly Inter Acting Feedback Effects' [RIAFE]. The Carbon Budget Accounting Tool (CBAT) offers a new methodology to address dangers of doing too little too late."

"As the planet warms, a steady rate of feedback acceleration in the years ahead makes it possible to contemplate a scenario where positive feedback is driving the system as a whole from a point after which 'human-budget-emission-control' becomes irrelevant.

To continue, after twenty years, to ignore this anywhere, let-alone in 'climate-science-policy modelling' community is another form of 'climate-denial'.

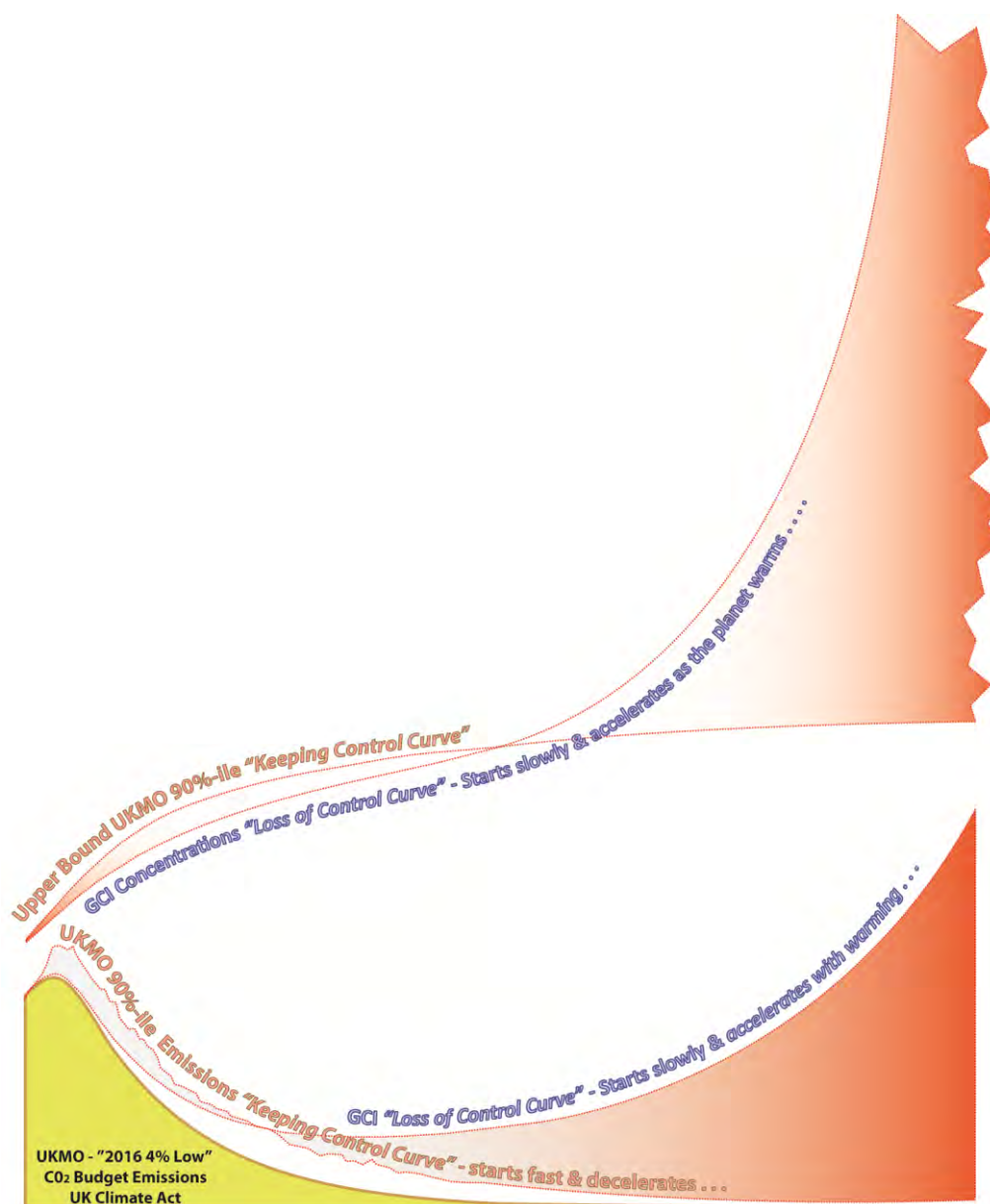
Doing this unintentionally provides assistance to 'climate-deniers' against whom James Hansen has already and rightly levelled the charge of crimes against humanity for willing dangerous rates of climate-change upon the future.

For UNFCCC-compliance, the struggle is now between control & a loss of control. To deal with this we need a new approach that will be precautionary, prevention-based and strategically goal-focused. It will distinguish between 'budget-emissions' which we can control and 'feedback emissions' and effects which we can't. The approach will quantify as best we can, the runaway potential of rates of change that result from 'Rapidly Inter Acting Feedback Effects' [RIAFE] and the dangers of doing too little too late."

Carbon Budget Climate Change Policy for UNFCCC-Compliance

the battle of the Rates is about the potential for RIAFE or

curves **Keeping Control** versus those **Losing Control**



The UK Climate Act

' . . . as the Planet warms . . . '

Budget-Emissions we can control while . . .

Accelerating Feedback-Emissions from RIAFE we cannot.

CONTENTS

New Approach needed; statement about RIAFE	Page 1
Imagery Keeping/Losing Control	Page 2
Contents	Page 3 & 4

UKMO Feedback Omissions

Preface re omission of feedbacks from climate-models	Page 5 & 6
Keeping Control Imagery	Page 7
Losing Control Imagery	Page 8
Contiguity of Permafrost with collapsing Artic	Page 9
Illustrative estimate of Permafrost CO ₂ release rate	Page 10
Summary re opaque UKCA Science-Policy Hybrid	Page 11

Recommendations/Statements re Omissions

	Page 12
UKMO Statements admitting Feedbacks Omissions	Page 13 & 14
Statement UNEP re AR5 & omitted Feedbacks	Page 15
Statement Stern to IMF re omitted Feedbacks	Page 16

6-Point Analysis of UK Climate Change Act [UKCA]

1. Budget/PPMV 2016 4% Low, 10%-ile, 90%-ile, Median	Page 17
Image showing Fractions Retained and Returned	Page 18
2. UKMO falsely claims carbon-cycle-coupling is in UKCA	Page 19
Imagery showing UKMO's claim of coupling in UKCA	Page 20
3. PPMV Array [Fractions of Budget Retained/Returned]	Page 21
Imagery PPMV Array [Fractions Retained/Returned]	Page 22
4. Budget array rebased to Median Path,	Page 23
Imagery Budget rebased to Median PPMV array	Page 24

5. Sensitivity & Convergence	Page 25
Sensitivity & Convergence	Page 26
6. 'Bulge and Trend' – arbitrary UKMO array	Page 27
Imagery 'Bulge and Trend' – arbitrary UKMO array	Page 28

UKMO persists repeatedly with Feedback Omissions

UKMO Advance paper aligning Hadgem Model & RCPs	Page 29
Imagery of Advance/RCP alignment	Page 30
Detail of Advance	Page 31
Imagery for Advance detail	Page 32
Lowe et al in Nature Climate February 2013	Page 33
Imagery Lowe et al in Nature January 2013	Page 34
NATURE Meinshausen \$100-\$1,000 Carbon Tax	Page 35
Imagery of what Nature left out [Peer Review Bathos]	Page 36
Arctic Bomb	Page 37
Imagery Arctic Bomb	Page 38

Carbon Budget Analysis Tool [CBAT] with Feedback Emissions

CBAT – a heuristic device in four domains

Draft description	Pages 39 & 40
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CBAT Domain 1 still imagery, with UKCA on/off switch for comparisons

Contraction & Concentrations Low	Page 41
Contraction & Concentrations Medium	Page 42
Contraction & Concentrations High	Page 43

online at: - <http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>

UKCA in relation to Carter, Hansen, GDR Budgets	Page 44
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UKMO FEEDBACK OMISSIONS - EAC Enquiry; the validity of Carbon Budgets in Climate Act

GCI welcomes this new EAC enquiry into the adequacy of the carbon-budgets in the UK Climate Act. In the previous enquiry in 2009, the UKMO gave misleading information to the EAC claiming that all relevant feedback effects were in the climate-model underpinning the Climate Act. They were not.

From the outset, GCI has constantly warned of feedback effects being omitted from climate-models. Starting in 1989, GCI proposed the thesis of "Equity & Survival" to the UN 1990-92. Through 1993-94 we countered its 'economic' antithesis of 'Efficiency with No-Regrets' as the 'Economics of Genocide'. In a document requested of GCI by IPCC in 1993 for the Second Assessment Report [SAR], GCI warned about the possibility and the dangers of positive feedback effects: -

http://www.gci.org.uk/Documents/Nairob3b_.pdf

THE "CONSTANT AIRBORNE FRACTION" (CAF)

"During the period 1860 to 1990 a constant fraction of CO2 emissions to the atmosphere in the order of 50% remained 'airborne'. However, given the possibility of enhanced positive feedback in the future, the fraction may not remain constant. In the face of continued industrial emissions and declining terrestrial sink-capacity, it will probably increase."

At the 2nd 'Conference of Parties' [COP-2] to the UN Framework Convention on Climate Change 1996, GCI tabled the Contraction and Convergence (C&C) model for achieving UNFCCC-compliance. At COP-2, GCI defended C&C at rates consistent with a 350 ppmv atmospheric stabilisation target. Again, we warned about the possibility of positive feedback: -

http://www.gci.org.uk/Documents/ZEW_CONTRACTION_&_CONVERGENCE.pdf

WHICH CONTRACTION BUDGET? WHICH CONVERGENCE DATE?

"These are the two main questions that arise once the twin-policy approach is accepted in principle. We will address 'which budget?' first, as the imperative of convergence only arises as a derivative of the imperative of contraction even if in turn, contraction is only practically achievable once global convergence has been accepted, agreed and configured."

Also, most known feedback mechanisms are not modelled into these runs. And while their interactive effects on climate forcing are still too complex to simulate in the models, the feedback signs are predominantly assumed positive - i.e. giving increased warming."

The Paper was presented to the ZEW conference in Mannheim Germany in June 1997. We continued the defence of 350 ppmv and the paper was ultimately published by ZEW through Springer Verlag in an updated form but where this defence was edited out: -

<http://www.gci.org.uk/papers/zew.pdf>

From 1995 onwards GCI has advocated the synthesis of 'Contraction & Convergence' [C&C] at the UN, continuously making the case for realistic feedback-averse rates of C&C to be adopted: -

<http://www.gci.org.uk/rates.html>

Since that time C&C has become the most widely internationally recognized, cited and arguably the most widely supported methodology in the process: - <http://www.gci.org.uk/news.html>

<http://www.gci.org.uk/endorsements.html>

C&C has also had considerable cross-party political support in the UK: -

http://www.gci.org.uk/Full_House.html

A campaign summary is here: - http://www.gci.org.uk/Documents/Campaign_Summary_.pdf

In 2008, Adair Turner, Chairman of the UK Climate Change Committee, recognized C&C as the basis of the UK Climate Act: - <http://www.youtube.com/watch?v=M1ampl1XAzs>

"In the UK Climate Act we have endorsed the C&C principle. It is pretty strong support for what Aubrey Meyer has said."

However, throughout and concomitant with all this, the UKMO has routinely excluded these feedback effects from the Climate Model underpinning the UK Climate Act. Indeed, in the EAC Enquiry in 2004, the UKMO made these inaccurate and misleading remarks about C&C and the Brazilian Proposal in their evidence about "Responsibility for mitigation": -

"The Brazilian proposal and other similar mechanisms provide frameworks that could be used to assign future responsibility for mitigation to those with greatest responsibility for past climate change. The Hadley Centre and other scientists around the world are working together to come up with a robust methodology to quantitatively estimate how future emissions reductions might be divided between nations in an equitable way, should such approaches be adopted by the international community. This information will underpin negotiations post Kyoto, and inform negotiations on contraction and convergence."

The problem with this as a statement about C&C was that from a policy perspective, there is no meaningful feedback measurement in the Brazilian Proposal whatsoever. When IA for that reason, GCI lodged a complaint about these remarks, the EAC chair accepted GCI's C&C definition statement and the UKMO told us to, "get a trademark". We did and two years later they agreed to respect it.

On June 23 2009, UKMO claimed to the EAC Enquiry that all relevant feedbacks were in the climate modelling behind the UK Climate Act: -

"The models will take into account all the feedbacks we are aware of that we think are important."

This was and remains an ambiguous and misleading statement and the carbon budget in the UK Climate Act is a product of it. In November 2010 the UKMO put an admission of this on its website: - <http://www.metoffice.gov.uk/climate-change/guide/science/explained/feedbacks>

At that time, UKMO claimed in the EAC 2009 Enquiry to have included coupled-carbon cycling [as in IPCC AR4] in the model used for the Act. However, what they actually introduced in the carbon-cycle was the first projection of *negative* – not *positive* – feedback in the twenty year history of climate-modelling in the IPCC's record. This claimed more than 100% 'Carbon-Sink-Efficiency' by 2050 in the carbon 'Contraction:Concentrations' budget [2016 4% Low] in the UK Climate Act. The UKMO ignored challenge on this but especially in the light of feedback omission, this projection remains and untrustworthy basis for policy development. This is analysed in some detail in this evidence.

Overall, the 'science/policy-hybrid' created by the UKMO and the CCC renders the Act itself opaque and falsely reassuring. Moreover, the problem remains as the UKMO are *still* omitting feedback effects from their model, having aligned it with the RCP projections in IPCC AR5, despite comments from other eminent sources. As UNEP said in "Policy Implications of Warming Permafrost" [2012]: -

"All climate projections in the IPCC 5th Assessment, due for release in 2013-14, are likely to be biased on the low side relative to global temperature because the models did not include Permafrost carbon feedback. So targets based on these projections would be biased high."

Nicholas Stern told the IMF last month, "Feedbacks and tipping points such as Permafrost melt are omitted in the scientific models. We need a new approach."

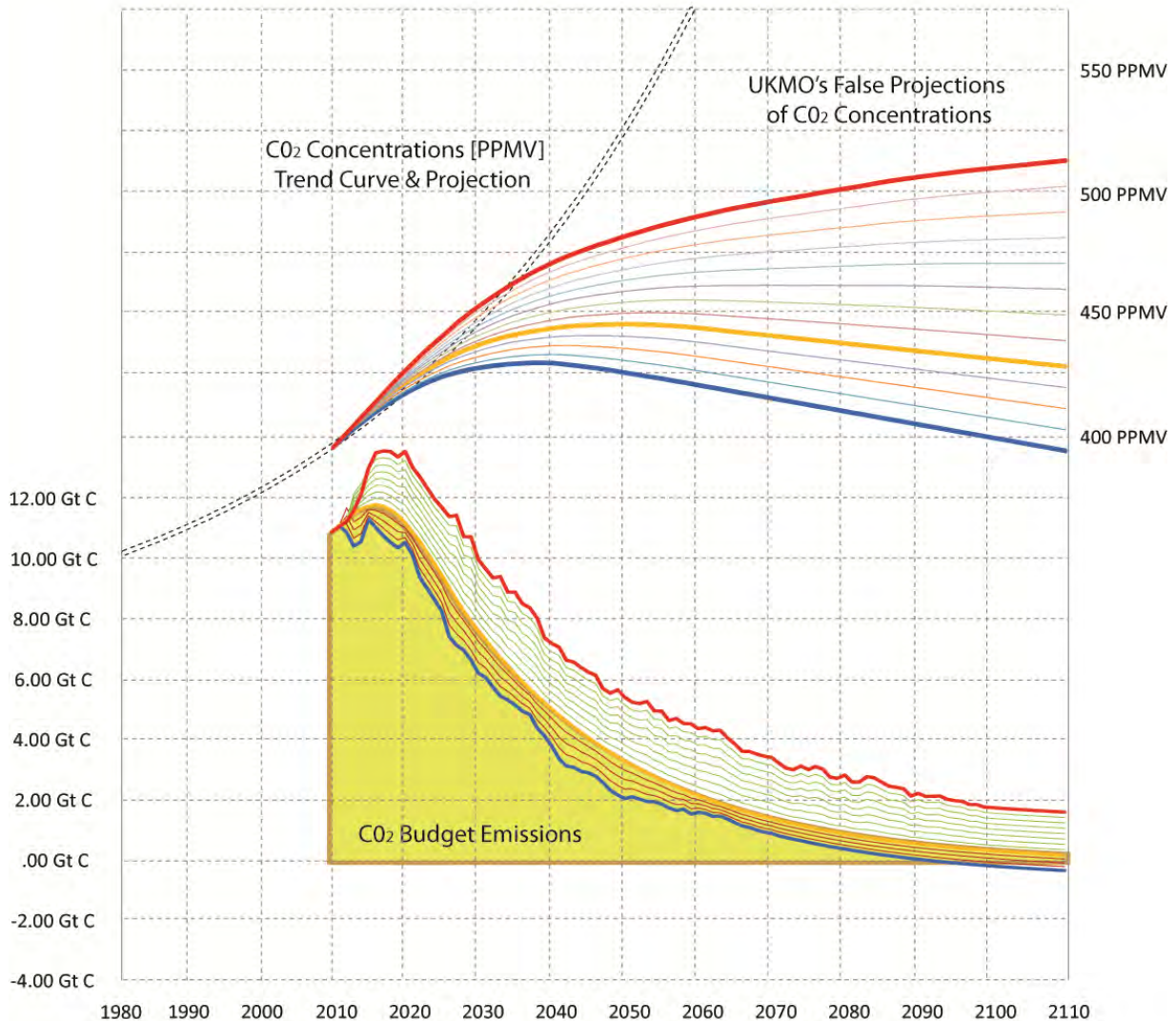
Because of RIAFE, dealing with this 'modelling challenge' is intractable, but in this evidence, GCI also offers a draft suggestion of what this new approach needs and might begin to look like: -

<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>

"Keeping Control Curves?"

FALSE EQUILIBRIUM BEHAVIOUR

**By omitting CLIMATE FEEDBACK EFFECTS from the Climate Act
UKMO falsely project only 'Keeping Control Curves'**



"The scientific models mostly leave out dangerous feedbacks/tipping points. At 6°, 5°, 4° or below, the probability of passing some tipping points, such as Permafrost melt may be high. If modellers cannot capture of model effects 'sufficiently clearly', they are omitted, but best guess is surely not zero. We need a new approach."

Nicholas Stern to IMF, May 2013

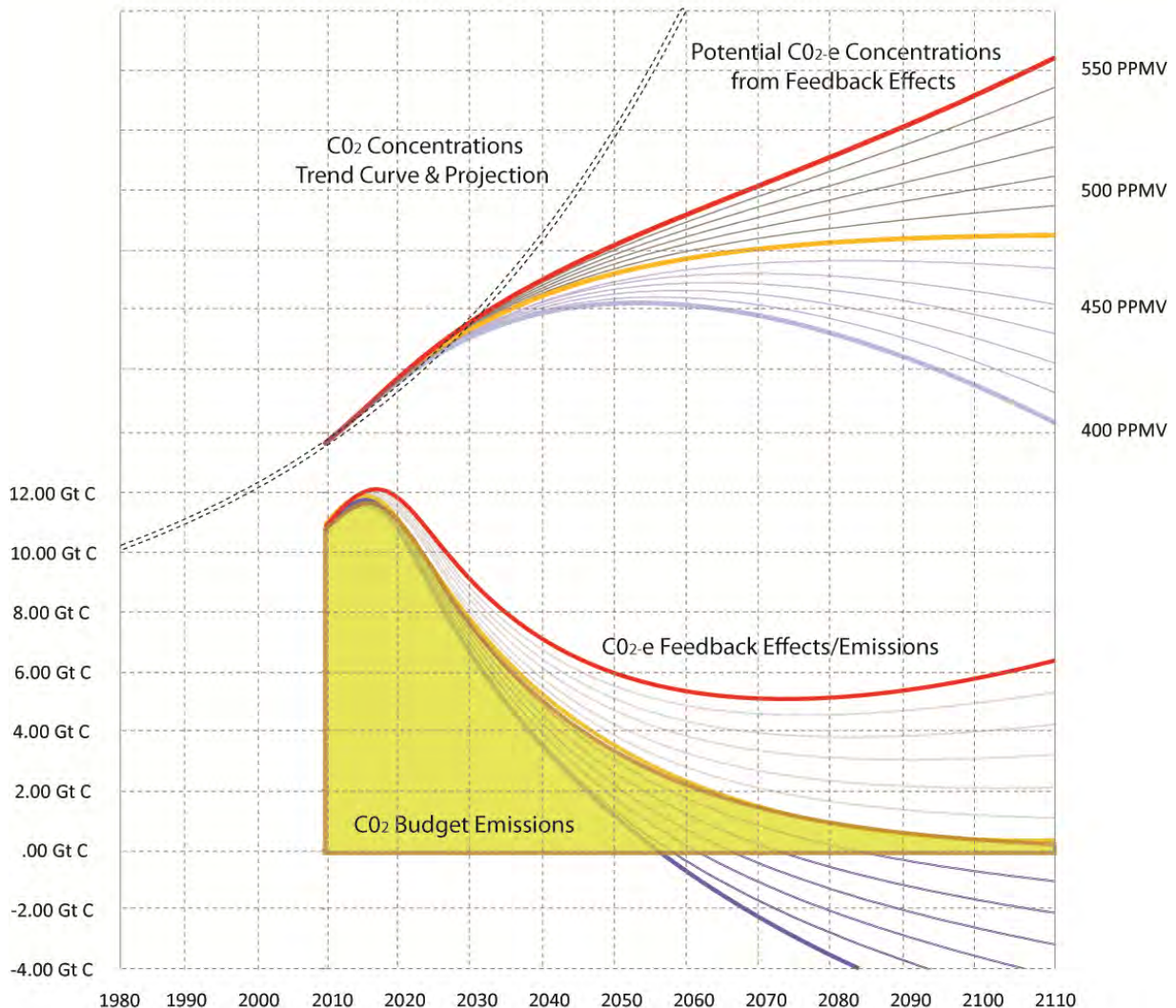
"All climate projections in the IPCC 5th Assessment, due for release in 2013-14, are likely to be biased on the low side relative to global temperature because the models did not include Permafrost carbon feedback. So target based on these climate projections would be biased high."

Policy Implications of Warming Permafrost, UNEP 2012

"Loss of Control Curves?"

POTENTIAL RUNAWAY BEHAVIOUR

**By admitting CLIMATE FEEDBACK EFFECTS to the Climate Act
Trend-Logic augurs the potential for *'Loss of Control Curves'***



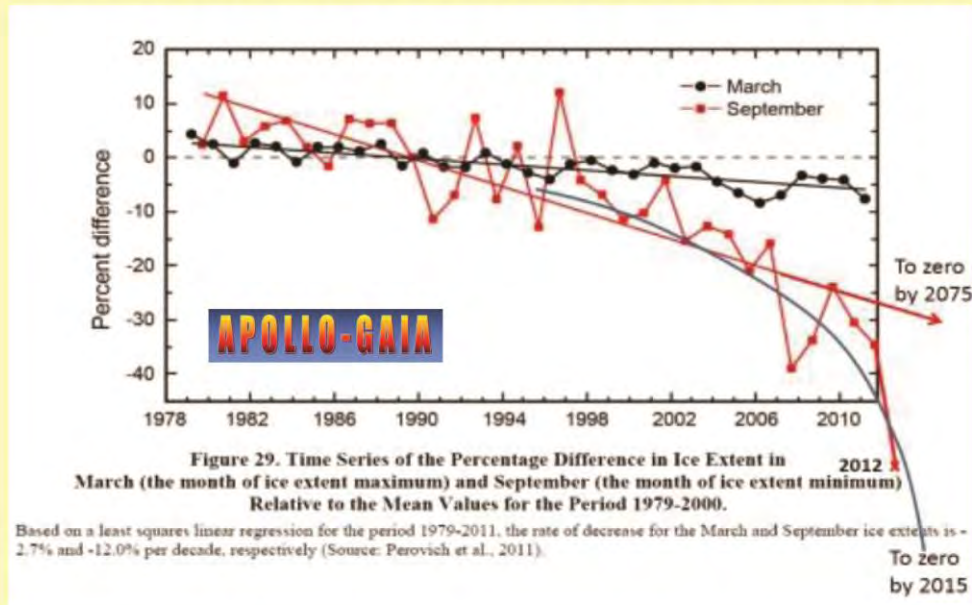
"The UKMO/CCC scenarios mimic a conceptual shortcoming in models over the last 17 years. Tipping points and the most important feedback effects leading to these, are still not in the climate-models being used."

GCI to EAC Enquiry, June 2009

"We must be precautionary and not run risks we cannot afford to run. The rates of CO2-emissions & concentrations considered in this study recognize that a steady rate of feedback acceleration in the years ahead, makes it possible to contemplate a scenario where positive feedback, for example from Permafrost melt, is driving the system as a whole from a point after which 'human-budget emission-control' becomes irrelevant. In 2013 it is of great concern that these feedback effects continue to be absent from UKMO's Climate-Models and the RCP scenarios being fed into IPCC AR5."

GCI to EAC Enquiry, May 2013

Accelerating collapse of Arctic 'ice-mass' due to warming 1978-2012, augurs zero-summer-ice by 2015.



Arctic area circumscribed by global permafrost area.



One of the effects of this is to accelerate permafrost melt.

"An Extra 1.9 Trillion tonnes Carbon just from CO₂." [CH₄ omitted].

"Ticking Arctic Carbon Bomb may be bigger than thought."

American Association for the Advancement of Science, December 2012

Science

AAAS

"Climate models exclude Permafrost Carbon Feedback." UNEP [2012]

Arctic ice collapses in local runaway rates of climate change before our eyes.

UKMO's "Jewel in the Crown" Climate Model, "entirely misses this point".

For 'illustrative purposes', here's a rate estimate of only CO₂ release from Permafrost Melt to 2210.

In this, UKMO's feedback-free decelerating "Keeping Control Curves" at their 90%-ile rate, are compared with GCI's slowly accelerating "Loss of Control Curves" curves.

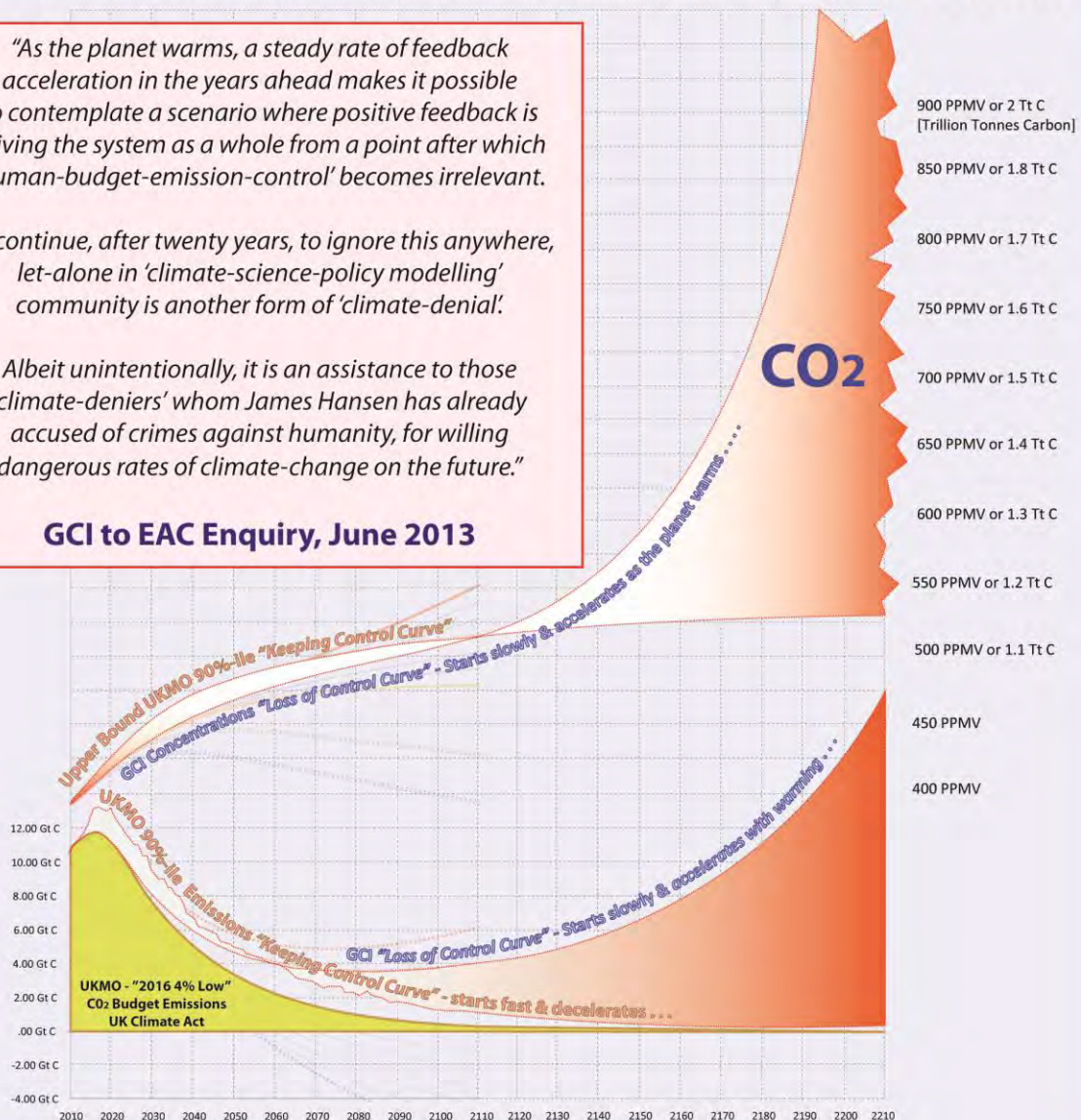
While, for the first 50 years, the emissions difference doesn't appear that great, the concentration differences are, because UKMO's 90%-ile curves unrealistically decelerate but GCI's curves do not.

"As the planet warms, a steady rate of feedback acceleration in the years ahead makes it possible to contemplate a scenario where positive feedback is driving the system as a whole from a point after which 'human-budget-emission-control' becomes irrelevant.

To continue, after twenty years, to ignore this anywhere, let-alone in 'climate-science-policy modelling' community is another form of 'climate-denial'.

Albeit unintentionally, it is an assistance to those 'climate-deniers' whom James Hansen has already accused of crimes against humanity, for willing dangerous rates of climate-change on the future."

GCI to EAC Enquiry, June 2013



The EAC Enquiry is into Global, International and UK Carbon Budgets as defined by the UK Climate Act [UKCA]. The Act consists of the: -

- a. Global CO2 Emissions 'Contraction & Concentrations' scenario ['2016 4% Low' 2000-2100] which came from the UK Meteorological Office [UKMO] and
- b. UK share of this using the 'Contraction & Convergence' [C&C] methodology which came from the UK Climate Change Committee [CCC].

1. The Act needs revision. As it stands, as it is inadequate, opaque, prescriptive and misleading because of the: -

- a. UKMO's omission of major feedback effects from calculation of 'Contraction & Concentrations' scenario & CCC giving only 44% odds for success avoiding more than a 2° temperature rise.
- b. Emissions 'Contraction' should be complete globally by 2050 if, once 'feedback effects' are included, we are to give better than 50:50 odds for keeping within the 2° rise.
- c. CCC also prescribing 2050 as the International 'Convergence' year, foregoing the need for any international negotiation of this date.

2. Together, these UKMO-CCC components present an opaque 'science-policy' hybrid where the: -

- a. Climate-model is an opaque 'black-box' obscuring the error of feedback-omission and
- b. Economic-model comes from a suite of opaque 'black box' models based on this, which in turn conceals incomplete, contestable and misleading economic computations of 'price and tax-signals' and also contains no damage function at all.

3. On the science side of the hybrid, the UKMO: -

- a. Omitted major feedback effects from '2016 4% Low'. Even now this is still not corrected and also appears likely to inform IPCC AR5 Working Group One due this year or next;
- b. Gave retained airborne fraction of anthropogenic emissions greater than 100% by 2050. In the light omitted feedbacks. In the light of 'a', this is an untrustworthy result;
- c. This was ignored when pointed out by GCI to UKMO in the EAC Enquiry 2009: - http://www.gci.org.uk/Document/GCI_EAC.pdf
- d. UKMO/CCC gave a 56% probability for failing to keep UNFCCC-compliance as temperature rose to and then beyond 2° Celsius;
- e. A UKMO spokesman has implied since then that the figures and values were actually for 'illustrative purposes only'.

4. On the policy side, the Climate Change Committee: -

- a. Uncritically accepted the UKMO's feedback-free Contraction:Concentration projections;
- b. Super-imposed on that international budgets derived from a prescription for a convergence date of 2050 [C&C 2050] and with this prescribed rate, helped to cause a major international incident at COP-15 in December 2009, over the perceived unfairness of this rate of Convergence by 2050 and its prescription;
- c. This issue was pointed out to UKMO/CCC in EAC's Enquiry in 2009 well before COP-15.
- d. The Chinese Government had offered to negotiate from immediate convergence: - http://www.gci.org.uk/UNFCCC_Submission.html
- e. However, this rate of 'C&C-2050' supported by other Europeans is now prominent in IPCC AR5 Working Group Three. At present C&C 2050 is written into the Summary for Policy Makers in WGIII which persistently and wrongly attributes this convergence rate to GCI, misquoting the source literature cited.

5. The misleading effect of this 'science-policy hybrid is to project the idea that: -

- a. We only face only the inconvenience of 'control-curves' – or *deceleration* curves – when feedbacks mean what we face is the potentially catastrophic consequences of 'loss-of-control-curves' – or *acceleration* curves.
- b. An opaque and feedback-omitting climate-science model is a sufficient basis on which to reliably predict future rates of climate change and UNFCCC-compliance.
- c. The UK share of this model using convergence as described by the Climate Change Committee [CCC]: - <http://www.climateconsent.org/flash2/turner.html> is a fair and sufficient basis upon which to *prescribe* the year 2050 for the future convergence to equal per capita sharing arrangements for UNFCCC-compliance.
- d. This in turn is a sufficient basis on which to use opaque and contestable economic models to estimate the 'price of carbon' or rates of 'carbon-tax' as a function of that procedure.

It would be extremely foolish to continue to deceive ourselves about these matters. To recover, we must be precautionary and not run risks we cannot afford to run. The rates of CO₂ emissions and concentrations contemplated in this study, recognize that a steady rate of feedback acceleration in the years ahead makes it possible to contemplate a scenario where positive feedback is driving the system as a whole from a point after which 'human-budget-emission-control' becomes irrelevant.

Consequently, there are two simple messages here. We need to: -

1. Leave fossil carbon [oil coal & gas] in the ground, all things considered it is 'cheaper';
2. Get on with the C&C organised control of 'human-budget-emissions' as quickly as possible.

6. So we urge EAC to recommend to the Government the need to: -

- a. "Understand the need for education to the scale of the challenge for the whole of the planet;" <http://www.youtube.com/watch?v=M1ampl1XAzs> [Turner Walley EAC 2009]
- b. Be strategically goal-focused on the absolute priority of UNFCCC-compliance [safe and stable GHG concentrations];
- c. Be seen to be committed to solving the problem faster than we are creating it;
- d. Recognize that the UK's transition to a net-zero-carbon future must be accelerated;
- e. Represent and include all feedback effects and the potential for RIAFE in climate models;
- f. However difficult, these feedbacks can no longer credibly be modelled as 'zero';
- g. Separately, measure rates of feedback-emissions as distinct from budget-emissions;
- h. Integrate these measurements into future science-policy models for UNFCCC-compliance noting, while the former accelerate and are uncontrollable, only the latter are controllable and that the former have a growing potential to overwhelm efforts to control the latter the longer we delay that control;
- i. Develop, from that safe and stable ppmv value, an inclusive, transparent & precautionary C&C-based policy strategy at rates consistent with UNFCCC-compliance;
- j. Transparently *negotiate* and not *prescribe* an accelerated rate of international convergence to a year that is 'agreed-by-the-majority-to-be-fair' within that C&C scenario;
- k. Move beyond models of 'carbon-pricing' in a 'Carbon-Market-Based Framework' where global climate is simply seconded to being a derivative of the global economy.
- l. Make all 'tax-rating' and 'carbon-pricing' a function of that 'Precautionary-Framework-Based-Market', in other words . . .
- m. Make efforts towards 'green growth' and 'ecological recovery, 'C&C-led' not 'price-led';
- n. Leave fossil carbon [oil coal & gas] in the ground as it is both safe and cheaper;
- o. Get on with the control of 'human-carbon-budget-emissions' and the conversion to non-carbon alternatives as quickly as possible.

THE UKMO ADMIT FEEDBACKS ARE OMITTED FROM THEIR MODEL

In June 23 2009 Professor Mitchell of the UKMO claimed to the EAC Enquiry that all relevant feedbacks were in the climate models behind the UK Climate Act: -

"The models will take into account all the feedbacks we are aware of that we think are important, then we can quantify that we understand, and to that extent the Climate Change Committee has obviously done that.

Science being science, we uncover new feedbacks and there is a delay in being able to incorporate those in the complex models.

One can use simple models to get, if you like, a fast-track estimate of what the effect would be, but one would have to refer to the more complex models to make sure that when you add that additional feedback you are actually taking into account all the processes that are important."

This was an incorrect and misleading statement. The UK Climate Act is a product of this and in November 2010 the UKMO put the following admission on its website: -
<http://www.metoffice.gov.uk/climate-change/guide/science/explained/feedbacks>

Are there feedbacks that *aren't* included in the models?

"There are some feedbacks we have recognised but remain big uncertainties. We don't know enough about them to include their effects in climate models. However, they are potentially very serious so there is still a lot of work going on to try to understand them and get them into our projections."

Methane hydrates (positive feedback)

"These are potentially a very big deal which could change our whole understanding of climate change, but it's very uncertain.

There are very large stores of methane locked away at depth in the ocean. We know the stability of these stores is dependent on temperature. As the oceans get warmer it's possible this balance could be upset and the stores released — which would be very serious. Methane is more than 20 times as potent as CO2 as a greenhouse gas.

There's some evidence to suggest that going back over a very long historical period (more than millions of years), the release of these methane stores may have played a big role in abrupt and severe changes to past climate. How close we are to any possible threshold is very much an open question."

Permafrost methane (positive feedback)

"This is a big question mark but also potentially a very big deal. There are very organic rich soils in certain parts of the world. At higher latitudes, these are frozen over by permafrost, and those greenhouse gases are effectively locked away. When the soil thaws due to rising temperatures, these gases could become unlocked and be released as CO2 or methane. At the moment we don't know how much of the CO2 is stored away or to what extent it would be released when the soil thaws.

These are two key questions, and we need to figure out how to resolve them on a global scale in a climate model before this effect can be included in our projections. Within the next five years we hope to know enough about this process to start including its effects."

Could there be other feedbacks that you don't yet know about?

"Yes, we assume there are hidden feedbacks in the system, but as long as we keep climate change relatively small we can be confident these unknown issues won't come in to play.

However, as we move further away from the present climate, we are exposing ourselves to more risk about these unknowns. Even only taking into account the climate feedbacks we are aware of now, they pose a great incentive for us to quickly reduce our greenhouse gas emissions to keep global temperature rises to a minimum."

Last Updated: 29 November 2010

Aligning itself with the RCP scenarios apparently now the base of IPCC AR5, UKMO published the 'Advance Paper' in 2010 last updated 29/04/2013: -

<http://www.gci.org.uk/Documents/advance.pdf>

The climate-modelling in this paper continues to omit the feedbacks listed on page 18 of the 'Advance' document, as do the RCP scenarios with which UKMO aligned itself

"We will continue to improve the representation of processes included in our model.

There are also a number of processes not currently included that could potentially have a major impact on the degree of warming for a given emissions scenario, quite apart from their impact on local and regional climate. Some of these processes have been discussed here and we are actively working on including them in the model: -

- The impact of ozone on plants reduces their ability to take up carbon. Given their major implications for international technology and economic development, policy decisions on climate change must be underpinned by the best possible evidence.*
- The deposition of black carbon on snow changes the reflectivity of the surface leading to more warming at high latitudes. Other processes are less well understood but are actively being researched with a view to including them in future models.*
- The ability of plants to take up carbon may be limited by the supply of nitrogen available naturally, but may be enhanced by man-made sources of nitrogen. Climate change itself may also increase available nitrogen and stimulate plant growth.*
- The thawing of permafrost may lead to large amounts of carbon release, but these processes are not well understood.*
- Dynamic ice processes could speed up freshwater supply from glaciers into the ocean.*
- The processes that affect methane in the Arctic Ocean could lead to increased methane release (the science is poorly understood so may take longer to include in models).*

The international science community is working hard to understand and narrow the uncertainties in future climate projections — and it is doing this primarily through model inter-comparison projects, comparison with observations, and the synthesis of results by the next IPCC report.

Understanding the interactions within the Earth system is critical."

"All climate projections in the IPCC Fifth Assessment Report, due for release in 2013-14, are likely to be biased on the low side relative to global temperature because the models did not include the permafrost carbon feedback."

In 2012, UNEP published *"The Policy Implications of Warming Permafrost."*

In the executive summary it made the following statements about IPCC AR5 and the omission of carbon feedback in the climate models that under-pin AR5.

"All climate projections in the IPCC Fifth Assessment Report, due for release in 2013-14, are likely to be biased on the low side relative to global temperature because the models did not include the permafrost carbon feedback."

Consequently, targets for anthropogenic greenhouse gas emissions based on these climate projections would be biased high.

The treaty in negotiation sets a global target warming of 2°C above pre-industrial temperatures by 2100.

If anthropogenic greenhouse gas emissions targets do not account for CO₂ and methane emissions from thawing permafrost, the world may overshoot this target."

UNEP [2012]

"Policy Implications of Warming Permafrost."

<http://www.gci.org.uk/Documents/permafrost.pdf>

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As things stand, this message from UNEP confirms the danger, indeed the likelihood that IPCC AR-5 will continue the pattern established over the past twenty years of under-estimating and under-representing the real risks we face.

Sir Robert Watson [a former Chairman of the IPCC at the time of the IPCC Third Assessment Report] said in a public session in San Francisco in December 2012: -

*"We were careful and conservative. If we had a strong statement subsequently proved wrong, we would lose all credibility as a scientific community. I thought we should always be slightly on the side of conservative. Otherwise we were going to get ripped apart by climate-deniers even for the simplest mistake."*

This is not just erring towards 'conservatism'. That suggests we face merely the inconvenience of 'control-curves' – or *deceleration* curves. Feedbacks mean what we face is the potentially catastrophic consequences of 'loss-of-control-curves' – or *acceleration* curves.

James Hansen has already

This is why we make the assertion that omitting feedbacks from the models: -

*" . . . unintentionally provides assistance to 'climate-deniers' against whom James Hansen has already and rightly levelled the charge of crimes against humanity for willing dangerous rates of climate-change upon the future."*

Nicholas Stern, author of the 2006 Stern Report, made a presentation in DAVOS in January this year saying: -

*"I got it so wrong on climate change, its far, far worse."*

<http://www.guardian.co.uk/environment/2013/jan/27/nicholas-stern-climate-change-davos>

Who advised him at the time of the original report?

Who advises him now when tells the IMF: -

***"The scientific models mostly leave out dangerous feedbacks/tipping points. We need new generation of models."***

In May 2013, the IMF published slides from a presentation there by Nicholas Stern.

On slide 9 and 10 Stern also points to the omission of melting Permafrost feedbacks and tipping points: -

*"The scientific models mostly leave out dangerous feedbacks/tipping points.*

*At 6°, 5°, 4° C or below, the probability of passing some tipping points, such as melting of permafrost, may be high. If modellers cannot capture or model effects 'sufficiently clearly' they are omitted. But best guess surely not zero.*

*The models are not built in a way that help us describe the impacts on people:*

*At sea level (SL) 2m higher a few hundred million might have to move (Nicholls, et al., 2011);*

*-At 3-4-5°C may see radical monsoon changes in India and substantial changes in flows of major rivers off the Himalayas (a billion plus people depend on them). Desertification of southern Europe?*

*Models should focus on understanding probabilities of events with severe consequences for people rather than on those bits which (on narrow assumptions) seem more tractable, such as change in agricultural output, relative to those effects that can be modelled more easily.*

*We need new generation of models."*

### **Nicholas Stern to IMF May 2013**

[http://www.gci.org.uk/Documents/Stern\\_IMF.pdf](http://www.gci.org.uk/Documents/Stern_IMF.pdf)

## What follows is an assessment of the 'Feedback-Free' Contraction:Concentrations Budget – or the opaque science/policy hybrid – that is the UK Climate Act

### 1. Opposite is an image showing the primary features of the Global 'CO<sub>2</sub>-carbon-emissions-contraction-budget' in the UK Climate Act which: -

- Is called '2016 4% Low'
- Flows from 2010 to 2110
- Peaks in 2016 at 11.8 Gigatonnes Carbon [Gt C]
- Declines on average thereafter at 4% per annum
- Until by 2110 it has reached an output value of 0.3 Gt C per annum
- Weighs a total of 395 Gt C between 2010 and 2110.

This is identical to the CBAT Medium Carbon-Emissions-Budget: -

<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>

The image also shows the range of atmospheric CO<sub>2</sub> concentration values calculated by UKMO as in the UK Climate Act.

They are measured in: -

- Parts Per Million by Volume [PPMV]
- And also as Weight in Gigatonnes Carbon [Gt C].

This ranges through: -

- 10%-ile [the lowest]
- To 90%-ile [the highest]
- With the '*Median*' case in between
- Median is what UKMO call, '*the most probable*'
- UKMO calculate that *Median* concentrations
- peak at 445 PPMV or 949.38 Gt C in 2050 and
- fall to 426 PPMV or 910.24 Gt C by 2100.
- this means that with the *Median* case, 19 PPMV or 39.14 Gt C
- was *removed* from the atmosphere 2050-2110 [equivalent to *negative* feedback]
- this also means that in total over the period 2010-2110
- while the human budget emissions in 2016 4% Low totalled 395.95 Gt C
- with *Median* only a net total of 35.35 Gt C was added to the atmosphere

This result is very questionable, even without feedback fully integrated in UKMO's model. When feedbacks omitted are added, UKMO's Median result is wholly implausible.

- In 2009, UKMO claimed to EAC that all relevant feedback effects were in their model
- UKMO admitted in 2010 various feedback effects had been left out of their model
- Saying in 2010 that they were committed to including them in
- However, nothing substantive has been done until now [2013]
- As the planet warms the net effect of these will be *positive* [not *negative*] feedback
- If feedback effects are added to the model - which they urgently need to be – UKMO's concentrations results are seen as under-estimates and misleading.
- It would be appropriate for the EAC to cross-examine UKMO closely on this.

These results are not the same as the CBAT Medium Carbon-Concentration-Profiles, as CBAT begins to lay out the basis for adding feedback effects in a measured and structured way.

However, CBAT enables users to switch-on and super-impose the UK Climate Act Emissions Budget & Atmospheric Concentrations on output from the CBAT methodology for the purposes of comparison see pages 39 – 43 and here: -

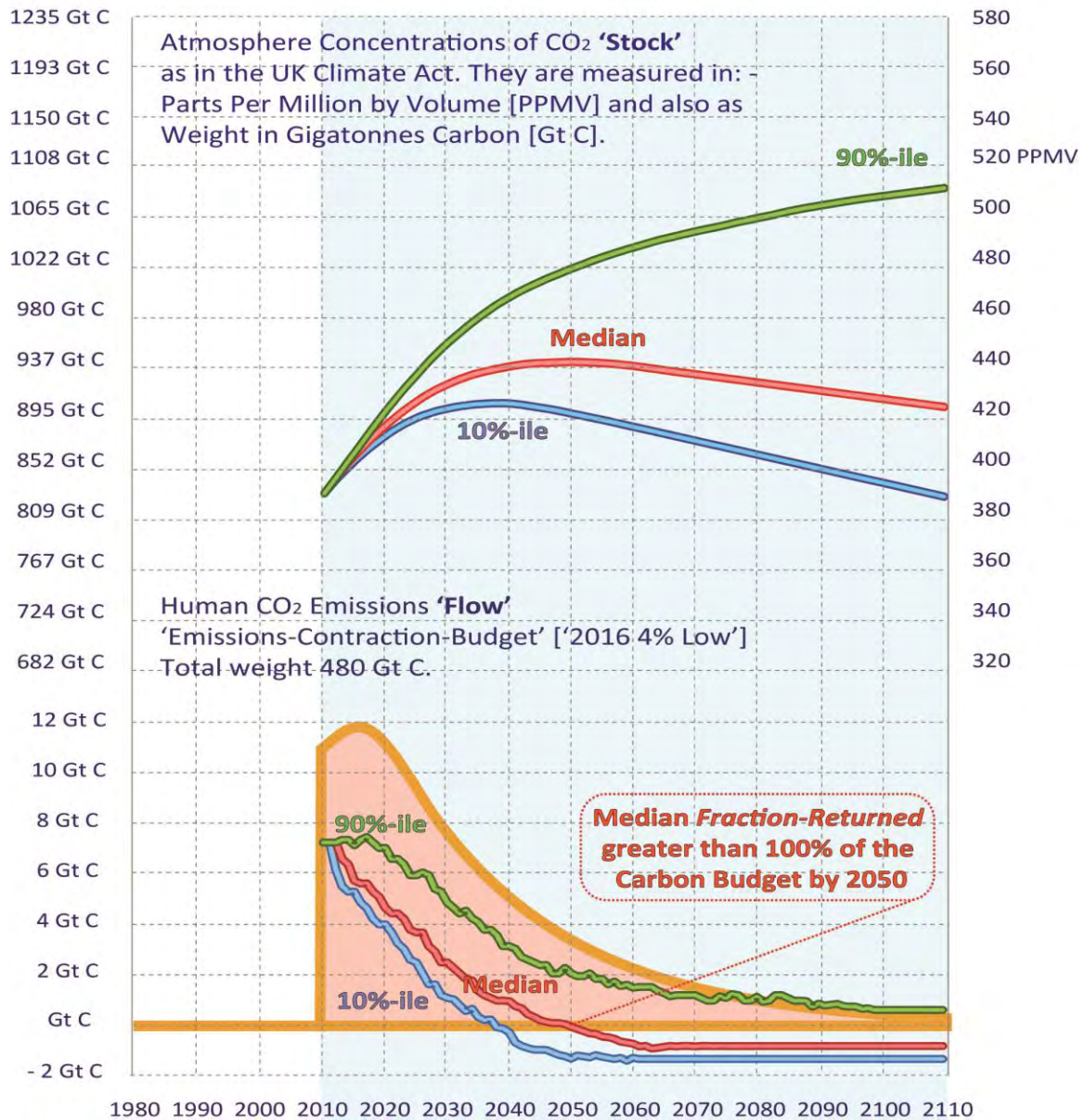
<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>



## UK Climate Act CO<sub>2</sub> 'Contraction' '2016 4% Low'

### UKMO PPMV Range 10%-ile, Median, 90%-ile

**NB - UKMO allege the sink is greater than the source [than 100% of the Carbon Budget by 2050] for MEDIAN 'Fraction-Returned' & is the 'most probable' PPMV path.**



At the EAC Enquiry in 2009, the UKMO insisted that UK Climate Act CO<sub>2</sub> 'Emissions-Contraction-Budget' [2016 4% Low] & the PPMV range '10%-ile, Median, 90%-ile', included all relevant feedbacks.

UKMO gave the 'Median' case as '*most probable*', while giving only 44% odds of keeping within 2 Degrees Celsius.

They admitted later that major feedbacks were omitted from this model and that this was a '*big deal*'.



**2. Opposite are two images detailing how UKMO stated in a supplement to the EAC Enquiry in 2009 ['answering GCI'] to have incorporated the Coupled-Carbon-Cycle modelling in IPCC AR4 from the C4MIP programme, into the global 'CO<sub>2</sub>-carbon-emissions-contraction-budget' on which the UK Climate Act is based.**

This is what UKMO stated in the memo: -

*"The models used by the Committee on Climate Change **did** include a coupling between climate and the carbon cycle & **took full account of the 'coupled' model research** presented in the AR4 WG1 report, the C4MIP study and related research."*

UKMO/Hadley's 'Uncoupled Carbon Budget' for 450 PPMV published in IPCC SAR and TAR: -

- Starting in 2010 at over 11.2 Gt C
- It peaks at around 13 Gt C around 2020
- Shrinks on average by ~ 3% a year by 2110
- When it has reached an output value of ~ 1.5 Gt C per annum
- Between 2010 and 2100 it weighed around 520 Gt C
- **Giving an outcome value for CO<sub>2</sub> concentrations of ~450PPMV or 960 Gt C.**

This is similar to the SRES range of Carbon-Emissions-Budgets for 450PPMV in SAR % TAR: -

UKMO/Hadley's 'Coupled Carbon Budget' for 450 PPMV published in IPCC SAR and TAR: -

- Starting in 2010 at around 9 Gt C
- It peaks at around 10 Gt C around 2020
- Shrinks on average by over 4% year
- And by 2070 has gone to nearly zero emissions
- Which is continued into the 22<sup>nd</sup> Century
- Between 2010 and 2100 it weighed around 295 Gt C [a reduction of over 50%] but
- **Giving an outcome value for CO<sub>2</sub> concentrations of ~450PPMV or 960 Gt C.**

Median CO<sub>2</sub> concentration value calculated by UKMO in the UK Climate Act measured in: -

- Parts Per Million by Volume [PPMV] and as Weight in Gigatonnes Carbon [Gt C].

The UKMO memo stating how the Carbon Budget modelling in the UK Climate Act reflected 'Coupled', compiled a Carbon Budget: -

- That starts in 2010 at 10.9 Gt C
- Peaks in 2016 just under 12 Gt C
- Shrinks on average by 4% a year
- Reaching an output value of 0.3 Gt C by 2100
- Weighing 395 Gt C 2010 – 2100
- Giving a peak value for CO<sub>2</sub> concentrations of PPMV as 445.72 or 949 Gt C in 2050
- **With an outcome value lowered to 427 PPMV or 910 Gt C in 2100**

**GCI's answer to this 'memo' is to point out that to, 'take full account of the Coupling' [in their words] in the UKCA Carbon Budget, what the UKMO did was: -**

- **To add over 114 Gt C or 25% to their 'Coupled Budget' but also . . .**
- **To subtract nearly 60 Gt C from their atmospheric concentration outcome [!]**

***This concentration result is negative feedback. It misled everyone. It was a result that contradicts all the models in the C4MIP study reported in the IPCC AR4, even before addressing the other positive feedback effects. While they subsequently admitted the omission of these, no attention was drawn to the negative feedback UKMO were now claiming for coupled carbon cycling, a totally opposite result.***

## Dr Jason Lowe to the EAC Enquiry into Carbon Budgets in the UK Climate Act 2009:

"I had a look at the submission from the Global Commons Institute last night and the figure I think you refer to comes from IPCC in chapter 10: -

[http://www.gci.org.uk/images/Coupled\\_Uncoupled\\_AR4.pdf](http://www.gci.org.uk/images/Coupled_Uncoupled_AR4.pdf) also animated here: -  
[http://www.gci.org.uk/Animations/BENN\\_C&C\\_Animation.swf](http://www.gci.org.uk/Animations/BENN_C&C_Animation.swf)

In this context, 'uncoupled' refers to whether temperature feeds back onto the carbon cycle, so where the temperature and rainfall can affect how trees take up carbon, and it has a very particular meaning.

For the curve in question, basically you run the model without this effect of climate feedback on to trees and the biosphere and you get one number, you run it again with this effect, the coupled version, you get a different number.

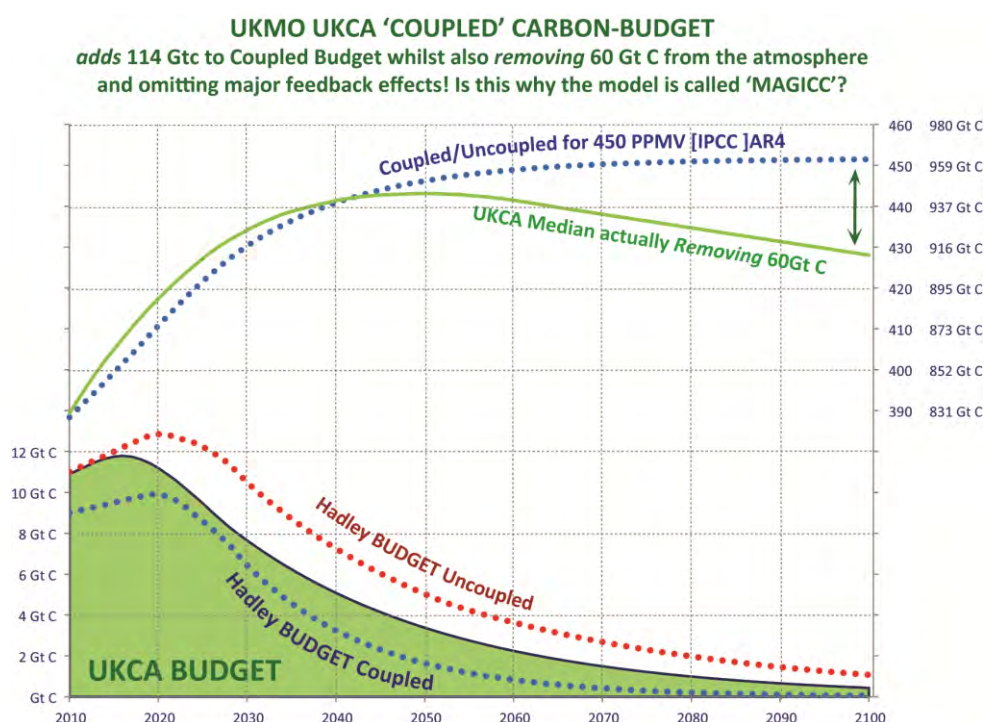
**If you have got the same emissions going in, the coupled version leads to typically a higher concentration because you are increasing the emissions that come back from the biosphere. [i.e. a positive feedback].**

The runs that the Climate Change Committee used to include those feedbacks, so in that definition they were described as coupled. The precise values we use to work out the magnitude of the coupling comes from elsewhere in IPCC and from a study referred to as a C4MIP study, which to date is the most comprehensive analysis of that particular type of feedback onto the carbon cycle."

**However, Dr Lowe must have known at that moment that coupled carbon cycling had been modelled in the UK Climate Act as a 'negative feedback' with falling not rising concentrations [as below] as the Climate Act became UK legislation in 2008.**

**Moreover, he and his colleagues have been modelling this as *negative* feedback ever since [see pages 29 to 34 this evidence] and have played a part in causing this *negative* feedback to be the basis of the RCP scenarios now informing IPCC AR5.**

**The spontaneous removal of CO<sub>2</sub> from the atmosphere is like the holy grail of carbon-management and UNFCCC-compliance. Why would we be spending billions of pounds on Carbon Capture and Storage, when 'Nature' is doing it for us?  
Or is there some 'non-scientific reason for projecting all this?**



**3. UKMO claims that by 2050 atmosphere concentrations of CO<sub>2</sub> are *falling* as '*most probable*'. This is because they claimed that CO<sub>2</sub> sinks are removing more than 100% of human source emissions from 2050. With feedbacks omitted this is '*most improbable*'.**

Here, the 'Stock' array of atmosphere concentrations of CO<sub>2</sub> is converted to weight so it can more easily be compared with the annual 'Flow' of CO<sub>2</sub> emissions in the 'carbon-budget'. This way we can easily assess a 13-step range for the changing 'Airborne Fraction of Emissions' in the different concentration pathways from: -

- The 10%-ile, the lowest concentration returning to 390 PPMV, adding 4 steps to the
- Median - UKMO's '*most probable*' pathway to 427 PPMV, with a further 7 steps to
- The highest concentration, the 90%-ile rising to 516 PPMV.

With UKMO's 'Median' case, the model states that by 2050, *concentrations are falling* as sinks are re-absorbing more than the sources of human emissions coming from the Climate Act's 'carbon-budget' from 2050. *With feedbacks omitted this is 'most improbable'*.

We have chosen to call this result, '*greater than 100% sink-efficiency by 2050*'. The UKMO are welcome to disagree with this term and to call it whatever they choose. However, changing the name won't change what is revealed in the numerical analysis of what they published in the UK Climate Act – i.e. that sinks are absorbing more than sources by 2050.

The carbon-budget is primarily *fossil*-carbon. Once burned it has to go somewhere. What doesn't stay in the atmosphere [the fraction *retained*] goes into the *biological* sinks on land and in the ocean [fraction *returned*]. In reality, that is true only to the extent these sinks hold up and can absorb this huge and sudden addition of carbon. With various feedbacks omitted from UKMO's model, this result is unrealistic and untrustworthy as a basis for strategic and precautionary global climate policy. Moreover, the UK Climate Act CO<sub>2</sub> 'Sink Function' from 10%-ile to 90%-ile covers the extreme range of: -

- 0% - 70% *Fractions-Retained* or
- 100% - 30% *Fractions-Returned*

Depending on the position selected, the whole budget is re-absorbed [*returned* in position 1] through to three quarters of it remaining in the atmosphere [*retained* in position 13]. This is not a small range of possibilities [uncertainties] it is *huge*. In policy terms it's like saying the car-speed-limit is somewhere between plus and minus 50 mile an hour.

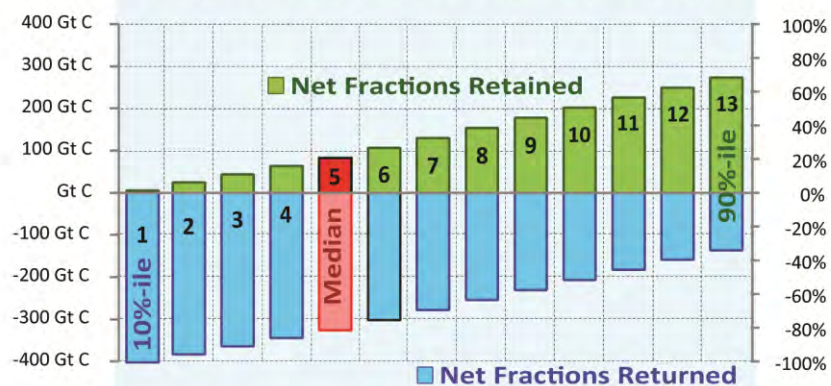
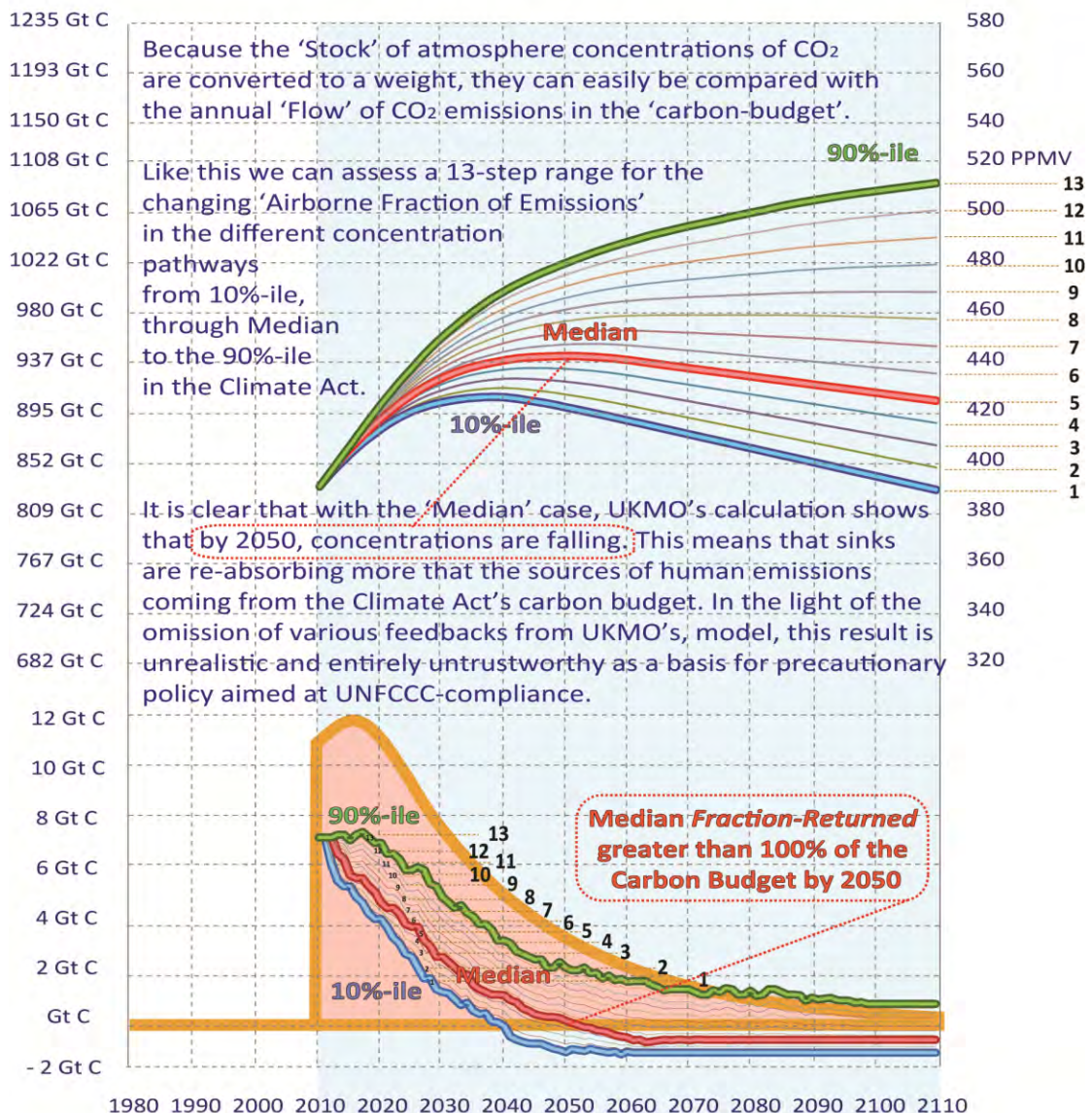
Moreover, GCI is of the view that UKMO climate-modellers have overestimated the capacity of the terrestrial and oceanic sinks to absorb the emissions consequences of burning huge amounts of fossil carbon [oil, coal and gas] that were not in the biological carbon-cycle until they were mined, burned and sent as greenhouse-flue-gas to the atmosphere.

All the extra carbon being dumped in the ocean, as a result of UKMO's Median 'sink-efficiency' would raise CO<sub>2</sub> concentration in the oceans, instead of in the atmosphere, lowering pH. UKMO says this will not lower pH as the 'biological pump' will remove it as the build-up accelerates. This is unsound as the pump operates on a timescale of Decades to Centuries and not the Years to Decades necessary to achieve what UKMO claim.

At this point it is also worth noting that the CO<sub>2</sub> from Permafrost melt is not fossil carbon. However, until the Permafrost melts it is not in the biological carbon-cycle either. As it is released due to melting, it is biological and this is augmented by the soils themselves becoming biologically active and generating more yet more CO<sub>2</sub> from this as well. Estimates in AAAS Science for the scale of just this CO<sub>2</sub> are in the region of an extra 1.9 trillion tonnes of carbon [1.5 Tt C] – see chart page 22.



## UK Climate Act. PPMV Curves converted to 13-step array in Gt C to show Fractions & %s of Emissions-Budget 'Retained' & 'Returned'.



UK Climate Act CO<sub>2</sub> 'Sink Function' Positions 1 - 13 show *huge* range: - 0% - 70% Fractions *Retained* or 100% - 30% Fractions *Returned*

4. Based on the 'Median' case as in UKCA '2016 4% Low', here is the 'carbon-budget' adjusted to the array of concentration pathways - either up or down - so the budget levels are adjusted always to return Median Concentrations whichever of the 13 levels of 'probability' is chosen. So if the Median concentration pathway is not as-stated the '*most probable*', UKMO's huge range creates a policy maker's nightmare. UKMO's approach is perhaps at best 'illustrative' as it is certainly not precise or precautionary.

With the 'Stock' of atmosphere concentrations of CO<sub>2</sub> converted to a weight array, these are easily compared with the annual 'Flow' of CO<sub>2</sub> emissions in the 'carbon-budget'.

Like this we can also adjust the carbon budget for the 13-step array of the changing 'Airborne Fraction of Emissions' in the different concentration pathways in UKCA: -

- From 10%-ile,
- Through Median
- To the 90%-ile

**Since the commitment at COP-15 was not to exceed 2 degrees, which of UKMO's Contraction:Concentrations pathway should we trust?**

Based on UKMO's 'Median' being the '*most probable*' being in their words, values that give us just a '44% chance' of keeping to 2 degrees, we can set these values as the reference-concentrations-case, and adjust UKMO's Carbon-Budget for all 13 positions so that these 'Median' PPMV values are always the outcome. The range of values is huge.

As the chart shows, while a: -

- '10%-ile adjusted budget' could be *increased* from 395 Gt C to 473 Gt C, a
- '90%-ile adjusted budget' needs to be *decreased* from 395 Gt C to just 204 Gt C
- Here is the full set of budget-integrals for adjustments against the array given.

|    |         |          |
|----|---------|----------|
| 1  | 10%-ile | 473 Gt C |
| 2  |         | 453 Gt C |
| 3  |         | 434 Gt C |
| 4  |         | 415 Gt C |
| 5  | Median  | 395 Gt C |
| 6  |         | 371 Gt C |
| 7  |         | 348 Gt C |
| 8  |         | 324 Gt C |
| 9  |         | 300 Gt C |
| 10 |         | 276 Gt C |
| 11 |         | 252 Gt C |
| 12 |         | 228 Gt C |
| 13 | 90%-ile | 204 Gt C |

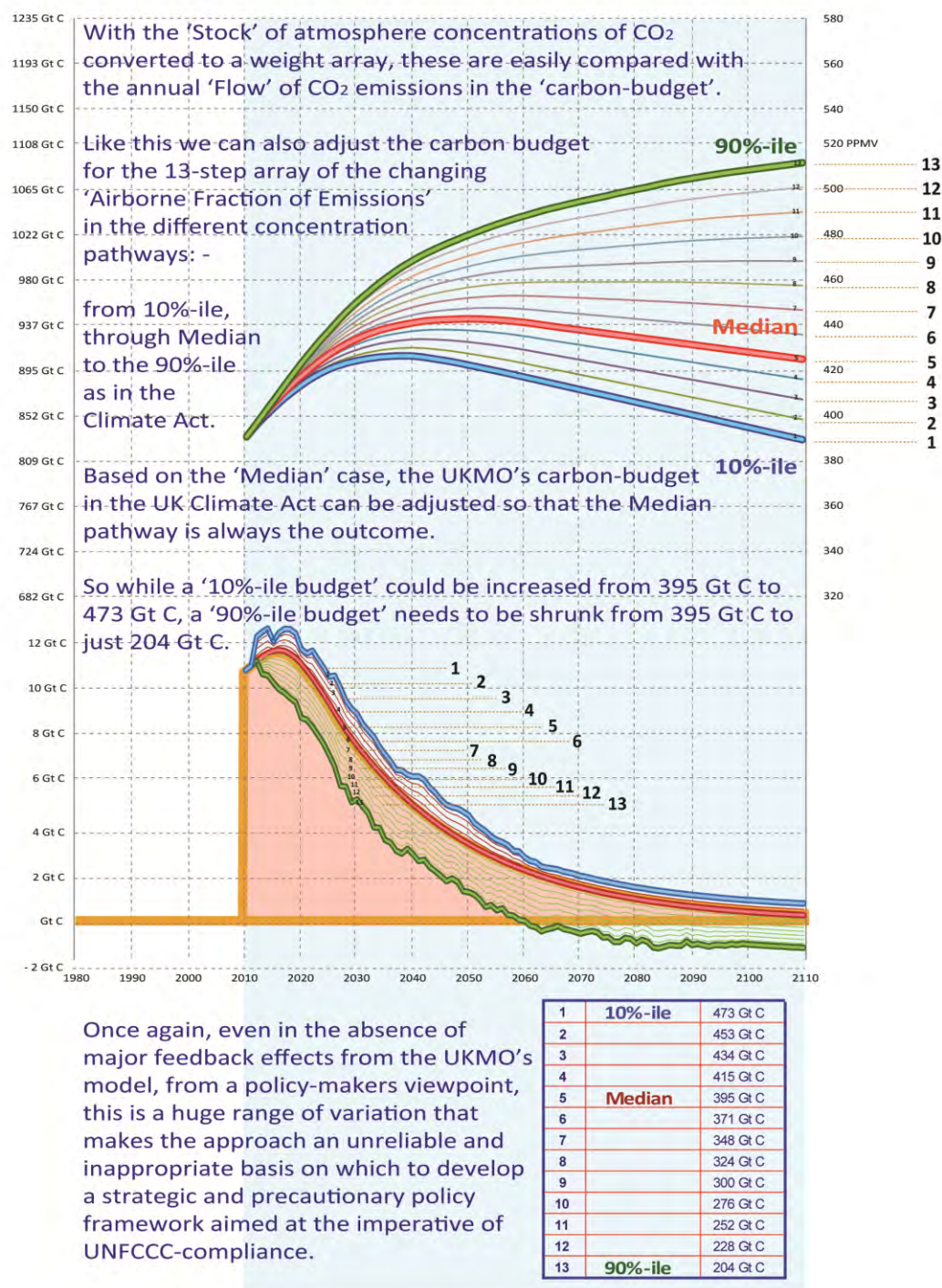
In reality, we need to fix the safe and stable concentration level and be transparent about the precautionary - and the likely - need to accelerate emissions-contraction to achieve it.

As is the UK Climate Act does the reverse. It fixes the budget and presents a huge array of possible concentration outcomes. Moreover, this it should be remembered is *before* a full ensemble of feedbacks has been included in the climate models.

So, even in the absence of these major feedback effects in the UKMO's model, from a policy-makers viewpoint, UKMO's huge range of variation on PPMV outcomes renders their approach an implausible basis on which to develop and then internationally negotiate the sharing of a precautionary carbon-budget with a policy framework aimed at the imperative of UNFCCC-compliance. Once again, UKMO's incomplete approach 'illustrative' as it is not 'precautionary'. Perhaps seeing it more as 'aspirational' than 'rational' is the best that can be said for it.



Based on the 'Median' case equals the 2016 4% Low here is the 'carbon-budget' adjusted to the array of concentration pathways - either up or down - so the budget always returns Median Concentrations



**5. Using the UKMO's '2016 4% Low scenario' the Climate Change Committee prescribed '2050' as the year for completing international Convergence to equal per capita budget sharing globally. "It wasn't just inadequate, it was unfair."**

While the principle of distributing the Contraction-Event with the Convergence procedure to equal per capita sharing globally is widely now accepted, *prescribing* the date – let-alone *that* date [2050] - of Convergence is not.

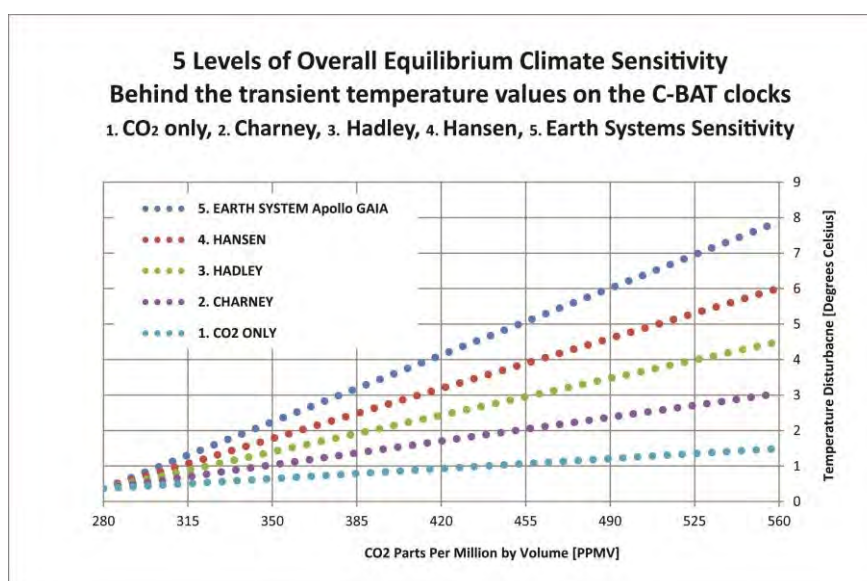
HMG were repeatedly advised by MPs, Select Committees, GCI and others from 2000 onwards to *negotiate* and not to *prescribe* the convergence date. The urgency that arises when the feedback omissions are addressed, shows [as addressed in the previous chart] that a '90%-ile version of the 2016 4% Low Carbon Budget' needs to be shrunk from 395 Gt C to half that size at 204 Gt C\*, i.e. achieving less than zero emissions globally after 2060.

In the light of this, *offering to negotiate a convergence date by 2040, or 2030 or even by 2020* would have been a more politically realistic way, and a more propitious way, to engage at COP-15 with Less Developed Countries [LDCs], whose per capita emissions are still on average, much lower than those of the Developed Countries [DCs] like the UK and the US. The Chinese Government proposed this prior to COP-15 and there is diverse and considerable support for this approach: - [http://www.gci.org.uk/UNFCCC\\_Submission\\_Co-Signatories.html](http://www.gci.org.uk/UNFCCC_Submission_Co-Signatories.html)

Authors of the UK Climate Act know the prescription of 2050 had a disastrous effect at COP-15. With the 'carbon-budget' adjusted to the concentration array so the budget always returns the Median path, the CCC's prescription of Convergence by 2050 was doubly provocative – it was inadequate and it was unfair. As Adair Turner agreed to Colin Challen in the DECC Committee enquiry in 2009, "*if the rate of contraction must be accelerated for reasons of urgency, the rate of convergence must be accelerated for reasons of equity.*"

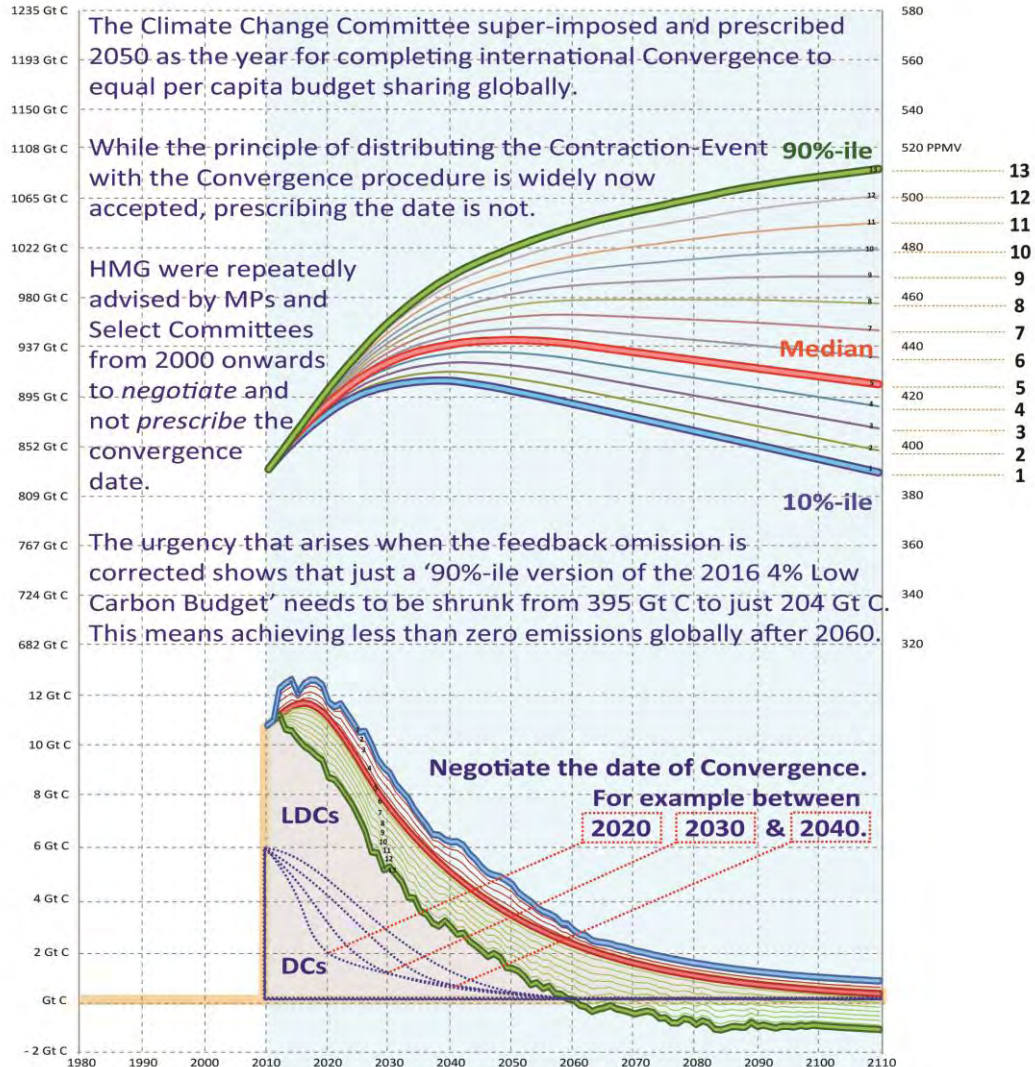
**James Hansen observes a higher level of Climate Sensitivity than UKMO [Hadley]**

This is why Hansen advocates a level of human emissions-control that would return us to 350 PPMV and told the EAC that the 2 degree target in the UK Climate Act and agreed at COP-15 is not safe. As presented in GCI's evidence to EAC in 2009, he argues for a carbon-budget between 124 and 320 Gt C <http://www.gci.org.uk/Documents/Hansen.pdf> & this is nearer the range advocated by GCI [see pages 25/6 & 41]. He calculates this as necessary, arguing that we are dealing with a considerably higher level of climate-sensitivity than the level used by UKMO, as in this 'Climate Sensitivity-Progression' [after D Wasdell] shows: - [http://www.gci.org.uk/Documents/Climate\\_Dynamics2.pdf](http://www.gci.org.uk/Documents/Climate_Dynamics2.pdf)





**With the ‘carbon-budget’ adjusted to the concentration array so the budget always returns the Median path, the CCC’s prescription of Convergence by 2050 was provocative and had disastrous results at COP-15.**



Consequently, if the available Carbon-Budget was as low as 204 Gt C, a figure much nearer to the one advocated by James Hansen and Bill McKibben, negotiating a convergence date by 2040, or 2030 or even by 2020 would be a more politically realistic - even propitious - way to engage with Less Developed Countries [LDCs], whose per capita emissions are still on average, much lower than those of the Developed Countries [DCs] such as the United Kingdom. A lesson for the authors of the UK Climate Act perhaps as the prescription of 2050 proved to have a disastrous effect at COP-15.

## 6. 'Bulge and Trend' – UKMO's opaque and arbitrary array of 'feedback-emissions'

In August 2012, the UKMO-led AVOID programme published a paper titled 'Emissions Pathways to Limit Climate Change': - [http://www.gci.org.uk/Documents/avoid6\\_flyer.pdf](http://www.gci.org.uk/Documents/avoid6_flyer.pdf) CO2 budget-emissions and temperature paths were shown as similar to the Climate Act. However, both CO2 concentration imagery and data were omitted from the paper.

The Director of the AVOID programme was asked to supply that data. He declined saying that there was too much data [*'several tens of thousands of pathways'*] and that the data had not been retained. He was finally forced to provide it under an FOI request where he said that the emissions, concentrations and temperature images were only for '*illustrative purposes*'. However, the same feedback-free modelling picture emerged from this.

Moreover, analysis of his paper in Nature [02 2013], '*A global assessment of the effects of climate policy on the impacts of climate change*' reveals once again, the same 'greater than 100% sink-efficiency by 2050' between emissions and concentrations [see pp 33/34] and: - [http://www.gci.org.uk/Documents/UKMO\\_Nature\\_Climate.pdf](http://www.gci.org.uk/Documents/UKMO_Nature_Climate.pdf)

The Director strongly resisted the suggestion that the UKMO's modelling results in the UK Climate Act were just for '*illustrative purposes*'. But on the evidence, perhaps that's all that can be said for UKMO's approach generally. As-is it means the UK Climate Legislation is just, "*for illustrative purposes only*" – and as-is, these 'purposes' mislead.

**UKMO's approach misleads because it implies we only face the 'control-curves' – in other words, deceleration curves. Feedbacks mean what we may face is 'loss-of-control-curves' – acceleration curves.**

Growth of the Annually Averaged Increments of PPMV CO2 'increase' 1980-2012 & projected to the year 2060 is @ 2.1% a year. If feedback emissions are already happening, this trend curve will include these. However, it will not suddenly '**bulge**' upwards as the UKMO curves show. The growth of these feedback emissions and their effect on, concentrations will be gradual & progressive, as the planet warms over the 21st Century.

Consequently, the 90%-ile, Median [& slightly the 10%-ile] '**bulge**' over that trend-curve, starting in 2010, is unrealistic. The trend average of the 'growth increments' has been at 2.1% per annum. At the outset, UKMO's curves for Median & 90%-ile upwardly violate this trend. This too makes UKMO's concentration curves arbitrary and unrealistic.

The growth of feedback emissions will **not** [as shown here] suddenly '**balloon up**' and then stop and reverse further increase, holding in line with the 'Median adjusted Budget'.

The way the UKMO have treated feedbacks they regarded as relevant, is to have created this quite arbitrary '**bulge**' above the CO2 concentrations growth trend, in order to then portray that the curves slow & come down sharply.

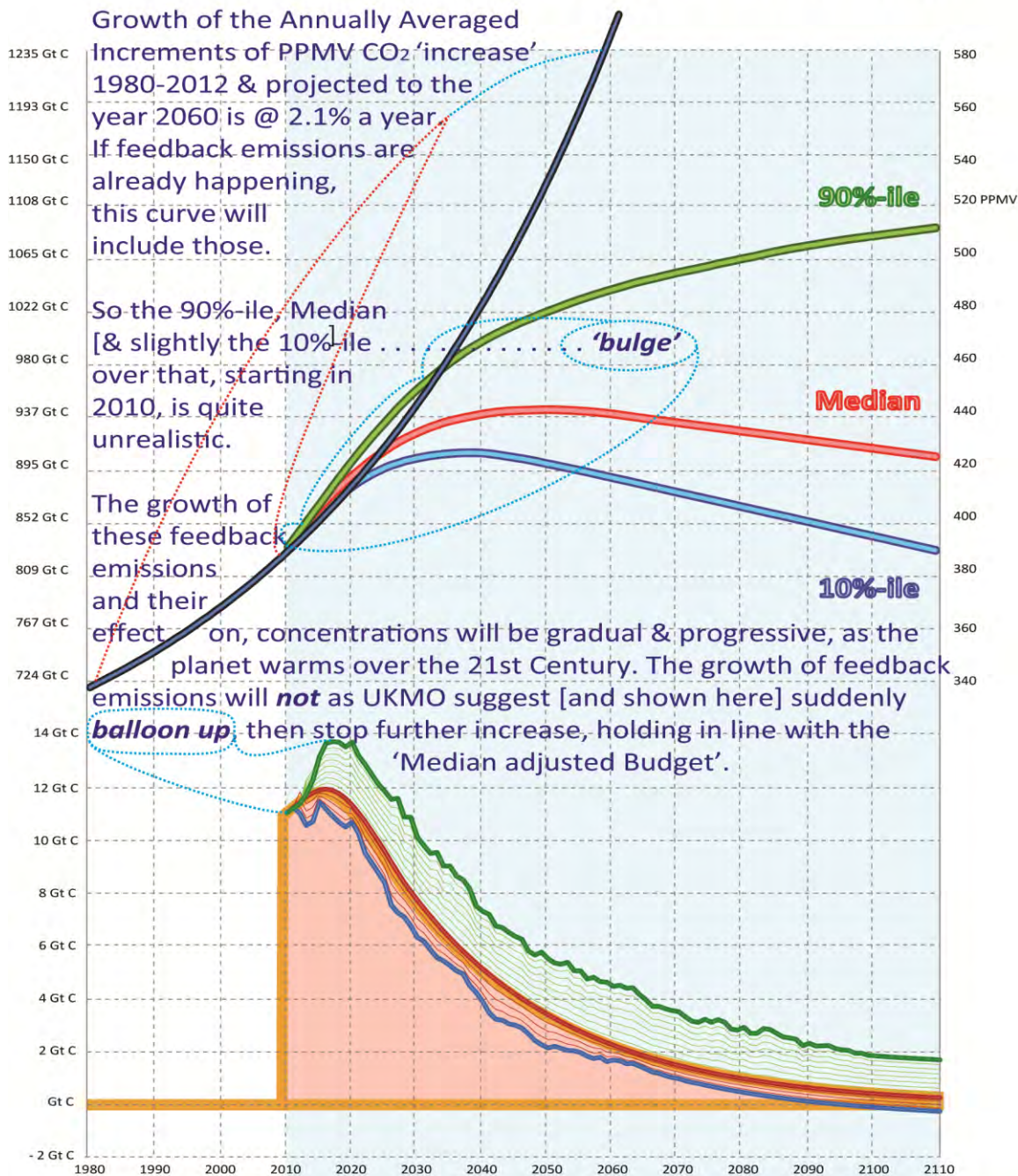
This means that UKMO's curves are 'control-curves'. These imply we will keep control of concentrations overall. However, feedback-effects and particularly feedback-emissions, imply that what we face is not-so-much 'control-curves', as '*loss-of-control-curves*'.

The point being that feedback emissions and their knock-on effect on concentrations – as in the case of CO2 emissions from Permafrost melt for example - are non-human, *accelerate*, start *gradually* [see page 24] but once under way the rate of increase is uncontrollable.

Unless these feedbacks are 'in the model' and leading to precautionary policy consequences, UKMO's results are implausible and irresponsible, rendering their present approach as generically misleading & an inappropriate basis upon which to develop precautionary climate policy for UNFCCC-compliance.



## The UK Climate Act, compared to the averaged growth of the annual increments of PPMV growth [2.1% a year], show UKMO PPMV Curves 'bulge' sharply above trend at the start.



What this means is that the way the UKMO have treated feedbacks they regarded as relevant, is to have created this 'bulge' above the CO<sub>2</sub> concentrations growth trend. The trend of the 'growth increments' has been at 2.1% per annum. At the outset, the curves for Median & 90%-ile introduced by UKMO, upwardly violate this trend and this alone makes them conspicuously unrealistic & arbitrary. The curves then come down sharply. This means that UKMO's curves all imply we can keep control of emissions overall despite their admitted but continued omission of feedbacks-emissions. This fails to represent that these feedback emissions accelerate, are non-human & uncontrollable. Unless these feedbacks are 'in the model' and the policy consequences, UKMO's results are implausible rendering their present approach as generically misleading & inappropriate.

**What we face is not so much the inconvenience of 'control-curves' as the potentially catastrophic consequences of 'loss-of-control-curves'. In the face of this UKMO continues to model growing 'Sink-Efficiency; [see 'Advance' paper; 2010].**

As with the UK Climate Act, in UKMO's 'Advance' Paper, the atmosphere CO<sub>2</sub> Concentrations trend accelerates upwards but then accelerates downwards. In 'Advance' CO<sub>2</sub> Concentrations & CO<sub>2</sub> Emissions-Budget show the Fraction of the Carbon Emissions-Budget returned to the sinks by 2050 [or 'sink-efficiency'] is greater than 100% after that year.

**But RCPs in UKMO & probably IPCC AR5 'are careful & conservative.' [Bob Watson]**

In the Advance paper, UKMO formally aligned itself with the RCP scenarios in 2010. These show the same feedback omissions are in the 'Representative Concentration Pathway [RCP] scenarios where CO<sub>2</sub> Concentrations & CO<sub>2</sub> Emissions-Budget show the Fraction of the Carbon Emissions-Budget returned to the sinks by 2050 [or 'sink-efficiency'] is greater than 100% after that year. It is understood that these RCP scenarios are being made the basis of the drafts of the forthcoming IPCC AR5 [due 2014/15]. If so, it suggests that these feedback omissions are likely to inform AR5 on publication.

So, after twenty years of IPCC Assessments, the danger is that the Fifth Assessment will again fail to address the issue of feedback effects being omitted from the climate models. If that happens, as the Advance paper suggests, they will have been assisted to that outcome by the UKMO and the *blinker* climate-modelling underpinning the UK Climate Act.

Sir Robert Watson [a former Chairman of the IPCC at the time of the IPCC Third Assessment Report] said in a public session in San Francisco in December 2012: -

*"We were careful and conservative. If we had a strong statement subsequently proved wrong, we would lose all credibility as a scientific community. I thought we should always be slightly on the side of conservative. Otherwise we were going to get ripped apart by climate-deniers even for the simplest mistake."*

**IPCC's credibility problem is due to this 'conservatism'**

In fact it is not just erring towards 'conservatism'. That suggests we face merely the inconvenience of 'control-curves' – or *deceleration* curves. Feedbacks mean what we face is the potentially catastrophic consequences of 'loss-of-control-curves' – or *acceleration* curves.

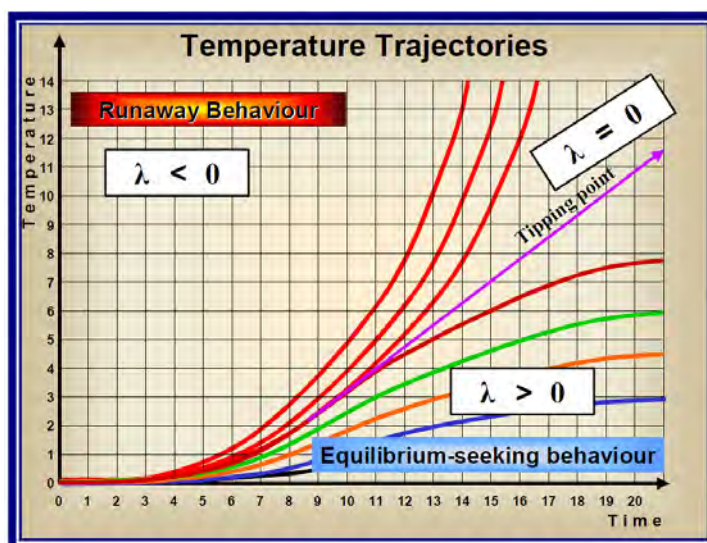
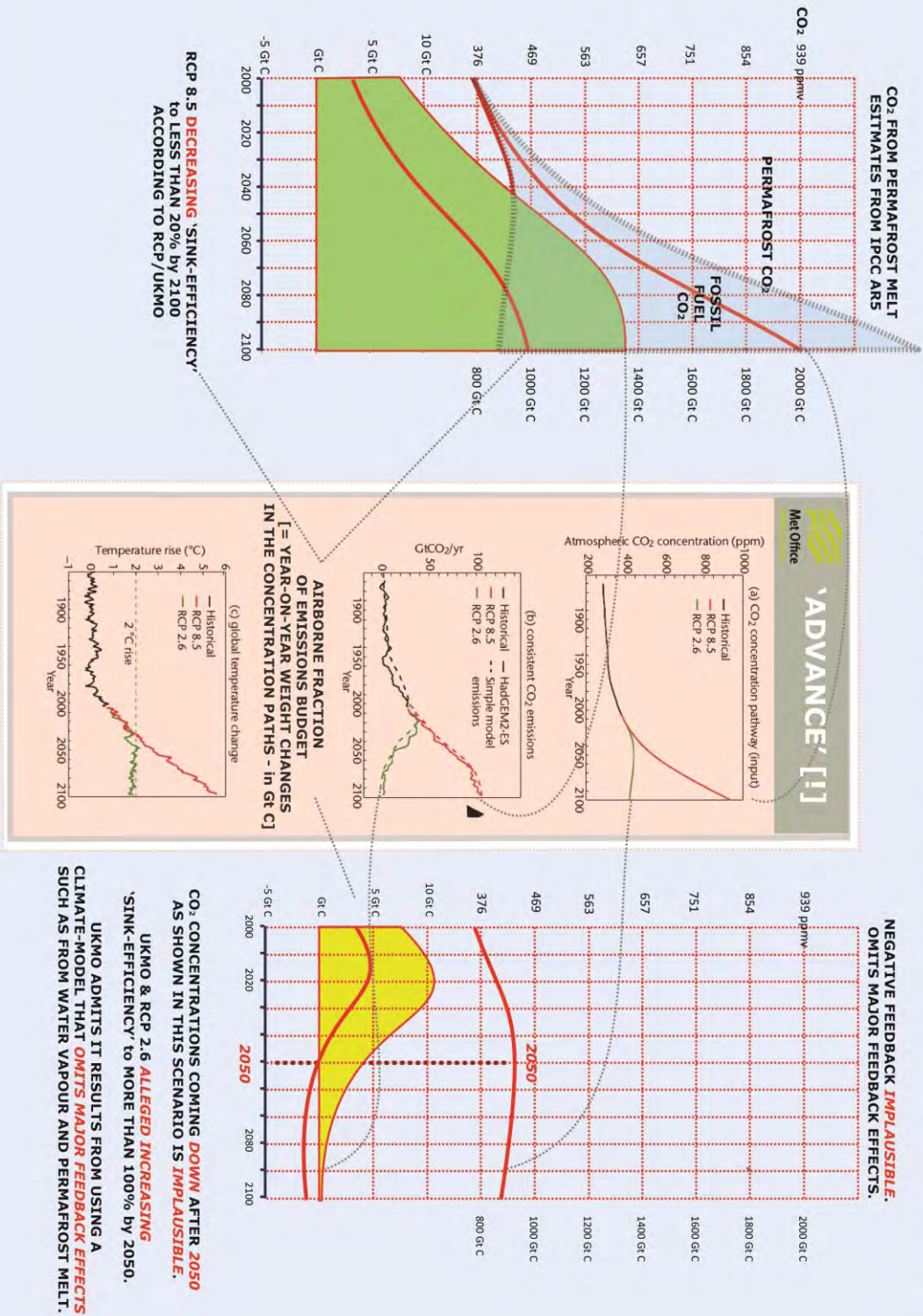


Image Wasdell – 'Feedback Dynamics, Sensitivity & Runaway Conditions': - [http://www.gci.org.uk/Documents/Climate\\_Dynamics2.pdf](http://www.gci.org.uk/Documents/Climate_Dynamics2.pdf)



UKMO'S 'ADVANCE' PAPER ALIGNS 'HADGEM' CLIMATE MODEL WITH THE RCP SCENARIOS IN IPCC AR5. SO ALL THESE RCP SCENARIOS OMIT MAJOR FEEDBACK EFFECTS TOO. ADDING JUST THE EXTRA CO<sub>2</sub> FROM MELTING PERMAFROST AS PPMV [AS ESTIMATED IN IPCC AR5 TEXT ONLY] IS ADDED IN BLUE



**In 'ADVANCE', UKMO's comment on feedback omission reads: -**

*We will continue to improve the representation of processes included in our model.*

*There are also a number of processes not currently included that could potentially have a major impact on the degree of warming for a given emissions scenario, quite apart from their impact on local and regional climate. Some of these processes have been discussed here and we are actively working on including them in the model: -*

- The impact of ozone on plants reduces their ability to take up carbon. Given their major implications for international technology and economic development, policy decisions on climate change must be underpinned by the best possible evidence.*
- The deposition of black carbon on snow changes the reflectivity of the surface leading to more warming at high latitudes. Other processes are less well understood but are actively being researched with a view to including them in future models.*
- The ability of plants to take up carbon may be limited by the supply of nitrogen available naturally, but may be enhanced by man-made sources of nitrogen. Climate change itself may also increase available nitrogen and stimulate plant growth.*
- The thawing of permafrost may lead to large amounts of carbon release, but these processes are not well understood.*
- Dynamic ice processes could speed up freshwater supply from glaciers into the ocean.*
- The processes that affect methane in the Arctic Ocean could lead to increased methane release (the science is poorly understood so may take longer to include in models).*

*The international science community is working hard to understand and narrow the uncertainties in future climate projections — and it is doing this primarily through model inter-comparison projects, comparison with observations, and the synthesis of results by the next IPCC report.*

*Understanding the interactions within the Earth system is critical."*

**Yet, aligning itself with the RCP scenarios now at the base of IPCC AR5, UKMO again publishes negative feedback in the 'Advance Paper' of 2010.**

The paper set out the alignment of UKMO HADGEM2-ES with the RCP scenarios that have replaced the SRES scenarios in previous IPCC Assessment Reports.

An analysis of the RCP 8.5 & 2.6 scenarios for airborne fractions of emissions shows the same rate of reabsorption as increasing to more than 100% of the budget by 2050 in the case of RCP 2.6 and decreasing to around 20% of the CO<sub>2</sub> budget by 2100 for RCP 8.5.

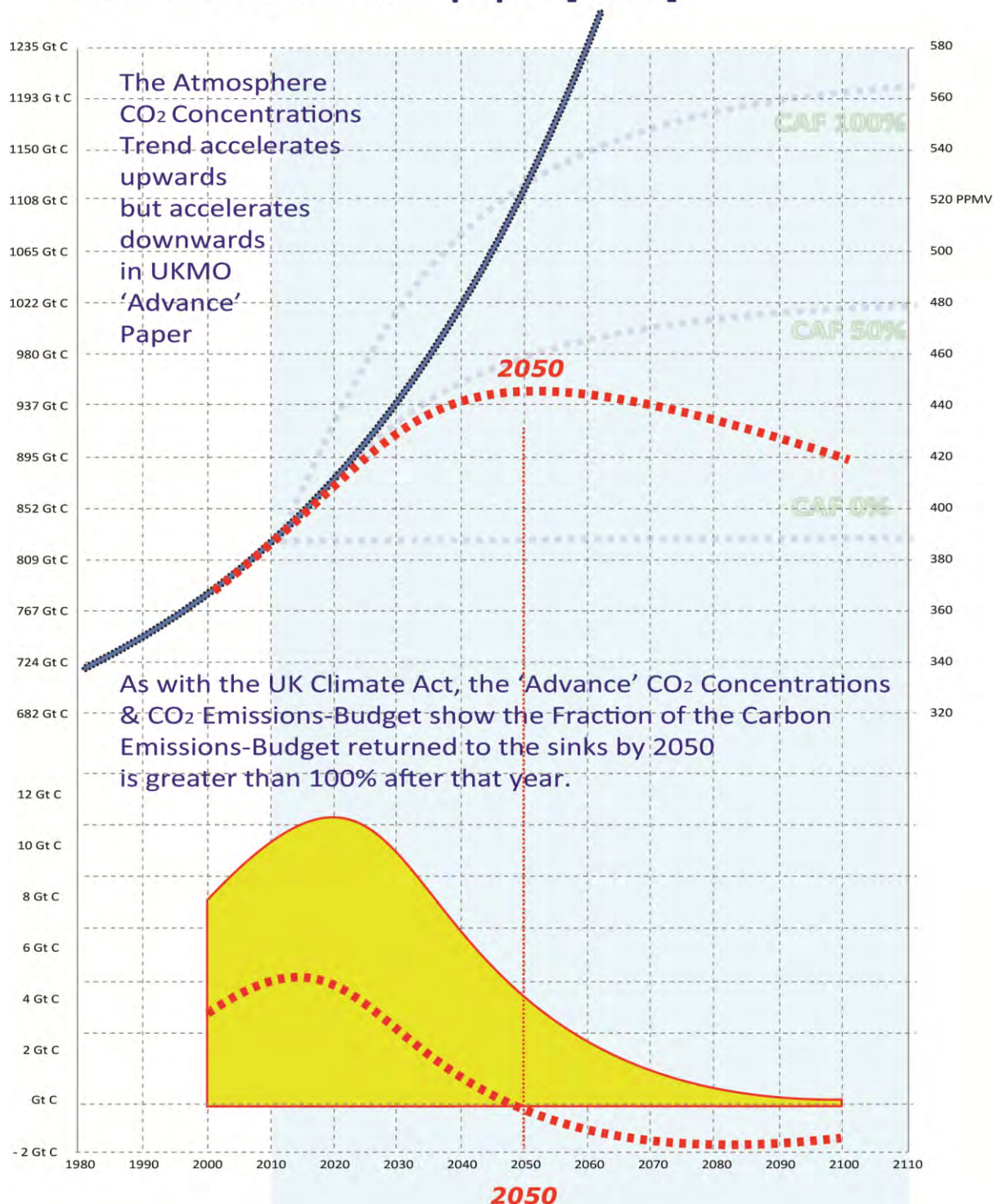
This is therefore true of the HADGEM2-ES runs as well and that the projections continue to be made on the basis of the continuing omission of major feedback effects in RCPs, currently drafted to inform IPCC AR5.

**It was updated by UKMO April 29<sup>th</sup> 2013: -**

<http://www.gci.org.uk/Documents/advance.pdf>



**Despite this & the CO<sub>2</sub> trend acceleration in PPMV, UKMO continues to model growing 'Sink-Efficiency, as in their 'Advance' paper [2010].**



In fact UKMO formally aligned itself with the RCP scenarios in 2010, shows the same feedback omissions are in the RCP scenarios [see next slide].

It is understood that these RCP scenarios are being made the basis of the drafts of the forthcoming IPCC AR5 [due 2014/15]. If so, it suggests that these feedback omissions could inform AR5 on publication.



## **UKMO's Feedback Omissions are in 'NATURE CLIMATE', February 2013**

"A global assessment of the effects of climate policy on the impacts of climate change"

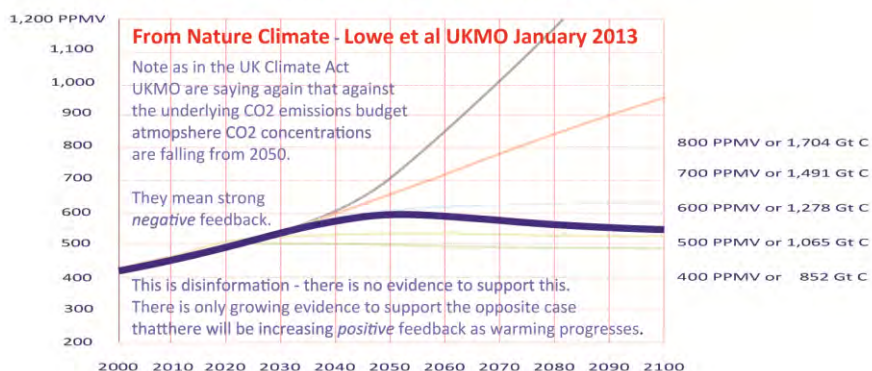
By UKMO's J. A. Lowe and other authors from the UKMO-led AVOID project, a global carbon budget weighing around 90 Gt C [or about twice the weight of the budget in the UK Climate Act] projects carbon emission, concentrations and temperature from 200 to 2100.

While temperature is projected to rise throughout to approaching 3 degrees above pre-industrial, and emissions fall in this case from 2030 onwards, CO<sub>2</sub> concentrations peak at 600 PPMV and then fall from 2050 onwards to around 550 PPMV by 2100.

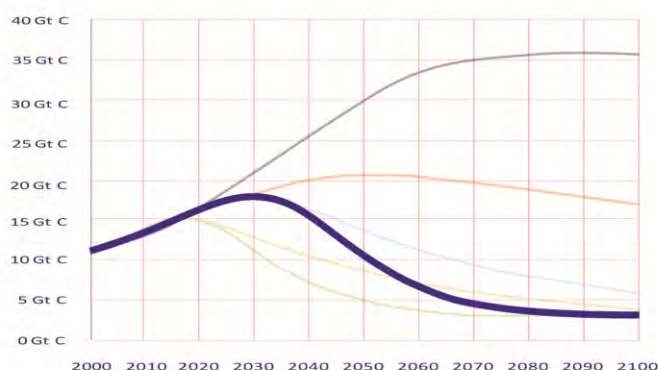
This projects yet again that according to the UKMO, CO<sub>2</sub> sinks are greater than Budget CO<sub>2</sub> sources [or more than 100% 'sink-efficiency' is projected] by 2050. This is yet further evidence of the fact that UKMO continues to use a climate-model that omits major feedback effects.

The conclusion that has to be drawn from all this is that use of this model as it is, results in unrealistic and misleading results.

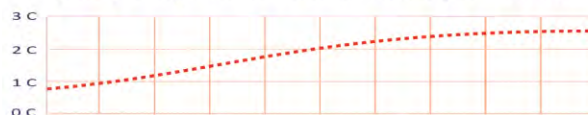
## UKMO Atmosphere CO<sub>2</sub> Concentrations



## UKMO Emissions CO<sub>2</sub>



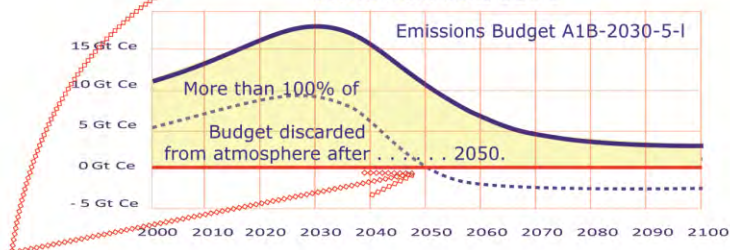
## UKMO Temperature Increase above pre-Industrial



## UKMO Atmosphere CO<sub>2</sub>-e Concentrations



## UKMO Emissions CO<sub>2</sub>-e



Once again in NATURE CLIMATE [January 2013] UKMO authors assert 'Negative Feedback' in the carbon cycle at the Budget volume/velocity i.e. the emissions rates of UK Climate Act. This means repeating the fallacy of achieving greater than 100% 'sink-efficiency' by 2050. and aligning the repeat of '*Feedback Omissions*' with the RCP scenarios in IPCC AR-5 drafts.

**Malte Meinshausen, a principal author of the RCP scenarios now likely to be the basis of the IPCC Fifth Assessment [AR5], co-authored a paper '*Probabilistic cost estimates for climate change mitigation*', published in Nature [January 2013]: -**  
[http://www.gci.org.uk/Documents/Nature\\_Meinshausen\\_et\\_al.pdf](http://www.gci.org.uk/Documents/Nature_Meinshausen_et_al.pdf)

The paper argued that a 'carbon-tax' of \$100/Tonne now would help to avoid the \$1,000/Tonne that would be necessary later if the delay in emissions-control continues.

A range of 27 CO<sub>2</sub>-emissions-contraction-events for the period 2000-2100 were published. The contraction-events continued over the period 2100-2200 were *omitted* as were the atmospheric concentrations outcomes of these over two Centuries.

When concentrations are added and values for 2100-2200 are *added*, the range of CO<sub>2</sub> budget-integrals, CO<sub>2</sub> concentration-outcomes go from lowest to highest with the nominally associated Tax-Rates are shown in the following table of values: -

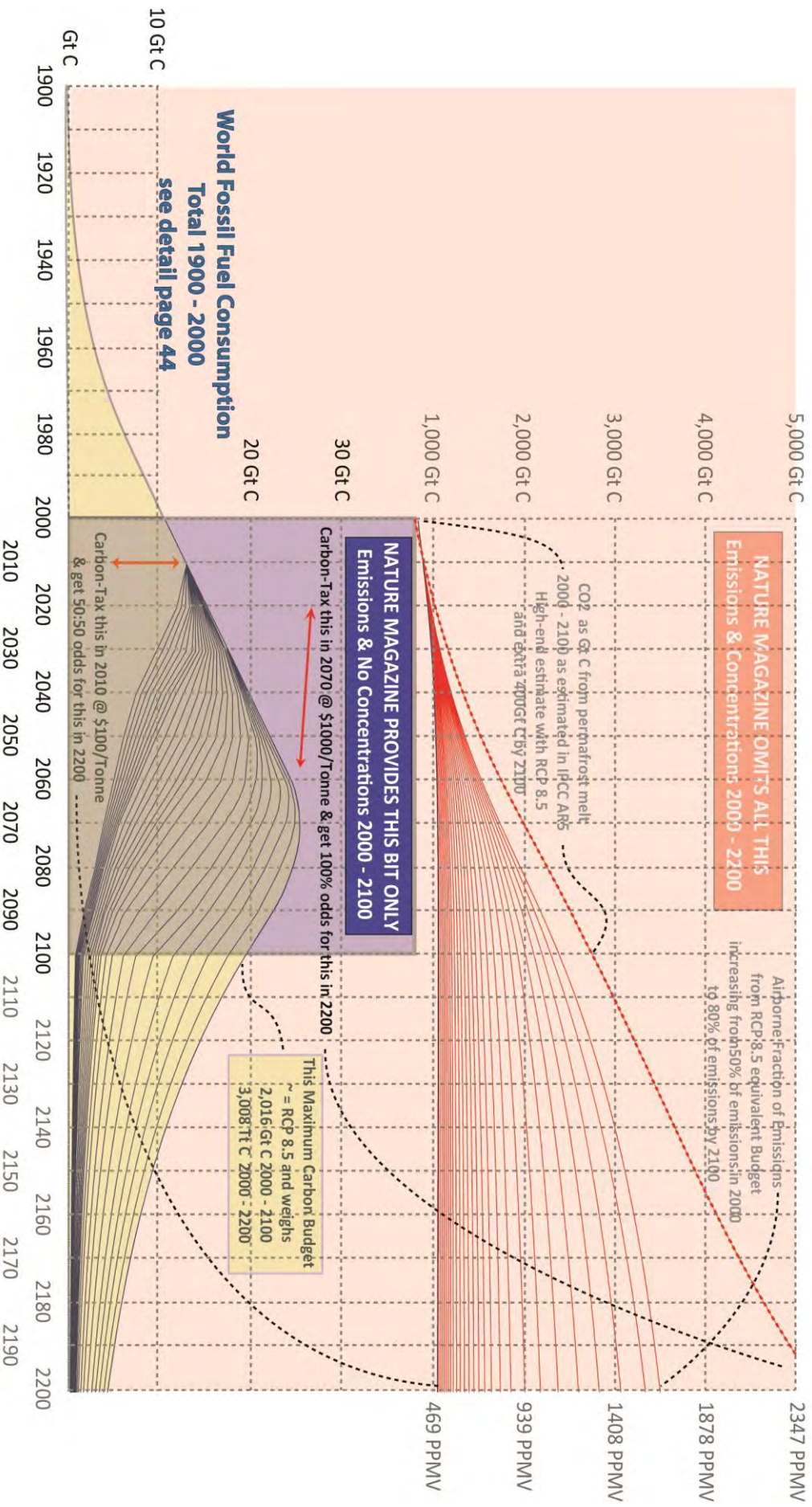
| Position | Emissions<br>Contraction-<br>Budget Integrals<br>[Gt C] | Atmospheric<br>Concentration<br>Outcomes<br>[PPMV] | Atmospheric<br>Concentration<br>Outcomes [Gt<br>C]] | Tax<br>Rate |
|----------|---------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|-------------|
| 1        | 711 Gt C                                                | 493                                                | 1,051 Gt C                                          | \$100       |
| 2        | 745 Gt C                                                | 497                                                | 1,058 Gt C                                          | \$135       |
| 3        | 779 Gt C                                                | 506                                                | 1,078 Gt C                                          | \$169       |
| 4        | 812 Gt C                                                | 516                                                | 1,099 Gt C                                          | \$204       |
| 5        | 844 Gt C                                                | 526                                                | 1,121 Gt C                                          | \$238       |
| 6        | 874 Gt C                                                | 537                                                | 1,145 Gt C                                          | \$273       |
| 7        | 904 Gt C                                                | 549                                                | 1,169 Gt C                                          | \$308       |
| 8        | 935 Gt C                                                | 561                                                | 1,195 Gt C                                          | \$342       |
| 9        | 967 Gt C                                                | 574                                                | 1,223 Gt C                                          | \$377       |
| 10       | 1,016 Gt C                                              | 591                                                | 1,259 Gt C                                          | \$412       |
| 11       | 1,074 Gt C                                              | 611                                                | 1,301 Gt C                                          | \$446       |
| 12       | 1,132 Gt C                                              | 632                                                | 1,346 Gt C                                          | \$481       |
| 13       | 1,194 Gt C                                              | 656                                                | 1,397 Gt C                                          | \$515       |
| 14       | 1,254 Gt C                                              | 681                                                | 1,450 Gt C                                          | \$550       |
| 15       | 1,311 Gt C                                              | 707                                                | 1,506 Gt C                                          | \$585       |
| 16       | 1,375 Gt C                                              | 737                                                | 1,570 Gt C                                          | \$619       |
| 17       | 1,451 Gt C                                              | 772                                                | 1,644 Gt C                                          | \$654       |
| 18       | 1,554 Gt C                                              | 817                                                | 1,741 Gt C                                          | \$688       |
| 19       | 1,676 Gt C                                              | 872                                                | 1,857 Gt C                                          | \$723       |
| 20       | 1,831 Gt C                                              | 943                                                | 2,010 Gt C                                          | \$758       |
| 21       | 1,993 Gt C                                              | 1024                                               | 2,180 Gt C                                          | \$792       |
| 22       | 2,162 Gt C                                              | 1115                                               | 2,376 Gt C                                          | \$827       |
| 23       | 2,344 Gt C                                              | 1220                                               | 2,599 Gt C                                          | \$862       |
| 24       | 2,514 Gt C                                              | 1327                                               | 2,827 Gt C                                          | \$896       |
| 25       | 2,677 Gt C                                              | 1439                                               | 3,065 Gt C                                          | \$931       |
| 26       | 2,855 Gt C                                              | 1565                                               | 3,334 Gt C                                          | \$965       |
| 27       | 3,008 Gt C                                              | 1642                                               | 3,497 Gt C                                          | \$1,000     |

As positions 1 – 27 go progressively towards a climate catastrophe, which no amount of carbon-tax could obviate or avoid, nothing more clearly shows the cul-de-sac of carbon-price-led climate-policy formulation.

This is an 'ideological-selection-bias' that we do not need. It misleads in favour of being led by 'price-signals' and calls the whole process of peer-reviewed articles on climate-economics in supposedly eminent journals into disrepute.



Malte Meinshausen, a principal author of the RCP Scenarios now in IPCC AR5 Co-Authored a paper in Nature [January 2013]. It argued that a 'carbon-tax' now of \$100/Tonne Carbon now would help to avoid \$1,000/Tonne that might be needed later. As the latter clearly bein a runaway climate-event, what is the point of clinging to 'Price-Led' 'Climate-Policy'. This 'selection-bias' misleads and calls the peer-review of scientific journals into question



**"Ticking Arctic Carbon Bomb May Be Bigger Than Thought." Science 7<sup>th</sup> 12, 2012: -**  
<http://news.sciencemag.org/sciencenow/2012/12/ticking-arctic-carbon-bomb-may-b.html>

AAA's article in Science [07 12 2012] argues the melt and CO<sub>2</sub> release has already begun.

The next image portrays the effect on the atmosphere of releasing the extra 1.9 Trillion Tonnes Carbon from CO<sub>2</sub> from Perma Frost melt in a defendably calculated time-frame.

It is now estimated that another 1.9 trillion tonnes of carbon is stored in the 'perma-frost'. In 2009, the estimate was at 1.4. This permafrost has already started slowly melting due to enhanced global warming.

Simply weighed on a scale of Billions of Tonnes of Carbon [Giga Tonnes or Gt C] it is easy to calculate the effect on CO<sub>2</sub> concentrations. It is a potential release. Once under way, it is impossible to stop. So, if we are to prevent this, the potential rate of release of this extra CO<sub>2</sub> to the atmosphere is on a time-frame that needs - however difficult - to be calculated.

The weight reaches the top of this yellow shape at around 3 trillion tonnes of atmospheric carbon, or 1400 ppmv carbon [only]. IPCC estimates 1000 CO<sub>2</sub>-e is equal to a temperature rise of 4-8°. So the worst-case of perma-frost melt alone, dwarfs human emissions control and presages a climate holocaust.

Atmospheric CO<sub>2</sub> concentrations could increase within the rate range suggested here. What is important to note is that this rate of growth is initially slower than the 90%-ile rate which was given as top rate of concentration build-up in the UK Climate Act. Moreover, it now also appears increasingly unlikely, due to the lack of fossil-source-emissions-control, that the Carbon Budget '2016 4% Low', cited in the UK Climate Act, will actually be adhered to.

Consequently, if CO<sub>2</sub> emissions, from Perma Frost melt, became part of this 90-ile rate - the highest rate above the Carbon Budget '2016 4% Low' (or higher) on which the UKCA is based, we are looking at the potential for a catastrophic runaway process of climate-change.

UKMO already specified that temperature will increase for the next 100 years. UKCA had just 44% odds for holding to a two degree temperature rise, even if the 'median case' for CO<sub>2</sub> concentration rise were to evolve.

Since, omitting feedback from melting permafrost, Climate Act authors is acknowledged the lined 'grey' areas in 'Emissions' and 'Concentrations' shown here are from CBAT. These mathematically relate the former to the latter in forty theoretical steps downward & upwards from 'the budget' with concentrations at CAF 50-% for Budget + 'feedback' in each of the steps. So these are showing the hypothetically possible rates of negative & positive feedback covering the process of carbon-cycling - including permafrost melt - as a whole.

In the cause of UNFCCC-compliance, the world might theoretically hold to the '2016 4% Low' Carbon Emissions Budget [as in the UKCA]. However, positive feedback in the carbon cycle may release more CO<sub>2</sub> than sinks can absorb, forcing atmosphere concentrations up.

Consequently the rates of CO<sub>2</sub> emissions:concentrations calculated in '2016 4% Low' suggest a rate of acceleration across the Century ahead is possible where by mid-Century a scenario with the consequences of positive feedback is driving the system as a whole to a point after which 'human-budget-emission-control' becomes completely futile and irrelevant.

There are two simple messages - we need to: -

3. Leave fossil carbon [oil coal & gas] in the ground
4. Get on with the control of 'human-budget-emissions' as quickly as possible.





CBAT  
Carbon Bomb Arctic Threat

# "Ticking Arctic Carbon Bomb May Be Bigger Than Thought."

Science  
AAAS

This image portrays the effect on the atmosphere of releasing another 1.9 Trillions Tonnes Carbon from CO<sub>2</sub> from Permafrost melt in a defendably calculated time-frame. AAAS's article in Science argues this release has already begun.

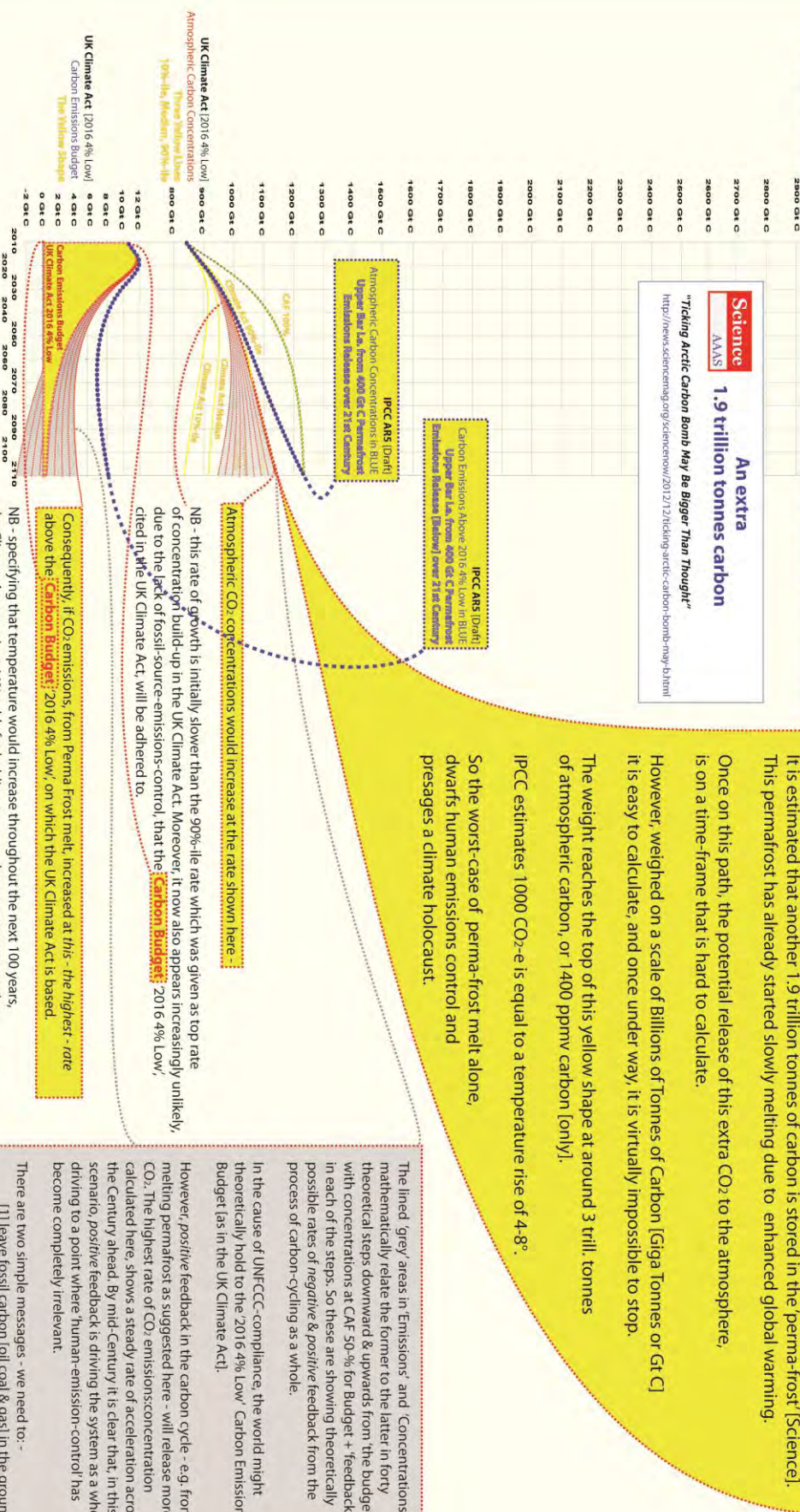
3000 Gt C

1,400 ppmv

Science  
AAAS  
An extra  
1.9 trillion tonnes carbon

"Ticking Arctic Carbon Bomb May Be Bigger Than Thought"

<http://news.sciencemag.org/sciencemag/2017/12/ticking-arctic-carbon-bomb-may-be.html>



# Carbon Budget Analysis Tool [CBAT]

## A Heuristic Device in 'Four inter-active Domains' [draft only]

A draft and incomplete version of this user-inter-active model is already on-line at: -

<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>

Domain One 'Contraction and Concentrations' governs the commitment to UNFCCC-compliance. In this sense, the C-BAT analysis isn't simply 'outcome-based' it is 'outcome-driven' by that goal.

C-BAT is an analysis tool. It is also a policy-planning model. This may seem deterministic, but proceeding this way is deliberate. Faced with the possibility of runaway rates of climate change taking hold, there is no point in achieving 'outcomes' that are 'inadvertently' the result of doing too little too late. We are in danger of doing this by simply continuing an inadequate 'climate-policy' discussion that has so far depended on the combination of opaque and inadequate climate models, ideologically confused and contestable policy models and risk-obtuse economic models that are dense with highly contestable economic assumptions and computations.

We must face this challenge of being UNFCCC-compliant on the basis of organising so that we are globally determined to do enough, soon enough to be UNFCCC-compliant. This means goal-focused C&C or being in-tune and in-time together, determined to be UNFCCC-compliant.

The detail of this work is still in progress. However, the calculating sequence goes from One to Four through FOUR DOMAINS starting with and crucially governed by: -

### DOMAIN ONE: - Contraction and Concentrations

This domain is 'global' and deals with the 'Common Good'. It directly addresses the 'objective' of the UNFCCC [the reason why the UNFCCC exists]. Here, the spread of changing concentration possibilities on any given future carbon-budget is mathematized in the light of certainly changing [and probably lessening] future sink-performance.

The primary numeraire in Domains One Two Three and Four is one tonne of carbon. The carbon in one part per million atmospheric CO<sub>2</sub> by volume [ppmv] equals 2,130,000,000 tonnes carbon or 2.13 Gigatonnes Carbon [i.e. Gt C or 2.13 Billion Tonnes Carbon]. Conversely, 1 tonne carbon equals 0.0000000046948357 ppmv atmospheric CO<sub>2</sub>. Using this numeraire for both CO<sub>2</sub> emissions & concentrations makes Carbon-Budget Analysis easily doable.

In Domains Three and Four the \*the dollar-numeraire is governed by CBAT's carbon-numeraire.\*

Overall, there are three Budgets in all [High, Medium & Low] though any weight/rate/date budget can be introduced as a new xml data sheet and the model will respond accordingly.

As things stand with CBAT model development so far, 400 different carbon-path-integrals have been computed using this numeraire. These are being animated in a user-friendly way with all these derived details that have been quantified and this makes risk analysis of all the future rates of change much easier to visualize, compare and evaluate.

There are two ways of measuring feedbacks in Domain One. These are *Integrated* [as in UKCA] & *Segregated* [as now proposed by GCI]. The difference between accelerating and decelerating curvature can easily be seen and the 'runaway-climate' inferences easily drawn.

An on/off switch enables all results to be compared with the Contraction:Concentrations Budget in UK Climate Act [2016 4% Low]. The animated version of this gives users 'Budget Control' with the drag up/down slider on the right-hand side. This takes the carbon-emissions budget and concentrations above the budget and concentrations @ CAF-50% in 40 steps up [positive feedback] and below the budget and concentrations @ CAF-50% in 40 steps down [negative feedback].



Concentrations, temperature, sea-level rise and ocean CO<sub>2</sub> deposition/acidification are visible 'consequences' of this 'Budget Control' and all values [sourced] for these are shown on clocks that will move in synch with the slide use for 'Budget Control'.

5 levels of 'climate-sensitivity' are programmed in against these budgets and users can select each of these levels to see the results from low to high.

Domains two, three and four are governed by user choices made in domain one and these Domains will exchange with the centre-stage of position [here of Domain one] when their icons on the left are touched. Then the Slider over the years becomes active e.g. selecting and measuring and weighing the convergence-rates/weights/dates for the contraction rate chosen from Domain one.

Domain 'icons' on the left are mouse-sensitive and will come centre-stage when 'mouse-touched', moving the Domain at the centre to the left where it remains inter-active. Users can select the Domain One path-integral they feel is relevant to achieving UNFCCC-compliance and to hold this choice as they then progress through Domains two, three and four. As twenty years of negotiations at the UNFCCC now clearly show, not proceeding in a manner governed by this sequence generates an increasingly chaotic process that is less and less governed by the demands of UNFCCC-compliance.

## **DOMAIN TWO: - Contraction and Convergence**

This domain is international. It addresses the 'Common but Differentiated Good' of negotiating to share what is left in the future global carbon budget in a rational manner. For all the contraction rates in Domain One, all convergence rates are being computed and animated as between consumers above and below the global per capita average arising.

Population growth rates and the effect of a population base-year in the C&C accounts are addressed here. Also convergence procedures derived from C&C such as Common but Differentiated Convergence, Cap and Dividend, Cap and Share and Greenhouse Development Rights are compared with C&C.

Users are invited to select the convergence-rate they feel relates to the path-integral already chosen in Domain One and so successfully achieving UNFCCC-compliance and hold this choice through Domains three and four.

## **DOMAIN THREE: - Contraction and Conversion**

This domain is technological and economic and will explore the options for sustaining or not sustaining present levels of production and consumption. It is in essence the position where C&C without 'Green Growth' of some kind is useless, but 'Green Growth' without C&C is dangerous.

Users can evaluate in this Domain subject to the choices already made in Domains One and Two.

## **DOMAIN FOUR: - Damages and Growth**

Domain Four is really where economics is relevant. It is the domain of climate-damages versus conventional 'growth', based on forward projecting Munich Re trends as recorded over the last forty years. All rates shown are functions of results and choices made in Domain One. So users can see whether their efforts have passed the crucial test of doing enough soon enough to achieve UNFCCC-compliance. If not they can go back and re-run their analysis based on different choices being made in Domains One Two and Three.

The overall animation is still in preparation but a taster is here [load and re-load this file]: -

<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>

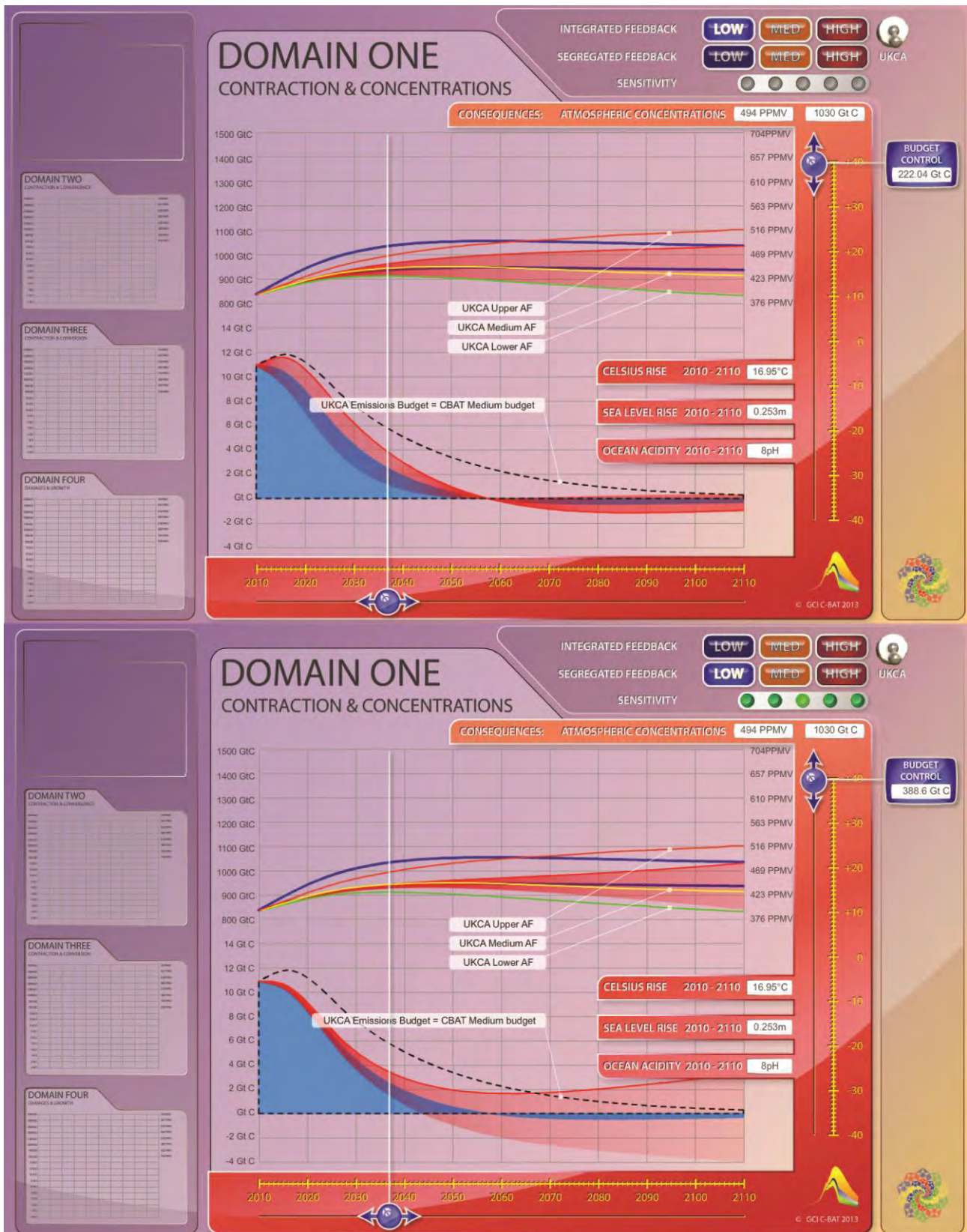
CBAT is an elaboration of: - [http://www.gci.org.uk/Animations/BENN\\_C&C\\_Animation.swf](http://www.gci.org.uk/Animations/BENN_C&C_Animation.swf)



## CBAT Domain One

### Contraction and Concentrations - Low Budget

#### Feedbacks Integrated and Segregated

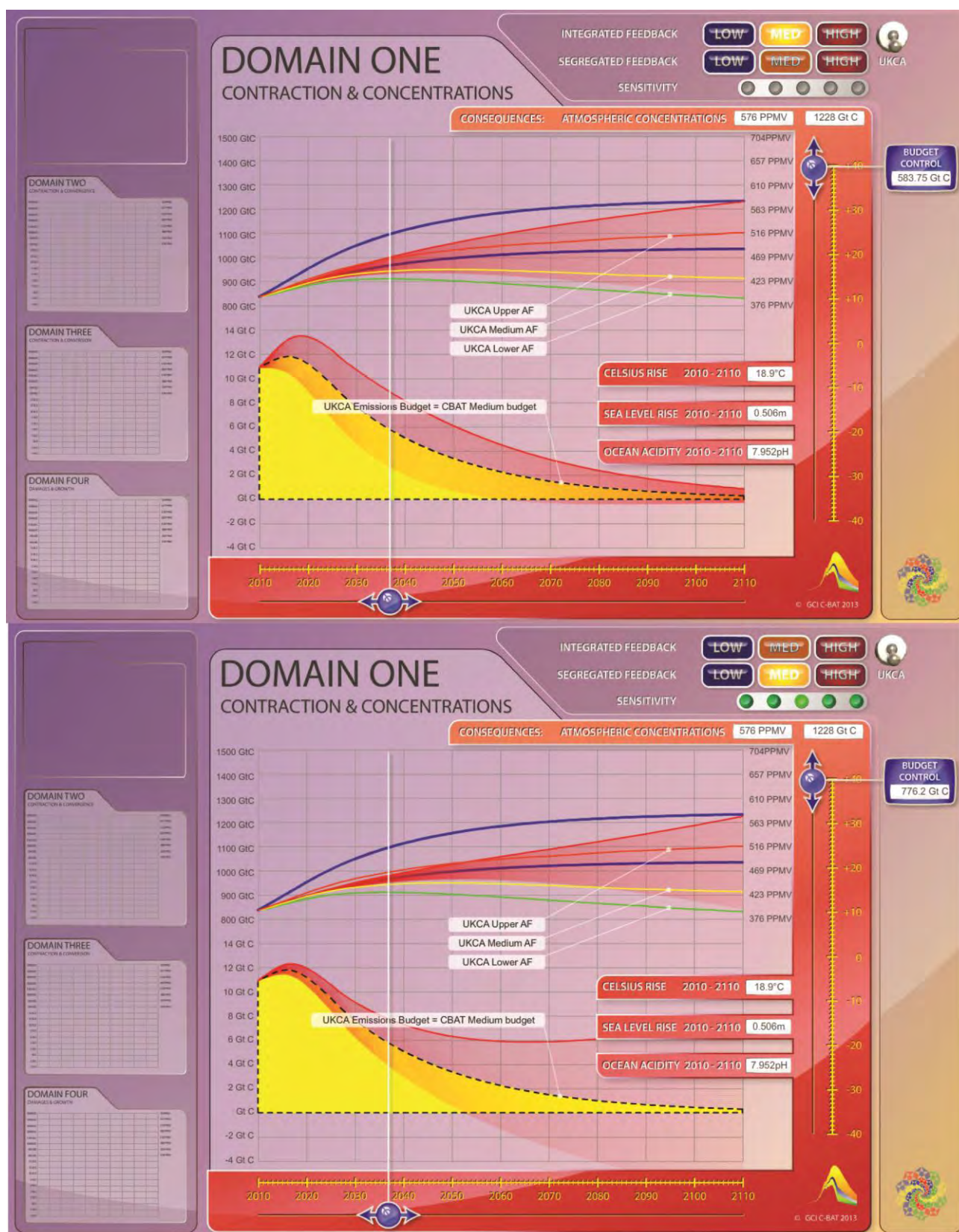




## CBAT Domain One

### Contraction and Concentrations - Medium Budget

#### Feedbacks Integrated and Segregated



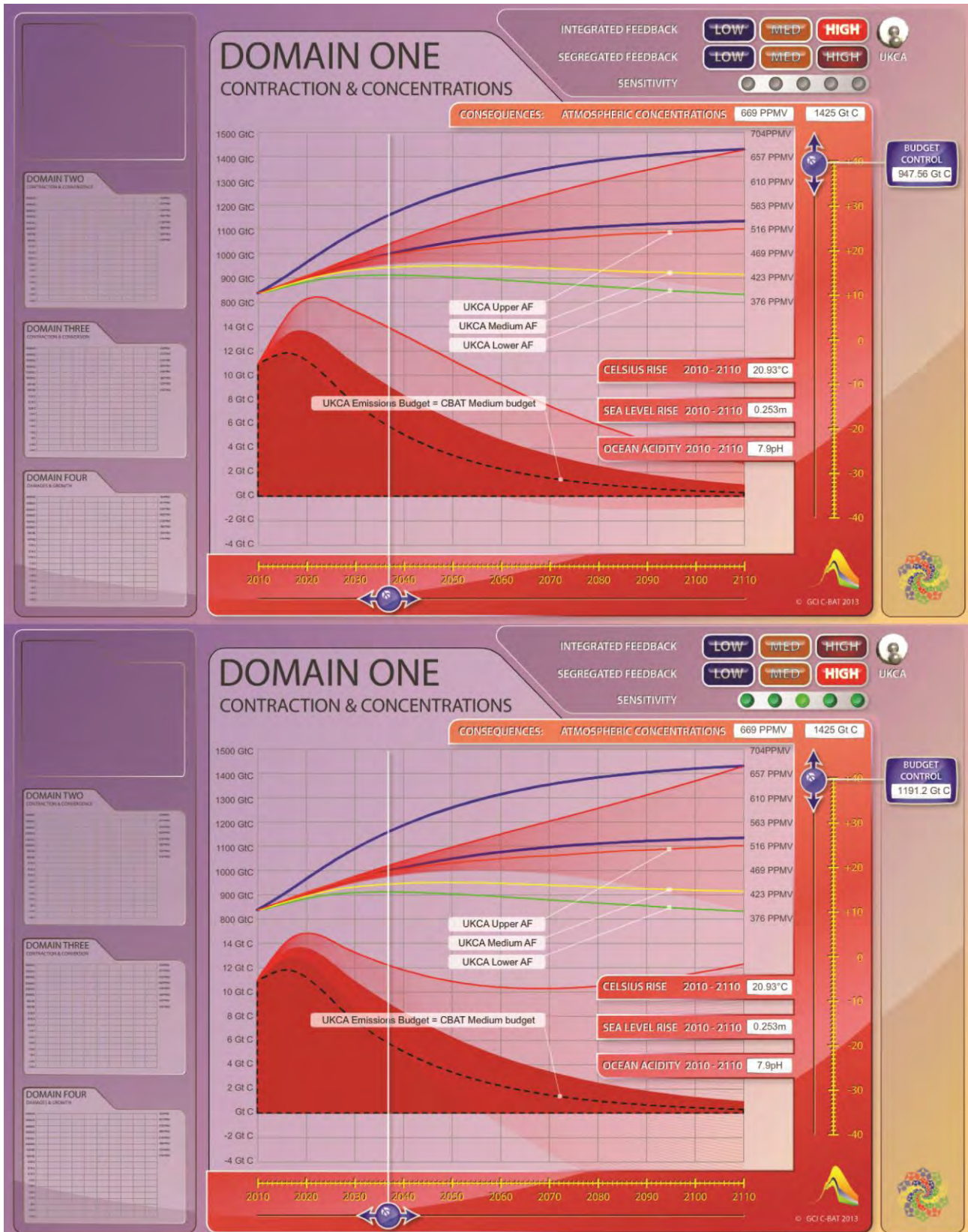
<http://www.gci.org.uk/CBAT/cbat-domains/Domains.swf>



## CBAT Domain One

### Contraction and Concentrations – High Budget

#### Feedbacks Integrated and Segregated





Climate Act Budget in Relation to Hansen and other Budgets

