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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

THE PEOPLE OF THE STATE OF CALIFORNIA Plaintiff, v. BP P.L.C., et al. Defendants.	Case Nos. C-17-06011 WHA and C-17-06012 WHA Date: March 21, 2018 Time: 8:00 AM Judge: Hon. William Alsup Location: Courtroom 8 on 19th Floor

BRIEF OF *AMICI CURIAE*:

(1) THE VISCOUNT MONCKTON OF BRENCHLEY, (2) DR WILLIE WEI-HOCK SOON, (3) PROFESSOR DAVID LEGATES, (4) DR WILLIAM M. BRIGGS, (5) DIPL.-ING. MICHAEL LIMBURG, (6) DR DIETRICH JESCHKE, (7) MR ALEX HENNEY, (8) MR JOHN WHITFIELD, AND (9) MR JAMES MORRISON

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[1] The present brief addresses two scientific results. The *amici curiae*, therefore, do not cite legal precedents. An alphabetical list of scientific authorities cited herein is offered. Copies of any of these authorities will be provided upon request. The First *Amicus* will attend in person if asked. The *amici curiae* stand ready to provide answers not only to the eighth scientific question raised in the Court's Order of March 6, 2018, which they have answered herein, but also to the other questions therein: but they have anticipated that parties will answer those questions.

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INTEREST OF *AMICI CURIAE*

1. The *amici curiae* are an international team of scientific researchers concerned that scientific questions should be answered scientifically, rationally, dispassionately and logically. They have been investigating climate change for up to 12 years, and have intensively studied the question how much global warming we may cause (the "climate sensitivity" question). Their purpose in submitting the present brief is address the eighth question put to parties by the Court in an Order of March 6, 2018 for a tutorial hearing on climate science to be held on March 21, 2018. *Amici* will answer the question by providing and justifying two material scientific results not contained in the parties' briefs. The Court's eighth question was:

> What are the main sources of heat that account for the incremental rise in temperature on Earth?

2. Christopher Monckton of Brenchley, author of some two dozen peer-reviewed papers and book chapters on climate sensitivity and mitigation economics, is a Master in Classical Architecture in the University of Cambridge, where *inter alia* he studied the philosophy of science, logic and applied mathematics; **Dr Willie Soon** is an award-winning astrophysicist of a quarter of a century's standing at the Harvard-Smithsonian Center for Astrophysics (here speaking for himself only), who has written numerous peer-reviewed papers on the Sun's influence on terrestrial climate; **Dr David Legates** is Professor of Climatology in the University of Delaware and a former Delaware State Climatologist; **Dr William M. Briggs** is a statistician and emeritus professor in the Weill Cornell School of Medicine at Cornell University; **Dipl.-Ing. Michael Limburg** is an electronics engineer with practical knowledge of control theory, the study of feedback in dynamical systems; **Dr Dietrich Jeschke** is a lecturer in applied control theory in the University of Applied Sciences, Flensburg, Germany; **Mr Alex Henney** is a specialist in the electricity supply industry who has advised on electricity markets and regulation in the United States and other countries; **Mr John Whitfield** is an electronics engineer who built a test circuit to verify the present result, on the basis of which a new circuit was designed and a government laboratory was commissioned to build and run it; and **Mr James Morrison** is an undergraduate in Environmental Sciences at the University of East Anglia.

3. All of the *amici curiae* act solely *ex proprio motu*, hold no shares or other proprietary interests in any of the Parties' or their competitors' corporations or undertakings, and have neither received nor offered nor been offered any payment for preparing or submitting their brief. Some have, in

the past, received research grants or expenses from coal-owning interests, though most have never received such grants or expenses and none have done so for some years.

INTRODUCTION AND SUMMARY OF THE ARGUMENT

4. Methods: The *amici curiae* present herein two scientific results not mentioned in the parties' briefs but directly and decisively relevant to the determination not only of these but of all suchlike proceedings. The first result has been peer-reviewed and published; the second is currently under peer review. The underlying science is simple enough to allow the Court, which has earned a unique and commendable reputation for diligent mastery of scientific questions, to understand the argument and to verify its soundness. To assist the Court and to vitiate any allegation of prejudice on the part of its *amici*, they will state explicitly whether each premise is regarded as mainstream climate science, in which event they will provide mainstream citations from peer-reviewed learned journals.

5. First result: The *amici curiae* will demonstrate that there is no "consensus" among scientists that recent global warming was chiefly anthropogenic, still less that unmitigated anthropogenic warming has been or will be dangerous or catastrophic. The "consensus" proposition, as defined by the Intergovernmental Panel on Climate Change (IPCC), states no more than that most of the global warming observed since 1950 was anthropogenic. That proposition does not necessarily entail the conclusion that global warming has been or will be net-harmful. In 2013, a paper was published falsely asserting that some 97.1% of 11,944 peer-reviewed papers on climate and related topics published in the learned journals during the 21 years 1991-2011 had explicitly stated in their abstracts that recent global warming was chiefly anthropogenic. That paper received worldwide publicity. However, its authors did not ask whether the 11,944 papers had stated that unmitigated global warming might prove catastrophic. It will be shown that on careful examination of the list of all 11,944 papers only 43, or 0.3%, had in reality stated their assent even to the anodyne proposition that recent warming was chiefly anthropogenic. In any event, argument from "consensus" is a logical fallacy. Thus, there is no agreement among relevant experts on the fraction of observed warming since 1950 that was anthropogenic, and, therefore, no such agreement on the answer to the Court's eighth question.

6. Second result: The *amici curiae* will demonstrate that, even if it be assumed *ad argumentum* that all of the 0.8 Kelvin global warming since anthropogenic influence first became potentially

significant in 1950 was attributable to us, in the present century little more than 1.2 K of global warming is to be expected, not the 3.3 K that the Intergovernmental Panel on Climate Change (IPCC) had predicted. It will be demonstrated that the current models greatly overstate the feedback response to direct warming, owing to a long-standing error of physics recently discovered by the *amici curiae*, the decades-old official predictions that upon the restoration of thermal equilibrium in the climate system following a doubling of the atmospheric concentration of carbon dioxide there will have occurred a global surface warming of 3.3 ± 1.2 K, are excessive. Accordingly the extreme predictions of 4.5 K to 11 K on which national and international policies and plaintiff's case have been predicated are excessive *a fortiori*; global warming will be small, slow and net-beneficial; and plaintiff's case must fall.

7. Verification: By several methods whose results cohere, the *amici curiae* determined and verified that the mid-range estimate of global warming per doubling of atmospheric carbon dioxide (approximately equivalent to expected 21st-century warming from all anthropogenic sources) will not be 3.3 ± 1.2 K but only 1.2 ± 0.15 K If these results be correct, concern about global warming is unnecessary, whereupon not only must plaintiff's case fail but defendants' public assertions that global warming is a serious problem are also unjustifiable.

8. Respectful submission: The *amici curiae*, therefore, respectfully submit that, in the light of these results, which are directly relevant to the issue before the Court, plaintiff's claims should be dismissed and defendants, having based their public expressions of concern about global warming on the same error as plaintiff, should meet their own costs in the cause.

ARGUMENT

A. First result: The global-warming "consensus" proposition says nothing of impending "catastrophe" and only 0.3% of scientists, not 97%, assent to it.

9. The official answer to the Court's eighth question, asking about the causes of the 0.8 K global warming since our influence first became potentially significant in 1950, is given e.g. in the *Fifth Assessment Report* (2013, p. 17) of the IPCC:

> It is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period.

10. Such statements encapsulate the official definition of the "consensus" proposition. In any event, nothing in that proposition necessarily entails the conclusion that unmitigated anthropogenic global warming will be dangerous, still less that it will be catastrophic.

11. Cook *et al*. (2013), after a subjective review of the abstracts of 11,944 papers on climate change which matched the topics "global climate change" or "global warming", concluded that 97.1% of those that expressed an opinion endorsed IPCC's definition. However, two-thirds of the abstracts had expressed no position. Thus, 32.6% of the entire sample, or 97.1% of the 33.6% that had expressed an opinion, were said to be in agreement with the standard definition. This assertion of a 97% "consensus" attracted considerable worldwide publicity. Numerous commentators have repeated the 97% figure.

12. In some respects, Cook (*op. cit.*) had adopted a reasonable approach: for, unlike others purporting to demonstrate a scientific "consensus" about global warming, they had based their results on reading papers that had been peer-reviewed, rather than conducting a sort of opinion poll among scientists whose opinions as expressed in such polls had not been subjected to the rigors of peer review. Also, unlike other authors, Cook et al. had selected a sample that was sufficient to allow statistically respectable conclusions to be drawn. However, they had not appreciated the logical fallacy (*argumentum ad populum*) of doing science by mere head-count, even if those heads were learned (*argumentum ad verecundiam*) and their opinions had been peer-reviewed. Worse, Cook et al. misreported and materially misrepresented their own results.

13. Legates *et al.* (2013) obtained a copy of the data-file in which Cook et al. had listed the names and authors of all 11,944 papers and the rankings they had assigned to each of the papers, and performed two independent tests on the file. First, they used the search facility in Microsoft Word to identify every paper for which the data string in the comma-delimited text file ended with ",1", by which Cook et al. had signified their view that that paper had supported the first of seven "levels of endorsement" of the imagined "consensus", namely "explicit, quantified endorsement" of the "consensus" proposition. In this context, "quantified endorsement" meant that the paper had stated that > 50% of the global warming of recent decades had been anthropogenic. The *amici*'s search, conducted manually, showed that Cook *et al.* had themselves categorized and listed only 64 papers, or just 0.5% of the entire sample, as having explicitly and quantitatively endorsed the standard definition of the "consensus" proposition.

14. Legates et al., surprised by the very large discrepancy between the 97.1% "consensus" reported by Cook et al. and what their search had found to be the 0.5% explicit and quantified endorsement of the "consensus" proposition, wrote a computer program to read down the entire file, byte by byte, this time searching for ",1" followed by a carriage return and a linefeed. This search confirmed that Cook *et al*. had themselves recorded, in their own data file, that only 64 papers had explicitly and quantitatively endorsed IPCC's "consensus" proposition.

15. Legates *et al.* then read all 64 papers and discovered that only 41, or 0.3% of all 11,944 papers, had thus endorsed the "consensus" proposition. These results were peer-reviewed and published but received negligible publicity. Cook and one of his co-authors (Bedford & Cook, 2013) published a reply saying:

> The point being made by citing statistics about the existence and strength of the scientific consensus on human induced climate change is to demonstrate that this consensus is real and strong. (p. 6)

16. On five separate occasions, Bedford & Cook wrote of a near-unanimous (but actually non-existent, as Cook's own data file had shown) "consensus" among scientists that most of the global warming of recent decades was anthropogenic:

> ➢ First, there is an overwhelming consensus within the scientific community on several fundamental points regarding human-induced climate change (also known as global warming: the Earth's global average temperature is increasing, and human emissions of greenhouse gases especially carbon dioxide, are the **main** cause. (p. 4)
>
> ➢ … Is there a consensus within the scientific community on the basic science of human-induced climate change? Here, as in Bedford (2010) and in most studies on the scientific consensus on this issue, this basic science is defined as the findings that greenhouse gas concentrations have been rising since the Industrial Revolution; this has occurred largely, though not exclusively, due to the burning of fossil fuels, and this increase in greenhouse gas concentrations is the **main** cause of an observed increase in Earth's global average temperature over the period of instrumental record (generally since the mid-late 19th century). (p. 6)
>
> ➢ Of the 4014 abstracts that expressed a position on the issue of human-induced climate change, Cook *et al.* (2013) found that over 97% endorsed the view that the Earth is warming up and human emissions of greenhouse gases are the **main** cause. (p. 6)
>
> ➢ … the widely agreed-upon basic points on the science of human-induced climate change that we have emphasized throughout this response: carbon dioxide is a greenhouse gas, its concentration in the atmosphere has risen dramatically since the Industrial Revolution, and this has been the **main** cause of an increase in Earth's global average temperature, observed since the late 19th Century. (p. 14)

> ➢ Detailed examination of the peer-reviewed literature, as discussed earlier, suggests that the overwhelming majority of published research supports the scientific consensus that the Earth's global average temperature is increasing, **mainly** due to the increased concentration of greenhouse gases that has resulted from human burning of fossil fuels since the Industrial Revolution (e.g. Cook *et al.*, 2013). (p. 18) *[amici's emphases]*

17. All of the above assertions were false. From the research by Legates *et al.,* in the peer-reviewed journals it is evident there is little explicit support therein for the "consensus" proposition that recent warming was chiefly anthropogenic.

18. The immediate answer to the Court's eighth question, therefore, is that, however often or shrilly it be asserted that such a "consensus" exists, the relative contributions of Man and Nature to the 0.8 K warming since 1950 have not been and cannot be determined in the present state of scientific knowledge. For this reason the *amici curiae,* in their second and more important scientific result, will cautiously assume *ad argumentum,* but without warranty, that all global warming since global temperature records were first kept in 1850 has been anthropogenic.

B. Second result: After correction of a substantial error of physics discovered by the *amici curiae*, the global warming to be expected this century, or upon doubling the atmospheric concentration of carbon dioxide, will not be 3.3 ± 1.2 K but 1.2 ± 0.15 K.

19. Underlying the Court's eighth question, concerning the apportionment of recent global warming between Man and Nature, lies the question – central to the present case – of how much global warming we may in future cause. The standard metric for estimations of future global warming is "Charney sensitivity", which is the equilibrium warming (after all feedbacks of sub-decadal duration have acted) in response to doubled atmospheric carbon dioxide concentration.

IPCC (1990, p. *xxiv*) made the following prediction:

> The numbers given below are based on high-resolution models, scaled to be consistent with our best estimate of global mean warming of 1.8 K by 2030 [compared with pre-industrial temperature] … the numbers below should be reduced by 30% for the low estimate or increased by 50% for the high estimate.

20. The least-squares linear-regression trend on the HadCRUT4 monthly global mean surface temperature anomalies from January 1850 to December 1989 was 0.45 K. Thus, IPCC (1990) was predicting a mid-range estimate of $(1.8 - 0.45)$, or 1.35 K, of anthropogenic warming in the 41 years 1990 to 2030, equivalent to $1.35(100/41)$, or 3.3 K, over a century. Reduction by 30% and

increase by 50% from this value give a range of 2.3 to 4.9 K for IPCC's "business-as-usual" prediction in 1990 assuming little or no mitigation of anthropogenic emissions.

21. The 21st-century anthropogenic warming from all causes is thought to be approximately equivalent to Charney sensitivity. Sure enough, the fifth-generation (CMIP5) ensemble of the atmosphere-ocean general-circulation models of the Climate Model Intercomparison Project (Andrews 2012), the latest generation, predicts 3.3 [2.0, 4.5] K warming in response to doubled CO_2 concentration, close to IPCC's original prediction of 3.3 [2.3, 4.9] K business-as-usual 21st-century warming. Henceforth, for brevity, only the mid-range estimate 3.3 K will be considered.

22. The *amici curiae* derived a new mid-range estimate of Charney sensitivity by several methods. The first method provides a formal demonstration of a significant error in the application of feedback theory to climate. The additional methods cohere with and confirm the result. If the result be correct, global warming will be small, slow, harmless and beneficial and plaintiff's case must fall.

FIRST AND SECOND METHODS OF DERIVING CHARNEY SENSITIVITY

23. One of the most powerful techniques in logic is Socratic elenchus or formal argumentative scrutiny. Elenchus tests the logical self-consistency of an argument by exposing any inherent contradictions. The internal-consistency test is the first of four tests recommended by Karl Popper in his 1934 masterwork *Logik der Forschung* (The Logic of Scientific Discovery). Popper held that no scientific hypothesis was justifiable unless it had passed the four tests.

24. Socratic elenchus contrasts two formal arguments. In logic, an "argument" comprises at least one declarative premise and a conclusion. If the premises entail the conclusion, the argument is valid but the conclusion may or may not be true and the argument may or may not be sound. If the premises entail the conclusion and are all true, the conclusion is necessarily true and the argument is not only valid but also sound.

25. First, several premises (here in the form of definitions and equations) common to the two arguments and likely to be agreed by all sides will be stated and referenced in unimpeachable, mainstream sources. Thereupon the conclusions of two arguments, each incorporating the common premises, will be presented. However, a striking contradiction between the conclusions of the two arguments will appear, pointing to the presence of a deeper but less visible contradiction that will

be seen to be the root cause of the long-standing and recently-identified error of physics without which concern about global warming does not arise.

26. The definitions from mainstream sources, with relevant values also from mainstream sources, are as follows.

DEFINITIONS

27. Terms that are underlined are defined in this list.

Albedo is the fraction of incident radiation reflected harmlessly back to outer space, chiefly from cloud tops, ice or snow. Today's albedo is 0.293 (Loeb 2006).

CO_2 forcing $\Delta Q_0 = 3.5$ Watts per square meter ($W\,m^{-2}$) is the radiative forcing from doubled CO_2 concentration, diagnosed from the CMIP5 model ensemble (Andrews et al. 2012), where "Δ" indicates a change in an underlying quantity, here incoming solar irradiance $Q_0 = 241.2\ W\,m^{-2}$ after allowing for albedo.

Emission temperature $\boldsymbol{T_E} = 255$ K, the global mean surface temperature that would obtain at the Earth's surface for a given albedo in the absence of any greenhouse gases or temperature feedbacks, depends only upon the incoming solar irradiance and the albedo (Hansen et al. 1981, Schlesinger 1985, IPCC 1990 p. *xiv*, Schmidt et al. 2010, WMO 2018).

Equilibrium temperature $\boldsymbol{T_{eq}}$ (or **equilibrium temperature change** $\boldsymbol{\Delta T_{eq}}$, also known as **equilibrium sensitivity**) is the global mean surface temperature (or temperature change) when the climate system has returned to equilibrium after accounting for both the reference temperature (or temperature change) and the feedback response (IPCC, 2007, ch. 6.1).

Feedback fraction $\boldsymbol{f}$ is the fraction of equilibrium temperature T_{eq} (or equilibrium temperature change ΔT_{eq}) represented by the feedback response $\Delta T_{(ref)}$ (Roe 2009). Pre-industrial and industrial-era feedback fractions f are currently thought to be approximately identical (Lacis et al. 2010).

Feedback response $\boldsymbol{\Delta T_{(ref)}}$**,** denominated in Kelvin, is equal to the product $k\lambda_0$ of the total temperature feedback k and the Planck sensitivity parameter λ_0. It is the additional warming arising from the presence of the temperature feedback k (Roe 2009). Bracketed subscripts distinguish feedback responses from the reference temperatures T_{ref} or reference sensitivitiws ΔT_{ref} that induced them: for example, $\Delta T_{(B)}$ is the feedback response to ΔT_B.

Industrial-era warming ΔT_A ($= \Delta T_N + \Delta T_{(N)}$) from 1850-2011, the least-squares linear-regression trend on the HadCRUT4 dataset, was 0.76 K (Morice et al. 2012, updated). It will be assumed *ad argumentum*, but without warranty, that ΔT_A is entirely anthropogenic.

Natural greenhouse effect ΔT_G ($= \Delta T_B + \Delta T_{(B)} = 8 + 24 = 32$ K) is currently defined as the difference between natural temperature T_N ($= 287$ K) in 1850 and emission temperature T_E ($= 255$ K). The presence of the naturally-occurring, non-condensing greenhouse gases (chiefly CO_2 and CH_4) causes a radiative forcing ΔQ_0 that directly drives the pre-industrial reference sensitivity $\Delta T_B = 8$ K, about a quarter of ΔT_G, while the remaining three-quarters, $\Delta T_{(B)} = 24$ K, is at present considered to be the feedback response to ΔT_B (Lacis et al., 2006).

Natural temperature in 1850, T_N, was equal to $T_S - \Delta T_A = 288 - 0.8$, or about 287 K.

Planck sensitivity parameter λ_0 ($= 0.3125 = 3.2^{-1}$ K W^{-1} m^2) (Roe 2009; IPCC 2007, p. 631 fn.), is the quantity by which a radiative forcing ΔQ_0 is multiplied to yield the reference sensitivity to that forcing.

Radiative forcing ΔQ_0, denominated in W m^{-2}, is a change in the net (down minus up) radiative flux density Q_0 ($= 241.2$ W m^{-2}) at the tropopause (the top of the climatically-active region of the atmosphere). Net industrial-era anthropogenic forcing ΔQ_0 from all sources from 1850-2011 was 2.29 W m^{-2} (IPCC, 2013, table SPM.6).

Reference temperature T_{ref} (or **reference temperature change ΔT_{ref}**, also known as **reference sensitivity**) is the global mean surface temperature (or temperature change) in response to a radiative forcing ΔQ_0 before any feedback response induced by the reference temperature T_{ref} or reference sensitivity ΔT_{ref} have been taken into account (Roe, 2009).

Surface temperature T_S is today about 288 K (ISCCP, 2018).

Temperature feedback k, denominated in W m^{-2} K^{-1} of the reference temperature T_{ref} or reference sensitivity ΔT_{ref} that induced it, is a knock-on, additional radiative forcing. It is this temperature feedback forcing k that drives the feedback response $\Delta T_{(\mathrm{ref})}$. Typically, many individual temperature feedbacks k_i, summing to k, operate in the climate system, some positive (amplifying the reference temperature T_{ref} or reference sensitivity ΔT_{ref}) and others negative (diminishing them) (Roe 2009, Bates 2016).

EQUATIONS

28. The following equations are from mainstream climatological sources.

The zero-dimensional model equation, Eq. (1) (Roe 2009; IPCC 2007, p. 631 fn.; Bates 2016), derives equilibrium temperature T_{eq} or equilibrium sensitivity ΔT_{eq} by applying the feedback fraction f to reference temperature T_{ref} or reference sensitivity ΔT_{ref}. Thus, the feedback response $\Delta T_{(\mathrm{ref})}$ represents the entire difference between reference and equilibrium temperature or sensitivity. Each term in Eqs. (1-2) is defined in the "Definitions" section above. Models do not explicitly use Eqs. (1, 2), but they must necessarily reflect these control-theory equations.

$$\Delta T_{\mathrm{eq}} = \Delta T_{\mathrm{ref}}/(1-f). \quad (1)$$

Where ΔT_{ref} and ΔT_{eq} are specified, rearranging Eq. (1) as Eq. (2) yields the feedback fraction f.

$$f = 1 - \Delta T_{\mathrm{ref}}/\Delta T_{\mathrm{eq}}. \quad (2)$$

The reference-sensitivity equation. Eq. (3), gives reference sensitivity ΔT_{ref} as the product of a radiative forcing ΔQ_0 and the Planck sensitivity parameter λ_0 (Bony et al. 2006; IPCC 2007, p. 631 fn.; Roe 2009).

$$\Delta T_{\mathrm{ref}} = \Delta Q_0 \lambda_0. \quad (3)$$

With this background, the conclusions of two logical arguments whose common premises are the above definitions and equations will be stated and then compared.

SOCRATIC ELENCHUS

29. With this background, the conclusions of two logical arguments whose common premises are the above definitions and equations will be stated and then compared.

ARGUMENT 1

30. **Conclusion 1:** Where pre-industrial reference sensitivity $\Delta T_{\mathrm{ref}} = 8$ K and equilibrium sensitivity ΔT_{eq} is 32 K, the natural or pre-industrial feedback fraction f derived in Eq. (2) is equal to $1 - 8/32$, or 0.75, and industrial-era f is also 0.75 (Lacis et al., 2010).

ARGUMENT 2

31. Argument 2 is in two parts, 2a and 2b.

Conclusion 2a, serving also as a premise to Argument 2b, is that, from Eq. (3), industrial-era reference sensitivity $\Delta T_N = \Delta Q_0 \lambda_0$ is equal to $2.29 \times 0.3125 = 0.72$ K.

Conclusion 2b: The feedback fraction $f = 1 - \Delta T_N/\Delta T_A$ in the industrial era to date is equal to $1 - 0.72/0.76$, or 0.05, from Eq. (2).

A VISIBLE CONTRADICTION

32. A striking contradiction exists between conclusions 1 and 2b. While argument 1 concludes that the pre-industrial feedback fraction $f = 0.75$, argument 2b concludes that industrial-era f is an order of magnitude less, at just 0.05. Yet both values should be identical at 0.75 (Lacis 2010). Since conclusions 1, 2a and 2b depend upon mainstream premises, current climate science devoted to the derivation of equilibrium sensitivities $\Delta T_{\rm eq}$ fails the internal-consistency test, whereupon at least one of the two arguments is unsound. Since the conclusions of arguments 1, 2a and 2b are validly drawn from the premises, one or more of the premises must be false.

33. The contradiction thus identified is directly material to the matter now before the Court. Recall that the forcing ΔQ_0 in response to doubled CO_2 concentration is 3.5 Watts per square meter, so that the reference sensitivity $\Delta T_{\rm ref} = \Delta Q_0 \lambda_0$ is equal to $3.5/3.2$ or 1.1 K, derived in Eq. (3). Then, from Eq. (1), if conclusion 1 is correct Charney sensitivity $\Delta T_{\rm eq}$ (equilibrium sensitivity to doubled CO_2) is $1.1/(1 - 0.75) = 4.4$ K, but if conclusion 2b is correct $\Delta T_{\rm eq}$ is only $1.1/(1 - 0.05) = 1.2$ K.

34. Deploying in Eq. (1) the feedback fraction $f = 0.75$ in Lacis et al. (2010) would imply that, in response to $\Delta T_{\rm ref} = 0.72$ K, the industrial-era equilibrium warming $\Delta T_{\rm eq}$ to 2011 should have been 2.9 K. However, that value is approaching four times the 0.76 K observed warming. Even if one were to use the somewhat less excessive feedback fraction $f = 0.67$ derivable using Eq. (2) from the CMIP5 models' mid-range estimate of 3.3 K Charney sensitivity, equilibrium warming $\Delta T_{\rm eq}$ to 2011 should have been 2.2 K, or almost thrice the observed industrial-era warming of 0.76 K from 1850-2011.

THE UNDERLYING CONTRADICTION

35. The above visible contradiction, readily discernible by the semi-formal use of logic in an instance of Socratic elenchus, arises from the curious and not so easily detected internal contradiction between the defined value 255 K of emission temperature and conclusion 1, which assumes what turns out to be the erroneous premise that three-quarters of the 32 K difference between natural and emission temperature, i.e., $\Delta T_{(B)} = 24$ K, is the feedback response to the

$\Delta T_B = 8$ K directly-forced warming caused by the presence of the naturally-occurring, non-condensing greenhouse gases (Lacis et al. 2010). Here, then, is the underlying contradiction: if 8 K of warming drove a 24 K feedback response, the 255 K emission temperature T_E should have driven a feedback response $\Delta T_{(E)} = 765$ K, making the natural temperature T_N in 1850 equal to $(T_E + \Delta T_{(E)} + \Delta T_B + \Delta T_{(B)}) = (255 + 765 + 8 + 24) = 1052$ K, almost four times the 287 K true value.

36. Throughout the 122 years since Arrhenius (1896) first attempted to derive Charney sensitivity, climatology has assumed, inconsistently, that the feedback response to the emission temperature of 255 K was nil, while the feedback response to the next 8 K of temperature caused by the direct warming owing to the presence of the naturally-occurring, non-condensing greenhouse gases, was 24 K. It was only when the *amici curiae* found the inconsistency between arguments 1 and 2 that this underlying inconsistency was identified.

37. The physical error of asserting that a small direct warming would induce a feedback thrice itself while assuming, contradictorily, that the large pre-existing emission temperature would induce no feedback response arose for two reasons. The proximate cause was that, though the form of the zero-dimensional model embodied in Eq. (1) is not incorrect, its presentation in climatology has proven misleading in that it specifies that a feedback arises only where there is a change ΔT_{ref} in the pre-existing temperature T_{ref}, and that no feedback arises from T_{ref} itself.

38. In fact, Eq. (1) is also valid where the changes in the input and output signals are replaced by the entire input and output signals themselves (Bode 1945, p. *vii* and ch. 3). Illustratively assuming that the pre-industrial feedback fraction was constant, the true pre-industrial feedback response to emission temperature 255 K and to the 8 K warming caused by the presence of the greenhouse gases is derived by adopting the corrected approach in Eq. (4), where the emission temperature T_E (= 255 K), is added to the warming ΔT_{ref}, in this instance equal to the directly-forced warming ΔT_B (= 8 K) from the naturally-occurring, non-condensing greenhouse gases, to serve as the input signal or reference temperature $T_{\text{ref}} = 255 + 8 = 263$ K, while the equilibrium temperature T_{eq} replaces the equilibrium sensitivity ΔT_{eq} as the output signal.

$$f = 1 - (T_E + \Delta T_B)/T_N = 1 - T_{\text{ref}}/T_{\text{eq}} = 1 - (255.4 + 8)/287.5 = 0.08. \quad (4)$$

39. Accordingly, the 32 K difference between natural temperature $T_N = 287$ K in 1850 and emission temperature $T_E = 255$ K in reality comprises about 23.4 K feedback response $\Delta T_{(E)}$ to T_E; 8 K direct greenhouse warming ΔT_B; and only 0.7 K (rather than 24 K) feedback response $\Delta T_{(B)}$

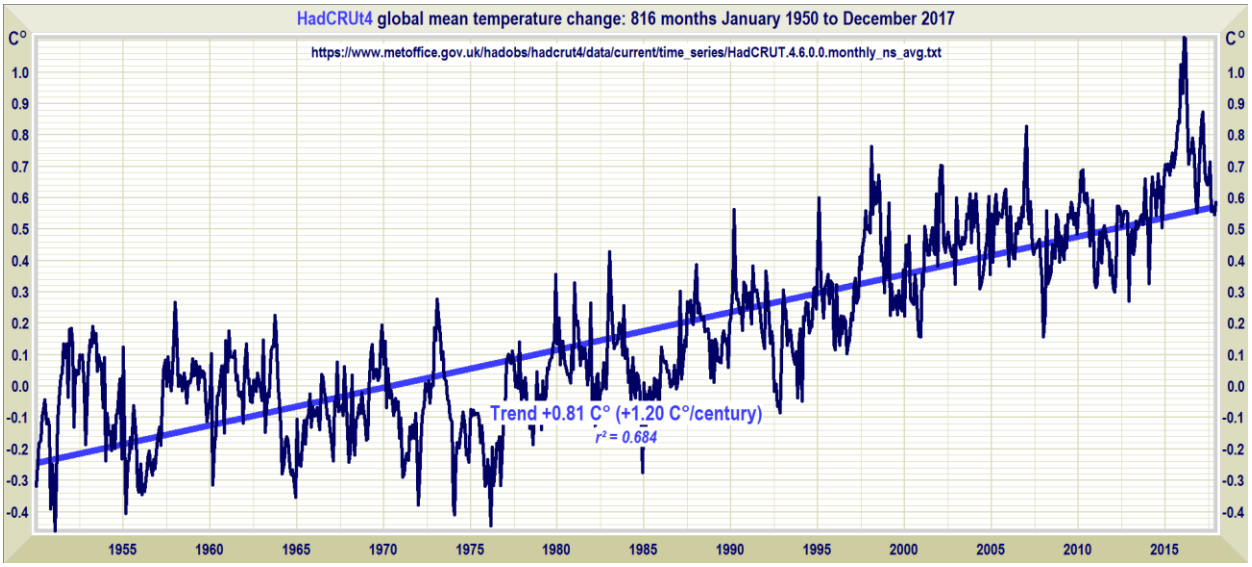
to ΔT_B. Pre-industrial f thus falls by an order of magnitude from $24/32 = 0.75$ to $\Delta T_{(B)}/(\Delta T_B + \Delta T_{(B)}) = 0.7/8.7 = 0.08$. Once this corrected method is applied, taking proper account of the large feedback $\Delta T_{(E)}$ to T_E rather than erroneously overstating the feedback fraction f by including $\Delta T_{(E)}$ as though it were part of the feedback response $\Delta T_{(B)}$ to the directly-forced warming ΔT_B from the presence of the naturally-occurring, non-condensing greenhouse gases, it is shown that pre-industrial f $(= 0.08)$ coheres with the industrial-era f $(= 0.05)$ derived in conclusion 2b, resolving the contradiction between arguments 1 and 2b.

40. By this deployment of formal logic in the form of a Socratic elenchus, two distinct methods of deriving Charney sensitivity – the first a theoretical derivation in the pre-industrial era before 1850 and the second an empirical derivation in the industrial era from 1850-2011, are found to cohere. Where reference sensitivity ΔT_{ref} to doubled carbon dioxide is 1.1 K, as in Eq. (3), and whether the feedback fraction f is equal to the industrial 0.05 or pre-industrial 0.08, Charney sensitivity ΔT_{eq} is found in Eq. (1) to be $1.1/(1 - f) = 1.2$ K.

THIRD METHOD OF DERIVING CHARNEY SENSITIVITY

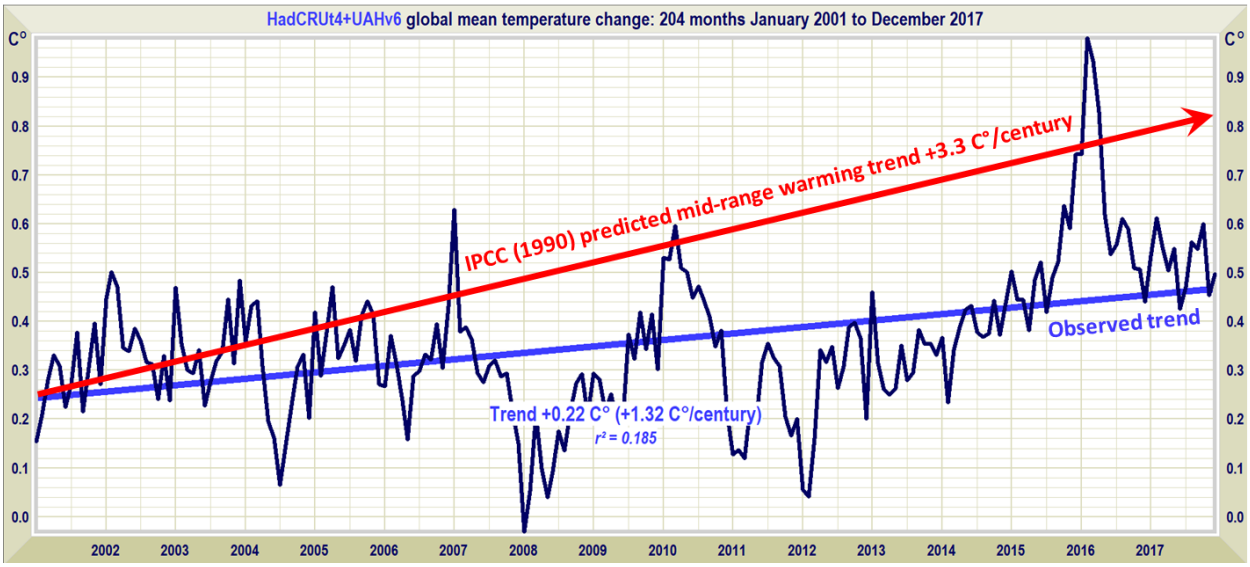
41. To make assurance triply sure, the *amici curiae* conducted an empirical campaign in which ten estimates of net industrial-era anthropogenic forcing from all greenhouse gases were obtained from mainstream sources and converted to reference sensitivities using Eq. (3), while the equilibrium sensitivities were taken as the least-squares linear-regression trends on the HadCRUT4 monthly global mean surface temperature anomalies (Morice et al. 2012) for each of the ten periods. Using the CMIP5 feedback fraction $f = 0.67$ the mean ratio of predicted to observed industrial-era global warming was found to be 2.6, a grave excess of prediction over observation, while the ideal unit ratio was attained for $f = 0.12$. Deploying this empirically-derived value of industrial-era f in Eq. (1), Charney sensitivity $1.1/(1 - 0.12) = 1.25$ K was derived, cohering closely with the value 1.2 K obtained by the first and second methods.

FOURTH METHOD OF DERIVING CHARNEY SENSITIVITY



42. To confirm that the 1.2 K Charney sensitivity (and, equivalently, the 1.2 K warming from all anthropogenic forcings in the 21st century) was consistent with observed temperature change since 1950, when according to IPCC the influence of Man on climate first became significant, the *amici curiae* derived the least-squares linear-regression trend on the HadCRUT4 monthly global mean surface temperature anomalies over the 68 years 1950-2017, the only dataset to commence as early as 1850. The result, shown above, is that warming in the two-thirds of a century since 1950 has occurred at a rate equivalent to 1.2 K/century, again cohering with the Charney sensitivity found using the theoretically-derived pre-industrial feedback fraction $f = 0.08$ and from the industrial-era range of f between 0.05 and 0.12.

FIFTH METHOD OF DERIVING CHARNEY SENSITIVITY



43. The *amici curiae* also averaged the monthly global mean surface and lower-troposphere temperature anomalies from the HadCRUT4 terrestrial and UAH satellite datasets and derived the least-squares linear-regression trend (the bright blue line on the graph) for the 17 years 2001-2017, the first one-sixth of the 21st century. The satellite data were included because they cover a five-mile-high slab of the atmosphere immediately above the surface, and have a coverage greater than the terrestrial measurements. The trend was found to be 0.22 K, equivalent to 1.3 K/century. This result was close to the theoretically-derived 1.2 K/century pre-industrial value, the 1.2-1.25 K industrial-era value derived by two empirical methods and the trend since 1850, but far below the 3.3 K/century predicted by IPCC in 1990.

VERIFICATION BY LABORATORY EXPERIMENTS

44. It will be seen from the foregoing argument that the question of equilibrium sensitivity – the "how-much-warming" question – is chiefly a question of the magnitude of the feedback response to the direct or reference warming caused by anthropogenic enrichment of the atmosphere with greenhouse gases. Hitherto, climatology has imagined that the feedback response is 2-4 times the reference sensitivity, with some extreme estimates of up to 10 times reference sensitivity. The results obtained by the *amici curiae* suggest that the feedback response adds only 0.1 K to reference sensitivity of 1.1 K to give Charney sensitivity of 1.2 K.

45. In the climate, it is not possible to use measurement either to distinguish individual temperature feedbacks from each other or to distinguish the sum of all positive and negative feedbacks from the radiative forcings that induced them. However, control theory, which is the study of feedback

in dynamical systems, applies *mutatis mutandis* to all such systems. The equations are standard. Feedback theory was originally developed at Bell Labs, then in New York, in the 1920s and 1930s, leading to a magisterial paper by Harold S. Black (discoverer *inter alia* of negative feedback) in 1934, and to codification of feedback theory in a popular textbook by his colleague Hendrik Wade Bode, first published in 1945. Bell Labs developed feedback theory because, in the era before digital communications, telephone circuits were notoriously unstable and their researchers had found that incorporating feedback loops in the circuits would assist in stabilizing them.

46. In an electronic circuit that incorporates a feedback loop, it is possible to specify and then set the input signal (equivalent to the 255 K emission temperature in the climate), the direct-gain signal in the gain block (equivalent to the amplification of the input signal caused by an anthropogenic radiative forcing), and the feedback fraction, which is the fraction of the output signal (i.e., of equilibrium sensitivity in the climate) that is fed back to the input node. Thereupon the output signal (equilibrium sensitivity in the climate) can be measured directly.

47. A government laboratory was commissioned to construct and operate an electronic test feedback circuit to simulate the climate feedback loop. One of the groups of tests on the circuit demonstrated that, even without any gain such as that which is forced by the presence of greenhouse gases, the theoretically-expected feedback response to an input signal T_{ref} (in this context, the Earth's emission temperature) was evident. For, in a dynamical system, even an unamplified input signal induces a response to any feedback (Bode 1945, p. *vii*. and ch. 3).

UNCERTAINTIES

48. The *amici curiae* draw the Court's attention to the following uncertainties:

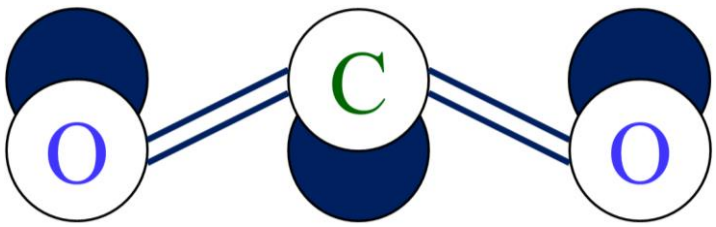
Equilibrium not yet attained: The *amici curiae* also considered whether, over the pre-industrial and industrial-era periods they had considered, there were some temperature feedbacks that had not fully acted, so that equilibrium in respect of the warming over those periods had not yet been attained. However, the feedbacks listed in IPCC (2013, p. 818, table 9.5) as being relevant to the derivation of equilibrium sensitivity are described by IPCC (2013, p. 128, Fig. 1.2) as having the following durations: Water vapor and lapse-rate feedback *hours;* Cloud feedback *days*; Surface albedo feedback *years.* Therefore, all or very nearly all of the feedback responses examined here will have operated during the periods under consideration.

Delay in sensible atmospheric warming owing to ocean overturning: It is possible that some of the warming that might otherwise have become detectable has been taken into the

subsurface strata of the ocean by the overturning process, but that process is of millennial duration and very little of that subsurface heat can be expected to be returned to the surface layer in a policy-relevant timeframe.

Nonlinearities in feedbacks: The *amici curiae* also considered whether nonlinearities in individual feedbacks might make the industrial-era feedback fraction significantly greater than the 0.05 derived earlier herein from the 2.29 Watts per square meter current best estimate of total anthropogenic forcing to date given in IPCC (2013, p. 14, Fig. SPM.5). By testing various values of the feedback fraction in Eq. (1), the *amici curiae* found that to reach IPCC's current lower-bound estimate of 1.5 K Charney sensitivity a feedback fraction as much as 5-6 times the industrial-era value 0.05 would be required. Given the similarity between the pre-industrial and industrial values of the feedback fraction derived earlier, and indeed the identity between these two values posited e.g. in Lacis et al. (2010), so sudden a jump in the value of the feedback fraction in response to a future doubling of atmospheric carbon dioxide concentration is not plausible. It is extremely unlikely, therefore, that equilibrium sensitivity to doubled atmospheric carbon dioxide concentration (or, equivalently, 21st-century global warming) will reach even 1.5 K.

Uncertainty in the CO_2 radiative forcing: IPCC (2013, p 676, §8.3.2.1) says there is a 0.1 K uncertainty in the radiative forcing of 3.5 Watts per square meter in response to doubled CO_2 concentration. However, Professor Will Happer of Princeton University, one of the world's foremost optical physicists, gave a lecture at the 2015 annual meeting of the World Federation of Scientists in Erice, Sicily, in which he reported that the models on which that estimate was based had incorrectly assumed that the collisions between photons of long-wave radiation and CO_2 molecules that induce a quantum oscillation (illustrated above) in the bending vibrational mode of those molecules occurred instantaneously. In passing, this type of oscillation cannot be collisionally initiated in molecules such as N_2 or O_2, the principal constituents of the atmosphere, for they consist of fewer than three atoms, answering another of the Court's questions. The CO_2 molecule, being symmetrical, does not possess a dipole moment unless it is collisionally excited.



Oscillation of the CO_2 molecule in its bending vibrational mode

In optical physics, the assumption of collisional instantaneity is usually of little import. It simplifies the otherwise intractable partial differential Lorentzian or Voigt lineshape equation. In climatology, however, Professor Happer explained that this assumption had led to a 40% overstatement of the CO_2 radiative forcing and consequently of Charney sensitivity. If so, the CO_2 forcing is not 3.5 but 2.5 Watts per square meter; reference sensitivity to CO2 is not 1.1 K but 0.8 K, and, for industrial-era $f = 0.05$, equilibrium sensitivity is $0.8/(1 - 0.05) = 0.8$ K.

Anthropogenic fraction of industrial-era warming: As demonstrated earlier, there is no "consensus" as to what fraction of industrial-era warming was anthropogenic. It has here been assumed *ad argumentum* that all industrial-era warming was anthropogenic: but if, for instance, only half of it were anthropogenic, the other half being attributable to the considerable internal variability arising from factors such as variations in the rate of ocean overturning, in volcanic activity, in cloud cover and in the solar irradiance reaching the surface, the empirically-derived industrial-era feedback fraction will be smaller than shown here.

Observed warming in some datasets is greater than shown here.

THE SIGNIFICANCE OF COHERENCE IN SCIENTIFIC RESULTS

49. Since all five methods cohere in finding Charney sensitivity or, equivalently, centennial warming to be 1.2 to 1.3 K, it is submitted that the uncertainties listed above – to the extent that they are not self-canceling, since some point one way and others another – will not significantly alter the results presented herein. Whenever so many methods of addressing a single question cohere, and provided that, as here, the theoretical method adopted is scientifically correct, the fact of the coherence strongly supports the results that are obtained. Three days before the Court's list of questions was issued, the *amici curiae* submitted a scientific paper announcing their result to a leading climatological journal. Thus, though the first part of the argument set forth herein has passed peer review and has been published, the second part has not yet been sanctified by peer review. However, the argument is simple enough to allow the Court to understand it completely and to verify for itself that the result is likely to be sound.

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CONCLUSION

50. Notwithstanding assertions to the contrary in IPCC's *Assessment Reports* and in the peer-reviewed journals, examination of almost 12,000 of papers on climate and related topics over a 21-year period reveals that only 0.3% of those papers had explicitly stated their quantified assent

to the "consensus" proposition that at least half of the global warming of recent decades was anthropogenic. What is more, that "consensus" proposition says nothing about whether anthropogenic global warming has been or will be dangerous, let alone catastrophic.

51. Climatologists have hitherto omitted the emission temperature of 255 K from the input signal in their form (Eq. 1) of the zero-dimensional model. This omission had misled them into erroneously including the 23.4 K feedback response to the 255 K emission temperature with the 0.7 K feedback response to the 8 K direct warming caused by the presence of the naturally-occurring, non-condensing greenhouse gases. Consequently, they had overstated the feedback fraction by an order of magnitude (i.e., approximately tenfold) and had thus overstated the mid-range estimates of Charney sensitivity (and of all other mid-range equilibrium sensitivities) threefold. Since the mid-range estimate of Charney sensitivity (and, equivalently, of 21st-century global warming) should not be 3.3 K, as had hitherto been thought, but only 1.2 K, and even the high-end estimate will almost certainly be less than 1.4 K, action to prevent global warming is no longer necessary.

52. For the foregoing reasons, the Court should reject Plaintiff's case and should also reject those of Defendants' submissions that assert that global warming is a serious problem requiring urgent mitigation: for it was only the error that made it appear to be a problem. It is not a problem at all.

DATED: March 16, 2018

Respectfully submitted,

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By: ____/s/ Peter Ferrara__

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