Feedback misdefined: how models forgot the Sun

By Christopher Monckton of Brenchley

Here is the 15-minute presentation I gave at a recent scientific conference in Porto, Portugal.

Feedback misdefined

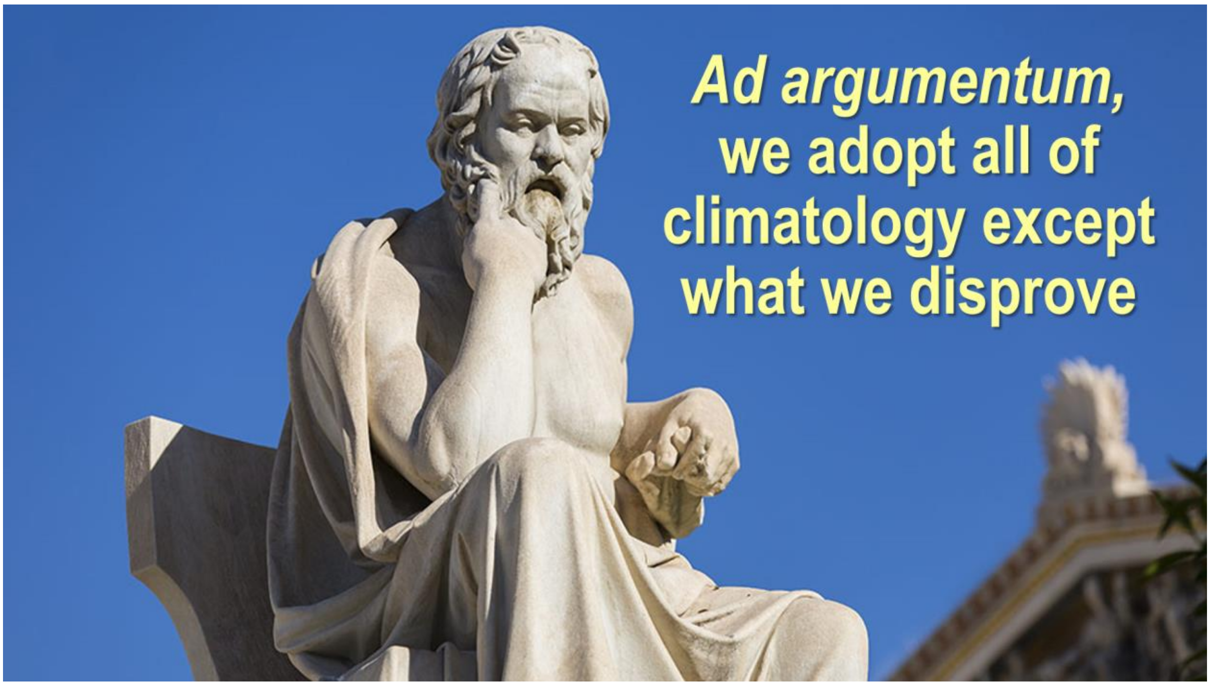
How models forgot the Sun

Christopher Monckton of Brenchley

monckton@mail.com

Porto, 7 September 2018

Concern about catastrophic global warming arose solely from a serious error of physics. Venerable fathers of science, I reported our earliest results to your 2016 London conference, and further progress at the 2017 Düsseldorf conference. Our conclusions are now under peer review at a leading journal. In 15 minutes I shall describe climatology’s error, prove it, quantify it, correct it and demonstrate that global warming will be small.



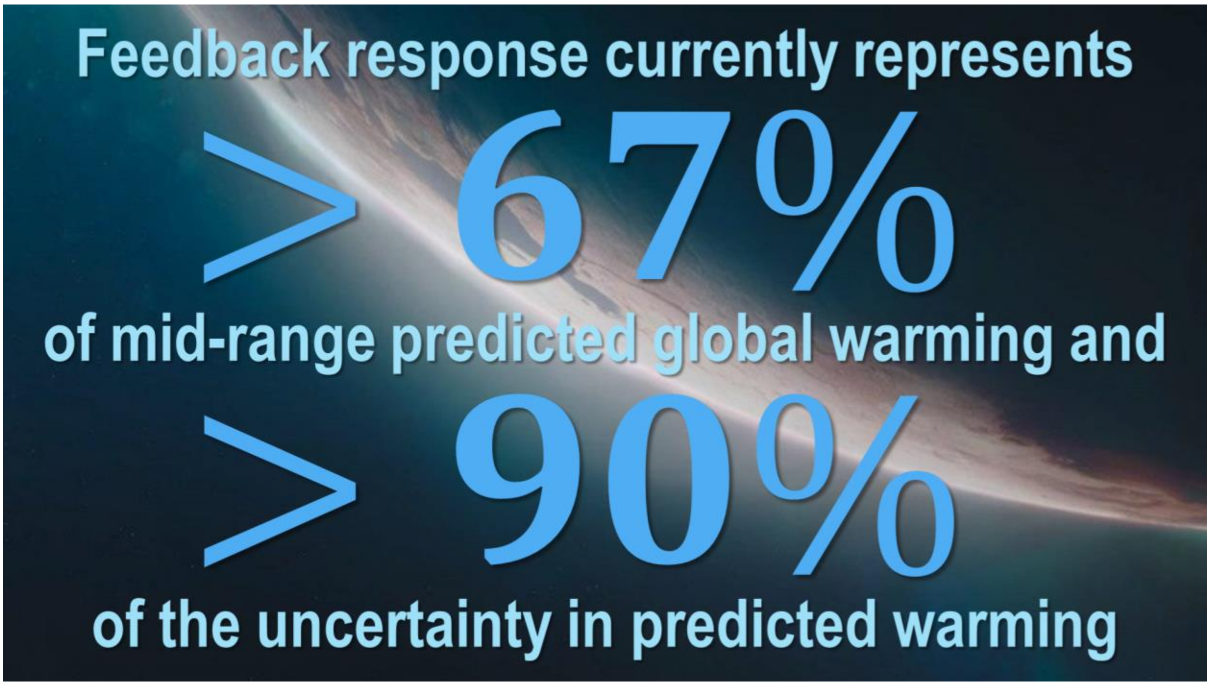
Ad argumentum, we adopt all of climatology except what we disprove

Purely for the sake of argument, we adopt all of climatology except what we disprove.

monckton@mail.com

Large feedback: the chief pretext for large warming

Climatology’s error lies in its implementation of feedback mathematics, borrowed from control theory with inadequate understanding.



Feedback response currently represents

> 67%

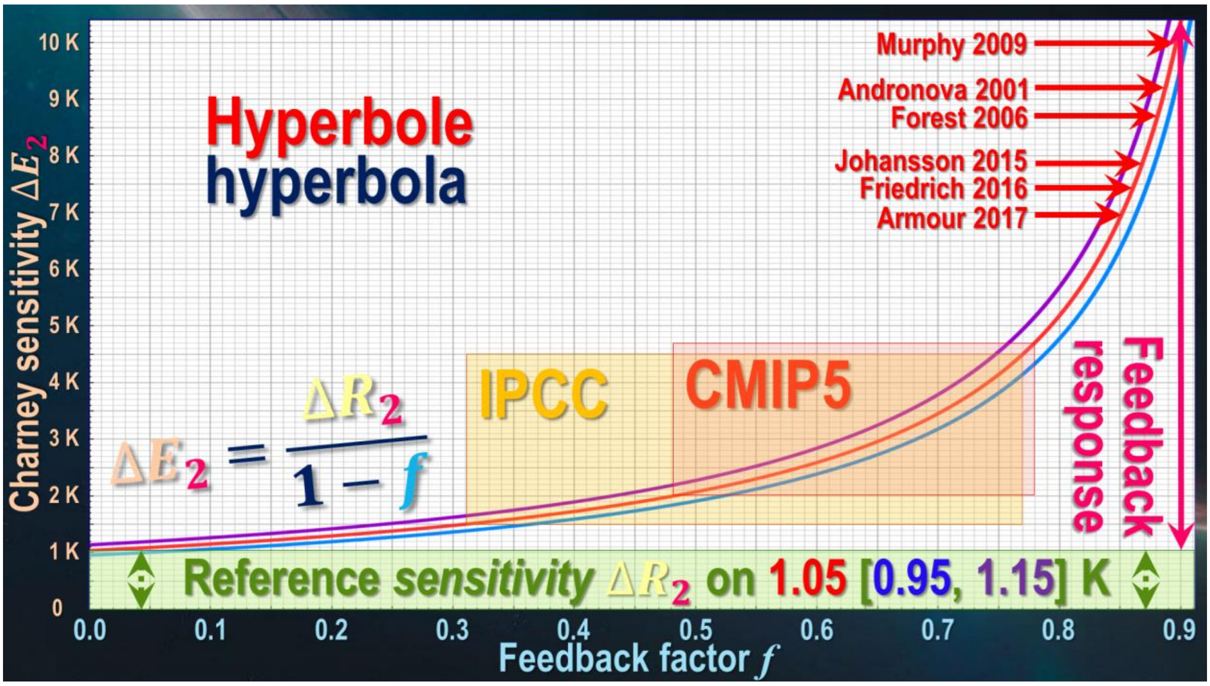
of mid-range predicted global warming and

> 90%

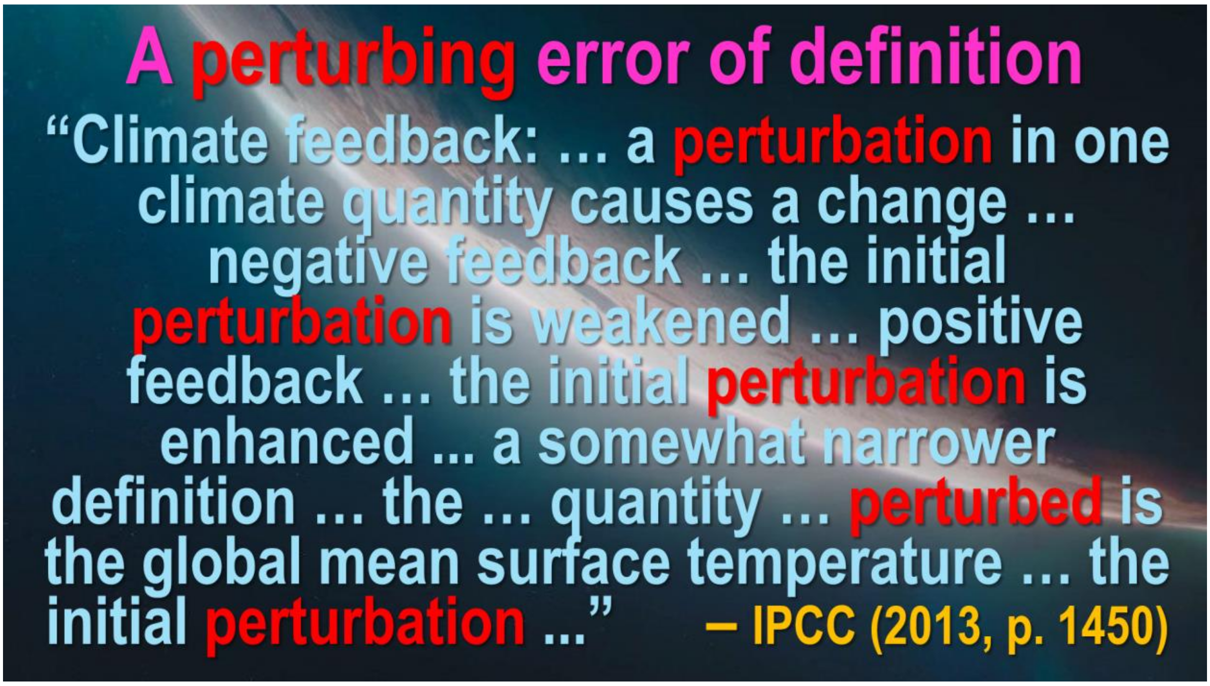
of the uncertainty in predicted warming

Feedback has been the chief cause of uncertainty in equilibrium sensitivity because hitherto climatology had assumed that most manmade warming would arise not from direct forcings but from consequent feedbacks.

IPCC (2013) predicted 1.5-4.5 K Charney sensitivity (equilibrium sensitivity to doubled CO_2). The CMIP5 models predict 2.1-4.7 K. Extremist papers predict up to 10 K. All but the first 1.1 K of predicted warming – the reference sensitivity – is feedback response.



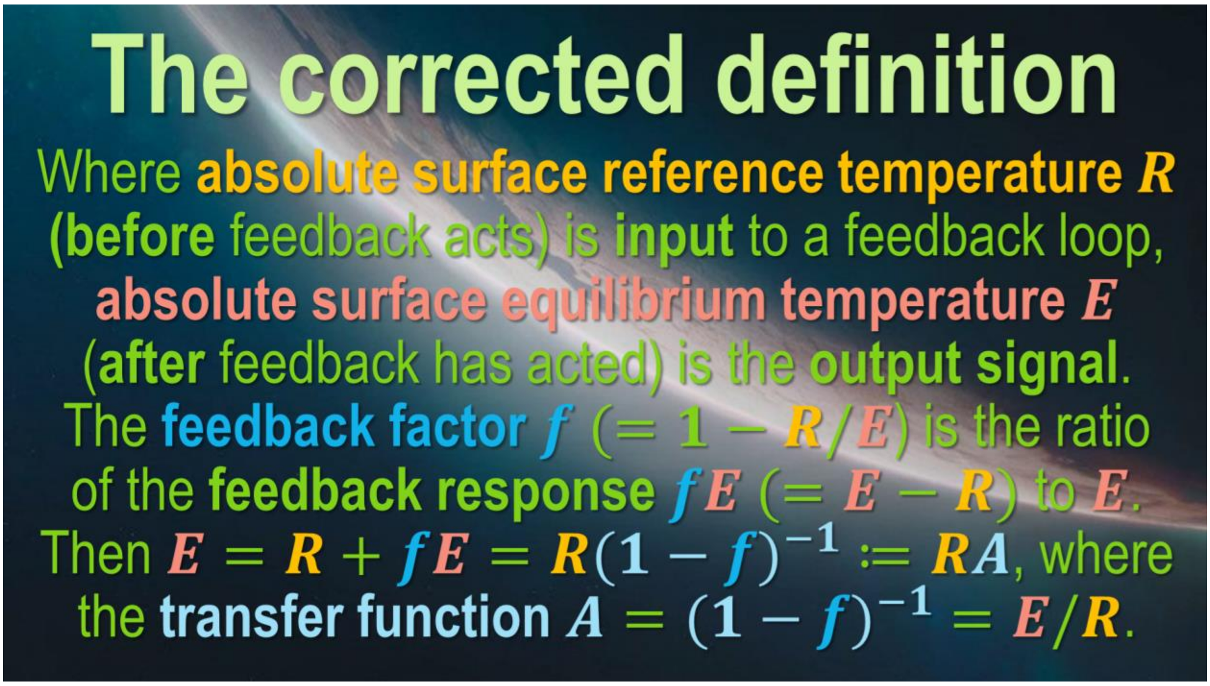
Extreme predictions arise because the curve of system response to feedback factors is a rectangular hyperbola. Feedback response is the difference between models' reference sensitivity 1.1 K (green bar) and equilibrium sensitivity at the hyperbola.



A perturbing error of definition

"Climate feedback: … a perturbation in one climate quantity causes a change … negative feedback … the initial perturbation is weakened … positive feedback … the initial perturbation is enhanced ... a somewhat narrower definition … the … quantity … perturbed is the global mean surface temperature … the initial perturbation ..." – IPCC (2013, p. 1450)

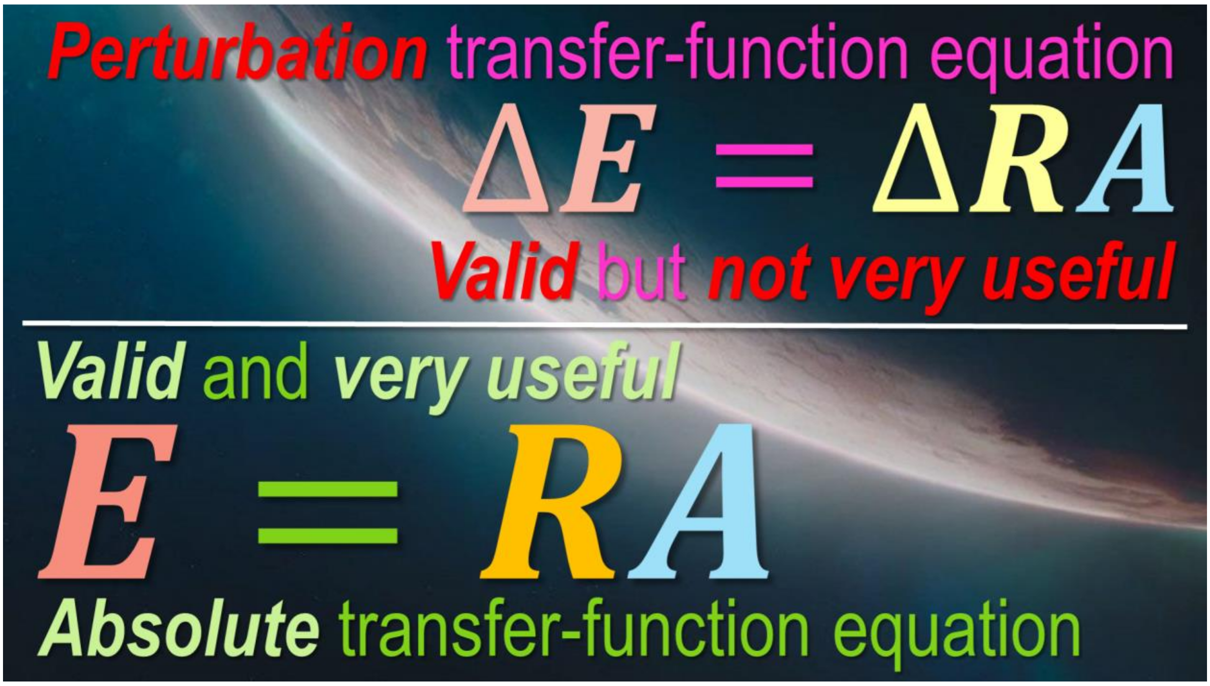
The current transfer function is excessive because climatology misdefines feedback as responding only to "perturbations" in reference temperature, when in control theory it responds also to absolute reference temperature. "Perturb" or "perturbation" appears 5 times.



The corrected definition

Where absolute surface reference temperature R (before feedback acts) is input to a feedback loop, absolute surface equilibrium temperature E (after feedback has acted) is the output signal. The feedback factor f $(= 1 - R/E)$ is the ratio of the feedback response fE $(= E - R)$ to E. Then $E = R + fE = R(1 - f)^{-1} := RA$, where the transfer function $A = (1 - f)^{-1} = E/R$.

In the corrected definition, the transfer function is the ratio of absolute equilibrium temperature to absolute reference temperature.



Perturbation transfer-function equation

$$\Delta E = \Delta R A$$

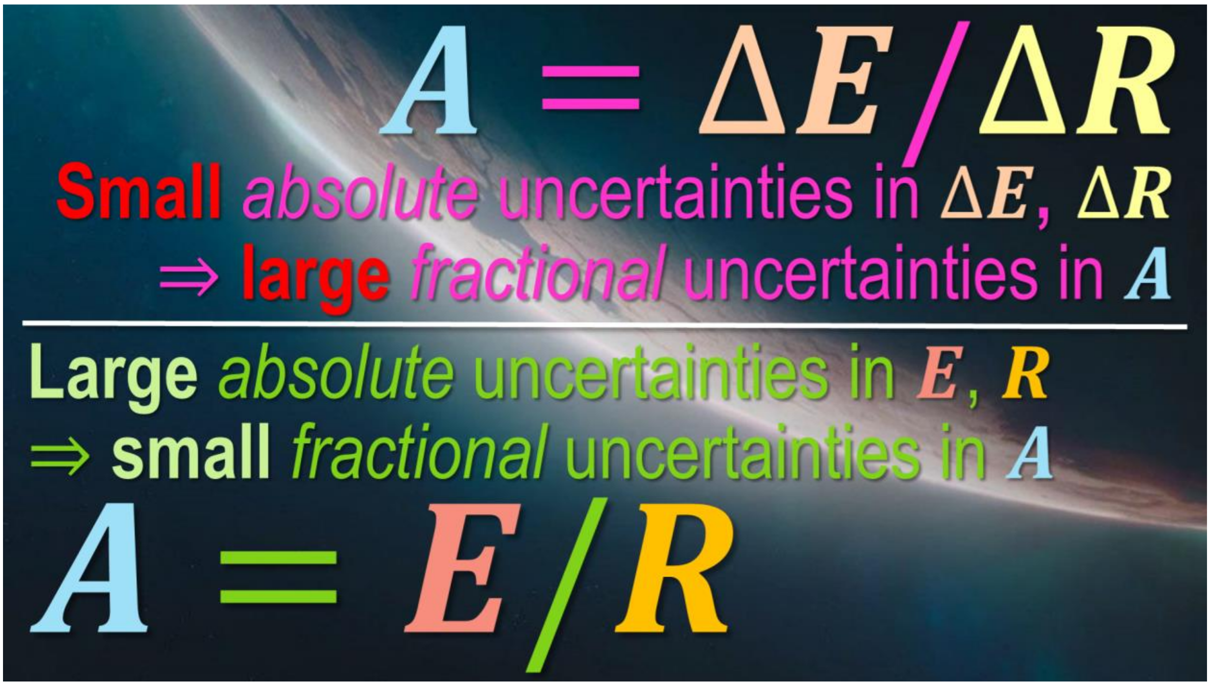
Valid but **not very useful**

Valid and **very useful**

$$E = R A$$

Absolute transfer-function equation

Climatology’s perturbation transfer-function equation (top right) and control theory’s absolute equation (bottom left) are both valid: but the latter, where equilibrium temperature is the product of reference temperature and the transfer function, proves more useful.



$$A = \Delta E / \Delta R$$

Small *absolute* uncertainties in ΔE, ΔR

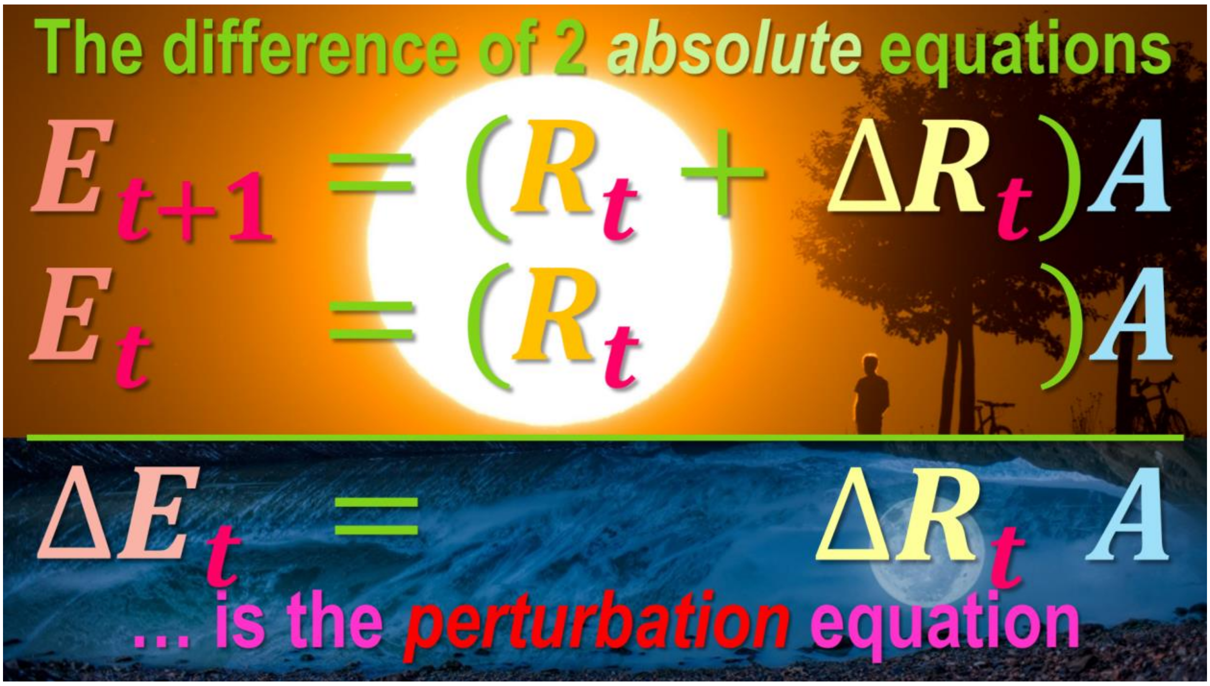
⇒ **large** *fractional* uncertainties in A

Large *absolute* uncertainties in E, R

⇒ **small** *fractional* uncertainties in A

$$A = E / R$$

In the perturbation equation (top), small absolute uncertainties in sensitivities yield large fractional uncertainties in the transfer function. In the absolute equation (bottom), even large uncertainties in temperatures yield small fractional uncertainties in the transfer function, improving constraint of equilibrium sensitivity.



The difference of 2 *absolute* equations

$$E_{t+1} = (R_t + \Delta R_t)A$$

$$E_t = (R_t)A$$

$$\Delta E_t = \Delta R_t A$$

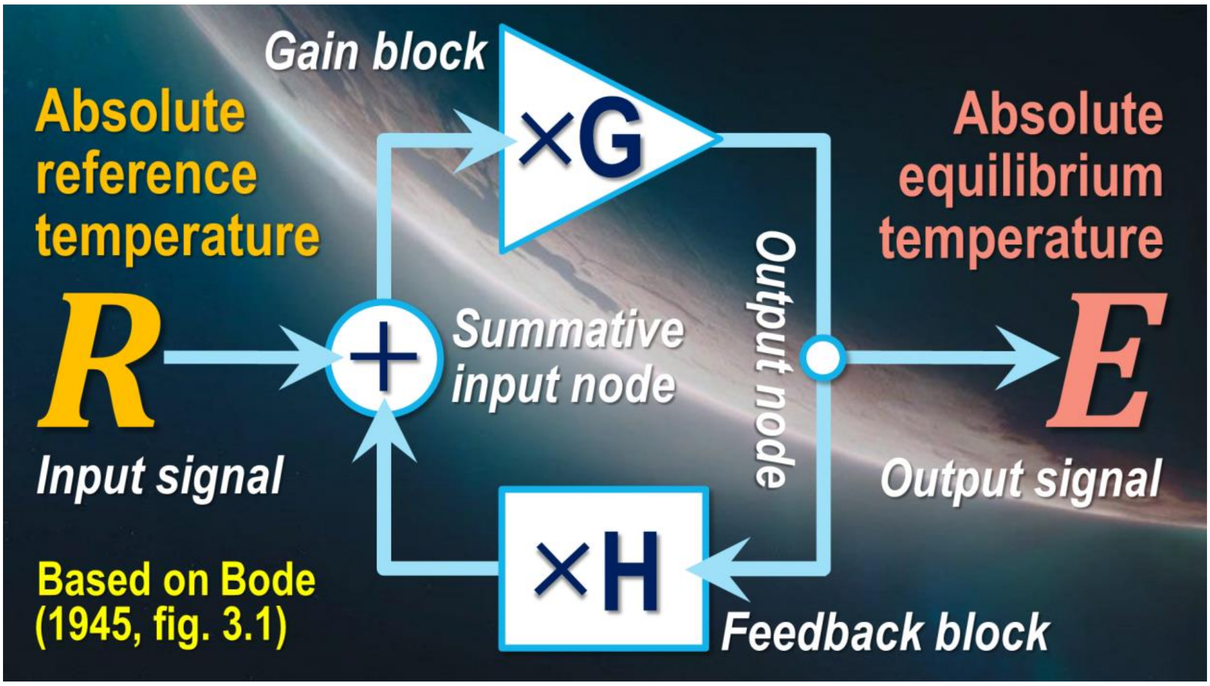
… is the *perturbation* equation

The perturbation equation represents the difference between two instances of the absolute equation, which is thus consistent with it: but reference temperature, which includes emission temperature and warming from pre-industrial non-condensing greenhouse gases, is subtracted out and becomes lost information. Then even small uncertainties in sensitivities drive unphysically large uncertainties in the transfer function and hence in equilibrium sensitivities.

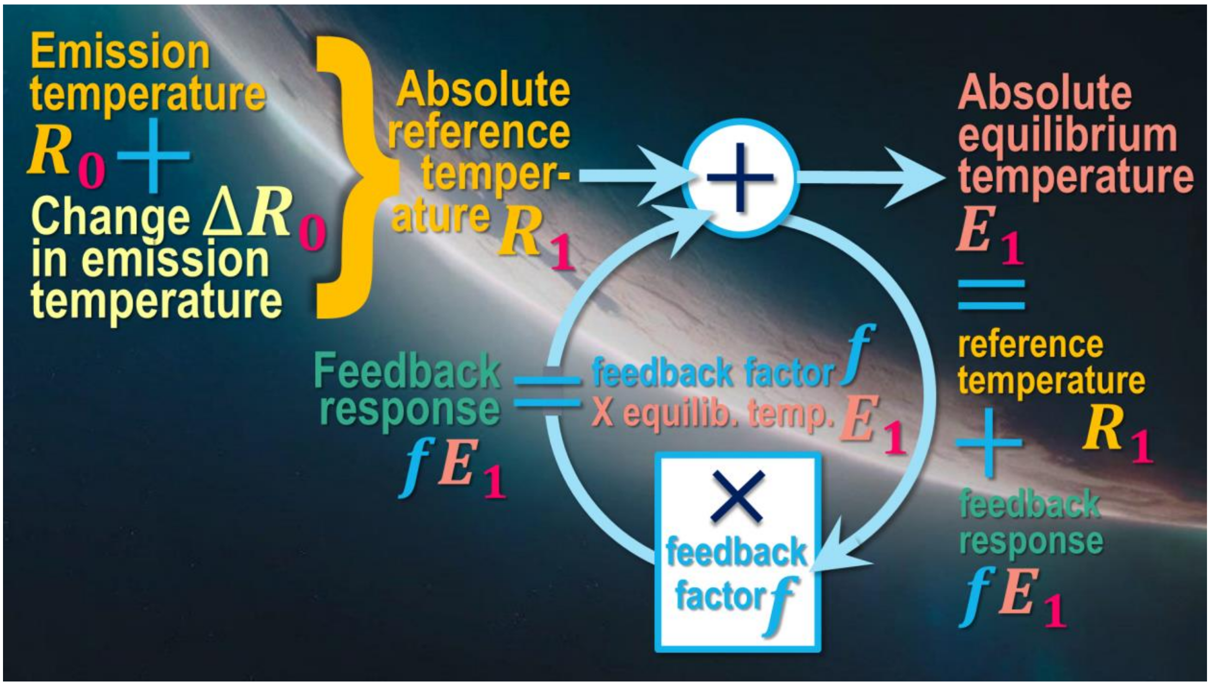
monckton@mail.com

Some linear network analysis to simplify the argument

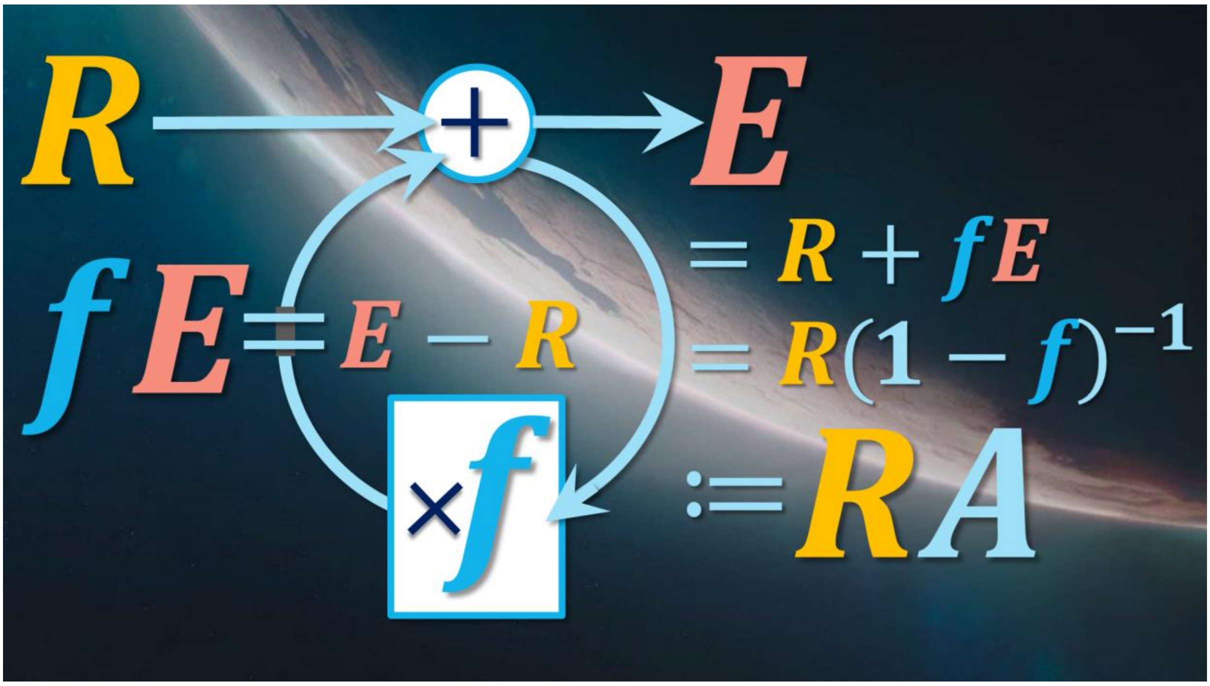
Modeling to derive feedback from microphysical processes (many at sub-grid scale) is over-complex and uncertain. The absolute equation offers a simpler, surer method.



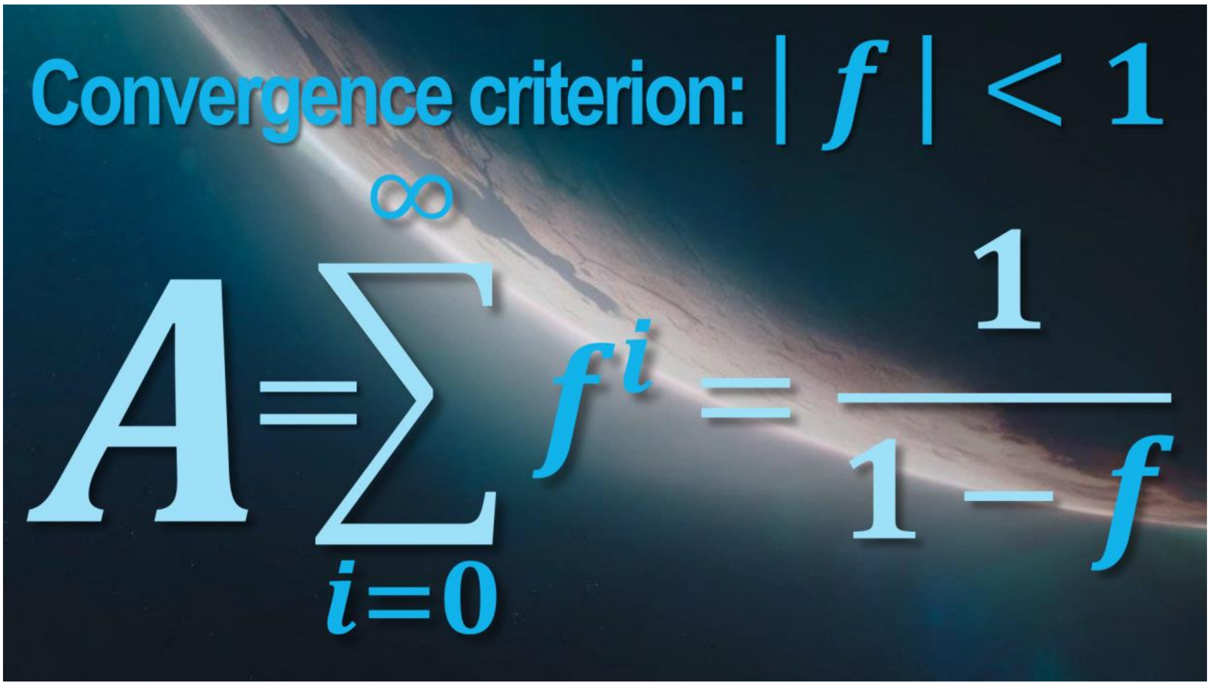
In a Bode feedback loop, reference temperature passes via the summative input node and the gain block to the output node, whence a fraction returns via the feedback block to the summative node. Climatology simplifies this – as do we – by removing the gain block and adding any change in reference temperature to the input. A single input/output node then replaces the two nodes.



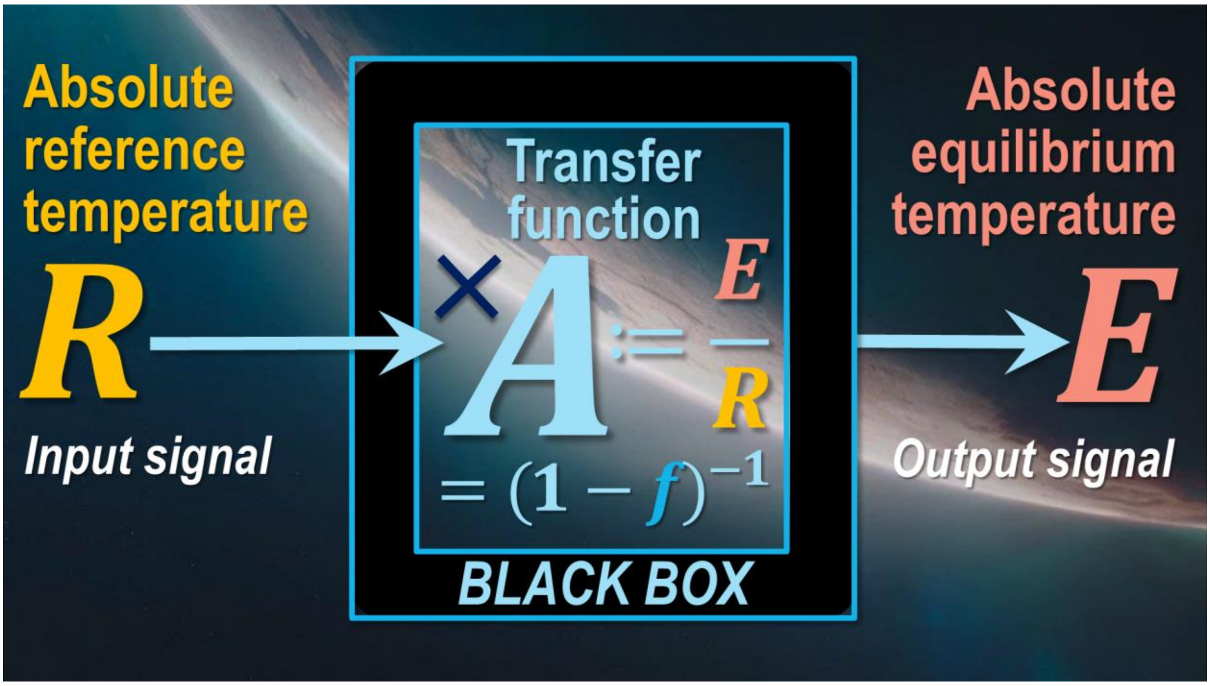
In the simplified diagram, reference temperature – the sum of emission temperature and any change thereto – is input to the summative input/output node. The signal passes around the feedback loop and back to the node, thence outward as equilibrium temperature. Self-evidently, feedback must respond to the entire reference temperature.



A little linear algebra shows equilibrium temperature is the product of reference temperature and the reciprocal of (1 minus the feedback factor), defined as the transfer function – the ratio of equilibrium to reference temperature.



Since the signal passes an infinite number of times round the feedback loop, the transfer function is the sum of all powers of the feedback factor *ad infinitum*. Under the convergence criterion that the feedback factor’s absolute value be < 1, the sum of this convergent infinite geometric series is again the reciprocal of (1 minus the feedback factor).



Absolute reference temperature

R

Input signal

Transfer function

$\times A := \frac{E}{R} = (1 - f)^{-1}$

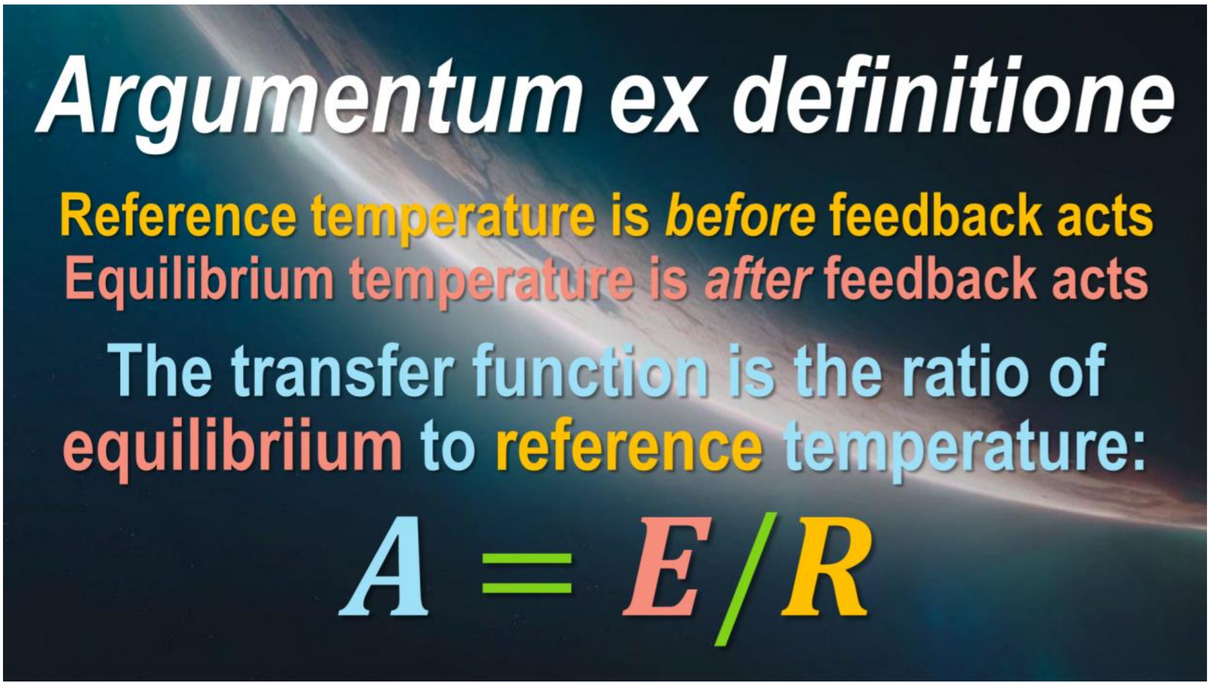
BLACK BOX

Absolute equilibrium temperature

E

Output signal

The block diagram thus reduces to a simple black box with equilibrium temperature out, reference temperature in and the transfer function as their ratio.



Argumentum ex definitione

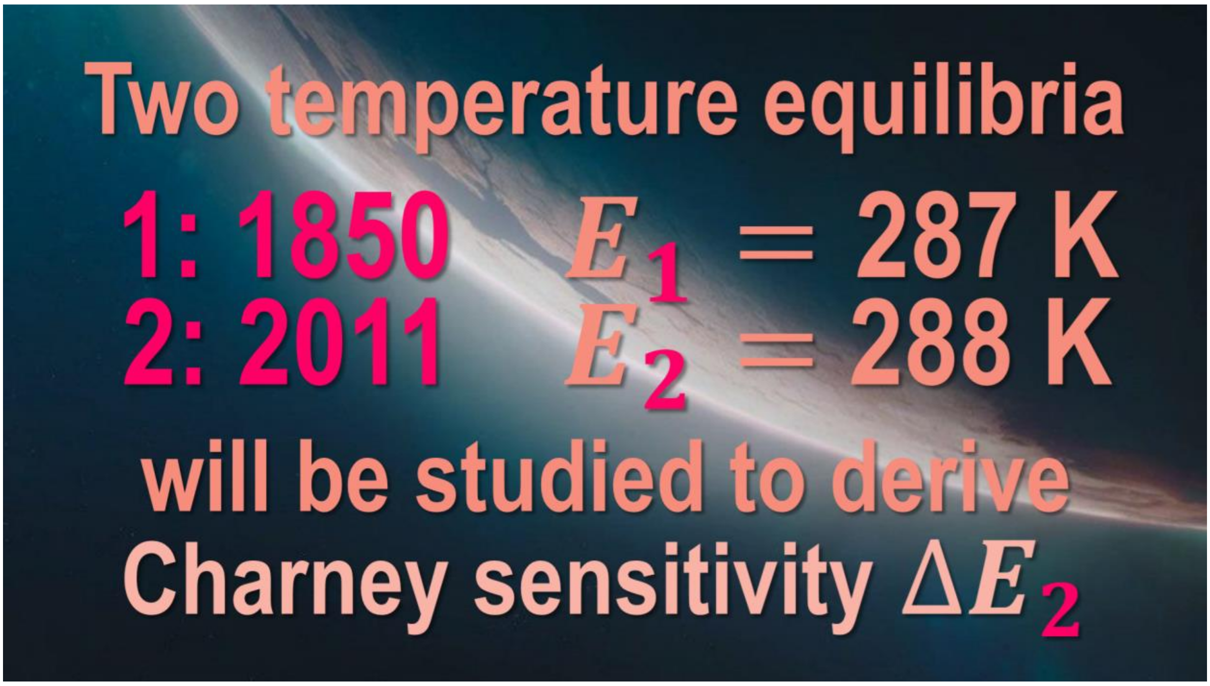
Reference temperature is *before* feedback acts

Equilibrium temperature is *after* feedback acts

The transfer function is the ratio of equilibriium to reference temperature:

$$A = E/R$$

Then, where reference and equilibrium temperature at any time are known, we need not know the values of feedbacks, or whether they interact or are nonlinear, or even what a feedback is. We may simply proceed *ex definitione*. From the definitions of reference and equilibrium temperature, it follows that the transfer function, which embodies the entire influence of feedback at any chosen time, is the ratio of equilibrium to reference temperature.



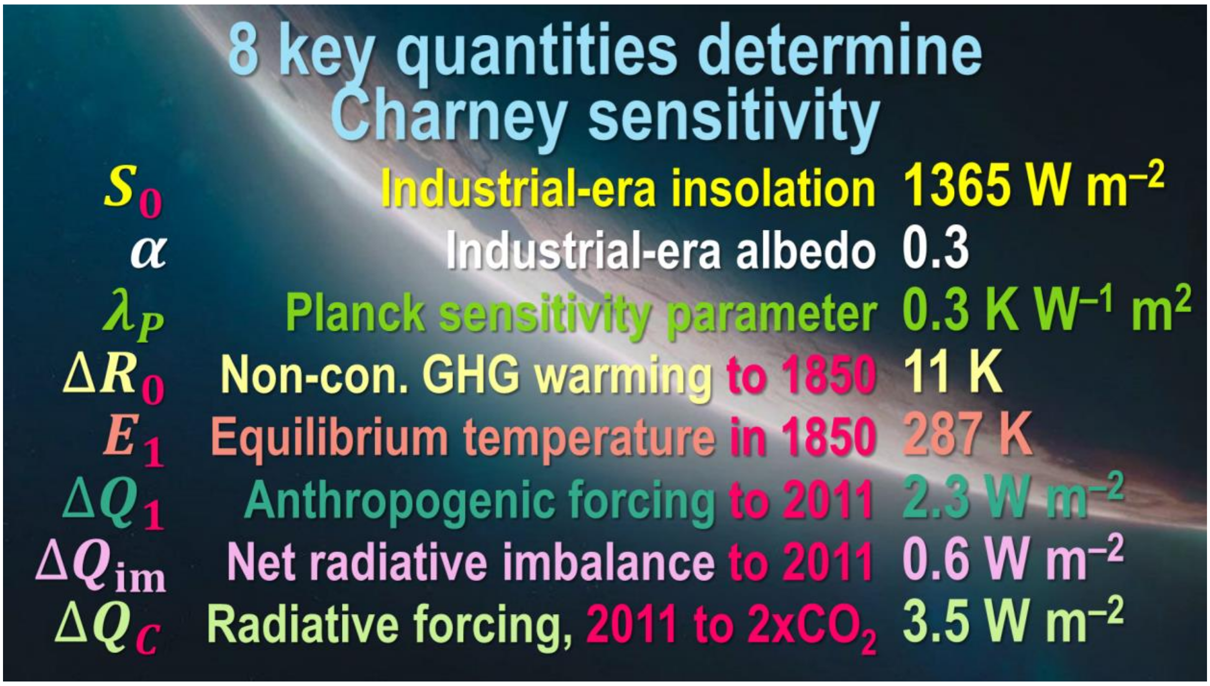
Two temperature equilibria

1: 1850 $E_1 = 287$ K

2: 2011 $E_2 = 288$ K

will be studied to derive Charney sensitivity ΔE_2

To establish the rate of change in the transfer function over time, we go to 1850, early in the industrial era, when the HadCRUT4 temperature dataset began, and then to 2011, 161 years later, when data were revised in preparation for IPCC (2013).



8 key quantities determine Charney sensitivity

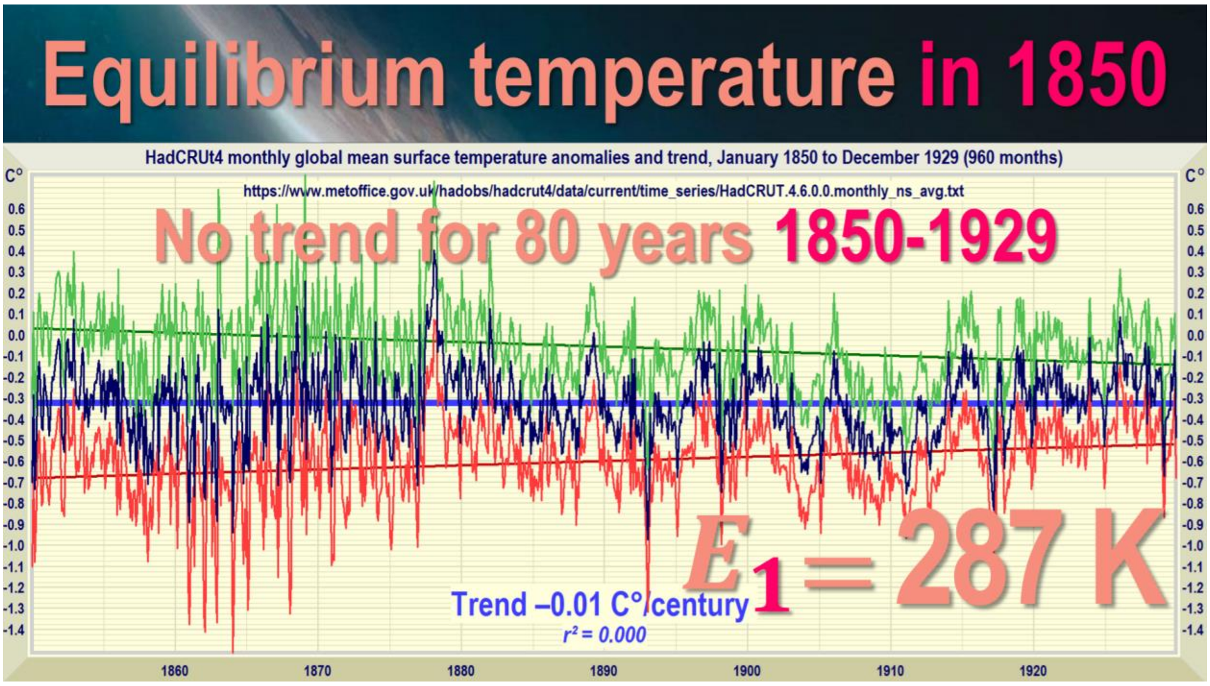
S_0	Industrial-era insolation	1365 W m^{-2}
α	Industrial-era albedo	0.3
λ_P	Planck sensitivity parameter	0.3 K W^{-1} m^2
ΔR_0	Non-con. GHG warming to 1850	11 K
E_1	Equilibrium temperature in 1850	287 K
ΔQ_1	Anthropogenic forcing to 2011	2.3 W m^{-2}
ΔQ_{im}	Net radiative imbalance to 2011	0.6 W m^{-2}
ΔQ_C	Radiative forcing, 2011 to $2xCO_2$	3.5 W m^{-2}

Models will prove unnecessary. Just eight quantities determine Charney sensitivity.

moncknton@mail.com

First equilibrium: 1850

We begin in 1850, when the HadCRUT4 global-temperature dataset, the first of its kind, began.



Equilibrium temperature in 1850

HadCRUt4 monthly global mean surface temperature anomalies and trend, January 1850 to December 1929 (960 months)

https://www.metoffice.gov.uk/hadobs/hadcrut4/data/current/time_series/HadCRUT.4.6.0.0.monthly_ns_avg.txt

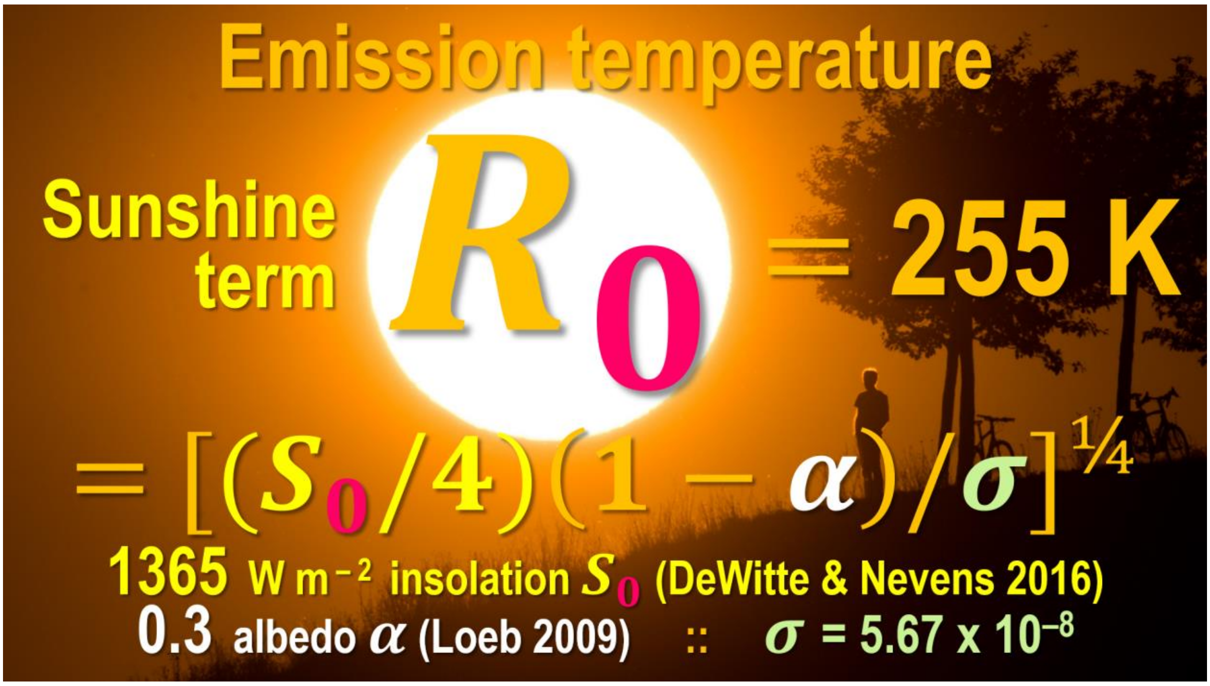
No trend for 80 years 1850-1929

$E_1 = 287$ K

Trend –0.01 C°/century

$r^2 = 0.000$

There was a temperature equilibrium that year: the trend in the HADCRUT4 monthly mean temperature anomalies was to be zero for the 80 years 1850-1929.



Emission temperature

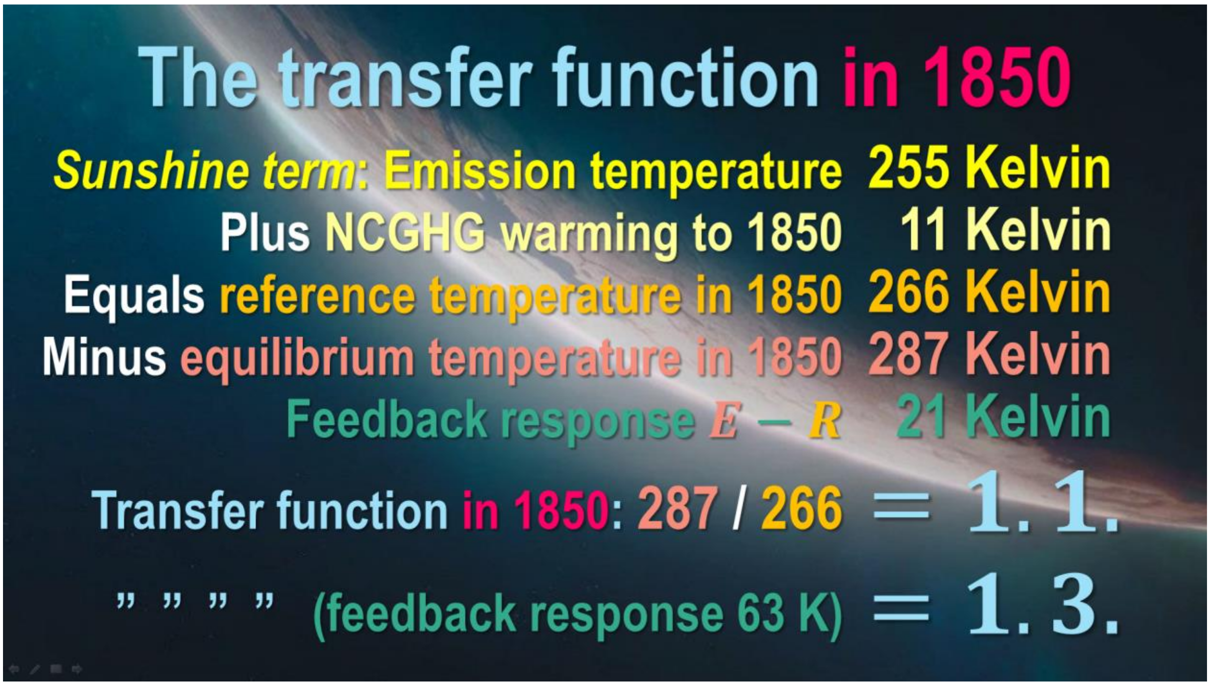
Sunshine term $R_0 = 255$ K

$$= [(S_0/4)(1-\alpha)/\sigma]^{1/4}$$

1365 W m^{-2} insolation S_0 (DeWitte & Nevens 2016)

0.3 albedo α (Loeb 2009) :: $\sigma = 5.67 \times 10^{-8}$

From insolation and albedo, the fundamental equation of radiative transfer yields emission temperature – the sunshine term omitted by climatology in its feedback analysis.



The transfer function in 1850

Sunshine term: Emission temperature 255 Kelvin

Plus NCGHG warming to 1850 11 Kelvin

Equals reference temperature in 1850 266 Kelvin

Minus equilibrium temperature in 1850 287 Kelvin

Feedback response $E - R$ 21 Kelvin

Transfer function in 1850: 287 / 266 = 1.1.

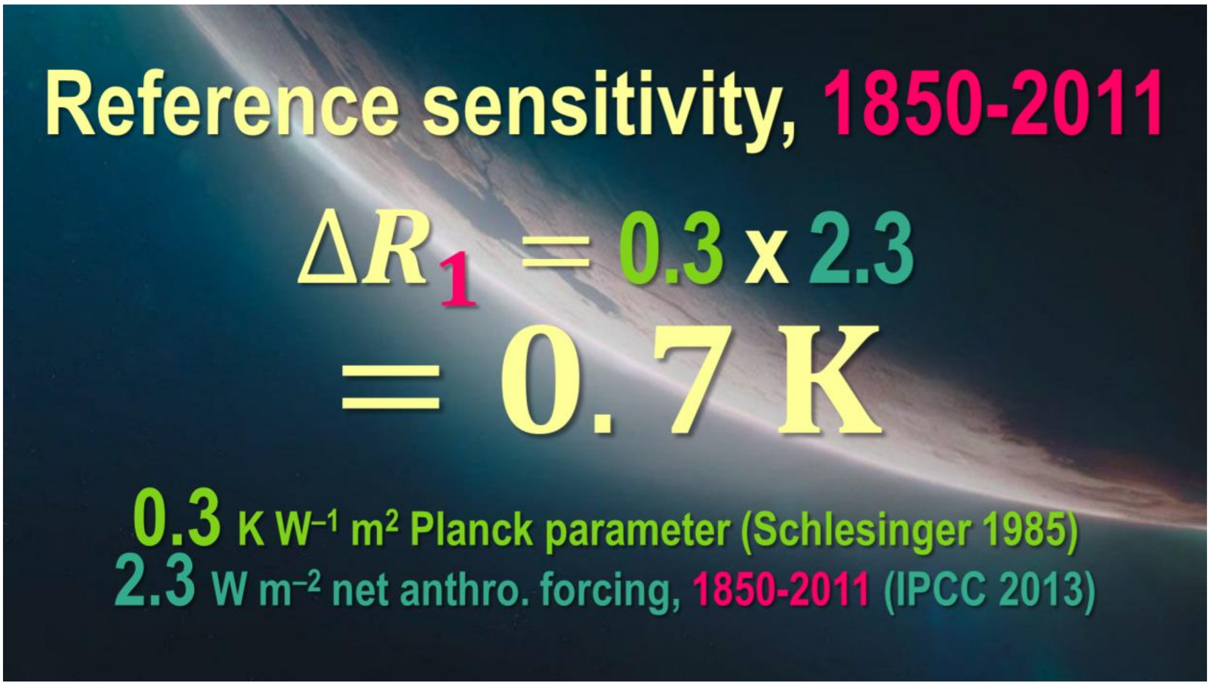
” ” ” ” (feedback response 63 K) = 1.3.

For reference temperature in 1850, add 11 K warming from pre-industrial greenhouse gases to the 255 K emission temperature. The transfer function, the ratio of equilibrium to reference temperature that year, is only 1.1, one-third of models’ implicit midrange estimate 3.25. Use of absolute values fortifies the result: even if the feedback response were thrice the 21 K shown, the transfer function would not much exceed 1.3.

moncKton@mail.com

Second equilibrium: 2011

The 2011 equilibrium temperature is inferred: not all manmade warming had yet appeared.



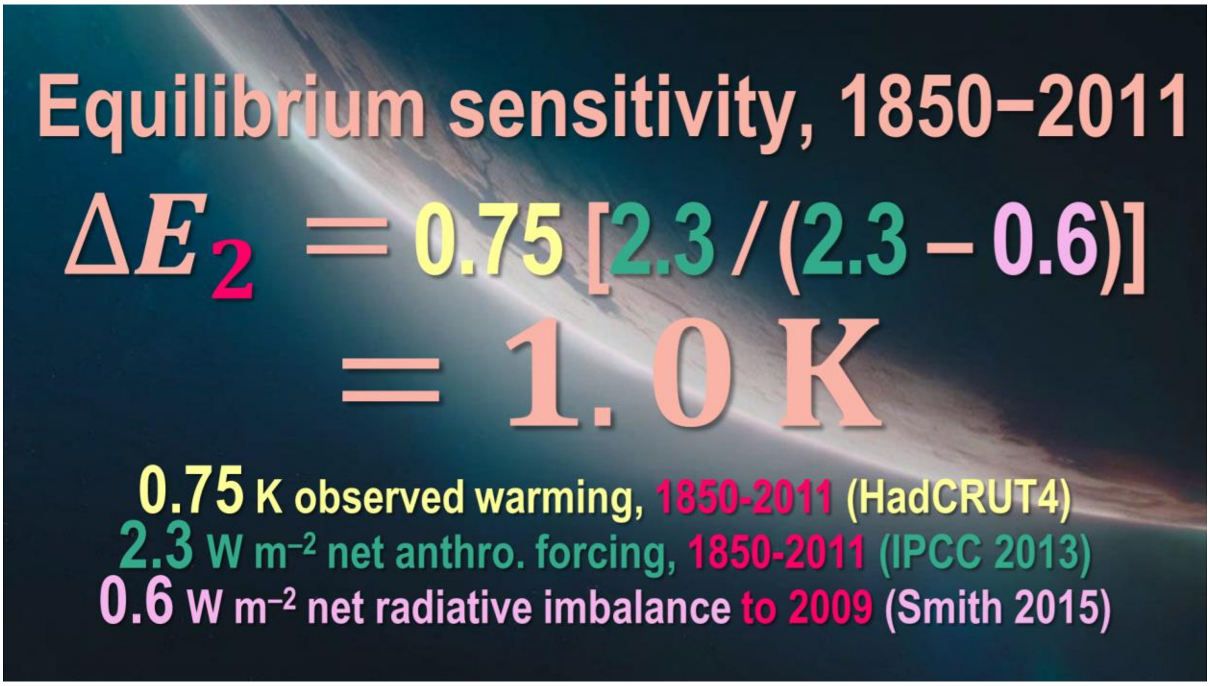
Reference sensitivity, 1850-2011

$$\Delta R_1 = 0.3 \text{ x } 2.3$$

$$= 0.7 \text{ K}$$

0.3 K W^{-1} m^2 Planck parameter (Schlesinger 1985)
2.3 W m^{-2} net anthro. forcing, 1850-2011 (IPCC 2013)

Reference sensitivity for 1850-2011, the product of the Planck parameter and estimated net period anthropogenic forcing, was 0.7 K.

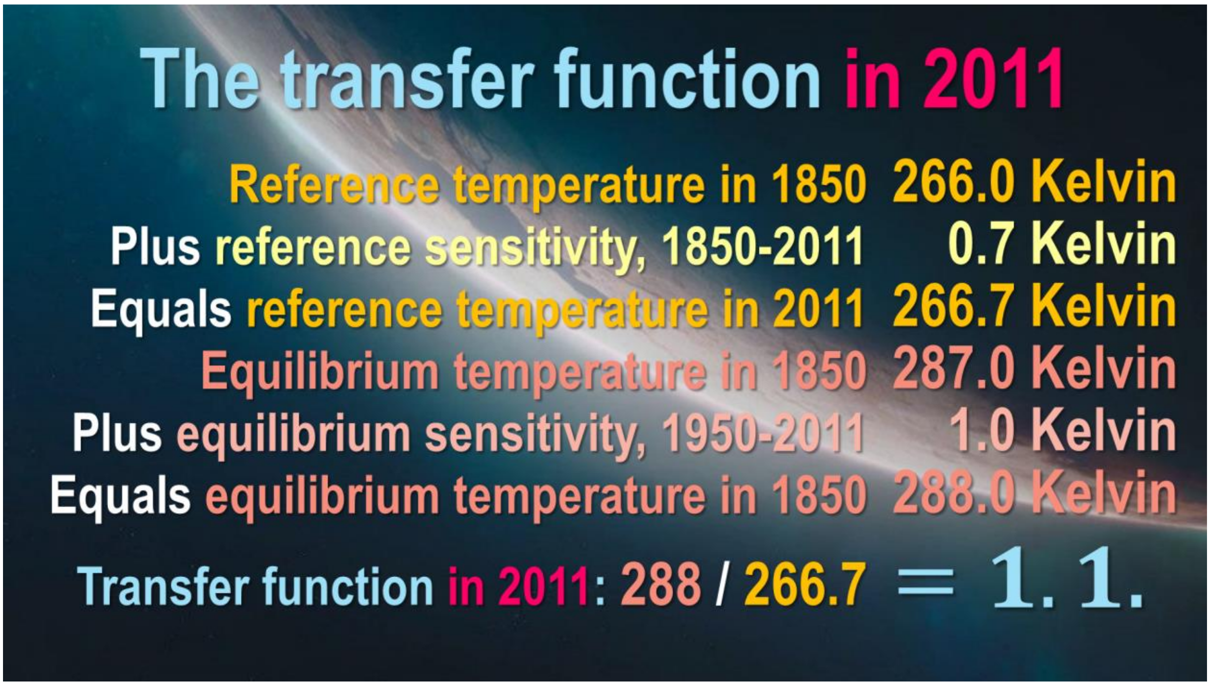


Equilibrium sensitivity, 1850–2011

$$\Delta E_2 = 0.75\,[2.3\,/\,(2.3 - 0.6)] = 1.0\text{ K}$$

0.75 K observed warming, 1850-2011 (HadCRUT4)
2.3 W m^{-2} net anthro. forcing, 1850-2011 (IPCC 2013)
0.6 W m^{-2} net radiative imbalance to 2009 (Smith 2015)

Allowing for a 0.6 W m^{-2} radiative imbalance delaying anthropogenic warming, the 1 K inferred equilibrium sensitivity to the 2.3 W m^{-2} net period anthropogenic forcing exceeded the 0.75 K observed period warming by about a third.



The transfer function in 2011

Reference temperature in 1850	266.0 Kelvin
Plus reference sensitivity, 1850-2011	0.7 Kelvin
Equals reference temperature in 2011	266.7 Kelvin
Equilibrium temperature in 1850	287.0 Kelvin
Plus equilibrium sensitivity, 1950-2011	1.0 Kelvin
Equals equilibrium temperature in 1850	288.0 Kelvin

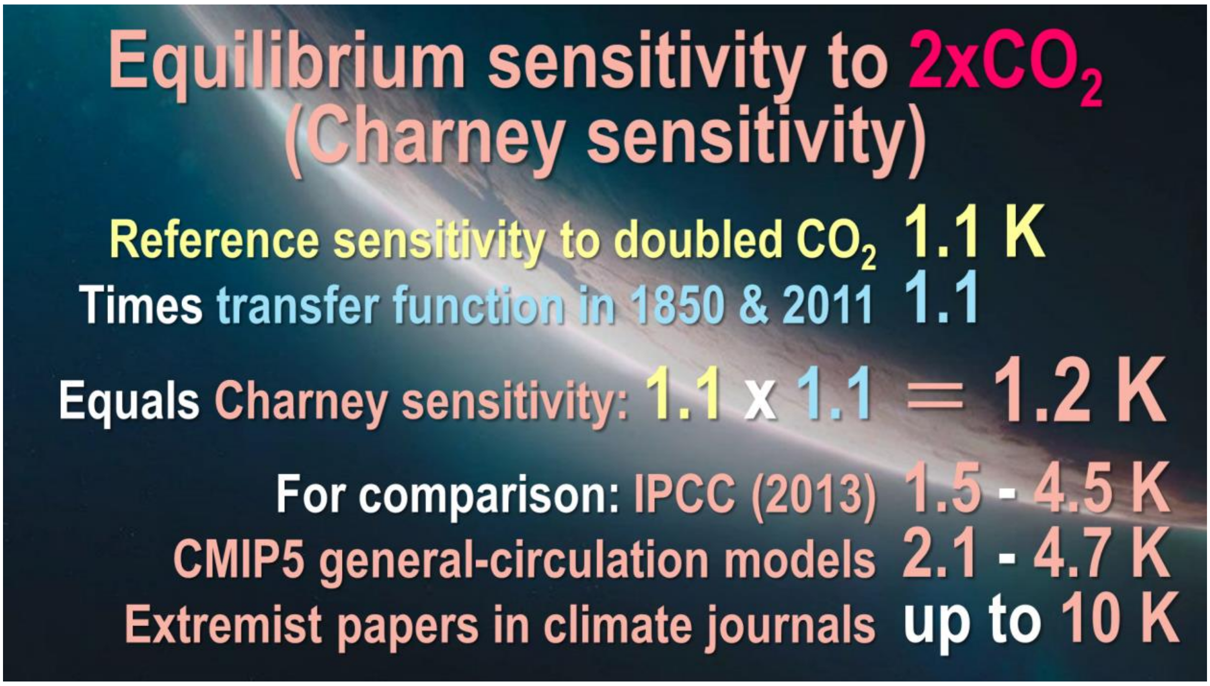
Transfer function in 2011: 288 / 266.7 = 1.1.

The transfer function for 2011 was 1.1, as in 1850, when reference temperature was 380 times the anthropogenic reference sensitivity from 1850-2011. That ratio is why our activities barely alter the transfer function over time.

monckton@mail.com

Charney sensitivity: $2xCO_2$

We now apply the transfer function 1.1 in the perturbation equation, whose defect we have overcome by deriving the transfer function from the absolute equation.



Equilibrium sensitivity to $2xCO_2$
(Charney sensitivity)

Reference sensitivity to doubled CO_2 1.1 K
Times transfer function in 1850 & 2011 1.1

Equals Charney sensitivity: 1.1 x 1.1 = 1.2 K

For comparison: IPCC (2013) 1.5 - 4.5 K
CMIP5 general-circulation models 2.1 - 4.7 K
Extremist papers in climate journals up to 10 K

Corrected Charney sensitivity is just 1.2 K.

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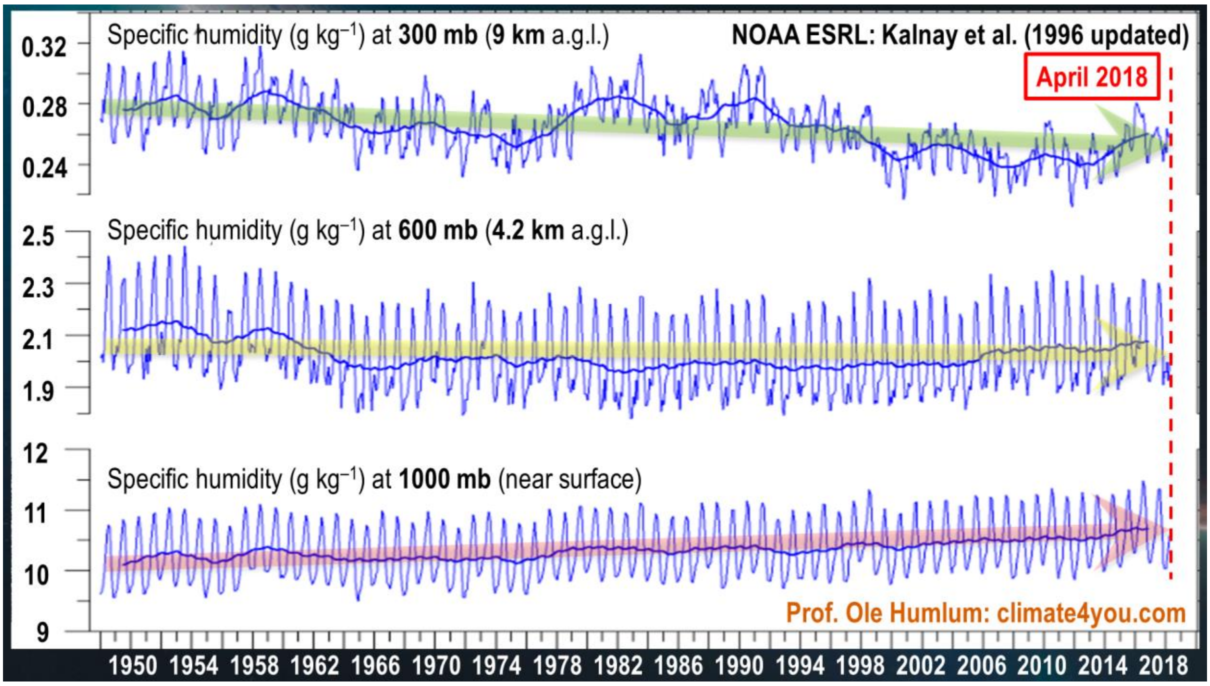
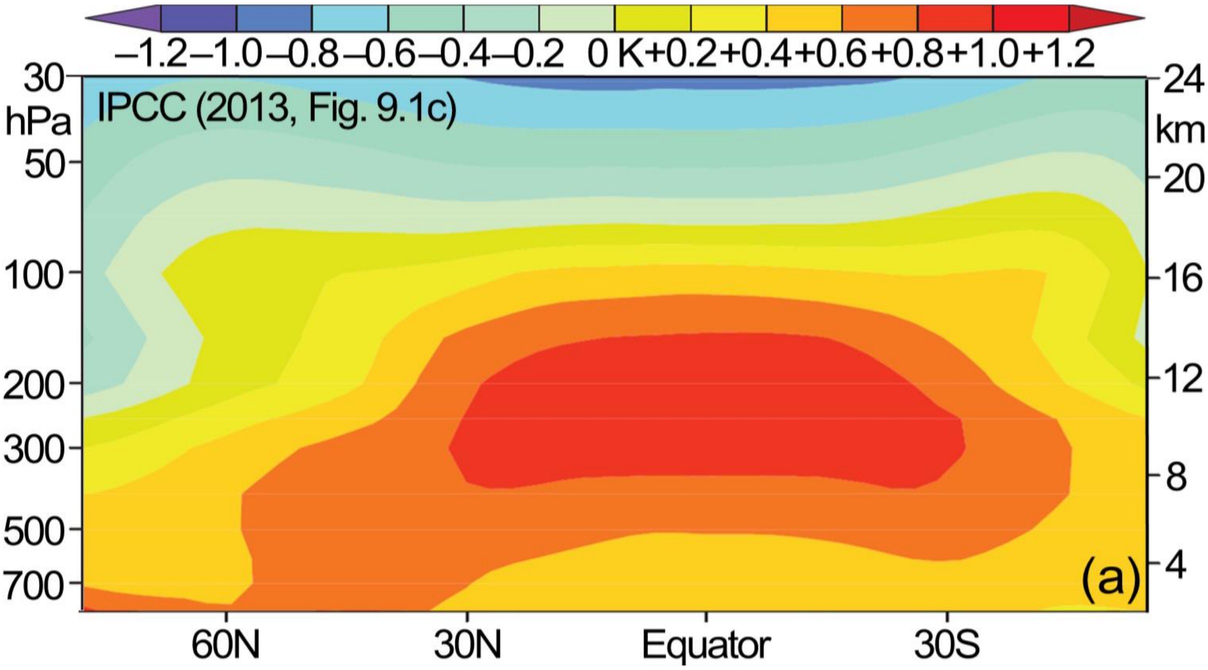
Models' chief physical error

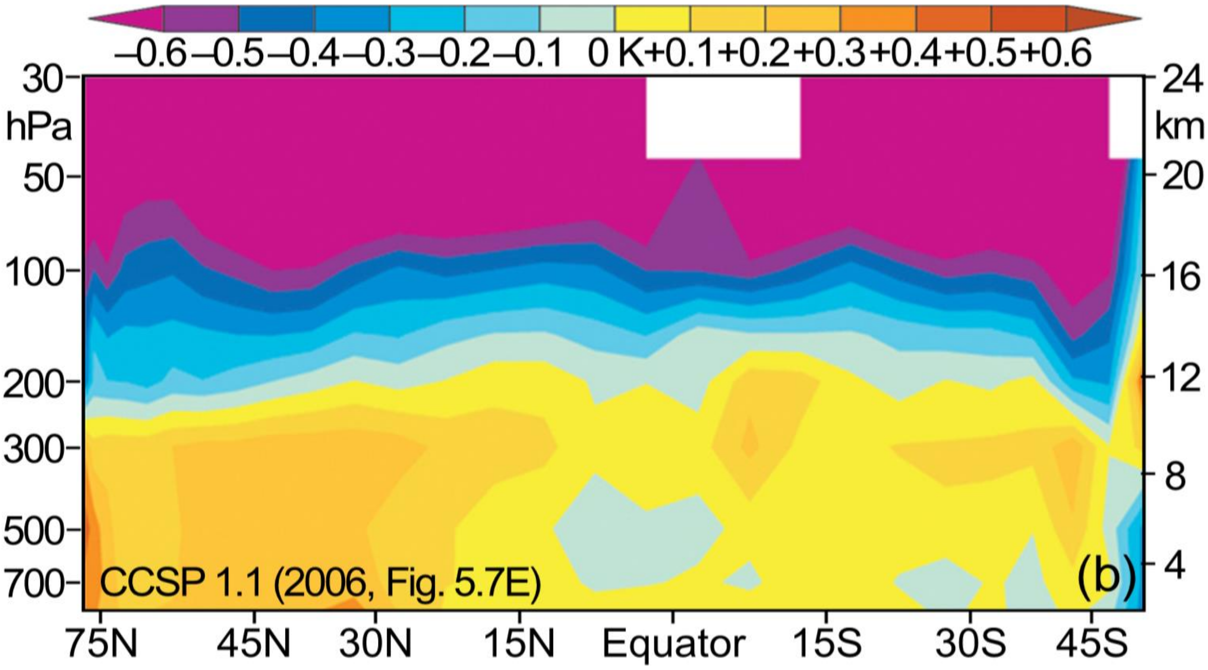
There is a physical explanation of the error we have demonstrated by theoretical means.



In IPCC (2013), all feedbacks but water vapor self-cancel. Water vapor feedback drives the entire feedback response. By the Clausius-Clapeyron relation, the atmosphere *can* (not *must*) carry 7% more water vapor per Kelvin, as is observed near the surface. However, specific humidity is unchanged at 600 mb, and actually declines at the crucial 300 mb pressure altitude.

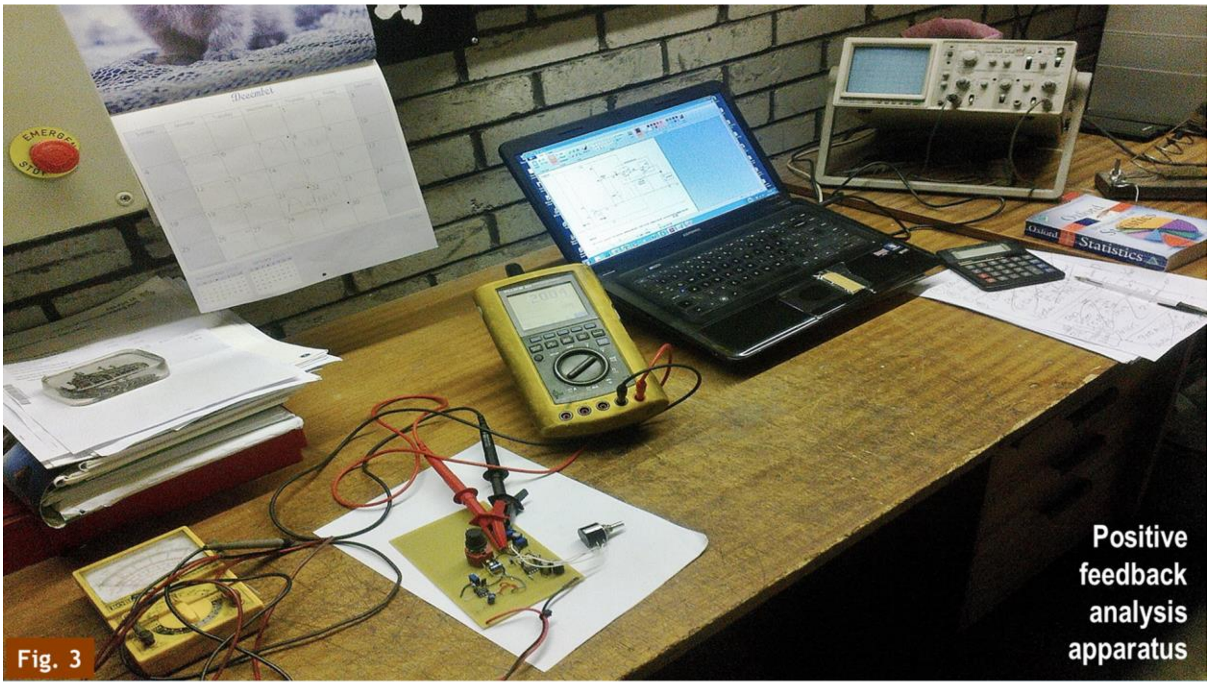


At 300 mb in the tropics, 9 km up, models predict warming at twice or thrice the surface rate.

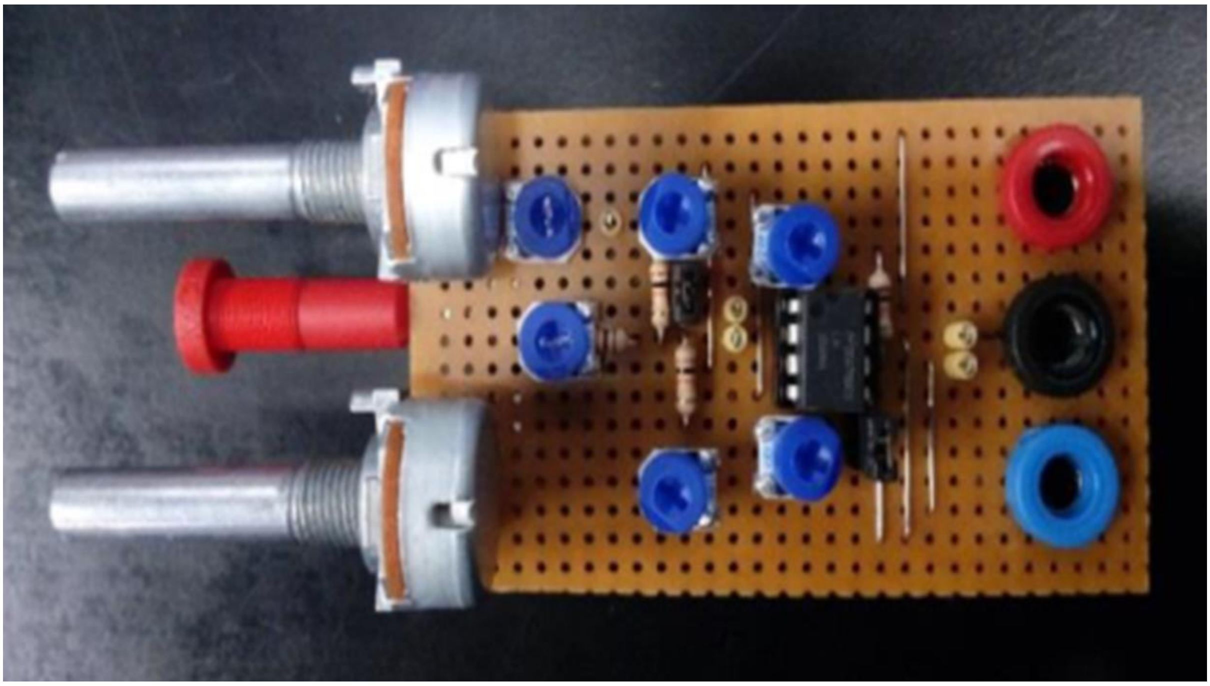


Yet the predicted tropical mid-troposphere "hot spot" is not observed. Our result explains why not. Without the hot spot, the water vapor feedback is necessarily weak and equilibrium sensitivity small.

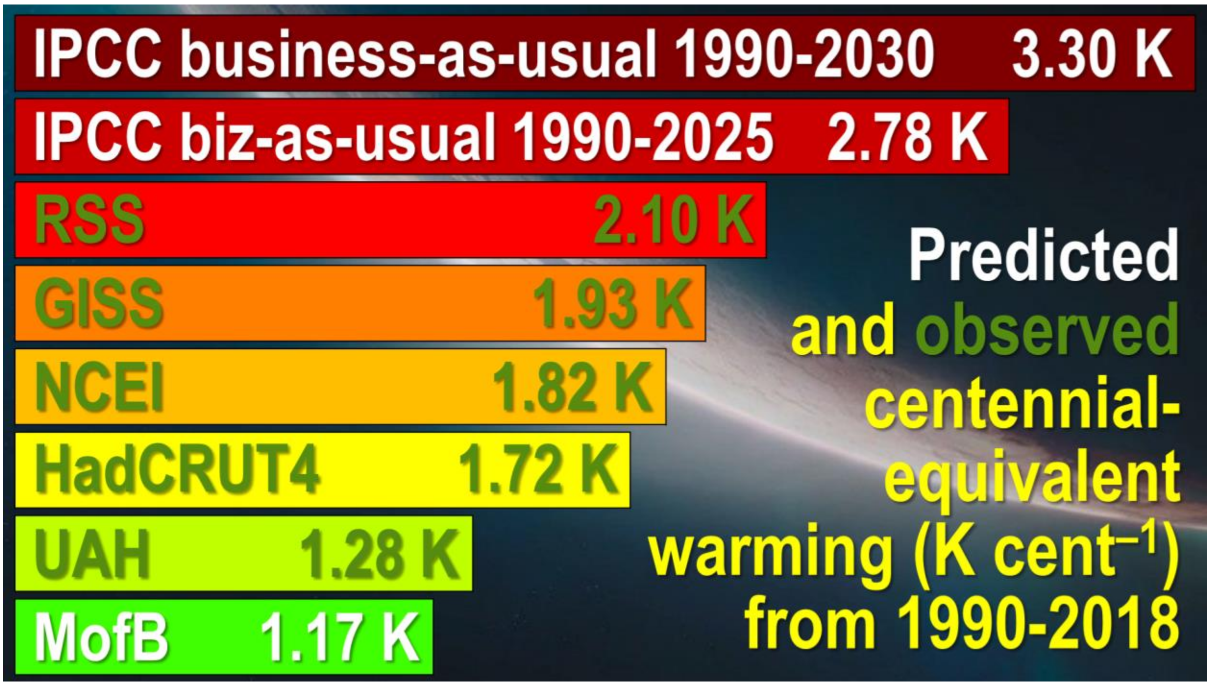
Our team includes a professor of applied control theory and two control engineers. One built a circuit to study the control theory applicable to all feedback-moderated dynamical systems.



Results confirmed we had understood the theory. Feedback processes do respond not merely to a change but to the entire input signal. Testing was not necessary, for feedback theory is well established. Yet we double-checked.

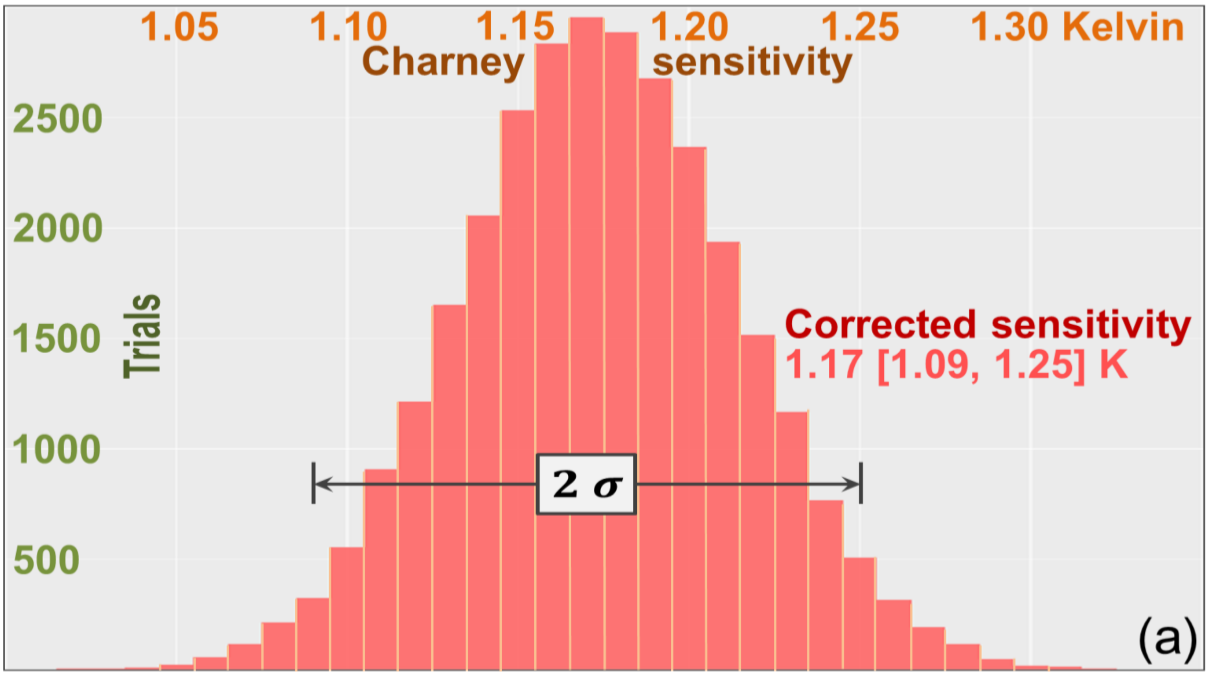


We also commissioned a government laboratory to build a more sophisticated (but still very simple) circuit. Results of 23 tests agreed with our calculations to within 0.05 K equivalent.

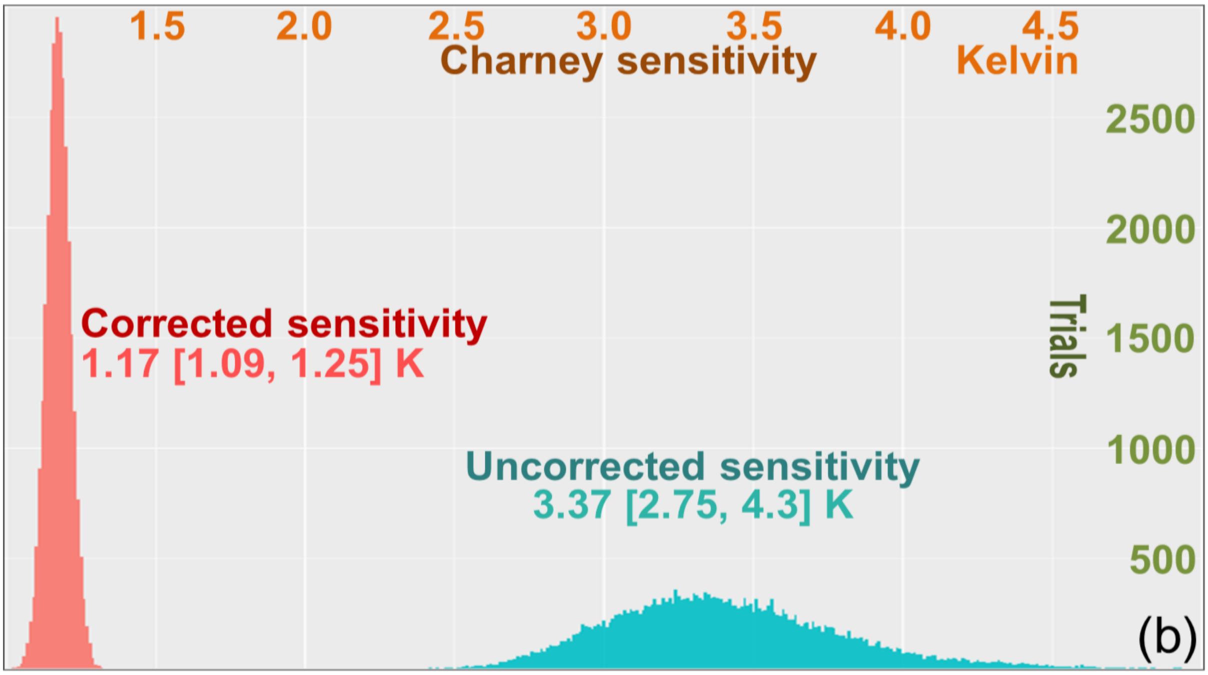


IPCC's business-as-usual mid-range centennial-equivalent warming rates from 1990-2030 and from 1990-2025 are here compared with the observed centennial-equivalent warming rates from January 1990 to June 2018 in five datasets, and with our prediction.

Our emeritus professor of statistics computed the 2-sigma confidence interval of Charney sensitivities derived from the absolute equation by the corrected method.

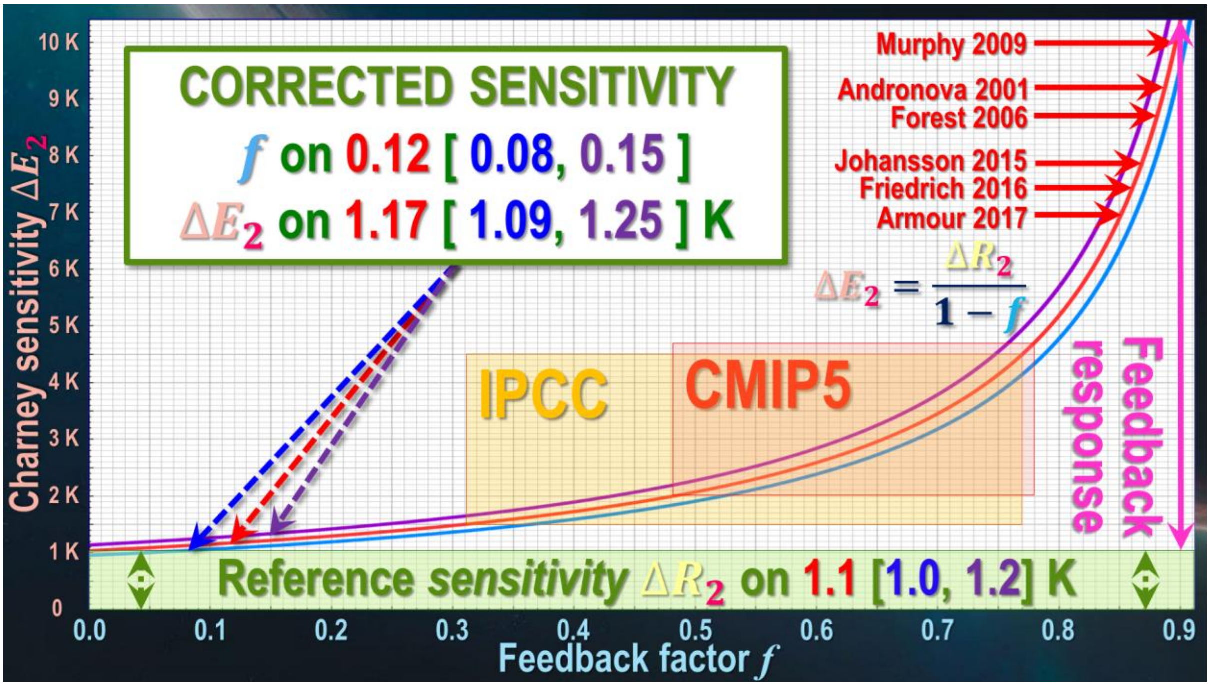


A 30,000-trial Monte Carlo simulation found the confidence interval to be just 0.08 K either side of corrected midrange Charney sensitivity.

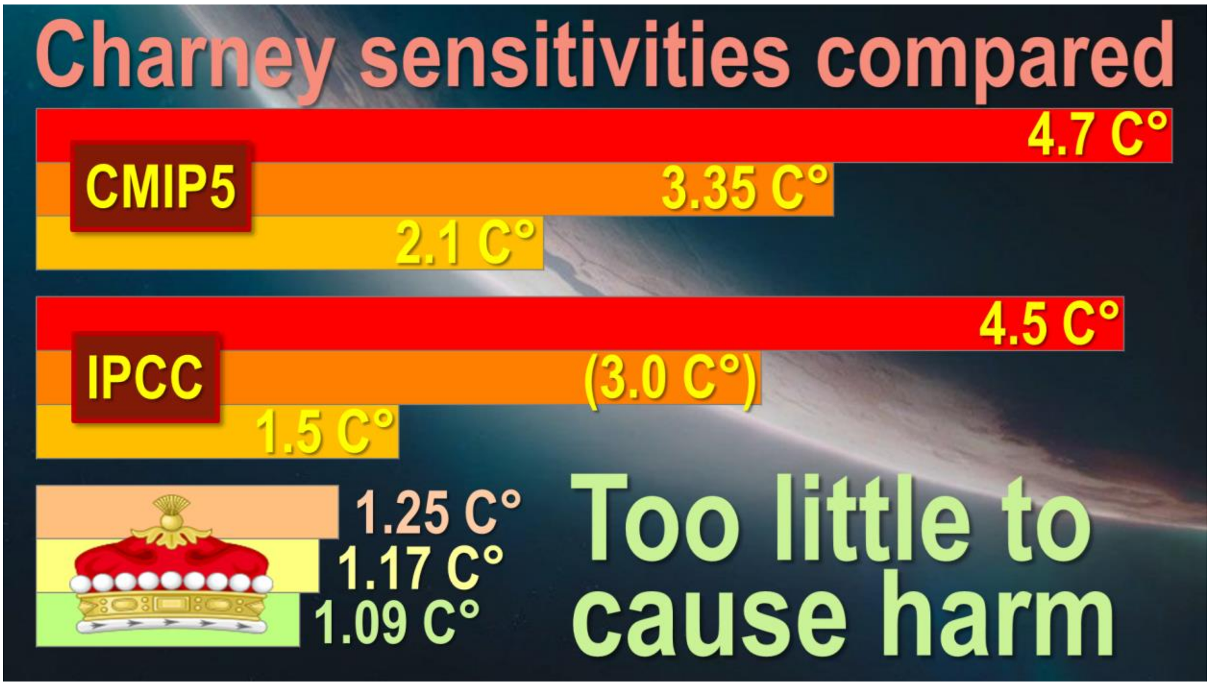


A second simulation, this time for models' Charney sensitivities (blue), was plotted against the first. The fat-tailed distribution reported in the journals duly appeared: but models' entire Charney-sensitivity interval is excessive and less well constrained than ours (pink).

Finally, we compared our predicted interval of Charney sensitivities with official predictions.



Corrected Charney sensitivity falls on 1.17 [1.09, 1.25] K, against IPCC’s 1.5-4.5 K, models’ 2.1-4.7 K and up to 10 K in some papers.

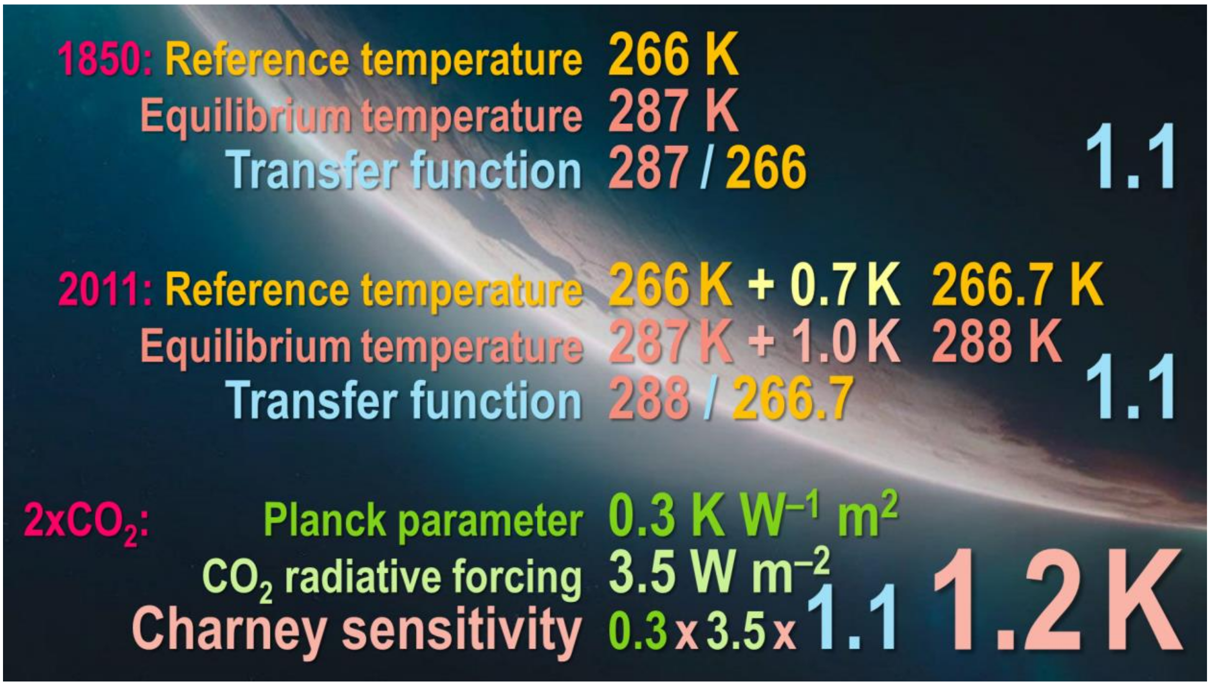


After correcting climatology’s error in defining temperature feedback as responding to perturbations only, anthropogenic warming will be too small and slow to cause harm.

monckton@mail.com

End of the global warming crisis in a single slide

Here, then, is the end of the global warming crisis in one slide.



1850: Reference temperature 266 K
Equilibrium temperature 287 K
Transfer function 287 / 266 1.1

2011: Reference temperature 266 K + 0.7 K 266.7 K
Equilibrium temperature 287 K + 1.0 K 288 K
Transfer function 288 / 266.7 1.1

$2xCO_2$: Planck parameter $0.3\ K\ W^{-1}\ m^2$
CO_2 radiative forcing $3.5\ W\ m^{-2}$
Charney sensitivity 0.3 x 3.5 x 1.1 1.2 K

In 1850 and 2011, the transfer function was 1.1. Charney sensitivity, the product of the transfer function 1.1 and the reference sensitivity 1.1 K, is just 1.2 K.

We have twice notified the IPCC Secretariat of its misdefinition of temperature feedback. We have explained why correcting the error ends the global warming crisis. We have asked IPCC to activate its error protocol. IPCC has not replied. Please sign the letter to the Secretariat from this conference insisting that IPCC should activate the protocol, not only in compliance with its own procedures but also for the sake of scientific integrity and objective truth.

"There's ane end o' ane auld sang," as the Earl of Seafield said in 1707 when signing Scotland's independence away in return for English cash. **All readers:** To add your name to the letter asking IPCC to activate its error protocol and investigate our result, do send me an email at the address shown on several of the slides and I'll send you a copy of the letter.