

Appendix I

Climate Change and the Integrity of Science

A Letter to the editor was published on May 7, 2010, in *Science*, signed by 255 scientists. The full text of the letter and a correction notice is provided below.

A response written by Atmospheric Scientist Dr. Gerhard Kramm of the University of Alaska, Fairbanks, is also provided. Dr. Kramm is at the Geophysical Institute and Department of Atmospheric Sciences, College of Natural Science and Mathematics.

<http://www.gi.alaska.edu/~kramm>

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LETTERS

edited by Jennifer Sills

Climate Change and the Integrity of Science

WE ARE DEEPLY DISTURBED BY THE RECENT ESCALATION OF POLITICAL ASSAULTS ON SCIENTISTS in general and on climate scientists in particular. All citizens should understand some basic scientific facts. There is always some uncertainty associated with scientific conclusions; science never absolutely proves anything. When someone says that society should wait until scientists are absolutely certain before taking any action, it is the same as saying society should never take action. For a problem as potentially catastrophic as climate change, taking no action poses a dangerous risk for our planet.

Scientific conclusions derive from an understanding of basic laws supported by laboratory experiments, observations of nature, and mathematical and computer modeling. Like all human beings, scientists make mistakes, but the scientific process is designed to find and correct them. This process is inherently adversarial—scientists build reputations and gain recognition not only for supporting conventional wisdom, but even more so for demonstrating that the scientific consensus is wrong and that there is a better explanation. That's what Galileo, Pasteur, Darwin, and Einstein did. But when some conclusions have been thoroughly and deeply tested, questioned, and examined, they gain the status of “well-established theories” and are often spoken of as “facts.”



For instance, there is compelling scientific evidence that our planet is about 4.5 billion years old (the theory of the origin of Earth), that our universe was born from a single event about 14 billion years ago (the Big Bang theory), and that today's organisms evolved from ones living in the past (the theory of evolution). Even as these are overwhelmingly

accepted by the scientific community, fame still awaits anyone who could show these theories to be wrong. Climate change now falls into this category: There is compelling, comprehensive, and consistent objective evidence that humans are changing the climate in ways that threaten our societies and the ecosystems on which we depend.

Many recent assaults on climate science and, more disturbingly, on climate scientists by climate change deniers are typically driven by special interests or dogma, not by an honest effort to provide an alternative theory that credibly satisfies the evidence. The Intergovernmental Panel on Climate Change (IPCC) and other scientific assessments of climate change, which involve thousands of scientists producing massive and comprehensive reports, have, quite expectedly and normally, made some mistakes. When errors are pointed out, they are corrected. But there

is nothing remotely identified in the recent events that changes the fundamental conclusions about climate change:

(i) The planet is warming due to increased concentrations of heat-trapping gases in our atmosphere. A snowy winter in Washington does not alter this fact.

(ii) Most of the increase in the concentration of these gases over the last century is due to human activities, especially the burning of fossil fuels and deforestation.

(iii) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

(iv) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic.

(v) The combination of these complex climate changes threatens coastal communities and cities, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.

Much more can be, and has been, said by the world's scientific societies, national academies, and individuals, but these conclusions should be enough to indicate why scientists are concerned about what future generations will face from business-as-usual practices. We urge our policy-makers and the public to move forward immediately to address the causes of climate change, including the unrestrained burning of fossil fuels.

We also call for an end to McCarthy-like threats of criminal prosecution against our colleagues based on innuendo and guilt by association, the harassment of scientists by politicians seeking distractions to avoid taking action, and the outright lies being spread about them. Society has two choices: We can ignore the science and hide our heads in the sand and hope we are lucky, or we can act in the public interest to reduce the threat of global climate change quickly and substantively. The good news is that smart and

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effective actions are possible. But delay must not be an option.

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Notes

1. The signatories are all members of the U.S. National Academy of Sciences but are not speaking on its behalf.
2. Signatory affiliations are available as supporting material at www.sciencemag.org/cgi/content/full/328/5979/689/DC1.

Shifting the Debate on Geoengineering

AS DISCUSSED IN THE RECENT POLICY FORUM “The politics of geoengineering” (J. J. Blackstock and J. C. S. Long, 29 January, p. 527), there is growing recognition that avoiding dangerous climate change during the 21st century may require society to adopt geoengineering technologies to supplement CO₂ emission reduction efforts. Unfortunately, despite the essential role

that CO₂ removal (CDR) and solar radiation management (SRM) technologies may play in reducing the risks of dangerous climate change, discussions of the necessary research and development [including the Policy Forum and others (1, 2)] frequently turn into debates about the environmental costs and benefits of SRM. A more productive approach would shift the debate to comparing the relative costs and benefits of CDR and SRM.

CDR approaches are frequently discounted because, as Blackstock and Long explain, “technical challenges and large uncertainties [surround] large-scale CDR deployment.” Although this may be true for human-built systems that capture CO₂ from air at ambient concentrations, there are other technologies based on biological carbon fixation that could be fast-tracked for rapid deployment during the next few decades (3). Most major international energy corporations are investing in algal-based biofuel technologies because of the tremendous production potential of algae relative to terrestrial energy crops (4). Commercial-scale production of algal biofuels will begin during the next 5 years, and rapid scaling up can be expected afterward if the economic incentives are favorable. However, becoming carbon negative will require society to develop plans for retrofitting existing coal-fired power plants and building future ones so that they can burn algal biomass and capture the emitted CO₂ for subsequent sequestration. The basic technologies described here are not novel; rather, I am proposing a conceptual rearrangement that may enable society to transition more gracefully

CORRECTIONS AND CLARIFICATIONS

Research Articles: “Doc2b is a high-affinity Ca²⁺ sensor for spontaneous neurotransmitter release” by A. J. Groffen *et al.* (26 March, p. 1614). Several author affiliations were not footnoted properly; three corrected affiliations follow. Y. Takai, Department of Biochemistry and Molecular Biology, Kobe University Graduate School of Medicine, Kobe 650-0017, Japan. J. G. Borst, Department of Neuroscience, Erasmus MC, University Medical Center, Rotterdam, 3000 CA, Netherlands. N. Brose, Max-Planck-Institut für Experimentelle Medizin, Abteilung Molekulare Neurobiologie, 37075 Göttingen, Germany.

Letters: “Oil and water do mix” by J. L. Kavanau (19 February, p. 958). Due to an editorial error, the title was incorrect. It should have been “Opposites attract.”

Reports: “100-million-year dynasty of giant planktivorous bony fishes in the Mesozoic seas” by M. Friedman *et al.* (19 February, p. 990). The author Matt Friedman’s affiliation should have been “Committee on Evolutionary Biology, University of Chicago, 1025 East 57th Street, Chicago, IL 60637, USA.” The affiliation that was listed is his present address.

News of the Week: “DSM-V at a glance” by G. Miller and C. Holden (12 February, p. 770). In the sidebar, it was reported that the term “gender identity disorder” has been retained. In fact, a different term—“gender incongruence”—has been proposed.

Research Articles: “PRDM9 is a major determinant of meiotic recombination hotspots in humans and mice” by F. Baudat *et al.* (12 February, p. 836). M. Lichten was incorrectly listed as an author in references 18 and 19. The correct authors for reference 18 are C. Grey, F. Baudat, and B. de Massy; for reference 19, the correct authors are E. D. Parvanov, S. H. Ng, P. M. Petkov, and K. Paigen.

Reports: “Epigenetic transgenerational actions of endocrine disruptors and male fertility” by M. D. Anway *et al.* (3 June 2005, p. 1466). As clarification of the abstract to Anway *et al.*, the F₁ to F₄ generations were examined after vinclozolin treatment, and F₁ and F₂ generations were examined after methoxychlor treatment. To clarify data referred to in the last paragraph of the Report, serum testosterone measurements after vinclozolin treatment were shown in reference 21 (Uzumcu *et al.*) for the F₁ generation. Data for the F₁ to F₄ generations were subsequently published in Anway *et al.*, *J. Androl.* **27**, 868 (2006). Serum testosterone measurements after methoxychlor treatment were shown in reference 20 (Cupp *et al.*) for the F₁ generation, but measurements of the F₂ generation have not been published. The *Science* Anway *et al.* manuscript showed DNA methylation analysis after vinclozolin treatment, but the DNA methylation data after methoxychlor treatment have not been published.

from fossil to modern carbon fuel sources while simultaneously reducing CO₂ levels in the atmosphere and ocean.

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3. D. W. Keith, M. Ha-Duong, J. K. Stollaroff, *Climat. Change* **74**, 17 (2006).
4. M. E. Huntley, D. G. Redalje, *Mitigation Adapt. Strategies Global Change* **12**, 573 (2007).

Response

GREENE SUGGESTS THAT CO₂ REMOVAL methods deserve expanded evaluation and research. We agree. In the long run, these methods may be the only way to reduce atmospheric concentrations of CO₂ to values closer to those of the preindustrial era. Greene suggests a scheme for using biomass to generate electricity combined with carbon capture and storage. This idea has merit. Even schemes that capture CO₂ directly from the air deserve expanded research.

However, Greene's statement that "discussions of the necessary research and

development...frequently turn into debates about the environmental costs and benefits of SRM [solar radiation management]" misses a key point motivating all three of the articles he cites [our Policy Forum and (1, 2)]. The two approaches differ in both strategic impact and risks. Most CO₂ removal schemes, including those suggested by Greene, would be slow acting and expensive, and would pose no transboundary risks. In contrast, SRM techniques appear inexpensive and could have rapid climatic impact, but present a host of global climatic and political risks.

The low cost and technical feasibility of some SRM technologies (particularly stratospheric aerosol injection) mean that SRM might be our only response if a "climate emergency" develops. However, these traits also mean that SRM could be globally tested unilaterally by a single country, to the possible detriment of others (3). Beyond the climatic risks this presents, such actions could also severely disrupt progress on international climate policy.

The discussion of urgent governance challenges in the articles Greene cites is not a distraction; it is central to figuring out how

to safely and prudently conduct research into SRM technologies. No such acute research governance challenges exist for most CO₂ removal techniques.

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Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

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Climate Change and the Integrity of Science

P. H. Gleick *et al.*

Correction

The image associated with this article was selected by the editors. We did not realize that it was not an original photograph but a collage, and it was a mistake to have used it.

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Atmospheric Scientist Slaps Down 255 Warming Scientists Letter: There is 'no scientific evidence that burning of fossil fuel is responsible for climate change'

The 'arguments of these 255 scientists is based on pure speculation... Speculation is not covered by any scientific standard'

By **Marc Morano** – Climate Depot

Monday, May 10, 2010

Special to Climate Depot -- Written by Atmospheric Scientist Dr. Gerhard Kramm of the University of Alaska Fairbanks. Dr. Kramm is at the Geophysical Institute and Department of Atmospheric Sciences, College of Natural Science and Mathematics – Dr. Kramm's website: <http://www.gi.alaska.edu/~kramm>

May 6, 2010 – By Dr. Gerhard Kramm

The 255 warming scientists stated in their letter: (I)

The planet is warming due to increased concentrations of heat-trapping gases in our atmosphere. A snowy winter in Washington does not alter this fact.

Professor Kramm's Response: Until today there is no scientific evidence that the increase of the globally averaged near-surface temperature by less than one Kelvin during the last 160 years (see HadCRUT3 data) can be linked to the increase of the atmospheric concentrations of so-called greenhouse gases. The notion "heat-trapping" is unphysical and does not describe the radiative processes taking place within the atmosphere.

In 1971, Prof. Dr. Heinz Fortak, the Director of the Institute for Theoretical Meteorology at the Free University of Berlin, Germany, and one of the world leading theorists in meteorology stated in his book "Meteorologie": "The 'cycle' of the long-wave radiation between that Earth's surface and the atmosphere does not contribute to the heating of the system. The outgoing emission of infrared radiation only serves to maintain the radiative equilibrium at the top of the atmosphere."

All explanations of the so-called atmospheric greenhouse effect are linked to a global scale. This means that the global energy budget for the system 'Earth-atmosphere' has to be considered. Based on this global energy budget one can show that Heinz Fortak was right. Note that a "global climate" does not exist. It is a contradiction in terms.

The 255 Scientists Stated: (II) Most of the increase in the concentration of these gases over the last century is due to human activities, especially the burning of fossil fuels and deforestation.

Prof. Kramm's Response: If the first argument of these 255 scientists is not correct as documented before, no scientific evidence that the burning of fossil fuel is responsible for climate change does exist. Deforestation may alter the planetary albedo of the system 'Earth-atmosphere' in the solar range. To investigate such land-use changes numerically, the so-called GCMs are rather inappropriate for this purpose because their grid increments are too coarse to fit the requirements in simulating the soil-biosphere-atmosphere interactions with a sufficient degree of accuracy. Is one of these 255 scientists able to formulate the stomatal conductance for an area of more the 60,000 km², the typical area of a grid element in a GCM?

The 255 Scientists Stated: (III) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

Professor's Kramm's Response: If the first argument of these 255 scientists is not correct, as documented before, their third argument is so useless like their second argument.

The 255 Scientists Stated: (IV) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and

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alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic.

Professor's Kramm's Response: The fourth argument of these 255 scientists sounds like chatting about possible injuries while playing soccer. It is based on pure speculation because the arguments (I) to (III) are irrelevant. Speculation is not covered by any scientific standard.

The 255 Scientists Stated: (V) The combination of these complex climate changes threatens coastal communities and cities, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.

Professor Kramm's Response: If the arguments (I) to (III) are irrelevant, the fifth argument of these 255 scientists is based on pure speculation, too.

Professor Kramm Continues: It seems that some further explanations are indispensable. The projecting of the climate using GCMs (Global circulation models) does not fit scientific standards because any numerical result requires its verification by observation. In addition, as argued by Kramm and Dlugi (2009, <http://arxiv.org/abs/0911.2286>), the inherent uncertainty prevents that climate is predictable with a sufficient degree of accuracy. In their conclusion Kramm and Dlugi stated: "It is not surprising to us that the National Science Foundation (NSF) recently announced solicitation 09-568, Climate Process and Modeling Teams (CPT), where the key aim of the CPT concept is to speed development of global coupled climate models and reduce uncertainties in climate models by bringing together theoreticians, field observationalists, process modelers and the large modeling centers to concentrate on the scientific problems facing climate models today."

Since any change can only be identified with respect to a reference state, climate change can only be identified on the basis of, at least, two non-overlapping climate periods. According to the recommendations of the international meteorological conferences held in 1935 and 1957, a climate period should comprise 30 years for statistically describing the weather pattern on a long-term scale. Consequently, at least, 60 years are required to identify climate change.

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Filed under: ipcc, science, cru, climate depot, consensus buster

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